Deputy Registrar.

INDIAN INSTITUTE
OF
TECHNOLOGY, KHARAGPUR

ORDINANCES,
REGULATIONS,
RULES
&
SENATE INSTRUCTIONS
(1967-68)

VOLUME IV

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Deputy Registrar.

In this volume the word "he" shall mean a student, either male or female

PART I

ORDINANCES

ORDINANCE I

COURSES OF STUDIES

1. The Institute shall provide :—

(*a*) Courses leading to the Bachelor's Degree in different branches of Engineering, Technology, Science, and in Architecture, and in such other branches of study as may be instituted by the Board either on its own initiative or on the recommendation of the Senate ; (Schedule I, XI, XXIII).

(*b*) Courses leading to the Master's Degree in different branches of Engineering, Technology and Science, and in Architecture and Planning, and in such other branches of study as may be instituted by the Board either on its own initiative or on the recommendation of the Senate ; (Schedule XVII, XXIII, XXIX).

(*c*) Courses leading to the Postgraduate Diploma in different branches of Engineering, Technology, Science, and in Architecture and Planning, and in such other branches of study as may be instituted by the Board either on its own initiative or on the recommendation of the Senate ; (Schedule XXIX).

(*d*) Facilities for, and courses and training in, Research in the various branches of study. (Schedule XXXV).

2. The Institute may, also, from time to time, provide short-term and part-time courses in subjects of scientific, technological and professional interest.

ORDINANCE II

ADMISSION

1. Admission to the Institute shall be open to students, irrespective of sex, race, creed, caste or class provided they satisfy the minimum educational and other requirements as prescribed in the regulations (Schedule I, XI, XVII, XXIII, XXIX and XXXVI).

2. Admission to the different stages of the degree and diploma courses shall be granted in order of merit to be judged on the results of such test or tests as may be prescribed by the Senate from time to time provided that the Board of Governors may, for sufficient reasons, on the recommendations of the Senate, grant relaxation in favour of applicants coming from the educationally backward sections of the people and foreign students or Indian students residing outside India.

3. The Senate shall appoint each year Admission Committee or Committees for the conduct of examination or test or tests for admission of students to the undergraduate and postgraduate courses.

4. Admission to the undergraduate and postgraduate courses shall ordinarily be made at the beginning of the academic session.

5. The Chairman of the Senate may admit a student for research training with or without scholarship at any time during the academic year on the recommendation of Admission Committee or Committees as may be set up by the Senate.

6. The Senate shall constitute from time to time one or more Doctoral Scrutiny Committee to consider applications from research workers, and staff of the Institute for registration for the Doctorate Degrees of the Institute.

7. The Chairman of the Senate may admit students for short-term and part-time courses as may be offered from time to time on the recommendation of Committee or Committees set up to organise such courses.

ORDINANCE III

REQUIREMENTS FOR EXAMINATION AND GRADUATION

1. For admission to the prescribed examinations of the Institute for the purpose of graduation, a student shall be regular in attendance and studies, and shall conform to the standard of conduct to the satisfaction of the teachers and the Senate.

2. *Bachelor's Degree.*—A student of the Institute who fulfils the requirements for graduation as laid down in the Regulations shall, on the recommendation of the Senate, be awarded the Degree of Bachelor of Science (B.Sc.), or Bachelor of Technology (B. Tech.), or Bachelor of Architecture (B. Arch.) as the case may be. (Schedule IV, XIV and XXVI).

3. *Master's Degree.*—On satisfactory completion of a prescribed course of study and on passing the prescribed examinations which may include a thesis or dissertation, as laid down in the Regulations, a student or a member of staff of the Institute shall, on the recommendation of the Senate, be awarded the Degree of Master of Science (M.Sc.), or Master of Technology (M. Tech), or Master of City Planning (MCP), or Master of Regional Planning (MRP) as the case may be. (Schedule—XX, XXVI, XXXII).

4. *Postgraduate Diploma.*—On satisfactory completion of a prescribed course of study and on passing the prescribed examinations which may include a dissertation, as laid down in the Regulations, a student or a member of the staff of the Institute shall, on the recommendation of the Senate, be awarded the postgraduate Diploma (D.I.I.T.) of the Institute (Schedule XXXII).

5. *Doctorate Degree.*—A registered Research student or a member of staff of the Institute, on the results of his study and Research and on his satisfying the requirements as prescribed in the respective Regulations, shall, on the recommendation of the Senate, be awarded the Degree of Doctor of Philosophy (Ph.D) or the Degree of Doctor of Science (D.Sc.). (Schedule XXXVII, XXXVIII).

6. The Degrees and Diplomas to be awarded by the Institute shall be signed by the Chairman of the Board of Governors, the Director and the Registrar.

7. The Senate shall have the right to withhold recommendation to the Board for any of these awards, or to withdraw it with the approval of the Board

at any time on the ground that the student has been found to have contravened the provisions under Ordinance VII. (Conduct and Discipline).

8. A suitable certificate may be issued to a person who satisfactorily completes a short-term or a part-time course.

ORDINANCE IV

FELLOWSHIPS, EXHIBITIONS, SCHOLARSHIPS, MEDALS AND PRIZES

1. Fellowships, Exhibitions, Scholarships, Medals and Prizes shall be awarded by the Senate to the students on the recommendation of a Committee or Committees as may be constituted by the Senate for the purpose.

2. The Senate shall have the right to withhold or cancel any of these awards at any time on grounds of irregular attendance, or unsatisfactory progress or unbecoming conduct.

ORDINANCE V

BOARDS OF EXAMINERS AND THE EXAMINATION COMMITTEE

1. The Senate shall appoint each year Boards of Examiners for the different examinations of the Institute with duties as may be laid down from time to time.

2. The Senate shall appoint each year an Examination Committee for the conduct of examinations of the Institute.

ORDINANCE VI

STANDARD OF EXAMINATION

The standard of examinations shall be as determined by the Senate from time to time, and the standard so determined shall be accessible only to the Senate and the Boards of Examiners appointed by it.

ORDINANCE VII

CONDUCT AND DISCIPLINE

1. Students shall conduct themselves within and outside the precincts of the Institute in a manner befitting the students of an institution of national importance. They shall show due respect to the teachers of the Institute, the Wardens of the Halls of Residence, the officers of the National Cadet Corps, courtesy and consideration to the employees of the Institute and of the Halls of Residence ; and good neighbourliness to fellow students. They shall also pay due attention and courtesy to visitors.

2. Lack of courtesy and decorum ; ungentlemanly conduct, both in and outside the Institute and the Halls of Residence ; wilful damage or removal,

without permission, of Institute or Hall properties, or belongings of a fellow student ; interfering with his studies or disturbing him ; adoption of unfair means in the examination ; noisy and unseemly behaviour in the Halls of Residence, Library, Laboratories, Field, examination halls and elsewhere, all these shall constitute violation of the code of conduct and breach of Regulations and Rules of the Institute, and shall invite disciplinary measures and may merit punishment, such as, reprimand, fines, debarring from examination, and even dismissal from the Institute.

3. For committing any of the offences, mentioned in the preceding paragraph, either inside the Hall of Residence or outside, the Warden of the Hall of Residence shall have the power to reprimand or impose fine or take any other suitable measure. For committing such offences or misbehaving in the class taken by a teacher of a Department, the Head of that Department shall have the power to reprimand or fine a student or take any other suitable step. For breach of rules in an examination hall, an offender may be debarred from proceeding with the examination by the teacher in charge of the hall. All such cases of orders imposing punishment shall be reported to the Senate at its next meeting.

4. In all cases, other than reprimand and fines, Director shall pass orders, under report to the Senate, after considering the recommendations of the standing Discipline Committee or Committees appointed by the Senate for the purpose and giving the student or students a hearing.

5. A student who has been found guilty of any of these offences may not be recommended by the Senate to the Board of Governors for the award of Degree or Diploma or Certificate.

ORDINANCE VIII

PAYMENT OF FEES AND OTHER DUES

1. All students, Research Scholars and Fellows, and other trainees shall pay the Institute and Hall dues as prescribed in the Statutes on dates to be specified by the Registry.

2. The first instalment of fees which a student, a Research Scholar/Fellow shall be required to pay at the time of admission will cover :

(i) Admission Fee (for Undergraduate and Postgraduate students only).

(ii) Registration fee.

(iii) First instalment of Tuition fee—(except for Post-Doctoral Research fellows).

(iv) First instalment of seat rent including water and electricity charges in the Hall of Residence.

(v) Fees for Students' Gymkhana, Medical examination and medical aid.

(vi) Institute Caution money.

(vii) Hall Caution money.

(viii) Mess advance.

(ix) Any other fees.

In addition, students, Research Scholars/Fellows and trainees resident in a Hall of Residence shall be required to pay messing charges and other dues as may be specified by the Warden of the Hall every month and in accordance with the rules framed.

3. Fees mentioned in (i) to (v) of paragraph 2 above shall not be refunded. All caution money is refundable in accordance with the provisions of the Statutes. Mess advance shall be refunded only after adjustment of mess dues.

4. A student or a Research scholar or a Fellow or a trainee who does not pay the requisite fees including the Hall dues within the specified dates shall not be permitted to stay in the Hall of Residence and shall be debarred from sitting at examinations. His name shall be struck off the rolls in accordance with the provisions of the Statute 24(2).

ORDINANCE IX

MEDIUM OF INSTRUCTION

The medium of instruction shall, at all levels, be English.

ORDINANCE X

RESIDENCE

1. The Institute is residential and all students shall be required to reside in the Halls of Residence.

2. Under special circumstances, the Director may permit a student to reside with his father or guardian on the Institute campus or within a reasonable distance from the Institute. Such a student shall, however, be attached to a Hall of Residence and pay seat rent, and Hall establishment charges as may be fixed by the Warden. He shall, however, be required to come into residence in the event of unsatisfactory progress.

3. No *married* accommodation shall be provided to any student.

ORDINANCE XI

COMMITTEES

1. The Senate shall constitute each year the following Committees at appropriate time as mentioned in Schedule XLIII.

(1) Advisory Committees :

The Senate shall constitute an Advisory Committee for each of the teaching Departments comprising leading educationists and experts from Research and Industrial organisations.

(2) Admission Committee (Undergraduate courses).

(3) Admission Committees (Postgraduate courses).

(4) Admission Committees (Research).

(5) Post-Doctoral Fellowship Committee.

(6) Scholarships Committees.

(7) Examination Committee.

(8) Board of Examiners (Bachelor's Degree course examination).

(9) Examination Results Review Committee.

(10) Board of Examiners (Postgraduate Degree and Diploma examinations).

(11) Doctoral Scrutiny Committees.

(12) Training and Placement Committee.

(13) Medals and Prizes Committee.

(14) Convocation Committee.

(15) Conduct and Discipline Committee.

(16) Social and Welfare Committee.

(17) Library Committee.

(18) Workshops Committee.

(19) Central Instruments Services Section Committee.

(20) Journal and Publications Committee.

(21) Ordinance Review Committee.

2. The Senate shall have the power to constitute any other Committee or committees as it may deem necessary.

PART II

REGULATIONS

CURRICULA AND SUBJECTS OF INSTRUCTION FOR B. TECH. AND B. ARCH. DEGREE COURSES

SCHEDULE I

REGULATION NO. 1

Admission to the First Year Class of the Five-Year, Five-and-a-Half Year and Six-Year Courses (B. Tech. and B. Arch. Degrees)

(*a*) *Minimum educational qualifications*:

Admission to the First Year Class of the five-year, five-and-a-half year and six year courses leading to the Degrees of Bachelor of Technology (B. Tech.) and Bachelor of Architecture (B. Arch.) shall be made on the results of an Entrance Examination (Schedule II) which shall be open to any person who has passed or is expected to pass before 1st July of the year of admission in any one of the following examinations:—

(*i*) Higher Secondary Examination of recognised Boards of Secondary Education or Universities either in the Science stream with Chemistry, Mathematics and Physics or in the Technical Stream;

(*ii*) Pre-University or Pre-Degree or University Entrance Examination of a recognised University or Board with Chemistry, Mathematics and Physics after passing the Matriculation or School Final or S.S.L.C. or High School or equivalent examination conducted by a recognised University or Board;

(*iii*) Indian School Certificate or Senior Cambridge Examination with Elementary Mathematics and Additional Mathematics, Physics and Chemistry as separate subjects;

(*iv*) First Year Examination of the Two-Year Inter-Science or F.Sc. course of a recognised University or Board or Institute affiliated to a recognised University or Board with Chemistry, Mathematics and Physics as separate subjects;

(*v*) Jamia Higher Secondary (Three-Year course after eighth standard) with Chemistry, Mathematics and Physics as separate subjects;

(*vi*) First Year Examination of the Two-Year course of the Joint Services Wing of the National Defence Academy with Chemistry, Mathematics and Physics as separate subjects;

(*vii*) Army Higher Secondary Certificate Examination with Chemistry, Mathematics and Physics and

(*viii*) General Certificate Examination ("O" level) with Chemistry, Mathematics and Physics as separate subjects.

(Candidates who have passed the Intermediate Science or any higher examination of a recognised University or Board with Chemistry, Mathematics and Physics are also eligible provided they fulfil other requirements, *viz*., age and standard of physical fitness).

(*b*) *Age Limit*:

To be eligible for admission to the First Year class a candidate must have, on the 1st of October of the year of admission, completed 16 years of age.

(*c*) *Standard of Physical Fitness*:

Candidates seeking admission to the First Year class should fulfil the prescribed standard of physical fitness as given below:

(*i*)	Height ...	1.5 metre
(*ii*)	Weight ...	41 Kilogram
(*iii*)	Chest Measurement ...	69 Centimetre (with satisfactory limits of expansion and contraction)

(*iv*) Heart and Lungs ... There should be no abnormality

(*v*) Vision ... ... Better eye / Worse eye

Better eye	Worse eye	
6/9	6/9	Corrected
6/6	6/12	with glasses.

Eyes should be free from congenital or other diseases.

(*vi*) Hearing ... ... Normal.

(*vii*) Good general health and build.

(*viii*) Hernia, Hydrocele, Vericocele and Piles are temporary disqualifications to be rectified before joining.

Opinion of the Institute Medical Board set up by the Institute where the candidate is interviewed shall be final and there shall be no appeal.

REGULATION NO. 2

Admission to the First Year Class of the Special Three-Year Courses for the B. Tech. Degree

(*a*) *Minimum Educational Qualifications*:

Admission to the First Year class of the special Three-Year courses for the B. Tech. Degree shall be open to candidates who have passed or are expected to pass, before the 1st August of the year of admission, the Bachelor of Science (B.Sc.) Degree examination of a recognised University with (*i*) Honours in Chemistry or in Mathematics or in Physics and Physics and Mathematics, or Chemistry and Physics, or Chemistry and Mathematics as subsidiary subjects respectively; or (*ii*) Chemistry, Mathematics and Physics as major subjects in case no Honours course is offered by the University concerned.

A student of the Institute who has successfully completed the first two years of the 5 and 5½-year B. Tech. Degree course is also eligible.

(*b*) *Age Limit*:

To be eligible for admission to the First Year class a candidate must have completed 18 years of age on the 1st October of the year of admission.

(*c*) *Standard of Physical Fitness*:

(*i*) Height ... ... 1.52 metre.

(*ii*) Weight ... ... 43 Kilogram.

(*iii*) Chest Measurement ... 71 Centimetre (with satisfactory limits of expansion and contraction).

(*iv*) Heart and Lungs ... There should be no abnormality.

(*v*) Vision ... ... Better Eye / Worse Eye

Better Eye	Worse Eye	
6/9	6/9	Corrected
6/6	6/12	with glasses.

Eyes should be free from congenital or other diseases.

(*vi*) Hearing ... ... Normal.

(*vii*) Good general health and build.

(*viii*) Hernia, Hydrocele, Vericocele and Piles are temporary disqualifications to be rectified before joining.

The decision of the Institute Medical Board in regard to the fitness of a candidate shall be final and there shall be no appeal.

SCHEDULE II

REGULATION NO. 3

Entrance Examination for Admission to the First Year classes of the five-year, five-and-a-half year and Six-Year courses (B. Tech. and B. Arch. Degrees)

1. Admission to the First Year class of the five-year, five-and-a-half year and Six-Year courses shall be made on the results of a written Entrance Test to be called Joint Entrance Examination for admission to all the five Indian Institutes of Technology. The Examination shall be organised and conducted by an Admission Committee to be constituted by the Senate each year.

2. The Entrance Examination shall be held at various centres on dates normally in the first week of May to be fixed by the Senate. Candidates may take the Entrance Examination at a centre nearest to their place of residence or at any other centre where the examination may be held.

3. The Standard of the Examination shall be, as may be determined by the Senate from time to time. The question papers shall be set in English and the candidates shall be required to answer in English.

4. Subjects of the Joint Entrance Examination shall be:

Group A			**Group B**	
English	... 1 paper		English ...	... 1 paper
Mathematics	... 1 paper		Mathematics ...	... 1 paper
Physics	... 1 paper	or	Physics & Chemistry	... 1 paper
Chemistry	... 1 paper		Drawing ...	... 1 paper

Each paper shall be of three hours' duration and carry 100 marks. Papers on English and Mathematics shall be common for Group A and Group B. Paper on Physics & Chemistry for Group B candidates shall be in two halves each carrying 50 marks.

5. Syllabi for the subjects of Joint Entrance Examination shall be as may be determined by the Senate from time to time. (Present Syllabi are given in Schedule V).

6. The marks of the Entrance Examination shall be treated as confidential.

7. Candidates whose performance in the written examination is of the requisite standard in the opinion of the Admission Committee shall be required to appear at their own expense, before a Committee or Committees for interview and also for a medical examination on a date and at a place to be notified to such candidates in due course.

REGULATION NO. 4

Entrance Test for admission to the First Year Class of the Special Three-Year Courses for the B. Tech. Degree

1. A preliminary selection of candidates shall be made by an Admission Committee after scrutiny of applications including mark sheets and testimonials and only the candidates who *prima facie* satisfy the minimum requirements will be called for the entrance test, the scope of which shall be determined by the Admission Committee. The Entrance Test, written and/or oral, shall be held at the Institute on a date to be fixed by the Senate.

2. Admission to the First Year Class of the Special Three-Year Course for the B. Tech. Degree shall be made in order of merit on the results of the Entrance Test.

SCHEDULE III

REGULATION NO. 5

Undergraduate Courses of Study and Duration

Degree of Bachelor of Technology (B. Tech.) (Five-Year Course):

1. The Institute shall provide undergraduate courses leading to the Honours Degree of Bachelor of Technology (B. Tech.) in any or all the branches, mentioned below, as the Senate may decide from time to time taking into consideration the accommodation and staff position and other facilities available:

(*i*) Aeronautical Engineering; (*ii*) Agricultural Engineering; (*iii*) Chemical Engineering; (*iv*) Civil Engineering; (*v*) Electrical Engineering; (*vi*) Electronics and Electrical Communication Engineering; (*vii*) Mechanical Engineering; (*viii*) Metallurgical Engineering ing; (*ix*) Mining Engineering.

2. The curricula for the Degree of Bachelor of Technology in the branches, mentioned above, shall extend over not less than five academic sessions, each consisting of three terms except that there shall be an additional fourth term of about four weeks' duration in the final session.

3. The course work as mentioned in the preceding paragraph shall also include industrial or professional training of about twelve weeks at appropriate stages as may be determined by the Senate from time to time, except that in the case of Mining Engineering, such training shall extend over a period of at least six months.

REGULATION NO. 6

Degree of Bachelor of Technology (B. Tech.) in Naval Architecture

(Five-and-a-half-year Course)

1. The Institute shall provide undergraduate course leading to the Honours degree of Bachelor of Technology (B.Tech.) in Naval Architecture provided that the Senate is satisfied that adequate accommodation, staff and other facilities are available.

2. The curriculum for the degree of Bachelor of Technology in Naval Architecture shall extend over not less than five academic sessions each consisting of three terms except that in the final session there shall be two terms, each of three month's duration, to be devoted to course work and another term of about nine months' duration to be devoted to practical training.

3. The course work mentioned in the preceding paragraph shall also include practical training extending over a period of about four months at appropriate stages, as provided in the curriculum or as may be decided by the Senate from time to time.

REGULATION NO. 7

Degree of Bachelor of Technology in Naval Architecture (Naval Construction)

(Six-Year Course)

7 1. The Institute shall provide undergraduate course leading to the Honours Degree of Bachelor of Technology (B.Tech.) in Naval Architecture (Naval Construction) provided the Senate is satisfied that adequate accommodation, staff and other facilities are available.

2. The curriculum for the degree of Bachelor of Technology in Naval Architecture (Naval Construction) shall extend over not less than six academic sessions each consisting of three terms except that there shall be an additional fourth term of about four weeks' duration in the final session.

3. The course work, as mentioned in the preceding paragraph shall include practical training in shipyards extending over a period of about four months at appropriate stages as provided in the curriculum, or as may be decided by the Senate from time to time.

REGULATION NO. 8

Degree of Bachelor of Technology

(Three-Year Course)

1. The Institute shall provide Special Three-Year courses leading to the Honours Degree of Bachelor of Technology in any or all the branches, mentioned below, as the Senate may decide from time to time, taking into consideration the accommodation and staff position and other facilities available :—

(*i*) Engineering Science (Civil, Electrical or Mechanical) ;

(*ii*) Chemical Engineering;

(*iii*) Electronics and Electrical Communication Engineering;

(*iv*) Metallurgical Engineering.

2. The curricula for the Degree of Bachelor of Technology in the branches, mentioned above, shall extend over not less than three academic sessions each consisting of three terms, except that there shall be an additional fourth term of about six weeks' duration in the first session and of four weeks' duration in the final session.

Students from the 5-year B.Tech. Course admitted to the First Year of this Course shall follow a special curriculum as prescribed by the Senate.

3. The course work as mentioned in the preceding paragraph shall, in addition, include industrial or professional training of about six weeks at appropriate stages as may be determined by the Senate from time to time.

REGULATION NO. 9

Degree of Bachelor of Architecture (B. Arch.)

(Five-and-a-Half-Year Course)

1. The Institute shall provide undergraduate course leading to the Honours Degree of Bachelor of Architecture (B. Arch.) provided that the Senate is satisfied that adequate accommodation, staff and other facilities are available.

2. The curriculum for the Degree of Bachelor of Architecture shall extend over not less than five academic sessions, each consisting of three terms except that there shall be an additional fourth term of about six months' duration in the final session and that the first term of the final session and the preceding summer vacation shall be devoted to practical training in an Architect's office.

3. The course work mentioned in the preceding paragraph, shall also include professional training extending over a period of about twelve weeks at appropriate stages as provided in the Curriculum or as may be decided by the Senate from time to time.

SCHEDULE IV

REGULATION NO. 10

Graduation Requirement

Bachelor's Degrees (B.Tech. and B.Arch.)

A. *General Regulation*:

1. Every student for the Bachelor's Degree must, before entering on the curriculum, have complied with the admission requirements.

2. A student shall not be permitted to proceed to the next higher class unless he has fulfilled to the satisfaction of the Senate all the requirements in respect of attendance and study and has passed the prescribed examinations.

3. A student shall not be permitted to take any of the examinations unless (*i*) he has been regular in attendance (a student shall be expected to be regular in attendance in all lectures, tutorials, laboratories, guided studies, drawing office, field work and workshop classes), and (*ii*) he has satisfied all class teachers that he has conducted himself well within and outside the class room and that he has been regular, diligent and methodical in his study and has independently and satisfactorily performed the home and sessional assignments and has regularly submitted these for teachers' scrutiny.

4. A student may study in the fourth and fifth sessions an additional subject of his choice from amongst the approved optional subjects listed in Schedule X if he desires and receive in the examinations such credit over and above his total aggregate marks in the obligatory subjects, as may be prescribed by the Senate.

5. During the first two sessions, it shall be obligatory for all men students to participate in one of the Units of the National Cadet Corps; for the foreign students, the women students, and for those men students who may not be upto the standard of physical fitness required in the National Cadet Corps, it shall be obligatory to participate in Physical Training.

In the third, fourth and fifth sessions all students are expected to participate in Physical Training or Social Service Programme, as may be organised for them and may receive in the examinations such additional credit over and above their aggregate total marks in the obligatory subjects, as may be prescribed by the Senate.

6. Subjects of each examination shall be as given in Schedule VII. In each subject of examination there shall be written paper or papers and/or sessional assignments as prescribed in the Regulations. The sessional assignments may comprise tutorial, guided studies, laboratory and field work, workshop practice and drawing office work.

7. The marks allotted to each subject in the terminal as well as the end-sessional examinations shall be as prescribed in Schedule VI.

8. The Senate shall determine, in respect of each subject of study, the scope of the course and the relative proportion in each course of lectures and/or practical or laboratory work. The Senate shall also determine in respect of several examinations leading to the degree conditions for admission and the standard of examination.

9. Special Senate instructions specifying the standard of examination shall be kept with the Registry to be made available only to the Senate and the Board of Examiners.

10. A student who does not comply with all the provisions of the Ordinances and Regulations for an Honours degree but has, in the opinion of the Senate, shown sufficient merit in his studies and examination may, on the special recommendation of the Senate, be admitted by the Board of Governors to the ordinary Degree and the Diploma be suitably inscribed to that effect.

11. A student who, after admission to the first or the second year class, does not qualify in the First or the Second Examination respectively within one academic session of attendance at the Institute shall be required to leave the Institute unless specifically permitted by the Senate to repeat the course on grounds to be recorded by the Senate.

12. A student who fails in any of the subsequent examinations may be allowed to repeat the course, subject to the following conditions:

An entrant into the First Year Class shall be required to qualify in the First, Second and the Intermediate Examinations within a maximum period of four years of study at the Institute and an entrant into the Second Year class shall be required to qualify in the Second and the Intermediate examinations within a maximum period of three years of study at the Institute unless specifically permitted by the Senate to exceed these on being allowed to repeat any part of the prescribed course and take the examinations on grounds to be recorded by the Senate.

Thereafter, every student shall be required to qualify in the Fourth and Final Examinations within a maximum period of three years of study at the Institute unless specifically permitted by the Senate to exceed this period on being allowed to repeat any part of the prescribed course and take the examinations on grounds to be recorded by the Senate.

The same principle, *mutatis mutandis*, shall apply to the Special Three-Year and Six-Year courses for B.Tech. Degree.

13. If a student fails in an examination and is permitted to repeat the course, his marks shall be as may be secured by him when he repeats the course.

14. If a student is allowed to appear at an examination without repeating the course, the marks allotted to him for the sessional assignments and the terminal examination shall be the marks as he had secured when he completed the course.

15. The Senate shall be competent, on the recommendation of the Board of Examiners, to deviate from the prescribed Ordinances & Regulations relating to the examination and consider the special cases of students not covered by the Ordinances and Regulations, subject to the approval of the Board of Governors.

B. *The Degree of Bachelor of Technology*

(*a*) Five-Year and Five-and-a-Half-Year Courses

1. Subject to the provisions of the Ordinances and Regulations the Degree of Bachelor of Technology shall be conferred on students who have followed the prescribed curricula for not less than five academic sessions studying subjects set forth in the Regulations (Schedule VII) and who have reached the Honours standard in the examinations in one of the following branches:

(*i*) Aeronautical Engineering;

(*ii*) Agricultural Engineering;

(*iii*) Chemical Engineering;

(*iv*) Civil Engineering;

(*v*) Electrical Engineering;

(*vi*) Electronics & Electrical Communication Engineering;

(*vii*) Mechanical Engineering;

(*viii*) Metallurgical Engineering;

(*ix*) Mining Engineering;

(*x*) Naval Architecture.

2. There shall be five complete examinations for the Degree of Bachelor of Technology (B.Tech.), *viz.*, (*i*) the First Examination, (*ii*) the Second Examination, (*iii*) the Intermediate Examination, (*iv*) the Fourth Examination, and (*v*) the Final Examination.

3. For each examination a Board of Examiners shall be constituted by the Senate and the Board of Examiners shall comprise the teachers in the subjects of examination and the Additional Examiner or Examiners and other experts.

4. No student may present himself for examination in any subject until he has duly completed the prescribed courses of instruction to the satisfaction of the teachers concerned,

5. *The First Examination*:

(i) The First Examination shall be taken in three sections consisting of two Terminal Examinations each covering the term's work and an End-sessional Examination covering the entire course of the First Examination.

(*ii*) No student may present himself for the End-sessional Examination in any subject unless he has secured on the total of the two Terminal Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects and in each of the sessional assignments.

(iii) A student shall be deemed to have passed the First Examination provided he has secured on the total of the two Terminal and the End-sessional Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects, in each of the sessional assignments, and in the aggregate.

6. *The Second Examination*:

(i) No student may present himself for examination in any subject of the Second Examination until he has passed the whole of the First Examination except those who have been granted admission direct to the Second Year class and exempted from the First Examination.

(ii) The Second Examination shall consist of two Terminal Examinations each covering the term's work and an End-sessional Examination covering the entire course of the Second Examination.

(iii) No student may present himself for the End-sessional Examination in any subject unless he has secured on the total of the two Terminal Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects and in each of the sessional assignments.

(iv) A student shall be deemed to have passed the Second Examination provided he has secured on the total of the two Terminal and the End-sessional Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects, in each of the sessional assignments, and in the aggregate.

7. *The Intermediate Examination*:

(i) No student may present himself for examination in any subject of the Intermediate Examination until he has passed the whole of the Second Examination except those who have been granted admission direct to the Third Year class and exempted from the First and Second Examinations.

(ii) The Intermediate Examination shall consist of two Terminal Examinations each covering the term's work and an End-sessional Examination covering the entire course of the Intermediate Examination.

(iii) No student may present himself for the End-sessional Examination in any subject unless he has secured on the total of the two Terminal Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects and in each of the sessional assignments.

(iv) A student shall be deemed to have passed the Intermediate Examination provided he has secured on the total of the two Terminal and the End-sessional Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects, in each of the sessional assignments and in the aggregate.

8. *The Fourth Examination*:

(i) No student may present himself for examination in any subject of the Fourth Examination until he has passed the whole of the Intermediate Examination except those who have been granted admission direct to the Fourth Year Class and exempted from the First, Second and Intermediate Examinations,

(ii) The Fourth Examination shall consist of two Terminal Examinations each covering the term's work and an End-sessional Examination covering the entire course of the Fourth Examination.

(iii) No student may present himself for the End-sessional Examination in any subject unless he has secured on the total of the two Terminal Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects and in each of the sessional assignments.

(iv) A student shall be deemed to have passed the Fourth Examination provided he has secured on the total of the two Terminal and the End-sessional Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects, in each of the sessional assignments and in the aggregate.

9. *The Final Examination*:

(i) No student may present himself for Examination in any subject of the Final Examination until he has passed the whole of the Fourth Examination.

(ii) The Final Examination shall be taken in five sections comprising the two Terminal Examinations, each covering the term's work and an End-sessional Examination, a *Viva-voce* Examination and an examination on a thesis on an approved subject which each student shall be required to carry out in the Fourth term of the Final session.

The Final Examination for the Naval Architecture course shall be taken in five sections comprising one Terminal Examination covering the term's work and an End-sessional Examination, a *Viva-voce* Examination and an examination on a thesis on an approved subject which each student shall be required to carry out in the final session and practical training during the extended third term.

(iii) No student may present himself for any subject of the End-sessional Examination, in the *Viva-voce* Examination, and in the Thesis Examination unless he has secured on the total of the two Terminal Examinations the requisite minimum marks in the written paper or papers of each of the obligatory subjects and in each of the sessional assignments.

Except that a student of Naval Architecture course may not present himself for any subject of the End-sessional Examination, in the *Viva-voce* Examination and in the Thesis Examination unless he has secured in the Terminal Examination requisite minimum marks in the written paper or papers of each of the obligatory subjects and in each of the sessional assignments.

(iv) The End-sessional Examination shall cover the entire course prescribed for the Final Examination.

(v) A student shall be deemed to have passed the Final B. Tech. Examination if he has secured on the total of the two Terminal and the End-sessional Examinations in requisite minimum marks in the written paper or papers of each of the obligatory subjects, in each of the sessional assignments, in the *Viva-voce* Examination, in the Thesis Examination and in the aggregate.

A student for the Degree of Bachelor of Technology in Naval Architecture shall be deemed to have passed the Final Examination, if he has secured on the total of the Terminal and End-sessional Examinations the requisite minimum marks in the written paper or papers of each of the obligatory subjects, in each of the sessional assignments including practical training during the extended third term, in the *Viva-voce* Examination, in the Thesis Examination and in the aggregate.

10. *The Maximum Marks*:

(i) The maximum marks for the First, Second, Intermediate and the Fourth Examinations shall be the total of the maximum marks prescribed for the obligatory subjects of the respective End-sessional Examinations plus fifty per cent of the total of the maximum marks prescribed for the obligatory subjects of both the Terminal Examinations.

(ii) The maximum marks for the Final Examination shall be the total of the maximum marks prescribed for the obligatory subjects of the End-sessional Examination, for the *Viva-voce* Examination and for the Thesis Examination plus fifty percent of the total of the maximum marks prescribed for the obligatory subjects of both the Terminal Examinations.

(iii) The maximum marks for the final Examination for the degree of Bachelor of Technology in Naval Architecture shall be the total of the maximum marks prescribed for the obligatory subjects of the End-sessional Examination, for the *Viva-voce* Examination, and for the Thesis Examination plus fifty per cent of the total of the maximum marks prescribed for the obligatory subjects of the First Terminal Examination plus the maximum marks prescribed for practical training during the extended third term.

11. *The Weighted Maximum Marks*:

(i) The weighted maximum marks for the First, Second and the Fourth Examinations shall be the maximum marks for the First, Second and the Fourth Examinations respectively.

(ii) The weighted maximum marks for the Intermediate Examination shall be the maximum marks for the Intermediate Examination plus two-thirds of the weighted maximum marks of the Second Examination plus one-third of the weighted maximum marks of the First Examination.

(iii) The weighted maximum marks for the Final Examination shall be the maximum marks of the Final Examination plus two-thirds of the weighted maximum marks of the Fourth Examination plus one-third of the weighted maximum marks of the Intermediate Examination.

12. A student passing in all the five Examinations for the Degree of Bachelor of Technology (B. Tech.) shall be declared to have passed with Honours in the appropriate branch on the basis of his overall performance in all the five Examinations.

13. The students found eligible for the Honours Degree shall, in each branch, be classified in three groups to be denominated respectively First Class with Distinction, First Class and Second Class on the basis of the weighted total marks they secure out of the prescribed weighted maximum marks of the Final Examination. The names of the students in the First Class with Distinction shall be arranged in order of merit and of others in the alphabetical order.

14. The students satisfying all the conditions prescribed and having passed the prescribed Examinations shall be entitled to receive the Degree of Bachelor of Technology (B. Tech.) with Honours in the appropriate branch of study.

15. A student who has been admitted at a stage higher than the First Year class may be allowed to graduate with First class Honours with Distinction, First class Honours or Second class Honours on the results of the complete Examinations which he takes to the satisfaction of the Board of Examiners, on a criterion to be determined by the Senate. He will not, however, be ranked.

16. For the degree of Bachelor of Technology with Honours in any branch as set forth above the graduate shall receive a Diploma wherein shall be set forth the branch of study in which he has obtained Honours and the Class in which he has been placed.

(*b*) Six-Year Bachelor of Technology Degree Course:

1. Subject to the provisions of the Ordinances and Regulations the Degree of Bachelor of Technology shall be conferred on students who have followed the prescribed curricula for not less than six academic sessions studying subjects set forth in the regulations (Schedule VII)

and who have reached the Honours standard in the Examinations in Naval Architecture (Naval Construction).

2. There shall be six complete Examinations for the Degree of Bachelor of Technology (B. Tech.) in Naval Architecture (Naval Construction), namely, (i) the First Examination, (ii) the Second Examination, (iii) the Intermediate Examination, (iv) the Fourth Examination, (v) the Fifth Examination, and (vi) the Final Examination.

3. For each Examination a Board of Examiners shall be constituted by the Senate and the Board of Examiners shall comprise the teachers in the subjects of Examination and the additional examiner or examiners and other experts.

4. No student may present himself for an Examination in any subject until he has completed the prescribed course of instructions to the satisfaction of the teachers concerned.

5. *The First Examination*:

(i) The First Examination shall be taken in three sections consisting of two Terminal Examinations each covering the term's work and an End-sessional Examination covering the entire course of the First Examination.

(ii) No student may present himself for the End-sessional Examination in any subject unless he has secured on the total of the two Terminal Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects and in each of the sessional assignments.

(iii) A student shall be deemed to have passed the First Examination provided he has secured on the total of the two terminal and the End-sessional Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects, in each of the sessional assignments, and in the aggregate.

6. *The Second Examination*:

(i) No student may present himself for examination in any subject of the Second Examination until he has passed the whole of the First Examination except those who have been granted admission direct to the Second Year Class and exempted from the First Examination.

(ii) The Second Examination shall consist of two Terminal Examinations each covering the term's work and an End-sessional Examination covering the entire course of the Second Examination.

(iii) No student may present himself for the End-sessional Examination in any subject unless he has secured on the total of the two Terminal Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects and in each of the sessional assignments.

(iv) A student shall be deemed to have passed the Second Examination provided he has secured on the total of the two terminal and End-sessional Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects, in each of the sessional assignments and in the aggregate.

7. *The Intermediate Examination*:

(i) No student may present himself for examination in any subject of the Intermediate Examination until he has passed the whole of the Second Examination except those who have been granted admission direct to the Third Year class and exempted from the First and the Second Examinations.

(ii) The Intermediate Examination shall consist of two Terminal Examinations each covering the term's work and an End-sessional Examination covering the entire course of the Intermediate Examination.

(iii) No student may present himself for the End-sessional Examination in any subject unless he has secured on the total of the two Terminal Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects and in each of the sessional assignments.

(iv) A student shall be deemed to have passed the Intermediate Examination provided he has secured on the total of the two Terminal and the End-sessional Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects, in each of the sessional assignments and in the aggregate.

8. *The Fourth Examination*:

(i) No student may present himself for Examination in any subject of the Fourth Examination until he has passed the whole of the Intermediate Examination except those who have been granted admission direct to the Fourth Year class and exempted from the First, Second and Intermediate Examinations.

(ii) The Fourth Examination shall consist of two Terminal Examinations each covering the term's work and an End-sessional Examination covering the entire course of the Fourth Examination.

(iii) No student may present himself for the End-sessional Examination in any subject unless he has secured on the total of the two Terminal Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects and in each of the sessional assignments.

(iv) A student shall be deemed to have passed the Fourth Examination provided he has secured on the total of the two Terminal and the End-sessional Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects, in each of the sessional assignments and in the aggregate.

9. *The Fifth Examination*:

(i) No student may present himself for examination in any subject of the Fifth Examination until he has passed the whole of the Fourth Examination except those who have been granted admission direct to the Fifth year class and exempted from the First, Second, Intermediate, and the Fourth Examinations.

(ii) The Fifth Examination shall consist of two Terminal Examinations each covering the term's work and an End-sessional Examination covering the entire course of the Fifth Examination.

(iii) No student may present himself for the End-sessional Examination in any subject unless he has secured on the total of the two Terminal Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects and in each of the sessional assignments.

(iv) A student shall be deemed to have passed the Fifth Examination provided he has secured on the total of the two Terminal and the End-sessional Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects, in each of the sessional assignments and in the aggregate.

10. *The Final Examination*:

(i) No student may present himself for examination in any subject of the Final Examination until he has passed the whole of the Fifth Examination.

(ii) The Final Examination shall be taken in five sections comprising the two Terminal Examinations each covering the term's work and an End-sessional Examination, a *Viva-voce* Examination and an Examination on thesis on an approved subject which each candidate shall be required to carry out in the Final session.

(iii) No student may present himself in any subject of the End-sessional Examination, in the *Viva-voce* Examination, and in the Thesis Examination unless he has secured on the total of the two Terminal Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects and in each of the sessional assignments.

(iv) The End-sessional Examination shall cover the entire course prescribed for the Final Examination.

(v) A student shall be deemed to have passed the final B. Tech. Examination if he has secured on the total of the two Terminal and the End-sessional Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects, in each of the sessional assignments, in the *Viva-voce* Examination, in the Thesis Examination, and in the aggregate.

11. *The Maximum Marks*:

(i) The maximum marks for the First, Second, Intermediate, Fourth and the Fifth Examinations shall be the total of the maximum marks prescribed for the obligatory subjects of the respective End-sessional Examination plus fifty per cent of the total of the maximum marks prescribed for the obligatory subjects of both the Terminal Examinations.

(ii) The maximum marks for the Final Examination shall be the total of the maximum marks prescribed for the obligatory subjects of the End-sessional Examination, for the *Viva-voce* Examination and for the Thesis Examination plus fifty per cent of the total of the maximum marks prescribed for the obligatory subjects of both the Terminal Examinations.

12. *The Weighted Maximum Marks*:

(i) The weighted maximum marks for the First, the Second, the Fourth, and the Fifth Examinations shall be the maximum marks for the First, the Second, the Fourth and the Fifth Examinations respectively.

(ii) The weighted maximum marks for the Intermediate Examination shall be the maximum marks for the Intermediate Examination plus two-thirds of the weighted maximum marks of the Second Examination plus one-third of the weighted maximum marks of the First Examination.

(iii) The weighted maximum marks for the Final Examination shall be the maximum marks of the Final Examination plus two-thirds of the weighted maximum marks of the Fifth Examination plus half of the weighted maximum marks of the Fourth Examination plus one-third of the weighted maximum marks of the Intermediate Examination.

13. A student passing in all the six Examinations for the degree of Bachelor of Technology (B. Tech.) shall be declared to have passed with Honours in Naval Architecture (Naval Construction) on the basis of his overall performance in all the six Examinations.

14. A student found eligible for the Honours degree shall be classified in three groups to be denominated respectively First Class with Distinction, First Class, and Second Class on the basis of the weighted total marks he secures out of the prescribed weighted maximum marks of the final Examination. The names of the students placed in the First Class with Distinction shall be arranged in order of merit and of others in the alphabetical order.

15. A student who has been admitted at a stage higher than the first year class may be allowed to graduate with First Class Honours with Distinction, or First Class Honours, or Second Class Honours on the results of the complete Examinations he takes to the satisfaction of the Board of Examiners on a criterion to be decided by the Senate. He will not, however, be ranked.

16. Students satisfying all the conditions prescribed and having passed the prescribed Examinations shall be entitled to receive the Degree of Bachelor of Technology (B. Tech.) with Honours in Naval Architecture (Naval Construction).

17. For the Degree of Bachelor of Technology with Honours in Naval Architecture (Naval Construction) a graduate shall receive a Diploma wherein shall be set forth the branch of study in which he has obtained Honours and the Class in which he has been placed.

(*c*) Special Three-Year B. Tech. Degree course

1. Subject to the provisions of the Ordinances and Regulations the Degree of Bachelor of Technology shall be conferred on students who have followed the prescribed curricula for not less than three academic sessions studying subjects sets forth in the regulations (Schedule IX), and who have reached the Honours standard in the Examinations in one of the following branches:

(i) Engineering Science (Civil, Electrical or Mechanical);

(ii) Chemical Engineering;

(iii) Electronics & Electrical Communication Engineering ;

(iv) Metallurgical Engineering.

2. There shall be three complete Examinations for the Degree of Bachelor of Technology (B. Tech.) *viz.*, (*a*) the Part I Examination, (*b*) the Part II Examination, and (*c*) the Final Examination.

3. For each Examination a Board of Examiners shall be constituted by the Senate and the Board of Examiners shall comprise the teachers in the subjects of Examination and the Additional Examiner or Examiners and other experts.

4. No student may present himself for Examination in any subject until he has duly completed the prescribed course of instruction to the satisfaction of the teachers concerned.

5. *The Part I Examination*:

(i) The Part I Examination shall be taken in four sections consisting of two Terminal Examinations each covering the term's work and an End-sessional Examination covering the entire course of the first three terms and an Examination on the work of the fourth term.

(ii) No student may present himself for the End-sessional Examination in any subject unless he has secured on the total of the two terminal Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects and in each of the sessional assignments.

(iii) A student shall be deemed to have passed the Part I Examination provided he has secured on the total of the two terminal, the End-sessional, and the fourth term Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects, in each of the sessional assignments, and in the aggregate.

6. *The Part II Examination*:

(i) No student may present himself for examination in any subject of the Part II Examination until he has passed the whole of the Part I Examination except those who have been granted admission direct to the Second Year class and exempted from the Part I Examination.

(ii) The Part II Examination shall be taken in three sections consisting of two terminal Examinations each covering the term's work and an End-sessional Examination covering the entire course of the Part II Examination.

(iii) No student may present himself for the End-sessional Examination in any subject unless he has secured on the total of the two Terminal Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects and in each of the sessional assignments.

(iv) A student shall be deemed to have passed the Part II Examination provided he has secured on the total of the two Terminal and the End-sessional Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects, in each of the sessional assignments and in the aggregate.

7. *The Final Examination*:

(i) No student may present himself in any subject of the Final Examination until he has passed the whole of the Part II Examination.

(ii) The Final Examination shall be taken in five sections comprising the two terminal Examinations each covering the term's work and an End-sessional Examination, a *Viva-voce* Examination and an Examination on a thesis on an approved subject which each student shall be required to carry out in the Fourth term of the Final session.

(iii) No student may present himself in any subject of the End-sessional Examination, in the *Viva-voce* Examination and in the thesis Examination unless he has secured on the total of the two Terminal Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects and in each of the sessional assignments.

(iv) The End-sessional Examination shall cover the enitre course prescribed for the Final Examination.

(v) A student shall be deemed to have passed the Final B. Tech. Examination if he has secured on the total of the two Terminal and the End-sessional Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects, in each of the sessional assignments, in the *Viva-voce* Examination, in the Thesis Examination and in the aggregate.

8. *The Maximum Marks*:

(i) The maximum marks for the Part I Examination shall be the total of the maximum marks prescribed for the obligatory subjects of the End-sessional Examination plus two-thirds of the total of the maximum marks prescribed for the obligatory subjects for the first and the Second Terminal Examinations plus fifty per cent of the maximum marks prescribed for the obligatory subjects of the fourth term Examination.

(ii) The maximum marks for the Part II Examination shall be the total of the maximum marks prescribed for the obligatory subjects of the End-sessional Examination plus fifty per cent of the total of the maximum marks prescribed for the obligatory subjects for both the Terminal Examinations.

(iii) The maximum marks for the Final Examination shall be the total of the marks prescribed for the obligatory subjects of the End-sessional Examination, for the *Viva-voce* Examination and for the Thesis Examination plus fifty per cent of the total of the maximum marks prescribed for the obligatory subjects of both the Terminal Examinations.

9. *The Weighted Maximum Marks*:

(i) The weighted maximum marks for the Part I and the Part II Examinations shall be the maximum marks of the Part I and Part II Examinations respectively.

(ii) The weighted maximum marks for the Final Examination shall be the maximum marks of the Final Examination plus two-thirds of the weighted maximum marks of the Part II Examination plus half of the weighted maximum marks of the Part I Examination.

10. A student passing in all the three Examinations for the Degree of Bachelor of Technology (B. Tech.) shall be declared to have passed with Honours in the appropriate branch on the basis of his overall performance in all the three Examinations.

11. The students found eligible for the Honours Degree shall in each branch be classified in three groups to be denominated respectively: First Class with Distinction, First Class and Second Class on the basis of the weighted total marks they secure out of the prescribed weighted maximum marks of the Final Examination. The names of the students in the First class with Distinction shall be arranged in order of merit, and of others in alphabetical order.

12. The students satisfying all the conditions prescribed and having passed the prescribed Examinations shall be entitled to receive the Degree of Bachelor of Technology (B. Tech.) with Honours in the appropriate branch of study.

13. A student who has been admitted at a stage higher than the First Year class may be allowed to graduate with First class Honours with Distinction, First class Honours or Second class Honours on the results of the complete Examinations which he takes to the satisfaction of the Board of Examiners, on a criterion to be determined by the Senate. He will not, however, be ranked.

14. For the degree of Bachelor of Technology (B. Tech.) with Honours in any branch, as set forth above, the graduate shall receive a Diploma wherein shall be set forth the branch of study in which he has obtained Honours and the Class in which he has been placed.

(*C*) *The Degree of Bachelor of Architecture*

(Five-and-a-Half-Year Course)

1. Subject to provisions of the Ordinances and Regulations the Degree of Bachelor of Architecture shall be conferred on students who have studied, on the prescribed curriculum for

not less than five academic sessions, subjects as set forth in the Regulations (Schedule VII) and who have reached the Honours standard in the Examinations in Architecture.

2. There shall be five complete Examinations for the Degree of Bachelor of Architecture (B. Arch.), *viz.* (i) the First Examination ; (ii) the Second Examination ; (iii) the Intermediate Examination ; (iv) the Fourth Examination ; and (v) the Final Examination.

3. For each Examination a Board of Examiners shall be constituted by the Senate and the Board of Examiners shall comprise the teachers in the subjects of Examination and the Additional Examiner or Examiners and other experts.

4. No student may present himself for Examination in any subject until he has duly completed the prescribed course of instruction to the satisfaction of the teachers concerned.

5. *The First Examination*:

(i) The First Examination shall consist of two Terminal Examinations each covering the term's work and an End-sessional Examination covering the entire course of the First Examination.

(ii) No student may present himself for the End-sessional Examination in any subject unless he has secured on the total of the two Terminal Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects and in each of the sessional assignments.

(iii) A student shall be deemed to have passed the First Examination provided he has secured on the total of the two Terminal and the End-sessional Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects, in each of the sessional assignments, and in the aggregate.

6. *The Second Examination*:

(i) No student may present himself for examination in any subject of the Second Examination until he has passed the whole of the First Examination except those who have been granted admission direct to the Second Year class and exempted from the First Examination.

(ii) The Second Examination shall consist of two Terminal Examinations each covering the term's work and an End-sessional Examination covering the entire course of the Second Examination. There shall be review by the Board of Examiners of all the studio work done by the students upto the Second Examination.

(iii) No student may present himself for the End-sessional Examination in any subject unless he has secured on the total of the two Terminal Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects, and in each of the sessional assignments.

(iv) A student shall be deemed to have passed the Second Examination provided he has secured on the total of the two Terminal and the End-sessional Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects, in each of the sessional assignments and in the aggregate.

7. *The Intermediate Examination*:

(i) No student may present himself for Examination in any subject of the Intermediate Examination until he has passed the whole of the Second Examination except those who have been granted admission direct to the Third Year class and exempted from the First and Second Examinations.

(ii) The Intermediate Examination shall consist of two Terminal Examinations each covering the term's work and an End-sessional Examination covering the entire course of the Intermediate Examination. There shall be a review by the Board of Examiners of all the studio work done by the students upto the Intermediate Examination.

(iii) No student may present himself for the End-sessional Examination in any subject unless he has secured on the total of the two Terminal Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects and in each of the sessional assignments.

(iv) A student shall be deemed to have passed the Intermediate Examination provided he has secured on the total of the two Terminal and the End-sessional Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects, in each of the sessional assignments, and in the aggregate.

8. *The Fourth Examination*:

(i) No student may present himself for examination in any subject of the Fourth Examination until he has passed the whole of the Intermediate Examination except those who have been granted admission direct to the Fourth Year class and exempted from the First, Second and Intermediate Examinations.

(ii) The Fourth Examination shall be taken in three sections comprising the two Terminal Examinations each covering the terms work and an End-sessional Examination covering the entire course of the Fourth Examination. There shall be a review by the Board of Examiners of all the studio work done by the students upto the Fourth Examination.

(iii) No student may present himself for the End-sessional Examination in any subject unless he has secured on the total of the two Terminal Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects and in each of the sessional assignments.

(iv) A student shall be deemed to have passed the Fourth Examination provided he has secured on the total of the two Terminal and the End-sessional Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects, in each of the sessional assignments, and in the aggregate.

9. *The Final Examination*:

(i) No student may present himself for Examination in any subject of the Final Examination until he has passed the whole of the Fourth Examination.

(ii) The Final Examination shall be taken in six sections comprising the practical training in the first term of the final session and the preceding summer vacation, the Second Terminal Examination covering the second term's work, and an End-sessional Examination covering the work of the second and third terms, the Fourth Terminal Examination covering the fourth term work, a *Viva-voce* Examination, and an examination on a thesis on an approved subject which each student shall be required to carry out in the fourth term of the final session.

(iii) No student may present himself in any subject of the End-sessional Examination, in the Fourth Terminal Examination, in the *Viva-voce* Examination and in the thesis Examination unless he has secured in the second terminal Examination requisite minimum marks in the written paper or papers of each of the obligatory subjects and in each of the sessional assignments including practical training of the first term and the preceding summer vacation.

(iv) The End-sessional Examination shall cover the course prescribed for the second and third terms of the final session.

(v) A student shall be deemed to have passed the final B. Arch. Examination provided he has secured on the total of the Second terminal and the End-sessional Examinations and the Fourth Terminal Examination the requisite minimum marks in the written paper or papers of each of the obligatory subjects, in each of the sessional assignments including practical training in the first term and the preceding summer vacation, on the thesis, and in the *viva-voce* Examination and in the aggregate.

10. *The Maximum Marks*:

(i) The maximum marks for the First, Second, Intermediate and the Fourth Examinations shall be the total of the maximum marks prescribed for the obligatory subjects of the respective End-sessional Examinations plus fifty per cent of the total of the maximum marks prescribed for the obligatory subjects of both the Terminal Examinations.

(ii) The maximum marks for the Final Examination shall be the total of the maximum marks prescribed for the obligatory subjects of the End-sessional Examination, the Fourth Terminal Examination, for the *Viva-voce* test, for the thesis examination plus fifty per cent of the total of the maximum marks prescribed for the obligatory subjects of the Second Terminal Examination plus the maximum marks prescribed for the practical training in the first term and the preceding Summer Vacation.

11. *The Weighted Maximum Marks*:

(i) The weighted maximum marks for the First, Second and the Fourth Examinations shall be the maximum marks for the First, Second and Fourth Examinations respectively.

(ii) The weighted maximum marks for the Intermediate Examination shall be the maximum marks of the Intermediate Examination plus two-thirds of the weighted maximum marks of the Second Examination plus one-third of the weighted maximum marks of the First Examination.

(iii) The weighted maximum marks for the Final Examination shall be the maximum marks of the Final Examination plus two-thirds of the weighted maximum marks of the Fourth Examination plus one-third of the weighted maximum marks of the Intermediate Examination.

12. A student passing in all the five examinations for the Degree of Bachelor of Architecture (B. Arch.) shall be declared to have passed with Honours on the basis of his overall performance in all the five examinations.

13. The students found eligible for the Honours Degree shall be classified in three groups to be denominated respectively First class with distinction, First Class, and Second Class on the basis of the weighted total marks they secure out of the prescribed weighted maximum marks for the Final Examination. The names of the students in the First Class with Distinction shall be arranged in order of merit and of others in alphabetical order.

14. The students satisfying all the conditions prescribed and having passed the prescribed examinations shall be entitled to receive the Degree of Bachelor of Architecture (B. Arch.) with Honours in Architecture.

15. A student who has been admitted at a stage higher than the First Year class may be allowed to graduate with First Class Honours with Distinction, First Class Honours or Second Class Honours on the results of the complete examinations which he takes to the satisfaction of the Board of Examiners, on a criterion to be determined by the Senate. He will not, however, be ranked.

16. For the Degree of Bachelor of Architecture with Honours the graduate shall receive the Diploma wherein shall be set forth the subject and the Class in which he has been placed.

SCHEDULE V

REGULATION NO. 11

Syllabi for the Joint Entrance Examination

The syllabi for the subjects of the Joint Entrance Examination for admission to the First Year of the five-year, five-and-a-half-year and six-year courses (B.Tech. and B.Arch. Degrees) shall be as may be decided by the Senate from time to time. The present syllabi are given below :—

1. ENGLISH

(Common for Groups A and B)

English Composition, e.g., Essay Writing (Description, Narration, Discussion)—Organisation and Presentation of Ideas—Clear Expression. Comprehension and Precis Writing. English Grammar and Structure—Syntax—Punctuation—Use of Idioms—Indirect Speech etc. Vocabulary—ability to recognise and use common and useful English words.

2. MATHEMATICS

(Common for Groups A and B)

Algebra—Remainder theorem ; Laws of indices ; Surds ; Logarithms ; Imaginary numbers ; Solution of quadratic equation, theory of quadratic equation and expression ; Simple simultaneous equations ; Elimination ; Arithmetic, geometric and harmonic progressions ; Permutation and combination ; Statement, proof and applications of Binomial theorem with positive integral index.

Plane Geometry—Simple properties of triangle and circle ; similar triangles ; Practical constructions.

Trigonometry—Addition and subtraction formulae ; Multiple and sub-multiple angles ; General solution of simple trigonometric equation ; Relations between sides and angles of a triangle ; Solution of triangle ; Heights and distances ; Graphs of simple trigonometric functions.

Coordinate Geometry—Rectangular cartesian coordinates in a plane ; Length of segment ; Area of a triangle ; Straight line.

Mensuration—Parallelopiped ; Right circular cone ; Prism and pyramid ; Cylinder and sphere (expressions without proof for surface and volume of these solids).

3. CHEMISTRY

(For Group A only)

Laws of Chemical combination: gas laws; Avogardro's hypothesis; Avogadro's number; elements of atomic structure and valency; ionic and covalent bonds; equivalent, atomic and molecular weights; electrolysis; oxidation, reduction and neutralisation; chemical analysis; chemical calculations.

Chemistry of the following elements: hydrogen, halogens (excepting fluorine), oxygen, sulphur, nitrogen, carbon, sodium, potassium, magnesium, calcium, aluminium, copper, silver, zinc, tin, lead and iron.

Chemistry of the following compounds: oxides, hydroxides, sulphides and halides of the above metals; oxides of hydrogen, carbon, nitrogen and sulphur; hydrogen halides, hydrogen sulphide, ammonia and ammonium salts; hypochlorous acid, chloric acid, perchloric acid, sulphurous acid, sulphuric acid, nitrous acid, nitric acid, carbonic acid and their salts; methane, ethylene, acetylene, chloroform, carbon tetrachloride, carbon di-sulphide and ethyl alcohol.

4. PHYSICS

(For Group A only)

Units and measuring instruments; Newton's Law of motion; simple kinematics; conditions of equilibrium; centre of gravity; balance, lever and pulley; conservation of energy and momentum; centripetal and centrifugal forces; simple harmonic motion; simple pendulum.

Statement of the general properties of solids, liquids and gases; pressure at a point; Pascal's law, hydraulic press, Archimedes' principles; specific gravity and density; barometer; siphon and pumps; Hooke's Law and elastic constants.

Heat and temperature; thermometry; thermal expansion of solids and liquids; gas laws; perfect gas scale of temperature; specific heat, calorimetery; change of state; vapour pressure; gas and vapour; relative humidity, hygrometry, dew point; mechanical equivalent of heat; heat transfer by conduction, convection and radiation.

Electric and Magnetic intensity; potential and lines of force; electrostatic and magnetostatic induction; electrophorus; gold leaf electroscope; capacity; magnetic moment; magneto-meter; elements of terrestrial magnetism. Primary and secondary cells; Ohm's law; measurement of resistance; combination of cells and resistance; heating, chemical and magnetic effects of current; galvanometer, ammeter, voltmeter; electromagnetic induction, induction coil, principles of telegraph and telephone.

Rectilinear propagation of light; eclipses; photometry, reflection and refraction at plane and curved surfaces; refractive index and its measurements; critical angle; total reflection, mirage; behaviour of thin lens; prism, minimum deviation; dispersion; pure spectrum; descriptive treatment of ultraviolet, visible, infrared radiations; simple optical instruments; velocity of light.

Nature of sound and its propagation in a medium; velocity of sound; intensity; pitch and quality of sound, reflection and refraction of sound; echo; beats; laws of transverse vibration of string; sonometer; vibration of air column in pipes.

5. CHEMISTRY AND PHYSICS

(For Group B only)

(*a*) *Chemistry*—Matter, its composition and properties; gas laws and laws of chemical combination; Avogadro's hypothesis; valency; equivalent, atomic and molecular weights; electrolysis; simple chemical calculations.

An elementary study of the following: hydrogen, oxygen, water, nitrogen, ammonia and ammonium salts, nitric acid, chloride, hydrogen chloride, sulphur, hydrogen sulphide, sulphuric acid, carbon and its oxides; sodium, calcium, magnesium, aluminium, copper, iron, and their oxides, hydroxides, chlorides, sulphides, sulphates, nitrates and carbonates.

(*b*) *Physics*—Units and measuring instruments; Newton's laws of motion; simple kinematics; conditions of equilibrium; centre of gravity; balance lever and pulley; conservation of energy and momentum; centripetal and centrifugal forces; simple harmonic motion; simple pendulum.

Statement of the general properties of solids, liquids and gases; pressure at a point; Pascal's law, hydraulic press. Archimedes' principle; specific gravity and density; barometer; siphon and pumps; Hooke's law and elastic constants.

Heat and temperature; thermometry; thermal expansion of solids and liquids; gas laws; perfect gas scale of temperatures; specific heat, calorimetry; change of state; vapour pressure; gas and vapour; relative humidity, hygrometry, dew point; mechanical equivalent of heat; heat transfer by conduction, convection and radiation.

Electric and Magnetic intensity; potential and lines of force; electrostatic and magnetostatic induction; lectrophorus; gold leaf electroscope; capacity, magnetic moment; magnetometer; elements of terrstrial magnetism. Primary and secondary cells; Ohm's law; measurement of resistance; combination of cells and resistances; heating, chemical and magnetic effects of current; galvanometer, ammeter, voltmeter; electromagnetic induction, inductioncoil; principles of telegraph and telephone.

6. DRAWING

(For Group B only)

(*a*) Lettering (Block and Italics), Scales (Plain and Diagonal) regular Polygons, Curve drawing and their applications (circle, ellipse, parabolla, involute and cycloid);

(*b*) Elementary problems on orthographic projection of simple objects and isometric views from orthographic projections.

(*c*) Imaginative free hand sketching of objects from day to day experience.

(*d*) General layout and neatness of drawing.

Note—The candidates will use their own drawing instruments and scales, set squares, pencils, etc., and answer in the Answer Book to be supplied.

SCHEDULE VI

REGULATION NO. 12

Schedule of courses and Distribution of Marks for 5-year, 5½-year and 6-year Bachelor of Technology and 5½-year Bachelor of Architecture Courses

1. The academic year of about 30 weeks is divided into three terms except that in the final year there is an additional fourth term as prescribed in the Regulations. In the Schedule of courses given in the following pages the number of hours per week for each subject is indicated. Number of hours per week denotes the hours in class, that is, lectures, seminars (represented by the first figure) and the hours in tutorials, laboratory, field, drawing and design (represented by the second figure). Each student is expected to devote about 20 hours per week to study and home preparation.

2. Marks, the number of papers and the duration of each paper for each subject of examination are also shown against each subject. The first figure under the column "Marks" indicates marks for written paper or papers and the second figure for sessional assignments including practical training, etc.

3. Each subject of instruction is given a reference number, the first year subjects being numbered from 111 to 199, the second year subjects from 211 to 299 and so on. List of optional subjects is given in Schedule X, the subjects being numbered separately.

The following is the key to the abbreviations used to indicate the departments which shall normally be responsible for organising the courses of study and examinations:—

Aeronautical Engineering	AE
Agricultural Engineering	AgE
Applied Chemistry	Ch
Architecture and Regional Planning	Ar
Chemical Engineering	ChE
Civil Engineering	CE
Electrical Engineering	EE
Electronics and Electrical Communication Engineering	Comm
Geology and Geophysics	Ge
Humanities and Social Sciences	Hu
Mathematics	Ma
Mechanical Engineering	ME
Metallurgical Engineering	Met
Mining Engineering	Min
Naval Architecture and Marine Engineering	NA
Physics and Meteorology	Ph

Course Schedule and Distribution of Marks

A. **Bachelor of Technology (B. Tech.)—5-year 5½-year and 6-year Integrated Courses**

I FIRST YEAR

[Common to all courses leading to the degree of Bachelor of Technology (B. Tech.)]

(For Science Stream candidates)

Subject No.	Subjects for the First Examination	All Terms: Hours per week	All Terms: Marks	No. of papers for examination	Duration of Examination papers
Hu 111	English	2— 2	100— 50	1	2 hrs.
Hu 112 Hu 113	History Principles of Government }	2— 0	100— 0	1	2 hrs.
Ch 111	Chemistry	3— 3	150—100	1	3 hrs.
CE 111	Drawing and Descriptive Geometry	1— 4	50—150	1	3 hrs. (Exam. to be arranged by Dept.)
Ma 111	Mathematics and Mechanics	4— 2	200— 50	2	2 hrs. each
ME 121	Workshop Practice	1— 3	50—150	1	2 hrs.
Ph 111	Physics	3— 3	150—100	1	3 hrs.
	NCC or Physical Training	0— 3	0—100	—	—
	*Orientation Course	1— 0	— —	—	—
	Hindi or Regional language (other than mother tongue)	1— 0	— —	—	—
		18—20	800—700	8	

*Orientation course will be given by the respective departments.

Note: All papers for the End-Sessional examination for all the years shall be of 3 hours' duration.

(For Technical stream candidates)

Subject No.	Subjects for the First Examination	All Terms Hours per week	All Terms Marks	No. of papers for examination	Duration of examination papers
Hu 111	English	2— 2	100— 50	1	2 hrs.
Hu 112 Hu 113	History Principles of Government }	2— 0	100— 0	1	2 hrs.
Ch 112	Chemistry	4— 3	200—100	2	2 hrs. each
CE 112	Drawing and Descriptive Geometry	0— 3	0—100	—	—
Ma 112	Mathematics and Mechanics	5— 2	250—100	2	2 hrs. each
ME 122	Workshop Practice	0— 3	0—100	—	—
Ph 112	Physics	4— 3	200—100	2	2 hrs. each
	NCC or Physical Training	0— 3	0—100	—	—
	*Orientation course	1— 0	— —	—	—
	Hindi or Regional language (other than mother tongue)	1— 0	— —	—	—
		19—19	850—650	8	

* Orientation course will be given by the respective departments.

II—SECOND YEAR

Common to all courses leading to the Degree of Bachelor of Technology (B. Tech.)

Subject No.	Subjects for the Second Examination	All Terms Hours per week	All Terms Marks	No. of papers for examination	Duration of examination papers
Hu 211	English	1— 1	50— 50	1	2 hrs.
Hu 212	History	1— 0	100— 0	1	2 hrs.
Hu 215	Industrial Development in India	1— 0			
Ch 211	Chemistry	3— 3	150—100	1	3 hrs.
*CE 211	Engineering Drawing	0— 4	0—150	—	—
Ma 211	Mathematics and Mechanics	4— 2	200— 50	2	2 hrs. each
@ME 221	Workshop Theory and Practice	1— 3	50—100	1	2 hrs.
ME 261	Applied Mechanics I	2— 2	100— 50	1	2 hrs.
Ph 211	Physics	3— 3	150—100	1	3 hrs.
	NCC or Physical Training	0— 3	0—100	—	—
		16—21	800—700	8	

*Students of the Naval Architecture course will have the following subject instead of "Engineering Drawing" with changed number of hours and marks:

NA 221	Ship Drawing and Calculation ...	2—3	50—100	1	3 hrs.	18—20	850—650

@50 marks shall be allotted in the First Term to the students of the Naval Architecture course for Practical Training during the preceding Summer Vacation.

III—THIRD YEAR

1. AERONAUTICAL ENGINEERING

Subject No.		Subjects for the Intermediate Examination	All Terms: Hours per week	All Terms: Marks	No. of papers for examination	Duration of Examination papers
Hu	314	Economics and Economics of Industrial Labour ...	2— 0	100— 0	1	2 hrs.
Comm EE	311 311	Principles of Electronics Electrical Technology	3— 2	150— 50	1	3 hrs.
Ma	311	Mathematics	2— 1	100— 50	1	2 hrs.
ME	331	Heat Technology	2— 1	100— 50	1	2 hrs.
ME	351	Machine Elements Design and Drawing	2— 3	100—100	1	2 hrs.
Met Phy	311 311	Elements of Metallurgy Physics	3— 0	150— 0	1	3 hrs.
AE AE	311 351	Principles of Aeronautics ... Mechanics ...	3— 2	150—100	1	3 hrs.
AE	341	Aircraft Layout and Detailed Design	1— 4	50—200	1	3 hrs.
		NCC or Physical Training	0— 2	0— 50	—	—
			18—15	900—600	8	

2. AGRICULTURAL ENGINEERING

Subject No.		Subjects for the Intermediate Examination	All Terms: Hours per week	All Terms: Marks	No. of papers for examination	Duration of examination papers
Hu	314	Economics and Economics of Industrial Labour ...	2— 0	100— 0	1	2 hrs.
AgE	311	Botany	2— 2	100— 50	1	2 hrs.
CE	311	Applied Mechanics—II	2— 2	100— 50	1	2 hrs.
CE	315	Building Construction and Surveying	2— 3	100—100	1	2 hrs.
Comm EE	311 311	Principles of Electronics Electrical Technology	3— 2	150— 50	1	3 hrs.
Ma	311	Mathematics	2— 1	100— 50	1	2 hrs.
ME	331	Heat Technology	2— 1	100— 50	1	2 hrs.
ME	351	Machine Elements Design and Drawing	2— 3	100—100	1	2 hrs.
Met Ph	311 311	Elements of Metallurgy Physics	3— 0	150— 0	1	3 hrs.
		N. C. C. or Physical Training	0— 2	0— 50	—	—
			20—16	1000—500	9	

3. CHEMICAL ENGINEERING

Subject	No.	Subjects for the Intermediate Examination	All Terms: Hours per week	All Terms: Marks	No. of papers for examination	Duration of exam. paper.
Hu	314	Economics and Economics of Industrial Labour ...	2— 0	100— 0	1	2 hrs.
ChE	311	Chemical Engineering Stoichiometry	2— 1	100— 50	1	2 hrs.
ChE	312	Chemical Engineering Equipment Drawing ...	0— 2	0—100	—	—
CE	311	Applied Mechanics—II	2— 2	100— 50	1	2 hrs.
Comm EE	311 311	Principles of Electronics Electrical Technology	3— 2	150— 50	1	3 hrs.
Ma	311	Mathematics	2— 1	100— 50	1	2 hrs.
ME	321	Workshop Practice	0— 3	0—100	—	—
ME	331	Heat Technology	2— 1	100— 50	1	2 hrs.
ME	351	Machine Elements Design and Drawing	2— 3	100—100	1	2 hrs.
Met Ph	311 311	Elements of Metallurgy Physics	3— 0	150— 0	1	3 hrs.
		N. C. C. or Physical Training	0— 2	0— 50	—	—
			18—17	900—600	8	

4. CIVIL ENGINEERING

Subject	No.	Subjects for the Intermediate Examination	All Terms: Hours per week	All Terms: Marks	No. of papers for examination	Duration of exam. paper
Hu	314	Economics and Economics of Industrial Labour ...	2— 0	100— 0	1	2 hrs.
CE	313	Surveying, Building Construction and Estimating ...	2— 4	100—150	1	2 hrs.
CE CE	317 3	Fluid Mechanics ... ... Strength of Materials	2— 2 1— 2	150—100	1	3 hrs.
Comm EE	311 311	Principles of Electronics Electrical Technology	3— 2	150— 50	1	3 hrs.
Ma	311	Mathematics	2— 1	100— 50	1	2 hrs.
ME	331	Heat Technology	2— 1	100— 50	1	2 hrs.
ME	351	Machine Elements Design and Drawing	2— 3	100—100	1	2 hrs.
Met Ph	311 311	Elements of Metallurgy ... ... Physics	3— 0	150— 0	1	3 hrs.
		N. C. C. or Physical Training	0— 2	0— 50	—	—
			19—17	950—550	8	

5. ELECTRICAL ENGINEERING

Subject	No.	Subjects for the Intermediate Examination	All Terms Hours per week	All Terms Marks	No. of papers for examination	Duration of exam. paper
Hu	314	Economics and Economics of Industrial Labour ...	2— 0	100— 0	1	2 hrs.
CE	311	Applied Mechanics II	2— 2	100— 50	1	2 hrs.
Comm	312	Principles of Electronics	2— 2	100— 50	1	2 hrs.
EE	321	Electrical Circuits and Machines	3— 4	150—150	1	3 hrs.
Ma	311	Mathematics	2— 1	100— 50	1	2 hrs.
ME	321	Workshop Practice	0— 3	0—100	—	—
ME	331	Heat Technology	2— 1	100— 50	1	2 hrs.
ME	351	Machine Elements Design and Drawing	2— 3	100—100	1	2 hrs.
Met Ph.	311} 311}	Elements of Metallurgy ... ... Physics	3— 0	150— 0	1	3 hrs.
		N. C. C. or Physical Training	0— 2	0— 50	—	—
			18—18	900—600	8	

6. ELECTRONICS AND ELECTRICAL COMMUNICATION ENGINEERING

Subject No.		Subjects for the Intermediate Examination	All Terms: Hours per week	All Terms: Marks	No. of papers for examination	Duration of exam. paper.
Hu	314	Economics and Economics of Industrial Labour ...	2—0	100— 0	1	2 hrs.
CE	311	Applied Mechanics II	2—2	100— 50	1	2 hrs.
Comm	312	Principles of Electronics	2—2	100— 50	1	2 hrs.
EE	321	Electrical Circuits and Machines	3—4	150—150	1	3 hrs.
Ma	311	Mathematics	2—1	100— 50	1	2 hrs.
ME	321	Workshop Practice	0—3	0—100	—	
ME	331	Heat Technology	2—1	100— 50	1	2 hrs.
ME	351	Machine Elements Design and Drawing ...	2—3	100—100	1	2hrs.
Met Ph	311 311	Elements of Metallurgy ... ... Physics	3—0	150— 0	1	3 hrs.
		NCC or Physical Training	0—2	0— 50	—	—
			18—18	900—600	8	

7. MECHANICAL ENGINEERING

Subject No.		Subjects for the Intermediate Examination	All Terms: Hours per week	All Terms: Marks	No. of papers for examination	Duration of exam. paper.
Hu	314	Economics and Economics of Industrial labour ...	2—0	100— 0	1	2 hrs.
CE	311	Applied Mechanics II	2—2	100— 50	1	2 hrs.
Comm EE	311 312	Principles of Electronics ... ... Electrical Technology—I	3—2	150— 50	1	3 hrs.
Ma	311	Mathematics	2—1	100— 50	1	2 hrs.
ME	321	Workshop Practice	0—3	0—100	—	—
ME	331	Heat Technology	2—1	100— 50	1	2 hrs.
ME	351	Machine Elements Design and Drawing ...	2—3	100—100	1	2 hrs.
ME	354	Theory of Machines and Mechanism I	1—2	50—100	1	2 hrs.
Met Ph	311 311	Elements of Metallurgy ... ... Physics	3—0	150— 0	1	3 hrs.
Met	312	Metallurgy Laboratory	0—2	0—100	—	—
		NCC or Physical Training	0—2	0— 50	—	—
			17—18	850—650	8	

8. METALLURGICAL ENGINEERING

Subject No.		Subjects for the Intermediate Examination	All Terms		No. of papers for examination	Duration of exam. paper
			Hours per week	Marks		
Hu	314	Economics and Economics of Industrial Labour ...	2—0	100— 0	1	2 hrs.
ChE	315	Fuels and Furnaces	3—2	150—100	1	3 hrs.
CE	311	Applied Mechanics II	2—2	100— 50	1	2 hrs.
Comm EE	311 311	Principles of Electronics Electrical technology	3—2	150— 50	1	3 hrs.
Ge	312	Geology for Metallurgists	2—2	100— 50	1	2 hrs.
Ma	311	Mathematics	2—1	100— 50	1	2 hrs.
ME	351	Machine Elements Design and Drawing ...	2—3	100—100	1	2 hrs.
Met	313	General Metallurgy	2—2	100— 50	1	2 hrs.
Ph	312	Physics	2—0	100— 0	1	2 hrs.
		NCC or Physical Training	0—2	0— 50	—	—
			20—16	1000—500	9	

9. MINING

Subject No.		Subjects for the Intermediate Examination	All Term Hours per Week	
Hu	314	Economics and Economics of Industrial Labour	2	0
CE	311	Applied Mechanics II	2	2
Comm	311	Principles of Electronics	3	2
EE	312	Electrical Technology—I		
GE	311	Physical and Structural Geology	2	2
Ge	313	Mineralogy and Petrology	2	2
Ma	311	Mathematics	2	1
ME	331	Heat Technology	2	1
ME	351	Machine Elements Design and Drawing	2	3
Ph	312	Physics	2	0
Min	311	Mining Engineering I	2	0
		Mining Geology Camp	—	
		Vacation Mining Training Report	—	
		N. C. C. or Physical Training	0	2
			21	15

ENGINEERING

1st Term			2nd Term			3rd Term		
Marks	No. of papers for Examination	Duration of Exam. papers	Marks	No. of papers for Examination	Duration of Exam. papers	Marks	No. of papers for Examination	Duration of Exam. papers
100— 0	1	2 hrs.	100— 0	1	2 hrs.	100— 0	1	3 hrs.
100— 50	1	2 hrs.	100— 50	1	2 hrs.	100— 50	1	3 hrs.
150— 50	1	3 hrs.	150— 50	1	3 hrs.	150— 50	1	3 hrs.
75— 75	1	2 hrs.	75— 75	1	2 hrs.	75— 50	1	3 hrs.
75— 75	1	2 hrs.	75— 75	1	2 hrs.	75— 75	1	3 hrs.
100— 50	1	2 hrs.	100— 50	1	2 hrs.	100— 50	1	3 hrs.
100— 50	1	2 hrs.	100— 50	1	2 hrs.	100— 50	1	3 hrs.
100—100	1	2 hrs.	100—100	1	2 hrs.	100—100	1	3 hrs.
100— 0	1	2 hrs.	100— 0	1	2 hrs.	100— 0	1	3 hrs.
75— 0	1	2 hrs.	100— 0	1	2 hrs.	100— 0	1	3 hrs.
—	—	—	—	—	—	0— 25	—	—
0— 25	—	—	—	—	—	—	—	—
0— 50	—	—	0— 50	—	—	0— 50	—	—
975—525	10		1000—500	10		1000—500	10	

10. NAVAL ARCHITECTURE

Subject No.		Subjects for the Intermediate Examination	All Terms: Hours per week	All Terms: Marks	No. of papers for examination	Duration of exam. paper.
Hu	314	Economics and Economics of Industrial Labour ...	2—0	100— 0	1	2 hrs.
CE	311	Applied Mechanics II	2—2	100— 50	1	2 hrs.
Comm EE	311 311	Principles of Electronics Electrical Technology	3—2	150— 50	1	3 hrs.
Ma	311	Mathematics	2—1	100— 50	1	2 hrs.
ME	331	Heat Technology	2—1	100— 50	1	2 hrs.
ME	351	Machine Elements Design and Drawing ...	2—3	50—100	1	2 hrs.
NA	311	Ship Theory I	2—0	100— 0	1	2 hrs.
NA NA	313 312	Statics of Ship Forms ... ... Practical Ship-Building	4—0	150— 0	1	3 hrs.
NA	321	Ship Drawing and Calculation II	0—6	0—200*	—	—
Ph	312	Physics	2—0	100— 0	1	2 hrs.
		NCC or Physical Training	0—2	0— 50	—	—
			21—17	950—550	9	

* 50 marks in the First term for Practical Training of one month in a Shipyard during the preceding Summer Vacation.

IV. FOURTH YEAR

1. AERONAUTICAL ENGINEERING

Subject No.		Subject for the Fourth Examination	All Terms		No. of papers for Examination	Duration of Exam. paper
			Hours per week	Marks		
Hu	414	General and Industrial Psychology	2—0	100— 0	1	2 hrs.
Ma	415	Mathematics	2—1	100— 50	1	2 hrs.
ME	422	Metal Processing	1—2	50— 50	1	2 hrs.
ME	462	Mechanics of Materials and Machines	2—1	100— 50	1	2 hrs.
AE	411	Fluid Mechanics	2—2	100— 50	1	2 hrs.
AE	412	Aircraft Performance	1—1	50— 50	1	2 hrs.
AE	421	Elements of Aircraft Vibration	2—1	100— 50	1	2 hrs.
AE	422	Aircraft Structures I	2—3	100—100	1	2 hrs.
AE	431	Aircraft Propulsion I	2—3	100—100	1	2 hrs.
AE	441	Aircraft Design I	1—4	50—150*	Oral Examination to conducted	
			17—18	850—650	9	by Dept.
		Option	2—0	100— 0	1	
		Physical Training	19—18	0—100	—	—

* 50 marks in the first term for practical training during the preceding Summer vacation.

2. AGRICULTURAL ENGINEERING

Subject No.		Subject for the Fourth Examination	All Terms		No. of papers for Examination	Duration of Exam. paper
			Hours per Week	Marks		
Hu	414	General and Industrial Psychology	2—0	100— 00	1	2 hrs.
AgE	411	Soil Science	2—3	100—100	1	2 hrs.
AgE	412	Crop Production	2—2	100—100	1	2 hrs.
AgE	413	Farm Machinery	2—3	150—100*	1	2 hrs.
AgE	414	Theory and Design of Farm Structures	2—3	150—100*	1	2 hrs.
AgE	415	Rural Electrification	1—1	50— 50	1	2 hrs.
Ge	411	Geology	1—1	50— 50	1	2 hrs.
ME	432	Heat Power Engineering	2—2	100— 50	1	2 hrs.
ME	452	Machine Elements Design	2—2	100— 50	1	2 hrs.
			16—17	900—600	9	
		Option	2—0	100— 0	1	
			18—17			
		Physical Training	—	0—100		

* 50 marks from each in the first term for six weeks' Practical training during the preceding Summer Vacation.

3. CHEMICAL ENGINEERING

Subject No.	Subjects for the Fourth Examination	First Term Hrs. per Week	First Term Marks	No. of papers for Exam.	Duration of Exam. paper	Second Term Hrs. per Week	Second Term Marks	No. of papers for Exam.	Duration of Exam. paper	Third Term Hrs. per Week	Third Term Marks	No. of papers for Exam.	Duration of Exam. paper
Hu 414	General and Industrial Psychology	2 0	100— 0	1	2 hrs.	2 0	100— 0	1	2 hrs.	2 0	100— 0	1	3 hrs.
Ch 419	Physical Chemistry for Chemical Engineers ...	2 3	100— 75	1	2 hrs.	2 3	100— 75	1	2 hrs.	2 3	100— 75	1	3 hrs.
Ch 420	Organic Chemistry for Chemical Engineers ...	2 3	100— 75	1	2 hrs.	2 3	100— 75	1	2 hrs.	2 3	100— 75	1	3 hrs.
ChE 411	Chemical Process Technology (Tech—I)	2 0	100— 50	1	2 hrs.	0 3	0—100	—	—	2 3	100— 50	1	3 hrs.
ChE 412	Flow of fluids and fluid handling (Unit Op. I) ...	2 0	100— 50	1	2 hrs.	2 0	100— 50	1	2 hrs.	1 0	50— 50	1	3 hrs.
ChE 413	Heat Transfer (Unit Operation II) ...	—	—	—	—	2 0	100— 50	1	2 hrs.	2 0	100— 50		
ChE 414	Size reduction and Mechanical operations (Unit Op. III)...	2 0	100— 50	1	2 hrs.	—	—	—	—	2 0	100— 50	1	3 hrs.
ChE 415	Unit operation Lab. I ...	0 5	0—200*	—	—	0 5	0—150*	—	—	0 5	0—150*	—	—
ChE 416	Fuels, Combustion and Furnaces	2 2	100—100	1	2 hrs.	2 2	100—100**	1	2 hrs.	2 0	100— 0	1	3 hrs.

3. CHEMICAE ENGINEERING—Contd.

Subject No.	Subjects for the Fourth Examination	First Term Hrs. per Week		First Term Marks	No. of papers for Exam.	Duration of Exam. paper	Second Term Hrs. per Week		Second Term Marks	No. of papers for Exam.	Duration of Exam. paper	Third Term Hrs. per Week		Third Term Marks	No. of papers for Exam.	Duration of Exam. paper
ChE 417	Applied Mathematics for Chemical Engineers ...	—		—	—	—	2	0	100— 0	1	2 hrs.	1	0	50— 0	1	3 hrs.
ME 433	Applied Thermodynamics & Heat Power	2	2	100—100	1	2 hrs.	2	2	100—100	1	2 hrs.	2	2	100—100	1	3 hrs.
		16	15	800—700	8		16	18	800—700	8		18	16	900—600	9	
	Option	2	0	100— 0	1		2	0	100— 0	1		2	0	100— 0	1	
		18	15				18	18				20	16			
	Physical Training ...			0—100					0—100					0—100		

* 50 marks in the first term for Factory Training during the preceding Summer Vacation and 75 marks in all terms for Drawing and Design.

** 25 marks for Educational Tour.

4. CIVIL ENGINEERING

Subject No.		Subject for the Fourth Examination	All Terms		No. of papers for Examination	Duration of Exam. paper
			Hours/per Week	Marks		
Hu	414	General and Industrial Psychology	2—0	100— 0	1	2 hrs.
CE	411	Theory of Structures and Soil Mechanics ...	2—2	100—100	1	2 hrs.
CE	412	Design of Structures—Concrete and Steel ...	2—2	100—100	1	2 hrs.
CE	413	Hydraulics, Hydrology and Irrigation	3—2	150—100	1	3 hrs.
CE	414	Surveying and Construction	2—5	100—100	1	2 hrs.
CE	415	Engineering Laboratory	0—6	0—300*		
CE	417	Sanitary Engineering	2—2	100— 50	1	2 hrs.
Ma	411	Mathematics	2—0	100— 0	1	2 hrs.
			15—19	750—750	7	
		Option	2—0	100— 0	1	
			17—19			
		Physical Training		0—100		

* 50 marks in the first term for Professional Training during the preceding Summer Vacation,
* 50 marks for Educational Tour in the second term and
* 50 marks for Survey Camp in the third term.

5. ELECTRICAL ENGINEERING

Subject No.		Subjects for the Fourth Examination	All Terms: Hours/per Week	All Terms: Marks	No. of papers for Exam.	Duration of Exam. paper
Hu	414	General and Industrial Psychology	2—0	100— 00	1	2 hrs.
Comm	411	Principles of Electrical Communication	2—1½	100— 50	1	2 hrs.
EE	421	Electrical Circuits and Measuring Instruments ...	2—1	100— 50	1	2 hrs.
EE	431	Electrical Machines	3—1	150— 50	1	3 hrs.
EE	441	Power Systems I	2—2	100—100*	1	2 hrs.
EE	451	Electrical Laboratory I	0—4½	0—150**	—	—
Ma	412	Mathematics of Circuit Analysis	2—0	100— 0	1	2 hrs.
ME	434	Prime Movers	2—3	100—100	1	2 hrs.
ME	453	Machine Elements Design	2—2	100— 50	1	2 hrs.
Ph	411	Physics	2—0	100— 0	1	2 hrs.
			19—15	950—550	9	
		Option	2—0	100— 0	1	
			21—15			
		Physical Training	—	0—100	—	—

* 50 marks in the first term for Practical Training during the preceding Summer Vacation and 50 marks for Educational Tour.
** 100 marks in the third term for Laboratory Test.

6. ELECTRONICS AND ELECTRICAL COMMUNICATION ENGINEERING

Subject No.	Subjects for the Fourth Examination	All Terms		No. of papers for Exam.	Duration of Exam. paper
		Hours/per Week	Marks		
Hu 414	General and Industrial Psychology	2—0	100— 0	1	2 hrs.
Comm 412	H.F. Measurements and Electro Acoustics ...	2—0	100— 0	1	2 hrs.
Comm 413	Networks and Transmission Lines	2—1½	100— 50	1	2 hrs.
Comm 414	Electronic Circuits	3—1	150— 50	1	3 hrs.
Comm 415	Radio Engineering I	2—1	100— 50	1	2 hrs.
Comm 416	Electronics and Electrical Communication Engineering Laboratory	0—6	0—150	—	—
EE 415	Electrical Measurements, Transmission and Distribution	3—1	150— 50*	1	3 hrs.
EE 416	Electrical Machines	3—1	150— 50*	1	3 hrs.
EE 417	Electrical Laboratory	0—4½	0—150**	—	—
Ph 411	Physics	2—0	100— 0	1	2 hrs.
		19—16	950—550	8	
	Option	2—0	100— 0	1	
		21—16			
	Physical Training		0—100		

* 25 marks from each for Educational Tour report (total 50 marks).

** 50 marks in the first term for Practical Training during the preceding Summer Vacation and 100 marks in the third term for Laboratory Test.

7. MECHANICAL ENGINEERING

Subject No.		Subjects for the Fourth Examination	All Terms		No. of papers for Exam.	Duration of Exam. paper
			Hours/per Week	Marks		
Hu	414	General and Industrial Psychology	2—0	100— 0	1	2 hrs.
EE	412	Electrical Technology II	2—3	100—100	1	2 hrs.
ME	421	Production Technology	2—3	100—100*	1	2 hrs.
ME	431	Heat Power Technology I	2—2	100—100	1	2 hrs.
ChE	433	Testing of Fuels				
ME	441	Hydraulic Machines	2—2	100— 75	1	2 hrs.
ME	451	Machine Design	2—3	100— 75	1	2 hrs.
ME	454	Theory of Machines and Mechanisms II ...	2—1	100— 50	1	2 hrs.
ME	461	Mechanics of Solids I	2—3	100—100*	1	2 hrs.
Ma	413	Mathematics	1—1	50— 50	1	2 hrs.
			17—18	850—650	9	
		Option	2—0	100— 0	1	
			19—18			
		Physical Training		0—100		

* 50 marks (25 marks from each subject) in the :—
I Term towards Practical Training during the preceding Summer Vacation ;
II Term towards Educational Tour.

8. METALLURGICAL ENGINEERING

Subject No.		Subjects for the Fourth Examination	1st and 3rd Terms		No. of papers for exam.	Duration of exam. papers	2nd Term		No. of papers for Exam.	Duration of exam. papers
			Hrs. per Week	Marks			Hrs. per Week	Marks		
Hu	414	General and Industrial Psychology	2—0	100—0	1	2 hrs.	2—0	100—0	1	2 hrs.
Ch	412	Assaying and Metallurgical Analysis	1—3	50—100	1	2 hrs.	1—3	50—100	1	2 hrs.
ChE	431	Mineral Dressing	2—2	100—50	1	2 hrs.	2—2	100—50	1	2 hrs.
Met	411	Extractive Metallurgy of Iron and Steel I	2—1	100—50	1	3 hrs.	2—1	100—50	1	2 hrs.
Met	414	Refractories	1—0	50—0			0—2	0—50		
Met	412	Foundry Metallurgy	2—3	100—100	1	2 hrs.	2—3	100—100	1	2 hrs.
Met	413	Physical Metallurgy—I ...	2—3	100—100	1	2 hrs.	2—3	100—100	1	2 hrs.
Met	415	Mechanical Metallurgy—I ...	2—3	100—100	1	2 hrs.	2—3	100—100	1	2 hrs.
Met	416	Extractive Metallurgy of Non-Ferrous Metals	2—1	100—50	1	2 hrs.	2—1	100—50	1	2 hrs.
Met	417	Metallurgical Thermodynamics and Chemical Kinetics	2—1	100—50	1	2 hrs.	2—1	100—50	1	2 hrs.
			18—17	900—600	9		17—19	850—650	9	
		Option	2—0	100—0	1		2—0	100—0	1	
			20—17				19—19			
		Physical Training		0—100				0—100	—	

9. MINING ENGINEERING

Subject No.		Subjects for the Fourth Examination	Hours per Week 1st term		2nd term		3rd term		Marks 1st term	2nd term	3rd term	No. of papers for Exam.	Duration of the paper for terminal exam.
Hu	414	General and Industrial Psychology	2	0	2	0	2	0	100— 0	100— 0	100— 0	1	2 hrs.
ChE	432	Mineral Dressing	2	0	2	3	2	3	75— 0	75— 75	75— 75	1	2 hrs.
EE	413	Electrical Technology II ...	2	1	2	1	2	1	100— 50	100— 50	100— 50	1	2 hrs.
Ge	423	Stratigraphy, Paleontology, Economic Geology and prospecting ...	4	2	3	2	3	2	175— 50	150— 50	150— 50	1	3 hrs.
Min	411	Mining Engineering II ...	3	0 3 hrs.	2	0	2	0	100— 0	100— 0	100— 0	1	2 hrs.
Min	412	Mining Engineering III ...	2	0	2	0	2	0	100— 0	100— 0	100— 0	1	2 hrs.
Min	413	Mining Engineering IV ...	2	3	2	3	2	3	100—100	100—100	100—100	1	2 hrs.
Min	414	Mining Machinery I	3	2 3 hrs.	2	2	2	2	100—100	100—100	100—100	1	2 hrs.
Min	415	Mine Surveying I	3	3	3	3	2	3	100—100	100—100	100—100	1	3 hrs.
		Viva-voce	...		...		...		0— 50	0— 50	0— 50	—	—
		Vacation Training Report ...	—		—		—		0—100	—	—	—	—
		*Survey Field Work	—		—		—		—	0— 50	—	—	—
		**Mining Field Trip	—		—		—		—	—	0— 50	—	—
			23	11	20	14	19	14	950—550	925—575	925—575	9	—
		Option	2	0	2	0	2	0	100— 0	100— 0	100— 0	1	
			25	11	22	14	21	14					
		Physical Training							0—100	0—100	0—100	—	—

*10 days during the IV year Educational Tour period.
**Two weeks at the beginning of 3rd Term.
Two days excursion to Mosabani Mine towards the end of second term.

10. NAVAL ARCHITECTURE

Subject No.		Subject for the Fourth Examination	First and Second Terms: Hrs./per Week		Marks	No. of papers for Exam.	Duration of Exam. papers	Third Term: Hrs./per Week		Marks	No. of papers for Exam.	Duration of Exam. papers
Hu	414	General and Industrial Psychology	2	0	100—0	1	2 hrs.	2	0	100—0	1	3 hrs.
ChE	435	Plastics and Paints	1	0	50—0	1	2 hrs.	—		—		—
CE	418	Advanced Strength of Materials	2	2	100—100	1	2 hrs.	2	2	100—100	1	3 hrs.
ME	433	Applied Thermodynamics and Heat Power ... ... (Marine Power Engineering) ...	2	2	100—100	1	2 hrs.	2	2	100—100	1	3 hrs.
Met	419	Engineering Metallurgy ...	2	0	100—0	1	2 hrs.					
NA	411	Sea-going Qualities of Ships ...	1	0	150—0 (411 and 412 together)	1	3 hrs.	2	0	200—0 (411 and 412 together)	1	3 hrs.
NA	412	Resistance of Ships	2	0				2	0			
NA	413	Strength of Ships	2	0	100—0	1	2 hrs.	2	0	100—0	1	3 hrs.
NA	421	Ship Drawing and Calculations III	0	14	0—400*		—	0	14	0—500		
NA	424	Ship Hydrodynamics—I ...	2	0	100—0	1	2 hrs.	2	0	100—0	1	3 hrs.
NA	428	Ship Design—I	1	0	100—0	1	3 hrs.	2	0	100—0	1	3 hrs.
			17	18	900—600	9		16	18	800—700	7	
		Option	2	0	100—0	1		2	0	100—0	1	
			19	18				18	18			
		Physical Training			0—100					0—100		

*50 marks in the first term for Practical Training of six weeks in a shipyard during the preceding Summer Vacation.

FIFTH YEAR

1. AERONAUTICAL ENGINEERING

Subject No.		Subjects for the Final Examination	All Terms Hours/per Week		Marks	No. of papers for Exam.	Duration of Exam. paper
Hu		*Humanities Elective (any one)	1	0	50— 0	1	2 hrs.
AE	511	Aerodynamics	2	3	100—100	1	2 hrs.
AE	512	Aircraft stability and control	2	1	100— 50	1	2 hrs.
AE	522	Aircraft Structures II	2	3	100—100	1	2 hrs.
AE	531	Aircraft Propulsion II	2	3	100—100	1	2 hrs.
AE	541	Aircraft Design II	1	4	50—200	Oral Examination to be arranged by the Dept.	
**		Elective—A (any one)	2	1	100— 50	1	2 hrs.
@@AE Comm	552 552	Systems Engineering I and II	2	3	100—100	1	2 hrs.
		@Elective—B (any one)	2	0	100— 0	1	2 hrs.
			16	18	800—700	8	
		Option	2	0	100— 0	1	
			18	18			
		Physical Training			0—100		
		Viva-voce			0—200		
		Thesis/Project ...			0—300		

*For Humanities Electives see Foot-note on page 55

***Elective-A*

AE 513 Gas Dynamics
AE 514 Wind Tunnel Design and Testing
AE 515 Helicopter, VTOL & STOL Aircraft
AE 521 Aero-elasticity
AE 523 Aircraft Fatigue.
@@AE 552 Third term only
Comm 552 First and Second Terms.

@Elective B

AE 532 Combustion Engineering.
Ma 521 Elements of orbital Mechanics and space vehicles
Ma 522 Computational methods and mathematical programming
ME 511 Industrial Management
Ph 522 Meteorology and Aeronomy.

2. AGRICULTURAL ENGINEERING

Subject No.		Subjects for the Final Examination	All Terms Hours per Week		All Terms Marks	No. of papers for Exam.	Duration of Exam. paper
Hu		*Humanities, Elective (any one)	1	0	50— 0	1	2 hrs.
AgE	511	Farm Management	2	2	100— 50	1	2 hrs.
AgE	512	Agricultural Co-operation and Extension ...	1	0	50— 0	1	2 hrs.
AgE	513	Soil and Water Conservation Engineering ...	2	3	100—100	1	2 hrs.
AgE	514	Irrigation and Drainage	2	3	100—100	1	2 hrs.
AgE	515	Farm Engines and Tractors	2	3	100—100	1	2 hrs.
AgE	516	Farm Machinery and Power Management ...	1	0	100— 0	1	2 hrs.
AgE	517	Problems	0	3	0—100	—	—
AgE	521	Project, Report and Seminar	1	4	0—300†	—	—
		**Elective (any one)	2	2	100— 50	1	2 hrs.
			14	20	700—800	8	
		Option	2	0	100— 0	1	
			16	20			
		Physical Training ...			0—100		
		Viva-voce			0—200		
		Thesis/Project			0—300		

****Electives***

1. AgE 518 Earth Moving Machinery.
2. AgE 519 Tube Wells and Pumps.
3. AgE 520 Agricultural Process Engineering.
4. CE 520 Dam and Water Power Engineering.
5. ME 523 Production Engineering.

†100 marks in the first term for practical training during the preceding Summer Vacation and 50 marks for tour report at the end of Second term.

***Humanities Electives**

Hu 511 Modern Drama.
Hu 512 Shakespeare.
Hu 513 Asia in Transition.
Hu 514 Public Administration.
Hu 515 Industrial Relations.
Hu 516 Human Engineering.
Hu 517 Contemporary Problems.
Hu 518 Problems of Philosophy.

3. CHEMICAL

Subject No.	Subjects of the Final Examination	First Term Hours/Week		First Term Marks	No. of papers for exam.	Duration of exam. papers
Hu	†Humanities (Elective)	1	0	50— 0	1	2 hrs.
ChE 511	Diffusional Operations	4	2	200—100	1	3 hrs.
ChE 515	Unit Operations Lab. II ...	0	6	0—200	...	—
ChE 516	Chemical Process Technology (Tech—II)	2	3	100—100	1	2 hrs.
ChE 521	Materials of Construction ...	1	0	50— 0	1	2 hrs.
ChE 522	Instrumentation and Process Control	...		..	..	..
ChE 523	Chemical Engineering Thermodynamics	2	1	100— 50	1	2 hrs.
ChE 524	Engineering Economics ...	1	0	50— 0	1	2 hrs.
ChE 526	Fundamentals of Molecular Phenomena	2	1	100— 50	1	2 hrs.
ChE 527	Chem. Engg. Plant and Equipment Design	1	3	50—200*	1	2 hrs.
	**Elective (any one)	2	0	100— 0	1	2 hrs.
		16	16	800—700	9	
	Option	2	0	100— 0	1	
		18	16			
	Physical Training			0—100		

*50 marks in the first term for Factory Training during the preceding Summer Vacation.

***Electives*

ChE 528 Petroleum Refinery Engineering:
ChE 529 Synthetic Fuel Engineering:
ChE 530 Coal Chemicals:
ChE 531 Biochemical Engineering.

†For Humanities Electives see foot-note on page 55.
††25 marks for Educational Tour.
***25 marks for Seminar.

ENGINEERING

Second Term				Third Term			
Hours/Week	Marks	No. of papers for exam.	Duration of exam. papers	Hours/Week	Marks	No. of papers for exam.	Duration of exam. papers
1 0	50— 0	1	2 hrs.	1 0	50— 0	1	3 hrs.
4 1	200—100	1	3 hrs.	4 1	200—100	1	3 hrs.
0 6	0—200	—	—	0 6	0—200	—	—
2 3	100—100††	1	2 hrs.	2 0	100— 50	1	3 hrs.
1 0	50— 0	1	2 hrs.	—	—	—	—
2 1	100— 50	1	2 hrs.	2 3	100— 50	1	3 hrs.
2 1	100— 50	1	2 hrs.	1 1	50— 50	1	3 hrs.
1 0	50— 0	1	2 hrs.	2 0	100— 0	1	3 hrs.
—	—	—	—	2 1	100—100***	1	3 hrs.
1 6	50—200	1	2 hrs.	1 6	50—200	1	3 hrs.
2 0	100— 0	1	2 hrs.	—	—	—	—
16 18	800—700	9		15 18	750—750	8	
2 0	100— 0	1		2 0	100—0	1	
18 18				17 18			
	0—100				0—100		

Viva voce ... 0—200
Thesis/Project ... 0—300

4. CIVIL ENGINEERING

Subject	No.	Subjects for the Final Examination	All Terms: Hours per Week		All Terms: Marks	No. of papers for exam.	Duration of exam. paper
Hu		*Humanities, Elective (any one)	1	0	50— 0	1	2 hrs.
CE	511	Structural Analysis and Foundation Engineering ...	2	2	100—100	1	2 hrs.
CE	512	Design of Concrete Structures	2	1	100— 50	1	3 hrs.
CE	513	Roads, Railways and Airports	2	0	100— 0	1	2 hrs.
CE	515	Geodesy and Construction	3	2	150— 50	1	3 hrs.
CE	525	Design of Steel Structures	2	1	100— 50	1	2 hrs.
		**Electives (any two)	4	2	200—100	2	2 hrs. each
CE	529	Project	0	6	0—200†	—	—
Ge	519	Geology for Civil Engineers	2	3	100— 50	1	2 hrs.
			18	17	900—600	9	
		Option	2	0	100— 0	1	
			20	17			
		Physical Training			0—100		
		Viva-voce ...			0—200		
		Thesis/Project ...			0—300		

*For Humanities Electives see foot-note on page 55

**Electives:

CE 520 Dam and Water Power Engineering.
CE 521 Irrigation and Maritime Engineering.
CE 522 Bridge Engineering.
CE 523 Advanced Structural Engineering.
CE 524 Highways, Airports and Tunnels.

†50 marks in the first term for Professional Training during the preceding Summer Vacation and 50 marks in the second term for Educational tour.

5. ELECTRICAL ENGINEERING

Subject No.		Subjects for the Final Examination	All Terms: Hours per Week		All Terms: Marks	No. of papers for exam.	Duration of exam. paper
Hu		†Humanities Elective (any one)	1	0	50— 0	1	2 hrs.
Comm	511	Applied Electronics	2	1½	100— 50	1	2 hrs.
EE	521	Instrumentation and Control	3	1	150— 50	1	3 hrs.
EE	531	Machines and System Components	2	1	100— 50	1	2 hrs.
EE	532	Electrical Machine Design	2	0	100— 0	1	3 hrs.
EE	541	Power Systems II	2	4	100—150*	1	2 hrs.
EE	551	Electrical Laboratory II	0	4½	0—150**	—	—
EE	561	Project	0	4	0—150***	—	—
††Comm Ma	531 511	Computer Technology	2	0	100— 0	1	2 hrs.
Ph	521	Solid State and Nuclear Physics	2	0	100— 0	1	2 hrs.
ME	511	Industrial Management	2	0	100— 0	1	2 hrs.
			18	16	900—600	9	
		Option	2	0	100— 0	1	
			20	16			
		Physical Training			0—100		
		Viva-voce ...			0—200		
		Thesis/Project ...			0—300		

*50 marks in the first term for Practical Training during the preceding Summer Vacation.
**100 marks in the Third Term for Laboratory Test.
***50 marks for Educational Tour.
†For Humanities Electives see foot-note on page 55.
††Comm 531 First Term.
Ma 511 Second and Third Terms.

6. ELECTRONICS AND ELECTRICAL COMMUNICATION ENGINEERING

uSbject No.	Subject for the Final Examination	All Terms Hours per Week		All Terms Marks	No. of papers for exam.	Dnration of exam. paper
*Hu	Humanities, Elective (any one)	1	0	50— 0	1	2 hrs.
Comm 512	Line Communication Engineering	2	1½	100— 50	1	2 hrs.
Comm 513	Mathematics of Circuit Analysis	2	1	100— 50	1	2 hrs.
Comm 514	Radio Engineering II	3	1	150— 50	1	3 hrs.
Comm 515	Engineering Electronics	2	1½	100— 50	1	2 hrs.
Comm 516	E. M. Waves, Radiation and Propagation ...	2	0	100— 0	1	2 hrs.
Comm 517	Physics of Electronic Devices	2	0	100— 0	1	2 hrs.
Comm 518	Design and Report	0	6	0—250†	...	—
Comm 519	E. C. E. Laboratory	0	6	0—150	...	—
ME 511	Industrial Management	2	0	100— 0	1	2 hrs.
	**Elective (any one)	2	0	100— 0	1	2 hrs.
		18	17	900—600	9	
	Option	2	0	100— 0	1	
		20	17			
	Physical Training			0—100		
	Viva-voce ...			0—200		
	Thesis/Project ...			0—300		

**Electives

Comm	520	Antenna and Wave Propagation.
Comm	521	Servomechanism and Control Engineering.
Comm	522	Microwave Engineering.
Comm	523	Electronic Computers.
Comm	524	T. V., Radar and Aids to Navigation.
Comm	525	Acoustics.
Ph	511	Semi-conductor Physics.

*For Humanities Elective see footnote on page 55.

†50 marks in the first term for Practical Training during the preceding Summer Vacation and 50 marks in the third term for Tour Report.

7. MECHANICAL ENGINEERING

Subject No.		Subjects for the Final Examinaiton	All Terms Hours per Week	All Terms Marks	No. of Papers for Exam.	Duration of Exam. Paper
Hu		Humanities Elective @	1—0	50—0	1	2 hrs.
ME	511	Industrial Management	2—0	100—0	1	2 hrs.
ME	521	Metal Proccessing	2—3	100—100	1	2 hrs.
ME	524	Production Engineering Project	1—5	50—200*	1	2 hrs.
ME	555	Design Project	1—5	50—200*		
ME	531	Heat Power Technology II	2—4	100—150	1	2 hrs.
ME	554	Instrumentation and Controls	2—1	100—50	1	2 hrs.
ME	561	Mechanics of Solids II	2—1	100—50	1	2 hrs.
		** Elective, any one	1—1	50—50	1	2 hrs.
			14—20	700—800	8	
		Option	2—0	100—0	1	
			16—20			
		Physical Training		0—100		
		Viva-voce ...		0—200		
		Thesis/Project ...		0—300		

** *Electives*: ME 528 Engineering Quality Control (1—1).
ME 568 Applied Fluid Flow, Plasticity and Experimental Stress Analysis (1—1).

* 50 marks (25 from each subject) in the :—
I term for Practical Training during the preceding Summer Vacation ; II term for Educational Tour.

@ For Humanities Elective see foot-note on page 55

8. METALLURGICAL ENGINEERING

Subject No.		Subjects for the Final Examination	All Terms		No. of Papers for Exam.	Duration of Exam. Paper
			Hours per Week	Marks		
Hu		* Humanities (Elective, any one)	1—0	50— 0	1	2 hrs.
ME	511	Industrial Management	2—0	100— 0	1	2 hrs.
Met	511	Extractive Metallurgy of Iron and Steel II ...	2—1	100— 50	1	2 hrs.
Met	512	Mechanical Metallurgy II	1—0	75— 0	1	2 hrs.
Met	513	Physical Metallurgy II	2—3	100—150	1	2 hrs.
Met	514	Applied X-ray and Metal Physics	2—3	100—100	1	2 hrs.
Met	515	Extractive Metallurgy Laboratory	0—3	0—125	—	—
Met	517	Material Engg. and Powder Metallurgy ...	1—0	75— 0	1	2 hrs.
Met	525	Electrometallurgy and Corrosion	1—1	75— 50	1	2 hrs.
Met	521	Seminar	0—1	0— 50	—	—
Met	522	Project and Report	0—6	0—150	—	—
		** Elective (any one)	2—2	100— 50	1	2 hrs.
			14—20	775—725	9	
		Option	2—0	100— 0	1	—
			16—20			
		Physical Training		0—100		
		Viva-voce		0—200		
		Thesis/Project		0—300		

* For Humanities Electives—see foot-note on page 55

** *Electives*: Met 516 Advanced Metallurgy of Alloy Steel.
Met 518 Furnace Technology.
Met 520 Advanced Foundry Metallurgy.
Met 524 Metallurgy of Atomic Energy Metals.

9. MINING ENGINEERING

Subject No.		Subjects for the Final Examination	Hours per Week 1st Term	2nd Term	3rd Term	Marks 1st Term	No. of papers for Exam.	Duration of Exam. Papers	Marks 2nd Term	No. of papers for Exam.	Duration of Exam. papers	Marks 3rd Term	No. of papers for Exam.	Duration of Exam. papers
Hu		*Humanities (Electives, any one)	1 0	1 0	1 0	50—0	1	2 hrs.	50—0	1	2 hrs.	50—0	1	3 hrs.
ChE	520	Fuels	1 0	2 3	2 3	50—0	1	2 hrs.	100—100	1	2 hrs.	50—100	1	3 hrs.
Met	314	Elements of Metallurgy ...	2 0	2 0	—	100—0	1	2 hrs.	100—0	1	2 hrs.	—		—
CE	517	Building Materials ...	—	—	2 0	—		—	—		—	100—0	1	3 hrs.
ME	511	Industrial Management ...	2 0	2 0	2 0	100—0	1	2 hrs.	100—0	1	2 hrs.	100—0	1	3 hrs.
ME	532	Steam and Compresed Air Power	1 2	1 0	1 0	50—75	1	2 hrs.	50—0	1	2 hrs.	50—0	1	3 hrs.
Min	511	Mining Engineering—V ...	3 2	3 2	3 2	100—100	1	3 hrs.	100—100	1	3 hrs.	100—100	1	3 hrs.
Min	512	Mining Machinery—II ...	3 0	2 0	2 0	100—0	1	3 hrs.	100—0	1	2 hrs.	100—0	1	3 hrs.
Min	513	Mining Legislation and Mine Safety and Mineral Economics	2 0	2 0	2 0	100—0	1	2 hrs.	100—0	1	2 hrs.	100—0	1	3 hrs.
Min	514	Mine Surveying II ...	2 3	2 3	2 3	100—100	1	2 hrs.	100—100	1	2 hrs.	100—100	1	3 hrs
Min	515	Project	0 6	0 6	0 6	0—250	—	—	0—250	—	—	0—300	—	—
		Mining Seminar ...	0 2	0 2	0 2	—	—	—	—	—	—	0—50	—	—
		Viva-voce	—	—	—	0—100	—	—	0—100	—	—	—	—	—
		**Mining Field trip ...	—	—	—	—	—	—	0—50	—	—	—	—	—
		***Mine Survey Camp ...	—	—	—	—	—	—	—	—	—	0—100	—	—
		Vacation Mining Trag. Report	—	—	—	0—125	—	—	—	—	—	—	—	—
			17 15	17 16	17 16	750—750	9		800—700	9		750—750	9	
		Option	2 0	2 0	2 0	100—0	1		100—0	1		100—0	1	
			19 15	19 16	19 16									
		Physical Training ...	—	—	—	0—100			0—100	—		0—100	—	

*For Humanities Electives see foot-note on page 55.
**One week to open cast (mines of the 2nd term).
***Three weeks at the beginning of the third term.

Viva-voce	...	0—200
Thesis/Project	...	0—300

10. NAVAL ARCHITECTURE

(REGULAR COURSE)

Subject No.		Subjects for the Final Examination	First and Second Terms: Hours per Week		Marks	No. of papers for examination	Duration of exam. papers
Hu		†Humanities (Elective, any one)	1	0	50— 0	1	2 hrs.
ME	557	Cargo Handling	2	2	100—100	1	2 hrs.
NA	515	Shipyard Organisation, Tenders and Contracts ...	3	0	100— 0	1	3 hrs.
NA	516	Propulsion and Steering	4	6	200—200	1	3 hrs.
NA	521	Ship Drawing and Calculation—IV	0	12	0—400*	—	—
NA	524	Ship Hydrodynamics II	2	1	100— 50	1	2 hrs.
NA	528	Ship Design—II	3	0	200— 0	1	3 hrs.
			15	21	750—750	6	
		Option	2	0	100— 0	1	
			17	21			
		Physical Training ...			0—100		
		Viva-voce ...			0—200		
		Thesis/Project ...			0—300		

Practical Training for about nine months during the third term,
Summer Vacation and first two terms of the following year — 0—750.

*100 marks in the first term for four weeks' training in the department during the preceding Summer Vacation.

†For Humanities elective see foot-note on page 55

11. NAVAL ARCHITECTURE

(Naval Construction—Option)

Subject No.		Subjects for the Fifth Examination	First and Second Terms: Hours per Week		Marks	No. of papers for exam.	Duration of exam. papers	Third Term: Hours per Week		Marks	No. of papers for exam.	Duration of exam. papers
Hu		†Humanities (Elective, any one) ...	1	0	50— 0	1	2 hrs.	—		—	—	—
CE	591	Advanced Structural Engineering I	2	1	100— 50	1	2 hrs.	2	1	100—100	1	3 hrs.
Met	529	Metallurgy	2	2	100—100	1	2 hrs.	2	2	100—100	1	3 hrs.
NA	517	Propulsion and Steering ...	4	3	200—100	1	3 hrs.	0	3	0—150		
NA	524	Ship Hydrodynamics II ...	2	1	100— 50	1	2 hrs.	2	1	100— 50	1	3 hrs.
NA	525	Design of Warships	2	0	100— 0	1	6 hrs.	2	0	100— 0	1	6 hrs.
NR	526	Warship Drawing and Calculation I	0	12	0—400	—	—	0	16	0—500	—	—
NA	527	Practical Warship Building ...	1	0	50— 0	1	2 hrs.	2	0	100— 0	1	3 hrs.
NA	529	Stability of Warships	2	0	100— 0	1	2 hrs.	2	0	100— 0	1	3 hrs.
			16	19	800—700	8		12	23	600—900	6	
		Optional	2	0	100— 0	1		2	0	100— 0	1	
			18	19				14	23			

†For Humanities elective see foot note on page 55

SIXTH YEAR

1. NAVAL ARCHITECTURE

(Naval Construction—Option)

Subject No.		Subjects for the Final Examination	All Terms				No. of papers for examination	Duration of exam. papers
			Hours per Week		Marks			
CE	691	Advanced Structural Engineering II	2	2	100	100	1	2 hrs.
NA	611	Resistance and Propulsion of Warships	2	0	100	0	1	2 hrs.
NA	612	Structural Design of Warships	2	0	200	0	1	3 hrs.
NA	615	Shipyard Organisation, Tenders and Contracts ...	2	0	100	0	1	2 hrs.
NA	624	Ship Hydrodynamics III	2	1	100	50	1	2 hrs.
NA	626	Warship Drawing and Calculations II	0	20	0	650	—	—
Ph	697	Physics	2	0	100	0	1	2 hrs.
			12	23	700	800	6	

Viva-voce ...	0—200
Thesis/Project ...	0—300

B. BACHELOR OF ARCHITECTURE

(i) FIRST YEAR

Subject No.		Subjects for the First Examination	All Terms Hours per Week		All Terms Marks	No. of papers of examination	Duration of exam. papers
Hu	111	English	2	1	100— 50	1	2 hrs.
Hu	114	History	1	0	50— 0	1	2 hrs.
Ch	113	Chemistry	3	2	150— 50	1	3 hrs.
Ma	111	Mathematics and Mechanics	4	2	200— 50	2	2 hrs. each
Ph	113	Physics	3	2	150— 50	1	3 hrs.
Ar	111	Elements of Architecture	1	4	50—150	1	6 hrs.
Ar	112	Freehand Drawing—I	0	4	0—100	—	—
Ar	113	Descriptive Geometry	0	4	0—100	—	—
Ar	120	Building Materials and Workshop Practice	1	3	50—100	1	2 hrs.
		N.C.C. or Physical Training	0	3	0—100	—	—
			15	25	750—750	8	

(*ii*) SECOND YEAR

Subject No.		Subjects for the Second Examination	All Terms		No. of papers for examination	Duration of exam. papers
			Hours per Week	Marks		
Hu	211	English	1 0	50— 0	1	2 hrs.
Hu	216	Industrial Development in India	1 0	50— 0	1	2 hrs.
CE	215	Surveying	1 3	50—100	1	2 hrs.
CE	216	Structural Mechanics—I	1 3	50—100	1	2 hrs.
Ar	212	Freehand Drawing—II	0 3	0— 50	—	—
Ar	214	History of Architecture—I	2 0	100— 0	1	2 hrs.
Ar	215	Architectural Design—I	2 12	100—500	1	6 hrs.
Ar	220	Building Construction—I	2 6	100—150	1	2 hrs.
		N.C.C. or Physical Training	0 3	0—100	—	—
			10 30	500—1000	7	

(*iii*) THIRD YEAR

Subject No.		Subjects for the Intermediate Examination	All Terms: Hours per Week		All Terms: Marks	No. of papers for examination	Duration of exam. papers
Hu	315	Economics	1	0	50— 0	1	2 hrs.
CE	316	Structural Mechanics—II	2	2	100— 50	1	2 hrs.
CE	321	Services—I	2	0	100— 0	1	2 hrs.
Ar	314	History of Architecture—II	2	0	100— 0	1	2 hrs.
Ar	315	Architectural Design—II	0	16	0—600*	—	—
Ar	320	Building Construction—II	2	6	100—150	1	2 hrs.
Ar	323	Specification	2	0	50— 0	1	2 hrs.
Ar	330	Climatology and Architecture	2	1	100— 50	1	2 hrs.
		N.C.C. or Physical Training	0	2	0— 50	—	—
			13	27	600—900	7	

*100 marks in the first term for Training during the preceding Summer Vacation.

(*iv*) FOURTH YEAR

Subject No.		Subjects for the Fourth Examination	First and Second Terms		No. of papers for exam.	Duration of exam. papers	Third Term		No. of papers for exam.	Duration of exam. papers
			Hours per Week	Marks			Hours per Week	Marks		
Hu	415	Social and Industrial Psychology ...	1 0	50— 0	1	2 hrs.	1 0	50— 0	1	3 hrs.
CE	416	Structural Design—I	2 3	100—100	1	3 hrs.	2 3	100—100	1	3 hrs.
CE	421	Estimating and Specification ...	2 0	100— 0	1	2 hrs.	2 0	100— 0	1	3 hrs.
EE † ME	414 435	Services II Electrification and Illumination „ Airconditioning and Ventilation ...	2 0	100— 0	1	2 hrs.				
Ph	413	Architectural Acoustics ...	2 0	100— 0	1	2 hrs.	2 0	100— 0	1	3 hrs.
Ar	414	Introduction to Landscape Architecture	1 0	50— 0	1	2 hrs.	1 0	50— 0	1	3 hrs.
Ar	415	Architectural Design—III ...	0 18	0—700			0 18	0—800		
Ar	420	Building Construction—III ...	2 3	100—100	1	2 hrs.	2 3	100—100	1	3 hrs.
			12 24	600—900	7		10 24	500—1000	6	
		Option	2 0	100— 0	1		2 0	100— 0	1	
			14 24				12 24			
		Physical Training		0—100				0—100		

†EE 414 First Term only
ME 435 Second Term only

(v) FIFTH YEAR

Subject No.		Subjects for the Final Examination	Second and Third Terms: Hours per Week		Marks	No. of papers for exam.	Duration of exam. paper	Fourth Term: Hours per Week		Marks	No. of papers for exam.	Duration of exam. paper
Hu		†Humanities, Elective (any one) ...	1	0	50— 0	1	2 hrs.	—		—	—	—
CE	516	Structural Design—II ...	2	3	100—100	1	3 hrs.	2	3	100— 50	1	3 hrs.
Ar	516	Professional Practice	2	0	100— 0	1	2 hrs.	2	0	100— 0	1	2 hrs.
Ar	517	Housing and Urban Design ...	2	3	100—150	1	3 hrs.	2	3	100—150	1	3 hrs.
Ar	515	Architectural Design	0	20	0—800	—	—	0	19	0—100	—	—
Ar	525	Historical Development of Contemporary Architecture ...	2	0	100— 0	1	2 hrs.	—		—	—	—
			9	26	450—1050	5		6	25	300—300	3	
		Option	2	0	100— 0	1		2	0	100— 0	1	
			11	26				8	25			
		Physical Training			0— 100							

†For Humanities elective see Footnote on page 57
Practical training in an Architect's Office during the first term and the preceding summer vacation — 0-750.

Fourth Term of about six months from June to November of Sixth Year.

(a) Course work as mentioned above from July to September ... 300—300
(b) Thesis/Project ... ... 0—600
(c) *Viva-voce* ... ... 0—200

DISTRIBUTION OF MARKS
(For each Examination)

I. Five-Year B. Tech. Degree Course

Examination	First Term Examination Marks	Second Term Examination Marks	End-Sessional Examination Marks	Maximum Marks	Weighted Maximum Marks
First ...	1,500	1,500	1,500	3,000	3,000
Second ...	1,500	1,500	1,500	3,000	3,000
Intermediate ...	1,500	1,500	1,500	3,000	6,000
Fourth ...	1,500	1,500	1,500	3,000	3,000
Final ...	1,500	1,500	1,500	3,500	7,500

+ *Viva-voce* ... 200
+ Thesis ... 300

II. Five-and-a-Half-Year B. Tech. Degree Course in Naval Architecture

First ...	1,500	1,500	1,500	3,000	3,000
Second ...	1,500	1,500	1,500	3,000	3,000
Intermediate ...	1,500	1,500	1,500	3,000	6,000
Fourth ...	1,500	1,500	1,500	3,000	3,000
Final ...	1,500	~~1,500~~	1500*	3,500	7,500

+ *Viva-voce* ... 0—200
+ Thesis ... 0—300
+ Training ... 0—750

* taken at the end of 2nd sem.

III. Six-Year B. Tech. Degree Course in Naval Architecture with Naval Construction option

First ...	1,500	1,500	1,500	3,000	3,000
Second ...	1,500	1,500	1,500	3,000	3,000
Intermediate ...	1,500	1,500	1,500	3,000	6,000
Fourth ...	1,500	1,500	1,500	3,000	3,000
Fifth ...	1,500	1,500	1,500	3,000	3,000
Final ...	1,500	1,500	1,500	3,500	9,000

+ *Viva-voce* ... 200
+ Thesis ... 300

IV. Five-and-a-Half-Year B. Arch. Degree Course

First ...	1,500	1,500	1,500	3,000	3,000
Second ...	1,500	1,500	1,500	3,000	3,000
Intermediate ...	1,500	1,500	1,500	3,000	6,000
Fourth ...	1,500	1,500	1,500	3,000	3,000
Final ...	750	1,500	1,500	4,400	8,400

+ *Viva-voce* ... 200
+ Thesis/Project ... 600
+ Fourth Term exam. ... 600

SCHEDULE VII

REGULATION No. 13

Subjects of instruction for 5 and 5½-year integrated B. Tech. and B. Arch. Degree Course

Aeronautical Engineering (AE)

311. Principles of Aeronautics : (1-1).

Scope of the subject : This is a kind of slightly elevated orientation course covering the braod principles of Aeronautics without mathematical details.

Aerodynamic forces on lifting surfaces and bodies, Non-dimensional force coefficients, Aerofoils, How they produce lift, Variation of lift, drag and pitching moment with incidence for typical aerofoils. Finite wings and types of flow. Effect of Reynolds number, Mach number and sweep.

Types of flying machines, Description and purpose of the aeroplane components, the Mechanics of flight.

Experimental techniques, lowspeed wind tunnels, components and application.

341. Aircraft Layout and Detail Design : (1-4).

Requirements for a good layout ; Descriptive geometry for airplane layout ; Lifting ; Aerofoils ; General design considerations ; Connections, Fabrication methods ; Strength Calculations for rivetted and bolted joints ; Bending and Torsional Stresses, Strength of struts and columns, Thin web beams.

351. Mechanics (2-1).

Kinematics : Expression for acceleration in different systems, rotating axes, Coriolis acceleration, displacement of rigid bodies, Euler's theorem, Eulerian angles, rate of change of Eulerian angles and their relation to rates of yaw, pitch and roll of an aeroplane. Basic equations of rigid dynamics from equation for system of particles. Two-dimensional motion under finite and impulsive forces including motion of imperfectly rough bodies. Motion when mass enters or leaves the system with elementary application to jets. Three dimensional motion ; billiard ball on imperfectly rough plane, sphere on perfectly rough cylinder, rolling discs, gyroscope, gyrostatic action of propellers, use of gyroscope for turn indicator, artifical horizon etc., Motion under no force.

411. Fluid Mechanics (2-2).

Inviscid Flow : Basic equations of motion, Basic definitions Circulation, Vorticity, Stream function, Velocity potential. Types of two-dimensional flows : sources, doublets, vortices, Primciple of combination of flow types with selected examples ; Flow past a circular cylinder with circulation, Conformal transformations the Blasius Theorem, the Joukowski transformation, the karman-Trefftz transformation. Complex potential Derived aerofoil, the Kutta-Joukowski theorem, Origin of circulation and the Kutta-Joukowski hypothesis.

Viscous Flow : Elementary treatment of the Navier-Stokes equation, Various forms of energy equations. Some exact solutions of the Navier-Stokes equation : the Poiseuille flow. Elements of two-dimensional laminar boundry layer theory. Elementary study of turbulence, Simple treatment of turbulent boundry layer theory. Elements of heat transfer theory.

412. Aircraft Performance (1-1).

Standard atmosphere ; Power plant data; Power available calculations ; Estimation of Drag of the airplane ; Power (or thrust) available and power (or thrust) required curves, performance analysis ; calculation of range, endurance, rate of climb, glide, maximum speed take off and landing distances. Effect of wing loading, power loading and aspect ratio. Manoeuvring turn, dive, pull out from a dive, roll, loop, spin and inverted flight.

421. Elements of Aircraft Vibration (2-1).

Vibration of one and two degrees of freedom systems free and forced, damped or undamped ; dynamic vibration absorber ; Coupling. Principal modes and principal frequencies. Conservative multidegree freedom systems, Approximate solutions ; Normal modes ; orthogonality relations. Vibrations of slender beams. Vibration measuring instruments. Resonance testing of structures. Elements of Aeroelasticity ; mechanism of flutter ; brief mention of derivatives ; binary flutter of a typical wing section in two-dimentional incompressible flow.

422 Aircraft. Structures I (2-3).

Equilibrium of force systems, trusses, space structures. Bending and torsion of closed and open sections. Engineering theory of bending and Bredt-Batho theory of torsion, shear flows, shear centre and flexural axis, warp ; case of Unsymmetric sections. Analysis of typical members of semi-monocoque construction bulkheads, wing ribs, shear in tapered webs and cut outs. Deflection of structures. Moment distribution methods of analysis. Statically indeterminate structures.

431. Aircraft Propulsion I (2-3).

Introduction to propulsive system—aircraft and guided weapon propulsion units. Power plants.

Fundamentals : Thermodynamics, Gas Dynamics and heat transfer Propulsive system performance : theory of propulsion, propulsive efficiency, effect of intake. Applications to various power units. Component efficiencies. Effect of variations in altitude and forward speed. Choice of a power plant for a given application.

441. Aircraft Design I (1-4).

General Design : Introduction to the scope and principles of Aircraft Design. Aircraft specifications and airworthiness requirements. Design organisation and Design procedures. Materials, specification & parts of the plane like spars, ribs, fittings, engine mounts, etc. (to be carried out by the students). Familiarisation with design office procedures and hand books.

Aerodynamic Design : Choice of aerofoil section, collection of aerodynamic characteristics of aerofoils ; plotting wing sections.

511. Aerodynamics (2-3).

Incompressible Flow : Thin Aerofoil theory, Elements of thick aerofoil theory : Theodorsen's method and by distribution of singularities.

Finite wing Theory : Prandtl's lifting line theory, Solution of the basic integral equation (i) Glauert's method, (ii) Multhopp's method Aerodynamic characteristics of three-dimensional wings.

Compressible Flow: Basic equations. Aerofoils in compressible flow, similarity rules. Shock and expansion waves, Method of characteristics and its applications influence of compressibility on two and three-dimensional wings, sweptback wings.

Elements of two-dimensional supersonic aerofoil theory, Brief discussion of transonic flows past aerofoils. The slender body theory.

512. Aircraft Stability and Control (2-1).

Concept of stability, stability criterion. Longitudinal static stability, stick-fixed and stick free stability margins, C.G. position and travel ; Manoeuvring stability, manoeuvre margins, load factors ; control forces, hinge moments, aerodynamic and mass balancing, powered controls. Lateral stability and directional stability.

Dynamic stability : Stability criterion and equations of motion, stability derivatives ; longitudinal dynamic stability, phugoid motion, airplane density factor ; lateral stability and directional stability.

513. Gas dynamics (2-1).

Basic thermodynamics.

Equations of one-dim. compr. flow ; normal shocks, weak waves and their reflections and interactions ; one-dim. flow with heat addition and with friction.

Equation of two-dim. flow ; Mach angles and Mach cones, weak waves ; Prandtl Meyer expansion ; oblique shock waves, intersections and reflections ; Shock expansion theory, weak waves and first-order theory for thin aerofoils ; Occurrence of shock-waves in practical situation.

Flow in ducts and wind tunnels ; convergent-divergent nozzles ; Numerical methods for solns of 2-dim. problems, method of characteristics.

Experimental techniques.

An introduction to real gas effects with emphasis on effects on viscosity.

514. Wind Tunnel Design and Testing (2-1).

Types of wind tunnels and general design features; Principles of design and operation of subsonic, transonic and supersonic wind tunnels. Methods of flow Visualisation Measurement of fluid velocity and model forces, manometres and balances ; special measurements. Model testing procedure and reduction of test data.

515. Helicopter, VTOL & STOL Aircraft (2-1).

Performance, Control and stability, vibration of helicopters, vertical take-off and short take-off aircraft. Principles of design including methods of blade analysis, dynamics of rigid and flexible blade and control. Methods of obtaining increased lift in the case of STOL aircraft.

521. Aeroelasticity (2-1).

Nature of Aeroelastic problems. Mechanism of flutter. Binary flutter of wings with and without control surfaces. Unsteady Aerofoil theory. Derivatives in compressible flow. Control surface dynamic balancing and flutter prevention. Problems of divergence and aileron reversal.

522. Aircraft Structures II (2-3)

Analysis of multicell and multibay structures. Torsion of open sections, torsion-bending theory of Wagner-Kappus. Introduction to the instability of thinwalled structures, Primary instability, flexural—torsional instability and local instability. Plates under transverse and end loads, flat stiffened panels in compression ; Tension field beams. Introduction to Energy methods and matrix methods of structural analysis. Analysis and design of composite structures.

523. Aircraft fatigue (2-1).

Nature and mechanism of fatigue failure. Influence of the different parameters like size, frequency, mean stress, stress concentration etc. on fatigue strength. Under-stressing and overstressing. Cumulative fatigue and Miner's criterion. Methods of component and phototype testing. Design for fatigue.

531. Aircraft Propulsion II (2-3).

Aircraft Piston Engine : Operating cycles, efficiency and factors governing cylinder design. Carburettors. Fuel injection system. Supercharger. Engine supercharger matching. Ignition and cooling system.

Engine performance under varying conditions of power, altitude and forward speed.

Axial flow compressors. Axial and radial flow turbines. Ramjet and Rockets—their thermodynamic considerations and propellant performance.

Elements of propeller theory.

532. Combustion Engineering (2-0).

Selected topics of combustion explosion process, thermal theory of autoignition and spark ignition. Theory of combustion and oscilation of hydrocarbons. Combustion in auto-engines. Fuel injection and mixing. Flame stabilization : flame stabilization in bulb-bodies in fuel air mixture, in fuel airspray mixture, inside perforated liners, in boundary layers. Combustion chamber design development and performance.

541. Aircraft Design II (1-4).

Aerodynamic, structural and systems engineering aspects of design and their interaction.

Loads of an aircraft : aerodynamic loads, inertia loads ; aircraft in symmetrical steady and accelerated flights ; flight envelope. Manoeuvre loads ; a symmetric flights. Gust loads. Landing and ground manoeuvring loads. V-g recorders.

Preliminary design ; power plant selection ; weight control and weight estimation ; preliminary side view drawing ; balance diagram and cg travel ; three view drawing.

(The class work as a team in the design of a complete plane from a specification laid down by the staff. The preliminary design of the plane is carried out by the class or worked out by the staff and the data given to the students so that each group of students not exceeding three in number work out the detail design of one unit like fuselage, tail plane or control system).

552. System Engineering (2-3) Third Term

Hydraulic Systems—Hydraulic circuits and components. Variable pump displacement and valve controlled servo systems. Pressure supply, actuation, sequence of operations, emergency operations. Shock absorbers : Oleo-pneumatic, liquid spring. Jacks and accumulators. Comparison of hydraulic, pneumatic and electric actuation systems. Landing gear. Elements of pneumatic and hydraulic control and its applications to flying controls.

Agricultural Engineering (AgE)

311. Botany (2-2)

Physical, chemical and biological characteristics of living systems. Metabolic, growth and reproductive processes. Heredity and evolution. Basis of plant and animal classification.

Morphology and characteristics of important economic plants.

Diseases and pests. Principles of plant and animal improvement. Adaption of plants to environments.

411. Soil Science (2-3).

Fundamental principles underlying soil formation and classification. Great soil groups of the world and the important soil types of India. Soil survey. Soil colloids. Cation exchange and soil reaction. Physical properties of soils. Mechanical composition. Soil consistency and soil structure. Soil Water. Soil organic matter. Trace elements. Soil conditions and plant nutrition. Soil fertility management. Saline and alkaline soils.

412. Crop Production (2-2).

Farm crops of India—distribution, acreage add yield ; Tillage—its objectives and methods ; Manures and fertilizers ; Principles of manuring—doses, time and methods of application ; Weeds and weed control ; Important field crops of India—seed bed preparation, sowing time, seed rate, spacing, manuring, intercultivation, water requirement, harvesting, threshing and processing ; Principles underlying crop rotation ; Croping schemes ; Mixed cropping ; Agronomical practices for soil management ; Important pests and diseases of crops and control measures ; Calendar of farm operation.

413. Farm Machinery (2-3).

Farm Power ; Manual, animal and mechanical power—their application, availability, limitations, cost ; Manual and animal power operated tools and implements—classification according to source of power and functions.

Materials of construction ; Wood, iron, steel, selection, properties and use.

Tools and implements : Types, construction, working and performance cost of ploughs, harrows, clod crushers, levellers, scoops, V-drags, ridgers, seed drills, planters, dibblers, hoes, cultivators, harvesting and threshing equipment, winnowing fans ; processing equipment, such as chaff cutters, sugar-cane crushers, oil ghanis, rice hullers, cotton gins, feed preparation devices, cleaning and grading tools ; Plant protection equipment ; Farm transport : Dairy machines.

414. Theory and Design of Farm Structures (2-3).

Columns—Formulae for their design, Beams-design principles distribution of shear and bending stresses—deflection of beams.

Roof Trusses—graphical and analytical procedures for evaluating forces in members—design of joints, members and gusset plates truss connections—Rivetted and welded joints.

Reinforced Concrete—Technique of good concrete making—design of mixes—principles of design of simple slabs and beams—balanced section regulations for design—shear distribution in R. C. Sections—doubly reinforced beams—T beams—Design of columns and column footings.

Farm Structures—Location and layout—their functional requirements—requirement of building for special uses—Floor roof loads—design of foundations—Estimating quantities and costs—Rural water-supply, sanitation and roads.

415. Rural Electrification (1-1).

Power generation transmission and distribution of Electric supply—A.C. and D.C. circuits. Applications of electricity ; on the farm ; storage batteries. Electric motors used in agriculture—types, operating characteristics, installation, maintenance, and selection.

Lighting and power circuits, selection of materials—service connections—metering. Application of electricity for irrigation water supply, sorting and grading, grinding, milk handling, refrigeration of dairy products, vegetables and fruits. Tariff.

511. Farm Management (2-2).

Types and systems of farming—their characteristics, suitability to Indian conditions. Types of farms, their characteristic features ; selection, purchase and acquisition of land. Land development—culturable wastes and reclaimable areas—Farm layout—requisites of an ideal layout. Farm organisation—principle, selection and combination of enterprises, farm machinery and power in relation to system of farming and size of holdings ; their working cost. Economics of farm practices and cost of production studies. Factors affecting profits of a farm, Marketing of farm produce. Farm records. Field experimenal technique.

512. Agricultural Co-operation and Extension (1-0).

Origin and nature of Agricultural Cooperation ; General principles ; The history of movement in India ; General forms of co-operation—credit, production, purchase and sale. Crop and cattle, implement and machinery, Insurance, Consolidation of holding, Better farming, Irrigation etc. Co-operative development, organisation and management in India and in other countries ; Multipurpose co-operatives ; Co-operation and Agricultural planning.

Agricultural Extension—Its philosophy and scope ; Extension methods ; Extension worker, his role and quality ; Extension Service. Adoption of improved Agricultural technique for community welfare schemes.

513. Soil and Water Conservation Engineering (2-3).

Conservation defined—Erosion as a cause of damage—various types of erosion—mechanics of wind erosion and its control—water erosion—types of water erosion and their causes.

Rainfall and its measurement—Runoff as a major factor of erosion—factors affecting runoff—measurement of runoff—Water Stage Recorder—stream gauging—evaluation of runoff from rainfall.

Control of erosion—methods of controlling sheet erosion—biological and engineering methods and their limitations—terrace outlets and grassed waterways and their hydraulics.

Gully erosion and methods of control—biological methods—various structures used in control—permanent and temporary structures—their planning and design phases.

Farm ponds—flood routing—principles of flood control. Earth dams—their design and construction.

Stream bank erosion and its control—temporary and permanent structures—their layout and design.

Principles of Watershed management and Soil Conservation. Planning in River Valley Projects—investigations and data needed—method of procedure for investigations and data collection.

514. Irrigation and Drainage (2-3).

History and extent of Irrigation in India—Sources and types of irrigation—importance of irrigation in the development plans—Planning and design of minor irrigation projects—Design of canals and canal structures.

Soil moisture relationships—Relationship between moisture and properties of soils—movement of soil moisture. Infiltration ; methods of finding infiltration rates—permeability—field and laboratory methods of measuring permeability—Water conductivity—surface, tension—tensiometers—methods to determine soil moisture content—soil water storages.

Disposal of Irrigation water applied to the soil : Surface waste—deep percolation—plant transpiration ratio—consumptive use of water—factors affecting consumptive use—duty of water.

Field layout and methods of applying irrigation water : Land clearing—levelling and smoothing—layout and plots—methods of applying water—flooding—furrow and corrugation systems—border methods—basin irrigation—subirrigation—sprinkler irrigation.

Field irrigation systems and structures : Functional requirement of field channels—capacity and design—methods of construction-pipelines—Head gates—diversion boxes—check gates—drops—road crossings.

Water requirements of crops. Measurement and cost of irrigation water : Units of measurement-flow through orifices, weirs and flumes—measuring devices—irrigation rates :

Field Drainage : Benefits of drainage—Surface and sub-surface drainage—drainage systems—Locations of drains—Design and construction of open drains—Maintenance of drains—drainage disposal.

515. Farm Engines and Tractors (2-3).

Thermodynamic Principles of I.C. Engines—Diesel, Powerine and Petrol Engines—Two stroke and four stroke cycle engines—Fuels and combustion—Combustion knock and knock rating. Carbueration and fuel injection—Valves and valve mechanisms—Engine governing—Engine lubrication and lubrication systems—Air intake systems—Cooling system—Exhaust system—Starting methods—Engine installation—Engine Testing and performance—Types of Tractors—Chassis mechanics—Tractors transmission—Traction and traction devices—Electric circuits on Tractors—Tractors tests—Tractor maintenance and repair—overhauling—Reconditioning of parts. Cost of using farm engines and tractors.

516. Farm Machinery and Power Management (1-0).

Factors affecting selection of farm implements, machines and power units. Their maintenance and repairs. Economics of using farm machines and power.

517. Problems (0-3).

To work out numerical exercises on Agricultural Engineering Problems.

518. Earth Moving Machinery (2-2).

Land Reclamation—Methods of clearing tropical forests and scrub jungle—Selection of machinery—Reclamation of weed infested lands—Crawler tractors—Bulldozers—Angle and tree dozers—Power control units—Rooters and root rakes—Scrapers and graders—Construction of bunds, terraces and ditches—Machinery for field maintenance and servicing—Field and base workshops—Handling fuel oils, lubricants and greases—Stocking of spares and mechanical store handling—Cost of operations.

519. Tube Wells and Pumps (2-2).

Origin and occurrence of ground water—Hydraulics of wells—Types of wells and their construction—Drilling methods—Various types of boring equipment and tools—Construction and use—Choice of equipment—well curbing—casting pipes and well screen—Well development—Testing of wells.

Shallow well pumps—Rotary pumps—Axial flow, Propeller and Centrifugal pumps—Deep well pumps—Plunger pumps—Deep well turbine pumps—Submersible pumps—Air lift pumps—Cost of installation and operation—Characteristics curves—Selection of pumps.

520. Agricultural Process Engineering (2-2).

Considerations in processing cereal grains, oil seeds, leaf crops and fodder crops. Flow measurements, heat transfer, mass-transfer, air-moisture mixtures. Fans, crop-drying, milling and allied equipment. Crop handling equipment. Crop Storage. Cold storage. Plant layout. Economics. Processes and machines for processing of animal products, such as milk and milk products, poultry products etc.

521. Project, Report, Seminar (1-4).

Students will be given project work with a view to develop initiative, planning and organization to carry out research work and to write reports and to give seminar talks.

Note : Lectures on Palaeo-botany are given to the students of Geology in the third term by this department for course No. Ge-222 (Elements of Palaeontology and Indian Stratigraphy).

ARCHITECTURE AND REGIONAL PLANNING (Ar)

111. Principles of Architecture (1-4)

Lettering, calligraphy.

Basic Design : Composition of 2 dimensional forms, Texture, and Pattern. Effect of colour and form in space. Abstract compositions.

Plan, Section, Elevation, Scale Drawing—Simple design problems in relation to construction and materials.

112. Free-hand Drawing I (0-4).

Simple line sketches, studies of natural forms, combination of geometrical solids, object drawing and still life.

113. Descriptive Geometry (0-4).

Solid forms ; Interpenetration of Solids. Isometric, Axonometric, Oblique and Planometric projections, Perspective, parallel, angular and three point. Study of Sciography on plain, curved and irregular surfaces. Application to buildings, furniture, etc.

120. Building Materials and Workshop Practice (1-3).

Primary elements of building and their functions. Detailed study of Basic materials like brick, stone and timber ; strength of materials. Workshop practice.

212. Free-Hand Drawing I (0-3).

Outdoor sketching with particular reference to composition of simple building forms in relation to their setting. Colour circle, Oswald system, constrast and harmony. Tone and colour. Techniques of rendering-crayon, pastel, water-colour, poster colour. Colouring techniques on printed drawings.

214. History of Architecture I (2-0).

The development of Indian Architecture from ancient times ; Indus civilisation and Vedic culture. Asokan school and Budhist Architecture. Golden Age of Gupta Architecture. Chalukyan, Dravidian and Jain Architecture. Indo-Aryan style. Brahmanical buildings of Bengal. Buildings in greater India. Western Architecture—Egyptian, West Asiatic, Greek and Roman, Byzantine Early Christian and Romanesque Architecture.

215. Architectural Design I (2-12).

Design of single storey buildings containing two or three large cells with auxiliary units —e.g. residential buildings, small school, dispensary, club town hall, etc.—with particular attention to room uses, circulation and orientation. Scale models.

220. Building Construction I (2-6).

Detailed study of brick-laying and bonding, stone masonry and tools. Special use of simple materials like brick, stone, timber. Study of soil types ; foundations and footings, basement floors and water-proofing, damp proof courses. Shoring, Needling, Under-pining and Centering. *Floors* : wooden, brick, concrete, composite and their finishes. *Roofs* : Brick and stone vaults, jack, arch, concrete, R.C.C., timber and steel roofs with covering materials. *Openings* : Doors, windows, fan-lights. Partitions, Lantern lights, Rendering and decorative finishes. Glass, paints and varnishes. Complex exercises in construction.

314. History of Architecture II (2-0).

The growth of Islamic Architecture with particular reference to developments in India. Architecture of Pathan dynasties and their work in Delhi region. Provincial manifestations like Gujarat, Malwa, Deccan, Bengal and other parts of India. Moghul Architecture in Delhi Region. Western Architecture—Mediaeval, Gothic and Renaissance in Europe. Measured Drawing.

315. Architectural Design II (1-15).

Design of complex vertical buildings—repeating and non-repeating units. Small frame structures. The studio work should include time sketches, project drawings, perspectives, models and interior design and details.

320. Building Construction II (2-6).

Indigenous Indian building materials and their improved uses. Synthetic building materials. Built in furniture, panelling, shop fittings, and counters, light fittings, staircases : simple and complex. Uses of marble and other facing materials Terrazzo and patent flooring. Sliding doors and windows. False and suspended ceilings. Hearths and chulas. Problems of specialized constructional features.

323. Specifications (2-0).

Definition and use of specifications. Methods of writing and order sequence. Specifications of materials and finishes.

330. Climatology and Architecture (2-1).

Types of tropical climate. The main climatic groups, temperature, humidity, rain fall, wind, sky, ground, vegetation, etc. Importance of micro-climatological factors. Measurement of climatic factors, study of indoor climate and its effect on comfort and efficiency. Problems of lighting and acoustics in tropics. Community traditions and their effects on planning problems. Advanced study of climatic factors and their effect on design. Hot dry regions, warm humid regions, monsoon climates. Special problems, such as, maritime climates, monsoon climates. Building materials and techniques in relation to climates. Economic considerations. Study of special types of buildings such as schools, hospitals, etc.

414. Introduction to Landscape Architecture (1-0).

Landscape design in relation to topography, surroundings, climate and buildings. Use, purpose and maintenance of gardens, as part of recreational planning. Analysis of factors relating to site planning. Design Synthesis.

General survey of history of garden art with special reference to gardens in India, Japan, China, Italy and Spain.

A general understanding of horticultural practices in India.

415. Architectural Design III (0-18).

Planning of groups of houses. Analysis and inter-relationship of areas devoted to residential, commercial, industrial, recreational and other uses. Multi-storey frame-buildings ; planning of units in relation to each other along with financial, legal and administrative problems of public regulations of landuse.

420. Building Construction III (2-3).

Contemporary building materials such as plastics, metals and alloys. Lightweight construction. Influence of environmental technology on construction. Methods of Building Science.

515. Architectural Design IV (0-10) Second and third Terms (0-19) Fourth term.

Problems of Urban design. A building complex to be attempted ; appreciation of building byelaws, planning legislation, landscaping, etc.—Group project with planning AR 606 and AR 706.

516. Professional Practice (2-0).

The duties and responsibilities of the profession, its code of ethics and etiquette includingstandard of charges as adopted by the profession. Administration of an architects office in private practice and in Governmental set-up. Building laws, types of Contracts, handling of tenders, valuation of buildings, accountancy, professional salesmanship and public relations. Programming, work-study and computation.

517. Housing and Urban Design (2-3).

The beginning of modern town. Development of planning in North India and southern peninsula in mediaeval times. The Renaissance and early industrialization. The contributions of eminent town planners, like Haussman, Burnham, Howard, Geddes, Perry, Stein, Abercrombic and others ; Contemporary planning trends.

Housing for all income groups. Relation of housing to national economy. Problem of land ownership and control in relation to housing ; the public interest in the provision of adequate housing, slum clearance. Development of national Housing policy.

525. Historical Development of Contemporary Architecture (2-0) Second and Third terms.

Sources of modern movement in Architecture. Industrial revolution and Great Exhibitions. William Morris's Arts and Crafts Movement. Humanism and Romanticism, Archaeology, Age of Revivals and Ecclectics. The emergence of the Engineer and growth of specialisation—Jenny, Robert Maillart, Eiffel and others. New materials and techniques. Evolution of the steel frame building. Adler and Sullivan. Organic Architecture and Frank Lloyd Wright. R.C.C. and its influence on Free Planning. Modern movement of arts. Cubism and Le Corbusier. Bauhaus and Gropius. Works of eminent Architects like Aalto, Bruer, Mies Van der Rohe, Nowicki, Lucio Costa, Oscar Niemeyer, Kahn, Tange, Doxiadis, Nervi, Candela, Buckminster Fuller and others. New Delhi Capital Project, Chandigarh and Brasilia.

Thesis—

Thesis Design shall be on a major Building Project and its programming worked out by the student himself. The work should include an intensive study of topography, climatology and problems concerned with development of useful pattern in space and structure, based on correlation and interpretation of the social, economic and physical, data. Solution of the problems with the methods of Architect, Engineer, Planner and Landscape architect in the preparation of written report and the drawings. The project work should include the following :—

The preliminary design, presentation drawings, working drawings (whole project or part thereof) written report of about 20,000 words. Any two of the following topics as advanced objectives :—

(1) Structural drawings supported with detailed calculations.

(2) Detailed estimates and specifications.

(3) Building construction techniques and the details of the use of new materials.

(4) Mechanical equipments like Air-conditioning, Acoustics.

(5) Study of interiors, furnishings, fittings and finishes.

(6) Or any other approved by the Department.

APPLIED CHEMISTRY (Ch.)

111. Chemistry (3-3).

Physical Chemistry :

Properties of gases ; Kinetic theory ; equation of state ; ideal gas laws ; deviations ; van der Waal's equation, liquefaction and continuity of states ; Joule Thomson's effect ; liquefaction of air. Solutions : Nomenclature, modes of expressing the composition ; solubility curves ; colligative properties of dilute solution. Solution of electrolytes : Deviations and van't Hoff's factor, Arrhenius' theory of dissociation ; degree of dissociation ; strong and weak electrolytes ; Faraday's laws ; electrolysis of fused and aqueous solution of electrolytes of technical importance ; specific and equivalent conductance ; conductance ratio ; ionic conductance ; mobility and transport numbers ; simple application. First law of Thermodynamics and thermochemistry : Internal energy ; heat content ; specific heats of gases ; heat of reaction ; Hess's law, Kirchoff's law.

Organic Chemistry :

Classification ; nomenclature ; general methods of preparation ; properties and uses of hydrocarbon including benzene, alcohols, ethers, amines, aldehydes, ketones, acids and their derivatives.

General and Inorganic Chemistry :

Matter and its properties ; Kinds of matter ; specific properties ; isolation and purification. Atoms, molecules and crystals ; dalton's atomic theory ; size of atoms and molecules ; their crystals ; van der Waal's forces. Elements and compounds : Definition and differentiation ; Avogadro's Number ; atomic weight and its scale ; physical and chemical methods of determination ; electron, proton and neutron ; their sources, charges and masses. Elements of atomic theory : Electronic shells ; stability of electronic groups ; periodic law ; periodic table and its basis. Valency : Covalency ; electrovalency ; octet theory and deviations. Oxidation and reduction : Electronic interpretation ; oxidising and reducing agents ; oxidation equivalent ; balancing of equations. Systematic study of elements of groups V, VI and VII of periodic table.

Chemistry Laboratory :

Study of Bunsen burner ; fitting up of simple apparatus ; separation of mixtures involving distillation, crystallisation and filtration. Detection of the following acid radicals by dry and wet tests : CO_3, NO_3, SO_4, S, Cl, Br, I in a mixture containing not more than two radicals. Detection of the following basic radicals by dry tests only. Na, K, NH_4, Cu, Ag, Mg, Ca, Sr, Ba, Zn, Hg, Al, Sn, Pb, Bi As, Fe, Ni, Co, Mn, Cr (mixtures must not contain more than two radicals). Semimicro technique for qualitative analysis of basic radicals in a mixture containing not more than two radicals. (For Science stream).

112. Chemistry (4-3).

Same as Ch. 111 and,

Equivalent weights ; laws of chemical combination and atomic theory, Avogadro's law and its application ; acidimetry ; alkalimetry, Study of the following elements and their compounds : H_2 O_2, N_2, P, C, Si, B, S, halogens and inert gases. (For Technical stream).

113. Chemistry (3-2).

Physical Chemistry :

kinetic theory, equation of state, deviation, van der Waal's equation, theory of corresponding state, first law of thermodynamics, thermochemistry, chemical equlibrium, phase rule, chemical kinetics, electrochemistry, colloids.

Organic Chemistry :

classification, nomenclature, general methods of preparation, properties and uses of hydrocarbons, alcohols, ethers, aldehyders, ketones and acids ; solvents and dyes.

General and Inorganic Chemistry :

fundamental laws and concepts, fundamental particles, atomic structure & valency, periodic classification of elements, oxidation and reduction, simple chemical calculations.

Engineering and Industrial Chemistry :

clay and clay products, cement, glass and other refractories, treatment of water for industrial use, paints and varnishes, wood, rubber and plastics, iron and steel, alloys, corrosion and its inhibition.

Chemistry Laboratory :

simple qualitative analysis. (For Architects).

211. Chemistry (3-3).

Physical Chemistry :

Law of Mass action and chemical equilibrium in homogeneous and heterogenous systems, Le chatelier and Braun's principle for effect of external factor on equilibrium. Chemical Kinetics : Order and molecularity of reactions ; rate equation for first and second order ; temperature coefficient and energy of activation ; catalysis. Homogeneous and heterogenous, criteria of catalysis and its technical application. Ionic equilibrium ; common ion effect ; solubility product ; ionic product of water ; pH ; hydrolysis ; indicator ; buffer solution ; standard electrode potential ; simple galvanic cell ; secondary cell. Colloid : Classification ; preparation ; purification and properties of colloidal systems. Emulsions : Types ; stability and application. Phase rule : Single component system.

General and Inorganic Chemistry :

Systematic study of the elements of groups I to IV of the periodic table. Atomic Structure : Cathode ray ; Bohr's theory ; sublevels in electronic shell ; Rutherford's experiments ; Mosley's work and atomic number. Radio-activity and Nuclear Chemistry : α β γ—rays ; U-series ; isotopes and mass spectrography ; binding energy ; nuclear transformation ; artificial radioactivity ; nuclear fission and nuclear energy.

Water and its treatment, corrosion-causes and prevention.

Chemistry of Engineering materials

Important metals and alloys ; lime ; cement ; mortar and glass (only chemistry of manufacture and utilisation).

Rubber, plastics and wood (a brief survey of the chemistry of processes and utilisation).

Elementary treatment of fuels : solid, liquid and gaseous.

Chemistry Laboratory :

Quantitative analysis : Use of chemical balance ; estimation of equivalent weight of metals ; solubility ; water of crystallisation ; acidimetry and alkalimetry ; hardness of water ; estimation of Fe by permanganate and dichromate ; estimation of Cu by iodometry ; estimation of Ca ; gravimetric estimation of Fe; gas analysis. (For Science stream).

412. Assay and Metallurgical analysis (1-3).

Representative sample for analysis. Common methods of sampling of coal, ore, metals and alloys ; special sampling methods adopted in mines. Complete analysis and assay of rocks and minerals, ores, refractories, fluxes, slags, metals and alloys. Estimation of Si, Ni, Mn, W, Mo, Cr, V. P. S. in steel and cast iron.

Principles underlying polarographic and spectroscopic methods of analysis. Identification of simple compounds and mixtures by X-ray method (for Metallurgists).

419. Physical Chemistry for Chemical Engineers (2-3).

Laws of thermodynamics, Thermodynamic functions. Chemical equilibria, Free energy changes. Laws of thermochemistry.

Order and molecularity of reactions. Rate equations for simple and complex reactions. Study of complex reaction. Heterogeneous reactions. Theory of reaction rates. Elements of catalysis.

Galvanic cells. Electrode potentials. Chemical and electrical energy. E.M.F. of a cell. Concentration cells. Reference electrodes and glass electrode. pH and its determination. Electroanalysis. Electrolysis, decomposition voltage, polarization, deposition potential, overvoltage. Corrosion and passivity. Secondary cells.

Adsorption on solid surfaces, liquid surfaces and in solutions. Gibbs adsorption equation. Chromatography. Films of soluble and insoluble substances. Emulsions. Emulsification. Wetting and detergency. Phase Equilibria of pure substances. Solutions of gas in liquid. Binary liquid systems. Extraction. Distillation.

Physical Chemistry Laboratory :

Determination of molecular weights by freezing point method and vapour density method, determination of surface tension, viscosity, partition coefficient, vapour density, refractive index, optical activity, order of a reaction, solubility, adsorption, pH, conductance, transition temperature, conductometric and potentiometric titrations.

420. Organic Chemistry for Chemical Engineers (2-3)

Purification and analysis of organic compounds. Formulae, constitution and classification of organic compounds.

Aliphatic compounds ; paraffins, halogen derivatives, alcohols, ethers, aldehydes, ketones, fatty acids and their derivatives, and chlorides, anhydrides, amides, esters, sulphur compounds, unsaturated hydrocarbons and their derivatives, polyhydric alchohols, carbohydrates, dibasic acids, Stereochemistry and electronic theory of valency.

Aromatic compounds : hydrocarbons, halogen compounds, nitro and amino compounds, diazonium salts and diazo compounds, azo compounds, sulphonic acids, phenols, aromatic alcohols, aldehydes, ketones and quinones, aromatic acids, terpenes and camphors, multinuclear hydrocarbons and their derivatives, naphthalene, anthracene and their derivatives.

Complex compounds : Heterocyclic compounds, alkaloids, ureides, compounds of biological importance.

Organic Chemistry Laboratory :

Qualitative detection of elements (N_2, S, P, halogens) and functional groups (COOH, OH, CHO, CO, NO_2, NH_2 & COOR). Preparation of organic compounds involving acetylation, benzoylation, nitration, halogenation, esterification, reduction, oxidation, hydrolysis, etc. Qualitative determination of equivalent weights of acids and bases. Estimaion of phenols, acids and aldehydes.

CHEMICAL ENGINEERING (Ch.E.)

111. Orientation (1-0)

Introduction to chemical engineering profession. Scope of chemical engineering, ethics of chemical engineers.

311. Chemical Engineering Stoichiometry (2-1).

Units and dimensions employed in chemical engineering calculations. Introduction to dimensional analysis. Material balance of chemical engineering processes.

Vapour pressure, humidity and saturation, solubility and absorption. Thermophysics and thermochemistry. Fuels and combustion. Chemical systems and processes.

312. Chemical Engineering Equipment Drawing (0-2).

Simple drawings like,

Pipe fittings: Socket, bend, tee, reducer, union, plug, flange, etc.

Valves: Gate, globe, needle, non-return, butterfly, etc.

Equipments: Heat-exchangers, autoclaves, overhead tanks, crushers, grinders, etc.

315. Fuels and Furnaces (3-2).

Fuels

Classification of fuels and general uses.

Solid fuels: Wood, charcoal, coal, etc. Origin and classification of coal, characteristics and distribution of indian coals, storage and spontaneous ignition. Mineral matters in coal, their effect and removal, coal briquettes, manufacture of metallurgical coke and its characteristics. Testing of coke, methods of improving coking quality of coal.

Liquid fuels: Petroleum and its characteristics, coal tar distillation products, shale oil, alcohol.

Gaseous fuels: Coal gas, water gas, producer gas mechanism of formation, and use in I. C. Engines. Combustion of fuel and gas oils in furnaces. Efficiency and heat losses in furnaces.

Testing of liquid fuels: Specific gravity, viscosity, flash point and calorific value.

Heat transfer

Conduction: Mechanism of heat transfer, Fourier's law, steady state heat transfer for several bodies in series. Logmean area, unsteady state heat transfer.

Convection: Film concept, equations for heat transfer coefficients. Heat exchangers, condensation of vapour, boiling liquids.

Radiation: Concept of black body. Laws of radiation. Allowance for non-black and re-radiating surfaces. Radiation from non-luminous gases. Radiation error in pyrometry.

Furnace Design

Burning of coal on grates, mechanical firing, pulverized fuel. Combustion calculations. Different industrial furnaces—solid, liquid and gas fired. Furnace heat balance calculations with special reference to blast furnace, open hearth furnace, etc. Thermal efficiency and fuel economy in furnaces.

FOR METALLURGICAL ENGINEERS

411. Chemical Process Technology (Tech. I.)—(2-0) First Term, (0-3) Second Term, (2-3) Third Term.

Heavy Chemical industries: Sulphuric acid, nitric acid, caustic soda, chlorine, industrial gases, etc.

Fertilisers—Nitrogeneous, phosphatic and mixed fertilisers.

Electro-chemical and electro-thermal industries: Industrial salts, *e.g.*, potassium permanganate, potassium dichromate, sodium hydrosulphate, etc.

Technology of silicate industries: Cement, porcelain, refractories, glass, etc.

Present development and progress of the above industries in India.

412. Flow of fluids and fluid handling (Unit Op. I)—(2-0) First and Second Terms, (1-0) Third Term.

Energy of a fluid in motion. Lost work due to friction. Elements of boundary later theory.

Hagen-Poiseuille's law, viscosity. Newtonian and non-Newtonian fluids.

Bernoulli's Theorem. Fanning's friction factor. Reynolds number. Critical veolcity and turbulence. Loss of head due to flow through pipe fittings, bends, sudden enlargements and constrictions, etc. Hydraulic gradient. Dimensional analysis and its application to fluid flow problems.

Introduction to flow of compressible fluids. Measurement of fluid flow, *e.g.* orifice and venturi meters, pitot tubes, rotameters, flow nozzles, weirs, anemometers, dilution meters, etc.

Transportation of fluids. Operating characteristics of reciprocating, rotary and centrifugal pumps, compressors, blowers, fans and other devices for fluid handling.

Flow across immersed bodies, Stoke's law. Preliminary concept for flow through fixed bed, Kozeny-Carman equation. Modified friction factor and pressure drop calculations for flow through packed, moving and fluidized beds. Aggregative and particulate fluidization.

413. Heat Transfer (Unit Op. II)—(2-0) Second and Third Terms.

Conduction: Mechanism of heat transfer by conduction in steady state, Fourier's law. Equation for steady state heat conduction and its integration for different cases. Heat flow through a cylinder. Heat loss and insulation, compound resistance in series. Heat transmission by conduction in unsteady state.

Convection: Film concept, individual film coefficients and factors affecting them, overall coefficients. Natural convection. Dimensional analysis applied to heat transfer, important dimensionless groups and their significance, Reynold's analogy. Extended surfaces. Packed beds. Condensation of vapours, boiling liquids, effect of noncondensible gases. Design of different types of heat exchangers and condensers.

Radiation: Concept of black body. Laws of radiation. Allowance for non-black and re-radiating surfaces. Radiation from non-luminous gases and flames. Radiation errors in pyrometry.

Evaporation: Different types of evaporators and their applications. Principles of single and multiple-effect evaporators and their design calculations. Vapour recompression systems. Evaporator auxiliaries.

414. Size reduction and mechanical operations (Unit Op. III)—(2-0) First and Third Terms.

Size reduction: Types of crushers, grinders and disintegrators for coarse, intermediate and fine grinding. Relation between power requirements and size reduction. Closed circuit grinding. Important operating variables.

Size separation: Particle size analysis, screening, industrial screening equipments.

Mechanical separations: Principles of particle mechanics. Free and hindered settling. Classification, sedimentation, thickening, tabling, jigging, elutriation. Cyclones and hydroclones.

Flotation, electrostatic and magnetic separations. Centrifugal separation.

Filtration: Different types of batch and continuous filters. Theories of filtration. Constant pressure and constant rate filtration. Design of industrial filters. Filter aids.

Mixing and Agitation: Fundamentals of mixing and characteristics of mixing equipments. Power consumption and efficiency. Emulsification.

Mechanical handling of materials: Elevators, conveyors, fluidization and pneumatic conveyance. Storage of solids.

415. Unit Operations Laboratory—I—(0-5).

Laboratory experiments and design calculations to illustrate the principles covered in Ch.E. 412, 413 and 414.

416. Fuels, combustion and furnaces—(2-2) First and Second Terms, (2-0) Third Term.

Fuels: Review of world's fuel resources. Principal solid, liquid and gaseous fuels.

Solid Fuels: Wood, charcoal, coal, etc. Origin and classification of coal. Characteristics and distribution of indian coals. Spontaneous ignition of coal, storage problems. Washability of coal, coal washing plants. Briquetting of coal, coal carbonisation, by-product and modern coke ovens. Manufacture, testing and specification of metallurgical coke.

Liquid Fuels: Petroleum and its derivatives, coal tar, shale oil, synthetic liquid fuels.

Gaseous Fuels: Coal gas, water gas, producer gas. Mechanism of gasification.

Combustion and Furnace Design: Principles of combustion, flame characteristics, Burning of coal on grates, hand and mechanical firing, pulverized coal. Combustion calculations. Different industrial furnaces. Furnace heat balance calculations. Thermal efficiency and fuel economy in furnaces. Boiler feed water treatment. Efficient use of steam.

Laboratory experiments based on the above syllabus.

417. Applied Mathematics for Chemical Engineers—(2-0) Second Term, (1-0) Third Term.

Dimensional analysis. Units and dimensions. Dimensionless numbers. Dimensional similitude. Differential and partial differential equations. Application to chemical engineering problems. Statistical methods of quality control. Use of control charts. Application to manufacturing and inspection operations.

431. Mineral Dressing (2-2).

Mineral characteristics. Hardness and surface liberation. Size reduction. Equipments for coarse, intermediate and fine grinding, *e.g.*, Jaw crusher, Gyratory crusher, Ball mill, Rod mill, etc. and their characteristics. Energy requirement in comminution, Rittinger's, Kick's and Bond's laws.

Mechanical separation: Sieve analysis, mechanical size separation units, Grizzlies, industrial screens, capacity and efficiency of size separation units. Hydraulic and pneumatic classification, laws of settling, Stoke's law, Newton's law, different industrial classifiers and their characteristics.

Froth flotation: Contact angle and its application to flotation, wetting agents, frothing agents, industrial froth flotation apparatus and their application.

Filtration and dewatering processes. Drying. Transport and conveyance of material.

Process flowsheets for important indian ores, *e.g.*, Gold, Copper, Lead, Zinc, Iron and Uranium ores.

(For Metallurgical Engineers)

432. Mineral Dressing—(2-0) First Term, (2-3) Second and Third Terms.

Recovery of minerals from ores. Machines and operations used for coarse and fine grinding. Classification and preparation for concentration. Methods of concentration including gravity and magnetic methods, flotation etc. Flow-sheet study of important mineral dressing operations.

Laboratory experiments based on the above Syllabus.

(For Mining Engineers)

433. Testing of Fuels (0-2).

Sampling of coal, proximate analysis, calorific value of solid fuels, bomb calorimeter, caking index of coal. Calorific value of liquid fuels, flash and fire points, pour point, viscosity, Conradson carbon residue test, ASTM distillation.

Calorific value of gaseous fuels, Junker's gas calorimeter. Orsat gas analysis.

(For Mechanical Engineers)

435. Plastics and Paints (1-0) First and Second Terms.

Plastics: Natural and synthetic resins, types of synthetic resin, thermoplastic and theromosetting ; polymerisation and condensation—polymerisation ; general properties and uses ; outline of methods of production of plastics.

Paints: Types of paints and compounds, methods of setting ; mechanical and chemical protection by painting, painting sequences for iron and steel, zinc and aluminium ; various types of paint failure, economics of painting.

(For Naval Architects)

511. Diffusional Operations (Unit Op. IV) (4-2) First Term, (4-1) Second and Third Terms.

Nature and theory of diffusion. Mass transfer by molecular and eddy diffusion. Analogy between momentum heat and mass transfer. Mass transfer coefficients and their correlations.

Theory of gas absorption. Design and operation of plate and packed towers. Concept of H.E.T.P., H.T.U. and N.T.U. Absorption coefficients. Flooding and loading points. Multi-component systems. An elementary idea of simultaneous absorption and chemical reaction.

Distillation: Batch, continuous, flash, steam, vacuum, molecular, azeotropic and extractive distillations. Theory of fractional distillation for binary mixtures. Ponchon-Savarit and Mc-Cabe Thiele methods. Optimum reflux, plate efficiency and tray hydraulics. Design of bubble-cap, sieve plate and packed columns.

Leaching: Different types of equipments. Ideal stages in counter-current leaching. Stage efficiency.

Liquid-liquid extraction: Different types of equipments. Principles of extraction, triangular and rectangular co-ordinates, design calculations for extraction in packed and spray columns.

Crystallization: Principles, crystal formation and growth. Different types of batch and continuous crystallizers, design calculations.

Theory of adsorption. Recovery of solvent vapours by adsorption. Industrial adsorbents.

Air-water contact operations: Hygrometry and humidity charts, Mechanism of contact operations, rate equations for simultaneous heat and mass transfer. Methods of humidification, dehumidification and air conditioning. Design of different types of equipments. Water coolers and their design.

Drying: Theory and mechanism of drying, drying rates, drying characteristics of materials. Different types of dryers used for solids, liquids and slurries. Design and performance of continuous and batch dryers.

515. Unit Operations Laboratory II (0-6).

Laboratory experiments to illustrate the principles covered in ChE 431 and 511.

516. Chemical Process Technology (Tech. II) (2-3) First and Second Terms, (2-0) Third Term.

Unit processes of organic synthesis with special reference to selected industries.

Nitration: Explosives, T.N.T., nitroglycerine, nitrobenzene, nitrocellulose.

Amination by reduction: Aniline.

Sulfonation: Benzene sulfonic acid, dodecyl benzene sulfonic acid, napthalene-sulfonic acid, etc.

Oxidation : Acetaldehyde and formaldehyde from ethanol and methanol respectively, acetic acid from acetaldehyde, styrene from ethylbenzene, phthalic anhydride from napthalene, chemicals from partial oxidation of petroleum products.

Hydrolysis: Phenols, napthols, ethyl alcohol, soap, paper, hydrolysis of cellulose to sugar.

Esterification: Industrial solvents *e.g.* ethyl acetate, butyl acetate, amyl acetate, cellulose acetate, vinyl acetate.

Hydrogenation: Edible oils and fats, coal tar hydrogenation, hydroforming, hydrocracking, etc.

Alkylation: Special reference to petroleum industry, cumene, ethyl benzene.

Diazotization: Dye-stuff.

Polymerisation: Rubber, plastics, synthetic fibres, etc.

Biochemical industries. Pharmaceutical industries. Sugar. Leather. Paints and varnishes. Oils, fats, waxes and detergents.

Development and present position of organic chemical industries in India.

Flowsheets with material and energy balances.

520. Fuels (1-0) First Term, (2-3) Second and Third Terms.

Classification of fuels. Origin and formation of coal. Coal classification—Seylar, A.S.T.M., Indian and international classification. Indian coal reserve. Petrography of coal. Spontaneous ignition and storage of coal. Commercial gradation of indian coal.

Principles of coal washing. Washability curves. Design and operation of different types of coal washing plants.

Principles of coal carbonisation and by-product recovery. Gasification of coal. Liquid fuel. Petroleum and its characteristics. Combustion. Limits of inflammability. Rate of flame propagation.

(For Mining Engineers)

521. Materials of construction (1-0) First and Second Terms.

Corrosion: Types of corrosion and their prevention. Cathodic protection with special reference to pipe line protection.

Metals: Ferrous, non-ferrous and their alloys with special reference to application in chemical and petroleum industry.

Nonmetals: Formation, structure and physical properties. Special polymeric materials of construction.

Refractories: Study and application.

522. Instrumentation and process control (2-1) Second Term, (2-3) Third Term.

Standards of measurements, components of an instrument, static and dynamic characteristics of instruments.

Temperature measuring instruments: Filled system thermometer, radiation and optical pyrometers, other temperature measuring devices.

Pressure measuring elements: Mechanical pressure elements, strain gauges and other pressure transducers, high vacuum measurement.

Flow measuring elements: Head and area flow meters, positive displacement meters, mass and magnetic flow meters.

Liquid and solid level measuring elements.

Measurement of chemical composition: Emission and mass spectrometry, ultraviolet absorption and infra-red analysis, solution potential measurement, pH and electrical conductivity measurement, thermal conductivity gas analysis, O_2 and CO_2 analysis, other methods of analysis.

Measurement of miscellaneous process variables, *e.g.* velocity, density and specific gravity, viscosity and consistency, humidity and photometric variables.

Indicating and recording instruments, scanning instruments, galvanometers and other moving coil instruments, potentiometers, electrical bridge and self-balancing instruments.

Concept of feedback loop, process characteristics, modes of control, generation of control actions, final control elements and valve positioners, transmitting and telemetering devices, typical industrial control schemes.

Application of Fourier and Laplace transformations. Open loop response of simple systems, feedback element and controller characteristics. Elements of frequency response analysis, stability and quality of a control system, optimum controller settings, feed forward control, cascade control. Process dynamics of heat exchangers, level and flow systems, distillation columns and chemical reactors. Introduction to systems engineering, plant dynamics study for optimisation, elements of control design, computer control.

523. Chemical Engineering Thermodynamics (2-1) First and Second Terms, (1-1) Third Term.

Energy functions, interconversion of energy functions. Equations of state, thermodynamic functions of actual gases. Construction of thermodynamic charts, generalized charts. Liquefaction of gases. Thermodynamics of solutions. Criteria of physical equilibria, vapour—liquid equilibria at atmospheric and super-atmospheric pressures, chemical equilibria in homogeneous and heterogeneous systems.

524. Engineering Economics (1-0) First and Second Terms, (2-0) Third Term.

Elements of economics, economic laws, banking. Business organisation, proprietorship, partnership, joint stock company and other forms of business organization. Capital and different methods of raising capital. Management of companies, Indian Companies Act.

Industrial Legislations: Factories Act and other Acts. Industrial relationship, labour, wages.

Resources of India: Transport, minerals, fuels, electricity, etc. Trade, balance of payment, finance.

Industry: History and development of different industries in India, Tariff, subsidy, patent, national plans.

Cost Accounting: Methods of calculating depreciation, different types of costing and costing calculations. Accounting, book-keeping, balance sheet.

Factory design: Economic location, layout and cost estimation. Different types of organisation for factory management, sales, purchases, reports, charts, budgets, time-and-motion study and other methods of factory control.

526. Fundamentals of Molecular Phenomena (2-1) First and Third Terms.

Molecular phenomena—I: Transport properties with low entropy changes. Momentum transport. Velocity distributions in laminar flow. Energy transport, temperature distribution in solids and in laminar flow. Mass transport, concentration distribution in solids and in laminar flow. Equations of change.

Molecular phenomena—II: Transport properties with high entropy changes. Homogeneous reactions, catalytic reactions, flow reactor concept.

Gas-solid and liquid-liquid reactors of industrial importance.

527. Chemical Engineering Plant and Equipment Design (1-3) First Term, (1-6) Second and Third Terms.

Introduction to Chemical Plant Design. Development of project, process research, pilot and semi-commercial plant. Scale-up techniques and application of models in chemical plant design. Process design. Selection and specification of process equipments and materials of construction. Plant layout. Piping design and layout. Process auxiliaries. Application of systems engineering in the design of a chemical plant.

The work will-include design and fabrication drawings of simple units of plants, *e.g.* heat exchangers, reactors, dryers, evaporators, absorbers, distillation columns, etc. to meet specified requirements with reference to functional efficiency, ease of control and maintenance.

528. Petroleum Refinery Engineering (Elective) (2-0) First and Second Terms.

Origin and occurrence of petroleum, classification of crude oils, physical properties of petroleum and petroleum products.

Evaluation of crude oil, selection of products, straight-run distillation of crude. Details of equipments, *e.g.* tube-still heater, stripper, etc.

Introduction to chemical treatments of gasoline, light and heavy distillates.

Gas processing and natural gasoline production. Refinery location and layout, storage and transportation.

Thermal cracking, catalytic cracking, catalytic reforming, hydrogenation and alkylation.

529. Synthetic Fuel Engineering (Elective) (2-0) First and Second Terms.

Fischer-Tropsch process. Bergius process. High pressure and high temperature techniques.

530. Coal Chemicals (Elective) (2-0) First and Second Terms.

By-products from coal. Recovery of benzene, xylene and toluene. Recovery of phenols. Nitrogen bases from coal tar distillation. Coal tar hydrogenation. Treatment of bases, napthalenes, etc.

531. Biochemical Engineering (Elective) (2-0) First and Second Terms.

Processing, preservation and disposal of materials of biological, biochemical and microbiological origin.

Food processing techniques, thermal processing of in-can foods, freezing, thawing and freeze drying, pasteurization and sterilization by thermal or other methods, irradiation, preparation and handling of biol, suspensions, dehydration, preservation through fermentation, production of proteins and amino-acids by large-scale fermentation, etc. Use of continuous culture techniques, methods of air, equipment and media sterilization by various ways, mass transfer in biol systems, biochemical kinetics, rheological properties of biol, fluids, etc.

Processing of synthetic foods, antibiotics, yeasts, vitamins and steriods, biopolymers, organic acids, etc.

CIVIL ENGINEERING (CE)

111. Drawing and Descriptive Geometry (1-4).

Lettering, Scales, Mathematical curves, lines and planes, Isometric and Oblique views, Orthographic Projections, Conventions and Dimensioning, Sketching and elementary Machine drawing.

Representation of plane figures and solids, edge views and true shapes, location of planes, inclination of planes, distances of lines and planes, Intersection of planes, Sections, Interpenetration of bodies, Development of surfaces, Determination of shadows and perspective drawings.

(For Science Stream)

112. Drawing and Descriptive Geometry (0-3).

Revision of Mathematical curves, Isometric and Oblique views, Orthographic Projections, Sketching and elementary machine drawing, Intersection of surfaces and Development of Surfaces.

Cycloids, Involutes, Helices and screw threads, Graphic statics, elementary Building and Structural Drawing, Determination of shadows and perspective drawing.

(For Technical Stream)

211. Engineering Drawing (0-4).

Graphical determination of Centroid, first and second moments of areas ; Building and Structural drawing—elementary and advanced ; Cycloids, Involutes, Helices and Screw threads, drawing of complex machine parts, assembly drawing and details, tracing and blue printing.

(Except for Naval Architects)

215. Surveying (1-3).

Principles and use of scales both metric and British. Use of the various types of instruments, including the dumpy level. Levelling ; the use of the staff, contouring, spot levels, plotting. Use of survey maps ; reducing and enlarging.

(For Architects)

216. Structural Mechanics—I (1-3).

Stress, Strain, Hooke's law for elastic bodies ; Elastic constants ; moments of inertia ; composite sections ; Loads on buildings ; bending moments and shear forces in simple beams and cantilevers ; Theory of simple bending ; deflection of simple beams ; Introduction to principles of Reinforced concrete.

Graphical methods of determination of bending moments and shear forces ; analytical and graphical determination of forces in trusses.

(For Architects)

311. Applied Mechanics II (2-2).

Properties of Fluids: Buoyancy and metacentre ; laws of fluid motion ; Bernoulli's theorem—application, Momentum equations, Vortex notion, Flow through Orifices, mouthpieces, notches ; Flow through pipes and nozzles ; Water hammer, Pipe fittings, Open channel flow, Back water curves, Measurement of Fluid flow.

313. Surveying and Building Construction and Estimating (2-4).

Surveying: Principles and Practice of Chain and compass surveying, plane table surveying ; two and three point problems. Use and adjustment of instruments ; levelling ; Contours and sections ; Setting out buildings, measurement of earthwork ; Planimeter—its theory and use. (Field Practice).

Building Construction and Estimating: Foundations, safe bearing pressures. Timbering of trenches, brickwork and masonry construction ; opening in brickwork and masonry. Damp proof courses ; timber construction ; joints in wood work ; floor and roof construction ; drawing of brickbonds ; foundation (Plain Concrete) ; details of doors, windows, roof trusses and simple buildings.

315. Building Construction and Surveying (2-3).

Building Construction: Foundations; Brickwork and Masonry; Damp-Proof course; Timber Construction; Joints in Timber Floors and Roofs.

Building Drawing; Foundations and Footings; Brick bonds; Details of Doors, Windows, trusses and lintels.

Estimating: Taking Quantities, Rates and Costing; Plinth area and cubic meter rates, approximate estimates.

Principles and Practice of Chain and compass Surveying and Plotting, Plane table surveying; two and three point problems. Use and adjustment of instruments; levelling; contours and sections; setting out buildings, measurement of earth work, Planimeter—its theory and use.

Elementary principles of Theodelite traverse (Field Practice).

(For Agricultural Engineers)

316. Structural Mechanics—II (2-2).

Fixed and continuous beams; determination of moments and shear forces in continuous beams from hand books.

Further problems in reinforced concrete including framed structures; Foundations;—footings, pile and grillages.

(For Architects)

317. Fluid Mechanics (2-2).

Properties of fluids, buoyancy and metacentre, laws of fluid motion, Bernoulli's theorem—applications, momentum equations, vortex motion, flow through orifices, mouthpieces, notches, flow through pipes and nozzles, water hammer, pipe fittings, open channel flow, backwater curves, measurement of fluid flow.

318. Strength of Materials (1-2).

Strain energy—repeated and impact loading, riveted and welded joints bending and shearing stresses in composite beams including reinforced concrete sections.

Deflection of statically determinate beams, statically indeterminate beams, combined direct and bending stresses, columns.

Special Topics: Moment of inertia, unsymmetrical bending, thick cylinders, shear centre etc.

321. Services I (Plumbing Drainage and Sanitation) (2-0).

Internal water supply to buildings; Lay out drawings—Principles and design of internal water supply lines including those for multistoried buildings—materials and fittings for water supply. Drawing system for buildings—lay out drawings—principles and design of waste pipe line—materials and fittings for waste water collection system—Septic tank, Soak well and tile fields principles of design. Rain water drainage—principle of design. Maintenance problems for internal water supply and waste water systems—Refuse collection for buildings.

(For Architects)

411. Theory of Structures and Soil Mechanics (2-2).

Theory of Structures: Three-hinged and two-hinged arches, Fixed beams, Moving loads, Influence lines in Simple cases, Continuous beams, Deflection of beams by virtual work, Deflection of trusses, Redundant frames, Trussed beams, Graphics of B. M. and S. F. in continuous beams, Williot—Mohr diagram.

Soil Mechanics: Physical and engineering properties of soils, identification and classification, Stability of slopes. Earth pressures.

412. Design of Structures—Concrete and Steel (2-2).

Reinforced concrete, simple beams and slabs, short columns, Footings, Retaining walls, Staircases, Design of Riveted and Bolted joints, Welded connections, Design of columns, Roof Trusses and plate Girders.

413. Hydraulics, Hydrology and Irrigation (3-2).

Open channels—non-uniform Flow, Hydraulic Jamp, Fluming ; Dimensional analysis, Viscous Flow, Boundary layer, Hydroelectric Turbines, Pumps, and other Hydraulic machines.

Measurement and study of rainfall, run off and storage. Well and flow irrigations, Duty of water, Diversion works, Canal systems, Falls and Cross-drainage works.

414. Surveying and Construction (2-5).

Surveying: Theodolite surveying ; traversing and adjustment of errors ; tacheometric surveying. Curves—circular and transition, setting out. (Field Practice).

Building Construction: Foundations dewatering, laying concrete underwater. Pile and well foundations. Building rates, plinth area and cubic metre rates. Construction equipment, excavation and quarrying methods. Demolition, underpinning, scaffolding, hoisting. Fire proof construction.

415. Engineering Laboratory (0-6).

Experiments connected with Hydraulics, Structures (including models), Soil Mechanics (including Highways) and Sanitary Engineering.

416. Structural Design I (2-3).

Design of flat slabs ; rigid frames analysis, moment distribution and slope deflection methods.

Design of riveted joints, and connections ; design of tension and compression members and beams ; design of members subjected to axial compression and bending—design of Grillage foundation.

General principles of design of prestressed concrete.

(For Architects)

417. Sanitary Engineering (2-2).

Estimation of water consumption, Sources, quality, Collection, purification, Conveyance and distribution.

Flow in Sewers, design of sewerage system, sewer appurtenances, pumping, sewage disposal works, laboratory work.

418. Advanced Strength of Materials and Structures (2-2).

Failure under steady stress ; slip and separation in relation to shear and bulk stresses. Maximum principal stress, strain and shear hypotheses. Total and shear strain-energy theories.

Beams ; distribution of stresses in curved beams, elastic and plastic design of beams.

Deflection from tangent ; application to encastro, tapered and continuousbeams ; Clapeyron's theorem ; relaxation methods.

Influence line ; moving loads.

Struts and ties ; ideal ; eccentrically loaded ; laterally loaded ; end constraints ; analytical and polar diagram treatments ; tapered and continuous struts.

Torsion of circular and non-circular sections ; effective J ; open-coiled springs with and without end constraints.

Arched ribs ; three pin, two pin and encastre arches ; temperature stresses ; influence lines.

Portals ; closed frames ; application to ship and submarine frames.

Strain-energy methods for direct bending and shear deflections. Distribution of shear stress in riveted, bonand other joints.

Framed structures ; typical frames ; Clerk Maxwell diagram ; method of sections.

Space frames ; Southwell's tension coefficients.

Elastic and plastic design of portals.

Deflection of frames by kinematics and energy methods.

Redundant plane and space frames ; secondary stresses in deficient and redundant frames ; stiff-jointed frames.

Laboratory Work A selection from the following:

Determination of elastic constants of engineering materials.

Tests to fracture ; in tension. compression and torsion.

Hardness tests.

Notched-barimpact tests.

Instability of slender struts.

Lateral instability of beams.

Deflection and reactions of continuous beams.

Calibration of electrical resistance strain gauges.

(For Architects)

421. Estimating and specifications (2-0).

General introduction and estimates on floor area and cubic contents.

Detailed-methods of taking out quantities of buildings—small and large.

Costing: Standard rates and their derivation from given data.

Definition and use of specifications. Methods of writing order and sequence.

Specification of material finishes etc. Clause by clause analysis of standard specifications.

Inspection of works in progress.

(For Naval Architects)

511. Structural Analysis and Foundation Engineering (2-2).

Structural Analysis: Analysis of Statically indeterminate structures by slope deflection, moment distribution methods and influence lines, curved beams, fixed arches, Spandrel braced arches and continuous trusses.

Foundation Engineering: Theories of foundation failures, Principles of foundation action, spread footings, mats, piles and pile foundations, coffer dams, caissons.

512. Design of Concrete Structures (2-1).

Design of concrete mix. Review of design of beam and slab, ultimate load design, Variation in modular ratio.

Raft and pile foundations, R. C. column subject to direct and bending stresses, Retaining walls, Rectangular and circular water towers, flat slab construction, Shell constructions, Dams, Principles of prestressed concrete construction, Common methods.

513. Roads, Railways, and Airports (2-0).

Roads and Railways—Location, Ruling curves and gradients typical sections for roads in plain and hilly areas, Construction and maintenance of macadamised bituminous concrete and paved roads, construction and maintenance of railway track, Superelevation. Points and crossings, station buildings, signalling and safety device, curve compensation. Airports—Location and layout of airports and land strips, Construction and design of runways.

515. Geodesy and Construction (3-2).

Geodetic Surveying: Baseline measurements and triangulation; precise and trigonometrical levelling. Field astronomy determination of azimuth, latitude, longitude and time. Setting of parallels of latitude and longitude. Tunnel surveying, hydrographic surveying, aerial surveys.

Construction: Orientation of buildings, public buildings, cinemas, markets, schools, hospitals, stadium. Low cost housing, methods of prefabrication; heating and ventilation; accounstics. Building regulations and bye-laws, special foundations. Earthquake structures. Contracts and works organisation. Evaluation of properties.

516. Structural Design II (2-3).

Architectural concepts of structural engineering; general principles of shell structures; design of spherical domes and cylindrical shells.

(For Architects)

517. Building Materials (2-0) III term only.

Soils—Classification and identification, hydraulic and Mechanical properties. Bricks—Types, manufacture and uses, brickbonds. Building stones: Types, properties and uses; correction and prevention of defects. Concrete: Composition, properties and uses of cements and concrete mixtures.(For Mining Engineering).

(For Mining Engineers)

520. Dam and Water Power Engineering (2-1).

Principles of Design of dams of Gravity, Arch, Buttress, Earth and other types, Appurtenant works—spillways, gates, gallaries, outlets, contraction joints, grouting, river diversion, project planning, selection of type of dam.

Problems involved in location, design, construction and economics of hydroelectric developments, estimates of water power from stream flow data, hydraulic turbines, intakes, conduits and penstocks, power-house structures.

521. Irrigation and Maritime Engineering (2-1).

Application of Khosla's theory—the design of weirs on permeable foundations, fluming of canals, non-uniform flow and back water curves, river training, guide banks, inland navigation, reclaiming land from sea.

Tides and tidal currents, wave action, beach erosion, methods of shore protection, layouts of channels and harbour basins, wet, dry and floating docks, quay walls, jetties appurtenances.

522. Bridge Engineering (2-1).

Brief historical review and modern development with examples of outstanding bridge constructions. Classification of bridges and bridge components.

Bridge site, essential design data, designed maximum discharge waterway, scour calculations, depth of foundations, afflux, economics of span lengths and pier location, Loadings and forces.

Foundations (open, pile and well), abutments, piers, wingwalls—different types.

Design of slab, T-girder and Hollow girder R. C. bridges, Simply supported and cantilever types of spans, general features of design of arch. Continuous, rigid frame and prestressed concrete bridges. Plate girder and truss—Bridge bearings.

Aesthetics of Bridge Design.

523. Advanced Structural Engineering (2-1).

Analysis of building frames, continuous trusses and bents, continuous girders and frames with variable moments of inertia. Analysis of statically determinate structures such as cables, suspension systems and space frames.

Brief introduction to advanced structural mechanics including analysis of plates and shells, buckling behaviour and response of structures to dynamic loading.

Introduction to elementry concepts of plastic theory as applied to slab and reinforced concrete structures. Analysis of R. C. members in combined bonding and Torsion.

524. Highways, Airports and Tunnels (2-1).

Classification of roads, estimation of traffic, Geometric standards in the design of highways, Sight Distances, Vertical curves, Transition curves, superelevation. Earth work computation, mass diagram. Hill road planning and design. Soil stabilization. Design principles governing flexible and rigid pavements.

Classifications of airports, standards and design of geometric elements, Drainage of airports.

Tunnels—types, construction, ventilation and lighting, precautions for safety.

525. Design of Steel Structures (2-1).

Design of steel framed structures—semirigid connections, design of steel framed multistoreyed buildings. Industrial buildings and factory roof structures, design of crane and gantry girders and colums. Design of steel silos and bunkers. Design of steel bearings, high strength bolts and welded structures, introduction to light alloy steel structures—design code and specifications.

591. Advanced Structural Engineering I (2-1).

Thick tubes under internal and external pressure: elastic and plastic stress distributions; compounding of elastic tubes; residual stresses due to partial yield; approximations for pipes and thin shells.

Torsion of non-circular sections; membrane analogy; Bredt-Batho theory for thin shells.

Membrane stresses: Surfaces of revolution under internal pressure; pipe bends; shear flows and torsion-bending; sheet-stringer hypothesis; and constraint and Wagner theory.

Beams on an elastic foundation; application to grillages and to local bending at discontinuities in thin shells.

Bending of flat plates under lateral loads; circular plates; edge constraint and joint efficiency; minimum energy principle for rectangular plates; grillages; plastic design.

Elastic instability struts, beams, plates and shells.

(For Naval Constructors)

691. Advanced Structural Engineering II (2-2).

Alternating stresses; fatigue; S-N curves; dynamic loading of structure and components; combined steady and alternating stress; Goodman and Gerber lines for high tensile and mild steels; hysteresis; nature of fatigue fractures; corrosion fatigue; fatigue at stress concentrations.

Elasto Plastic analysis of structural systems.

Plane stress in two dimensions; photo-elasticity; application to stress concentrations and to shear diffusion problems.

Limit analysis and design, Variational methods and application to structural problems.

Vibration of complex structures and structural system.

Periodic motion: simple and complex harmonic motions, representation of harmonic motion in phase diagrams, natural damped and forced vibrations in stable systems; frequency of vibration of shallow and deep beams of uniform section, of irregular section, and of ships' structure; whirling of shafts with damping and thrust and torsion.

Torsional vibrations: shafts, structural members and ships; critical speeds.

Vibration of propeller blades; in air and water; flutter; hysteresis.

Gyros; characteristics and principles.

Stress waves: propagation; characteristics of stress waves in elastic medium.

Contained Plasticity and non linear analysis of typical structural systems.

Henkey's theorem and plastic flow problems associated with structural systems.

Experimental Stress analysis:

Laboratory Work:

Tensile tests, plain and welded specimens.

Strain gauges.

Overstrain of metals.

Elastic and plastic behaviour of thick tubes.

Plastic bending of beams.

Shear-centre of asymmetric beams.

(For Naval Constructors)

ELECTRICAL ENGINEERING (EE)

111. Orientation (1-0).

311. Electrical Technology (2-2).

Introductory study of magnetic and electric fields and circuits. Direct and alternating current machines. Current, voltage, power, and energy meters. Electrical installation of buildings. Elements of power generation, transmission and distribution. (For Aeronautical, Agricultural, Chemical, Civil, Metallurgical Engineers and Naval Architects).

312. Electrical Technology I (2-2).

Introdcutory study of magnetic and electric fields and circuits. Elements of circuit theory. Construction, principles of operation and characteristics of d.c. machines, transformers and alternators. Measurements and measuring instruments. (For Mechanical and Mining Engineers).

321. Electrical Circuits and Machines (3-4).

Electric and magnetic field concepts and system parameter calculations. Formulation of equilibrium equations for simple d. c. and a.c. networks and evaluation of transient and steady state behaviour. Vector loci and circle diagrams. Newwork theorems and application to single and three-phase circuits.

Theory and performance of d.c. machines including windings, armature reaction, and commutation. Special types of machines. Storage batteries. Laboratory assignments covering circuits and machines. (For Electrical and Electronics & Electrical Communication Engineers).

412. Electrical Technology II (2-3).

Synchronous motors, induction motors, converters, and single-phase machines. Transmission and distribution. Overhead lines and underground cables. Electric power utilisation. Elementary principles of industrial motor control. Power station and sub-station layout. (For Mechanical Engineers).

413. Electrical Technology II (2-1).

Sychronous motors ; induction motors ; single-phase machines, converters and rectifiers. Transmission and distribution. Mining cables ; flameproofing and intrinsic safety ; mining switchgear and protecting devices ; signalling systems for shafts and roadways ; electric drives for compressors, pumps, fans, mine winders and electric locomotives.

(For Mining Engineers)

414. Services II (2-0) First Term.

Electric installation of buildings, electrical appliances, illumination, lighting of interior and exterior of buildings.

(For Architects).

415. Electrical Measurements, Transmission and Distribution (3-1).

Detailed study of instruments and meters. Extension of instrument range. Instrument transformers. Measurement of magnetic and electric quantities. Direct and alternating current bridges and bridge measurements for resistance, inductance, capacitance, and frequency. D.C. and A.C. potentiometers.

General study of engineering and economic factors relating to transmission and distribution of electrical energy. Different systems of transmission and distribution. Design of transmission lines. Circuit breakers. Protection. Interference with telephone lines.

(For Electronics & Electrical Communication Engineers).

416. Electrical Machines (3-1).

Ployphase synchronous, induction, and commutator machines. Single-phase motors. Converting machines and rectifiers. Principles of working, characteristics and application of rotating amplifiers, synchros and servomotors.

(For Electronics & Electrical Communication Engineers).

417. Electrical Laboratory (0-4½).

Experiments covering EE 415 and EE 416.

(For Electronics and Electrical Communication Engineers)

421. Electrical Circuits and Measuring Instruments (2-1).

Symmetrical components and three-phase circuit analysis. Two-terminal and four-terminal passive networks and evaluation of input, output and transfer functions. A, B, C, D and image parameters. Reflection effects and travelling waves on transmission lines. Description and mapping of impedance functions in the frequency domain. Pole-zero configuration. Synthesis of simple two-terminal networks.

Instrument classification. Equation of performance of the moving system and extension to develop instruments for measurement of voltage, current, charge, and flux-linkages. Torque equations for moving iron, dynamometer, electrostatic and induction systems. Instrument transformers.

431. Electrical Machines (3-1).

Theory and performance of transformers, synchronous and asynchronous machines. Converters and rectifiers.

441. Power Systems I (2-2).

Engineering and economic factors relating to transmission and distribution of electrical energy. Electrical and mechanical characteristics of overhead lines. Different systems of transmission and distribution. Synchronous phase-modifiers and capacitors. Insulators and supports. Underground cables. Analysis of system over-voltages and travelling waves. Lightning arresters. Grounding. Line interference. Dielectrics and their breakdown. Grading of cables. Condenser bushing. Insulation strength and losses. Discharges in solids, liquids, and gases. Corona. Production and measurement of direct, alternating and impulse voltages. High-voltage and impulse testing. High speed oscillograph. High-voltage d.c. transmission.

451. Electrical Laboratory I (0-4½).

Experiments covering EE 421, 431 and 441.

521. Instrumentation and Control (3-1).

Magnetic measurements. Fault localization and earth testing. D.C. and A.C. bridge-networks and potentiometers. Errors and their estimation. Transducers and measurement of non-electrical quantities. Open and closed-loop control schemes. Block diagrams. Equation of performance of simple schemes. Error coefficients. Feedback and its effects. Transfer functions and frequency response plots. Stability criteria. Study of classified examples of control schemes employed in recording, telemetering and automatic control systems.

531. Machines and System Components (2-1).

A.C. commutator machines. Unbalanced and transient operation of machines and transformers. Magnetic amplifiers and crossfield machines. Servo-motors, selsyns and their applications. Electro-magnetic fields and their properties. Two dimensional fields and field mapping techniques.

532. Electrical Machine Design (2-0).

Constructional details of electrical machines and transformers. Insulation, ventilation and cooling. Evaluation of machine parameters.

541. Power Systems II (2-4).

Fuses and circuit breakers. Different types of oil and air-blast circuit breakers.

Restriking and recovery voltages. Symmetrical and asymmetrical fault calculations. Sequence networks. Potective relays. Protection of power system including equipments. Testing of circuit breakers and relays. Carrier relaying, telemetering and supervisory control. Elements of steady-state and transient stability of power systems. Methods of improving stability.

Steam-power generation. Efficiency and load studies. Hydro-electric power generation. Atomic power plant. Power station planning. Economics of hydel, steam and nuclear power generation. Basic insulation level and insulation co-ordination. Electrification of urban and rural areas, and industrial undertakings. Electrical Drives and elements of Illumination Engineering. Electricity Rules and Regulations. Codes of engineering practice and standard specifications. Electricity tariff.

551. Electrical Laboratory II (0-4½).

Experiments covering EE 521, 531 and 541.

561. Project (0-4).

Specification and design of typical machines and transformers. Project assignments on automatic control schemes.

ELECTRONICS AND ELECTRICAL COMMUNICATION ENGINEERING (Co.)

311. Principles of Electronics (1-0).

Vacuum tubes and transistors—equivalent circuits, amplifiers, oscillators, and rectifiers' Electronic instruments.

(For Aeronautical, Agricultural, Chemical, Civil, Mechanical, Metallurgical and Mining and Naval Architects)

312. Principles of Electronics (2-2).

A.C. circuits, resonance and coupled circuit ; Network theorems. Vacuum tubes and transistors, Rectifiers, amplifiers, Feedback ; Oscillators ; modulation and demodulations ; C R O.

411. Principles of Electrical Communication (2-1½).

Voltage and Power amplifiers, Oscillators.

Pulse Circuits, Multivibrator, blocking oscillator, time base generators, counters, logic circuits.

Power rectifiers. Voltage Stabilisers.

Gas tubes, Thyratron, Ignitron ; Induction and dielectric heating.

(For Electrical Engineers)

412. H. F. Measurements and Electro-acoustics (2-0).

Measurements of parameters of passive and active devices, amplifiers, receivers and transmitters ; Frequency and time measurements. Electro-acoustic transducers. Recording and reproduction of sound. Reverberation and room acoustics. Ultrasonics. ITU Standrds.

413. Networks and Transmission Lines (2-1½).

Loop and node analysis, matrices. Two terminal and four terminal network parameters. Constants of transmission line. A.F. and R.F. transmission lines. Electromagnetic field configuration and Power flow in transmission lines. Wave equation.

414. Electronic Circuits (3-1).

Small signal amplifiers—AF, RF, Video and operational amplifiers, Feed-back amplifiers ; Oscillators. Pulse-circuits, Multivibrators, blocking Oscillator, time base generators, and counters ; Logic circuits.

415. Radio Engineering I (2-1).

Large signal amplifiers—AF, and RF ; Generation and detection of AM, PM, FM and SSB signals. Description and design considerations of various units in Radio Transmitters and Receivers.

416. Electronics and Electrical Communication Engineering Lab. (0-6).

Laboratory work to be based on Comm. 414 and 415.

511. Applied Electronics (2-1½).

Elements of Telegraphy & Telephony. Modulation & Demodulation—AM, FM, SSB, Pulse Modulation. VF and Carrier telegraphy and telephony. Power line carrier and telemetry. Radio Communication, transmitters and receivers. Electronic measurement and control circuits.

(For Electrical Engineers)

512. Line Communication Engineering (2-1½).

Manual and machine telegraphy. Manual and auto-telephone. Design of switching circuits ; Strowger System. Long distance VF and carrier telegraph and telephone systems. Coaxial cable systems and power line carrier systems. Filters and Equalisers.

513. Mathematics of Circuit Analysis (2-1).

Matrices and determinants ; Vector Algebra, Complex Variables. Special functions Wave equation. Fourier series and Integral. Laplace and Fourier Transforms.

514. Radio Engineering II (3-1).

Elements of Communication theory ; Pulse Modulation Systems. System Details of various communication links. Television ; Radar, Aids to Nagivations ; Elements of VHF and Microwave techniques.

515. Engineering Electronics (2-1½).

Power rectifiers. Magnetic and Servo amplifiers, Voltage stabilisers ; thyratron and ignitron. Induction and Dielectric heating. Industrial control circuits. Servo-mechanism ; Control elements and stability considerations.

516. EM Waves, Radiation and Propagation (2-0).

Fields, Maxwells' equations, Wave equations. Plane waves. Rectangular wave-guide. Incremental antenna, Quarter-wave and half wave antenna. Practical antennas. Ionosphere. Propagation through troposphere and ionosphere.

517. Physics of Electronic Devices (2-0).

Motion of electrons, Electron optics. Thermionic omission, Gas tubes, TV camera tubes. Interaction of electron and waves, microwave tubes. Physics of junction diode and transistors. Photo-electric, Thermoelectric, Hall and other solid-state devices, measurements.

518. Design and Report (0-6).

Some selected topics from circuits, instruments and systems.

519. Electronics and Electrical Communication Engg. Lab. (0-6).

Based on all departmental courses.

520. Antenna and Wave Propagation (2-0).

Dipole and linear antenna. Antenna in the Long, Medium, Shortwave and VHF ranges. Microwave antenna. Ground wave propagation. Propagation of waves through ionosphere and troposphere.

521. Servomechanism and Control Engineering (2-0).

Theory of servomechanism. Servo elements, Servo-amplifiers. Various transducers and industrial instrumentation. Servo systems including nonlinear controls.

522. Microwave Engineering (2-0).

Guided wave propagation. Ressonators. Microwave Generators. Microwave components, Microwave antenna. Microwave measurements. Microwave Systems.

523. Electronic Computors (2-0).

Analogue computers—operational amplifiers, function generator. Applications. Digital Computers—Switching theory, arithmetic units. Organisation and programming of computers.

524. TV, Radar and Aids to Navigations (2-0).

Television—Camera tubes, Scanning, Synchronisation, transmission and reception. Colour TV. Principles of Radar—range, resolution accuracy and data presentation, Radar receiver, different types of Radar. Aids to Navigation for long, medium, and short distances.

525. Acoustics (2-0).

Vibration of strings, bars and membranes. Wave equation. Resonators. Analogy with other systems. Electro-acoustic transducers. Recording and reproduction of sound. Room acoustics ; ultrasonics.

531. Computer Technology (2-0) first term).

Analogue computers ; operational amplifier. Applications. Digital computers ; logical gates, memory devices. Organisation of computers.

(For Electrical Engineers)

552. System Engineering (2-3). First and Second Terms.

Simple passive circuits. Amplifiers AF and RF—voltage and Power. Oscillators Power Supply units. Modulation and Demodulation. Acoustical mechanical and optical transducers. Measuring Instruments. Elements of Electronic control—Autopilot.

(For Aeronautical Engineers)

GEOLOGY & GEOPHYSICS (Ge)

311. Physical and Structural Geology (2-2).

Natural processes at the surfaces and inside the earth. Origin and age of the earth. A short geological history of the earth. Principles of structural geology: Description of folds, faults, joints, unconformities, lineations, foliations etc. ; the mechanics of their formations. Geological maps and sections.

(For Mining Engineers)

312. Geology (2-2).

Principles of crystallegraphy, chemical and physical properties of various rockforming and ore minerals, their association, origin and modes of occurrence. The nature, composition and classification of igneous, sedimentary and metamorphic rocks, elements of petrogenesis. Nature, origin and occurrences of mineral deposits, types and controls of ore deposition, geographical distribution and details of Indian deposits of Fe, Cu Mn, Pb, Zn, Ag, Au. Elements of Mining and prospecting. Estimation of ore reserves. India's potentials of metallic and non-metallic minerals and discussion of the mineral development during the five-year plans.

(For Metallurgical Engineers)

313. Mineralogy and Petrology (2-2).

Principal crystal forms of minerals, their recognition, identification and classification, the physical, chemical and optical properties of common rock forming minerals: their association, classification and modes of occurrence.

The nature, composition, classification of igneous, metamorphic and sedimentary rocks,

their identification in the field and laboratory: elements of petrogenesis.

(For Mining Engineers)

411. Geology (1-1).

Principles of petrology, physical geology, crystallography and mineralogy. Elements of Geomorphology, study of aerial maps. Applied aspects of geology in Agriculture.

(For Agricultural Engineers)

423. Stratigraphy, Palaeontology, Economic Geology and Prospecting—(4-2) First Term, (3-2) Second and Third Terms.

Principles of stratigraphy. A brief description of the stratigraphic units of India. Elements of palaeontology with special reference to coal-field flora. Study of important plant and animal fossils.

Physico-chemical principles of ore deposition. Important Indian metallic and non-metallic mineral deposits, their occurrence, origin, structure and value. Principles and techniques of geological, geophysical, and geochemical prospecting.

(For Mining Engineers)

519. Geology (2-3).

Minerals and their properties. Igneous, sedimentary and metamorphic rocks and the processes involved in their formation. Earthquakes, Origin, interior and age of the Earth. Geological structures. Historical geology. Engineering aspects of Geology and Geophysics.

(For Civil Engineers)

HUMANITIES AND SOCIAL SCIENCES (Hu).

111. English (2-2) (for Engineers).

(2-1) (for Architects).

The object of the programme is to teach students how to express themselves in good, simple, and correct English and to help them develop a taste for literature.

TUTORIAL PROGRAMME

1st Term.

The main rules of syntax ; the sentence ; its structure ; punctuation ; paragraph: no formal grammar lessons are given ; correct use is taught through composition.

2nd Term.

Preciswriting ; letterwriting ; comprehension test ; etc.

3rd Term.

Paraphrasing ; imaginative writing ; Report writing ; dialogue, diary, etc. ; writing short notes on topical issues.

Anthologies of essays and poems and a modern play will be chosen as text for the lecture classes. The texts will be changed from time to time.

112. History (1-0).

The purpose of this compulsory course in History is to stimulate the interest of the young students in some of the more important epochs of World History and to help them analyse and interpret the story of India against the background of developments elsewhere.

The legacy of ancient civilisations and the Indian inheritance. Influence of Indian culture abroad. Rise and spread of Islam. Europe in medieval times: Church and State. The intellectual stir and Humanism ; Renaissance and Reformation. Cultural Synthesis in India.

113. Principles of Government (1-0).

1. Society, State, and Government. Relation between the State and the Individual Citizenship rights and duties. Functions of government. Sphere and purposes of the State. Dictatorship *vs.* Democracy. Welfare state.

2. Structure of government. Constitution of India with reference to some modern constitutions.

3. World order and the U. N. O.

114. History (1-0).

The same as Hu 112 (for Architects).

211. English (1-1) (for Engineers).
(1-0) (for Architects).

TUTORIAL PROGRAMME

Advanced Prose Composition including precis writing ; Discussion and review of important books ; summarising technical reports.

In the lecture classes two books will be discussed in detail ; one, preferably a prose play by an outstanding playwright, in the first two terms and the other, an anthology of poems or short stories or essays.

212. History (1-0).

Commercial Revolution—Growth of nation-states. The rise of the middle class and the bid for political power.

India and the West.

French Revolution and Napoleon.

The Industrial and Technological Revolution as a factor in Modern History.

India, China & Japan and the Impact of the West.

Nationalism, Internationalism, Democracy and Communism as world forces.

215. Industrial Development in India (1-0).

1. Industrial Revolution in the U.K. and other countries.

2. Industrial Structure of India at the beginning of the 19th century—predominance of small industries.

3. Beginning of modern industries since early 19th century—Tea and Coal. Growth of industries during the 1850's—Jute, Cotton. Railways.

4. Industrial Development and policy upto the first world war.

5. The Inter-war period—changes in the policy of the Government—Adoption of the policy of discriminating protection and its impact on industrial development.

6A. Indian Industries on the eve of the 1st Plan.

6B. Industrial Development during the Plan period—Industrial Policy Resolutions of 1948 and 1956—Industries Regulation and Development Act 1951—The new Protectionist Policy—Rise of the public sector industries. Organisation and financing-managing agency system—banks and industrial finance—Industrial Finance Corporation and other specialised institutions—Foreign capital and Foreign Investment.

(For Engineers)

216. Industrial Development in India (1-0).

The same as Hu 215.

(For Architects)

314. Economics and Economics of Industrial Labour (2-0)

Economics.

1. Economics and Technology—Cost, Utility and Excellence—Human Factor—Economy study of a project—Selections—Impact of Engineering on Economics and *vice versa.*

2. Economic Problems—Economics and Human Behaviour—Exchange, Scarcity, Choice.

3. Economic Systems—Industrial Revolution—Factory Systems—Capitalism, Socialism.

4. National Output and Income and its distribution.

5. Organisation of Production—Division of Labour—Use of machinery—Location—Economic, Social and Strategic Consideration in Industrial Location.

6. Forms of Business Organisation—The Corporate Sector.

7. Scale of Production—Economies and Diseconomies of Large and Small Scale Production—External and Internal Economies—Laws of Returns—Diminishing, Increasing and Constant Returns—scale of production—Economies of increased dimensions and linked processes.

8. Size of a unit—Factors determining size—optimum size.

9. Integration—Motives of Integration—Methods of Integration—Direction of Growth—Integration and Social interest.

10. Value, Depreciation, Depletion and allied Problems.

11. Pricing of commodities—Perfect markets—Imperfect competition—monopoly and oligopoly.

12. Factor pricing—wage determination.

13. Problems of Money & Foreign Exchange.

14. Banking, Central, Commercial, and 2nd Investment.

15. Economic activities of Government.

16. Economic Planning.

Economics of Industrial Labour.

1. Industrial Labour in India—Its Distribution.

2. Efficiency of Labour—Responsibility of Employers.

3. Recruitment, Training etc.

4. Methods of Wage payment and Incentive Schemes—Bonus—Profit sharing—Cost of Living—Sliding Scale—Wage and Labour Policy of Government of India.

5. Scientific System of Wage Payment—Payment by results.

6-7. Factory and Labour Legislation.

8. Trade Unionism and Collective Bargaining—Prospects of Collective Bargaining.

9. Industrial Peace.

10. Industrial Welfare and Personnel Management.

11. Social Legislation—Minimum Wages—Provident Fund Scheme—Health and Unemployment Insurance—Social Security and Social Insurance.

12. Labour Administration in India.

315. Economics (1-0).

1. Economics and Technology—Cost, Utility and Excellence—Human Factor—Economy study of a project—Selections—Impact of Engineering on Economics and *vice versa.*

2. Economic Problems—Economics and Human Behaviour—Exchange, Scarcity, Choice.

3. Economic Systems—Industrial Revolution—Factory Systems—Capitalism, Socialism.

4. National Output and Income and its distribution.

5. Organisation of Production—Division of Labout—use of machinery—Location—Economic, Social and Strategic Considerations in Industrial Location.

6. Forms of Business Organisation—The Corporate Sector.

7. Scale of Production—Economies and Diseconomies of Large and Small Scale Production—External and Internal Economies—Laws of Returns—Diminishing, Increasing and Constant Returns—scale of production—Economies of increased dimensions and linked process.

8. Size of a unit—Factors determining size—optimum size.

9. Integration—Motives of Integration—Methods of Integration—Direction of Growth—Integration and Social Interest.

10. Value, Depreciation, Depletion and allied Problems.

11. Pricing of Commodities—Perfect markets—Imperfect competition—monopoly and oligopoly.

12. Factor pricing—wage determination.

13. Problem of Money & Foreign Exchange.

14. Banking, Central, Commercial and Investment.

15. Economic activities of Government.

16. Economic Planning.

414. General and Industrial Psychology (2-0).

Psychology.

The course gives the basic ideas about human behaviour which forms the basis for the application of psychological principles in industry. It presents a broad picture of the psychological factors underlying human efficiency in industry.

1. General Psychology: Development of experimental psychology.

Motivation: general characteristics biogenic and sociogenic. Emotions: their nature and physiology changes. Perception: its nature; illusions. Learning—types and principles. Remembering and its characteristics. A general idea about personality and its measurement.

2. Industrial Psychology—General principles of group behaviour—study of human factor in industry. Human and Social problems of industrialisaton.

Industrial Psychology.

1. Industrial fatigue and monotony : causation and remedies.
   Personnel selection : Interviewing and psychological tests.
   Industrial training : its benefits and principles.
   Accidents : their causes and prevention.
   Merit-rating
   Wage and Incentives.
   Maladjustment—absenteeism and labour turnover—the maladjusted worker.

2. Human relation in industry—its principles and practices in relation to morale and productivity—industrial conflict.

3. Leadership and Supervision in industry.

415. Social and Industrial Psychology (1-0)

Introduction—some concepts of general psychology—different schools of psychology—Perception—Social perception—human groups—group dynamics—leadership—mass opinion and propaganda—opinion and attitude survey—motivation for work—working environment—environment and fatigue—accident—human engineering—social aspects of industrial psychology.

(For Architects)

511. Modern Drama (1-0).

This course deals with English Drama since G. B. Shaw.

Thesis plays, Irish Revival, Poetic Drama, Comedy of Fantasy.

George Bernard Shaw: *The Doctor's Dilemma, Man and Superman, St. Joan* ;
John Galsworthy: *Strife, Justice, Loyalties* ;
Yeats: *The Heart's Desire* ;
J. M. Synge: *Riders to the Sea* ;
T. S. Eliot: *Murder in the Cathedral* ;
Auden and Isherwood: *The Ascent of F6* ;
Sean O' Casey: *Juno and the Paycock.*

512. Shakespeare (1-0).

The aim is to introduce Shakespeare's plays and sonnets and to give an appreciation of his excellence as a poet and dramatist.

A brief introduction followed by lectures round one or two most important plays and a few sonnets.

513. Asia in Transitition (1-0).

This course in History will be offered with a view to acquainting the students with the general nature of the Asian resurgence since about 1850 in some well-marked regions like India, China, Japan, South-East Asia and West Asia. Emphasis shall also be laid on the problems that these different areas face.

The following topics will be discussed:—

(i) The commercial and political expansion of the West and the Asian reaction.

(ii) The impact of the Western civilisation.

(iii) The recovery of Asia.

(iv) The new factors:

  (*a*) The Russian Revolution.
  (*b*) First World War.

(c) Second World War.

(v) The challenge of communism.

(vi) The impact of Asia.

(vii) Asia and the world ; future trends.

514. Public Administration (1-0).

Definition and scope of Public Administration.

Organisation—mechanical and humanistic views of organisation: the basic concept of organisation—division of work—the principles of hierarchy ; delegation of authority ; integrated and disintegrated organisation: coordination as an organisation problem: span of control ; unity of command.

Administrative units—distinction between line organisation and staff organisation.

Administrative area—distinction between administrative area and governmental areas ; centralisation and decentralisation.

Executive Management ; The Chief Executive and his function. Principal elements of management.

Administrative Policy, Administrative Powers and Responsibility.

Methods of recruitment and training.

Civil Service in India—Methods of Recruitment and Training—Problems of Discipline and Morale.

Management of Public Enterprise (Public Sector).

515. Industrial Relations (1-0).

The course deals specifically with the psychological problems arising out of interaction between workers and management and with the effect of this interaction on job satisfaction, morale and productivity.

Psychologists' point of view—Principles of motivation and their application with reference to job satisfaction incentives, income aspiration, etc. Principles of perception and their application with reference to perception of people (union and management), issues and groups ; leadership and supervision—type of organisation and organisational effectiveness. Union-management conflict.

516. Human Engineering (1-0).

The prime concern of this course is with the problems related to machine design and control: study of man-machine systems, characteristics of human performance.

Principles of vision and application to problems of visual displays, *e.g.* design of scales, dials, etc. Problems of visibility and legibility.

Principles of hearing—their application to communication problems.

Characteristics of motor behaviour and their accuracy ; their application to design of machine controls, like gear ratio, etc. Relations between displays and controls—coordination—optimal conditions for them.

517. Contemporary Problems (1-0).

This will be in the nature of a composite course laying emphasis on economic problems, political and constitutional developments, and problems of current history. The syllabus may be distributed termwise.

The syllabus shall have to be reviewed every three to five years in the light of new developments with a view to ensuring its adequacy and contemporaneity.

To begin with, selection may be made from the following topics:

(A) CURRENT ECONOMIC PROBLEMS OF INDIA

(i) Agrarian reorganisation with special reference to co-operative farming in India.

(ii) Dynamics of rural development with special reference to community Development.

(iii) The Problems of Industry: small-scale industries; large scale industries.

(iv) Choice of techniques—capital intensive or labour-intensive.

(v) Agricultural labour and Industrial labour.

(vi) Economic incentives and Industrial Relations.

(vii) Money market, Capital market, and Industrial finance.

(viii) Theory of Developmental Planning. India's Five Year Plans.

(B) POLITICAL & CONSTITUTIONAL DEVELOPMENT

(i) Indian Constitution: Trend of amendments.

(ii) Reorganisation of States: Forces at work.

(iii) Language Question: Importance of the regional language. The question of the official language.

(iv) General Elections in India: Indexes of Socio-political trends.

(v) Indian Political Parties: Their role in a democratic state.

(vi) India and the U. N.

(C) PROBLEMS OF CURRENT HISTORY

(i) The Background of India's Foreign Policy.

(ii) Factors behind the Transfer of Power.

(iii) Disarmament and international peace.

(iv) Middle East and South-East Asia in International politics.

(v) Asia and the Future of Democracy.

(vi) Africa in International Politics.

518. Problems of Philosophy (1-0).

Students will be broadly acquainted with the main philosophical problems that have engaged the attention of thinkers at all times. In course of the discussion of these problems, reference will be made to both thinkers and systems from the East and the West.

1. The problem of Appearance and Reality—views of early Greek thinkers, especially Plato and Aristotle. Approach of the Empiricists and the Rationalists—Locke, Berkeley, Hume, Descartes, Spinoza and Leibniz.

   The problem of Appearance and Reality in Indian Philosophy—the Upanishads, Buddhism, Nyaya, Samkhya and Vedanta.

2. The nature of "Good"—postulates of morality-ethical standards—Hedonism of Mill, Rigorism of Kant and Perfectionism of the Idealists. The problem of Evil in Indian Thought—Buddhism, Samkya, Vedanta, Tagore, Gandhi.

3. The problem of Knowledge-nature, source and validity of Knowledge-Plato and Aristotle-Empiricists and Rationalists, Nyaya and Vedanta. Philosophical Analysis and Logical Positivism.

4. Some contemporary trends in Philosophy-Evolutionism of Bergson, Scientific Philosophy of Whitehead, Existentialism, Dialectical Materialism, Marx-Engels-Lenin.

5. Types of Modern Indian Philosophy—Practical Vedanta of Vivekananda, Personalism of Tagore, Ethical Idealism of Gandhi, Integral Idealism of Aurobindo.

MATHEMATICS (Ma)

111. Mathematics and Mechanics (4-2).

Limit and continuity, Binomial theorem for any index, exponential and logarithmic series, Elements of convergence, Differentiation of simple functions like Algebraic, circular, hyperbolic, logarithmic, successive differentiation, Tangents and normal, elements of partial differentiation.

Integration as the inverse process of differentiation and as the limit of sum.

Methods of integration—substitution, by parts, decomposition into a sum. Reduction formulae ; Definite integrals, Integration interpreted as area determination.

Elements of tracing simple curves.

Rectification and quadrature as applied to the simple curves.

Differential Equations.

Indeterminate forms, Maxima Minima, Taylor's, Maclaurin's, Rolle's Theorem, Mean value theorems.

Mechanics.

Vectors, Kinomatics of motion in a straight line (using calculus)—displacement—parallelogram law of velocity. Force—Newton's laws, Motion of connected systems, Parallelogram law of forces, Parallel forces, Moments, Couples, Centre of Gravity, Equalibrium of co-planar forces, Friction. Work, Power and Energy ; Collision of elastic bodies.

(For Science Stream)

112. Mathematics and Mechanics (5-2).

Same as Ma 111 and

Summation of series, Permutations and Combinations, Partial fractions. Theory of quadratic equations, Imaginary quantities.

(For Technical Stream)

211. Mathematics and Mechanics (4-2).

Co-ordinate Geometry of two dimensions, Determinants Asymptote, curvature, curve tracing ; Trigonometry—Argand diagram, De Moivre's Theorem, Hyperbolic functions, Gregory's series.

Co-ordinate Geometry of three dimensions ; Planes, straight lines, conicoids in simplified form-sphere, cone, cylinder, ellipsoid, hyperboloid, paraboloid.

Mechanics.

Centre of gravity ; Virtual work, strings, Stability of equilibrium ; Acceleration in different systems of coordinates. Projectiles, Motion under constraints. Simple Harmonic Motion, D'alemberts principle, Plane motion of rigid bodies under finite and impulsive forces.

311. Mathematics (2-1).

Convergence of series.

Partial Differentiation, Fourier Series and Multiple Integrals.

Line integrals in the plane, Formation of partial differential equations, Lagrange's linear partial differential equations, Linear partial differential equations of higher orders with constant coefficients, Vibrating String, Rectangular Vibrating membrane, Steady Heat Flow in two dimensions, Unsteady heat flow in one dimension.

Elementary Probability theory and Statistics.

Definition of Probability, Theorems on total and compound probability, Random variables and probability distributions, Binomial, Poisson and Normal distributions, Mathematical expectations.

Elements of Complex Variables.

Cauchy Riemann Differential Eqns., Cauchy's Integral Theorems,

Singularities, Mapping of elementary functions.

411. Mathematics (2-0).

Matrices, Vector fields, Complex variables, Partial Differential equations by method of separation of variables with applications to problems of Engineering.

Tensor analysis, Laplace's equation, Fourier transforms, Numerical methods.

(For Civil Engineers)

412. Mathematics of Circuit Analysis (2-0).

Circuit Analysis—Detailed study of well known circuit problems through Matrices. Stability criteria, Laplace, Fourier and other integral transforms.

Electromagnetism and Mechanics of Continua—Formulation of Maxwell's equations, discussion of their determinacy, Deduction of circuit formula from Field Formulation, Study of Selected special cases of field problems, Formulation of equations of fluids and deformable bodies.

(For Electrical Engineers)

413. Mathematics. (1-1).

Matrices, Laplace and Fourier transforms and their use in solving differential equations.

Numerical methods, Analogue and Digital Computation.

Probability: Occupying and ordering problems—Addition and multiplication theorems of probability—Conditional probability Mathematical Expectation—Binomial and Poisson and Normal distributions—Limit theorem.

Statistics: Frequency distribution—Moments and cumulants—correlation, regression and prediction—Sampling distribution—Tests of significance—Analysis of variance and co-variance—Elements of sample surveys—Preparation of statistical reports—Time series analysis, interpretation of index numbers—Concept of quality control in industry—Sampling inspection schemes.

(For Mechanical Engineers)

415. Mathematics (2-1).

Infinite integrals. Selected topics on special functions.

Matrices: eigenvectors, eigenvalue. Complex varible: Conformal transformation, Schwarz—Christoffel transformation, Contour integration, Bromwich path. Transforms: Laplace and Fourier transform, their use in solving differential equation. Partial differential equations: method of separation of variables.

(For Aeronautical Engineers)

511. Computer Technology (2-0). Second and Third Terms.

Simple programs—Logical decisions—Program Modifications.

Flow diagrams.

The Machine-oriented, symbolic and problem-oriented programs—a general discussion.

Compilers and Interpretative programme: Outlines of the procedures of translating the source to object programme.

Subroutines—their specific uses: function generation, address modification, data conversion into different modes.

Source programming languages: a survey.

Fortran and its dialects.

Machine language Programming for IBM 1620; outlines of the compiler for Fortran with Format on IBM 1620. Study of object decks of Fortran with Format programs; Modification of the object deck.

Debugging and tracers; Precopiling and object deck 'identifiers', Multiprogramming and Monitors.

Introduction to the theory of Automata: Finite State Machines, Probabilistic automata, Memoray and state, Program modifications and learning.

(For Electrical Engineers)

521. Elements of Orbital Mechanics and Space Vehicles (2-0).

Orbital Mechanics: Orbit established from initial conditions, launching of satellites, Contangential transfer between Coplaner Circular Orbits, Orbital change due to impulsive thrust; perturbation of orbital parameter, elementary treatment of stability of orbits, interception and related problems, long range ballistic trajectories.

Space Vehicles: Review of general equations, thrust misalignment, nearly symmetric bodies, despinning of satellites, altitude dift of space vehicles, general motion of spinning bodies with mass entering or leaving the system.

Performance of Rockets and Optimization Problems:

Performance of single-stage rockets, optimization of multistage rockets, flight trajectory optimization, optimum programme for propellant utilization.

(For Aeronautical Engineers)

522. Computational Methods and Mathematical Programming (2-0).

Methods of approximating a function in a given interval Finite difference interpolation and curve fitting. Linear inequalities and related systems. Solution of algebraic and transcendental equations. Numerical solution of differential equations: Extremes. Mathematical programming: Linear programming, simplex method, quadratic programming. Dynamic programming and multistage decision processes. Simulation techniques. Digital computer programming. Elements of Analogue Computation.

(For Aeronautical Engineers)

MECHANICAL ENGINEERING (ME).

111. Orientation (1-0). in Mechanical Engineering discipline.

121. Workshop Practice (1-3).

Lecture classes will be based on the following practice :—

(*a*) Carpentry — Classification and use of timber, tools, machines ; different types of joints and glues ; painting and polishing.

(*b*) Fitting — Tools and processes.

(*c*) Smithy — Forging equipment and accessories ; tools and operations.

Practical work covering the above.

(For Science Stream)

122. Workshop Practice (0-3)

Practical course as in 121.

(For Technical Stream)

221. Workshop Theory and Practice (1-3)

General metal working processes :—Machining and machine tools ; cold working of metals ; welding and foundry. Workshop measurements. A course of workshop practice consisting of :—

(*a*) Machine shop :—Centre lathe, drill press, shaper, milling machine ; use of simple measuring instruments. Demonstration of various other uses of lathe, milling machine, planer, boring machine and grinder.

(*b*) Foundry :—Common tools and equipment ; cupola melting ; moulding and core making ; hand and machine moulding (demonstration only).

(*c*) Welding :—Gas welding and cutting ; are welding ; soldering and brazing.

(For all courses leading to B.Tech. Degree)

261. Applied Mechanics-1 (2-2).

Static equilibrium. Plane trusses—graphical and analytical methods.

Kinematics and Kinetics of rigid bodies :—

(*a*) Rectilinear notion.

(*b*) Curvilinear motion.

(*c*) Rotation about fixed axis. and

(*d*) Plane motion.

Static and kinetic friction in machine members.

Stress, strain and elastic constants. Thermal stress. Thin cylinders. Statically indeterminate problems of axial loads. Torsion of circular shafts. Elements of principal stresses. Bending moment and shear force diagrams. Bending and shear stresses in simple and composite beams. Deflection of simple beams. Euler's theory of columns.

(For all courses leading to B.Tech. Degree)

321. Workshop Practice (0-3).

A course of workshop practice consisting of :—

(*a*) Taper turning, thread cutting, boring, profile and form milling, gear cutting, cylindrical grinding, surface grinding and centreless grinding.

(*b*) Use of combination square, bevel protractor, clinometer, precision measuring gauges and sine bar.

(*c*) Operation of press tools.

(*d*) Advance practice in gas and are welding, resistance welding, inert gas welding and welding of non-ferrous metals.

(*e*) Methods of moulding simple castings, machine moulding and pouring.

(For ChE, EE, Comm and ME)

331. Heat Technology (2-1).

Engineering system of metric units.

Application of First and Second laws of thermodynamics to closed systems and steady flow systems encountered in Heat technology and related engineering problems. Methods of representing property relations for pure substances. Use of steam tables and Mollier chart. Ideal thermodynamic vapour cycles. Introduction to steam power generating equipment. Properties of gases and gaseous mixtures. Ideal thermodynamic cycles for internal combustion engines. Introduction to internal combustion engines and gas turbines.

(For AE, AgE, ChE, CE, EE, Comm, ME, Min and NA)

351. Machine Elements Design and Drawing (2-3).

Drawing : assembly and detail drawings from sketches of complete machines like engines, pumps, compressors and turbines.

Design : (*a*) principles of design and theories of failure,

(*b*) design of castings and

(*c*) design of parts subjected to—

(i) direct and shear stress : pin joints, cotter joints, rivetted joints, welded joints, press fits, thin cylinders, screw fastenings, turnbuckles, etc.,

(ii) bending : levers, beams, etc.,

(iii) torsion : shafts, couplings, keys, valve springs, etc., and

(vi) thrust : pillar with direct and eccentric loading, push rods, connecting rods, piston rods, etc.

(*d*) Bearings and lubrication.

(For AE, AgE, ChE, CE, EE, Comm, ME, Met. Min and NA)

354. Theory of Machines and Mechanisms I (1-2).

Analysis and kinematics of plane mechanisms. Mechanisms for intermittent motion.

Inertia forces in machine parts. Piston effort and crank effort diagrams; bearing loads.

Introduction to the theory of lubrication and bearings.

Flywheels. Governors. Gears and gear trains. Cams.

421. Production Technology (2-3).

Theory of metal cutting : design of cutting tools ; machine tools for thread and gear manufacture ; superfinishing processes.

Metrology : limits, fits and tolerances ; methods of assembly, interchangeable and selective ; comparators, thread and gear measurement ; surface flatness and roughness ; interferometry ; machine tool testing.

Foundry engineering : properties and testing of sands ; binders and additives ; solidification of castings ; gates and risers ; modern casting processes ; foundry practice relating to grey iron, malleable iron, steel, copper and aluminium base alloys ; defects in castings ; inspection of castings.

Heat treatment.

A practical course covering the above.

422. Metal Processing (1-2).

Theory of metal cutting and metal forming : cutting forces, tool geometry and cutting fluids ; plastic working, stresses and loads ; forming, machining and drawing of aircraft materials ; introduction to numerical control applied to machining.

Engineering metrology : geometric errors and control of screw thread and gear teeth, etc. ; comparators and measuring machines.

Die casting : materials and dies ; die casting processes.

Welding : welding of non-ferrous materials, equipment and testing.

Finishes used on aircraft materials.

(For Aeronautical Engineers)

431. Heat Power Technology I (2-2).

Heat transfer by conduction. Forced convection heat transfer without phase change. Introduction to heat transfer in condensing and boiling of pure substances. Heat transfer by radiation through non-absorbing medium between solids. Introduction to heatexchangers. Analysis of parallel flow and counter flow heat exchangers. Steam generating equipment and accessories. Steam turbines and auxiliary equipment. Fuels for steam plants and introduction to combustion phenomena.

Actual internal combustion engine cycles. Reciprocating internal combustion engines and auxiliaries. Performance and testing of internal combustion engines. Rating of fuels and lubricants.

432. Heat Power Engineering (2-2).

Internal combustion engine theory and practice. Refrigeration and cold storage practice and equipment.

(For Agricultural Engineers)

433. Applied Thermodynamics and Heat Power (2-2).

Steam generating equipment and accessories. Steam turbines and auxiliary equipment. Fuels for steam plants and introduction to combustion phenomena.

Actual internal combustion engine cycles. Reciprocating internal combustion engines and auxiliaries. Performance and testing of internal combustion engines. Rating of fuels and lubricants.

Single and multistage expansion and compression of gases.

Vapour compression and vapour absorption refrigeration cycles.

Air compressors and auxiliaries.

Introduction to gas turbines.

The course includes tutorials as well as laboratory work in the Steam Laboratory and Internal Combustion Engines Laboratory.

(For Chemical Engineers and Naval Architects)

434. Prime Movers (2-3).

Reciprocating and rotary type internal combustion engines. Water power engineering. Steam power generating equipment.

(For Electrical Engineers)

435. Air Conditioning and Ventilation (2-0), Second Term.

Psychrometric properties of air. Inside and outside design conditions. Estimation of cooling loads and calculation of supply air quantities. Ventilatiion requirements. Air conveying equipment. Air cleaning. Principles of vapour compression refrigeration. Air conditioning systems.

(For Architects)

441. Hydraulic Machines (2-2).

Dynamic action of moving fluids.

Construction, operation and performance of impulse and reaction turbines : Pelton wheel, Francis turbine, Kaplan turbine and tubular turbine.

Dimensional analysis and principle of similitude applied to turbines. Specific speed of turbines.

Construction, operation and performance of positive displacement pumps : reciprocating pump and rotary pumps.

Construction, operation and performance of rotodynamic pumps : centrifugal, mixed flow and axial flow pumps.

Dimensional analysis and principle of similitude applied to rotodynamic pumps. Specific speed of pumps.

Construction and operation of fluid coupling, torque converter and hydraulic dynamometer.

Cavitation in hydraulic machines.

Hydrostatic machines : accumulators, intensifiers, jacks, lifts and presses.

Oil hydraulic systems : oil pressure governors and control mechanisms ; oil pressure circuits for machine tools.

451. Machine Design (2-3).

Design of machine parts subjected to :

(*a*) friction, such as clutches, brakes and belt drives ;

(*b*) combined loads and shock loads, such as crankshafts, springs, buffers and gears.

Design of space mechanisms such as universal joints and steering gears.

Design of flywheels, high speed rotors and thick cylinders.

Design of bearings.

Design of pressure vessels such as air receivers and accumulators.

452. Machine Elements Design (2-2).

Same as 451 but problems for design practice to be suitably modified.

(For Agricultural Engineers)

453. Machine Elements Design (2-2).

Clutches, brakes and different types of drives, such as, belt, rope, chain and gear. High speed bearings. Design of springs for shock and vibration isolation. Design of flywheels and high speed rotors.

(For Electrical Engineers)

454. Theory of Machines and Mechanism II (2-1).

Three-dimensional kinematics and kinetics. Space mechanisms. Hooke's joint. Steering gears. Gyroscope and its applications.

Balancing of rotating and reciprocating masses. Balancing of multi-cylinder in-line and radial engines.

Vibration of single degree of freedom systems. Transverse and torsional vibrations of shafts and rotors. Critical speeds.

461. Mechanics of Solids I (2-3)

Plain stress and strain analysis and strain rosettes ; problems of combined bending, twisting and axial loading.

Statically indeterminate beams. Unsymmetrical bending of beams ; shear flow in beams. Bending of curved beams ; circumferential and radial stresses.

Thick walled cylinders and compound cylinders.

Rotating discs of uniform thickness.

Strain energy under different kinds of loading. Energy methods for statically determinate and indeterminate problems.

462. Mechanics of Materials and Machines (2-1).

Curved beams. Unsymmetrical bending of beams. Thick cylinders. Strain energy, and its use in analysis of structures. Torsion of non-circular sections. Elements of fatigue and creep of metals. Stress concentrations. Strain measuring equipment and methods.

Kinematics of plane and space mechanisms. Static and inertia forces analysis in mechanisms and machines. Friction in machines. Clutches. Friction, belt, rope and chain drives. Cams. Flywheels. Governors. Static and dynamic balancing. Balancing of radial and in-line engines. Gyroscopes.

(For Aeronautical Engineers)

511. Industrial Management (2-0).

Development of production system and forms of ownership.

Evolution of management science.

Decision making for production system through economic, graphical, statistical and mathematical tools.

Design, operation and control of production systems covering product, organisation, work study, plant location, plant selection and layout, plant buildings, production planning and control, inventory control, quality control, plant maintenance, job evaluation, merit rating, wages and incentives.

Cost control including budgetary control and depreciation studies.

(For AE, EE, Comm, ME, Met and Min)

521. Metal Processing (2-3).

Elements of applied plasticity including rolling, extrusion and power spinning. Principles of sheet metal fabrication. Introduction to recent developments in machining and welding. Design of machine tool elements. Programme controlled machine tools.

A course of laboratory experiments covering the above.

523. Production Engineering (Elective) (2-2).

Metal manufacturing processes ; foundry, forging, machining and welding. Machine tools and small tools ; applications. Manufacturing economics.

(For Agricultural Engineers)

524. Production Engineering Project (1-5).

Design of production tooling ; jigs and fixtures, cams and layout for turret lathes and single spindle automatics. Plastic workihg tools. Limit gauges. Introduction to the design of a production system.

A course of project relating to the above.

528. Engineering Quality Control (Elective) (1-1).

Basic concepts in statistical quality control. Theory of errors. Chance and assignable causes. Machine capability and its relation to dimensional tolerances.

Control charts :—X-R charts, p-charts, c-charts, some special control charts.

Acceptance sampling :—single, double and multiple sampling plans. Elements of reliability engineering.

531. Heat Power Technology II (2-4).

Elements of gas dynamics. One dimensional flow.

Aerofoil theory. Cascade theory. Gas turbine cycles.

Axial flow compressors. Centrifugal compressors. Combustion chambers. Gas turbine characteristics. Refrigeration cycles and equipment. Air conditioning principles and practice.

532. Steam and Compressed Air Power, First Term (1-2), Second and Third Terms (1-0).

Steam boilers, boiler fittings and accessories. Steam turbines and condensers. Power plant economics. Compressed air generation, distribution and utilisation.

Laboratory work in the first term only.

(For Mining Engineers)

554. Instrumentation and Controls (2-1).

Mechanical transients. Instruments and instrumentation for measurement of mechanical quantities. Accuracy, precision, error and calibration. Introduction to dynamics of automatic controls.

555. Design Project (1-5).

A general design course based on topics covered in the earlier courses on drawing and design and involving detailed design calculations, economy analysis and preparation of working drawings of complete machines such as water turbines, pumps, jacks, pulley blocks, winches, cranes, conveyors, presses and simple machine tools.

557. Cargo Handling (2-2), First and Second Terms.

Equipment on board ships :—Pulley blocks, winches, capstans, derricks and floating cranes.

Dockyard equipment :—Rotary jib cranes, wharf cranes with grabs, belt and pneumatic conveyors and bucket elevators.

(For Naval Architects)

561. Mechanics of Solids II (2-1).

Columns and beam-columns. Elements of beams-on-elastic-foundation. Bending of thin circular plates.

Elements of three dimensional stresses. Theories of elastic failure.

Elements of theory of elasticity. Two dimensional problems in rectangular and polar co-ordinates.

Torsion of non-circular sections ; analogies.

568. Applied Fluid Flow, Plasticity and Experimental Stress Analysis (Elective), (1-1).

Unsteady flow in one dimension ; steady flow in two dimensions.

General analytical relations for viscous flow.

Theory of hydrodynamic lubrication.

Elements of plasticity and experimental stress analysis.

METALLURGICAL ENGINEERING (Met.)

311. Elements of Metallurgy (1-0).

Introduction : Indian Mineral resources and metallurgical industries, location of ore bodies and the extraction plants, economic importance of metallurgical industries.

Extractive Metallurgy : Preparation of ore, elements of ore-dressing and ore beneficiation, principles involved in the different processes used in extraction, roasting, reducing, smelting, refining, simple flowsheets for Fe, steel, Cu, etc.

Physical Metallurgy : Crystal structure and grain formation of pure metals, cold working of metals, effects and annealing. Equilibrium diagrams of binary alloys.

Iron & Steel : Iron-carbon equilibrium diagram, heattreatment, properties and uses of plain carbon steels. T-T-T diagram, carbon and alloy steels, annealing, normalising and hardening improtant alloy steels, their heattreatment, properties and uses. Selection of steels for specific purposes and their heat-treatments.

Non-ferrous metals and alloys : Cu, Cu-Sn, Cu-Zn, Cu-Ni, Al and its alloys, bearing alloys, properties, uses and heat-treatment of industrial alloys.

(For AE, AgE, ChE, CE, EE, Comm., ME)

312. Metallurgical Laboratory (0-2).

Practical work will include metallography, heat-treatment of metals and alloys, use of hardness testing equipment etc.

(For Mechanical Engineers)

313. General Metallurgy (2-2).

Introduction : Indian mineral resources and metallurgical industries, location of ore bodies and extraction plants, economic importance of metallurgical industries.

Extractive Metallurgy : Preparation of the ore, elements of ore-dressing and ore benefication, principles involved in the different processes used in extraction, roasting, reducing, smelting, refining, simple flowsheets for Fe, Steel, Cu, Al, Zn and Mg. Familiarising the students with some typical names : checker works, tapping and tap holes, pitside, ingot and ingot molds, soaking pit, reheating furnances, size of a rolling mill.

Physical Metallurgy (General) : Metallic bonds, different kinds of metallic crystals, solid solutions, substitutional and interstitial types. Grain formation in crystals, chill castings nucleation and growth. Electrical and magnetic properties of metals. Elastic and plastic properties of single and polycrystalline solids, cold and hot working, grain-refinement. Binary alloys, equilibrium diagrams, complete solid solubility, partial solubility, complete immiscibility, intermetallic compounds, thermal analysis.

Physical metallurgy of Iron & Steel and non-ferrous metals : Iron-carbon equilibrium diagram, plain carbon steel, annealing and normalising, T-T-T curve, metallography and properties of ordinary cast iron. Equilibrium diagrams of alloys like Cu-Zn, Cu-Sn, Cu-Ni, and Al-Cu, heat-treatment, properties and uses.

314. Elements of Metallurgy (2-0), First and Second Terms.

Same as Met—311 except paras 1 & 2 (For Final Year Mining Engineers).

411. Extractive Metallurgy of Iron and Steel I (2-1).

Manufacture of Iron & Steel in ancient India ; World's production of Iron & Steel—India's share, occurence and distribution of iron ores, iron ores of India, preparation of iron ores.

Blast furnace and its accessories : Iron blast furnace, general features, construction of the furnace, foundation, hearth, tuyeres, bosh and bosh angle, stack and top. Furnace lines, furnace linings, hoisting appliances, trend of modern improvements in blast furnace construction, Two-pass and three-pass stoves, stove burners and valves, stove linings, dust catcher and gas mains, cleaning of blast furnace gas and its utilisation, blowing engines, plant layout.

Operation and other details: Smelting of iron ores in the blast furnace, chemistry of smelting, burden calculations, advantage and necessity of preheating of the blast, evil effects of too much moisture in the blast, conditioning of blast, effect of furnace burden and conditions of working on the different composition of pig iron, heat balance, entichment of blast, distribution of raw materials, high top pressure and other recent trends leading to reduced coke consumption and increased production. Some common operating troubles—causes and remedies, consideration on the design of blast furnaces, blast furnace products, composition and grading of pig iron, influence of different constituents on the properties of pig iron, manufacture of spiegeleisen, ferromanganese, ferrosilicon in blast furnace, manufacture of pig iron by processes other than blast furnace, manufacture of sponge iron, wrought iron.

412. Foundry Metallurgy (2-3).

Cupola and Air furnaces, charge calculation and operation of cupola, sizing, grading and handling of mould materials, standard and modern methods of moulding, melting, alloying, gating, venting, production of non-ferrous castings and inherent difficulties, choice of sands, etc., for non-ferrous alloys, metallurgy of inoculation and nodularising treatment.

Practical work in the Institute's foundry shop based on theoretical syllabus.

413. Physical Metallurgy I (2-3).

Crystalline nature of metals, lattice parameter, miller indices, important crystalline planes, closepacking of atoms in FCC and HCP lattice, grain formation of metals by various processes, nucleation, grain growth, heating and cooling curves. Effect of a second element on the structure of metals, properties, crystal structure, location of the second atom (Fe-C, Cu-Ni etc.). Hume-Rothery rules, substitutional and interstitial solid solutions, intermediate phases, ordered pase—typical example of industrial alloys like Cu-Ni, Fe-C, Cu-Zn, Cu-Sn, etc.

Equilibrium diagrams : Systematic studies of various types of binary diagrams, correlation among equilibrium structure, microstructure and physical properties of alloys like Fe-Fe_3C/, Cu-Zn, Cu-Sn, Cu-Ni, Pb-Sn, Al-Cu, Al-Si. Ternary equilibrium diagrams, typical alloys. Methods of detection of phase changes and construction of equilibrium diagram, resistivity measurement, dilatometry, cooling and heating curves, specific heat measurement.

Temperature measurement and control : Thermocouple, resistance optical radiation, photoelectric type pyrometers, temperature controllers etc.

Metallurgical Microscope : Types of eyepieces and objectives generally used, blooming, resolving power, magnification, depth of focus, photomicrography.

Practical and sessional work will be based on the above syllabus.

414. Refractories (1-0), First / Third terms, and (0-2), Second term.

Refractories—different types, physico-chemical properties, resistance to erosion, high temperature, temperature variation, molten metal and slag, expansion, contraction, specific heat, porosity, permeability, thermal and electrical conductivity, preparation of refractory materials, their use in the manufacture of fifebricks, silica bricks, etc., refractory materials used in different types of metallurgical furnaces.

415. Mechanical Metallurgy I (2-3).

Elastic and plastic deformation of single crystal and polycrystalline aggregates, annealing, recovery, recrystallisation and grain growth, hot and cold working, orange peel effect, stretcher strain, yield point phenomena. Ageing—quench ageing, strain ageing, strain age-hardening. Flow and fracture of metals, effects of temperature, strain rate, composition, structure, triaxiality of stress. Testing—scope, purpose, interpretation of testing ethods, sampling and its limitations. Destructive testing—tensile, impact, fatigue, creep etc., dependence of composition and structure. Non-destructive testing—magnetic, ultrasonic, electrical etc., limitations of each method, inspection of defects and different methods of testing.

416. Extractive Metallurgy of Non-ferrous metals (2-1).

Study of the processes relating to recovery of non-ferrous metals, their refining, reclamation of secondary metals, metals to be studied consist of Cu, Pb, Zn, Ni, Sn, Cd, Mn, Au, Mg, Ag, Cr, W, Mo, V and Ti. Recent developments of non-ferrous metals industry in India, metallurgical calculations related to different processes, chief physical, mechanical and chemical properties as well as the uses of the above metals and alloys.

417. Metallurgical Thermodynamics and Chemical Kinetics (2-1).

Laws of thermodynamics, Maxwell relations—applications, thermal capacity of gases and solids, Hess's law, use of standard tables, free energy and thermodynamic potential, condition of equilibrium, chemical equilibrium, equilibrium constants of homogeneous and heterogeneous systems, use of standard tables of thermodyanmic functions, solutions, dilute solutions, derivation of Raoult's law, deviations, concentrated solutions, concept of activity, activity coefficient, partial molar free energies, choice of standard state, electrolytic solutions, electrode potential, chemical and electrical energy, reference electrode, polarisation over-voltage, electrodeposition of metals and alloys. Phase rule—application to systems, adsorption and absorption, adsorption on surfaces, Gibb's equation, chemical kinetics, importance of rate of nucleation, concept of activated state, order of reaction, applications.

419. Engineering Metallurgy (2-0), First and Second Terms.

Indian mineral resources and metallurgical industries, location of ore bodies, and the extraction plants, economic importance of metallurgical industries. Crystal structure and grain formation of pure metals, cold working of metals, effects and annealing, equilibrium diagram of binary alloys. Study of Fe-C equilibrium diagram, heat treatment, properties and uses of plain carbon, low alloy structural and high alloy steels, hardenability, selection of steels for specific purposes. Cu-Zn, Cu-Sn, Cu-Ni, Al and its alloys, properties, uses and heat treatment of industrial alloys. Tensile, impact, fatigue and creep, dependence on composition, structure and significance of various tests. Theories of corrosion, general principles of corrosion control, methods of corrosion prevention, selection of metals for use at low and high temperatures, corrosion testing, metal finishing, surface treatments.

(For Naval Architects)

511. Extractive Metallurgy of Iron and Steel—II (2-1).

Cementation and crucible steel making processes, importance and uses of crucible steel, active and inactive metal mixers. Acid and Basic Bessemer processes, construction and lining of converters, raw materials, operation of the converters, recarburisation, teeming, chemistry of the processes, methods used to follow the progress of the blow, after blow in the basic process, modern developments and modification of the process. Acid and Basic open hearth process, raw materials, furnace, general features, size, capacity, bottom, hearth, roof, refractories used, life of furnace, regenerators, parts and valves, fuels, tapping, types of furnaces—stationary and tilting, operation of the furnace, chemistry and kinetics of the processes, furnace charges, slag volume, removal of impurities, slag control, deoxidation, ladle additions, duplex and triplex processes, recent developments leading to increased production. Electric processes, power requirements, arc furnaces and induction, chemistry and kinetics of the reactions, pit side practices, ingot structure and ingot defects, remedies with reference to type of molds, teeming speed, chemistry of steel, dressing of molds. etc., comparison of steels made by different processes, use and general properties, brief outlines of the processes of manufacturing alloy steels.

512. Mechanical Metallurgy—II (1-0).

Working of metals, stress conditions governing the flow of metals in hot and cold working, work of deformation, characteristics and elements of the theories of various shaping operations—forging, rolling, extrusion, drawing relationship between the properties of metal and shaping processes. Metallurgical defects and difficulties encountered in metal forming, joining methods, welding, brazing and soldering.

513. Physical Metallurgy—II (2-3).

Heat treatment of cast iron and carbon steels, various processes and their effects on microstructures and physical properties, isothermal transformation in steel, effects of alloy additions in steel, modification of heat treatment operations, heat treatment of important alloy steels. Grain size, grain growth, overheated and burnt steel, temper brittleness. Mass effect, hardenability, measurement, calculation, calculation from composition, effect of quenching severity of cooling media etc. Special methods of heat treatment, martempering, austempering, deep freezing, case hardening, cyaniding, nitriding, induction hardening, gas carburizing. brief reviews of the theories of age-hardening. Furnaces for heat treatment, atmosphere and temperature control. Microscopic, dilatometric, magnetic and resistivity methods of studying equilibrium and isothermal diagrams.

Practical work based on the above syllabus covering all phases of theoretical study.

514. Applied X-Ray and Metal Physics (2-3).

X-Ray diffraction : Elements of crystallography, stereographic projection, generation of X-Rays, filters and mono chromators, types of X-Ray tubes, diffraction of X-Rays various methods and types of cameras used for powder method. Interpretation of diffraction patterns. Applications—lattice constants, phase boundaries, intensity of powder lines, retained austenite, stress measurements, broadening of diffraction lines—crystal size.

Industrial Radiography : Operation of X-Ray Industrial unit limitations and precautions. Use of Radiography and radiography with radioactive cobalt, comparison between their fields of applications.

Metal Physics : Structure of atom, quantum numbers, exclusion principle, electronic configuration of important elements and its influence on the properties. Bonds, Hume Rothary rules and formation of alloys, uncertainty principle, electron theory of metals, electrical and thermal conductivity, magnetism, specific heat of metals. Elements of Zone theory and its application. Elements of the following topics—internal friction, diffusion, radiation damage, electron microscopy and diffraction, metallurgy of the liquid state.

515. Extractive Metallurgy Laboratory (0-3).

Experiments are designed to illustrate the principles involved in the extraction of metals—thermal decomposition of carbonates, oxides, sulphides etc., reduction of iron oxides, C—CO—CO_2 reaction, chloridation metallurgy, matte-metal reaction, electrometallurgy experiments. The students are required to study the thermodynamics and kinetics of the reactions.

516. Advanced Metallurgy of Alloy Steel (Elective) (2-2).

Detailed study of important low, medium, high alloy steel manufacture, fabrication, heat treatment, constitution metallography, selection and application. Austenitic transformation by nucleation, growth and other mechanisms, application of stress to austenitic steels and their effects on Ms, hardenability, and its determination.

517. Material Engineering / Powder Metallurgy (1-0).

Materials for heavy structures (plain carbon and alloy steels), materials for tools, materials for electrical industries magnets, resistance elements, electrical contacts etc., elements of Powder metallurgy.

518. Furnace Technology (Elective) (2-2).

Heat transfer as a thermodynamic problem—laws of heat transfer—conduction—general laws. Non-luminous and luminous radiation, heat transfer in furnace chamber, thermodymamics of furnace heating. Fluid flow, aerodynamics of hot systems, factors governing the total quantity of gas flowing in the circuit, fundamental principles, sources of aero-motive force, buoyancy, fans, ejectors, chimneys. Theory of heating and cooling of solids. Furnace construction, principles of walls and crown construction, furnace roofs, catenary arch, expansion stresses in arches and suspended roofs. Speed of combustion and rate of heat release, gas flow pattern, path of a jet speed of mixing of two streams, speed of entrainment of the surrounding fluid by a jet. Calculation of regenerator, recuperator, reheating furnace, open hearth furnace, burmer calculations.

520. Advanced Foundry Metallurgy (Elective) (2-2).

Advanced study of the topics covered under Met. 412.

521. Seminar (Works visit, vacational training etc.) (0-1).

522. Project and Report (0-6).

524. Metallurgy of Atomic Energy Metals (Elective) (2-2).

Physical and extraction metallurgy of metals and alloys used in Atomic Energy generation, niobium, plutonium, thorium, uranium, etc., discussion of the metallurgical processes of fabrication and handling techniques of these metals and their alloys, metallurgy of liquid metals and radiation damage.

525. Electrometallurgy and Corrosion (1-1).

Principles of extraction and refining of metals and alloys and electroplating of metals and alloys, flowsheet of electrolytic extraction and refining of the following metals—Ca, Mg, Al, Cu, Zn, Ni, Pb, Mn, Au, Ag. Electro-plating of Cu, Zn, Cd, Ni, Cr and their alloys. Electro-thermal process of reducing iron from its ore. Theories of corrosion, general principles of corrosion control methods c ` corrosion prevention, selection of metals for use at high and low temperatures, corrosion testing, metal finishing, surface treatment.

529. Metallurgy (2-2).

Hot working of steel ingots : forging : hammer forging, drop forging, press forging : rolling of plate, sheet, sections, bar, rod, etc.: fibre, effect of working temperature on final structure and properties, defects ; final heat treatment ; effect of size. Cold working ; reasons for cold working ; strengthening, surface finish, demensional accuracy etc. ; cold forming, strainageing, etc. Surface hardening of steels ; flame hardening, induction hardening ; carburising ; nitriding. Alloy steels ; the functions of alloying elements ; effects on thermal equilibrium and resulting changes in response to heat treatment ; hardenability—effect on overall mechanical properties ; other effects of alloying elements. Engineering steels and their treatment ; oilhardening steels, temper brittleness. Alloy structural steels ; heat treatment, weldability. Stainless steel and heat-resisting steels : martenistic, i.e. heat treatable stainless ferritic stainless irons ; austenitic steels, weld decay and its prevention, Hadfield manganese steel. Tool steels : carbon steels, low alloy die-steels ; high speed steel, red hardness, carbide-tipped tools. Armour plate : Cemented plate alloy plate. Creep : Metallurgical aspects, and creep resistance, compositions. Brittle fracture : relation to lattice structure ; effect of composition on transition temperature. Cast irons : equilibrium relationships ; effect of composition, rate of cooling, superheat, on carbide/graphite reaction. White iron, grey iron, phosphoric iron ; malleablised iron castings, spheroidal graphite iron, alloy cast irons. Joining of metals : Fusion welding of steels : grain structure of welds ; single and multi-run welds ; stresses in weld-metal ; effect of martensite and hydrogen in welds ; weld cracking and its avoidance ; welding of dissimilar steels. Welding of aluminium and other non-ferrous metals. Brazing and soldering. Cold welding. Laboratory work : To cover the different aspects of the above syllabus.

(For Naval Constructors).

MINING ENGINEERING (Min.)

311. Mining Engineering I (2-0).

Boring : Simple hand methods, percussive and rotary boring methods for prospecting and miscellaneous purposes (both surface and undergeound) ; drilling for petroleum ; deviation of horeholes ; difficulties in boring ; borehole surveying and logging ; directional drilling.

Explosives : Nature, characteristics and classification ; tests ; fuses, datonators, blasting devices and accessories ; substitutes for explosives ; handling and storage ; charging and firing ; safety precautions.

Blasting : Theory of blasting ; pattern of holes ; blasting practices in coal and metal mines.

Mine Support : Mine timber ; simple timber-, steel-, masonry-, and concrete supports for roadways and faces ; pillars ; filling.

Mine Gases : Occurance, properties, physiological effects, detection and estimation.

411. Mining Engineering II—First Term (3-0). Second and Third Terms (2-0).

Mine Development : general principles of planning for coal and metal Mines ; mine entries ; drifting and tunnelling ; winzing and raising ; other subsidiary developments.

Shaft Sinking : Ordinary and special methods for vertical and inclined shafts ; shaft support ; widening and deepening of shafts ; internal shafts.

Rock Mechanics : physico-mechanical properties of rocks ; rock pressure, its measurement and influence on mine design ; mine subsidence.

412. Mining Engineering III (2-0).

Underground methods of mining coal : general principles and modern practices of underground mining methods.

Underground metalliferous mining methods : general principles, and methods of stoping; caving methods.

413. Mining Engineering IV (2-3).

Temperature and humidity ; air conditioning for mines ; mechanics of air-flow ; natural ventilation : mechanical ventilation ; distribution and regulation of air quantities ; auxiliary ventilation ; ventilation measuring instruments ; ventilation surveys ; ventilation planning.

Mine fires and mine explosions.

Mine Illumination : Vision ; standards of lighting ; problems and practices of illumination in mines ; flame and electric safety lamps ; lamphouses, maintenance and organisation.

Mining Engineering Laboratory work in Ventilation : measurement of air quantity, pressure, temperature, humidity, cooling power, resistance in an air-way ; determination of pressure loss due to bends and changes of cross-section in ducts, fan characteristics. Calibration of air measuring instruments : detection and estimation of firedamp ; analysis of mine air.

414. Mining Machinery I (3-2) First Term (2-2) Second & Third Term.

Elementary treatment of mechanical transmission of power, couplings and clutches, brakes, pneumatic and electric drills, drill steels and bits.

Pneumatic picks ; coalcutting Machines,

Ropes, rope haulages and rope haulage calculations. Mine locomotives and locomotive haulage calculations.

Mine cars ; tracks.

Cages, skips ; shaft-fittings ; head frames and bins.

Pitbottom and surface layouts.

Mine pumps.

Mining Machinery Laboratory work.

415. Mine Surveying I (3-3). First and Second Terms, (2-3)—Third Term.

Principles of mine surveying. Linear Surveying.

Ordinary levelling : Definitions ; the earths curvature and atmospheric refraction.

Methods of levelling. Levels : types, their construction, adjustment and care.

Types of levelling. Setting out levels. Errors in levelling, accuracy.

Angles and directions : Bearings and azimuth.

The Compasses : their construction tests and adjustments.

Compass surveying, sources of errors.

Plane table Surveying : The plane table. Systems of plane tabling. Sources of error.

The theodolites : Types, construction and adjustments.

Measurement of angles. Sources of errors.

Errors : Definitions. Probable error, weights and corrections.

Theodolites Surveys : Methods of traversing surface and underground. Checks, accuracy, and adjustments.

Triangulation : systems, classification, location of stations, measurement of angles and the base line, adjustments.

Stadia surveying : Theory, instruments, methods. Errors and accuracy.
Contours, contouring and contour-map studies.

Dip and fault problems, computation of areas and volumes, enlarging and reducing of plans. Fieldwork, computations and plotting connected with the above surveys.

511. Mining Engineering V (3-2).

Opencast mining : general principles and modern practices of opencast mining of coal, lignite, ores and other minerals ; alluvial mining. Mine rescue and recovery work ; water dangers in mines.

Advanced face and roadway support.

Methods of roof control : caving ; partial-, and solid stowing methods. Mine Hygiene : occupational diseases ; pathogenic dust, its measurement and control.

A more advanced treatment of special subjects dealt with in Mining Engineering III & IV.

A course of lectures on First Aid to the injured.

512. Mining Machinery II (3-0) First Term (2-0) Second and Third Terms.

Conveyors : shaker-belt, steel plates, and scraper chain types, their construction and design ; spiral chutes.

Aerial ropeways : their construction and design.

Mine hoists : types, safety and control devices ; brakes. Loading machines at coal faces, in stopes, and tunnels.

Coal face mechanisation.

Advanced treatment of some opencast mining equipment.

513. Mining Legislation, Mine Safety & Mineral Economics (2-0).

Statutory provisions relating to safety, welfare, connession and conservation, and their administration.

Mine safety engineering. Mine accidents ; Statistics, causes, prevention and cost.

World mineral economics ; mineral industry in India. Mine sampling ; mine reserves ; mine examination and valuation ; mineral conservation. Organisation of mining enterprises ; mine organisation and administration.

514. Mine Surveying II (2-3).

Precise levelling : Instruments and method, accuracy. Transfering the meridian through vertical and inclined mine openings.

Control of direction and grade of inclined workings.

Measurement of depth of shaft ; shaft plumbing.

Setting out curves on surface and underground.

Stope surveys ; Opencast survey.

Mine plans, projections and sections. Tridimensional representation of mine workings.

Special mine surveys : Boundary surveys, surveys for installation of mine structures and equipment, subsidence etc.

Elements of Photogrammetry.

Elements of astronomy and astronomical observations.

Computation of volumes of opencast excavations, spoilbanks, storage piles etc. Field-work ; Mine survey camp.

515. Project (0-6).

The preparation of a comprehensive plan for a part or complete coal or metal mining project.

Thesis :—A study of some special subject in coal or metal mining approved by the Head of the Department. Details of investigation are submitted for examination in the form of a thesis.

NAVAL ARCHITECTURE & MARINE ENGINEERING (N.A.)

111. Orientation (1-0).

221. Ship Drawing and Calculation I (2-3).

Simpson's, Techebycheff's, Gauss's and Trapezoidal rules.

Conditions of equilibrium, Initial stability.

Longitudinal metacentre and trim.

Launching.

Linesplan, Bonjean curves, Hydrostatic calculations.

311. Ship Theory I (2-0).

Planimeter, Integrator and Integraph.

Stability of ships at large angles.

Flooding and subdivision.

Capacity, Loading calculations, Tonnage.

312. Practical Shipbuilding (2-0).

Types of ships, Shipbuilding Materials, Riveting and Welding.

Hull structures. Rules of the Classification Societies and the Ministry of Transport.

Ship's equipment and outfit.

313. Statics of Ship Forms (2-0).

Theorems on fluid pressure under gravity. Thrust on plane and curved surfaces. Centre of pressure.

Floating bodies, Dupin's Theorem, Leclert's Theorem, Application of the principle of energy.

Surface Tension.

Partial differential equations of first and second order. Laplace's equation in two and three dimensions. Legendre functions. Bessel functions.

321. Ship Drawing and Calculation II (0-6).

Launching calculations.

Flooding calculations.

Cross-curves of stability. Stability-balance experiments.

411. Seagoing Qualities of Ships (1-0) First and Second terms. (2-0) Third term.

Waves—theory and data.

Unresisted and resisted motions (rolling, pitching and heaving) in still water and in a regular seaway. Motion stabilisers.

Ship hull vibration. Vibration of a simple beam and its application to ships. Effects of entrained water, restricted water and shear. Calculation of frequency of vertical vibration by empirical formulas and by the full integral method. Horizontal and torsional vibrations. Propeller excited vibration. Prevention and reduction of ship vibration.

412. Resistance of Ships (2-0).

Components of total resistance.

Dimensional analysis. Reynolds number. Froude number.

Frictional resistance. Plank experiments.

Boundary layer concept. Separation

Effect of roughness.

Form resistance. Ship model correlation. Experiments with full-size ships.

Wave resistance and wave interference.

Resistance of a ship in shallow water.

Presentation of Resistance data.

Estimation of the resistance and effective power of ships from methodical series and statistical data.

Features of the hull form.

413. Strength of Ships (2-0).

Longitudinal strength. Bending moment in still water and in waves. Section moduli and stresses in structure. Weight, buoyancy and load curves. Deflection of ships.

Unsymmetrical bending. Discontinuities. Use of aluminium alloys. Shear stress in structure.

Transverse strength.

Strength of plating and bulkheads.

Estimate of steel weight of ships.

Full scale experiments on strength of ships.

421. Ship Drawing and Calculation III (0-14).

Longitudinal and transverse strength calculations. Midship section, hold section, bulkheads, and shell expansion drawings.

Calculation of frequency of vertical vibration by full integral method.

Estimation of effective power from series and statistical data. Preliminary calculation for design project.

424. Ship Hydrodynamics I (2-0).

Perfect fluids. Euler's equations of motion. Continuity equation. Bernoulli's equation. Velocity potential. Stream function. Torricelli's theorem. D'Alembert's paradox. Complex potential. Complex velocity. Mapping theorem. Conformal transformation. Circular cylinder in a stream : Circular cylinder placed in any flow pattern. Pressure distribution. Cavitation. Sources, sinks, doublets and images.

Viscous fluids. Navier—Stokes' equations. Prandtl's boundary layer theory. Momentum integral equation. Flow past flat plate and cylinders. Skin friction drag.

428. Ship Design I (1-0) First and Second Terms (2-0) Third Term.

General considerations of design factors and constants. Empirical and scientific methods of ship design. Preliminary calculation of weights for cargo ships. Empirical method for assessing stability. Freeboard regulations.

515. Shipyard Organisation, Tenders and Contracts (3-0) First & Second Terms.

Shipyard layout, equipment, and ship building methods.

Management. Stores and stores handling. General planning and production. Shipyard economy.

Origin and performance of a project. Contracts and specifications. Price calculation, speculation and guarantees.

516. Propulsion and Steering (4-6) First and Second Terms.

Types of propellers. Screw propeller geometry. Interaction between ship and propeller. Laws of similarity. Model experiments. Propeller constants and design charts. Cavitation. Strength of propellers. Propeller design. Trial and voyage analysis. Propeller theory and its application to design. Propelling machinery.

Turning motion of a ship. Equations of motion. Course stability. Action of a rudder in open water and behind a ship. Types of rudders. Factors affecting the manoeuvring qualities of a ship. Manoeuvring in confined waters. Steering Gear. Rudder design. Manoeuvring trials and model experiments.

517. Propulsion and Steering (4-3) First and Second Terms (0-3) Third Term.

Same as NA 516 but with reduced number of hours for Naval Construction Option.

521. Ship Drawing and Calculation IV (0-12) First and Second Terms.

Ship design project : calculations and drawings. Schedule of materials. Specifications. Tender letter.

524. Ship Hydrodynamics II (2-1) First and Second terms for regular course, and (2-1) all terms for Naval Constructor Option.

Theoretically developed aerofoil sections. Aerofoil of infinite span. Theory of thin aerofoils. Wing of finite span. Prandtl's wing theory. Ellipitic lift distribution. Induced velocity and induced drag. Stalling and high-lift devices. Elements of propeller theory.

(For Naval Construction Option) Third Term : Elliptic cylinder in a stream, elliptic coordinates, force and moment on elliptic cylinder in a stream ; Moving cylinders, kinetic energy, resistance ; Cylinder moving under gravity, Rotating cylinders containing fluid, Motion symmetrical about an axis, Stokes stream function, submarine explosion, airship forms, Sphere in a stream, Spherical harmonics ; Moving sphere, pressure distribution, Concentric spheres, Motion of two spheres, Sphere in the presence of a wall ; Motion of a solidthrough a liquid, the impulse, Kirchoff's equations, axes of permanent translation, stability.

525. Design of Warships (2-0).

Ship Design procedure ; Dimensions and form ; General layout ;

Estimation of effective power ; Selection of suitable forms ; Propulsion requirements,

Displacement and weight groups ; Armament group ; Radio and underwater protection group ; Machinery group ; Equipment group ; Hull group ; Fuel and endurance.

Aircraft carriers ; Submarines.

Completion and trials.

526. Warship Drawing and Calculation I (0-12) First and Second Terms. (0-16) Third Term.

Warship design project : preliminary calculations and drawings.

527. Practical Warship Building (1-0) First and Second Terms (2-0) Third Term.

Building slip ; Hull structure ; All welded construction by prefabrication methods ; and Launching arrangements.

Fresh and salt water services, Fuel oil system, Fire protection, Ventilation and air conditioning, Accommodation, Hull equipment and outfit.

Warship construction, Materials, Riveting and welding, Docks and caissons and

Special types of ships.

Some problems of laying-off.

528. Ship Design II (3-0) First and Second Terms.

Design Factors in different types of vessels.

Fixing of main dimensions.

Freeboard regulations and applications.

General arrangement. Accommodation. Outfit.

Method of calculation of weights.

Application of Classification Society and Ministry of Transport regulations.

Types of main and auxiliary machinery. Allotment of machinery space. Bunker capacity. Fire precautions etc.

529. Stability of Warships (2-0).

Special problems of warship, Production of stability curves (naval practice), Effect of free surface and moving weights, List and loll, Dynamical stability, Effects of grounding and docking, Effects of bilging and adding weights, Stability standards, Effect of subdivision, Stability after damage, Metacentric diagrams and their geometry ; Effect of dimensions and form, Pumping out of liquids from compartments, Submarine flotation and stability.

611. Resistance and Propulsion of Warships (2-0).

Some special problems of warships, Methods of calculating resistance, Model experiments, Iso-, (K) diagrams, Methodical series, Effect of shallow water, Interaction between ships, Effect of changes of dimensions and speed, Planing forms.

Some practical problems of propulsion, Hull efficiency components, Cavitation and cavitation tunnels, Propulsive efficiency, Prediction of optimum propulsive coefficient for new design, Propeller design, Estimation of endurance, Speed trials and their analyse.

612. Structural Design of Warships (2-0).

Basic principles. Types of loading, Longitudinal strength, Stress concentrations and discontinuities, Flat plates, Bending of stiffened plate, Superstructures, expansion joints, Grillages. Docking problems, Relaxation methods, Elastic instability, Submarine strength and structure, Plastic design, Dynamic loading, Vibration of ships, Brittle fracture, Under-water explosion and shock, Experimental stress analysis, Structural materials, Special structures, Main transverse bulkheads, Complete structure of ship.

615. Shipyard Organisation, Tenders and Contracts (2-0).

Same as NA 515 with reduced number of hours for Naval Constructor Option.

624. Ship Hydrodynamics III (2-1).

Wave motion, Shallow and deep water waves, Waves in a tank. Waves at an interface, Wave resistance, Surface tension ; ripples, Effect of wind.

Matrices and Tensors.

Interative methods for solutions of equations, Interpolation formulas, Numerical differentiation and integration, Numerical solution of ordinary and partial differential equations, Sets of linear equations, Relaxation methods, Approximation by series of orthogonal polynomials.

Probability ; Frequency distributions ; Means, moments, expected values, standard deviation, variance ; Binomial, Poisson, Gaussian and Gamma distributions ; The distribution of errors.

626. Warship Drawing and Calculation II (0-20).

Warship design project.

PHYSICS & METEOROLOGY (Ph.)

111. Physics (3-3).

General Properties of Matter :

Principles of measurement.

Review of the topics like work and energy ; conservative and dissipative forces. Conservation of energy and momentum ; Elastic and inelastic collisions ; Circular motion, simple harmonic motion etc. Graphical representation of S. H. M. Elastic constants and their measurements. Surface tension, angle of contact, simple cases of surface tension and its measurement.

Acoustics :

Progressive wave ; reflection, stationary wave, beats, combination tones. Velocity of sound ; transverse vibration of strings. Measurement of frequency of sound. Doppler's principle. Quality of sound, noise and musical sound, sound level. Elements of room acoustics. Ultrasonics.

Heat and thermal properties of matter :

Expansion of solid, liquid and gases ; spacific heat of gases, liquid and solids ; equation of state (results only). First law of thermodynamics, internal energy and external work ; isothermal and adiabatic processes. Humidity ; Dewpoint. Simple cases of heat flow by conduction, convection and radiation ; general properties of radiation, radiation Pyrometers.

Optics :

A short review of Geometrical Optics.

Combination of thin lenses, thick lenses, dispersion.

Illumination, intensity, power, etc. Elements of spectroscopy.

Nature of light.

Electricity and magnetism :

Review of the topics like electric and magnetic fields, potential, equi-potential surface, lines of force etc. Field due to a dipole and a magnet. Force and energy between two dipoles and magnets, electrostatic and magnetic instruments. Ohm's law and Kirchoff's law and their simple applications. Measurement of current, resistance and potential difference.

(For Science Stream)

112. Physics (4-3).

General properties of matter :

Principles of measurement, Mass and Weight, Specific gravity and density, Archimedes' principles, pressure in a fluid—measurement of pressure, centre of pressure, thrust, Pascal's law ; floating bodies, principle of stability ; Pumps, barometer. Review of the topics like work and energy, conservative and dissipative forces, virtual work, conservation of energy and momentum, elastic and inelastic collisions, circular motion, simple harmonic motion, etc. Graphical representation of S.H.M. ; principle of superposition, combination and resolution of S.H.M.

Acoustics :

Progressive wave, reflection, stationary wave, beats, combination of tones, velocity of sound. Transverse vibration of strings. Measurements of room acoustics.

Heat and thermal properties of matter :

Thermometry. Expansion of solid, liquid and gases. Specific heat of solids, liquids and gases ; equation of state (results only). Mechanical equivalent of heat. First law of thermodynamics ; internal and external work ; isothermal and adiabatic processes. Hygrometry ; Change of state ; transmission of heat, steam engine, petrol engine. Humidity.

Optics :

Selected topics of geometrical optics, velocity of light, group velocity, Mirage and rainbow, Eye as an optical instrument, production and measurement of spectrum. Kirchoff's law of emission and absorption and its application. Elements of photography. Defects of the image by a single lens. Combination of thin lenses, thick lenses, dispersion, optical instruments Illumination, intensity, power, etc.

Elements of electricity and magnetism :

Review of the topics like electric and magnetic fields, potential, equipotential surface, lines of force etc.. Field due to a dipole and a magnet. Force and energy between two dipoles and magnets ; Force and energy of a body in a magnetic or electric field ; electrostatic and magnetic instruments.

Ohm's law and Kirchoff's law and their simple applications. Measurement of current, resistance and potential difference. Simple Laboratory experiments (two hours per week) pertaining to subject matter covered.

(For Technical Stream)

113. Physics—(3-2).

Properties of matter :

Elasticity—Hooke's law and relation between elastic constants. Measurement of Y and n.

Surface tension—surface energy, rise of liquid in a capillary tube.

Viscosity of liquids—and Motion of liquid through a tube.

Sound :

Concepts of vibration, forced vibrations and resonance. Waves and their propagation in material media and related topics, musical scale.

Heat :

Review of thermometry and calorimetry.

Coefficient of expansion of solids and coefficient of real and apparent expansion of fluids.

Elements of heat transfer phenomena (conduction, convection and radiation).

Coefficient of humidity & its measurement. 1st and 2nd laws of thermodynamics.

Optics :

Refraction & Reflection at a curved surface, thin lenses and combination of thin lenses, chromatic and spherical aberration and their removal, & description of other defects of images.

Simple optical instrumentsand their magnifying and resolving powers.

Sources of light, measurement of their brightness and intensity of illumination, various units of measurements in photometry, some ideas of about optics of vision and colour. Elementary discussion about science of photography. Elements of wave theory of light (interference, diffraction and polarisation—(descriptive treatment only).

Electricity and Magnetism :

Review of basic laws of electrostatics and magnetostatics, qualitative ideas about conductors, insulators and magnetic materials.

Concept of magnetic and electric field intensity and induction vectors and potential. Field of a dipole.

Gauss's theorem and its simple applications.

Capacity of a conductor and its measurements in simple cases. Magnetic effect of an electric current. Laplace's rule, Tangent galvanometer, absolute and practical units for measurements of current, resistance and potential difference. Force on a current carrying conductor in a magnetic field. Principle of moving coil galvanometer, Ammeter and voltmeter—principles of action of primary and secondary cells. Potentiometer—Kirchoff's laws and their simple applications. Heating effect and Chemical effect of an electric current. Elements of thermoelectricity.

Phenomena of electro-magnetic induction, self and mutual inductance, growth and decay of current.

Elements of alternating current theory and L.C.R. circuit. Discharge of electricity through gases.

Discussion about various systems of units in electricity and magnetism.

(For Architects)

221. Physics (3-3).

Thermodynamics :

Reversible and irreversible process. Carnot's cycle ; laws of thermodynamics ; absolute scale of temperature ; entropy ; entropy of perfect gas. Maxwell's relations and simple applications. Discussion of black body radiation.

Kinetic theory of matter :

Boltzman velocity distribution law, Brownian motion, mean free path, transport phenomena. Equation of state. Vacuum pumps, measurement of low pressure.

Electricity and Magnetism :

Gauss's theorem and its simple applications. Descriptive treatment of dielectric and magnetic properties of matter ; hysteresis. Capacity and condensers. Thermoelectricity and its applications. Electromagnetism. Ampere's theorem and its applications. Electromagnetic induction and its application. Fundamentals of electromagnetic theory. Self and mutual inductance and capacitance in a circuit ; oscillatory circuit ; introduction to alternating current.

Wave optics :

Huyghen's principle. Selected topics of interference diffraction and polarisation. Magneto and electro-optical effects.

General properties of Matter :

Free, damped and forced oscillations, resonance ; Ballistic pendulum, conical pendulum. Rotational motion, moments of inertia, simple gyroscope.

Dimensions and use of dimensional method, streamline flow. Bernoulli's equations, viscosity of liquids and gases. Poisseulles equation and applications. Stokes law. Commercial viscometers. Gravitation and gravity.

Simple laboratory expts. (2 hrs. per wéek) pertaining to subject matter.

311. Physics (2-0).

Atomic Physics :

Elementary particles, atomic structure ; excitation and ionisation ; properties of gaseous ions. Discharge in gases ; glow discharge ; Thermionic emission.

Quantum Theory of Light :

Planck's law ; photoelectric effect ; photoelectric emission ; compton effect.

Atomic Spectra :

Energy levels ; quantum number ; elements of spectroscopy ; Pauli-Principle and periodic system of elements. X-rays and Crystal structure (Simple description).

Atomic Nucleus :

Atomic weight and atomic number ; mass defects and binding energy ; Isotopes. Natural and artificial radio activity—law of radioactive disintegration ; decay constant and half-life, etc. Radioactive series—nuclear structure and nuclear reactions.

Dual aspects of matter and radiation. One dimensional wave equation of matter.

Elementary ideas about solid state physics—thermal, electric and magnetic properties of solids.

(For AE, AgE, ChE, CE, EE, Comm & ME)

312. Physics.

Same as Ph—**311.**

(For Metallurgical and Mining Engineers and Naval Architects)

411. Physics (2-0).

Dielectric properties of matter—dielectric constant, polarisability, dipole relaxation, dielectric loss, dielectric break down and ferroelectricity.

Magnetic properties of matter—dia-, para-and Ferromagnetism, Antiferromagnetism and Ferrimagnetism.

Electrical properties of matter—Electrical conductivity and related phenomena and semiconductors ; Surface and Junction effects ; Photoconductivity. Superconductivity.

(For Electrical and Electrical Commn. Engineers).

413. Architectural Acoustics (2-0).

Propagation of elastic waves. Dependence of velocity on external conditions. Theory of sonometer. Forced vibration and damping. Psycho-acoustics. Measurement of absolute intensity. Decibel notation. Reverberation. Sabine's and modified Eyring's formulae for reverberation time. Optimum reverberation time. Theory and classification of sound absorbing materials. Measurements of absorption coefficient and reverberation time. Echoes and their remedies. Room resonance. Acoustical aspects of designing an auditorium. Practical methods of checking the acoustics of a hall before construction and after completion. Principles of prevention of air-borne and structure-borne noise. Theory and design of acoustical filters. Reduction of machinery vibrations. Sound distribution. Theory of microphones, loud speakers and amplifiers.

(For Architects)

511. Semiconductor Physics (2-0).

Fermi-Dirac law, Fermi level. Free electron theory of metals. Thermal, electrical and magnetic properties. Schrodinger wave equation and its properties and applications to simple problems. Motion of electrons in a periodic-potential, band theory of metals ; effective mass ; Brillouin zones ; insulators and conductors. Semi-conductors ; intrinsic conductivity, impurity conductivity, rectifications, crystal triodes or transistors.

(For Electrical Communication Engineers)

521. Solid State and Nuclear Physics (2-0).

Wave mechanics and basic electronic processes in matter. F-D statistics and its applications. Band theory and its consequences. Electrical conductivity and magnetoresistivity of metals and semi-conductors. Elements of solid state and gas plasma. Advanced concepts of electrical and magnetic susceptibilities. Advanced ideas of ferromagnetism and ferroelectricity.

Review of theories of nuclear structure. Fusion and Fission processes. Slowing down of neutrons. Age theory. Pile equations and critical pile dimensions. Description of typical reactors. Radiation hazards and shielding materials for reactor construction.

(For Electrical Engineers)

522. Meteorology and Aeronomy (2-0).

Meteorological parameters and their measurement. Composition of the atmosphere. Thermodynamic and other physical processes in the atmosphere including radiative and optical phenomena, condensation and precipitation. Mechanics of the atmosphere including weather systems and their motions. General circulation.

Physics of the stratosphere and the ionized layers. Composition and density of the upper atmosphere. Solar influences. Upper-atmosphereic winds.

(For Aeronautical Engineers).

697. Physics (2-0).

Selected topics of ultrasonic, Radiography and nuclear Physics

Elements of X-Ray and γ-Ray Radiography.

Ultrasonics and its application.

Introduction to nuclear physics and nuclear power :

fission, chain reaction, fission bomb ; fusion, thermo-nuclear reactions, thermo-nuclear bomb, Zeta ; types of nuclear reactors, nuclear reactor plants.

Radiation protection : blast, gamma flash, heat flash, fallout from bombs ; effect of nuclear radiations, their detection and measurement, unit of radiation dosage ; protection of ships and personnel from fallout.

(For Naval Constructors).

SCHEDULE—

REGULATION

Schedule of courses and

Special three-year Bachelor of Techonlogy (B. Tech.)

A. **ENGINEERING**

First year (Common to Civil, Electrical & Mechanical

Subject No.		Subjects for Part-I Examination	1st Term		No. of papers for Exam.	Duration of Exam.
			Hours per Week	Marks		
Hu	11	Humanities	2— 0	100— 0	1	2 hrs.
CE	11	Drawing, Design and	2— 3	100—100	1	3 hrs.
ME	11	Graphics—I	—	—	—	—
Ma	12	Mechanics, Strength of ...	3— 3	100—100	1	3 hrs.
ME	12	Materials, and Structural ...	—	—		
CE	12	Mechanics	—	—		
Comm	11	Electronics—I ...	1— 0	150—100	1	3 hrs.
EE	11	Applied Electricity—I ...	3— 3			
Ma	11	Mathematics	2— 0	100— 0	1	2 hrs.
Ma CE	16 16	Fluid Mechanics—I ...	2— 1	100— 50	1	2 hrs.
ME	13	Heat Technology ...	2— 2	100— 50	1	2 hrs.
ME	14	Manufacturing Science & Practice—I	1— 3	50—100	1	2 hrs.
Ph Met	11 12	Properties of Materials—I	2— 2	100— 50	1	2 hrs.
		N.C.C. Or Physical Training	0— 2	0— 50	—	—
			20 19	900—600	9	—

Subject No.		Subjects	Fourth Term
			Hours per Week
CE	17	Drawing	0— 9
ME	19	Manufacturing Practice	0—12
ME	18	Applied Mechanics	0— 3
EE	15	Applied Electricity IB	0— 3
EE	14	Applied Electricity IA	3— 3
ME	18A	Theory of Machines and Mechanisms—I ...	0— 3
CE	18	Surveying	0— 6

Duration of papers for end-sessional examinations shall be 3 hours.

VIII

No. 14

distribution of marks

Degree Courses

SCIENCES

Engineering specialisations)

2nd Term		No. of papers for Exam.	Duration of Exam. papers	3rd Term		No. of papers for Exam.	Duration of Exam. papers
Hours per Week	Marks			Hours per Week	Marks		
2— 0	100— 0	1	2 hrs.	2— 0	100— 0	1	3 hrs.
—	—	—	—	—	—	—	—
2— 3	100—100	1	3 hrs.	2— 3	100—100	1	3 hrs.
—	—	—	—	—	—	—	—
3— 3	100—100	1	3 hrs.	—	—	—	—
—	—	—	—	3— 3	100—100	1	3 hrs.
1— 0	150—100	1	3 hrs.	1— 0	150—100	1	3 hrs.
3— 3	—	—	—	3— 3	—	—	—
2— 0	100— 0	1	2 hrs.	2— 0	100— 0	1	3 hrs.
2— 1	100— 50	1	2 hrs.	—	—	—	—
—	—	—	—	2— 1	100— 50	1	3 hrs.
2— 2	100— 50	1	2 hrs.	2— 2	100— 50	1	3 hrs.
1— 3	50—100	1	2 hrs.	1— 3	50—100	1	3 hrs.
2— 2	100— 50	1	2 hrs.	2— 2	100— 50	1	3 hrs.
0— 2	0— 50	—	—	0— 2	0— 50	—	—
20—19	900—600	9		20 19	900—600	9	

Marks.

0—250 0—300 0—150	For Civil, Electrical & Mechanical Engineering specialisations.
0—150	For Civil & Mechanical Engineering specialisations.
150—150	For Electrical Engineering specialisation only.
0—150	For Mechanical Engineering specialisation only.
0—150	For Civil Engineering speialisation only.

SECOND YEAR

(i) CIVIL ENGINEERING SPECIALISATION

Subject No.	Subjects for Part II Examination	All Terms Hours per Week		All Terms Marks	No. of papers for Examination	Duration of Examination papers
Hu 21	Humanities	2	0	100— 0	1	2 hrs.
CE 21	Civil Engineering I ... ... (Building Construction, Drawing and Surveying and Transportation)	4	4	200—100	2	2 hrs. each
CE 22	Civil Engineering II ... ... (Irrigation, Water supply and Sewage disposal and Fluid Mechanics—II)	4	3	200—150	2	2 hrs. each
CE 23	Civil Engineering—III ... ... (Theory of Structures and soil Mechanics, and Principles of Structural Design)	4	7	200—200	2	2 hrs. each
CE 24	Civil Engineering laboratory	0	2	0—100*	—	—
Ge 21	Geology	1	2	50— 50	1	2 hrs.
Ph 22	Properties of Materials—II	1	0	50— 0		
Ma 21	Mathematics—II	2	0	100— 0	1	2 hrs.
		18	18	900—600	9	
	Option	2	0	100— 0	1	
		20	18			
	Physical Training			0—100	—	

*50 marks in the Second term for educational tour.

(*ii*) ELECTRICAL ENGINEERING SPECIALISATION

Subject No.	Subjects for Part II Examination	All Terms: Hours per Week		All Terms: Marks	No. of papers for Examination	Duration of Examination papers
Hu 21	Humanities	2	0	100— 0	1	2 hrs.
Comm 21	Electronics II	2	1½	100— 50	1	2 hrs.
EE 22	Electrical Circuits and Measuring Instruments ...	2	1	100— 50	1	2 hrs.
EE 23	Electrical Machines	3	1	150— 50	1	3 hrs.
EE 24	Power Systems I	2	2	100—100*	1	2 hrs.
EE 25	Electrical Laboratory I	0	4½	0—150**	—	—
Ma 21	Mathematics II	2	0	100— 0	1	2 hrs.
ME 22	Machine Design	1	3	50—100	1	2 hrs
ME 29	Prime Movers	2	3	100—100	1	2 hrs.
Ph 21	Properties of Materials II	2	0	100— 0	1	2 hrs.
		18	16	900—600	9	
	Option	2	0	100— 0	1	
		20	16			
	Physical Training			0—100	—	

*50 marks in the first term for practical training during the preceding Summer Vacation and 50 marks for educational tour.
**100 marks in the third term for laboratory tests.

(*iii*) MECHANICAL ENGINEERING SPECIALISATION

Subject No.		Subjects for Part II Examination	All Terms: Hours per Week		All Terms: Marks	No. of papers for Examination	Duration of Examination papers
Hu	21	Humanities	2	0	100— 0	1	2 hrs.
Comm	22	Electronics—II	2	1½	100— 50	1	3 hrs.
EE	21	Applied Electricity—II	2	3	100—100		
Ma	21	Mathematics—II	2	0	100— 0	1	2 hrs.
ME	21	Hydraulic Machines	2	1½	100— 50	1	2 hrs.
ME	22	Machine Design	1	3	50—100*	1	2 hrs.
ME	23	Heat Power Technology—I	2	1½	100— 50	1	2 hrs.
ME	24	Manufacturing Science and Practice—II	1	3	50—100*	1	2 hrs.
ME	25	Theory of Machines and Mechanisms—II ...	2	1	75— 50	1	2 hrs.
ME	26	Mechanics of Solids I	2	1	75— 50	1	2 hrs.
ME	28	Engineering Metallurgy	0	1½	0— 50		
Met	28		1	0	50— 0	1	2 hrs.
			19	17	900—600	10	
		Option	2	0	100— 0	1	
			21	17			
		Physical Training			0—100		

*50 marks (25 from each subject) in the second term for educational tour.

THIRD YEAR

(i) CIVIL ENGINEERING SPECIALISATION

Subject No.	Subjects for the Final Examination	All Terms: Hour per Week	All Terms: Marks	No. of papers for Examination	Duration of Examination papers
Hu 31	Humanities	2 0	100— 0	1	2 hrs.
CE 35	Design and Project	2 6	100—250**	1	2 hrs.
CE 37	Laboratories	0 2	0—100		
CE 38	Construction	2 0	100— 0	1	2 hrs.
Ma 31	Mathematics—III	1 0	50— 0	1	2 hrs.
Ph 31	Properties of Materials—III	1 1	50— 50	1	2 hrs.
	*Electives (any two)	8 8	400—300	4	two 2 hrs. each two 3 hrs. each
		16 17	800—700	9	
	Option	2 0	100— 0	1	
		18 17			
	Physical Training		0—100		

Electives:

CE — 31	Public Health Engineering	4 — 4
CE — 32	Structural Engineering	4 — 4
CE — 33	Foundation Engineering	4 — 4
CE — 34	Hydraulic Engineering	4 — 4
CE — 36	Transportation Engineering (Roads, Tunnels, Airports, Docks and Harbours).	4 — 4

Viva voce	0 — 200
Thesis-Project	0 — 300

**50 marks in the first term for professional training during the preceding summer vacation and 50 marks in the second term for educational tour.

(*iii*) ELECTRICAL ENGINEERING

Subject No.		Subjects for the Final Examination	All Terms: Hours per Week		All Terms: Marks	No. of papers for Examination	Duration of Esamination papers
Hu	31	Humanities	2	0	100— 0	1	2 hrs.
Comm	31	Electronics III	2	1½	100— 50	1	2 hrs.
EE	31	Instrumentation and Control	3	1	150— 50	1	3 hrs.
EE	32	Machines and System Components	2	1	100— 50	1	2 hrs.
EE	33	Electrical Machine Design	2	0	100— 0	1	2 hrs.
EE	34	Power Systems II	2	4	100—150*	1	2 hrs.
EE	35	Electrical Laboratories II	0	4½	0—150**		—
EE	36	Project	0	4	0—150***		—
Ma	31	Mathematics III	1	0	50— 0	1	2 hrs.
ME	31	Industrial Management	2	0	100— 0	1	2 hrs.
Ph	33	Solid State and Nuclear Physics	2	0	100— 0	1	2 hrs.
			18	16	900—600	9	
		Option	2	0	100— 0	1	
			20	16			
		Physical Training			0—100		
		Viva voce			0—200		
		Thesis-Project			0—300		

*50 marks in the First Term for practical Training during the preceding Summer Vacation.
**100 marks in the Third Term for Laboratory Tests.
***50 marks for educational tour.

(*iii*) MECHANICAL ENGINEERING SPECIALISATION

Subject No.	Subjects for the Final Examination	All Terms Hours per Week		All Terms Marks	No. of papers for Examination	Duration of Examination paper
Hu 31	Humanities	2	0	100— 0	1	2 hrs.
Ma 31	Mathematics—III	1	0	50— 0	1	2 hrs.
ME 31	Industrial Management	2	0	100— 0	1	2 hrs.
ME 32	Metal Processing Laboratory	0	3	0—100		—
ME 33	Heat Power Technology II	2	4	100—150	1	2 hrs.
ME 34	Instrumentation and Controls	2	1	100— 50	1	2 hrs.
ME 35	Design Project	1	5	50—200*	1	2 hrs.
ME 36	Production Engineering Project	1	5	50—200*		
ME 37	Mechanics of Solids II	2	1	100— 50	1	2 hrs.
	**Elective (any one)	1	1	50— 50	1	2 hrs.
		14	20	700—800	8	
	Option	2	0	100— 0	1	2 hrs.
		16	20			
	Physical Training			0—100		
	Viva-voce			0—200		
	Thesis/Project			0—300		

***Electives* :—
ME 38 — Engineering Quality Control. (1-1).
ME 39 — Applied Fluid Flow, Plasticity and Experimental Stress Analysis. (1-1).

*50 marks (25 from each subject)in the :—
I Term for practical training during the preceding summer vacation.
II Term for educational tour.

B. **CHEMICAL**

FIRST

Subject No.		Subjects for Part-I Examination	1st Term Hours per Week		1st Term Marks	No. of papers for Exam.	Duration of Exam. papers
Hu	11	Humanities ...	2	0	100— 0	1	2 hrs.
CE	11	Drawing, Design and	2	3	100—100	1	3 hrs.
ME	11	Graphics—I	—		—	—	—
ME	16	Machine Elements Design ...	—		—	—	—
ChE	11	Chemical Engineering Processing and Principles	2	3	100—100	1	2 hsr.
Comm	12	Principles of Electronics ...	1	2	50— 50	1	3 hrs.
EE	12	Electrical Technology ...	2	2	100— 50		
Ma	11	Mathematics—I ...	2	0	100— 0	1	2 hrs.
Mc	16	Fluid Mechanics—I ...	2	1	100— 50	1	2 hrs.
CE	16		—		-	—	—
CE	14	Applied Mechanics ...	2	2	100— 50	1	2 hrs.
ME	13	Heat Technology ...	2	2	100— 50	1	2 hrs.
ME	17	Manufacturing Practice ...	0	3	0— 50	—	—
Met	11	Elements of Metallurgy ...	1	0	50— 0	1	2 hrs.
Ph	14	Material Science ...	1	0	50— 0		
		NCC or Physical Training	0	2	0— 50	—	--
			19	20	950—550	9	

Curricula for the Second and Third Years shall be the same as for the Fourth and Fifth Years of the five-year integrated course in Chemical Engineering.

Subject No.		Subjects	Fourth Term Hours per Week		Fourth Term Marks
CE	17	Drawing	0	9	0— 250
ME	18	Applied Mechanics ...	0	3	0— 150
ME	19	Manufacturing Practice ...	0—12		0— 300
EE	15	Applied Electricity—I B ...	0	3	0— 150
ChE	13	Fuels and Furnaces ...	0	3	0— 150
			0	30	0—1000

ENGINEERING

YEAR

2nd Term: Hours per Week	2nd Term: Marks	No. of papers for Exam.	Duration of Exam. papers	3rd Term: Hours per Week	3rd Term: Marks	No. of papers for Exam.	Duration of Exam. papers
2 0	100— 0	1	2 hrs.	2 0	100— 0	1	3 hrs.
—	—	—	—	—	—	—	—
2 3	100—100	1	3 hrs.	—	—	—	—
—	—	—	—	2 3	100—100	1	3 hrs.
2 3	100—100	1	2 hrs.	2 3	100—100	1	3 hrs.
1 2	50— 50 }	1	3 hrs.	1 2	50— 50 }	1	3 hrs.
2 2	100— 50 }			2 2	100— 50 }		
2 0	100— 0	1	2 hrs.	2 0	100— 0	1	3 hrs.
2 1	100— 50	1	2 hrs.	—	—	—	—
—	—	—	—	2 1	100— 50	1	3 hrs.
2 2	100— 50	1	2 hrs.	2 2	100— 50	1	3 hrs.
2 2	100— 50	1	2 hrs.	2 2	100— 50	1	3 hrs.
0 3	0— 50	—	—	0 3	0— 50	—	—
1 0	50— 0 }	1	2 hrs.	1 0	50— 0 }	1	3 hrs.
1 0	50— 0 }			1 0	50— 0 }		
0 2	0— 50	—	—	0 2	0— 50	—	—
19 20	950—550	9		19 20	950—550	9	

C. ELECTRONICS & ELECTRICAL

Subject No.		Subjects for Part-I Examination	1st Term Hours per Week		1st Term Marks	No. of papers for Exam.	Duration of Exam.
Hu	11	Humanities	2	0	100— 0	1	2 hrs.
CE ME	11 11	Drawing, Design and Graphics I	2	3	100—100	1	3 hrs.
ME	16	Machine Elements Design	—		—	—	—
Comm	13	Electrical and Electronic Circuits	4	3	150—150	1	3 hrs.
CE	15	Applied Mechanics ...	2	0	100— 0	1	2 hrs.
EE	13	Applied Electricity ...	3	3	150—100	1	3 hrs.
Ma	11	Mathematics I ...	2	0	100— 0	1	2 hrs.
ME	14	Manufacturing Science and Practice I	1	3	50—100	1	2 hrs.
ME	15	Mechanics of Machines and Machine Elements Design	1	2	50— 50	1	2 hrs.
Ph	12	Physics	2	1	100— 50	1	2 hrs.
		NCC or Physical Training	0	2	0— 50	—	—
			19	17	900—600	9	

Subject No.		Subjects	Fourth Term Hours per Week		Fourth Term Marks
CE	17	Drawing	0	9	0— 250
ME	18	Applied Mechanics ...	0	3	0— 150
ME	19	Manufacturing Practice ...	0	12	0— 300
Comm	14	Communication Engineering Laboratory	0	6	0— 300
			0	30	0—1000

COMMUNICATION ENGINEERING

2nd Term			No. of papers for Exam.	Duration of Exam. papers	3rd Term			No. of papers for Exam.	Duration of Exam. papers
Hours per Week		Marks			Hours per Week		Marks		
2	0	100— 0	1	2 hrs.	2	0	100— 0	1	3 hrs.
—		—	—	—	—		—	—	—
2	3	100—100	1	3 hrs.	—		—	—	—
—		—	—	—	2	3	100—100	1	3 hrs.
4	3	150—150	1	3 hrs.	4	3	150—150	1	3 hrs.
2	0	100— 0	1	2 hrs.	2	0	100— 0	1	3 hrs.
3	3	150—100	1	3 hrs.	3	3	150—100	1	3 hrs.
2	0	100— 0	1	2 hrs.	2	0	100— 0	1	3 hrs.
1	3	50—100	1	2 hrs.	1	3	50—100	1	3 hrs.
1	2	50— 50	1	2 hrs.	1	2	50— 50	1	2 hrs.
2	1	100— 50	1	2 hrs.	2	1	100— 50	1	3 hrs.
0	2	0— 50	—	—	0	2	0— 50	—	—
19	17	900—600	9		19	17	900—600	9	

SECOND YEAR

Subject No.	Subjects for Part II Examination	All Terms: Hours per Week		All Terms: Marks	No. of papers for Examination	Duration of Examination papers
Hu 21	Humanities	2	0	100— 0	1	2 hrs.
Comm 23	Mathematical Methods in Electronic Engineering ...	2	1	100— 50	1	2 hrs.
Comm 24	Networks and Transmission Lines	3	1½	150— 50	1	3 hrs.
Comm 25	Electronic Circuits	3	6	150—200**	1	3 hrs.
Comm 26	Industrial Electronics	2	1½	100— 50	1	2 hrs.
Comm 27	Drawing and Workshop Practice	1	3	50—100*	1	2 hrs.
EE 28	Electrical Measurements, Transmission and Distribution	3	3	150—100	1	3 hrs.
Ph 23	Material Science	3	0	150— 0	1	3 hrs.
		19	16	950—550	8	
	Option	2	0	100— 0	1	
		21	16			
	Physical Training	—		—100	—	

*50 marks in the first term for practical training during the preceding summer vacation.
**50 marks in the second term for educational tour.

THIRD YEAR

Subject No.	Subjects for the Final Examination	All Terms: Hours per Week		All Terms: Marks	No. of papers for Examination	Duration of Examination papers
Hu 32	Humanities	1	0	50— 0	1	2 hrs.
Comm 32	Network Theory	2	1	100— 50	1	2 hrs.
Comm 33	Electromagnetic Waves and Radiation Systems ...	3	1½	150— 50	1	3 hrs.
Comm 34	Radio Engineering	2	3	100—100	1	2 hrs.
Comm 35	Line and Radio Communication Engineering ...	3	1½	150— 50	1	3 hrs.
Comm 36	Project	0	6	0—200*	—	—
ME 31	Industrial Management	2	0	100— 0	1	2 hrs.
Ph 32	Semiconductor and Plasma Physics	2	0	100— 0	1	2 hrs.
	**Electives (any two)	4	3	200—100@	2	2 hrs. each
		19	16	950—550	9	
	Option	2	0	100— 0	1	
		21	16			
	Physical Training			0—100	—	
	Viva-voce			0—200		
	Thesis/Project			0—300		

***Electives*

Comm 37A Radar and Aids to Navigation.
Comm 37B Antenna and Wave Progagation.
Comm 37C Network Design.
Comm 37D Acoustics.
Comm 37E Servomechanism.
Comm 37F Electronic Computers.
Comm 37G Line Communication.

*50 marks in the first term for training during the preceding Summer Vacation.
@ 50 marks in the second term for educational tour.

D. **METALLURGICAL**

FIRST

Subject No.		Subjects for Part-I Examination	1st Term Hours per Week		1st Term Marks	No. of papers for Exam.	Duration of Exam.
Hu	11	Humanities	2	0	100— 0	1	2 hrs.
CE	11	Drawing, Design ...	2	3	100—100	1	3 hrs.
ME	11	Graphics	—		—	—	—
ME	16	Machine Elements Design ...	—		—	—	—
Comm	12	Principles of Electronic ...	1	2	50— 50	1	3 hrs.
EE	12	Electrical Technology ...	2	2	100— 50		
CE	14	Applied Mechanics ...	2	2	100— 50	1	2 hrs.
ChE	12	Fuel Technology ...	2	0	100— 0	1	2 hrs.
Ge	11	Geology for Metallurgists ...	2	2	100— 50	1	2 hrs.
Ma	11	Mathematics—I ...	2	0	100— 0	1	2 hrs.
Ma / CE	16 / 16	Fluid Mechanics ...	2	1	100— 50	1	2 hrs.
ME	17	Manufacturing Practice ...	0	3	0— 50		
Met	13	General Metallurgy ...	2	1	100— 50	1	2 hrs.
Ph	13	Material Science ...	1	0	50— 0	1	2 hrs.
		NCC or. Physical Training	0	2	0— 50	—	—
			20	18	1000—500	10	

Subject No.		Subjects		Fourth Term Hours per Week		Fourth Term Marks
CE	17	Drawing ...	...	0	9	0— 250
ME	18	Applied Mechanics	...	0	3	0— 150
ME	19	Manufacturing Practice	...	0	12	0— 300
EE	15	Applied Electricity	...	0	3	0— 150
ChE	13	Fuels and Furnaces	...	0	3	0— 150
				0	30	0—1000

ENGINEERING

YEAR

2nd Term Hours per Week		2nd Term Marks	No. of papers for Exam.	Duration of Exam. papers	3rd Term Hours per Week		3rd Term Marks	No. of papers for Exam.	Duration of Exam. papers
2	0	100— 0	1	2 hrs.	2	0	100— 0	1	3 hrs.
2	3	100—100	1	3 hrs.	—		—	—	—
—		—	—	—	2	3	100—100	1	3 hrs.
1	2	50— 50	1	3 hrs.	1	2	50— 50	1	3 hrs.
2	2	100— 50			2	2	100— 50		
2	2	100— 50	1	2 hrs.	2	2	100— 50	1	3 hrs.
1	2	50— 50	1	2 hrs.	2	0	100— 0	1	3 hrs.
2	2	100— 50	1	2 hrs.	2	2	100— 50	1	3 hrs.
2	0	100— 0	1	2 hrs.	2	0	100— 0	1	3 hrs.
2	1	100— 50	1	2 hrs.	—		—	—	—
—		—	—	—	2	1	100— 50	1	3 hrs.
0	3	0— 50	—		0	3	0— 50		
2	1	100— 50	1	2 hrs.	2	1	100— 50	1	3 hrs.
1	0	50— 0	1	2 hrs.	1	0	50— 0	1	3 hrs.
0	2	0— 50	—	—	0	2	0— 50	—	—
19	20	950—550	10		20	18	1000—500	10	

SECOND YEAR

Subject No.	Subjects for Part II Examination	1st and 3rd Terms Hours per Week		1st and 3rd Terms Marks	No. of papers Exam.	Duration of Exam. papers	2nd Term Hours per Week		2nd Term Marks	No. of papers for Exam.	Duration of Exam. papers
Hu 21	Humanities	2	0	100— 0	1	2 & 3 hrs.	2	0	100— 0	1	2 hrs.
CE 26	Engineering Drawing	0	3	0—150	—	—	0	3	0—150	—	—
ChE 28	Mineral Dressing	2	2	100— 50	1	2 & 3 hrs.	2	2	100— 50	1	2 hrs.
Met 21	Refractories	1	0	50— 0 }	1	3 hrs.	0	2	0— 50 }	1	2 hrs.
Met 22	Extractive Metallurgy of Iron and Steel I	2	1	100— 50 }			2	1	100— 50 }		
Met 23	Foundry Metallurgy	2	3	100—100	1	2 & 3 hrs.	2	3	100—100	1	2 hrs.
Met 24	Physical Metallurgy I	2	3	100—100	1	2 & 3 hrs.	2	3	100—100	1	2 hrs.
Met 25	Mechanical Metallurgy I	2	3	100—100	1	2 & 3 hrs.	2	3	100—100	1	2 hrs.
Met 26	Non-Ferrous Metallurgy	2	1	100— 50	1	2 & 3 hrs.	2	1	100— 50	1	2 hrs.
Met 27	Metallurgical Thermodynamics and Chemical Kinetics	2	1	100— 50	1	2 & 3 hrs.	2	1	100— 50	1	2 hrs.
		17	17	850—650	8		16	19	800—700	8	
	Option	2	0	100— 0	1		2	0	100— 0	1	
		19	17				18	19			
	Physical Training			0—100		—			0—100	—	

THIRD YEAR

Subject No.	Subjects for the Final Examination	All Terms: Hours per Week	Marks	No. of papers for Examination	Duration of Examination papers
Hu 32	Humanities	1 0	50—0	1	2 hrs.
ME 31	Industrial Management	2 0	100—0	1	2 hrs.
Met 31	Extractive Metallurgy of Iron and Steel II	2 1	100—50	1	2 hrs.
Met 32	Electrometallurgy and Corrosion	1 1	75—75	1	2 hrs.
Met 33	Mechanical Metallurgy II	1 0	75—0	1	2 hrs.
Met 34	Physical Metallurgy II	2 3	100—150	1	2 hrs.
Met 35	Extractive Metallurgy Laboratory	0 3	0—100	—	—
Met 36	Applied X-Rays and Metal Physics	2 3	100—100	1	2 hrs.
Met 37	Material Engineering and Powder Metallurgy	1 0	75—0	1	2 hrs.
Met 38	Seminar	0 1	0—50	—	—
Met 39	Project	0 6	0—150	—	—
	*Elective (any one)	2 2	100—50	1	2 hrs.
		14 20	775—725	9	
	Option	2 0	100—0	1	
		15 20			
	Physical Training		0—100		
	Viva voce		0—200		
	Thesis/Project		0—300		

**Elective subjects* :*
Met 39A Advanced Metallurgy of Alloy Steel.
Met 39B Furnace Technology.
Met 39C Advanced Foundry Metallurgy.
Met 39D Metallurgy of Atomic Energy Metals.

3 Yr. B. Tech Degree Cour.

DISTRIBUTION OF MARKS

(for each Examination)

Examination	First Term Marks	Second Term Marks	End-Sessional Marks	Fourth Term Marks	Maximum Marks	Weighted Maximum Marks
Part I ...	1500	1500	1500	1000	4000	4000
Part II ...	1500	1500	1500		3000	3000
Final ...	1500	1500	1500		3500	7500
			Viva-voce 200			
			Thesis/Project 300			

SCHEDULE IX

REGULATION No. 15

(For 3-Year Special B.Tech. Degree Courses)

CHEMICAL ENGINEERING (Ch. E)

11. Chemical Engineering Processing and Principles (2-3).

Units and dimentions employed in Chemical Engineering calculations. Introduction to dimentional analysis. Material balance for Chemical Engineering processes, Vapour pressure, Humidity, Saturation, Solubility and Absorption, Thermophysics and Thermo-chemistry, Fuels and combustion. Chemical, Metallurgical, and petroleum process. Sessional work based on the above.

Drawing of Chemical Engineering Equipments.

12. Fuel Technology (2-0). First and Third Terms, (1-2). Second Term.

Classification of fuels, Chemical composition, calorific values and general uses.

Solid fuels, wood, charcoal, coal etc. origin and classification, characteristics and distribution of Indian coals, pulverised coal, coal briquetts, storage, spontaneous ignition. Mineral matter in coal, its effect, coal washing processes. Coal carbonisation. Low temp. carbonisation and manufacture of metallurgical coke.

Liquid fuels, petroleum and its characteristics, petroleum Processing, Coal Tar Byeproducts, Shale oil.

Gaseous fuels, Mechanism of gasification, production and properties of coal gas, producer gas and water gas. Combustion of fuels. Efficiency and distribution of heat losses, fuel economy in furnace practice. Sessional work based on the above syllabus.

(For Metallurgical Engineers)

13. Fuels and Furnaces (0-3). Fourth Term.

Sampling of solid fuels, proximate analyses of coal. Preliminary studies on Gas and Liquid burners. Rotary-kiln. Water-gas generator, Producer-gas generator.

(For Chemical and Metallurgical engineers).

28. Mineral Dressing (2-2)

Crushing, grinding, sizing and classification methods. Principles of hydraulic classification. Froth floatation, Magnetic and Electrostatic Separation Filtration and dewatering Processes. Drying. Flowsheets of treatment of important minerals and ores occuring in India. Principles of coal preparation.

(For Metallurgical Engineers)

CIVIL ENGINEERING (CE)

11. Drawing, Design & Graphics I (2-3). First Term only.

I.S. Code of Practice of General Engineering Drawing ; Pictorial views.

12. Structural Mechanics (3-3). Third Term only.

Moving loads and influence lines ; Statically Indeterminate Beams ; Strain Energy methods ; Stability of Equilibrium and Buckling of columns.

Moving loads and influence lines ; Statically Indeterminate Beams ; Strain Energy methods ; Stability of Equilibrium and Buckling of columns.

14. Applied Mechanics (2-2).

Fundamentals of mechanics ; Equilibrium of Force systems and engineering application ; Principle of virtual work.

Kinematics and dynamics of a particle and of a rigid body and applications to engineering structures and machines ; Work and energy ; Impulse and momentum. Introduction to mechanics of materials ; Analysis of stress and strain ; Stresses and deflections in straight uniform beams ; Torsion of prismatic bars and combined loading ; Statically indeterminate beams ; Strain Energy methods ; Stability of equilibrium and buckling of columns.

(For Chemical & Metallurgical Engineers).

15. Applied Mechanics (2-0).

Same course as CE-14 with reduced number of tutorial and laboratory hours.

(For Electronics & Elec. Comm. Engineers).

16. Fluid Mechanics I (2-1). Third Term only.

Dimensional Analysis and Laws of similitude ; Pipe flow and friction coefficient ; Flow meters and flow measurement.

17. Drawing (0-9). Fourth Term.

Scales and mathematical curves, projection of points, lines, planes and solids, auxiliary projections, principles of isometric projections.

(For Chemical, Communication and Metallurgical Engineers and Engineering Scientists).

18. Surveying (0-6). Fourth Term.

Principles and Practice of Chain and Compass surveying.

21. Civil Engineering I (4-4).

(i) *Building construction, Drawing and Surveying :*

Safe Bearing Capacity of Soils ; Foundations and footings ; Brick work-brick making, classification and Brick laying ; Stone masonry ; Damp proof courses ; Timbering in trenches ; Openings in Brick work ; Concrete-lime concrete, cement concrete ; Formwork ; Timber-seasening, classification, timber construction ; Floor and roof constructions ; Design of simple reinforced concrete structures.

Drawing of Brick Bonds ; Simple spread foundation, Details of doors and windows, Timber and steel roof trusses, Details of R.C. Lintels and roof slabs, Simple residential building and estimating.

Plane table surveying and levelling; Theodolite Traversing ; Tacheometry ; Carves—circular and transition ; Base line measurement and triangulation ; Trigonometrical levelling ; elements of field Astronomy—determination of azimuth, latitude, longitude and time ; Principles of aerial surveying.

(ii) *Transportation.*

Roads—Location, ruling curves and gradients, I.R.C. Standards, minimum and over-taking sight distances ; Typical sections of highways in plain and hilly areas ; Properties of highway materials ; Construction and maintenance of the different types of flexible and rigid pavements.

Railways—Construction and maintenance of railway track ; Super elevation ; Theory of points and crossings ; Curve compensation ; Signalling and safety devices.

22. Civil Engineering II (4-3).

(i) *Irrigation, Water Supply and Sewage disposal :*

Elements of hydrology—Well and flow irrigation, Diversion and storage works ; Canal systems ; Falls and Cross-drainage works ; Water logging and salt efflorescence.

Water supply systems—Estimate of water requirement ; Sources and collection ; Distribution ; Examinagion of water ; Standards of quality ; objects and methods of treatment; purification processes ; House water supply, Rural water supply.

Drainage systems—Estimate of waste water quantities ; Flow in sewers and appurtenances ; Collection, examination of waste water ; purification process ; Standards of quality ; House drainage ; Small scale sewage treatment plant ; Rural sanitation.

(ii) *Fluid Mechanics II :*

Open channel flow—Steady uniform and steady non-uniform flow, hydraulic jump, unsteady flow, noise and water hammer, cavitation.

Special problems of free surface flow—surges and flood waves in channels, elementary mechanics of surface waves, mechanics of scour and sediment transportation.

Hydraulic machinery—Turbines and pumps, theory of flow, performance characteristics.

23. Civil Engineering III (4-7).

(i) *Theory of Structures :*

Moving loads and influence lines, slopes and deflections ; Continuous beams and other indeterminate forms ; Suspension bridges ; Arches.

(ii) *Soil Mechanics :*

Physical and mechanical properties of soils, Identification and classification, Soil water, Capillary phenomena, Permeability, Seepage, Flow net, Compaction, moisture-density strength relationship, Theory of consolidation, Shear strength of soils, Earth presure theories, Stability of slopes, Soil sampling.

(iii) *Princples of Structural design :*

Steel-Design of riveted and bolted points, welded connections, Design of columns, Roof trusses and plate girders.

Reinforced concrete—Simple beams and slabs, Short columns. Footings, Retaining walls and staircases.

24. Civil Engineering Laboratories (0-2).

Experimental work in Soil Mechanics Laboratory, Public health engineering laboratory and models laboratory.

26. Engineering drawing (0-3).

Graphic statics—advanced ; Building and structural drawing—elementary and advanced ; Screw-threads, Drawing of complete machine parts, Assembly drawing and details, Tracing and blue printing.

(For Metallurgical Engineers).

31. Public Health Engineering (4-4).

Transmission of water ; Physical and chemical properties of water ; Kinetics of aerobic and anaerobic decomposition ; Sedimentation and floatation ; Chemical treatment of water ; Filtration ; Biological purification processes; Sludge treatment and disposal ; Control of living organisms; Taste and odour ; Natural purification of water ; Principles of ventilation, lighting and acoustics of buildings ; Refuse collection and disposal ; Sanitation problems.

32. Structural Engineering (4-4).

Deflection of trussed beams; continuous trusses and secondary stresses.

Analysis of multistoreyed buildings and continuous girders, Frames with variable moment of inertia ; Cables, suspension systems and space frames ; Continuous and rigid frame steel bridges ; Semi-rigid connections.

Design of R. C. columns subject to direct and bending stresses ; Rectangular and circular water towers ; Flat slab construction ; Shell construction ; Principles of prestressed concrete connection, common methods.

Brief introduction to analysis of plates and shells ; Buckling behaviour and response of structures to dynamic loading.

33. Foundation Engineering (4-4).

Plastic equilibrium of soils, Stresses in soils, theories of foundation failure ; Principles of foundation design ; Bearing capacity and settlement analysis ; Soil sampling ; Principles of foundation action ; Spread footings ; Mats ; Pier and pile foundations ; Cofferdams and caissons.

34. Hydraulic Engineering (4-4).

Dams—Principles of design of various types of dams ; appurtenant works—spillways, gates, galleries, outlets etc. River diversion ; Project planning and selection of type of dams. Water power engineering—planning of hydroelectric developments, estimates of water power from stream ; selection of hydraulic turbines ; Intakes, conduits and penstocks ; Power house structures.

Coastal engineering—Tides and tidal currents ; Wave action ; Beach erosion ; Principles and methods of shore protection ; Layout of channels and harbour basins.

35. Design and Project (2-6).

Complete design in steel or R. C. or residential building and industrial or factory building ; Silos, Bunkers, Water towers including preparation of working drawings, project reports, quantity estimation and analysis of costs.

Complete design of simple steel or R. C. bridge including costing and quantity estimation. Water supply and drainage scheme and design ; Design of a dam project including foundation treatment.

36. Transportation Engineering (Roads, Tunnels, Airports, Docks and Harbours) (4-4).

Classification of roads, estimation of traffic ; Geometric standards in the location of highways ; Road signs, Traffic control, Road furniture ; Structural design of pavements ; Tunnels types, construction, ventilation and lighting ; Precaution for safety.

General principles involved in the location of Civil and military airports, International standards in the design of airports.

Physical geography in relation to docks and harbours, coastal changes and effect of artificial interference, Tidal phenomena, Wave action, Choice of site; Break-waters and moles; Wet, dry and floating docks ; Locks, Construction of harbour structures ; River and canal navigation.

37. Laboratories (0-2).

Experimental work in structural laboratory (including models laboratory) Soils laboratory (including Highway laboratory) and Hudraulic laboratory (including Hydraulic machine laboratory).

38. Construction (2-0).

Orientation of buildings, Public buildings, Cinemas, Markets, Schools, Hospitals, Stadium, Low cost Housing, methods of prefabrication, Heating and ventilation, acoustics, building regulations & bye-laws, special foundations. Earthquake resistant structures, contracts and works organisation ; Labour Laws and Factory Act.

ELECTRICAL ENGINEERING (EE)

11. Applied Electricity I (3-3).

Electric and magnetic field concepts and system parameter calculations. Formulation of equilibrium equations for simple a.c. and d.c. networks and evaluation of transient and steady-state behaviour. Vector loci and circle diagrams. Network theorems and application to single and three-phase circuits.

Direct and alternating current machines and transformers. Current, Voltage, Power and energy meters. Electrical installation of buildings. Elements of generation, transmission and distribution of power.

(For Engineering Science students).

12. Electrical Technology (2-2).

Introductory study of magnetic and electric fields and circuits. Direct and alternating current machines. Current, voltage, power and energy meters. Electrical installation of buildings. Elements of power generation, transmission and distribution.

(For Chemical and Metallurgical Engineers).

13. Applied Electricity (3-3).

D.C. machines, single and poly-phase transformers, polyphase synchronous, induction and commutator machines. Single-phase motors. Converting machines and rectifiers. Principles of working, characteristics and application of rotating amplifiers, synchros and servomotors.

(For Electronics & Electrical Communication Engineers).

14. Applied Electricity—IA (3-3). Fourth Term.

Detailed study of the theory and performance of d.c. machines. Special types of d.c. machines. Storage batteries.

(For Electrical Engineering specialisation of Engineering Science course).

15. Applied Electricity—IB (0-3). Fourth Term.

Electrical Workshop and Laboratory.

(For Chemical and Metallurgical Engineers and Civil and Mechanical Engineering specialisations of the Engineering Science course).

21. Applied Electricity II (2-3).

Synchronous motors, converters and rectifiers. Single-phase machines. Transmission and distribution. Overhead lines and underground cables. Electric power utilisation. Elementary principles of industrial motor control. Power station and substation layout.

(For Mechanical Engineering Specialisation).

22. Electrical Circuits and Measuring Instruments (2-1).

Symmetrical components and three-phase circuit analysis. Two-terminal and four-terminal passive networks and evaluation of input, output and transfer functions. A, B, C, D and image parameters. Reflection effects and travelling waves on transmission lines. Description and mapping of impedence functions in the frequency domain. Pole-zero configuration. Synthesis of simple two-terminal networks.

Instrument classification. Equation of performance of the moving system and extension to develop instruments for measurement of voltage, circuit, charge and flux-linkages. Torque equations for moving iron, dynamometer, electro-static and induction systems. Instrument transformers.

23. Electrical Machines (3-1).

Theory and performance of transformers, synchronous and asynchronous machines. Converters and rectifiers.

24. Power Systems I (2-2).

Engineering and economic factors relating to transmission and distribution of electrical energy. Electrical and mechanical characteristics of overhead lines. Different systems of transmission and distribution. Synchronous phase-modifiers and capacitors. Insulators and supports. Underground cables. Analysis of system over-voltages and travelling waves.

Lightning arresters. Grounding. Line interference. Dielectrics and their breakdown. Grading of cables. Condenser bushing. Insulation strength and dielectric losses. Discharges in solids, liquids and gases. Corona. Production and measurement of direct, alternating and impulse voltages. High-voltage and impulse testing. High-speed oscillograph. High-voltage d.c. transmission.

25. Electrical Laboratory I (0-4½).

Experiments covering EE 22, 23 and 24.

28. Electrical Measurements, Transmission, and Distribution (3-3).

Detailed study of instruments and meters. Extension of instrument range. Instrument transformers. Measurement of magnetic and electric quantities. Direct and alternating current bridges and bridge measurements for resistance, inductance, capacitance and frequency. D.C. and A.C. potentiometers.

General study of engineering and economic factors relating to transmission and distribution of electrical energy. Different systems of transmission and distribution. Design of transmission lines. Circuit breakers. Protection. Interference with telephone lines.

(For Electronics & Electrical Communication Engineers).

31. Instrumentation and Control (3-1).

Magnetic measurements. Fault localization and earth testing. D.C. and A.C. bridge-networks and potentiometers. Errors and their estimation. Transducers and measurement of non-electrical quantities. Open and closed-loop control schemes. Block-diagrams. Equation of performance of simple schemes. Error coefficients. Feed-back and its effects. Transfer functions and frequency response plots. Stability criteria. Study of classified examples of control schemes employed in recording, telemetring and automatic control systems.

32. Machines and System Components (2-1).

A.C. commutator machines. Unbalanced and transient operation of machines and transformers. Magnetic amplifiers and cross-field machines. Servo-motors and selsyns and their application. Electro-magnetic fields and their properties. Two-dimensional fields and field mapping techniques.

33. Electrical Machine Design (2-0).

Constructional details of electrical machines and transformers. Insulation, ventilation and cooling. Evaluation of machine parameters.

34. Power Systems II (2-4).

Fuses and circuit breakers. Arc extinction and arc control devices. Different types of oil and air—blast circuit breakers. Restriking and recovery voltages. Symmetrical and and asymmetrical fault calculations. Sequence networks. Protective relays. Protection of power system including equipments. Testing of circuit breakers and relays. Carrier relaying, telemetering and supervisory control. Elements of study-state and transient stability of power systems. Methods of improving stability.

Steam-power generation. Efficiency and load studies. Hydro-electric power generation. Automatic power plant. Power station planning. Economics of hydel, steam and nuclear power generation. Basic insulation level and insulation co-ordination. Electrification of urban and rural areas, and industrial undertakings. Electrical Drives and elements of Illumination Engineering. Electricity Rules and Regulations. Codes of engineering practice and standard specifications. Electricity tariff.

35. Electrical Laboratory II (0-4½).

Experiments covering EE 31, 32 and 34.

36. Project (0-4).

Specification and design of typicl amachines and transformers. Project assignments on automatic control schemes.

ELECTRONICS AND ELECTRICAL COMMUICATION ENGINEERING (COMM).

11. Electronics I (1-0).

Vacuum tubes and transistors—equivalent circuits, amplifiers, oscillators and rectifiers. Electronic instruments.

(For Engineering Scientists).

12. Principles of Electronics (1-2).

Vacuum tubes and transistors—equivalent circuits, amplifiers, oscillators and rectifiers. Electronic instruments, Industrial applications.

(For Chemical and Metallurgical Engineers).

13. Electrical and Electronic Circuits (4-3).

A.C. circuits ; Resonance ; Network theorems. Loop and node analysis ; impedance transformation, Coupled circuits. Polyphase circuits, Symmetrical components. Junction diode and trasistors ; equivalent circuits ; Motion of electron, Vacuum tube, Frequency characteristic of basic amplifiers ; AF power amplifier ; CRO.

14. Communication Engineering Laboratory (0-6). Fourth Term.

Electronic components, soldering and layout. Simple experiments on amplifiers, oscillators and rectifiers. Building up and testing of experimental models.

21. Electronics II (2-1½).

Resonance ; coupled circuits ; filters ; power supplies. AF and RF voltage and power amplifiers ; Oscillators ; Modulation and demodulation, mixers. Magnetic and dielectric amplifiers.

(For Electrical Engineers)

22. Electronics II (2-1½).

Same as Comm. 21.

(For Mechanical Engineers).

23. Mathematical methods in Electronic Engineering (2-1).

Matrices and determinants ; Complex variable ; Special functions ; Vector calculus Tensor Analysis ; Wave equations ; Transformation calculus including Fourier transform. Elements of probability theory.

24. Networks and Transmission lines (3-1½).

Loop and node analysis. Two terminal and Four terminal network parameters ; Equalisers and Filters. Fields and power flow in transmission lines. Wave equation. Constants of a transmission lines. AF and RF transmission lines.

25. Electronic Circuits (3-6).

Amplifiers-single and multistage, feedback, operational and tuned. RF and UHF Oscillators, and mixers. Pulse circuits, multivibrators, blocking oscillators, time base generators and counters; Logic circuits. Modulation and demodulation.

26. Industrial Electronics (2-1½).

Power rectifiers and supplies. Gas tubes. Phototubes ; Magnetic and Servo amplifiers. Induction and dielectric heating. Voltage stabilisers ; Transducers and instrumentation. Control Systems.

27. Drawing and Workshop Practice (1-3).

Electronic circuit drawing ; Component fabrication and assembly ; Electronic Workshop —Special methods ; treatment of materials, printed circuits, panel fabrication.

31. Electronics III (2-1½).

Pulse circuits, multivibrators, time base generators, and counters. Electronic instruments ; transducers and instrumentation. Electronic control ; RF heating. Elements of Analogue and Digital computer.

(For Electrical Engineers).

32. Network Theory (2-1).

Fourier and Laplace transform ; Network Topology. Generalised Loop and node analysis. Network functions. Two terminal & four terminal networks. Active networks ; Elements of synthesis.

33. EM waves and Radiation Systems (3-1½).

Maxwell's equation. Static and time varying fields. Wave equation, Plane waves, waveguides, resonantors. Radiation ; Typical Antennas, measurements. Ground wave propagation, propagation through ionosphere and troposphere.

34. Radio Engineering (2-3).

Generation and detection of AM, SSB, FM and PM Signals. Noise, Pulse modulation, Microwave generators ; Power amplifiers—h.f., TWT and klystron. Electro-acoustic-transducers ; recording and reproduction of sound ; Reverberation and room acoustics ; Ultrasonics.

35. Line and Radio Communication Engineering (3-1½).

Principles of telegraphy and telephony. VF and Carrier systems. Communication theory ; RF communication systems. Television. UHF and Microwave techniques. Microwave communication systems ; Radar including Aids to Navigation.

37A. Radar and Aids to Navigation (2-1½).

Long distance aids to Navigation, Radio Compass, direction finders. Middle and short distance navigation aids. Radar equation, range, resolution, accuracy, and data presentation ; Rader receiver, different types of Radar.

37B. Antenna and wave Propagation (2-1½).

Dipole and linear antenna. Antenna in the long, medium, short wave, and VHF ranges. Microwave antenna. Ground wave progation ; propagation of waves through ionosphere and troposphere.

37C. Network Design (2-1½).

Image parameter and Insertion loss filters ; Equalisers ; Delay lines ; Amplifier networks ; Feedback amplifiers ; Pulse amplifiers. Active filters.

37D. Acoustics (2-1½).

Vibration of strings, bars and membranes. Wave equation. Resonators. Analogy with other systems. Electro-acoustic transducers. Recording and reproduction of sound. Room acoustics. Ultrasonics.

37E. Servemochanism (2-1½).

Theory of servomechanism. servoelements, servoamplifiers. Servo systems including nonlinear controls. Various transducers and industrial instrumentation.

37F. Electronic Computers (2-1½).

Analogue Computers—operational amplifiers, function generators. Applications. Digital Computers—Switching theory, arithmetic units. Organisation and programming of computers.

37G. Line Communication (2-1½).

Manual and machine telegraphy. Manual and auto telephony. Design of switching circuits. Strowger system. Long distance VF and carrier telegraph and telephone systems.

GEOLOGY (Ge)

11. Geology for Metallurgists (2-2).

Introduction : Geology difined, Origin of the Earth—Interior of the Earth—Age of Earth. Formation of oceans and continents.

Definition of minerals and crystals and scope of the science of crystallography.

Introduction to the morphology of crystals—face, edge, interfacial angle, forms, Axis—plane—centre of symmetry, crystallographic axes, parameters and indices, divisions into systems.

Systematic description of cubic, tetragonal, hexagonal, orthorhombic, monoclinic and triclinic systems.

Twinning, isomorphism.

Distribution of rocks in the crust of the Earth—Igneous, sedimentary and metamorphic rocks—origin of these above rock types.

Minerals—Rock forming and economic minerals.

Ore—Ore minerals, gangue minerals, simple and complex ores. Non-metallic minerals, mineral fuels.

Processes of formation of mineral deposits. Examples of mineral deposits formed by the different processes.

Textures and structures of ore deposits.

Important mineral deposits in India : Gold Copper, Aluminium, Iron, Magnanese, Coal, Mica, Chromium, Lead-zinc, Silver, Asbestos, Refractory minerals, Minerals used as flux.

Important geological formations in India, with their associated economic minerals of importance to metallurgists.

Development of mineral industry in the I, II & III five year plans. Elementary idea about prospecting of ores and minerals.

Laboratory :

Identification of the different crystals belonging to different systems with their systematic description.

Description and identification of rock-forming mineral. Description and identification of ore-forming minerals. Introduction to the study of geologic maps and sections.

21. Geology (1-2).

Minerals and their properties. Igneous, sedimentary and metamorphic rocks and the processes involved in their formation. Earthquakes, Origin, interior and age of the Earth. Geological structures. Historical geology. Engineering aspects of Geology and Geophysics.

(For Civil Engineers).

HUMANITIES AND SOCIAL SCIENCES (Hu)

11. Economics / English (2-0).

Economics

1. Economics and Technology—Cost, Utility, and Excellence—Human Factor—Economy study of a project—Selections—Impact of Engineering on Economics and vice versa.

2. Economic Problems—Economics and Human Behaviour—Exchange, Scarcity, Choice.

3. Economic systems—Industrial Revolution—Factory Systems—Capitalism, Socialism.

4. National output and Income and its distribution.

5. Organisation of Production—Division of Labour—use of machinery—Location—Economic, Social and Strategic Considerations in Industrial Location.

6. Forms of Business Organisation—The Corporate Sector.

7. Scale of Production—Economies and Diseconomies of Large and Small Scale Production—External and internal economies—Laws of Return—Diminishing, Increasing and Constant Returns—scale of production—Economies of increased dimensions and linked process.

8. Size of a unit—Factors determining size—optimum size.

9. Integration—Motives of Integration—Methods of Integration—Direction of Growth —Integration and Social interest.

10. Value, Depreciation, Depletion and allied problems.

11. Pricing of Commodities—Perfect markets—Imperfect competition—monopoly and oligopoly.

12. Factor pricing—wage determination.

13. Problem of money and Foreign Exchange.

14. Banking, Central, Commercial, and investment.

15. Economic activities of Government.

16. Economic Planning.

English

The object of the course in English is to teach students how to express their ideas in good, simple and correct English and to help them develop a taste for literature. The students will be taught suitable English texts.

21. Psychology & Economics of Industrial Labour (2-0).

The course gives the basic ideas about human behaviour which forms the basis for the application of psychological factors underlying human efficiency in industry.

Psychology

1. General Psychology : Development of experimental psychology. Motivation : general characteristics, biogenic and Sociogenic emotions : their nature and physiological changes. Perception : its nature : illusions. Learning—types and principles. Remembering and its characteristics. A general idea about Personality, and its measurement.

2. Industrial Psychology—General principles of group behaviour study of human factor in industry. Human and social problems and industrialisation.

Economics of Industrial Labour

1. Industrial Labour in India—Its Distribution.

2. Efficiency of Labour—Responsibility of Employers.

3. Recruitment, Training etc.

4. Methods of Wage Payment and Incentive Schemes—Bonus—Profit sharing—Cost of Living. Sliding Scale. Wage and Labour Policy of Government of India.

5. Scientific System of Wage Payment—Payment by results.

6-7. Factory and Labour Legislation.

8. Trade Unionism and Collective Bargaining—Prospects of Collective Bargaining.

9. Industrial Peace.

10. Industrial Welfare.

11. Social Legislation—Minimum Wages—Provident Fund Scheme—Health and Unemployment Insurance—Social Security and Social Insurance.

12. Labour Administration in India.

31. Industrial Psychology and English (2-0).

Industrial Psychology

Industrial fatigue and monotony : causation and remedies.

Personnel selection : Interviewing and psychological tests.

Industrial training : its benefits and principles.

Merit-rating.

Wage and Incentives.

Maladjustment—absenteeism and labour turnover—maladjusted worker.

Human relations in industry—its principles and practices in relation to morale and productivity—industrial conflict. Leadership and supervision in Industry.

English :

The object of the course is to teach students how to express their ideas in good, simple and correct English and to help them develop a taste for literature and also to help them acquire proficiency in report writing. Suitable text books will be used.

32. Problems of Philosophy (1-0).

Students will be broadly acquainted with the main philosophical problems that have engaged the attention of thinkers at all times. In course of the discussion of these problems, reference will be made to both thinkers and systems from the East and the West.

1. The problem of Appearance and Reality—views of early Greek thinkers, especially Plato and Aristotle. Approach of the Empiricists and Rationalists—Locke, Berkeley, Hume, Descartes, Spinoza and Leibniz.

   The problem of Appearance and Reality in Indian Philosophy—the Upanishads, Buddhism, Nyaya, Samkhya and Vedanta.

2. The nature of "Good"—postulates of morality-ethical standards—Hedonism of Mill, Rigorism of Kant and Perfectionism of the Idealists. The problem of Evil in Indian thought—Buddhism, Samkhya, Vedanta, Tagore, Gandhi.

3. The problem of Knowledge-Nature, source and validity of Knowledge-Plato and Aristotle-Empiricists and Rationalists, Nyaya and Vedanta. Philosophical Analysis and Logical Positivism.

4. Some contemporary trends in Philosophy-Evolutionism of Bergson, Scientific Philosophy of Whitehead, Existentialism, Dialectical Materialism, Marx-Engels-Lenin.

5. Types of Modern Indian Philosophy—Practical Vedanta of Vivekananda, Personalism of Tagore, Ethical Idealism of Gandhi, Integral Idealism of Aurobindo.

MATHEMATICS (Ma)

11. Mathematics—I (2-0).

Infinite series, convergence tests ; absolute and conditional convergence, uniform convergence, differentiation and integration of a series, Tayler's series, Maclaurin's series, Fourier series, solution of ordinary differential equations with constant coefficients ; partial differentiation. Taylor series, Maxima and Minima of two variables.

Basic ideas of three dimensional geometry ; straight lines ; general conicoid with special reference to sphere, ellipsoid and cone ; multiple integration and line integration.

Vector analysis ; differentiation of a vector ; gradient, divergence, curl and orthogonal curvilinear co-ordinates ; Stokes' theorem, Green's theorem ; Laplacian operator ; use of the vectors in fluid mechanics, heat flow, and electricity and magnetism.

12. Mechanics (3-3). First Term.

Fundamentals of Mechanics. Equilibrium of Force systems and engineering applications. Principle of virtual work. Kinematics and Dynamics of a particle and of a rigid body and application to engineering structures and machines. Work and energy methods. Impulse and momentum.

(For Engineering Scientists).

16. Fluid Mechanics—I (2-1). First and Second Terms.

Fluid Statics : Properties of fluids, pressure theorems, laws of equilibrium of floatation.

Fluid Dynamics : laws of fluid motion, Bernulli's equation, vertex motion.

Viscous fluids : Navier—stokes equations, geometrical and dynamical similarity, Boundary layers ; Turbulence.

21. Mathematics—II (2-0).

Matrix algebra, method of inversion of a matrix ; characteristic equation. Cayley Hamilton theorem, Eigen values, Sylvester's theorem ; application of matrix algebra.

Complex variable, general function of a complex variable, derivative and Cauchy-Rieman conditions, line integral of a complex function, Cauchy's integral formula, Taylor's series, Laurant series, Cauchy's Residue theorem, conformal transformation and its applications in hydrodynamics and electrastatics.

Partial differential equation—parabolic, elliptic and hyperbolic, discussion of the boundary and initial conditions required for the unique determination of their solution, examples ; Vibration of strings ; vibration of a rectangular and circular membrane. Two dimensional steady flow of heat, one dimensional unsteady flow of heat ; calculus of variations ; Hamilton's principle and Lagrange equation solution of transcendental and polynomial equation ; Newton and Raphson method ; interpolation and extrapolation formulae for forward, backward and central differences, numerical solution of ordinary differential equation.

(For Engineering Scientists).

31. Mathematics—III (1-0).

Special functions—hypergeometric, Legendre, Bessel, elliptic and their applications. Transforms—Laplace, Fourier Mellon and their applications. Numerical solution of partial differential equations, some knowledge of digital computor and programing.

(For Engineering Scientists).

MECHANICAL ENGINEERING (ME)

11. Drawing, Design and Graphics—I (2-3).

Graphic statics, geometrical curves and their applications. Dimensioning of machine parts. Design and drawing of simple machine elements. Graphical solutions of kinematic problems. Blue print reading and freehand sketching.

(For Engineering Scientists during Second and Third terms and for ChE, Comm and Met during the Second term only)

12. Mechanics, Strength of Materials and Structural Mechanics (3-3) Second Term.

Introduction to mechanics of materials ; members under axial loads, thermal stresses, thin cylinders and indeterminate problems of axial loads. Elements of principal stresses. Bending moment and shear force diagrams. Stresses and deflections of straight uniform beams. Torsion of circular bars.

(For Engineering Scientists).

13. Heat Technology (2-1).

Engineering system of metric units.

Application of First and Second laws of thermodynamics to closed systems and steady flow systems encountered in Heat technology and related engineering problems. Methods of representing property relations for pure substances. Use of steam tables and Mollier chart. Ideal thermodynamic vapour cycles.

Introduction to steam power generating equipment.

Properties of gases and gaseous mixtures.

Ideal thermodynamic cycles for internal combustion engines.

Introduction to internal combustion engines and gas turbines.

(For Engineering Scientists and Chemical Engineers).

14. Manufacturing Science and Practice—I (1-3).

Manufacturing processes : foundry, welding, machining ; hot and cold working. Metrology.

A practical course on the above.

(For Engineering Scientists and Communication Engineers).

15. Mechanics of Machines and Machine Elements (1-2).

Definitions, types and forms of mechanisms, machines and their inversions. Static and dynamic force analysis in simple machines. Friction. Geometry of cams and gears. Gear trains, flywheels and governors.

Strength of materials under different loadings. Castings. Temporary and permanent fastenings. Axles and shafts. Springs. Gears. Couplings and clutches. Lubrication and bearings.

(For Communication Engineers)

16. Machine Elements Design (2-3). Third Term.

Principles and design of castings, pin joints, rivetted and welded joints, press fits, screwed fastenings, thin cylinders, beams, shafts, couplings, keys, springs, bearings and members subjected to direct and eccentric thrust loads.

(For Chemical, Communication and Metallurgical Engineers)

17. Manufacturing Practice (0-3).

Practical course as in 14.

(For Chemical and Metallurgical Engineers).

18. Applied Mechanics (0-3). Fourth Term.

Practical work in Material Testing Laboratory and Instrumentation and Control Laboratory.

(For Engineering Scientists, and Chemical, Communication and Metallurgical Engineers)

18a. Theory of Machines and Mechanisms-I (0-6). Fourth Term.

Analysis and kinematics of plane mechanisms.

Mechanisms for intermittent motion.

Inertia forces in machine parts. Piston effort and crank effort diagrams ; bearing loads.

Introduction to the theory of lubrication and bearings.

Flywheels. Governors. Gear and gear trains. Cams.

19. Manufacturing Practice (0-12). Fourth Term.

Practical work in machine shop, press shop, welding shop and foundry to study the characteristics of machine tools, equipment, accessories, cutting tools and processes.

(For Engineering Scientists, and Chemical, Communication and Metallurgical Engineers)

21. Hydraulic Machines (2-1½).

Dynamic action of moving fluids.

Construction, operation and performance of impulse and reaction turbines: Pelton wheel, Francis turbine, Kaplan turbine and tubular turbine.

Dimensional analysis and principle of similitude applied to turbines. Specific speed of turbines.

Construction, operation and performance of positive displacement pumps: reciprocating pumps and rotary pumps.

Construction, operation and performance of rotodynamic pumps : centrifugal, mixed flow and axial flow pumps.

Dimensional analysis and principle of similitude applied to rotodynamic pumps. Specific speed of pumps.

Construction and operation of fluid coupling, torque converter and hydraulic dynamometer.

Cavitation in hydraulic machines.

Hydrostatic machines: accumulators, intensifiers, jacks, lifts and presses.

Oil hydraulic systems: oil pressure governors and control mechanisms; oil pressure circuits for machine tools.

22. Machine Design (1-3).

General manufacturing considerations of machine parts.

Design of machine parts subjected to friction, combined loads, dynamic loads and stress concentration.

Design of space mechanisms, flywheels, high speed rotors, thick cylinders, journal bearings and roller bearings.

Design of complete units of machines like drives, clutches, brakes and gear boxes.

(For Electrical and Mechanical Engineers)

23. Heat Power Technology-I (2-1½).

Heat transfer by conduction. Forced convection heat transfer without phase change. Introduction to heat transfer in condensing and boiling of pure substances. Heat transfer by radiation through non-absorbing medium between solids. Introduction to heat exchangers. Analysis of parallel flow and counter flow heat exchangers.

Steam generating equipment and accessories. Steam turbines and auxiliary equipment. Fuels for steam plants and introduction to combustion phenomena. Actual internal combustion engine cycles. Reciprocating internal combustion engines and auxiliaries, Performance and testing of internal combustion engines. Rating of fuels and lubricants.

24. Manufacturing Science and Practice-II (1-3).

Theory of metal cutting; design of cutting tools; developments in machining and welding. Applied plasticity. Programme controlled machine tools. A course of practice on the above.

25. Theory of Machines and Mechanisms-II (2-1).

Three dimensional kinematics and kinetics. Space mechanisms. Hooke's joint. Steering gears. Gyroscope and its applications. Balancing of rotating and reciprocating masses. Balancing of multi-cylinder in-line and radial engines.

Vibration of single degree of freedom systems. Transverse and torsional vibrations of shafts and rotors. Critical speeds.

26. Mechanics of Solids-I (2-1).

Plain stress and strain analysis and strain rosettes ; problems of combined bending, twisting and axial loading.

Statically indeterminate beams. Unsymmetrical bending of beams ; shear flow in beams. Bending of curved beams ; circumferential and radial stresses.

Thick walled cylinders and compound cylinders.

Rotating discs of uniform thickness. Strain energy under different kinds of loading. Energy methods for statically determinate and indeterminate probems.

28. Engineering Metallurgy (0-1⅓).

Experiments on rolling, yield point and ageing in metals ; cold working of metals and alloys ; quenching severity ; hardenability ; heat treatment of various steels; case carburizing.

Study of melting processes for cast irons, copper base and aluminium base alloys.

29. Prime Movers (2-3).

Reciprocating and rotary type internal combustion engines.

Water power engineering. Steam power generating equipment.

(For Electrical Engineers)

31. Industrial Management (2-0).

Development of production system and forms of ownership.

Evolution of management science.

Decision making for production system through economic, graphical, statistical and mathematical tools.

Design, operation and control of production systems covering product, organisation, work study, plant location, plant selection and layout, plant buildings, production planning and control, inventory control, quality control, plant maintenance, job evaluation, merit rating, wages and incentives. Cost control including budgetary control and depreciation studies.

(For Electrical, Communication, Mechanical and Metallurgical Engineers)

32. Metal Processing Laboratory (0-3)

A course of demonstration and experimetal investigation in the following :—

Metal cutting; study of cutting forces, temperature, wear and surface finish.

Metal forming ; sheet metal working, forging and rolling.

Machine tool testing.

33. Heat Power Technology-II (2-4).

Elements of gass dynamics. One dimensional flow. Aerofoil theory.

Cascade theory. Gas turbine cycles. Axial flow compressors. Centrifugal compressors. Combustion chambers. Gas turbine characteristics. Refrigeration cycles and equipment. Air conditioning principles and practice.

34. Instrumentation and Controls (2-1).

Mechanical transients. Instruments and instrumentation for measurement of mechanical quantities. Accuracy, precision, error and calibration. Introduction to dynamics of automatic controls.

35. Design Project (1-5).

A general design course based on topics covered in the earlier courses on drawing and design involving detailed design calculations, economy analysis and preparation of working drawings of complete machines such as water turbines, pumps, jacks, pulley blocks, winches, cranes, conveyors, presses and simple machine tools.

36. Production Engineering Project (1-5).

Design of production tooling ; jigs and fixtures, cams and layout for turret lathes and single spindle automatics. Plastic working tools. Limit gauges. Introduction to the design of a production system.

A course of project relating to the above.

37. Mechanics of solids-II (2-1).

Columns and beam-columns. Elements of beams-on-elastic-foundation.

Bending of thin circular plates.

Elements of three dimensional stresses. Theories of elastic failure.

Elements of theory of elasticity. Two dimensional problems in rectangular and polar co-ordinates.

Tersion of non-circular sections; analogies.

38. **Engineering Quality Control (Elective) (1-1).**

Basic concepts in statistical quality control. Theory of errors. Chance and assignable causes. Machine capability and its relation to dimensional tolerances.

Control charts :—$\bar{x}$-R charts, p-charts, c-charts, some special control charts.

Acceptance sampling :—single, double and multiple sampling plans. Elements of reliability engineering.

39. Applied Fluid Flow, Plasticity and Experimental Stress Analysis (Elective) (1-1).

Unsteady flow in one dimension ; steady flow in two dimensions.

General analytical relations for viscous flow.

Theory of hydrodynamic lubrication.

Elements of plasticity and experimental stress analysis.

METALLURGICAL ENGINEERING (MET)

11. Elements of Metallurgy (1-0).

Introduction : Indian mineral resources and metallurgical industries, location of ore bodies and extraction plants, economic importance of metallurgical industries.

Extractive Metallurgy : Preparation of the ore, elements of ore-dressing and ore beneficiation, principles involved in the different processes used in extraction, roasting, reducing, smelting, refining ; simple flowsheets for Fe, Steel, Cu Al, Zn and Mg. Familiarising the students with some typical names : checker works, tapping and tap holes, pitside, ingot and ingot molds, soaking pit, reheating furnaces, size of a rolling mill.

Physical Metallurgy (General) : Metallic bonds, different kinds of metallic crystals, solid solutions, substitutional and interstitial types. Grain formation in crystals, chill casting nucleation and growth. Electrical and magnetic properties of metals. Elastic and plastic properties of single and poly-crystalline solids, cold and hot working, grain-refinement. Binary alloys, equilibrium diagrms, complete solid solubility, partial solubility, complete immiscibility, intermetallic compounds, thermal analysis.

Physical metallurgy of Iron & Steel and non-ferrous metals : Iron-carbon equilibrium diagram, plain carbon steel, annealing and nomalising, T-T-T curve, metallography and properties of ordinary cast iron. Equilibrium diagrams of alloys like Cu-Zn, and Al-Cu, heat-treatment, properties and uses.

(For Chemical Engineers)

12. Properties of Materials (2-2).

Introductory course for SBT students in Engineering Science.

Space lattice, atomic arrangements in different space lattices, miller indices, crystal structure of some common metals. Solidification of some molten metals—dendritic freezing—structure of cast metals—grain refinement techniques. Study of binary equilibrium diagrams—types of solid solutions—property changes on alloying—study of some important binary systems like Fe-C, Cu-Zn, Cu-Sn, Cu-Ni, Al-Cu etc. Segregation—cored dendritic structures homogenizing anneal. Hume Rothary rules for formation of binary alloys. Elastic and plastic behaviour of single crystal of metals—stress-strain diagram, critical resolved shear stress for slipping and twinning, plastic deformation of polycrystalline metals, fiber texture and its importance ; annealing of cold worked metals. Fundamental principles of heattreatment of steels, annealing, normalising, hardening, tempering, T-T-T diagram, quenching media, microstructures and properties developed in different heat treatments.

(For Engineering Scientists)

13. General Metallurgy (2-1).

Introduction : Indian mineral resources and metallurgical industries, location of ore bodies and extraction plants, economic importance or metallurgical industries.

Extractive metallurgy : Preparation of the ore, elements of ore-dressing and ore beneficiation, principles involved in the different processes used in extraction, roasting, reducing, smelting, refining, simple flowsheets for Fe, Steel, Cu, Al, Zn and Mg. Familiarising the students with some typical names : checker works, tapping and tap holes, pitside, ingot and ingot molds, soaking pit, reheating furnaces, size of a rolling mill.

Physical Metallurgy (General) : Metallic bonds, different kinds of metallic crystals, solid solutions, substitutional and interstitial types. Grain formation in crystals, chill castings nucleation and growth. Electrical and magnetic properties of metals. Elastic and plastic properties of single and polycrystalline solids, cold and hot working, grain-refinement. Binary alloys equilibrium diagrams, complete solid solubility, partial solubility, complete immiscibility, intermetallic compounds, thermal analysis.

Physical Metallurgy of Iron & Steel and Non-Ferrous Metals : Iron-carbon equilibrium diagram, plain carbon steel, annealing and normalising, T-T-T curve, metallography and properties of ordinary cast iron. Equilibrium diagrams of alloys like Cu-Zn, Cu-Sn, Cu-Ni, and Al-Cu, heat treatment, properties and uses.

21. Refractories (1-0), First and Third terms, and (0-2) Second Term.

Refractories—different types, physico-chemical properties, resistance to erosion, high temperature, temperature variation, molten metal and slag, expansion, contraction, specific heat, porosity, permeability, thermal and electrical conductivity, preparation of refractory materials, their uses in the manufacture of firebricks, silica bricks, etc., refractory materials used in different types of metallurgical furnaces.

22. Extraction Metallurgy of Iron and Steel-I (2-1).

World production of Iron & Steel—India's share, role of Iron & Steel industry in the industrialisation of a country, raw material reserves—location and characteristics, preparation and beneficiation of raw materials, Iron blast furnace—general features and construction, smelting of ores in a blast furnace, critical appraisal of blast furnace reactions from the point of view of thermodynamics and kinetics of the process, charge and heat balance, preheating of blast, stoves and their operation. Blast furnace products, pig iron—different grades, slags—characteristics of indian pig iron and slags. Top gas—cleaning—ancillary equipment. Charge distribution at the top of the furnace—operating troubles associated with improper distribution of charge. Modern trends in blast furnace practice—oxygen enrichment, humidification and refrigeration of blast, fuel injection, high top pressure operation, unconventional methos of iron production, rotary kiln, low shaft furnaces. Manufacture of ferromanganese in blast furnace, production of other ferroalloys. Elements of blast furnace design.

23. Foundry Metallurgy (2-3).

Pattern making, molding processes and molding materials, molding and coreblowing machines, molding sands and clays, testing of sands, coremaking and testing of core sands, solidification of metals, pouring and feeding of castings ; metallurgy of gray iron—inoculation of gray irons, heat treatment, alloy gray irons. Malleable iron—metallurgy—production techniques. Nodular iron—manufacture, properties, heat treatment and uses ; melting of cast irons in cupola, air furnaces, electric arc furnaces, details of cupola operation and control. Gases in non-ferrous metals and degassification, melting furnaces for non-ferrous metals, melting techniques of some common non-ferrous metals and alloys.

24. Physical Metallurgy-I (2-3).

Atomic structure of metals and nature of metallic bonds, crystal structure of metals, indices for planes and directions, polymorphism, grain formation and importance of grain boundaries, thermodynamical considerations of liquid-solid, solid-solid transformations. Solid solutions, types, alloys, factors influencing solubility, thermodynamical conditions of equilibrium in alloys, mode of freezing of alloys, structure of alloys, solid state transformations, atomic migration in the solid state, diffusion, homogenisation, precipitation from supersaturated solutions, order-disorder changes, ternary diagrams—construction and interpretation—application to important industrial alloys. Metallurgical microscope and metallograph, pyrometry—principles and different types of pyrometres, their uses.

25. Mechanical Metallurgy—I (2-3).

Deformation and strength of single crystals and polycrystalline metals, theory of dislocations, Frank-Read sources, slip and twinning in FCC, BCC, HCP crystals, work hardening, yield point and precipitation hardening, Different methods of testing, scope, purpose, significance of tests, destructive and non-destructive testing.

26. Non-ferrous Metallurgy (2-1).

Importance and scope of non-ferrous metallurgy, non-ferrous metallurgy in India, —present and future, study of the different processes of extraction of non-ferrous metals—(*a*) pyrometallurgy, (*b*) hydrometallurgy, (*c*) electrometallurgy. General theoretical considerations —free energy of formation, freeenergy-temperature chart, activity and chemical potential, correlation of mode of occurance, reactivity, and the electrode potential series, study of unit processes and its importance in pyrometallurgy, roasting, sintering, fluidised bed roasting, direct and indirect smelting, smelting furnaces, slagging, converting, refining techniques, liquation, distillation, sublimation, catalytic distillation, Mond's process, metals to be studied,—Cu, Pb, Zn, Al, Ni, Sn, Mn, Ag, Au and refractory metals. Metallurgical calculations related to different processes, chief physical, mechanical, chemical properties as well as the uses of the above metals and alloys. Chlorine metallurgy, reclamation of secondary metals.

27. Metallurgical Thermodynamics and Chemical Kinetics (2-1).

Laws of thermodynamics, Maxwell relations—applications, thermal capacity of gases and solids, Hess's law, use of standard tables, free energy and thermodynamic potential, condition of equilibrium, chemical equilibrium, equilibrium constants of homogeneous and heterogeneous systems, use of standard tables of thermodynamic functions. Solutions, dilute solutions, derivation of Raoult's law, deviations, concentrated solutions, concept of activity, activity coefficient, partial molar free energies, choice of standard state, electrolytic solutions, electrode potential, chemical and electrical energy, reference electrode, polarisation over-voltage, electrodeposition of metals and alloys. Phase rule—application to systems, adsorption and absorption, adsorption on surfaces, Gibb's equation, chemical kinetics, importance of the rate of nucleation, concept of activated state, order of reaction, applications.

28. Engineering Metallurgy (1-0).

Elements of dislocation theory and plastic working of metals yield point, strain-ageing and other related phenomena. Review of theories of rolling, calculation of rolling load and torque, applications. Hardenability, measurement, calculation from composition, quenching severity of cooling media, applications to heat treatment problems.

31. Extractive Metallurgy of Iron and Steel—II (2-1).

Growth of steel industry in the world—India's plans. General character of steel making processes. Pneumatic processes—Bessemer process, Thomas process, suitability and limitations of raw materials for each process ; modern trends—basic oxygen processes—L.D., O.L.P., Kaldo, Rotor etc., comparison from the point of view of raw materials, technology, and products. Fundamentals of design of converters. Acid and Basic open hearth processes, raw materials, technology and chemistry of the processes of oxidising heats, oxygen cycle—nature of product, steel and slag. Construction and general features of the furnaces—refractories, fuels, regenerators, gas supply systems, regenerative principle of heating, slag control. Recent developments in open hearth furnace technology. Electric process of making steel, principle of energy supply to the furnace, chemistry of the processes, alloy steel production by basic electric process. Deoxidation—theory and technology, gases in steel, casting techniques, recent trends.

32. Electrometallurgy and Corrosion (1-1).

Principle of extraction of metals and electroplating of metals and alloys, principle guiding the choice of different electrolytic baths, complexing and addition agents for electroplating baths, their effect on physical properties of electrodeposits, flow sheet of electrolytic extraction and refining of the following metals—Ca, Mg, Al, Cu, Zn, Ni, Pb, Mn, Ag, Au. Electroplating of Cu, Zn, Cd, Ni, Cr and alloys. Electrothermal process for reducing iron from its ore. Theories of corrosion, general principle of corrosion control, methods of corrosion prevention, inhibitors—their properties and functions. Oxidation of metals and alloys, principle behind developement of high temperature oxidation resisting materials. Corrosion testing, metal finishing, surface treatments.

33. Mechanical Metallurgy—II (1-0).

Working of metals, stress conditions governing the flow of metals in hot and cold working, work of deformation, characteristics and elements of the theories of various shaping operations—forging, rolling, extrusion, drawing ; relationship between the properties of metal and shaping processes. Metallurgical defects and difficulties encountered in metal forming, joining methods, welding, brazing and soldering.

34. Physical Metallurgy—II (2-3).

Free-energy and composition diagrams to illustrate phase transformations, kinetics of the process, driving force, application to Fe+C system, pearlitic, bainitic and martensitic transformations, isothermal transformation in steel, its applications, grain size, grain growth, overheated and burnt structure of steel. Hardening of steel, hardenability determination, uses and limitations, tempering of steels Special methods of heat treatment of steels, modern methods to strengthen the steel by heat treatment and plastic straining. Heat treatment of important non-ferrous alloys, theories of agehardening. Use of controlled atmosphere, case and surface hardening of steel.

35. Extractive Metallurgy Laboratory (0-3).

Experiments are designed to illustrate the principles involved in the extraction of metals—thermal decomposition of carbonates, oxides, sulphides etc., reduction oxides, C—CO—CO_2

reaction, chloridation metallurgy, matte-metal reaction, electrometallurgy experiments. The students are required to study the thermodynamics and kinetics of the reactions.

36. Applied X-Rays and Metal Physics (2-3).

X-Ray diffraction : Elements of crystallography, stereographic projection, generation of X-Rays, filters and monochromators, types of X-Ray tubes, diffraction of X-Rays—various methods and types of cameras used for powder method. Interpretation of diffraction patterns. Applications—lattice constants, phase boundaries, intensity of powder lines, retained austenite, stress measurements, broadening of diffraction lines—crystal size.

Industrial Radiography : Operation of X-Ray industrial unit—limitations and precautions. Use of Radiography and radiography with radioactive cobalt, comparison between their fields of applications.

Metal Physics : Structure of the atom, quantum numbers, exclusion principle, electronic configuration of important elements and its influence on the properties. Bonds, Hume Rohary rules and formation of alloys, uncertainity principle, electron theory of metals, electrical and thermal conductivity, magnetism, specific heat of metals. Elements of the following topics —internal friction, diffusion, radiation damage, electron microscopy and diffraction, metallurgy of the liquid state.

37. Materials Engineering and Powder Metallurgy (1-0).

Materials for heavy structures, tools, materials for electrical industries—magnets, resistance elements, electrical contacts etc., powder metallurgy.

38. Seminar (Works visit, vacational training etc.) (0-1).

39. Project (0-6).

39A. Advanced Metallurgy of Alloy Steel (2-2).

Detailed study of important low, medium, high alloy steel manufacture, fabrication, heat treatment, constitution, metallography, selection and application. Austenitic transformation by nucleation, growth and other mechanisms, application of stress to austenitic steels and their effects on Ms, hardenability, and its determination.

39B. Furnace Technology (2-2).

Heat transfer as a thermodynamic problem—laws of heat transfer—conduction—convection—radiation—general laws. Non-luminous and luminous radiation, heat transfer in furnace chamber, thermodynamics of furnace heating. Fluid flow, aerodynamics of hot systems, factors governing the total quantity of gas flowing in the circuit, fundamental principles, sources of aeromotive force, buoyancy, fans, ejectors, chimneys. Theory of heating and cooling of soilds. Furnace construction, principles of walls and crown construction furnace roofs, catenary arch, expansion stresses in arches and suspended roofs. Speed of combustion and rate of heat release, gas flow pattern, path of a jet speed of mixing of two streams, speed of entrainment of the surrounding fluid by a jet. Calculation of regenerator, recuperator, reheating furnace, open hearth furnace, burner calculations.

39C. Advanced Foundry Metallurgy (2-2).

Advanced study of the topics covered under Met 23.

39D. Metallurgy of Atomic Energy Metals (2+2).

Physical and extraction metallurgy of metals and alloys used in Atomic Energy generation, niobium, plutonium, thorium, uranium, etc., discussion of the metallurgical processes of fabrication and handling techniques of these metals and their alloys, metallurgy of liquid metals and radiation damage.

PHYSICS AND METEOROLOGY—(Ph)

11. Properties of Materials—I (2-2).

Basic concepts of fundamental physical quantities ; structure of atom, brief discussion of quantum number and Pauli principle ; atomic aggregates-elementary discussion of statistical mechanics ; nature of chemical bonds ; crystal lattice and lattice energy ; role of imperfections in solids ; structure and essential physical properties of some common materials e.g., metals, glass, high-polymers etc.; atomic theory of elasticity ; lattice vibration and elastic waves ; thermal properties of solids ; theory of sp. heat, elements of emission and absorption spectra including X-ray, optical properties of solids.

(For Engineering Scientists).

12. Physics—(2-1).

Elements of atomic physics ; Spectroscopy and nuclear physics.

Introduction to statistical mechanics and quantum mechanics.

X-Rays and electron diffraction and structure of matter.

(For Communication Engineers).

13. Material Science—(1-0).

Atomic structure of matter—nuclei and electrons, electronic configuration of elements ; atomic aggregates, nature of chemical bonds, different kinds of crystal structure ; absorption and emission spectra including X-rays ; X-ray diffraction and its application; mechanical properties of solids—elasticity and plasticity, role of imperfections in solids ; dual aspect of matter and radiation, matter waves, quantization ; free electron theory of metals, energy bands in solids, electrical conduction in metals and semiconductors ; electrical properties of metals, semiconductors and dielectrics ; brief review of surface properties of defect solids ; selected topics in Physics—diffusion, paramagnetic resonance, ultrasonics etc.

(For Metallurgical Engineers)

14. Material Science—(1-0).

Same as Ph 13 for Chemical Engineers.

21. Properties of materials—II (2-0).

Selected topics in physics having application in the study of materials, ultrasonics, interferometry, radio-activity and tracer technique, X-ray diffraction and radiography, electron diffraction and electron microscopy etc. ; discussion of the nature of radiation and matter—quantum theory of radiation, dual aspect of matter and matter waves ; Schrodinger equation.

(For Electrical Engineers).

22. Properties of Materials—II (1-0).

Same as Ph. 21 for Civil Engineers with reduced number of hours.

23. Material Science—(3-0).

Bonding forces ; crystal structure, elastic and thermal properties ; free electron theory of metals ; band theory of solids. Electrical, magnetic and optical properties of solids. Selected topics of solid state physics.

(For Communication Engineers)

31. Properties of materials—III (1-1).

A brief discussion of energy-bands of solids and their relation to physical properties ; electrical and magnetic properties of conductors and semiconductors ; selected topics in physics —dielectrics, radiation damage etc.

(For Civil Engineers).

32. Semiconductors and Plasma Physics—(2-0).

Intrinsic and impurity semiconductors, junctions, rectification, transistors. Photoelectric, galvanomagnetic, thermoelectric and acoustoelectric devices—their fabrication. Quantum Electronics, elements of pasma physics and their important applications.

(For Communication Engineers).

33. Solid State and Nuclear Physics (2-0).

Wave mechanics and basic electronic processes in matter. F-D statistics and its applications. Band theory and its consequences. Electrical conductivity and magnetoresistivity of metals and semi-conductors. Elements of solid state and gas plasma. Advanced concepts of electrical and magnetic susceptibilities. Advanced ideas of ferromagnetism and ferroelectricity.

Review of theories of nuclear structure. Fusion and Fission processes. Slowing down of neutrons. Age theory. Pile equations and critical pile dimensions. Description of typical reactors. Radiation hazards and shielding materials for reactor construction.

(For Electrical Engineers).

SCHEDULE X

REGULATION NO. 16

Optional Subjects

(For Undergraduate Students)

A student may study, in the fourth and fifth sessions of the five-year, five-and-a-half-year and six-year B.Tech. degree courses, and five-and-a-half-year B.Arch. degree course, and in the second and third sessions of the Special three-year courses for the B.Tech. degree, an optional subject of his choice in consultation with his Department. A list of optional subjects is given in this Schedule. The departments will announce at the close of each academic session the optional subjects to be offered from out of the list during the following academic session.

All subjects under this Schedule carry a load of (2-0).

AgE. A. 41. Horticulture.

A course on flower and vegetable gardening, including ornamental plants suitable for avenues and gardens in India. Techniques for their successful culture: methods of raising seedlings and vegetative propagation of plants like cutting, grafting, etc. : making beds, pits and layout of gardens ; manuring and watering. Structure and functions of plant organs. Methods of breeding. Plant disease control. Storage of seeds and bulbs.

AgE. A 42. Soil Conservation.

Soil formation and classification, physical properties, soil fertility, causes of soil damage and depletion, erosion by water runoff and wind. Benefits of soil conservation, land use concept, vegetative and mechanical controls, terracing, contour practices, control of small water courses, and role of vegetation in conservation, pastures and forest. Water conservation, ponds, tanks, small earth dams, ground water recharging, drainage, irrigation, up stream flood control, conservation planning, and soil conservation organizations.

AgE. A 43. Irrigation and Drainage.

Soil profile, formation, classification and survey. Physical properties of soil, soil moisture. Irrigated soil problems, control and management. Soil, plant and water relationship. Water requirements of crops. Reclamation of saline and alkaline soils. Movement of water in soils. Lift irrigation. Measurement of irrigation water. Land preparation and methods of application. Consumption of water. Farm Drainage.

AgE. A 44. Farm Machinery.

The role of machinery and equipment in agriculture. Agricultural output by hand *vs.* mechanical methods. Tillage machinery, ploughs, harrows, disks and rollers ; seeding machinery, cultivators, harvesters and threshers. Special machinery for preparing fodder, grinding, fertilizer distribution, earth moving, and dairy farming. Selection, care and maintenance of machinery. Calculation of machinery capacity and costs.

Ar. A 41. Architecture and Town Planning.

Western and Indian history of architecture. Elements of composition, accommodation and circulation. Balance and proposition. Function. Harmony and contrast. Outlines of the history of town planning. Town planning practice.

Ch. A 41. Soil Chemistry.

General composition of the soils. Origin of soils ; ionic exchange in soils ; soil acidity and lime practice, soil alkalinity, artificial treatment of soil, chemical analysis of soil and its significance. Soil classification—chemical aspects of soil fertility, soil conservation.

Ch. A 42. Advanced Nuclear Chemistry.

Detailed study of measurements of radioactivity and radiations, health physics, more detailed study of techniques for investigating radio nuclides, further study in use of tracers in scientific and industrial problems, radiocarbon as tracer, geo-and cosmo-chronology.

Nature and theories of nuclear reactions—energetics—cross section—nuclear spins and moments—reaction at very high energies—Fission—theories of fission—spontaneous fission—nuclear states—nature of different radioactive processes—artificial radioactivity—new elements and their properties.

Nuclear reactors—elementary theory of reactors—types of reactors and their use—use of nuclear energy in war and peace—nuclear energy in India—energy production in stars—Genesis of elements.

ChE-A-51. Fuel Engineering.

(Except for Mechanical and Mining Engineers).

Coal : Nature, resources and classification. Beneficiation, storage. Carbonisation, modern coke ovens. Gasification, gas producers, material and energy balance, efficiency in gasification processes.

Liquid Fuels : Classification. Petroleum refinery operations, properties of petroleum products. Synthetic liquid fuels.

Combustion : Principles of combustion, flames, explosion and detonation. Appliances for combustion of fuels, performance factors and estimates. Combustion calculations, design performance and heat balance.

ChE-A-52. Transport Phenomena.

The course covers a unified physical treatment of processes with particular emphasis on the formulation and solution of typical boundary value problems, associated with energy, mass & momentum transport.

ChE-A-53. Chemical Machineries.

Introduction to Chemical Engineering and Elementary treatment of Unit Operations. Chemical machineries involved in fluid flow, heat transfer, evaporation, distillation, gas absorption, drying, filtration, size reduction and separation, extraction etc.

CE. A 41. Theory of Structures.

Moving loads and influence lines for simply supported beams and girders, continuous beams, Deflection of framed structures, Williot Mohr's diagram. Castigliano's theorems, redundant frames, Design of rivetted and welded joints under eccentric loading, columns and built up beams. Design of rivetted and welded trusses, plate girder bridges, Theory and design of simple reinforced concrete structures. General principles of soil mechanics. Stability of slopes and retaining walls, consolidation and settlement. Design of footings, rafts and pile foundations, Drainage and deep excavation work.

CE. A 42. Surveying.

Curves (plain and transition), Geodetic Surveying, base line measurements and triangulation, precise and trigonometrical levelling, field of astronomy. Determination of azimuth and altitude and meridian.

Comm. A 41. Basic Electronics.

Properties of resonant circuits ; four terminal network ; filters and attenuators ; amplifiers—class A, class B, class C ; simple A. F. and R. F. amplifiers, feedback in amplifiers ; oscillators ; principles of modulation and demulation ; single phase rectifiers ; electronic measurements ; photocell ; gas tubes and their simple applications ; elements of electronics in industry.

Hu. A41. Elementary French.

Basis and essentials of French language : graduated course to cover pronunciation and elements of grammar, reading of varied matter, literary and scientific, to lay the foundation and vocabulary for facilitating further independent reading of scientific journals and writings. Practice in hearing and speaking French may be supplemented by audio-visual devices, (French records, pictures, etc.).

Hu. A 42. Elementary German.

Basis and essentials of German language : graduated course to cover pronunciation and elements of grammar, reading of varied matter, literary and scientific, to lay the foundation and vocabulary for facilitating further independent reading of scientific journals and writings. Practice in hearing and speaking German may be supplemented by audio-visual devices. (German records, pictures, etc.).

HU. A 43. Elementary Russian.

Basis and essentials of Russian language : graduated course to cover pronunciation and elements of grammar, reading of varied matter, literary and scientific, to lay the foundation and vocbulary for facilitating further independent reading of scientific journals and writings. Practice in hearing and speaking Russian may be supplemented by audio-visual devices, (Russian records, pictures. etc.).

Hu. A 44. Elementary Hindi.

This course is intended to give instruction in the reading, writing, and speaking of simple Hindi, so that non-Hindi knowing people might have a working knowledge of Hindi.

Hu. A 45. Advanced Economics.

Section I—

1. Nature of an underdeveloped economy.

2. Keynesian Model and its extension with special reference to problems of underdeveloped countries.

(a) Theory of Employment—Classical Model—Keynesian Model—Model of 'Economic Growth' and employment problems under conditions of growth—specific employment problems of India.

(b) Consumption Functions—Keynes' Formulation of consumption Function—Its extension—consumption function and economic development—Multiplier—its operation in underdeveloped countries.

(c) Investment Functions—Keynes' Formulation of investment Function—its extension.

(d) Rate of interest—rate of interest and investment—rate of interest and employment.

Section II—

Theory of Economic Growth—basic principles—Land, Labour and Economic Growth—Capital and Economic Growth—Organisation and Economic Growth.

Economics of Planning : Basic principles—Planning in India—First Plan—Second Plan—Third Plan.

Hu. A 51. Advanced French.

This course is offered to students who have done their elementary course either at the Institute or elsewhere. Suitable text books will be used and more advanced exercises in writing and speaking the French language will be given. The aim of this course is to enable students to read and translate with ease and precision more advanced scientific journals and technical articles.

Hu. A 52. Advanced German.

This course is offered to students who have done their elementary course either at the Institute or elsewhere. Suitable text books will be used and more advanced exercises in writing and speaking the German language will be given. The aim of this course is to enable students to read and translate with ease and precision more advanced scientific journals and technical articles.

Hu. A 53. Advanced Russian

This course is offered to students who have done their elementary course either at the Institute or elsewhere. Suitable text books will be used and more advanced exercises in writing and speaking the Russian language will be given. The aim of this course is to enable students to read and translate with ease and precision more advanced scientific journals and technicalarticles.

HU. A 54. Advanced Hindi.

This course is intended to supplement the Elementary Hindi course and would be offered to non-Hindi speaking students who have done their elementary courses, either at the Institute or elesewhere. Suitable texts from the works of Tulsidas, Bharatendu Harischandra, Premchand, Nirala, Sumitranandan Pant etc., would be used and advanced exercises in writing and speaking the Hindi language will be given. Special emphasis will be laid on the essentials of Hindi grammar and composition and difficult vocabulary so that students may be able to read, speak, understand and translate with ease and precision literary, political and scientific articles.

Hu. A 56. Representative Men and Modern Age.

The purpose of this course is to acquaint the students with some leading personalities who have made significant contributions in the last one hundred and fifty years to the task of nation-building, to systems of ideas and to the general cause of humanism. This will help the students to evaluate some outstanding men and movements in recent history with special reference to India.

Discussions will centre round personalities like—Rammohun Roy, Iswarchandra Vidyasagar, Vivekananda, Dadabhai Naoroji, Govind Ranade, Tilak, Ghokhale, G. Subramania Aiyar, Surendra Nath Banerjee, Gandhi, Tagore, Karve, Nehru, Robert Owen, Marx, Bismarck, William Wilberforce, Jefferson, Lincoln, Lenin, Albert Schweitzer, etc.

HU. A 58. Special Area Studies in Psychology.

(i) Small group study, and (ii) Public opinion and mass communication.

This course is designed to acquaint students with the investigations on the effects of group on individual performance and influences operating upon his attitude and through group processes and methods of mass media of communication.

(i) Small group study : Orientation and methods of study. Theories of small group behaviour. Problem-solving group. Group goals, group cohesiveness and group locomotion. Structural properties of groups. Group composition and group effectiveness. Leadership. Changing behaviour in groups.

(ii) Public Opinion and Mass Communication : The nature of public opinion ; Public opinion and democroacy ; Measurement of public Opinion ; A general idea of Mass observation and Public Opinion Polls.

Changing public opinion : Public opinion and propaganda. Nature and Techniques of propaganda : political and commercial. Psychological Warfare.

Mass media of comunication—their role in changing public opinion.

Ma. A 41. Higher Mathematics.

Functions of a Complex variable : Elementary functions and their properties ; integration of complex functions ; Cauihy's Residue Theorem, Conformal Mapping. Matrices :

Definition, Sum, product and transpose. Application to linear equations. Partioned matrices in circuit problems. Operational calculus ; Fourier-Mellin transform and their essential properties. Applications to ordinary and partial differential equations. Special Functions ; Gamma, Beta, Legendre and Bessel's functions. Probability : Element of probability, theory of errors ; Normal, Binomial and Possion distribution.

Ma. A 42. Statistics I.

Probability : Occupancy and ordering problems, Addition and Multiplication theorems of probability, conditional probability, Binomial, Poisson and Normal distributions, Mathematical expectation, law of large numbers.

Statistics : Frequency distribution, moments and cumulants, correlation, regression and prediction, sampling distributions, tests of significance, analysis of variance and covariance, elements of sample surveys, preparation of statistical reports, time series analysis and interpretation of index numbers, concept of quality control in industry, sampling inspection schemes.

Ma. A 43. Statistics I.

Graphical and tabular representation of data. Theorems on probability and standard distributions, elements of sample surveys, preparation of statistical reports, time series anaysis, construction and use of index numbers.

Census and surveys, vital statistics and demography, methods of population projection. Estimation of parameter and tests of hypotheses. (For Architects).

Ma. A 44. Statistics I.

Probability and some standard probability distributions, empirical frequency distribution, 'Control' in experimentation, randomness, replication and local control in experimental designs, some common designs and associated analysis of variation, missing plot techniques, partial and multiple correlation and regression, analysis of counted data and non-parametric tests.

(For Agricultural Engineers).

Ma. A 52. Statistics II.

Theory of Inference : Estimation of Parameters by Maximum Likelihood and other methods, tests of Statistical Hypotheses, Non-Parametric-Tests, Analysis of variance. Multiple Regression and Correlation analysis. Design of Industrial Experiments. Probit analysis. Simple Stochastic Processes. Machine Interference problems. Elements of Operations Research. Monte Carlo Methods. Industrial Quality control : Control Charts, Single and Double Sampling Inspection Plans, Sampling Inspection by variables, Sequential Sampling Plans.

Ma. A 55. Hydrodynamics.

General theory of perfect fluids, Bernoulli's equation, Theory of potential motion, Conformal transformation, Discontinuous motion. Flow and Circulation theorems. Vortex motion. Gravity waves and related Hydraulic problems. Simple cases of motion in three-dimensions. Poiseuille flow. Boundary Layer theory.

Ma. A 56 Theory of Elasticity.

Analysis of stress and strain in two and three dimensions. Problems in plane stress and strain using Airy's stress function. Pure bending, torsion and flexure of cylindrical rod.

ME. A 41. Elements of Production Technology-I.

Machines and methods in manufacture : foundry engineering, machining and machine tools. Metrology. Plastic working of metals (cold and hot).

Welding engineering.

Auxiliary engineering processes.

(For Civil, Metallurgical and Mining Engineers)

ME. A 43. Prime Movers.

Reciprocating and rotary type internal combustion engines.

Water power engineering. Steam power generating equipment.

(For Civil and Communication Engineers)

ME. A 51. Elements of Production Technology-II.

(Pre-requisite ME. A 41).

Advanced study in manufacturing processes : jigs, fixtures, tools, gauges and dies.

Economics of manufacture.

ME. A 52. Elements of Industrial Engineering.

General description of a production system : ownership, major functions and management.

Decision making for production systems : problem areas and tools.

Design and operation of production systems : product, plant location, plant layout, work study and organisation. Control of production systems : production planning and control, inventory control, wages and incentives and cost control.

(For Agricultural and Civil Engineers and Naval Architects).

ME. A 54. Applied Elasticity.

Introduction to the theory of elasticity approach to stress problems as against the strength of materials approach.

Stress measurements by strain gauge, photoelastic and brittle coating methods.

(Except for Civil and Mechanical Engineers)

ME. A 55. Elements of Instruments and Controls

Theory of measurements, calibration and instrumentation. Instruments :—flow meters, thermometers, pyrometers, pressure indicators and recorders, strain gauges, deflectometers, speedometers, accelerometers and vibration instruments. Mechanical integraters and analysers. Control performances :—mechanical, hydraulic and pneumatic controls, automatic controls and speed regulators.

(For Agricultural, Civil and Mining Engineers and Naval Architects)

Met. A 41. Metallurgy I.

Iron and steel making, pitside practice, ingot defects and their remedy. Steel—low and medium alloy steels as are used in industry, their heat treatment. Important carbon and alloy tool steels : uses and heat treatment. Aluminium and its alloys, uses, heat treatment and properties.

Met. A 51. Metallurgy. II.

Plastic working of steel : hot and cold rolling, extrusion, drawing, etc. Advanced heat treatment of steel and non-ferrous engineering alloys.

Ph. A 41. Nuclear Physics.

Review of physical background especially important in Nuclear Physics. Charge, mass, radius, spin, nuclear moments and other static properties of nuclei. Fundamental particles. Problems of nuclear forces, binding energy. Different nuclear models. Radioactive transformations. Properties of neutrons. Origin of γ—rays. Transmutation, fission and fusion. Nuclear reactions. Artificial radioactivity. Description and use of counters, coincidence amplifiers, ionisation chambers, and the cyclotron. Biological effects of nuclar radiation and their prevention.

Ph. A 42. Thermodynamics and Statistical Mechanics.

First and second laws of thermodynamics. Equation of state. Thermodynamic potentials. Conditions of equilibrium and stability. Derivations of thermodynamic formulae. Gibb's phase rule, chemical equilibrium etc. Third law of thermodynamics, Production of low temperature. Entropy and probability. Boltzmann-Maxwell statistics, ideal gases, mean free-path, transport phenomenon. Fluctuations, Brownian movements. Equipartition law. Some more simple applications of Boltzmann distribution. Bose-Einstein and Fermi-Dirac statistics and their applications.

Ph. A 43. Elements of Quantum Mechanics.

Lagrangian and Hamiltonian mechanics. Hamilton-Jacobi's equation. Lorentz transformation : Lorentz contraction and time-dilatation : Elements of relativistic mechanics and mass energy relation.

Dual aspects of matter and radiation. Experimental basis of quantum mechanics. De Broglie's theory. Wave packets : uncertainty relations. Schrodinger wave equation. One dimensional problems : potential barrier. Oscillator, rotator and hydrogen problems. Angular momentum and spin. Elements of perturbation theory. Zeemann effect.

Many body problems : Symmetric and antisymmetric wave functions. Pauli principle: exchange degeneracy : Helium problems.

Elements of quantum theory of radiation : transition probabilities.

Ph. A 44. Applied X-rays.

Nature, production and properties of X-rays. Design and construction of modern X-ray tubes. Measurement of the intensity and wave length of X-rays. Scattering of X-rays. Introduction to X-ray spectroscopy and its technical applications. X-ray crystallography ; diffraction of X-rays by simple crystals and powders. Elements of crystal structure analysis. X-ray and X-ray radiography. Radiation hazards of protection measures. Scattering of X-rays by liquids, gases and glassy materials. Technical application of X-ray diffraction, determination of particle size and preferred orientation : stresses. Application of X-ray diffraction methods to phase diagrams. Order-disorder phenomena in alloys ; Lattice defects, etc.

Ph. A 45. Applied Spectroscopy.

Terms values, energy diagram, R-S coupling and j-j coupling. Discussion of the spectra of selected elements. X-ray spectra of elements. Techniques of Spectroscopy. Molecular spectra—their nature and origin, general discussion of results. Soectroscopic analysis—Absorption spectrometry. Raman effect and its applications. Elements of micro-wave and infra-red spectroscopy and their use.

Ph. A 46. High Vacuum Technique.

Fundamental considerations in vacuum technique : Equation of state ; molecular velocities ; transport phenomenon ; vacuum impedance, conductance and speed ; flow through short and long apertures ; duct and barriers ; pumping speeds of pumps and traps.

Elements of the vaccum systems : Different types of pumps and their speeds ; oil migration problems ; refrigerants ; characoal traps ; getters ; ultra high vacuum.

Vacuum measurements, materials and equipment : Vacuum gauges ; vacuum tanks, seals and gaskets, insulated seals, valves, protective devices.

Leak detections, instruments and techniques : Spart coils ; discharge tubes, rate of rise measurements, soap film method ; sealing substance outside and change of pressure ; commercial leak decectors ; technique of detecting leaks.

Technical applications : Sputtering, evaportion, etc. Properties of materials deposited in high vacuum.

Ph. A 47. Electro-magnetic Theory and Electron Optics.

Electromagnetic Theory : Maxwell's equation. Plane waves. Poynting's vector. Boundary conditions, reflection, refraction, absorption, skin effects.

Fourier analysis of plane waves. Group, phase and signal velocities.

Cylindrical and spherical waves.

Wave sources, retarded potentials, linear oscillator. Directional arrays. Guided waves.

Electron-Optics : Electrostatic and electromagnetic lenses ; field ploting and ray tracing ; focal lengths, aberrations. Application of electron optics.

PART III

REGULATIONS

Schedule of Courses, and Subjects of instruction for 3-year B.Sc. (Hons.) degree courses, and 2-year M.Sc. degree courses in Chemistry, Mathematics and Physics, and 5-year integrated B.Sc./M.Sc. degree courses in Applied Geology and Exploration Geophysics

SCHEDULE XI

REGULATION NO. 17

Admission to the First Year class of the Three-Year B.Sc. (Honours) Degree Course.

(a) Minimum Educational Qualifications.

Admission to the First Year class of the Three-Year B.Sc. (Hons.) Degree courses in Chemistry, in Mathematics and in Physics shall be open to any person who has passed or is expected to pass before the first July of the year of admission any one of the following examinations :

(i) Higher Secondary Examination of a recognised University or any of the recognised Boards of Secondary Education in the Scince stream with Chemistry, Mathematics and Physics as elective subjects.

(ii) Pre-University or Pre-Degree or University Entrance Examination of a recognised University or Board with Chemistry, Mathematics and Physics after passing the Matriculation or School Final or S.S.L.C. or High School or equivalent examination conducted by a recognised University or Board ;

(iii) Senior Cambridge or Indian School Certificate Examination with Elementary Mathematics and Additional Mathematics, Physics, and Chemistry as separate subjects ;

(iv) General Certificate Examination ('0' level) with Chemistry, Mathematics and Physics as separate subjects ;

(v) First Year Examination of the two-year Inter-Science or F.Sc. course of a recognised University or Board or Institute affiliated to a recognised University or Board with Chemistry, Mathematics and Physics as separate subjects ;

(vi) Jamia Higher Secondary (Three-Year course after VIII standard) with Chemistry, Mathematics and Physics as separate subjects ;

(vii) First Year Examination of the two-year course of the Joint Services Wing of the National Defence Academy with Chemistry, Mathematics and Physics as separate subjects, and

(viii) Army Higher Secondary Certificate Examination with Chemistry. Mathematics and Physics.

(b) Age limit.

To be eligible for admission to the First Year Class a candidate shall, on the 1st October of the year of admission, have completed 16 years of age.

(c) Standard of Physical Fitness.

A candidate seeking admission to the First Year Class must fulfil the prescribed standard of physical fitness as given below :

Height	1.5 m.		
Weight	41 kg.		
Chest Measurement	69 cm. (with satisfactory limit of expansion and contraction).		
Heart & Lungs	There should be no abnormality.		
Vision	Better eye		Worse eye
	6/9	or	6/9) Corrected
	6/6		6/12) with glass.
	Eyes shall be free from congenital or other diseases.		
Hearing	Normal.		

Good general health and build.	
Hernia, Hydrocele, Vericocele, Piles...	Presence of any of these is a temporary disqualification to be rectified at his own expense before joining.

Opinion of the Institute Medical Officer shall be final and there shall be no appeal.

SCHEDULE XII

REGULATION NO. 18

Method of admission to the First Year Class of the Three-Year B.Sc. (Honours) Degree Course.

1. Admission to the First Year Class of the Three-Year B.Sc. (Hons.) Degree course shall be made on the basis of the performance of the candidates in the qualifying examination as prescribed in Regulation No. 17 and on their being found medically fit by the Institute Medical Officer

2. Applications received by the Institute in response to advertisement shall be considered by an Admission Committee set up by the Senate for the purpose and selections be made on the basis of the standard as may be decided by the Senate from time to time.

SCHEDULE XIII

REGULATION NO. 19

Three-Year B.Sc. (Hons.) Degree Course and its duration.

1. The Institute shall provide Undergraduate courses leading to the Degree of Bachelor of Science (B.Sc.) with Honours in Chemistry, in Mathematics, and in Physics and in any other subject as the Senate may decide from time to time taking into consideration the accommodation and staff position and other facilities available.

2. The curriculum for the Degree of Bachelor of Science in the Subjects mentioned in para 1 shall extend over not less than three academic sessions each consisting of three terms.

SCHEDULE XIV

REGULATION NO. 20

Graduation Requirement—Three-Year B.Sc. (Hons.) Degree Course.

1. Every student for the Bachelor's Degree must, before entering on the curriculum, have complied with the admission requirements.

2. A student shall no be permitted to proceed to the next higher class unless he has fulfilled to the satisfaction of the Senate all requirements in respect of attendance and study and has passed the prescribed examinations.

3. A student shall not be permitted to take any of the examinations unless (i) he has been regular in attendance (a student shall be expected to be regular in attendance in all lectures, tutorials, laboratories, guided studies, drawing office, field work and workshop classes), and (ii) he has satisfied all class teachers that he has conducted himself well within and outside the class rooms and that he has been regular, diligent and methodical in studies and has independently and satisfactorily performed the home and sessional assignment and has regularly submitted these for teachers' scrutiny.

4. During the three years of study it shall be obligatory for all men students to participate in one of the units of the National Cadet Corps ; and for the women students and for those men students, who may not be upto the standard of physical fitness required in the National Cadet Corps, it shall be obligatory to participate in physical training.

5. Subjects of each examination shall be as given in Schedule XV. In each subject of examination there shall be written paper or papers and/or sessional assignments as prescribed in the Regulations. The sessional assignments may comprise tutorials, guided studies, laboratory and field work, workshop practice and drawing office work.

6. The marks allotted to each subject in the terminal as well as in the End-Sessional examinations shall be as prescribed in Schedule XV.

7. The Senate shall determine in respect of each subject of study the scope of the course and the relative proportion in each course of lectures and/or practical or laboratory work. The Senate shall also determine in respect of the several examinations leading to the Degree, the conditions for admission and the standard of examinations.

8. Special Senate instructions specifying the standard of examination shall be kept with the Registry to be made available only to the Senate and the Board of Examiners.

9. A student, who, does not comply with all the provisions of the Ordinances and Regulations for an Honours degree but has, in the opinion of the Senate, shown sufficient merit in his studies and examination may, on the special recommendation of the Senate, be admitted by the Board of Governors to the ordinary degree, the diploma being suitably inscribed to that effect.

10. A student shall be required to qualify in the first, Second and the Final Examinations within a maximum period of 4 years of study at the Institute.

11. If a student fails in an examination and is permitted to repeat the course his marks shall be as may be secured by him when he repeats the course.

12. The Senate shall be competent on the recommendation of the Board of Examiners to deviate from the prescribed Ordinances and Regulations relating to the examination and consider the special cases of candidates not covered by the Ordinances and Regulations subject to approval of the Board of Governors.

13. Subject to the provisions of the Ordinances and Regulations the Degree of Bachelor of Science shall be conferred on students who have followed the prescribed curricula for not less than three academic sessions studying subjects set forth in the Regulations (Schedule XV) and who have reached the Honours standard in the Examinations in one of the following branches :

(i) Chemistry ; (ii) Mathematics ; (iii) Physics.

14. There shall be three complete examinations for the Degree of Bachelor of Science (B.Sc.) viz., (i) the First Examination, (ii) the Second Examination, and (iii) the Final Examination.

15. For each examination a Board of Examiners shall be constituted by the Senate and the Board of Examiners shall comprise the teachers in the subjects of examination and the additional examiner or examiners and other experts.

16. No student may present himself for examination in any subject until he has duly completed the prescribed course of instruction to the satisfaction of the teachers concerned.

17. The First Examination

(i) The First Examination shall be taken in three sections consisting of two Terminal examinations each covering the term's work and an End-sessional examination covering the entire course of the First Examination.

(ii) No student may present himself for the End-sessional Examination in any subject unless he has secured on the total of the two Terminal Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects and in each of the sessional assignments and in the practical examination.

(iii) A student shall be deemed to have passed the First Examination provided he has secured on the total of the two Terminal and the End-sessional Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects, in each of the sessional assignments, in the practical examination and in the aggregate.

18. The Second Examination

(i) No student may present himself for examination in any subject of the Second examination until he has passed the whole of the First Examination except those who have been granted admission direct to the Second year class and exempted from the First examination.

(ii) The Second Examination shall consist of two Terminal examinations each covering the term's work and an End-sessional examination covering the entire course of the Second examination.

(iii) No student may present himself for the End-sessional Examination in any subject unless he has secured on the total of the two Terminal Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects, in each of the sessional assignments and in the practical examination.

(iv) A student shall be deemed to have passed the Second Examination provided he has secured on the total of the two Terminal and the End-sessional Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects, in each of the sessional assignments, in the practical examination and in the aggregate.

19. The Final Examination

(i) No. student may present himself in any subject of the Final examination until he has passed the whole of the Second Examination.

(ii) The Final examination shall be taken in four sections comprising two Terminal examinations each covering the term's work and an End-sessional examination and a viva-voce examination.

(iii) No student may present himself for examination in any subject of the End-sessional examination and in the viva-voce examination unless he has secured on the total of the two Terminal examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects, in each of the sessional assignments and in the practical examination.

(iv) The End-sessional examination shall cover the entire course prescribed for the Final examination.

(v) A student shall be deemed to have passed the Final B.Sc. Examination if he has secured on the total of the two Terminal and the End-sessional Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects, in each of the sessional assignments, in the practical examination, in the viva-voce examination and in the aggregate.

20. The Maximum marks

The maximum marks for the First, Second and the Final examinations shall be the total of the maximum marks prescribed for the obligatory subjects of the respective End-sessional Examination *plus* fifty per cent of the total of the maximum marks prescribed for the obligatory subjects of both the Terminal Examination.

21. The Weighted Maximum Marks

(i) The weighted maximum marks for the First and the Second Examinations shall be the maximum marks of the First and the Second Examinations respectively.

(ii) The weighted maximum marks for the Final Examination shall be the maximum marks of the Final Examination *plus* fifty per cent of the weighted maximum marks of the First and the Second examinations.

22. A student passing in all the three examinations for the Degree of Bachelor of Science (B.Sc.) shall be declared to have passed with Honours in the appropriate branch on the basis of his overall performance in all the three examinations.

23. The students found eligible for the Honours Degree shall, in each branch, be classified in two groups to be denominated respectively First and Second Class on the basis of the weighted total marks they secure out of the prescribed weighted maximum marks of the Final examination. The names of the candidates in the First Class shall be arranged in order of merit and those in the Second Class in the alphabetical order.

24. The students satisfying all the conditions prescribed and having passed the prescribed examinations shall be entitled to receive the Degree of Bachelor of Science (B.Sc.) with Honours in the appropriate branch of study.

25. A student who has been admitted at a stage higher than the first year class may be allowed to graduate with First or Second Class Honours on the results of the complete examinations which he takes to the satisfaction of the Board of Examiners, on a criterion to be determined by the Senate. He will not, however, be ranked.

26. For the degree of Bachelor of Science with Honours in any branch as set forth above the graduate shall receive a Diploma wherein shall be set forth the branch of study in which he has obtained Honours and the Class in which he has been placed.

SCHEDULE XV

REGULATION No. 21

Schedule of Courses and Distribution of Marks

Three-Year B.Sc. (Hons.) degree courses in Chemistry, Mathematics and Physics

FIRST YEAR (Common for all courses)

Subject	No.	Subjects for the First Examination	First and Second Terms: Hours per Week		Marks	No. of papers for exam.	Duration of exam. papers	Third Term: Hours per Week		Marks	No. of papers for exam.	Duration of exam. papers
Hu	101	English	2	1	100— 50	1	2 hrs.	2	1	100— 50	1	3 hrs.
Hu	103	Principles of Government ...	1	0	50— 0	1	2 hrs.	1	0	50— 0	1	3 hrs.
Ch	101	Chemistry	4	1	200— 50	2	2 hrs. each	4	1	200— 50	2	3 hrs. each
Ch	102	Chemistry Lab. I	0	5	0—125	—	—	0	5	0—125	—	—
Ma	101	Mathematics I	6	2	300— 75	2	3 hrs. each	6	2	300— 75	2	3 hrs. each
Ph	101	Physics I	4	1	200— 50	2	2 hrs. each	4	1	200— 50	2	3 hrs. each
Ph	102	Physics Lab. II	0	5	0—125	—	—	0	5	0—125	—	—
†ME CE	101 101	Workshop and Drawing ...	0	3	0— 75	—	—	0	3	0— 75	—	—
		NCC or Physical Training ...	0	3	0—100	—	—	0	3	0—100	—	—
			17	21	850—650	8		17	21	850—650	8	

†ME 101 First and Second Terms.
CE 101 Third Term.

Duration of papers for end-sessional examinations shall be 3 hours.

SECOND YEAR

(Common for all courses)

Subject No.		Subjects for the Second Examination	All Terms		No. of papers for Exam.	Duration of Exam. paper
			Hours per Week	Marks		
Hu	201	English	1 1	50— 50	1	2 hrs
Hu	202	Logic	1 0	50— 0	1	2 hrs.
Ch	201	Chemistry II	6 0	300— 0	2	3 hrs. each
Ch	202	Chemistry Lab. II	0 6	0—125	—	—
Ma	201	Mathematics II	6 2	300—100	2	3 hrs. each
Ph	201	Physics II	6 0	300— 0	2	3 hrs. each
Ph	202	Physics Lab. II	0 6	0—125	—	—
		NCC or Physical Training	0 3	0—100	—	—
			20 18	1000—500	8	

THIRD YEAR

(i) For Chemistry Honours Course Students

Subject No.		Subjects for the Final Examination	All Terms		No. of papers for Exam.	Duration of Exam. papers
			Hours per Week	Marks		
Ch	303	Physical Chemistry	3 0	150— 0	1	3 hrs.
Ch	304	Organic Chemistry	3 0	150— 0	1	3 hrs.
Ch	305	Inorganic Chemistry	3 0	150— 0	1	3 hrs.
Ch	306	Industrial Chemistry	3 0	150— 0	1	3 hrs.
Ch	307	General and Analytical Chemistry	3 0	150— 0	1	3 hrs.
Ch	308	Chemistry—Lab.—III	0 15	0—450	—	—
		Elective (any one of the subjects for Mathematics or Physics Honours Course)	3 0	150— 0	1	3 hrs.
		Viva voce		0—100		
		NCC or Physical Training	0 2	0— 50		
			18 17	900—600	6	

THIRD YEAR

(ii) For Mathematics Honours Course Students

Subject No.		Subjects for the Final Examination	All Terms		No. of papers for Exam.	Duration of Exam. papers
			Hours per Week	Marks		
Ma	303	Analysis	3 0	150— 0	1	3 hrs.
Ma	304	Modern Algebra and Pure Geometry	3 0	150— 0	1	3 hrs.
Ma	305	Probability, Statistics and Computation	3 0	150— 0	1	3 hrs.
Ma	306	Astronomy and Rigid Dynamics	3 0	150— 0	1	3 hrs.
Ma	307	Statics and Hydrostatics	3 0	150— 0	1	3 hrs.
Ma	308	Special Functions and Differential Equations ...	3 0	150— 0	1	3 hrs.
Ma	309	Mathematical Computation—Practical and Sessional ...	0 10	0—300	—	—
		Elective (any one of the subjects for Chemistry or Physics Honours course)	3 0	150— 0	1	3 hrs.
		Viva voce		0—100	—	—
		NCC or Physical Training	0 2	0— 50	—	—
			21 12	1050—450	7	

(iii) For Physics Honours Course Students

Subject No.		Subjects for the Final Examination	All Terms		No. of papers for Exam.	Duration of Exam. papers
			Hours per Week	Marks		
Ph	303	Mechanics and Properties of Matter	3 0	150— 0	1	3 hrs.
Ph	304	Heat and Thermodynamics	3 0	150— 0	1	3 hrs.
Ph	305	Physical Optics	3 0	150— 0	1	3 hrs.
Ph	306	Electricity and Magnetism	3 0	150— 0	1	3 hrs.
Ph	307	Atomic Physics	3 0	150— 0	1	3 hrs.
Ph	308	Physics Lab. III	0 15	0—450	—	—
Ma	310	Mathematics III	3 0	150— 0	1	3 hrs.
		Viva voce		0—100	—	—
		NCC or Physical Training	0 2	0— 50	—	—
			18 17	900—600	6	

DISTRIBUTION OF MARKS

(For each Examination)

Three-Year B.Sc. (Honours) Degree Courses

Examination	First Term Marks	Second Term Marks	End-Sessional Marks	Maximum Marks	Weighted Maximum Marks
First ...	1,500	1,500	1,500	3,000	3,000
Second ...	1,500	1,500	1,500	3,000	3,000
Final ...	1,500	1,500	1,500	3,000	6,000

SCHEDULE XVI

REGULATION No. 22

Subjects of Instructions for Three-Year Bachelor of Science (B.Sc.) (Honours) degree course

CHEMISTRY (Ch)

101. Chemistry—I (4-1).

(A) PHYSICAL CHEMISTRY

Gaseous state : Ideal gas laws and the molar gas constant, kinetic theory of gases, specific heats of gases, deviations from ideal behaviour. Van der waals equation, molecular weight and thermal dissociation, critical phenomena, continuity of state, liquefaction of gases.

Solution : Definition of terms, characteristic features of different types of solutions including distillation of binary liquid mixtures, extraction, solubility curves and fractional crystallisation.

Colligative properties of dilute solution : Osmotic pressure, lowering of vapour pressure, elevation of boiling point and depression of freezing point, experimental determination of molecular weights of solutes, abnormal colligative properties.

Electrochemistry : Arrhenius's theory of electrolytic dissociation, degree of dissociation and Vant Hoff's factor, Faraday's laws of electrolysis and some important electrolytic processes.

Chemical equilibrium : Reversible reactions, Law of mass action and chemical equilibrium in homogeneous and heterogeneous systems, Le Chatelier's principle and its applications.

Elements of thermodynamics & thermochemistry : First law of thermodynamics, internal energy, heat content and heat capacity, heat of reactions, heat of solution, heat of neutralisation, Hess's law of constant heat summation, heat of reaction at constant pressure and constant volume, effect of temperature on heat of reaction (Kirchoff's law).

(B) ORGANIC CHEMISTRY

Introduction to organic chemistry. Purification of organic compounds (solids and liquids).

Qualitative and quantitative analysis of organic compounds. Determination of molecular weight, empirical and molecular formula of organic compounds.

Constitution and classification of organic compounds. Functional groups and homologous series. Nomenclature. Distinction between aliphatic and aromatic compounds.

Aliphatic hydrocarbons : Saturated, unsaturated and alicyclic hydrocarbons, introduction, their general methods of preparation, properties and uses. Isomerism. Petroleum industry.

Halogen derivatives of alkanes : General methods of preparation of alkyl halides. Preparation, properties and uses of methyl, ethyl and propyl halides. Chloroform and carbon tetrachloride ; dihalogen derivatives (general introduction).

Organic compounds containing only one functional group : General methods of preparation, constitution and properties of aliphatic alcohols, ethers, aldehydes, Ketones, carboxylic acids (fatty acids), and esters. Studies of simple individual members in each class.

(C) INORGANIC CHEMISTRY

Hydrogen ; Water ; hydrogen peroxide and ozone.

Inert gases (excluding details of separation).

Study of the chemistry of the following elements and their compounds on the basis of the periodic classification (Metallurgical and industrial processes, the true peroxides and the true peracids are to be excluded).

Elements of groups IA, IB, IIA and IIB, (excluding francium and radium), the halogens, oxygen, sulphur (excluding thionic acids).

(D) GENERAL CHEMISTRY

Elementary idea of the nuclear atom and fundamental particles ; cathode ray, electron and the ratio e/m (experimental method for its determination is excluded) X'ray, radioactive rays, electronic charge, indentification of the particle and the nuclear atom, atomic number, Moseley's work (elementary concepts only), isotopes and isobars, Mendeleef and Bohr's periodic table ; group displacement law.

Electrovalency, covalency, metallic bond, Van der Waals bond, coordination bond, partial ionic character of covalent bond, molecular dipole, electronegativity of elements, octet rule and deviation from the octet rule, elements of Werner's coordination theory ; double and complex salts ; ionic hydration.

The electron, Faraday's laws and Avogadro number, electronic theory of oxidation and reduction, relation between the equivalent weight and electrons both in acid-base and oxidation-reduction, chemical calculations.

Volumetric and gravimetric compositions of H_2O, NH_3, N_20, NO, SO_2, CO, CO_2, CH_4, C_2H_4 and C_2H_8 ; chemical calculations involving volume to volume and weight to volume conversions.

Acids, bases and amphoteric oxides—elementary concept of the theory of acids and bases.

Metals and nonmetals—electrochemical series.

102. Chemistry Lab.—I (0-5).

Physical : Determination of the density of a gas, determination of the value of equilibrium constant, determination of the heat of neutralisation of an acid by a base, determination of the solubility of a substance at different temperatures, determination of the boiling points of solvent and solutions, verification of Faraday's laws and determination of equivalent weight of a metal.

Organic : Detection of elements in organic compounds (Nitrogen, halogen, sulphur), determination of melting points and boiling points, crystallisation.

Inorganic : Analysis of mixtures containing not more than three radicals (basic or acidic or both) from the following :

(*a*) Acid radicals : CO_3, Cl, Br, I, F, SO_4, SO_3, S_2O_3, S, NO_3, NO_2, PO_4, BO_3, CrO_4.

(*b*) Basic radicals : Na, K, NH_4, Cu, Ag, Ba, Ca, Sr, Mg, Zn, Cd, Hg, Al, Pb, Sn, Cr, Mn, Fe, Co, Ni, As, Sb, Bi.

201. Chemistry—II (6-0).

(A) PHYSICAL CHEMISTRY

Electrochemistry : Transport number, specific, equivalent and molar conductivity —their determination and variation with temperature and dilution ; Kohlrausch's law of ionic mobility, ionic conductance, conductometric titrations of acids and determination of solubility. Ostwald's dilution law, strong and weak electrolytes, effect of common ion, solubility product and its applications to analytical chemistry, ionic product of water, pH, strength of acids and bases, buffer solution, hydrolysis of salts, indicators, E.M.F. of galvanic cells, standard electrode potential and the electrochemical series.

Liquid state : Vapour pressure, surface tension, molecular weights of pure liquids, viscosity, relationship between physical properties and chemical constitution.

Solid state : Allotropy, isomorphism, Dulong and Petit's law.

Chemical kinetics : Molecularity and order of a reaction, expression for the rate constants of reactions of first and second order ; temperature coefficient and energy of activation.

Catalysis : Criteria of catalysis, homogeneous, heterogeneous and autocatalysis ; elementary theory of catalysis, promoters and poisons.

Phase rule and its applications to one and two component systems.

Colloid : Definition, classification, preparation and purification of colloids, thermal, optical and electrical properties, coagulation, peptisation, protective colloids and gold number.

(B) ORGANIC CHEMISTRY

Organic compounds containing only one functional group : General methods of preparation, constitution and properties of aliphatic acid amides, acid anhydrides, acid chlorides, nitro compounds, amines, nitriles and isonitriles. (Special treatment for the first four members of each group).

Hydrolysis of esters. Introduction to fats, oils and waxes.

Organometallic compounds : Compounds containing magnesium and their uses in organic synthesis.

Organic compounds containing more than one but not more than three functional groups : Methods of preparation, constitution and reactions of derivatives of unsaturated compounds (acrolein, acrylic acid) ; polyhydric alcohols (ethylene glycol, ethylene oxide, glycerol) ; di-and tribasic acids (oxalic, malonic, succinic, citric acids). hydroxy acids (lactic and tartaric acids), unsaturated acids (maleic and fumaric acids), keto acids (pyruvic and acetoacetic acids) ; carbonic acid derivative (carbonyl chloride and urea).

Stereochemistry : Optical and geometrical isomerism. Resolution of tartaric acid. Simple synthetic uses of acetoacetic and malonic ester. Reactive methylene groups.

Carbohydrates : Introduction, nomenclature, classification. Glucose, fructose—their structures, properties. Manufacture of sucrose, starch, cellulose. Nitrocellulose—its preparation and uses.

Aromatic hydrocarbons : Introduction. Kekule's theory and constitution of benzene. Aromatic properties. Coal tar distillation. Benzene, toluene and xylene—their properties and reactions. General synthetic methods of aromatic hydrocarbons (Friedel-Craft's reaction, Fittig's reaction), substitution reaction and orientation effects.

Armatic compounds with functional groups : Preparation, constitution and properties of halogenated compounds (chloro-, bromo-, iodo-benzene, benzylchloride, benzal chloride) ; nitro compounds (nitrobenzene, trinitrotoluene, picric acid), phenol, benzene sulphonic acid, benzyl alcohol, benzaldehyde, acetophenone, benzophenone, salicylaldehyde, benzoic and toluic acid, benzoic anhydride, benzamide, benzoic ester, phenyl acetic acid, cinnamic acid, salicylic acid, acetylsalicylic acid.

Naphthalene and its simple derivatives. Pyridine and its simple derivatives.

Introduction to Electronic theory in the elucidation of the course of organic reactions. Elementary study of the following reactions ; Reformatsky's reaction, Claisen reaction, Michael reaction, Reimer-Tiemann reaction, Cannizzaro's reaction, Perkin's reaction.

(C) INORGANIC CHEMISTRY

Metallurgy, uses and common alloys of Na, K, Cu, Ag, Au, Mg, Ca, Sr, Ba, Zn, Cd, Hg, Al, Sn, Pb, As, Sb, Bi, Fe, Ni.

Elementary ideas on the production of the following :

Cements and mortars, superphosphate, ceramics, glass, nitrogeneous fertilizers, lead and chrome pigments, lithopone, rouge, ferrocyanide, ferricyanide, Prussian blue, nitroprusside.

Manufacture of steel ; alloy steels and their uses.

Study of the chemistry of the following elements and their principal compounds.

B (nitrogen, hydrogen derivatives to be omitted ; diborane is included), Al, C, Si, Sn, Pb, N, P, As, Sb, Bi, Cr, Mn, Fe, Co, Ni.

(As far as practicable, periodic classification should be the basis for the study of the properties of these elements and their compounds).

202. Chemistry Lab—II (0-6).

(A) PHYSICAL CHEMISTRY

(*a*) Determination of the equivalent conductance of an electrolyte at different concentration, (*b*) Determination of viscosity and surface tension of liquids, (*c*) Determination of transition temperatures of solids (*d*) Properties of colloids.

(B) ORGANIC CHEMISTRY

(*a*) Tests and reaction of known compounds : Methyl alcohol, ethyl alcohol, glycerine, benzyl alcohol, chloroform, acetaldehyde, banzaldehyde, acetone, acetophenone, glucose, lactose, sucrose, starch, formic acid, acetic acid, succinic acid, citric acid, tartaric acid, benzoic acid, salicylic acid, ethyl acetate, phenol, resorcinol, nitrobenzene, aniline, methylaniline, dimethyl aniline, pyridine and urea.

(*b*) Identification of unknown monofunctional organic compounds (Hydroxyl, halo, carboxyl, ester, nitro, amino).

(C) INORGANIC CHEMISTRY

(*a*) Volumetric : Acidimetry and alkalimetry : determination of hardness of water ; estimations of oxalic acid and permanganate, and of ferrous iron (by permanganate and dichromate), estimations of ferric iron by permanganate and dichromate, of thiosulphate by dichromate and copper, of calcium by permanganate, and of silver by thiocynate ; estimation of available chlorine in bleaching powder.

(*b*) Gravimetric : Estimation of barium as barium sulphate, and iron as Fe_3O_4 ;

(*c*) Estimation of Cu and Fe or Ca and Fe in a mixture.

303. Physical Chemistry (3-0).

Gaseous state : Equations of state for real gases (Van der Waals', Barthelot's & Dieterici's), limiting density, the law of corresponding state, reduced equation of state, collision frequency, mean free path.

Liquid state : Surface tension, viscosity, latent heat, molecular volume, parachor, refraction and optical activity in relation to structure.

Solid state : Elementary idea about crystal structure.

Thermodynamics : First law of thermodynamics, adiabatic and isothermal processes, specific heats of gases, Joule-Thomson effect.

Second law of thermodynamics : reversible and irreversible processes. Carnot's cycle and its efficiency, entropy and its change in simple processes, work function, free energy, thermodynamic criteria of equilibrium, Gibbs-Helmholtz equation. Clapeyron-Clausius equation. Chemical potential and simple relations between thermodynamic functions.

Chemical equilibrium : Thermodynamic derivation of the law of mass action. Vant Hoff's reaction isotherm and isochore, free energy and equation constant.

Chemical kinetics : Rate equations for reactions of first, second and third order, determination of the order of a reaction, collision theory of chemical reactions, elementary idea about consecutive reactions and back reactions.

Surfact chemistry and catalysis : Types of adsorption, adsorption isotherms (of Freundlich and Langmuir).

Solution : Thermodynamic derivation of Raoult's law and Van't Hoff's equation for osmotic pressure of ideal solution, determination of molecular weights of solutes.

Phase equilibria : The equilibria between gas-liquid, liquid-liquid, and liquid-solid (Cases illustrating simple types only).

Electrochemistry : Transport number and its determination, ionic mobility and ionic conductance, applications of conductance measurement in titration, determination of solubility and basicity of acids, elementary idea about the interionic attraction theory, osmotic co-efficient and ionic strength.

Galvanic cells, E.M.F. and free energy, reversible cells and reversible electrodes, standard electrodes, standard electrode potential, oxidation-reduction potential, concentration cells, cells with and without transport, application of e.m.f. measurements in titration, calculation of heat of reaction, equilibrium constant and solubility product.

Strength of acids and bases, pH and its determination, buffer solution, ionic product of water and its determination, hydrolysis of salts, theory of indicators.

Colloids, origin of charge and stability of lyophobic solutions, determination of size of colloidal particles, colloidal electrolytes.

304. Organic Chemistry (3-0).

Introduction to ionic principles in organic chemistry. Detail study of alkanes. Cracking and synthetic fuels. Detail study of alkenes. Isolated double bonds. Conjugated double bonds. Condensation and polymerisation. Nutural and synthetic rubber. Synthetic plastics. Polythene and polyvinyl resins. Synthetic fibres.

Alicyclic compounds. Baeyer's Strain Theory. Theory of strainless rings. Large ring compounds.

Resonance and tautomerism. Polyfunctional group of organic compounds (Diketones, hydroxyaldehydes and hydroxyketones, hydroxyacids and lactones, amino acids and lactanes), ketenes, Quaternary ammonium compounds.

Aliphatic and aromatic diazocompounds : Diazomethane, diazoacetic ester. Diazonium salts and related compounds.

Stereochemistry of compounds of carbon, nitrogen, and sulphur. Asymmetric synthesis. Racemisation and eqimeric changes. Walden inversion.

Configuration of the monosaccharides, determination of the size of sugar rings. Mutarotation.

Detail studies of aromatic compounds, aromatic nitrose compounds, diamines, di-and polyhydric phenols, quinones and quinols, di-and tricarboxylic acids.

Polynuclear hydrocarbons and their derivatives : Diphenyl, di and tri-phenylmethane, dibenzyle, stilbene, benzoin. acenaphthene, indene, fluorene, anthrancene, phenanthrene. Their preparation, properties, constitution and uses.

Name reactions, condensations, rearrangements :

Dieckmann reaction, Knoevenagel reaction, Stobbe condensation, Mannichreaction, Diels-Alder reaction, Arndt-Eistert reaction, Hofmann degradation, Schmidt reaction. Curtius reaction.

Pinacol-pinacolone rearrangements, Benzidine rearrangements, Semidine rearrangements, Beckmann rearrangements.

Introduction to dye-stuffs. Classification of azodyes.

Introduction to hetercyclic compounds and alkaloids.

305. Inorganic Chemistry (3-0).

Treatment of the topics included in the first and second year courses on a more advanced level. The following additional elements are included :

Ra, Se, Te, U, Pt.

The following topics to be specially considered :

(1) Separation of inert gases from their mixture and their chemical characteristics.

(2) Oxides and oxyacids of halogens, interhalogens, polyhalides, pseudohalogens, basic property of iodine,

(3) Thionic acids,

(4) boron hydrides and boron nitride,

(5) silicon hydrides,

(6) Mercury-nitrogen compounds,

(7) Complex halides and cyanides of zinc, cadmium and mercury,

(8) peroxides and peracids of B, C, N, S and Cr.

(9) hydrides, carbides and nitrides (general treatment only).

(10) amides, acid amides and imides of S, P, N and C,

(11) study of the different valent-state (both normal and abnormal) compounds (simple and complex) of Cu, Ag, Au, Fe, Co, Ni, Hg, Pt, Cr. and Mn.

(12) Electrometallurgical processes with special reference to Mg ; Al, Zn ; electrorefining of elements, electroplating, metallurgy of copper, zinc, lead, tin and nickel, iron and steel industry.

(13) Important alloys (composition and uses only).

306. Industrial Chemistry (3-0).

Water treatment—Softening processes, preparation of medicinal potable water. Analysis of water. Numerical problems on Water softening.

Fuels—

(*a*) Solid fuel—(i) Coal—analysis, classification, carbonisation and recovery of coal chemicals (ii) Wood-distillation and its products.

(*b*) Liquid fuel—(i) petroleum—distillation, cracking and other unit processes, different petrochemicals. Gasolin and Diesel oil—their characterisation.

(ii) Synthetic liquid fuel—Fischer-Tropsch and Bergius processes ; power alcohol.

(*c*) Gaseous fuel—gasification of coal (producer gas and water gas, coal gas), natural gas.

Industrial gases—Oxygen and nitrogen by liquefaction, hydrogen, carbon dioxide, chlorine, hydrocarbon gases like acetylene, ethylene, etc.

Acids and alkalis of industrial importance—(i) Sulphuric acid, nitric acid and hydrochloric acid.

(ii) Caustic industry.

Fixation of nitrogen and related industries—(i) Ammonia, ammonium sulphate, ammonium nitrate, cyanamide and area.

(ii) Nitrogeneous and other fertilizers.

Electrochemical and electrothermal industries—(i) A short discussion on applied electro-chemistry and its utility in various industries.

(ii) Manufacture of carbides, hydrogen peroxide, and permanganate.

Ceramic industry—Lime, cements, refractories, glass. (Pottery, porcelain and enamels —to be discussed briefly).

Fermentation industry—Ethyl alcohol, acetone, butyl alcohol, lactic acid, acetic acid.

Sugar Industry—Glucose, cane-sugar, dextrine, utilisation of molasses.

Paper industry—mechanical and chemical methods of pulping and a short outline of the finishing operations.

Hydrogenation industry—hydrogenation of fats and oils.

Elementary ideas of the following industires—

(i) Leather tanning

(ii) Natural and synthetic rubbers.

(iii) Synthetic fibres and plastics

(iv) Paint, pigment and varnish

(Each of the above topics to be discussed with special reference to Indian conditions).

307. General and Analytical Chemistry (3-0).

Determination of e/m and e. X-ray spectra and atomic number. Isotopes and mass spectrography. Physical and chemical determination of atomic weights.

Bohr's theory of hydrogen spectrum, quantum numbers, Bohr-Sommerfeld model of atoms, Pauli's exclusion principle and distribution of electrons in the orbits.

Natural and artificial radioactivity, law of radioactive disintegration, radioactive equilibrium, particle accelerators, discovery of fundamental particles, the cloud chamber, cosmic ray, artificial transmutation.

Electronegativity scale of Pauling, elementary concept of atomic orbitals, covalency treated from stand point of atomic orbitals, "sigma" and "pi" bonds. Hybrid orbitals and directed bonds.

Resonance, Lowry-Bronsted concept of acids and bases. Reaction in liquid ammonia (elementary treatment).

Elements of Nuclear Chemistry—nuclear energy, fission, fusion, nuclear reactor (elementary concept only).

Polymorphism and isomorphism, simple and typical phase diagram of binary alloys.

Complexes—perfect and imperfect, double salts, method of study. Werner's theory. Chelates. Isomerism of complex compounds. Stereochemistry of tetra and hexaocvalent atoms. Thio acids and thiosalts. Abnormal valency of metals (only those within the course). Stabilisation of abnormal valency by complexing. Deuterium, tritium compounds and their separation.

Principles of permanganometry, dichrometry, iodometry, and argentometry ;

Gravimetric analysis : Principles of precipitation, coprecipitation, post-precipitation stages, theory of washing ;

Application of solubility product rule and adsorption ; variation of pH during acidimetric or alkalimetric titrations ; buffer solution ; use of pH and buffer in analysis. Variation of electrode potentials in redox titrations.

Indicators : pH, redox and adsorption indicators.

Use of complexing agents in analysis (examples from practical chemistry syllabus);

Calibration of burettes, pipettes, and weight boxes ; common errors in volumetric and gravimetric analysis.

308. Chemistry Lab.—III (0-15).

(A) PHYSICAL CHEMISTRY

Determination of density of liquids and solutions, refractive index and solubility.

Molecular weight determination by Victor Meyer's method and freezing point method. Partition co-efficient, adsorption isotherm, kinetics of hydrolysis of an ester. Determination and comparison of the strength of acids.

(B) ORGANIC CHEMISTRY

(*a*) Purifications of organic solvents : methyl and ethyl alcohols, benzene, chloroform.

(*b*) Preparation of simple organic compounds : methyl iodide, ethyl bromide, ethyl acetate, ethyl benzoate, nitro-benzene, aniline, chlorobenzene, *m* dinitrobenzene, picric acid, benzoic acid (from toluene), acetanillde, aspirin and methyl orange.

(C) INORGANIC CHEMISTRY

(*a*) Qualitative analysis of mixtures containing not more than four radicals (basic or acidic or both) selected from the list included in the common course and the following : ferrocyanide, ferricyanide, sulphocyanide, silicate, arsenite.

(*b*) Quantitative : (i) Volumetric estimation of phosphorus.

(ii) Gravimetric estimation of lead, magnesium, sulphate and manganese ;

(iii) Estimations in mixtures such as—

(*a*) Fe and Ca, (*b*) Fe and Mn,

(*c*) Ca and Ba, (*d*) Ca and Pb,

(*e*) Cu and Zn, (*f*) Pb and Cr,

(*g*) Fe and Mg, (*h*) Cr and Cu.

(*c*) Analysis of dolomite and/or brass.

CIVIL ENGINEERING (CE)

101. Drawing (0-3) Third Term.

Lettering, Lines, Scales, Dimensioning. Brief introduction to I.S. Code.

First angle and Third angle projections.

Orthographic projections of points, lines and solids. Brief introduction to Isometric and other pictorial projections.

Plan, Elevation and Sections of Simple Solids.

Intersection of Simple solids and development of surfaces.

Tracings and Blue and Ammonia Prints.

HUMANITIES AND SOCIAL SCIENCES (Hu)

101. English (2-1).

The object of the course in English is to teach students to express themselves in good, simple and correct English and to help them develop a taste for literature.

TUTORIAL PROGRAMME

Ist Term

The main rules of syntax ; the sentence : its structure ; punctuation ; paragraph etc. No formal grammar lessons are given ; correct use is taught through composition.

2nd Term.

Précis writing ; letter writing ; comprehension test, etc.

3rd Term.

Paraphrasing ; imaginative writing ; dialogue, diary, etc., writing short notes on topical issues.

Anthologies of essays and poems and a modern play will be chosen as text for the lecture classes every two years or so.

103. Principles of Government (1-0).

Society, State and Government. Relation between the State and the Individual. Citizenship : rights and duties. Functions of government. Sphere and purposes of the state. Dictatorship vs. Democracy. Welfare State.

Structure of Government ; Constitution of India with reference to some modern constitutions.

World Order and the U. N.

201. English (1-1).

TUTORIAL PROGRAMME

Advanced prose composition including précis writing ; discussion and review of important books ; summarising technical reports.

In the lecture classes two books will be discussed in detail ; one, preferably a prose play by an outstanding playwright, in the first two terms and the other, one or two long poems or a selection of poems by different poets, or short stories or essays.

202. Logic (1-0).

The province of logic : Nature, Scope and Utility of logic ; Fundamental concepts of logic. The relation of logic to psychology, grammar and mathematics.

Logic and language : Words and Terms : Denotation and Connotation and distribution of terms : Classification of terms. Propositions and sentence (classification of propositions, opposition of propositions).

Deductive Inference ; Nature and Implication : Immediate and Mediate. Immediate Inference : Conversion and Obversion. Mediate Inference : Syllogism (Pure categorical).

Inductive Inference : Problem, nature and methods, Relation between Induction and Deduction. Grounds of Inductive Inference ; Formal and Material. Formal Ground : Uniformity of Nature and Causality. Their definition and nature. Material Grounds : Observation and Experiment : their explanation and illustrations. Inductive procedure and methods : Hypothesis. Introduction to the theory of probability and its relation to Induction.

MATHEMATICS (Ma)

101. Mathematics I. (6-2).

(Calculus and Differential Equations).

Calculus—Number set. Irrational number. Linear continuum. Inequalities concerning modulii of sums.

Functions. Inverse function. Existence of inverse of monotonic function. Limit and continuity of functions. Interpretation of limit and continuity for functions whose graphs can be drawn. Existence and attainments of bounds of continuous functions and of intermediate values in closed interval.

Derivatives. Its geometrical interpretation. Interpretation as speed in s-t diagram. Rules of differentiation (including implicit and parametric forms). Rolle's theorem. Mean value theorems. Working knowledge of higher derivatives and partial derivatives. Total differential and its application to errors.

Taylor's theorem with remainders and its application to Binomial Theorem (any index), trigonometric function.

Maxima-Minima and Indeterminate forms.

Integration as area and limit of sum and as inverse of differentiation. Integration of standard forms (expressions not integrable in closed form to be pointed out). Use of tables of integrals. Logarithm defined as integral and exponential as its inverse.

Ordinary differential equation of first order and second order linear differential equation with constant coefficients. Reduction of second order differential equations to first order.

Geometry

Geometry—Analytical geometry of two dimensions—Transformation of rectangular axes-change of origin and direction—Invariants-Homogeneous equation of the second degree-its interpretation and properties. General equation of the second degree-condition for representing a pair of straight lines. Classification of conics-reduction of the general equation. Tangents, normals, conjugate diameters, Poles and Polas. Asymptotes. System of coaxial circles. Polar coördinates. Polar equation of conics.

Study of some well known curves (*e.g.* cycloid, cardiode etc. with the help of calculus wherever necessary).

Analytical geometry of three dimensions-Planes, Straight lines including parametric form and simple conicoids.

Algebra and Trigonometry

Complex Numbers and Trigonometry-Argands diagram. Demoiver's theorem and exponential sine—cosine (calculus may be used). Summation of trigonometrical series whose angles are in A.P. and simple cases by 'C+i S' method. Gregory's series. Inter-relation of trigonometric and hyperbolic functions. Geometrical interpretation of hyperbolic functions.

Algebra-Determinants of second, third and fourth order. Linear transformations. Matrices-addition, multiplication and inverse. Simple application to linear equation. Rank of matrices. Cramer's rule.

Polynomials. Division algorithm. Fundamental theorem of classical algebra (no proof required) and its consequences. Descartes' rule of signs and its applications. Relations between roots and co-efficients. Symmetric function of the roots. Transformations of polynomial equations. Cardan's solution of cubic. Horner's and Newton's method of calculation of roots.

201. Mathematics II (6-2).

Advanced Calculus

Calculus—Rigorous treatment of sequence, series (including proof of Weirtrass theorem).

Convergence-D'Alemberts ratio and Cauchy's root test. Comparison test for series and integrals with positive term. Elementary treatment of power series. Kummer's test and its special cases. Absolute and conditional convergence.

Functions of two or more variables. Geometric notion and their continuity. Successive partial derivatives. Statement of a set of sufficient conditions (without proof) for the commutative property of partial derivatives.

Definite Integrals including improper integral. Application to area, length, volume, surface, C.G.

Application to Geometry-Elementary treatment of asymptotes, nodes, cusps. Curvature.

Solution of ordinary differential equation by the method of series (simple cases). First order partial differential equation.

Fourier series (statement of Dirichlet conditions and coefficient calculation) Elementary idea of Fourier transform.

Complex Variables-Analytic function. Cauchy-Riemann differential equation. Complex Integration. Cauchy's theorem. Cauchy's Integral. Poles and residues. Contour integration (simple cases).

VECTORS AND TENSORS

Vectors-Addition. Scalar and vector multiplication. Triple product. Vector equation of lines and planes and their applications. Gradient of a scalar. Curl of a vector. Divergence theorem. Stokes theorem. Time differentiation of vectors. Elementary idea of tensors, their transformation laws and its interrelation to vectors including correlation of parallelogram property etc. with transformation laws.

Dynamics—motion of a straight line using differential calculus (including mass varying motion). Expression for velocity and acceleration in polar and intrinsic coordinates with simple application to free and constrained motion in two dimensions. Central orbits. Collision of elastic bodies, Projectiles, motion in a resisting medium. Motion in a circle.

Statics—Reduction of a system of coplanarforces. Equation of the line of action. Frames, Virtual work, Centre of gravity, Stability, Uniform string under gravity. Moments. Couples. Friction.

303. Analysis (3-0).

Functions of two or more variables and their continuity. Simple properties of continuous functions of two variables. (No proof). Partial derivative. Differentiability. Total differential, commutative property of the order of partial derivatives. Euler's theorem of homogeneous functions. Change of variables.

Taylor's developments in terms of two or more variables with remainder after n terms. Maxima and minima of functions of two or more variables. Lagrange's Multipliers.

Multiple integrals. Intersection of solids. Green's theorem. Line integrals. Fourier series (Proof). Fourier integrals.

First and Second Mean value theorem for integrals. Fundamental theorem of Integral Calculus. Improper Integrals. Elementary test of Convergence, Beta and Gamma functions. Differentiation and integration under sign of integration.

Formation of differential equations. Singular solution of first order equation. Exact equation Differential equation of second order with variable coefficients. Simultaneous linear differential equation with constant coefficients.

304. Modern Algebra and Pure Geometry (3-0).

Modern Algebra—Introduction to the concepts of Groups, Rings, Fields and Vector spaces. (Number of examples to be given and enough practice to be given for deducing simple properties from given axioms).

Pure Geometry—Cross-ratio of points and lines. Twenty-four cross-ratios reducible to six. Harmonic points and lines. Invariance of cross-ratio in projection and section. Points at infinity. Principle of duality. Complete quadrangle and complete quadrilateral. Projective generation of conics. Inversion. Reciprocation.

305. Probability, Statistics and Computation (3-0).

Probability—Fundamental Theorems, Random variables and Probability distributions. Law of Large Numbers. Characteristic functions. Limit Theorems. Recurrent Events. Markov Chains. Elements of Stochastic processes.

Statistics—Frequency Distributions. Moments and Cumulants. Correlation and Regression. Sampling Distributions. Tests of Significance. Estimation. Testing of hypotheses. Analysis of variance and co-variance.

Computation—Solution of simple equations by numerical methods, and interpolation and extrapolation formulae ; Remainder terms.

306. Astronomy and Rigid Dynamics (3-0).

Astronomy—Celestial Sphere : Astronomical Coordinates. The Earth : Diurnal Motion. Refraction. Parallex : Aberration : Precession and Nutation. The Moon. The Sun. The Eclipses. Planetary Motions. The Planets and their Satellites. The Observatory. The Stars. Galaxy and the Physical Universe.

Rigid Dynamics—Rigid Dynamics of three dimensions e.g. Motion of a billiard ball on a table, motion of a top. Lagranges equation (without proof) and simple applications.

307. Statics and Hydrostatics (3-0).

Statics—Forces in three dimensions. Theorem on moments. Reduction of force system in space. Poinsot's Central axis. Invariants of a system of forces. Equation of central axis. Condition of reduction to a single force.

Hydrostatics—Equilibrium of liquids. Thrusts on plane and curved surfaces. Centre of pressure. Density and specific gravity. Equilibrium of floating bodies and analytical discussion of the stability of equilibrium of a floating body. Properties of gases. Variation of pressure of atomsphere with height.

308. Special Functions and Differential Equations (3-0).

Legendre, Bessel and Gamma functions. Three well known types of partial differential equation and their simple solutions in cartesian, polar and cylindrical coordinates.

Practical—Statistics and Probability ; Numerical Methods.

310. Mathematics III (3-0).

Vector analysis : Gradient, divergence, curl and Laplacian in general orthogonal coordinates, spherical and cylindrical coordinates, Cartesian tensors, symmetric and antisymmetric forms.

Fourier series : Detailed discussion of Fourier series, Orthonormal function and notion of completeness.

Probability : Total and compound probability. Law of large numbers, expectation and dispersion, skewness, moments and cumulants, characteristic function, Bernoulli's series of trials, binomial, Poison and normal distribution, theory of errors, correlation and regression, chi-squared test with application, curve fitting.

Differential equation : Linear differential equations—integration in series, Bessel's and Legendre's equation and their solution, associated function, recursion formulae—simple partial differential equations occuring in physics—Laplace and Poison equation, vibration of strings and circular membranes, One dimensional heat flow, wave equation of D' Alembert etc.

Complex Variables : Consequences of Cauchy theorem, Calculus of residues—Contour integration.

Numerical methods : Numerical solution of algebraic and transcendental equation, ideas of accuracy and of successive approximations, iteration and Newton-Raphson methods and method of false position, numerical integration—Simpsons and Weddle's rules.

MECHANICAL ENGINEERING (ME)

101. Workshop and Drawing (0-3). First and Second Terms.

Practice in Carpentry, fitting, hand forging, tin and copper smithy, and simple electrical maintenance. Elementary Engineering drawing, engineering sketching of components and study of blue prints.

PHYSICS (PH)

101. Physics—I (4-1).

Mechanics & Properties of Matter

1. Review of the measurement of length, mass, time ; statics and hydrostatics.
2. Laws of motion ; circular motion, moment of inertia its calculation in simple cases ; angular momentum. Conservation of momentum and energy. Collision of elastic bodies.
3. Friction ; static and dynamic friction, limiting friction, Angle of repose.
4. Simple harmonic motion ; composition of S.H.M.s—simple pendulum, torsional oscillations. Conical pendulum ; Damped oscillation, forced oscillation and resonace.
5. Introduction to elastic properties of matter.
6. Pumps—descriptive treatment of production of high vaccum, mcleod gauge.

Sound & Wave Motion

1. Velocity of sound, effect of pressure, temperature and humidity ; measurement of velocity of sound in solids, liquids and gases.
2. Reflection, refraction and interference of sound, the phenomenon of beats.
3. Forced vibration and resonance.
4. General properties of wave motion ; progressive and stationary waves.
5. Pitch and quality of sound ; principles of analysis of compound notes. Tuning fork ; sonometer ; vibration of air column, organ pipes, musical sound and noise.
6. Doppler's principle and its application.
7. Elements of architectural acoustics.
8. Principle of sound recording and reproduction and sound ranging.

Heat & Thermodynamics

1. Temperature, Zeroth Law of Thermodynamics ; measurement of high and low temperatures—Modern methods. Expansion of solids, liquids and gases. Expansion of anisotropic solids (qualitative).
2. Methods of measuring specific heat of solids and liquids ; Radiation correction. Cp and Cv for gases and their measurement.
3. Change of state ; vapour pressure over curved surfaces.
4. Isothermal and adiabatic changes.

5. Kinetic theory of perfect gases.

   Deviation from Boyle's Law. Equation of state for a real gas ; critical constants ; Law of corresponding states.

Geometrical and Physical Optics

1. Fermat's principle, rectilinear propagation of light. Refractive index—its measurement.
2. Reflection and refraction at spherical surfaces. Thick lens ; principal points ; combination of thin lenses.
3. Spherical and chromatic aberrations and their removal. Descriptive treatment of other defects of images formed by a single lens.
4. Eye pieces and optical instruments—Telescopes and microscopes.
5. Prism ; Dispersion and deviation—Spectroscope, Direct vision spectroscope.
6. Velocity of light ; group velocity and wave velocity ; Doppler's principle in optics.
7. Photometry—Photometers ; Brightness of sources. Ideas about microphotometers and spectrophotometers.
8. Ideas about normal and anomalous dispersion—introduction to experimental spectroscopy.
9. Colour, vision, Rainbow.

Electricity and Magnetism

Review of electrostatics and magnetostatics.

1. Ohm's Law and Kirchhoff's Law and their applications. Electrical measurements and measuring instruments (D.C.) Sensitivity of galvanometers ; different types of bridges and potentiometers.
2. Ampere's theorem ; Laplace's Law. Calculation of magnetic field due to current in simple cases. Force on current carrying conductors in a field.
3. Various types of cells. Electrolytic conduction—ionic mobility, electrode potential and its measurement.

102. Physics Lab—I (0-5).

201. Physics—II (6-0).

Mechanics & Properties of Matter

1. Units and Dimensions—Dimensional analysis.
2. Law of Universal gravitation, Kepler's laws (statement only); Accurate determination of 'G' ; gravitational potential and force in simple cases. Kater's pendulum and other accurate methods of measurement of 'g'.
3. Elements of the theory of elasticity and elastic properties of matter, deviation from Hook's law ; relation between elastic constants. Bending of beams-simple special cases ; Flat spiral spring. Determination of elastic constants.
4. Flow of liquids, Bernoulli's Theorem and its simple applications.
5. Viscosity of fluids, critical velocity and Reynold's number, Poiseuille's equation ; compressible fluids. Determination of viscosity of fluids ; rotating viscometers, stokes law (statement only) and its application. Ideas about lubrication.
6. Surface tension and surface energy ; angle of contact, Neumann's triangle. Pressure difference and curvature of films. Rise of liquid in a capillary tube ; shape of large drops ; Measurement of surface tension, method of ripples.

Heat & Thermodynamics

1. First and second laws of thermodynamics ; Reversible process. Carnot's cycle and theorem. Absolute scale of temperature ; Entropy ; Maxwell's relations and their application. Clapeyron Clausius equation.

2. Conductivity and diffusivity, Measurement of thermal conductivity of good and bad conductors.

3. Elementary ideas about convection.

4. Nature of radiant heat ; Emissive and absorptive powers, Kirchhoff's law ; Black body radiation, Stefan's law. Wien, Rayleigh-Jeans, and Planck's law. Radiation Pyrometry.

Geometrical and Physical Optics

1. Huyghen's principle and rectilinear propagation of light ; reflection and refraction from wave theory of light.

2. *Interference of light :* Young's experiments ; conditions of interference ; Biprism, Lloyd's mirror ; Newtons rings ; Colours of thin films.

3. Michelson interferometer ; Standardisation of length.

4. Michelson-Morley experiment.

5. Diffraction ; Fresnel and Franunhofer diffraction ; Zone Plate, Simple treatment of diffraction by a straight edge, single slit ; double slit, plane grating, absent spectra, ghosts. Concave grating.

6. Resolving power—Resolving power of grating, prism-spectroscope ; telescope, microscope. Abbe's theory.

7. Polarisation : Methods of production and analysis of polarised light ; Nicol Prism ; circular and elliptic polarisation.

8. Optical activity—Fresnel's theory. Polarimeters. Laurent's plate and Biquartz.

Electricity and Magnetism

1. Thermoelectricity ; Peltier coefficient, Thomson coefficient, Thermo-electric power and Thermo-electric diagram. Measuring devices depending on thermo-electricity. Piezoelectricity ; Hall effect and related phenomena.

2. Potential and intensity of the electrical field ; dipole ; displacement current. Dielectric constant. Gauss's theorem and its applications. Mechanical force on the surface of a charged conductor. Condensers. Quadrant and absolute electrometers. Measurement of capacity and static dielectric constant. Electrostatic machines.

3. Laws of magnetism, potential and field due to a small magnet ; magnetic shell. Forces and couples between the two magnets. Magnetic paradox. Magnetometer and measurement of M and H. Terrestrial magnetism.

4. Magnetic properties of matter ; Dia—, para— and ferro—magnetism ; Hysteresis.

5. Electromagnetic Induction, self and mutual inductance. Calculation of L and M in simple cases. Eddy current ; Ballistic galvanometer and its use ; Flux-meter.

6. Growth and decay of currents ; charging and discharging of condenser ; Induction coil ; methods of measuring inductances.

7. Elementary theory of A.C. ; A. C. circuits containing L, C and R.

8. Discharge tube phenomena—cathode rays ; Measurement of e/m and e. Production and nature of X-Rays. Positive rays and isotopes.

9. Photoelectricity and its applications, simple facts about quantum theory of light. Simple ideas about structure of atom. Bohr's theory. Elements of radioactivity.

202. Physics Lab II (0-6).

303. Mechanics and Properties of Matter (3-0).

1. Dimensional analysis ——Theorem.

2. D'Alembert's principle, Principle of virtual work. Generalised coordinates and momenta. Lagrange's equation and Hamilton's principle.

3. Rotational motion of a rigid body—Euler's equation of motion of a rigid body. Precession and Nutation. Momental ellipsoid.

4. Rigorous treatment of pendulum (simple, compound and torsional), free and forced oscillations, Resonance, sharpness of resonance, coupled oscillation.

5. Variation of 'g'. Discussion of Kepler's laws—Rutherford's formula. Elementary discussion of space flight.

6. Wave equation, Harmonic waves ; solution of wave equation by separation of variables, Plane and spherical waves. Reflection and refraction of waves ; Partial and total reflection. Absorption coefficients.

7. Velocity of transverse waves in strings ; Theory of plucked, struck and bowed strings. Longitudinal and transverse vibration in bars and plates, rectangular and circular membranes.

8. Velocity of wave transmission in terms of elasticity and density ; propagation of sound waves in the atomosphere, zones of silence. Elementary discussion of supersonic speed of sound sources.

9. Velocity of gravity waves in a liquid ; capilliary waves, ripples.

10. Experimental determination of velocity of sound in fluids. Discussion of experimental results. Determination of frequency by stroboscope, phonic wheel and cathoderay oscilloscopes.

11. Measurement of the intensity of sound—Rayleigh's disc. Bel and decibels.

12. Principle of action of transducers.

13. Combination tones ; Diatonic scale, temperament, vowel tones, consonance, dissonance.

14. Principle of production of ultrasonics ; application of ultrasonics.

304. Heat and Thermodynamics (3-0).

1. Maxwell's law of distribution of velocities and its experimental verification—R.M.S., average and most probable velocity. Degrees of freedom. Law of equipartition of energy and its application to sp. heats of gases. Mean free path, experimental verification—transport phenomena. Brownian motion and measurement of Avogadro number.

2. Thermodynamical potentials and equilibrium of physicochemical systems ; chemical equilibria and law of mass action ; phase rule ; Saha's thermal ionisation formula. Third law of thermodynamics.

3. Application of thermodynamics to thermoelectricity and cells ; thermonic emission ; rise of boiling point and lowering of freezing point of solutions.

4. Variation of latent heat with temperature.

5. Production and measurement of low temperature. Joule-Thomson effect—experiment and theory ; its application for correcting gas thermometers. Liquefaction of gases. Adiabatic demagnetisation.

6. Fourier equation for the flow of heat in solids ; Thermal conductivity by steady and periodic flow methods. Wiedemann-Franz's Law.

7. Quantum theory of radiation ; Planck's law ; Temperature variation of specific heats of gases and solids—Einstein and Debye's theory.

8. Introduction to the distribution law for Maxwell Boltzmann, Bose-Einstein and Fermi-Dirac statistics. Entropy of a monatomic gas ; chemical constant.

305. Physical Optics (3-0).

1. Interferometry : Rayleigh and Jamin interferometers and their use. Interference with multiple beams ; Haidingers and Brewster's fringes, localised fringes, Testing of optical flats. Lummer-Gehrcke plate ; Fabry-Perot etalon.

2. Fraunhofer diffraction—Expressions for intensity for single slit, double slit, circular aperture and plane grating ; Concave grating and theory of different mountings. Echelon gratings.

3. Fresnel diffraction—Theory of diffraction at straight edge, slit and wire ; Cornu's spiral.

4. Polarisation—Elements of double refraction in uniaxial crystals ; ordinary and extraordinary wave surfaces ; Internal and external conical refraction.

5. Quarter and half wave plates ; Interference of polarised light. Crystal plates between crossed nicols in parallel and convergent (or divergent) beams of light.

6. Elements of electromagnetic theory. Derivation of wave equation from Maxwell's equations. Reflection and Refraction of plane waves. Polarisation and total reflection.

7. Elementary ideas in dispersion theory. Derivation of Sellmeyer's equation—Normal and anomalous dispersion. Wood's experiment for observing anomalous dispersion of Sodium vapour.

8. Elements of experimental spectroscopy in the visible, ultraviolent and infrared—Emission and absorption spectra. Fluorescence.

9. Classical theory of Zeeman effects. Description of Faraday, Stark and Kerr effects. Qualitative discussion of the phenomenon of scattering and Raman effects.

306. Electricity and Magnetism (3-0).

1. Potential energy of charged systems—Field as the seat of energy ; stresses in the electric field.

2. Dielectric polarisation, surface and volume distribution of charge in a polarised dielectric. Isotropic dielectric ; Boundary conditions for E and D.

3. Poisson's and Laplace's equation for electrostatic potential. Conducting spheres in uniform fields. Method of images. Point charge and plane ; point charge and sphere.

4. Fields of magnetised bodies ; Boundary condition for B and H. Paramagnetic sphere and cylinder in uniform fields. Magnetic shielding, measurement of susceptibility. Magnetic circuit.

5. System of units—M.K.S. system. Absolute measurements.

6. A.C. net works, Vector representation of alternating quantities, Kirchoff's laws. Tuned circuit (series and parallel) and principle of A.C. measuring instruments. (Amperebalance, Electrodynamometers, Watt balance) Elements of A.C. measurements. Theory of Transformers. An introduction to A.C. networks.

7. Maxwell's equations of the electromagnetic field. Plane waves in isotropic dielectrics. Poynting vector. Plane waves in conducting media. Skin effect, Hertz's experiments on production and detection of e.m. waves. Lecher wires.

8. Thermionic emission, Limitation of current by space charge ; Child-Langmuir equation ; deviation from Child's law. Fundamentals of electron tubes ; space charge effect and control of current flow. Vacuum and gas tubes ; thyratrons.

9. Diodes—characteristics and uses ; rectifying properties, smoothing circuits ; voltage regulators, constant current devices.

10. Triodes—characteristics of Triode as amplifier, voltage gain, audio and radio frequency amplifiers. Triode as oscillator ; Qualitative discussion about the multigrid tubes, photo cells and photomultipliers.

11. Qualitative discussion of the working principle and use of common electronic instruments, oscilloscopes, wave analysers., Q-meters and valve voltmeters.

307. Atomic Physics (3-0).

1. Conduction through gases, Ionisation current and its measurement ; Ionisation by collision ; mobility of ions. Spark discharge, radiation and ionisation potentials. Ionisation chamber. G.M. and other counters. Wilson's cloud chamber.

2. Positive ray analysis, Isotope and Isobars mass spectrograph. Mass defect of isotopes. Atomic mass unit.

3. Radioactive equilibrium. Radioactive series. Nature and Properties of α, β and γ—rays. Range of α—particles, Statement of Geiger-Nuttal Law. The energy spectrum of α, β and γ—rays. Descriptive treatment only.

4. Large angle scattering of α—particles and determination of nuclear charge.

5. Effect of motion of the nucleus in Bohr's theory of H-spectrum. Sommerfeld's theory of elliptical orbits. The alkali spectrum.

6. Pauli's exclusion principle. Periodic table.

7. Langevin theories of dia—, and paramagnetism ; Weiss theory of ferromagnetism.

8. Atomic theory of dielectric polarisation—Lorentz local field, Clausius-Mossotti (Lorentz-Lorentz) relation.

9. General properties of x-rays—Laue diffraction and wave-length of x-rays. Bragg diffraction and x-ray spectrometer, Mosley's law. White and characteristic x-rays. Absorption of X-Rays ; Thomson and Compton scattering ; Auger effect.

10. De Broglie matter waves, Davisson and Germer and Thomson experiments, Electron diffraction experiments. Statement of the uncertainty principle.

11. Discovery of neutrons and positrons. Artificial radioactivity. Elementary ideas of Nuclear fission and reactors.

12. Elementary discussion on cosmic rays.

308. Physics Laboratory III (0-15).

SCHEDULE XVII

REGULATION No. 23

Admission to the First Year Class of the Two-Year M.Sc. Degree Course

(*a*) *Minimum Educational Qualifications*:

A person seeking admission to the course leading to the Degree of Master of Science in any of the branches must have passed or is expected to pass, before the 1st August of the year of admission, the Bachelor of Science (B.Sc.) Examination of a recognised University either (*i*) with Honours in Chemistry, or in Mathematics, or in Physics, and Mathematics and Physics, or Chemistry and Physics, or Chemistry and Mathematics as subsidiary subjects respectively ; or (*ii*) with Chemistry, Mathematics and Physics as major subjects if no Honours course is offered by the University concerned.

(*b*) *Age Limit*:

To be eligible for admission to the First Year class of the two-year Master of Science Degree course a candidate shall, on the 1st October of the year of admission, have completed 18 years of age.

(c) *Standard of Physical Fitness*:

A candidate seeking admission to this course should fulfil the prescribed standard of physical fitness as given below :

Height	1.6 m.
Weight	46 Kg.
Chest Measurement	76 cm. with satisfactory limit of expansion.
Heart & Lungs	There should be no abnormality.
Vision	Better eye Worse eye 6/9 6/9 or } Corrected with glasses. 6/6 6/12 Eyes should be free of congenital or other diseases.
Hearing	Should be normal.
Good general health and build.	
Hernia, Hydrocele, Varicocele, Piles ...	Presence of any of these is a temporary disqualification to be rectified before joining.

Opinion of the Institute Medical Officer shall be final and there shall be no appeal.

SCHEDULE XVIII

REGULATION No. 24

Entrance Test for Admission to the First Year Class of the Two-Year Master of Science Degree Course

1. A preliminary selection of candidates shall be made by an Admission Committee after scrutiny of applications including mark sheets and testimonials and only the candidates who prima facie satisfy the minimum requirements will be called for the Entrance Test, the scope of which shall be determined by the Admission Committee. The Entrance Test, written and/or oral, shall be held at the Institute on a date to be fixed by the Senate.

2. Admission to the First Year Class of the course shall be made in order of merit on the results of the Entrance Test.

SCHEDULE XIX

REGULATION No. 25

Degree of Master of Science (M.Sc.)

Course and Duration:

1. The Institute shall provide courses leading to the Degree of Master of Science (M.Sc.) in Chemistry, in Mathematics, in Physics, or in any other science subject as the Senate may decide from time to time taking into consideration the accommodation, staff and other facilitites available.

2. For persons with adequate academic preparation, the curriculum for the Degree of Master of Science in the subjects mentioned above shall extend over not less than two academic sessions each consisting of three terms.

SCHEDULE XX

REGULATION No. 26

Graduation Requirement

(a) *General Regulations*:

1. A student shall not be permitted to appear at any of the examinations for the Degree of Master of Science (M.Sc.) unless (i) he has been regular in attendance in all lectures, laboratories, tutorials, guided studies etc. and (ii) he has satisfied all class teachers that he has conducted himself well within and outside the class room and that he has been regular, diligent and methodical in studies and has independently and satisfactorily performed home and sessional assignments and has regularly submitted these for the scrutiny of the teachers.

2. An entrant into the First Year class of the Two-Year M.Sc. Degree course shall be required to qualify in the First and the Final examinations within a maximum period of three years of study at the Institute.

3. The curriculum for the Degree of Master of Science shall consist of subjects as set forth in Schedule XXI, each of which shall be studied by attendance in lectures, tutorials, seminars, laboratories, as prescribed in the Schedule.

4. The scope of the subjects of instruction shall be as detailed in Schedule XXI. In each subject for examination there shall be written paper or papers or sessional assignments, or written paper or papers and sessional assignments including practicals, as prescribed.

5. The Senate shall determine in respect of each subject of study the scope of the course and the relative proportion in each course of lecture and/or practical, laboratory work and shall also determine in respect of several examinations for the Degree the conditions for admission and the standard of examinations.

6. The standard of examination shall be as prescribed in the special Senate Instructions which shall be kept with the Registry and be available only to the Senate and the Board of Examiners.

(b) *The Degree of Master of Science* (*M.Sc.*):

1. Subject to the provisions of the Ordinances and Regulations the Degree of Master of Science (M.Sc.) shall be conferred on students who have studied on the prescribed curriculum for not less than two academic sessions the subjects as set forth in Schedule XXI and who have reached the minimum standard in the examinations in one of the branches listed in Schedule XXI, Regulation No. 27.

2. There shall be two complete examinations for the Degree of Master of Science, namely, (i) the First Examination, and (ii) the Final Examination.

3. For each examination a Board of Examiners shall be constituted by the Senate and the Board of Examiners shall comprise the teachers in the subjects of examination and the additional examiner or examiners and other experts.

4. No student may present himself for examination in any subject until he has duly completed the prescribed courses of instruction to the satisfaction of teachers concerned.

5. *The First Examination*:

(i) The First Examination shall be taken in three sections consisting of two Terminal Examinations each covering the term's work and an End-sessional Examination covering the entire course for the First Examination.

(ii) A student shall be deemed to have passed the First Examination provided he has secured on the total of the two Terminal and the End-sessional Examinations requisite minimum marks in the written paper or papers of each subject, in each of the sessional assignments, in the practicals and in the aggregate.

6. *The Final Examination*:

(i) No student may present himself for examination in any subject of the Final Examination until he has passed the whole of the First Examination.

(ii) The Final Examination shall consist of two Terminal Examinations each covering the term's work and an End-sessional Examination covering the entire course of the Final Examination and a *Viva-Voce* Examination.

(iii) A student shall be deemed to have passed the Final M.Sc. Examination provided he has secured on the total of the two Terminal and the End-sessional Examinations requisite minimum marks in the written paper or papers of each of the subjects, in each of the sessional assignments, in the practicals, in the Final *Viva-Voce* Examination, and in the aggregate.

7. *The Maximum Mark*: The maximum marks for the First and Final Examinations shall be the total of the maximum marks prescribed for the subjects of the respective End-sessional Examination plus fifty percent of the total of the maximum marks prescribed for the subjects of the two Terminal Examinations.

8. *The Weighted Maximum Marks*:

(i) The weighted maximum marks for the First Examination shall be the maximum marks of the First examination.

(ii) The weighted maximum marks for the Final Examination shall be the maximum marks of the Final Examination plus the weighted maximum marks of the First Examination.

9. A student passing both the First and Final Examinations shall be declared to have qualified for the M.Sc. Degree in the appropriate branch on the basis of his overall performance in the First and Final Examinations.

10. The students found qualified for the M.Sc. Degree shall, in each branch, be classified in two groups to be denominated respectively First and Second Class on the basis of the weighted total marks they secure out of the weighted maximum marks of the Final Examination. The names of the students in the First class shall be arranged in order of merit and those in the Second class in the alphabetical order.

11. The students satisfying all the conditions prescribed and having passed the prescribed examinations shall be entitled to receive the Degree of Master of Science (M.Sc.) in the appropriate branch.

12. For the Degree of Master of Science in any branch, as set forth above, the graduate shall receive a Diploma wherein shall be set forth the branch of study in which he has obtained the Master's Degree and the Class in which he has been placed.

SCHEDULE XXI

REGULATION No. 27

Schedule of courses and distribution of marks for Two-year M.Sc. degree courses in Chemistry, Mathematics and Physics

I. CHEMISTRY

FIRST YEAR

Subject No.		Subjects for the First Examination	All Terms: Hours per Week		All Terms: Marks	No. of papers for Exam.	Duration of Exam. paper
Ch	401	Physical Chemistry—I	4	0	200— 0	2	2 hrs. each
Ch	402	Organic Chemistry—I	4	0	200— 0	2	2 hrs. each
Ch	403	Inorganic Chemistry—I	4	0	200— 0	2	2 hrs. each
Ch	404	Principles and Techniques of Analytical Methods ...	2	0	100— 0	1	2 hrs.
Ch	405	Advanced Chemistry Lab.—I	0	15	0—600	—	—
		*Elective (any one)	2	0	100— 0	1	2 hrs.
		Viva/Term paper	—	—	0—100	—	—
			16	15	800—700	8	

**Electives*
Ch 406 Mathematics
Ch 407 Physics

SECOND YEAR

Group A—**Physical Chemistry Option**

Subject No.		Subjects for the Final Examination	All Terms: Hours per Week		All Terms: Marks	No. of papers for Exam.	Duration of Exam. paper
Ch	506	Advanced Physical Chemistry—I	4	0	200— 0	2	2 hrs. each
Ch	507	Advanced Physical Chemistry—II	4	0	200— 0	2	2 hrs. each
Ch	502	Organic Chemistry—II	2	0	100— 0	1	2 hrs.
Ch	503	Inorganic Chemistry—II	2	0	100— 0	1	2 hrs.
Ch	505	Advanced Chemistry Lab.—II	0	12	0—600	—	—
		†*Elective (any one of the Physical Chemistry group of subjects)	4	0	200— 0	2	2 hrs. each
		Viva/Term paper	—	—	0—100	—	—
			16	12	800—700	8	

SECOND YEAR

Group B—**Organic Chemistry Option**

Subject No.		Subjects for the Final Examination	All Terms Hours per Week		All Terms Marks	No. of papers for Exam.	Duration of Exam. papers
Ch	508	Advanced Organic Chemistry—I	4	0	200— 0	2	2 hrs. each
Ch	509	Advanced Organic Chemistry—II	4	0	200— 0	2	2 hrs. each
Ch	501	Physical Chemistry—II	2	0	100— 0	1	2 hrs.
Ch	503	Inorganic Chemistry—II	2	0	100— 0	1	2 hrs.
Ch	505	Advanced Chemistry Lab.—II	0	12	0—600	—	—
		**Elective (any one of the Organic Chemistry group of subjects)	4	0	200— 0	2	2 hrs. each
		Viva/Term paper	—	—	0—100	—	—
			16	12	800—700	8	

Group C—**Inorganic Chemistry Option**

Subject No.		Subjects for the Final Examination	All Terms: Hours per Week		All Terms: Marks	No. of papers for Exam.	Duration of Exam. papers
Ch	511	Advanced Inorganic Chemistry—I	4	0	200— 0	2	2 hrs. each
Ch	512	Advanced Inorganic Chemistry—II	4	0	200— 0	2	2 hrs. each
Ch	501	Physical Chemistry—II	2	0	100— 0	1	2 hrs.
Ch	502	Organic Chemistry—II	2	0	100— 0	1	2 hrs.
Ch	505	Advanced Chemistry Lab.—II	0	12	0—600	—	—
		***Elective (any one of the Inorganic Chemistry group of subjects)	4	0	200— 0	2	2 hrs. each
		Viva/Term paper	—	—	0—100	—	—
			16	12	800—700	8	

ELECTIVE SUBJECTS

†**Group A*—**Physical Chemistry Option**

Ch 513 Advanced Catalysis.
Ch 514 Chemistry of High Pressure.
Ch 515 Chemistry of High Polymer and Rubber.

***Group B*—**Organic Chemistry Option**

Ch 516 Synthetic Drugs.
Ch 517 Chemistry of Natural Products.

****Group C*—**Inorganic Chemistry Option**

Ch 518 Chemistry of Co-ordination compounds.
Ch 519 Nuclear and Radio Chemistry.

II. MATHEMATICS

FIRST YEAR

Subject No.		Subjects for the First Examination	All Terms		No. of papers for examination	Duration of exam. paper.
			Hours per week	Marks		
Ma	401	Analysis, Theory of Real Variable and Complex Variable	4 0	200— 0	1	3 hrs.
Ma	402	Numerical Methods and High Speed Computations ...	4 0	200— 0	1	3 hrs.
Ma	403	Differential and Integral equations (Ordinary and partial) and functions	4 0	200— 0	1	3 hrs.
Ma	404	Differential Geometry, Tensors, Linear Algebra ...	4 0	200— 0	1	3 hrs.
Ma	405	Continuum Mechanics—I	4 0	200— 0	1	3 hrs.
Ma	406	Mathematical Computation Laboratory	0 5	0—100	—	—
		Sessional	— —	0—300	—	—
		Viva/Term paper	— —	0—100	—	—
			20 5	1000—500	5	

SECOND YEAR

Subject No.		Subjects for the Final Examination	All Terms				No. of papers for examination	Duration of exam. paper.
			Hours per week		Marks			
Ma	501	Analytical Dynamics, Theory of Potentials ...	4	0	200—	0	1	3 hrs.
Ma	502	Modern Algebra, Foundation of Geometry and Projective Geometry	4	0	200—	0	1	3 hrs.
Ma	503	Probability and Statistics	4	0	200—	0	1	3 hrs.
Ma	504	Electromagnetic Theory and Special Theory of Relativity	4	0	200—	0	1	3 hrs.
		*Elective (any one)	4	0	200—	0	1	3 hrs.
Ma	508	Statistical Laboratory	0	5	0—	100	—	—
		Sessional	—	—	0—	300	—	—
		Viva/Term paper	—	—	0—	100	—	—
			20	5	1000—	500	5	

*Elective Subjects:
Ma 505 Continuum Mechanics—II.
Ma 506 General Theory of Relativity.
Ma 507 Advanced Statistics.

III.

FIRST

Subject No.		Subjects for the First Examination	Hours per Week					
			First Term		Second Term		Third Term	
Ph	401	Mathematical Methods in Physics ...	2	0	2	0	2	0
Ph	402	Mechanics—I	2	0	2	0	2	0
Ph	403	Thermodynamics and Statistical Mechanics ...	2	0	2	0	2	0
Ph	404	Electromagnetic Theory	4	0	2	0	2	0
Ph	405	Optics	2	0	2	0	2	0
Ph	406	Quantum Mechanics I	2	0	2	0	2	0
Ph	407	Special Theory of Relativity	—	—	2	0	2	0
Ph	408	Electrical and Electronic Measurements ...	2	0	2	0	2	0
Ph	409	Advanced Physics Lab. I	0	15	0	15	0	15
		Viva/Term Paper	—	—	—	—	—	—
			16	15	16	15	16	15

PHYSICS

YEAK

First Term Marks	No. of papers for exam.	Duration of exam. papers	Second Term Marks	No. of papers for exam.	Duration of exam. papers	Third Term Marks	No. of papers for exam.	Duration of exam. papers
100— 0	1	2 hrs.	100— 0	1	2 hrs.	100— 0	1	3 hrs.
100— 0	1	2 hrs.	100— 0	1	2 hrs.	100— 0	1	3 hrs.
100— 0	1	2 hrs.	100— 0	1	2 hrs.	100— 0	1	3 hrs.
200— 0	2	2 hrs. each	100— 0	1	2 hrs.	100— 0	1	3 hrs.
100— 0	1	2 hrs.	100— 0	1	2 hrs.	100— 0	1	3 hrs.
100— 0	1	2 hrs.	100— 0	1	2 hrs.	100— 0	1	3 hrs.
— — —	—	—	100— 0	1	2 hrs.	100— 0	1	3 hrs.
100— 0	1	2 hrs.	100— 0	1	2 hrs.	100— 0	1	3 hrs.
0—600	—	—	0—600	—	—	0—600	—	—
0—100	—	—	0—100	—	—	0—100	—	—
800—700	8		800—700	8		800—700	8	

SECOND YEAR

Subject No.		Subjects for the Final Examination	All Terms Hours per week		All Terms Marks	No. of papers for examination	Duration of exam. paper.
Ph	502	Mechanics—II	2	0	100— 0	1	2 hrs.
Ph	506	Quantum Mechanics—II	2	0	100— 0	1	2 hrs.
Ph	511	Atomic Physics and Spectroscopy	2	0	100— 0	1	2 hrs.
Ph	512	Nuclear Physics and Cosmic Rays	2	0	100— 0	1	2 hrs.
Ph	513	Statistical Mechanics & Properties of Matter ...	4	0	200— 0	2	2 hrs. each
		*Elective (any one)	4	0	200— 0	2	2 hrs. each
Ph	509	Advanced Physics Laboratory II	0	12	0—600	—	—
		Viva/Term Paper/Seminar	—	—	0—100	—	—
			16	12	800—700	8	

*Elective subjects—
Ph 514 X'Rays and Structure of Matter.
Ph 515 Solid State Physics.
Ph 516 Nuclear Physics and Elementary Particles.

DISTRIBUTION OF MARKS

(For each Examination)

Examination		1st Term Marks	2nd Term Marks	End-Sessional Marks	Maximum Marks	Weighted Maximum Marks
First	...	1,500	1,500	1,500	3,000	3,000
Final	...	1,500	1,500	1,500	3,000	6,000

SCHEDULE XXII

REGULATION NO. 28

Subjects of Instruction for 2-Year Master of Science (M.Sc.) degree courses

CHEMISTRY (Ch)

401. Physical Chemistry I (4-0)

Gaseous State: Review of equations of state for gases ; Molecular velocities—average velocity, root mean square velocity, most probable velocity, Maxwell's law of distribution of velocity and energy, mean free path, collision frequency, viscosity, thermal conductivity, and diffusivity ; heat capacities and equipartition of energy.

Liquid State: Internal pressure of liquids, structure of liquids, the Vitreous state.

Solid State: The crystalline form, symmetry properties of crystals, diffraction of X'rays and electronwaves by crystals, Structure of solids, and heat capacities.

Thermodynamics: The fundamental concepts, first and second laws of thermodynamics and their applications to chemical systems, ideal and real gases, ideal and non-ideal solutions, partial and molar quantities, equilibrium systems, third law of thermodynamics and its application to chemical systems, free energy calculations.

Chemical Equilibrium: Thermodynamic derivation of the law of mass action, reaction isotherm and isochore, effect of temperature and pressure on equilibrium, determination of equilibrium constant in homogeneous and heterogeneous reactions.

Solution: Thermodynamics of dilute solution, non-ideal solutions and activity concept.

Phase rule and heterogeneous equilibrium: Derivation of phase rule equilibrium, Gibb's Duhem equation and distillation of liquid mixtures, Nernst law of distribution, phase diagram of two and three component systems.

Electrochemistry: Debye-Hückel theory of strong electrolyte, Onsager's equation, non-aqueous solvents, e.m.f. of reversible electrodes, galvanic and concentration cells, secondary cells, liquid junction potential, activity coefficient and its determination, acids and bases, ionic product of water, pH, hydrolysis of salts, theory of indicators, potentiometric titrations, electrolysis, decomposition voltage, overvoltage and polarisation.

402. Organic Chemistry I (4-0).

General theories of organic chemistry. Resonance and resonance energy. Electronic theories and mechanism of important organic reactions. Addition and substitution reactions. Elimination reactions. Isomeric changes, molecular rearrangements.

Unsaturation and conjugation. Electrophilic and nucleophilic substitution at unsaturated carbon atom. Natural and synthetic rubber. Synthetic plastics and fibres.

Terpenes: Introduction. Isoprene rule. Isolation and general methods of determining structures of terpenes. Classification. Detailed studies of open chain, monocyclic and bicyclic terpenes (one or two examples in each group).

Heterocyclic compounds: Compounds containing one hetero atom (Nitrogen, Sulphur, Oxygen) only. Studies of Furan, Pyrrole, Thiophene, Pyridine.

Alkaloids: Introduction and general treatment. Studies of Ephedrine, Nicotine, Conine, Cocaine, Atropine.

Synthetic Dye-Stuffs: Relation between colour and constitution. Nomenclature and classification of dyes. Nitro dyes, Nitroso dyes, diphenylmethane dyes, vat dyes, anthraquinoid dyes, Cyanine and Phthalocyanine dyes.

Aminoacids and Proteins: Introduction, classification. Isolation of amino acids. General methods of preparation and properties of amino acids. Polypeptides, synthesis, general properties and structure.

403. Inorganic Chemistry I (4-0).

Modern valency theory and nature of chemical bond.

Mode of occurrence, preparation and properties of elements and their important compounds treated from the point of electronic arrangements. Detailed and critical study of the periodic classification of elements.

Chemistry of the following elements and their relations with other elements in the periodic Table.

Be, Sc, Y, rare earths (general treatment only), Ga, In, Tl, Ti, Zr, Hf, Th, Ge, V, Nb, Ta, Mo, W, U, Se, Te and the platinum metals.

Orthohydrogen and parahydrogen, Active hydrogen, Active Nitrogen.

Boron hydrides and other recently discovered hydrides.

Peroxides and peracids.

Iso and Heteropoly acids.

Carbonyls, nitrosyls and allied compounds.

Inorganic rubber, Borazides, silicones and silicane.

Theory of Acids and Bases, reactions in nonaqueous media with particular reference to liquid ammonia and liquid sulphur-dioxides.

Complex compounds and their isomerism treated in details.

Recent developments in the chemistry of halogens.

404. Principles and Techniques of analytical methods (2-0).

Colorimetry: Visual and photo electric, Turbidimetry and Nephelometry.

Spectrophotometry: Ultraviolet and Visible and Infrared.

Emission Spectrography and Raman Spectrography.

X'Ray and Electron diffraction.

Mass Spectrometry.

Refractometry and Interferometry.

Polarimetry.

Chromatography and Ion exchange.

Conductometry, Potentiometry and Polarography.

Magnetochemical methods: Magnetic susceptibility and nuclear magnetic resonance.

Dielectric constant and Dipole Moment.

Methods of Gas Analysis: Classical, Thermal conductivity and Gas Chromatography.

405. Advanced Chemistry Lab. I (0-15).

Physical: Experiments involving the determination of density, Viscosity, surface tension and refractive index of pure liquids-solution.

Determination of molecular weight-degree of dissociation by vapour density, freezing point and boiling point methods.

Determination of equilibrium constant of the reaction $KI + I_2 = KI_3$.

Determination of the rate of hydrolysis of an ester (by titration) of cane sugar (by polarimeter).

Calibration of a thermocouple and study of the cooling curve of an alloy.

Determination of heat of neutralisation.

Determination of cell constant, specific conductivity of a solution and the degree of hydrolysis of a salt. Conducto-metric titration of an acid.

Determination of e.c.e. and transport number of an ion.

Organic: General operations for the purifications of compounds. Preparation of organic compounds of an advanced character.

Identification of simple organic compounds by systematic procedure. Separation of compounds from two component mixture containing acidic, basic and neutral substances and their identifications.

Quantitative determination of hydroxyl, amino, ester, amide, and carboxyl groups, Estimation of aldehydes. Molecular weight of an acid by the Ag salt method and by titration.

Inorganic: Qualitative analysis of mixtures containing not more than six ions including interfering ones and insoluble ones, ores and alloys by macro and semi-micromethods. Quantitative estimation of the following either alone or in mixtures, ores and alloys, by volumetric and gravimetric methods:

Ag, Pb, Cu, As, Sb, Sn, Fe, Al, Cr, Ni, Mn, Zn, Ca, Ba, Mg, SO_4, CO and CO_3.

406. Mathematics (2-0).

1. Functions of two and more variables—idea of continuity and limit—Rules of differentiation and higher derivatives—Total differentials—Maxima and minima.

2. Integration as area and limit of sum—Standard methods of integration—Definite integral including improper integral with applications to area, length volume.

3. Determinents of second, third and fourth order—linear transformation—matrices—Addition and multiplication and simple application to linear equation.

4. Complex numbers—Argands diagram—Demoivers theorem—Interrelation between trigonometric and hyperbolic functions.

5. Vector analysis—Addition—Scalar and vector multiplication—Triple product—Gradient of a scalar—Curl of a vector-orthogonal curvilinear coordinates—cylindrical and polar coordinates—Divergence theorem & Stokes theorem—Greens theorem (without proof).

6. Fourier series—Statement of Dirichlet conditions and coefficient calculation and application.

7. Ordinary differential equations of first order and second order—Linear differential equations with constant and variable coefficients—Solution by the method of series—Bessel's equation, Legenderes equation—simple partial differential equations—Laplace, poisson equation—One dimensional heat flow, wave equation.

8. Elements of probability theory: Definitions—Total and compound probabilities—Random variables—Probability distributions—Expectation and Moments—Special distributions (i) Binomial (ii) Poisson and (iii) Filters Normal.

407. Physics (2-0).

Elementary electronics. Tube constants, tube characteristics of diode, triode and pentode. Basic amplifiers. Power supply, rectifiers, Stabilised power supply. Cathode follower, push, pull amplifier. Common circuits and electronic instruments.

Introduction to magnetic and dielectrical properties of solids. Maxwell Boltzman, Fermi Driact and Bose Einstein statistics and their applications.

Introduction to solid state physics band theory of solids-band structure of matter, transition elements, alloys, Semiconductors—surface properties of semiconductors and thin films.

501. Physical Chemistry II (2-0).

Chemical Kinetics and Catalysis: Study of reactions of first, second and third order, consecutive reactions, back reactions and chain reactions, atomic reactions and ionic reactions and reactions in solution, mechanism of the chemical reactions.

Physical and chemical adsorption, adsorption isotherm, theories of catalysis, industrial applications of catalysis, kinetics of heterogeneous reactions, negative catalysis.

Photochemistry: Laws of absorption of light, measurement of high absorption and its application, first and second laws of photochemistry, elements of theoretical and practical photo chemistry, photosensitisation, elements of theoretical and practical photochemistry.

Colloid and surface chemistry : Gibbs' adsorption equation, surface films, adsorption of solids from solution, electrokinetic phenomena and zeta potential, electrocapillary phenomena, origin of charge on colloid, stability of lyophobic colloids, coagulation, protective action, size of colloidal particles Brownian motion and distribution of particles, Donnan membrane equilibrium, colloidal electrolytes, emulsions, detergents and gels.

502. Organic Chemistry II (2-0).

Physical properties and chemical constitution: Bond energy, Dissociation constants, Dipole moments. U.V., I.R., N.M.R. and Mass spectra as applied to organic structures. Optical rotatory dispersion.

Stereochemistry: Configuration and optical activity of diphenyl molecules.

Steric effects in Organic chemistry. Structure and Mechanism.

Acetylenes: Introduction to higher acetylene chemistry and its role in synthetic organic chemistry.

Application of Lithium aluminium hydride, sodium borohydride, N-bromosuccinimide, lead tetraacetate, periodic acid, alkali metals in liquid ammonia, diazomethane, diazoacetic esters, organolithium compounds and polyphosphoric acid in synthetic organic chemistry.

Vitamins: Introduction. Study of the following vitamins: Vitamin B_1, Vitamin B_2, Pyridoxine and Niacin.

Recent advances in organic chemistry of Free radicals. Reactions involving free radicals. Mechanism of polymerisation.

503. Inorganic Chemistry II (2-0).

General treatment of the chemistry of nontransitional elements.

Chemistry of the transition elements: (*a*) coordination complexes, (*b*) crystal field and ligand field theory, (*c*) complexes with π—bonding ligands, (*d*) organometallic compounds, (*e*) elements of the first transition series, (*f*) elements of the second and third transition series, (*g*) lanthanides and actinides.

Nuclear structure, Fission and Fusion reactions, Radioactive indicators and tracers.

Metals and intermetallic compounds.

505. Advanced Chemistry Lab. II (0-12).

Physical:

Electrochemistry: Determination of e.m.f. of a concentration cell, pH (e.m.f. method), transition temperature ; potentio-metric titration.

Colloid Chemistry: Preparation, properties of colloids and to determine speed of cataphoresis.

Verification of Beer's Law and determination of molecular extinction coefficient.

Identification of elements by spectroscope.

Column and paper chromatography.

Gas analysis : Chemical kinetics, determination of surface area of solids, studies on the kinetics of complex reactions (polymerisation) determination of the molecular weight distribution of a macromolecule, use of the D.T.A. technique to study the heat of structure change.

Elementary idea about handling of equipment used in (*a*) processing and testing of elastomers or (*b*) high pressure reactions.

Organic : Preparation of organic compounds involving two or three stages and based on important name reactions.

Use of special equipment for small scale preparations. Semimicro preparations. Resolution of racemic mixtures by chemical method.

Special techniques : Paper chromatography, U.V., and I.R. spectra, Catalytic hydrogenations, Periodate titrations, Molecular weight by Rast Method. Qualitative analysis. Identification of difficult compounds containing not more than two functional groups.

Quantitative analysis : Semimicro determination of C, H, N and halogens. Estimation of—COOH, —OH, —OMe, and acetyl groups. Determination or unsaturation. Estimation of sugars.

Inorganic : Qualitative analysis of mixtures containing not more than eight ions including rare metals.

Preparation of inorganic compounds of more difficult type. Quantitative analysis of more complex mixture and instrumental analysis.

506. Advanced Physical Chemistry I (4-0).

(In addition to the portions covered in Ch 501—Physical Chemistry II).

Chemical Kinetics : Theory of rate processes, theory of absolute reaction rates, a detailed analysis of energy of activation and activation volume.

A more elaborate treatment of chain reactions, reactions in solution, ionic reaction, atomic reaction and heterogeneous reaction.

Chemical Crystallography : Geometry of X-ray reflection, Bragg equation, reciprocal lattice, powder photograph and its interpretation, unit cell dimensions and positions of atoms, electron diffraction studies of thin films, neutron diffraction, evidence on crystal structure from physical properties.

Electrochemistry : Modification and extension of Debye—Hückel theory, dissociation constants of weak electrolytes in aqueous and non-aqueous medium, irreversible electrode phenomena, mechanism of cathodic and anodic processes discharge of H^+, discharge of metals, discharge of anions, anodic solutions, theory of overvoltage, energy affinity in irreversible electrode phenomena, passivity and corrosion.

507. Advanced Physical Chemistry II (4-0).

Quantum Mechanics : Limitations of old quantum theory, Heisenberg's uncertainty principle, origin of wave mechanics, analogy between optics and mechanics (semi quantitative treatment), de Broglie, relation ; electron diffraction, dual nature of light and matter ; Schroedinger equation for a particle in a box, quantisation of wave mechanics, Schroedinger equation for linear harmonic oscillator, solution by the polynomial method, Schroedinger equation for the hydrogen atom, separation of variables and indication of the method of solution, discussion of spherically symmetrical solutions of the wave equation of the hydrogen atom considered as one body problem. Angular momentum and its directional quantisation. Problem of two electrons. Exchange degencracy. Elements of perturbation theory. Exchange energy of helium atom. Electron spin. Hydrogen molecule. Valency. Resonance, Periodic system of elements.

Introduction to Statistical Mechanics : Principles of statistical mechanics, elements of probability theory, the ensemble in statistical mechanics, the isolated equilibrium system, system in equilibrium with a heat bath, energy and entropy in statistical mechanics, ideal gas, classical gas, and quantum gas—partition function, equilibrium constant for ideal gas reactions and heat capacity of gases.

508. Advanced Organic Chemistry I (4-0).

Polycyclic aromatic hydrocarbons: Various synthetic routes to polycyclic aromatics. Carcinogenic hydrocarbons and their nitrogen isologs.

A general study of *Azulenes* and *Tropolones*.

Carotenoids: Introduction. Carotenes. Caratenoid acids. Vitamin A.

Terpenes: Sesquiterpenes, Diterpenes and Triterpines. General study. Chemistry of one example of each group.

A general study of quinones, flavones, flavonoids, anthocyanines and xanthones (one or two example in each group).

Studies of naturally occurring benzoquinones, naphthoquinones and anthroquinones. *Vitamin K*. Dicoumarol and blood anticoagulants.

Chemistry of disaccharides (Maltose, lactose, sucrose and cellobiose) and polysaccharides (starch, glycogen and cellulose). Ascorbic acid.

509. Advanced Organic Chemistry II (4-0).

Heterocyclic compounds: Quinoline and Isoquinoline. Indole. Diazine and their benzo derivatives. Iminazole, Oxazole and Thiazole. Pteridine. Folic acid. Antimalarial and antiamoebic drugs.

Alkaloids. Detailed study of papaverine, quinine, emetine, reserpine and lysergic acid. Drugs affecting central nervous system.

Recent advances in *Protein* chemistry.

Enzymes. Nomenclature, classification. Conditions for enzyme action and their mechanism. Chemistry of *Coenzymes*.

Purines. Introduction. Uric acid and other purine derivatives. *Diuretics*.

Chemistry of nucleic acid. Anticancer drugs.

511. Advanced Inorganic Chemistry I (4-0).

Detailed study of d-block and f-block transition elements.

Stereochemistry of various transition metal ions.

Ligand field theory and its application in coordination compounds.

Magnetic and dielectric properties of solids. Band theory of solids and band structure of matter, alloys and semi-conductors.

Detailed study of natural and artificial radioactivity ; Nuclear structure. Mattauch's rule. Methods of study of fission products of heavy elements.

512. Advanced Inorganic Chemistry II (4-0).

Quantum mechanics: Heisenberg's uncertainty principle, de Broglie relation, Schroedinger equation for the hydrogen atom, Angular momentum and its directional quantisation, Problem of two electrons, Exchange degeneracy, Variation theory, Perturbation theory, Exchange energy of helium atom, electron spin, hydrogen molecule.

Introduction to Statistical Mechanics: Principals of statistics, mechanics, elements of probability theory, the ensemble in statistical mechanics, the isolated equilibrium system, system in equilibrium with a heat bath, energy and entropy in statistical mechanics, ideal gas, classical gas and quantum gas—partition function, equilibrium constant for ideal gas reactions and heat capacity of gases.

Crystal Chemistry: Symmetry in inorganic chemistry, non-stoichiometric compounds, Lattice defects. Organic reagents in inorganic analysis.

513. Advanced Catalysis (4-0).

Catalysis and Catalysts: functions of a catalyst homogeneous and heterogeneous (contact) catalysis. General scheme of contact catalysis. Adsorption and catalysis, Physical and Chemical adsorption. Adsorption data: isotherms, isobars and isosters. Heats of adsorption. Methods of adsorption studies. Multilayer adsorption and capillary condensation. B.E.T. Theory. Surface area measurements.

Activated adsorption. Active centres. Catalyst surface. Homogeniety and Heterogeneity of surfaces. Geometric factors in adsorption and catalysis. Structure of solids and their examination by electron microscope, electron diffraction, X-ray diffraction and Differential Thermal Analysis.

Theories of Metals and Alloys: Electrical and Magnetic properties of metals, insulators and semi—conductors. Electronic factor in adsorption and catalysis. Magnetism and catalysis. Poisons and inhibitors, carriers, promoters and accelerators. Mixed and Dual function catalysts. Mechanism of some individual reactions.

Kinetics of contact catalytic processes. Velocities of adsorption and desorption. Diffusion. Energy of activation. Real and apparent orders of a reaction. Parallel and consecutive reactions. Rate determining steps in heterogeneous reactions. Interpretation of kinetic data for explaining reaction mechanism.

Some technical aspects of catalysiss Preparation and characterisation of catalysts. Techniques of adsorption measurements and reaction studies. Catalysts used in some common industries.

514. Chemistry of High Pressure (4-0).

Uses and scope of high pressure in chemical synthesis. Synthesis of ammonia, methanol and higher alcohols. Fischer Tropsch and allied synthesis. Hydrogenation of coal, tar and oils by Bergius process. Synthesis of urea, polymerisation of olefines, etc. Recent advances in the high pressure chemistry of carbon monoxide and acetylene.

Selection of materials for high pressure work for service at ordinary, low and high temperatures. Design and construction of pressure vessels. Thin walled cylinders, gas storage cylinders. Thick cylinder. Theories of elastic failure. Joints and closures; Piping, valves and fittings. Flowmeters. Design and construction of chemical autoclaves. Catalytic circulatory plants.

P. V. T. relationships of gases and liquids, specific heats of gases, viscosity of gases, etc. at high pressure.

515. Chemistry of High Polymer & Rubber (4-0).

Introduction to and classification of high polymers; kinetics of polymerisation and copolymerisation.

Molecular weights of high polymers, distribution of molecular weights and chain length in simple systems, thermodynamics of polymers solution.

Chemistry of natural and synthetic elastomer and important compounding ingredients.

Techniques of and principles involved in processing of elastomers, ageing of rubbers.

Rheology and statistical theory of rubber elasticity.

ELECTIVE (ORGANIC GROUP)

516. Synthetic Drugs (4-0).

Chemotherapy: Introduction. Relation between structure and physiological action. Mechanism of action. Chemotherapy of some tropical diseases.

Organic Sulphur compounds: Sulphonamides and sulphones. Antitubercular and anti-leprosy drugs.

Analgesics and antipyretics: Morphine and morphine substitutes. Local and General Anaesthetics.

Introduction to Cardiac glycosides. Cardiovascular drugs.

Antibiotics: Penicillins, Streptomycin, Chloramphenicol, Tetracyclines and macrolides (one example only).

Horomones: Introduction. Classification. Chemistry of Adrenaline, Thyroxine. *Steroids*. Chemistry of Estrone, Andosterone and progestrone. Synthetic estrogens. Deoxycorticosterone and cortisone. Antifertility agents.

Synthesis of porphyrins. Structure of Chlorophyll, Haematin and haemoglobin. A general study of *Vitamin* B_{12}.

517. Chemistry of Natural Products (4-0).

Introduction, sources and classification of natural products, historical background of application of natural products as drugs—its growth and development. Relation of natural drugs with synthetic drugs. Advantages and disadvantages. Testing of drugs, mechanism of action, absorption, distribution, fate and excretion of drugs. Relation of chemical structure and biological activity, effect of solubility on duration of action of drugs, oxidation—reduction potentials and other related physical properties of drugs.

Bio—isosterism and bio—isosteric groups. Chemotherapy introduction, biological staining and classification of organisms, testing of chemotherapeutic drugs, mechanisms of the therapeutic action.

Detailed studies of alkaloids, steroids and hormones, proteins and amino acids, carbohydrates, vitamins, antibiotics, enzymes, purine derivatives, terpenes azulenes, and tropolones.

ELECTIVE (INORGANIC GROUP)

518. Chemistry of Coordination Compounds (4-0).

Ligand field theory: Correlation of structure, magnetic property and spectra of transition metal complexes.

Studies on metal ion complex formation in solution. Reaction rates of transition metal complex formation, decomposition and substitution.

Thermodynamics and kinetics of stereochemical changes in coordination compounds.

Ultraviolet, visible and infrared spectra of complex compounds.

Magnetochemistry of coordination compounds.

Use of ESR, EPR, NMR and Moss-bauer effect in the study of coordination complexes.

519. Nuclear and Radiochemistry (4-0).

Short historical development of nuclear theory.

Current picture of nuclear structure, properties of nucleus, binding energy, nuclear forces, energy levels in nuclei, stability rules, Liquid drop model and mass equation, shell model and magic number.

Radioactive decay processes, equations for decay and growth of radioactive substance, secular and transient equilibrium, theories of α and β decay.

Introduction of radiation with matter, range and energy determination of α and β particles. Energy determination of γ-rays, positrons and neutrons.

Detection of radiation, types of detection instruments, Ionisation chambers, GM tubes, proportional counter, Scintillation counters and coincidence counting.

Errors in radioactivity measurements, Geometry of the counters, Radioactivity as a statistical phenomenon review of distribution laws, Calculation of standard deviation in counting.

Induced nuclear reactions, conservation laws in nuclear reactions, Bohr's compound nucleus theory, potential carrier, reaction threshold, cross section, excitation function, Soppenheimer-Phillips process spallation, fission process, nuclear chain reaction, four factor formula, nuclear reactors (elementary theory, types and use), nuclear energy in India. Particle accelerators.

Principles of separation and identification of radio activities from irradiated or naturally occurring substances, precipitation methods.

NOTE: Some practical work in radiochemistry should be arranged.

Finding plateau of a GM counter.

Micropipetting and mounting of samples.

Statistics of counting with T1204.

Determining energy of particle by absorption.

Finding half life period of Mn56.

Isotopic and non-isotopic carriers, electrodepositions, ion exchange, solvent extraction, adsorption, volatilisation, Isotopic exchange law.

Chemical effects of nuclear reactions, physical basis, neutron capture, isomeric transition, other reactions, Szilard-Chalme r's process.

Chemical effects of nuclear radiation dosage, roentgen ray, rep. rem. R.B.E. biological effect of radiation, radiation protection, radiation hazards, shielding.

Application of radioisotopes in Analytical Chemistry.

Energy production in stars, Geo and cormochronology, Genesis of elements.

MATHEMATICS (Ma) 3(56)

401. Analysis—Theory of real and Complex variable (4-0).

Real Variable: Elements of point set theory: Finite, countable and uncountable sets, open set, closed set, connected set, compact set, perfect set.

Metric spaces: The real and complex numbers looked upon as metric spaces: limit, continuity, sequence, series defined on metric spaces.

Theory of Riemann-Stieltjes Integral: Definition and existence of the integral, the integral as a limit of sums, the fundamental theorem of integral calculus, functions of bounded variation.

The Lebesque Theory: Set functions, construction of the Lebesgue measure; measure spaces, measurable functions, simple functions, Integration, comparison with Riemann integral.

Fourier series and integral (rigorous treatment).

Complex Variable: Linear transformations and their group properties. Conformal transformation including Schwartz-Christoffell transformation. Power series in complex variable, term by term differentiation and integration. Jordan's theorem (statement only) and related lemmas. Complex integration. Couchy's integral theorem (rigorous proof) and its consequences. Taylors and Laurent's series. Analytic continuation. Poles, branch points and essential singularities. Behaviour near singular points. Contour integration (including problems involving branch points). Riemann surfaces. Selected advanced topics of current interest (like function of several variables etc.).

402. Numerical Methods and High Speed Computations (4-0).

System of linear and non-linear algebraic equations, Linear and non-linear difference equations. Partial differential equations with initial and boundary value problems. Variational methods. Stability of non-linear systems. Topological spaces, operators, Matrices as operators in vector spaces, Derivatives of operators. Elements of approximation theories, estimation of errors, various computational methods. High speed computation.

403. Differential and Integral Equations (ordinary and partial) and special funstions (4-0).

Differential and Integral equations: Geometrical interpretation, classification of equations and their solutions. Power series solutions and existence theorems. Linear differential equations of first and second order, adjoint systems, self-adjoint equations. Non-linear equations. Elliptic equations. Poisson equation and the fundamental solution, boundary value problems, eigen functions and expansions. Dirichlet's problem for Poisson's Characteristic surfaces, bicharacteristics. Discontinuities and singularities. Hyperbolic equations. Propagation of waves, initial value problems. Simple parabolic equations and their solutions.

Simple cases of standard integral equations. Use of integral transforms in the solution of equations, Laplace and Mellin transform and inversion, elementary ideal of other transforms.

Special functions: Gamma function. Hypergeometric and confluent hypergeometric functions. Legendre and Bessel's function. Elliptic function. Methieu function.

404. Differential Geometry, Tensors, Linear Algebra (4-0).

Differential geometry: Curves in space, Envelopes, Ruled surfaces, Curvature of surfaces, Lines of curvature. Asymptotic lines. Null lines. Geodesics. Minnardi-Godazzi equations. General ideas of Riemann Geometry.

Tensors: Spaces of N-dimensions. Coordinate transformations, summation conventions. Contravariant, covariant and mixed tensors. Kronecker delta, Tensors of rank greater than two. Scalers of invariants. Two point tensor fields. Symmetric and skew symmetric tensors. Fundamental operations with tensors. Metric tensors, invariants.

Application of tensors to physical problems: Form Invariance of physical laws, base vectors, physical components, stress and strain tensor. Covariant derivative and its physical meaning.

Linear Algebra: Linear Transformations and Matrices:—Linear transformation, Matrix of a linear transformation, Composition of matrices, Rank of a matrix, Transpose of a matrix. Symmetric, Skew-symmetric, Hermitian and unitary matrices.

Determinant, Non-singular matrix, Adjoint of a matrix, Inverse of a matrix.

Similarity of matrices, Characteristic polynomial of a matrix, Cayley-Hamilton theorem.

405. Continum Mechanics I (4-0).

Hydrodynamics: Invidcid Flow: Lagrangian and Eulerian method, velocity, acceleration and strain-rate tensor. Euler's Dynamical equation, Bernoulli's theorem, Sources, sinks and doublets in two and three dimensions, method of images. Irrotational motion, constancy of circulation, Motions of cylinder and sphere in perfect fluid. Kutta and Joukowski theorem, Discontinuous motion, free stream lines, jets of liquid through a fit in plane barrier, Borda's mouth piece.

Vortex motion: Circular vortex, Hollow circular vortex, Rankine combined vortex, rectilinear vortex filament, motion of a system of vortex filament, vortex doublet, Karman vortex sheet. Drag due to a vortex wake.

Waves: Wave motion, Kinematical condition at free surface, surface waves, Deep water waves, standing or stationary waves, waves at common surface of two liquids stability, group velocity and its dynamical significance.

Viscous flow: Measurement of viscosity, stresses in the fluid, constitutive equation of Newtonian fluids. Navier stokes equations, dissipation of energy, Reynolds number, vorticity vorticity and circulation in viscous fluid; slow motion of a sphere, Stokes and O'seen solution. Motion of viscous fluid in various simple cases. Elements of boundary theory and elementary idea of turbulance.

Modern topics: Selected topics of Non-Newtonian and viscoelastic fluids.

406. Mathematical Computation Laboratory (0-5).

Programming in Analog and Digital computer. Application to physical problems.

501. Analytical Dynamics, Theory of Potential (4-0).

Analytical Dynamics: Rotating axes, Euler's equation, Spinning tops, Lagrange's equations, Theory of small vibrations, Nother's theorem, Hamilton's equation's, Liouville's theorem. Contact transformations, Poisson Brackets, Hamilton-Jacobi equations, Lagrangian and Hamiltonian formalism for continuua.

Potential Theory: Applications of Gravitational Attraction and Potential Fields of force, Theorems of Laplace, Poisson and Gauss, Properties of Newtonian Potentials, Harmonic functions, Green's functions, Existence Theorems.

502. Modern Algebra, Foundation of Geometry and Projective Geometry (4-0).

Modern Algebra: Groups: Abelian and non-abelian, Subgroups, Isomorphism, Homomorphism, Cosets, Lagrange's theorem, Cycle and permutation groups, Groups of transformation, Conjugate and Classes, Normal Subgroups, Quotient groups.

Rings: Polynomial rings, Ideals, Residue Class rings, Integral Domains, Unique factorisation domain and principal ideal domains.

Fields: Skew fields, Subfields, Prime fields. Characteristic of a field.

Foundations of Geometry: Concept of space, Choice of system of Axioms, Finite Geometry Desargues' Theorem, Principle of duality, Fourth Harmonic point Harmonic Sequence and Fano's Axiom, Related Ranges of points, Reduction of a Projectivity to Two Perspectivities, Pappus' Theorem, Fundamental Theorem of projective Geometry, Affine and Euclidean Geometry, Ideal Elements, Co-ordinate systems, Addition and Multiplication of points on a Line, Order and Continuity, Consistency and Categoricalness, Correspondences and Imaginary' Elemnts.

Projective Geometry: Axiomatic foundation, Axiomatic introduction to higher dimensional space, Extended theory of projectivity, Cross ratio, Conics, Quadric surfaces, Ruled surfaces.

503. Probability and Statistics (4-0).

Probability: Measure Theory and Probability, Basic Laws of Probability, Posterior Probability and Likelihood. Laws of large number. Random precesses. Markov Chains.

Random Variables and Probability Distributions: Univariate discrete and continuous Distributions, Bivariate and Multivariate Distributions.

Statistical Inference: Sampling Distributions. Tests of significance. Theory of Estimation, General Theory of Testing Statistical Hypotheses.

Statistical Methods and Applications: Frequency Distributions and Curve Fitting. Correlation, Regression and Prediction. Quality Control Methods and Sampling Inspections. Designs and Analysis of Experiments.

504. Electromagnetic Theory and Special Theory of Relativity (4-0).

Electromagnetic Theory: Fundamentals of Electrostatics, Systems of conductors, Dielectrics and inductive capacity, General Analytical theorems, Method for the solution of special problems, Steady currents and linear conductors, Steady currents in continuous media, Fundamentals of electromagnetism, Induction of current in linear circuits, Induction of current in continuous media, Dynamic theory of currents, Displacement current, and electromagnetic waves, Motion of electrons.

Special Theory of Relativity: Postulates of the special theory of Relativity, Propagation of Light. Crucial experiments. Lorentz transformation and its consequences. Relativistic mechanics of mass points. Relativistic electrodynamics. Selected related topics like Lorentz group, application to modern physics etc.

505. Continuum Mechanics II (4-0). (Elective).

Deformation gradients, Deformation tensor, Rate of deformation tensor, Rotation tensor, Spin, Vorticity, Circulation, Material derivative of a tensor, Stress tensor, Stress flux, rate of stress tensor, stress invariants, strain invariants, material dervatives of elements of length of an arc, surface and volume Kinematics of line, surface and volume integration, strain energy.

Conservation laws (mass, energy, momentum, moment of momentum).

Thermodynamics of deformation, entropy, equation of heat conduction, equation of state, Thermal stresses.

Invariance requirements.

Constitutive equations: Definition, idealised models, hyperelastic bodies (Green's model), elastic bodies (Cauchy's model), isotropic ideally elastic bodies, Stokesian fluids, Simple Viscoelastic bodies.

Theory of finite deformation: System of equations by Green's notation and simple solutions.

Elastic-perfectly plastic bodies: Hencky, Von Mises, St. Venant theories and simple problems.

Elasticity: Definitions of stress and strain, Analysis of stress, Analysis of strain, stress equations of equilibrium, compatibility relations, Hooke's law, isotropic bodies, strain energy, anisotropic and aelotropic bodies, St. Venant's principle, simple problems, function theoretic method of solution of two dimensional elastic problems, elementary ideas of plates and shells, Elastic waves.

506. General Theory of Relativity (4-0).

Principle of equivalence. Curvature and contracted Curvature tensors. Einstein's equations for empty and non-empty fields. Approximate solutions of field equations and consequences. Exact solutions of Schwarzschild and Weyl. Simple exact solutions with electromagnetic field (including exact solution when attraction due to mass and repulsion due to charge balance). Analogue of Earnshaw's theorem in Relativity. Bianchi identity and its implications. Equations of motion. Three well known observational verifications. Descriptive study of Mossbauer effect and its possibilities in relativity. Cosmological equations and simple consequences.

507. Advanced Statistics (4-0). (Elective).

Candidates may offer any two of the following topics:

1. Stochastic processes.
2. Theory of games.
3. Operation Research Techniques.
4. Decision Theory.
5. Multrivariate Analysis (Advanced).
6. Non-Parametric Methods.
7. Information theory.

508. Statistical Laboratory (0-5).

Practical work based on the following:

1. Construction of Univariate frequency distributions from raw data and Graphical representations.
2. Computation of specified discrete probability distributions. Use of Random Numbers to generate specified frequency distributions and comparison of these frequencies with theoretical distribution.
3. Generation of Markov processes by using random numbers.
4. Fitting of a Normal Curve to given data.
5. Test of significance and Estimation in one variable.
6. Analysis of Variance.
7. Bivariate distributions, Scatter diagram and Correlation.
8. Multiple Regression.
9. Quality control charts and Sampling Inspection Plans.

PHYSICS (Ph)

401. Mathematical Methods in Physics (2-0).

Short review of the topics of Vector and Tensor Algebra, Fourier series, probability, Linear Differential Equations and Numerical Analysis as given in electrive mathematics for Physics Honours students.

Matrices—orthogonal, Hermitian and Unitary. Linear Transformation, Diagonalisation and eigen values of matrices.

Partial differential equations of common occurrence in Physics and special functions—*viz.*—Bessel, Legendre, Laguerre, Hermite and Hypergeometric functions (some simple properties).

Fourier and Laplace transforms.

Functions of complex variables. Cauchy theorem. Cauchy's integral formula. Singularities ; Contour integration ; Analytic continuation.

402. Mechanics I (2-0).

Principle of virtual work. D' Alembert's Principle. Generalised coordinates and moments, Lagrange's equations, Hamilton's principle and principle of least action. Hamilton-canonical equation. Contact transformation. Action integrals ; Hamilton-Jacobi equation ; Two body motion under central force ; Lagrange's and Poisson's brackets.

Motion of rigid body about a fixed axis, Euler's angles, Euler's equation of motion, precession and Nutation.

403. Statistical Mechanics and Thermodynamics (2-0).

Thermodynamics: A critical review of the first and second laws of Thermodynamics, thermodynamic potentials, conditions of equilibrium, Gibb's phase rule, Chemical equilibrium and Law of mass actions as included in the Honours course. Debye-Huckel theory. Nernst Heat theorem. Saha's Thermal Ionisation formula. Pressure Ionisation. Properties of matter at very high densities and temperatures. Absolute value of the entropy and chemical constant.

The Onsager relations; imperfect gases, Cluster configurations, the second virial coefficient, thermodynamic functions of imperfect gases, Equation of state.

Statistical Mechanics: Basic Principles, Liouville's, theorem, Ergodic Hypothesis. Maxwell-Boltzman Method, Gibb's method. Entropy and probability. Boltzmann's hypothesis. Boltzmann's integro-differential equation—derivation of Maxwell—Boltzmann's distribution function.

Thermodynamic probability and Boltzmann hypothesis. Relations between thermodynamic functions and partition functions. Maxwell-Boltzmann statistics and some of its applications. Entropy constant and chemical constant.

404. Electromagnetic Theory (4-0) First term and (2-0)—Second and third terms.

Fundamental relation of electricity and magnetism. Fields and interactions due to charges, current and magnets. Energy and stress in the medium. Specialised methods of solving potential and other problems.

Maxwell's equations and general boundary conditions; scalar and vector potentials; wave equations and its solutions; retarded potentials.

Currents and their interactions, magnetic materials and boundary value problems.

Theory of propagation of electromagnetic waves in the ionosphere.

Radiation patterns from simple antenna, radiation damping, wave guides (simple cases).

Retarded potentials, Lienard-Wiechert potentials. Field due to an arbitrary moving charge; its diploe-quadrupole radiation. Cerenkov radiation. Reaction of the radiation field. Classical theory of electrons. Self-force and self-energy; scattering of radiation by free and bound electrons. Absorption. Fourier analysis of radiation field. Elimination of longitudinal field coulmb energy.

405. Optics (2-0).

Review of Maxwell equation and their solutions.

Metallic reflection and optical constants. Discussion of the nature of experimental results.

Dispersion-normal and anomalous; absorption region, Dispersion formula for metals. Scattering-Tyndall, Rayleigh, Thomson, Raman and Compton.

Propagation of electromagnetic waves in crystals, Unaxial and biaxial; phase and ray velocities; principle of duality; Wave and normal surfaces; Conical refraction; birefringence.

Theories of Interference and diffraction; Babinet's principle. Theory of phase contrast microscope, Kirchhoff's formula; Fraunhofer diffraction for three dimensional gratings and Bragg's Law.

Optical rotation; Electro-optic and Magneto-optical phenomena.

406. Quantum Mechanics I (2-0).

Basic concepts and introduction to quantum theory; Matrix mechanics: The non-commutative law; Linear Oscillator according to matrix mechanics; Wave Mechanics: Schrodinger Equation. Linear Oscillator: The spectrum of Hydrogen. Scattering of Particles. X-ray scattering by nuclei. Formalism of wave mechanics: Equivalence of Matrix mechanics and wave mechanics. Angular Momentum.

Interpretation of quantum theory; The Uncertainty Principle. Measurement according to Quantum theory. Principle of Superposition: Introduction to symbolic theory. Dirac Formalism. Unitary Transformations. Representations.

407. Special Theory of Relativity (2-0) 2nd and 3rd terms.

Inconsistencies in classical theory. Fundamental postulates of relativity. Concept of space and time. Lorentz transformations and their kinematical consequences. Minkowski's space-time continuum. Linear orthogonal transformations. Lorentz group. Infinitesimal Lorentz transformation. Transformation equations for four vectors. Velocity and acceleration vectors, Fresnel's drag co-efficient in a dispersive medium. Phenomenon of aberration and Doppler effect. Mass-energy relation, Energy momentum tensor, relativistic mechanics. Wave propagation in space time.

Relativistic Lagrangian formalism and classical field theory, Maxwell-Lorentz equation; their covariance. Electromagnetic field tensor, Transformation equation for field variables. Hamiltonian functions. Covariant equation of motion of charged particles; motion in a magnetic field; Energy momentum tensor and conservation laws.

408. Electrical and Electronic Measurements (2-0).

Electromagnetic induction and its consequences. Transients in real circuits. Alternating current circuits and bridges. Magnetic circuits. Electrical and magnetic polarisation. Phenomena relating to Para-electricity and ferromagnetism. Relaxation in solids. Theory of measurements and measureing instruments of different types.

Physics of the Termionic tubes; typical tubes, their constants and use. Fundamental processes in gas discharges.

Phenomenolgical discussions about plsma physics. Amplifiers—resistance, transformers and impedence coupled. Audio-radio and vidio-frequency amplifiers, power amplifiers; feedback; cathode follower. Class A, B and pushpull amplifiers.

Oscillators-Tuned anode, Tuned grid, Hartley Oscillators. R. C. Oscillators, Multivibrators. Frequency Stabilisations. Voltage and power rectifiers; smoothing filters and power supply, Electronic regulators.

Integro-Differential circuits, Computing circuits, Gating circuits, Decade and binary scalers, Pulse height analysers.

Transistor-characteristics, application as an amplifier and oscillator, Typical transistor circuits.

Instruments-Valve voltmeter, cathode ray oscillograph, wave meter, Q-meter.

Elements of electron optics.

502. Mechanics II (2-0).

Stress strain relationship; strain energy function; Waves in unbounded elastic medium.

Theory of small vibrations, normal modes, normal coordinates. Vibrations of strings and membranes.

Euler's hydrodynamical equation of motion, Equation of continuity, Stream lines, Vorticity, Irrotational motion and velocity potential. Equations of motion of viscous fluid, Navier-Stokes equation, Stokes Law.

506. Quantum Mechanics II (2-0).

General Methods for application to physical problems. Perturbation Theory: Radiation. Transition Probabilities. Scattering. Born Approximation. Many particle systems. Density matrix. Relativistic particle Equations.

511. Atomic Physics and Spectroscopy (2-0).

Nature of radiation, Quantum theory and its experimental basis. Rutherford scattering, Bohr-Sommerfeld's theory of the spectra of hydrogen like atoms and ions, fine structure of H-lines, fine structure constant. Selection principle; correspondence principle, The centralfield model for atomic structure, periodic classification; One electron and many electron energies of an atom, self consistent field method, inner and outer shielding, quantum defect. Alkali atom spectra. Vector model of the atoms-multiplets as complex spectrum R-S and J-J couplings, Lande's theory; Zeeman effect and Stark effect of the hydrogen atoms.

X-ray emission and absorption spectra,—Spin and Screen doublets, Non diagram lines, absorption edges.

Transition probabilitis; Einstein's A & B coefficients, intensity of spectral line, absorption coefficient and oscillator strength; Breadth of spectral lines, life time of excited state.

Critical potential of atoms and molecules, collisions of the first and second kinds, resonance radiation and flourescence quenching and sensitisation.

General features of spectra of diatomic molecules, Franck-Condon principle, isotopic effects.

Experimental methods in spectroscopy in different spectral regions, absorption spectrophotometry; Instensity measurement of spectral lines.

Special topics—EPR & NMR spectra; Raman effect, Laser and their applications.

512. Nuclear Physics and Cosmic rays (2-0).

Detection and measurement of ionising radiations ionisation chamber, G.M. Counter, proportional counters, cloud chamber, bubble chamber. Crystal and scintillation counters, photographic emulsion technique. Simple type of γ-ray and X-ray spectrometers.

Particle accelerаters.

Mass spectrometry, Nuclear mass data, Weizsacker mass formula.

Static properties of nuclei, Determination of spin and magnetic moments-Schmidt lines. Nuclear binding energies.

Theories of the nucleus, Nuclear forces, theories of emission of α, β & γ-rays and their energy loss in matter, Mossbauer effect. Theory of deuteron, shell theory of nucleus, liquid drop model, nuclear isotopic spin; nuclear reactions; resonance and capture, nuclear fission; chain reaction.

Cosmic rays: primary cosmic-ray particles and their composition, relative abundance of various primary nuclei. Primary intensity and energy spectrum. Geomagnetic theory.

Secondary cosmic particles. and mesons, Hyperons and heavy mesons. Origin of cosmic radiation.

513. Statistical Mechanics and Properties of Matter (4-0).

Bose-Einstein and Fermi-Dirac statistics; their simple application—(i) Fermi-statistics to degenerate gas, (ii) Bose statistics to degenerate gas—Einstein's theory of condensation, super-fluidity and liquid helium II. Density matrix formalism. Energy and density fluctuations, critical opalescene.

Free electron theories of Lorentz and Sommerfeld, electrothermal effects, Hall effect Thermoionic emission, photoelectric effect, photoconduction. An introduction to the band theory of solids, introductory ideas of semiconduction.

Crystal structure : reciprocal lattice, structure factor, determination of structure by X-ray diffraction, electron diffraction, Neutron diffraction.

Radiation damage in solids, Diffusion in solids, dislocation and mechanical properties of metals.

Magnetic, Dielectric and thermal properties of matter.

Introduction to Band theory of solids : Introductory ideas of semiconductors, Elementary theory of super-conductivity, Introduction to low temperature physics, Elements of plasma Physics.

514. X-ray and Structure of matter (4-0).

X-ray generating equipments and accessories, X-ray detecting devices, photographic and counter measurement of X-ray intensities.

Scattering of X-ray by electrons, atoms and group of atoms ; X-ray diffraction by gases, liquids, amorphous and crystalline solids and fibres.

The powder diffraction technique and its applications in chemical analysis and in study of lattice imperfections. The low angle scattering technique.

Electron and X-ray microscopes. Principle of electron and neutron diffraction.

Various modern X-ray techniques of studying lattice imperfections. Industrial radiography.

Different types of X-ray spectrographs, Absorption and emission X-ray spectra, fluorescence analysis. Dispersion of X-rays, Compton scattering. Auger effect and associated phenomena.

Symmetry elements and space lattices, Derivation of point and space groups. The reciprocal lattice and its application in the interpretation of X-ray diffraction patterns. Different types of camera and other apparatuses for studying X-ray diffraction in disordered lattices.

Trial and error, Fourier transform, Vector set and direct method of crystal structure analysis: Instrumental techniques for structure factor and Fourier Synthesis calculation: Method of refinements of structure and estimation of accuracy of coordinates. Applications of neutron diffraction in crystal structure analysis.

515. Solid State Physics (4-0).

Classification of solids, Lattice energy of ionic crystals, cohesive energy of metals and ionic crystals, vibrations in one, two and three dimensions, Acoustical and optical modes, phonons, theory of specific heat of crystalline solids, elastic and force constants.

Optical properties of solids, excitons, Luminescence; Energy transfer processes, Radiation damage, colour centres.

Properties of defective solids, metals and order-disorder phenomena in alloys, Bragg-Williams' theory, Ising model.

Band approximation in solids, Kronig. Penney model, Brillouin Zones, connection between zone structure and crystal symmetry, Wigner-Seitz and tight-binding methods of band structure analysis, effective mass of electrons in crystals, application of Brillouin Zone theory to metals and semiconductors.

Intrinsic and impurity semiconductors ; donors and acceptors, Fermi level, life time and recombination, properties of metal-semi-conductor and semiconducor-semiconductor junctions, rectification, junction and other types of transistors, properties of important semiconducting materials.

Mechanism of electrical conductivity; modification of Boltzmann equation for the Bloch scheme; collison between electrons and lattice vibrations in metals; residual resistance; Galvano-magnetic, thermomagnetic and thermoelectric effects, superconductivity.

Magnetic properties of crystals; Van Vleck's theory of paramagnetism, internal crystalline fields in solids. Magnetism of free and quasibound electrons, de-Haas van Alphen effect, Weiss-Heisenberg and Bloch theories of ferromagnetism.

516. Nuclear Physics and Elementary Particles (4-0).

Fundamental properties and structure of nuclei, including the liquid drop, shell and collective models; Spin, parity and statistics; nuclear forces-High and low energy scattering; modes of nuclear decay ; nuclear reactions ; nuclear spectroscopy— β, and γ-ray spectra ; interaction of particles and radiation with matter particle accelerators.

Nuclear fission and reactor theory.

The properties of the elementary particles and their interactions, specially at high energies. The classification of particles and their properties, strangeness theory, pion-nucleon and nucleon interactions, photoproduction of pions, production of strange particles.

Shower Theory and related topics in cosmic rays.

SCHEDULE XXIII

REGULATION NO. 29

Admission to the First Year class of the 5-year integrated course leading to the B.Sc./M.Sc. Degrees.

(*a*) *Minimum Educational Qualifications*:

Admission to the First Year class of the 5-year integrated course leading to the M.Sc. Degree in Applied Geology and Exploration Geophysics shall be open to any person who has passed or is expected to pass before the 1st July of the year of admission in one of the following examinations :

(i) Higher Secondary Examination of a recognised University or of any of the recognised Boards of Secondary Education in the Science stream with Chemistry, Mathematics and Physics ;

(ii) Pre-University or Pre-degree or University Entrance Examination of a recognised University or Board with Chemistry, Mathematics and Physics after passing the Matriculation or School Final or High School or equivalent examination conducted by a recognised University or Board ;

(iii) Senior Cambridge or Indian School Certificate Examination with Elementary Mathematics and Additional Mathematics, Physics and Chemistry as separate subjects ;

(iv) General Certificate Examination 'O' level with Chemistry, Mathematics and Physics as separate subjects ;

(v) First Year Examination of the two-year Inter-Science or F.Sc. course of a recognised University or Board or Institute affiliated to a recognised University or Board with Chemistry, Mathematics and Physics as separate subjects ;

(vi) Jamia Higher Secondary Examination (Three-Year course after VIII standard) with Chemistry, Mathematics and Physics as separate subjects ;

(vii) First Year Examination of the two-year course of the Joint Services Wing of the National Defence Academy with Chemistry, Mathematics and Physics as separate subjects ;

(viii) Army Higher Secondary Certificate Examination with Chemistry, Mathematics and Physics ; and

(ix) Any other public examination deemed to be equivalent for the purpose by the Senate of the Institute.

Admission of a limited number of students to the Fourth Year of the course may be made from among the candidates who have passed the Three-Year B.Sc. Degree Examination of a recognised University either with Honours in Geology, and Chemistry and Physics or Mathematics as subsidiary subjects ; or with Honours in Physics (or Mathematics), and Geology and Mathematics or Physics as subsidiary subjects.

(*b*) *Age Limit*:

To be eligible for admission to the First Year class, a candidate shall, on the 1st October, of the year of admission, be over 16 years of age, and for admission to the Fourth year class shall be over 18 years of age.

(*c*) *Standard of Physical Fitness*:

Candidates seeking admission to the First Year class should fulfil the prescribed standard of physical fitness, as given below:

Height	...	1.5 m			
Weight	...	41 Kg.			
Chest Measurement	...	69 Cm. with satisfactory limit of expansion.			
Heart & Lungs	...	There shall be no abnormality.			
Vision	...	Better eye		Worse eye	
		6-9 6-6	or	6-9 6-12	corrected with glass.

Eyes shall be free from congenital or other diseases.

Hearing	...	Must be normal.
Good general health and build.		
Hernia, Hydrocele, Vericocele, Piles.	...	Presence of any of these is a temporary disqualification to be rectified at own expense before joining.

The decision of the Institute Medical Officer in regard to the fitness of a candidate shall be final and there shall be no appeal.

SCHEDULE XXIV

REGULATION NO. 30

Method of admission to the First Class of the five-year integrated course leading to the B.Sc./M.Sc. Degrees and to the Fourth year class of the course.

1. Admission to the First Year class of the 5-year integrated course leading to the B.Sc./M.Sc. degrees shall be made on the basis of the performance of the candidates in the qualifying examination as prescribed and on their being found medically fit by the Institute Medical Officer.

2. Applications received by the Institute in response to advertisement shall be considered by an Admission Committee set up by the Senate for the purpose and selections be made on the basis of the standard as may be decided by the Senate from time to time.

3. Direct admission to the Fourth Year class shall be made on the results of an entrance test, written and/or oral, as may be decided by the Senate from time to time. The test shall be held at the Institute on a date to be fixed by the Senate. A preliminary selection of candidates shall be made by an Admission Committee or Committees, set up by the Senate, after scrutiny of applications including mark sheets and testimonials and only the candidates who prima facie satisfy the minimum requirements will be called for the entrance test.

SCHEDULE XXV

REGULATION NO. 31

Five-Year Integrated course leading to the B.Sc./M.Sc. Degrees and its Duration

1. The Institute shall provide integrated course leading to the degree of Bachelor of Science (B.Sc.) with Honours in Geological Sciences at the end of the third year and to the Degree of Master of Science (M.Sc.) in Applied Geology or in Exploration Geophysics at the end of the Fifth year, as the Senate may decide from time to time taking into consideration the accommodation and staff position, and other facilities available.

2. The curriculum for the degree of Master of Science in the subjects mentioned in para 1 shall extend over not less than five academic sessions, each consisting of three terms except that there shall be an additional Fourth term in the Final session.

For the students admitted directly to the Fourth year of the course, the curriculum shall extend over not less than two academic sessions, provided that the students whose academic background is not considered upto the standard may be required to take up, in addition to the prescribed subjects, suitable pre-requisite course as may be decided in individual cases.

SCHEDULE XXVI

REGULATION NO. 32

Graduation Requirement

5-Year Integrated course leading to B.Sc./M.Sc. Degrees.

(*a*) *General Regulations*

1. Every candidate for the Bachelor's and Master's Degree must, before entering on the curriculum, have complied with the admission requirements.

2. A student shall not be permitted to proceed to the next higher class unless he has fulfilled to the satisfaction of the Senate all requirements in respect of attendance and study and has passed the prescribed examinations.

3. A student shall not be permitted to take any of the examinations unless (i) he has been regular in attendance (a student shall be expected to be regular in attendance in all lectures, tutorials, laboratories, guided studies, drawing office, field work and Workshop classes), and (ii) he has satisfied all class teachers that he has conducted himself well within and outside the class rooms and that he has been regular, diligent, and methodical in his studies and has independently and satisfactorily performed the home and sessional assignments and has regularly submitted these for teachers' scrutiny.

4. A student may study in the fourth and fifth sessions an additional subject of his choice from amongst the approved optional subjects listed in Schedule X, if he so desires, and receive in the examinations such credit, over and above his aggregate total marks in the obligatory subjects, as may be prescribed by the Senate.

5. During the first two sessions it shall be obligatory on the part of all men students to participate in one of the units of the National Cadet Corps ; for the women students, the foreign students, and for those men students who may not be upto the standard of physical fitness required in the N.C.C., it shall be obligatory to participate in Physical Training. In the third, fourth and fifth sessions, all students are expected to participate in Physical Training and may receive

in the examinations such additional credit over and above their aggregate total marks in the obligatory subjects as may be prescribed by the Senate.

6. Subjects of each examination shall be as given in Schedule XXVII. In each subject for examination there shall be written paper or papers and/or sessional assignments, as prescribed in the Regulations. The sessional assignments may comprise tutorials, guided studies, laboratory and field work, workshop practice and drawing office work.

7. The marks allotted to each subject in the terminal as well as in the end-sessional examinations shall be as prescribed in Schedule XXVII.

8. The Senate shall determine in respect of each subject of study the scope of the course and the relative proportion in each course of lectures, and/or practical or laboratory work. The Senate shall also determine in respect of several examinations leading to the degree, conditions for admission and the standard of examination.

9. Special Senate instructions specifying the standard of examinations shall be kept with the Registry to be made available only to the Senate and the Board of Examiners.

10. A student who, does not comply with all the provisions of the Ordinances and Regulations for an Honours Degree but has, in the opinion of the Senate, shown sufficient merit in his studies and examinations may, on the special recommendation of the Senate, be admitted by the Board of Governors to the Ordinary B.Sc. Degree at the end of the Third year, the diploma being suitably inscribed to that effect.

11. A student who after admission to the First Year class does not qualify in the first examination within one academic session of attendance at the Institute shall be required to leave the Institute unless specifically permitted by the Senate to repeat the course on grounds to be recorded by the Senate.

12. A student who fails in any of the subsequent examinations may be allowed to repeat the course subject to the following conditions:

That an entrant to the First year class shall be required to qualify in the First, the Second and the B.Sc. Examinations within a maximum period of four years of study at the Institute unless specifically permitted by the Senate to exceed this period by being allowed to repeat any part of the prescribed course and take the examination on grounds to be recorded by the Senate, and that, thereafter, every student shall be required to qualify in the Fourth and the Final M.Sc. examinations within a maximum period of three years of study at the Institute after passing the B.Sc. examination, and that a student admitted directly to the Fourth Year class shall be required to qualify in the Fourth and the Final M.Sc. examinations within a maximum period of three years of study at the Institute unless specifically permitted by the Senate to exceed this period by being allowed to repeat any part of the prescribed course and take the examination on grounds to be recorded by the Senate.

13. If a student fails in an examination and he is permitted to repeat the course his marks shall be as may secured by him when he repeats the course.

14. If a student is allowed to appear at an examination without repeating the course the marks allotted to him for the sessional assignments and the terminal examinations shall be the marks as he may secure when he completed the course.

15. The Senate shall be competent on the recommendations of the Board of Examiners to deviate from the prescribed Ordinances and Regulations relating to the examinations and consider special cases not covered by the Ordinances and Regulations subject to the approval of the Board of Governors.

(b) Other requirements

1. Subject to the provisions of the Ordinances and Regulations the degree of Bachelor of Science shall be conferred on students who have followed the prescribed curricula for not less than three academic sessions studying subjects set forth in the regulations (Schedule XXVII) and have reached the standard in the examinations in Geological Sciences; and the degree of Master of Science on those who have followed the prescribed curricula for not less than five academic sessions studying subjects set forth in the regulations (Schedule XXVII) and have reached the standard in the respective examinations in one of the following branches: (i) Applied Geology, (ii) Exploration Geophysics—except that those admitted to the fourth year class must have followed the prescribed curricula for not less than two academic sessions.

2. There shall be five complete examinations for the Degree of Master of Science (M.Sc.), namely, (i) the First examination, (ii) the Second Examination, (iii) the B.Sc. Examination, (iv) the Fourth Examination and (v) the Final M.Sc. Examination.

3. For each examination a Board of Examiners shall be constituted by the Senate and the Board of Examiners shall comprise the teachers in the subjects of the examination and the additional examiner or examiners and other experts.

4. No student may present himself for examination in any subject until he has duly completed the prescribed course of instruction to the statisfaction of the teachers concerned.

5. *The First Examination*: (i) the First Examination shall be taken in three sections consisting of two Terminal examinations each covering the term's work and an End-sessional Examination covering the entire course of the First Examination.

(ii) No student may present himself for the End-sessional Examination in any subject unless he has secured on the total of the two Terminal examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects and in each of the sessional assignments.

(iii) A student shall be deemed to have passed the First examination provided he has secured on the total of the two Terminal and the End-sessional Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects, in each of the sessional assignments and in the aggregate.

6. *The Second Examination*: (i) No Student may present himself for examination in any subject of the Second Examination until he has passed the whole of the First Examination except those who have been granted admission direct to the Second year class and exempted from the First examination.

(ii) The Second Examination shall consist of two Terminal Examinations each covering the term's work and an End-sessional Examination covering the entire course of the Second Examination.

(iii) No student may present himself for the End-sessional Examination in any subject unless he has secured on the total of the two Terminal Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects and in each of the sessional assignments.

(iv) A student shall be deemed to have passed the Second Examination provided he has secured on the total of the two Terminal and the End-sessional Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects, in each of the sessional assignments and in the aggregate.

7. *The B.Sc. Examination*: (i) No student may present himself for examination in any subject of the B.Sc. Examination until he has passed the whole of the Second Examination.

(ii) The B.Sc. examination shall consist of two Terminal Examinations each covering the the term's work and an End-sessional Examination covering the entire course of the B.Sc. Examiation and a Vive-voce Examination.

(iii) No student may present himself for the End-sessional Examination in any subject unless he has secured on the total of the two Terminal Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects and in each of the sessional assignments.

(iv) A student shall be deemed to have passed the B.Sc. Examination provided he has secured on the total of the two Terminal and the End-sessional Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects, in each of the sessional assignments, in the Viva-voce Examination and in the aggregate.

8. *The Fourth Examination*: (i) No student may present himself for examination in any subject of the Fourth Examination until he has passed the whole of the B.Sc. Examination, except those who have been admitted directly to the Fourth year of the course and Exempted from the First, Second and the B.Sc. Examinations.

(ii) The Fourth Examination shall consist of two Terminal Examinations each covering the term's work and an End-sessional Examination covering the entire course of the Fourth Examination.

(iii) No student may present himself for the End-sessional Examination in any subject unless he has secured on the total of the two Terminal Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects and in each of the sessional assignments.

(iv) A student shall be deemed to have passed the Fourth Examination provided he has secured on the total of the two Terminal and the End-sessional Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects, in each of the sessional assignments and in the aggregate.

9. *The Final Examination*: (i) No student may present himself for examination in any subject of the Final Examination until he has passed the whole of the Fourth Examination.

(ii) The Final Examination shall be taken in five sections comprising the two Terminal Examinations each covering the term's work and an End-sessional Examination, the Viva-voce Examination, and an examination on thesis on an approved subject which each student shall be required to carry out in the Final session.

(iii) No student may present himself in any subject of the End-sessional Examination, in the Viva-voce Examination, and in the Thesis Examination unless he has secured on the total of the two Terminal Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects and in each of the sessional assignments.

(iv) The End-sessional Examination shall cover the entire course prescribed for the Final Examination.

(v) A student shall be deemed to have passed the Final M.Sc. Examination if he has secured on the total of the two Terminal and the End-sessional Examinations requisite minimum marks in the written paper or papers of each of the obligatory subjects, in each of the sessional assignments, in the Viva-voce Examination, in the thesis Examination and in the aggregate.

10. *The Maximum Marks*: (i) The maximum marks for the First, Second, B.Sc. and the Fourth Examinations shall be the total of the maximum marks prescribed for the obligatory subjects of the respective End-sessional Examinations plus fifty percent of the total of the maximum marks prescribed for the obligatory subjects of both the Terminal Examinations.

(ii) The maximum marks for the Final Examination shall be the total of the maximum marks prescribed for the obligatory subjects of the End-sessoinal Examination, for the Viva-voce Examination and for the Thesis Examination plus fifty percent of the total of the maximum marks prescribed for the obligatory subjects of both the Terminal Examinations.

11. *The Weighted Maximum Marks*: (i) The weighted maximum marks for the First, Second and the Fourth Examinations shall be the maximum marks for the First, Second and the Fourth Examinations respectively.

(ii) The weighted maximum marks for the B.Sc. Examination shall be the maximum marks of the B.Sc. Examination plus two-thirds of the weighted maximum marks of the Second Examination plus one-third of the weighted maximum marks of the First Examination.

(iii) The weighted maximum marks for the Final Examination shall be the maximum marks of the Final Examination plus the weighted maximum marks of the Fourth Examination.

12. A student passing all the five examinations for the Degree of Master of Science shall be declared to have passed in the appropriate branch on the basis of his overall performance in all the five examinations, except that a candidate who has been admitted direct to the fourth year class shall be declared to have passed in the appropriate branch on the overall performance in the two examinations, *viz.*, the Fourth and the Final.

A student passing all the first three examinations, *viz.*, the First Examination, the Second Examination and the B.Sc. Examination shall be declared to have passed the B.Sc. Examination with Honours in Geological Sciences on the basis of his overall performance in all the three examinations.

13. The students found entitled to the Degree of Master of Science shall, in each branch, be classified in two groups to be denominated respectively the First and Second class on the basis of the weighted total marks they secure out of the prescribed weighted maximum marks of the Final Examination.

The students found eligible for the B.Sc. (Honours) Degree shall be also classified in two groups to be denominated respectively the First and Second class on the basis of the weighted total marks they secure out of the prescribed weighted maximum marks of the B.Sc. Examination.

14. The names of the students in the First class shall be arranged in order of merit and those in the Second class in the alphabetical order.

15. The students satisfying all the conditions prescribed and having passed the prescribed examinations as mentioned in para. 13 shall be entitled to receive the Degree of Master of Science and/or Bachelor of Science (with Honours) in the appropriate branch of study.

16. For the Degree of Master of Science (M.Sc.) in any branch as set forth above and the Bachelor of Science (B.Sc.) the graduate shall receive a Diploma wherein shall be set forth the branch of study in which he has obtained the Degree of Master of Science, or the Bachelor's Degree and the class in which he has been placed.

SCHEDULE XXVII

REGULATION No. 33

Schedule of Courses and Distribution of Marks for Five-year Integrated M.Sc. Degree Courses in Applied Geology and Exploration Geophysics

FIRST YEAR (Common)

Subject No.		Subjects for the First Examination	All Terms Hours per week		All Terms Marks	No. of papers for examination	Duration of exam. papers
Hu	111	English	2	2	100— 50	1	2 hrs.
Hu	113	Principles of Government	1	0	50— 0	1	2 hrs.
Ma	114	Mathematics I	6	2	300— 50	2	3 hrs. each
Ch	114	Chemistry I	4	1	200—125	2	2 hrs. each
Ch	115	Chemistry Lab. I	0	3			
Ph	114	Physics I	4	1	200—125	2	2 hrs. each
Ph	115	Physics Lab. I	0	3			
CE	113	Drawing and Descriptive Geometry	0	4	0—150	—	—
Ge	101	Introduction to Earth Sciences	1	0	50— 0	1	2 hrs.
		N.C.C./P.T.	0	3	0—100	—	—
			18	19	900—600	9	

Field Tour (one week).
Duration of papers for end-sessional examination shall be 3 hours.

SECOND YEAR (Common)

Subject	No.	Subjects for the Second Examination	All Terms Hours per week		Marks 1st term	Marks 2nd term	Marks 3rd term	No. of papers for examnation	Duration of exam. papers
Hu	211	English	1	1	50— 50	50— 50	50— 50	1	2 hrs.
Hu	212	Logic	1	0	50— 0	50— 0	50— 0		
Ma	214	Mathematics II	4	1	200— 50	200— 50	200— 50	2	2 hrs.
Ph	214	Physics II	3	1	150—100	150—100	150— 75	1	3 hrs.
Ph	215	Physics Lab. II	0	3					
Ch	214	Chemistry II	3	1	150—100	150—100	150— 75	1	3 hrs.
Ch	215	Chemistry Lab. II	0	3					
Ge	201	Principles of Geology	2	2	100— 50	100— 50	100— 50	1	2 hrs.
Ge	210	Crystallography and Mineralogy ...	2	3	100— 50	100— 50	100— 50	1	2 hrs.
Ge	222	Paleontology I	2	2	100— 50	100— 50	100— 50	1	2 hrs.
Ge	250	Field Geology II (4 weeks)	—	—	— —	— —	0— 50	—	—
		Viva-Voce	—	—	0— 50	0— 50	0— 50		—
		N.C.C./P.T.	0	3	0—100	0—100	0—100	—	—
			18	20	900—600	900—600	900—600	8	

Subject	No.	Subjects for the B.Sc. (Hons.) Examination	Hours per Week					
			First Term		Second Term		Third Term	
Ph	314	Atomic and Nuclear Physics ...	2	0	2	0	2	0
CE	214	Surveying	—	—	1	3	1	3
Ge	310	Optical Mineralogy	2	6	—	—	—	—
Ge	312	Petrology	2	0	2	6	2	6
Ge	322	Stratigraphy I	2	0	2	0	2	0
Ge	330	Economic Geology	2	0	2	0	2	0
Ge	340	Structural Geology	2	3	2	3	2	3
Ge	350	Field Geology II (4 weeks) ...	—	—	—	—	—	—
Ge	360	General Geophysics I	2	0	2	0	2	0
Ge	370	Applied Geophysics	3	0	3	0	2	2
		+Electives (any one Group) ...	3	3	3	3	3	3
		Viva Voce	—	—	—	—	—	—
		N.C.C. or P.T....	0	2	0	2	0	2
			20	14	19	17	18	19
		+Elective: A Group						
Ph	315	Physics Laboratory III	0	3	0	3	0	3
Ma	314	Adv. Calculus and Diff. Equations ...	3	0	3	0	3	0
		+Elective: B Group						
Ch	314	Physical and Analytical Chemistry ...	2	0	2	0	2	0
Ge	331	Economic Geology Laboratory ...	0	3	0	3	0	3
Ge	314	Rock Forming Minerals	1	0	1	0	1	0

YEAR (Common)

Marks 1st term	No. of Papers for exam.	Duration of exam. papers	Marks 2nd term	No. of papers for exam.	Duration of exam. papers	Marks 3rd term	No. of papers for exam.	Duration of exam. papers
100— 0	1	2 hrs.	100— 0	1	2 hrs.	100— 0	1	3 hrs.
— —	—	—	50— 50	1	2 hrs.	50— 50	1	3 hrs.
100—150	1	2 hrs.	— —	—	—	— —	—	—
100— 0	1	2 hrs.	100—150	1	2 hrs.	100—150	1	3 hrs.
100— 0	1	2 hrs.	100— 0	1	2 hrs.	100— 0	1	3 hrs.
100— 0	1	2 hrs.	100— 0	1	2 hrs.	100— 0	1	3 hrs.
100—100	1	2 hrs.	100—100	1	2 hrs.	100— 50	1	3 hrs.
— —	—	—	— —	—	—	0—100	—	—
100— 0	1	2 hrs.	100— 0	1	2 hrs.	100— 0	1	3 hrs.
150— 0	1	3 hrs.	150— 0	1	3 hrs.	100— 50	1	3 hrs.
150—100	—	—	150—100	—	—	150— 50	—	—
0—100	—	—	0—100	—	—	0—100	—	—
0— 50	—	—	0— 50	—	—	0— 50	—	—
1000—500	8		950—550	8		900—600	8	
0—100			0—100			0—100		
150— 0	1	3 hrs.	150— 0	1	3 hrs.	150— 0	1	3 hrs.
	9			9			9	
100— 0	1	2 hrs.	100— 0	1	2 hrs.	100— 0	1	3 hrs.
50—100	1	2 hrs.	50—100	1	2 hrs.	50—100	1	3 hrs.
	10			10			10	

Subject No.		Subjects for the Fourth Examination	Hours per Week					
			First Term		Second Term		Third Term	
Hu		*Language, (any one)	2	1	2	1	2	1
Ge	412	Igneous and Metamorphic Petrology	3	6	3	6	3	6
Ge	415	Geochemistry	—	—	3	0	—	—
Ge	420	Paleontology II	2	0	2	3	2	6
Ge	433	Non-Metallic Mineral Deposits ...	1	3	1	3	2	3
Ge	434	Geology of Coal	—	—	1	3	1	0
Ge	435	Geology of Petroleum	3	2	—	—	—	—
ChE	436	Testing of Solid Fuels	—	—	—	—	0	3
Ge	437	Ground Water Geology	2	0	—	—	—	—
Ge	438	Engineering Geology	—	—	2	0	2	0
Ge	440	Structural Geology and Tectonics ...	2	3	2	3	2	0
Ge	450	Field Geology III (8 weeks) ...	—	—	—	—	—	—
ChE	434	Mineral Dressing & Ore Beneficiation	2	3	—	—	—	—
		Viva Voce	—	—	—	—	—	—
			17	18	16	19	14	19
		Option	2	0	2	0	2	0
			19	18	18	19	16	19
		Physical Training						

*Languages
- Hu 411 Elementary French.
- Hu 412 Elementary German.
- Hu 413 Elementary Russian.

YEAR (Applied Geology)

Marks 1st term	No. of Papers for exam.	Duration of exam. papers	Marks 2nd term	No. of papers for exam.	Duration of exam. papers	Marks 3rd term	No. of papers for exam.	Duration of exam. papers
100— 50	1	2 hrs.	100— 50	1	2 hrs.	100— 50	1	3 hrs.
150—150	1	3 hrs.	150—150	1	3 hrs.	150—150	1	3 hrs.
— —	—	—	150— 0	1	3 hrs.	— —	—	—
100— 0	1	2 hrs.	100—100	1	2 hrs.	100—150	1	3 hrs.
50— 75	1	2 hrs.	50—100	1	2 hrs.	100—100	1	3 hrs.
150— 75	1	3 hrs.	50—100	1	2 hrs.	50—100	1	3 hrs.
100— 0	1	2 hrs.	100— 0	1	2 hrs.	100— 0	1	3 hrs.
100—100	1	2 hrs.	100—100	1	2 hrs.	100— 0	1	3 hrs.
— —	—	—	— —	—	—	0—150	—	—
100—100	1	2 hrs.	— —	—	—	— —	—	—
0—100	—	—	0—100	—	—	0—100	—	—
850—650	8		800—700	8		700—800	7	
100— 0	1		100— 0	1		100— 0	1	
0—100			0—100			0—100		

Subject No.		Subjects for the Fourth Examination	Hours per Week First Term		Second Term		Third Term	
Hu		*Language (any one)	2	1	2	1	2	1
Ph	414	Physics of Solids	2	0	2	0	2	0
Ph	415	Physics Laboratory IV	0	3	0	3	0	3
Ma	414	Methods of Applied Mathematics ...	4	0	3	0	3	0
EE	401	Electrical Technology	—	—	2	3	2	3
Comm	407	Electron Tubes and Circuits ...	2	3	2	3	2	3
Ge	437	Ground Water Geology	2	0	—	—	—	—
Ge	462	Theory of Fields I	4	0	—	—	—	—
Ge	490	Gravity and Magnetic Methods ...	0	3	4	3	4	6
Ge	464	Nuclear Geology	3	3	—	—	—	—
Ge	465	Radioactive Methods	—	—	2	3	1	0
Ge	496	Field Geophysics I (6 weeks) ...	—	—	—	—	—	—
		Viva Voce	—	—	—	—	—	—
			19	13	17	16	16	16
		Option	2	0	2	0	2	0
			21	13	19	16	18	16
		Physical Training						

*Languages
Hu 411 Elementary French.
Hu 412 Elementary German.
Hu 413 Elementary Russian.

YEAR (Exploration Geophysics)

Marks 1st term	No. of Papers for exam.	Duration of exam. papers	Marks 2nd term	No. of papers for exam.	Duration of exam. papers	Marks 3rd term	No. of papers for exam.	Duration of exam. papers
100— 50	1	2 hrs.	100— 50	1	2 hrs.	100— 50	1	3 hrs.
100—100	1	2 hrs.	100—100	1	2 hrs.	100— 50	1	3 hrs.
200— 0	1	3 hrs.	150— 0	1	3 hrs.	150— 0	1	3 hrs.
— —	—	—	100—100	1	2 hrs.	100—100	1	3 hrs.
100—100	1	2 hrs.	100—100	1	2 hrs.	100— 50	1	3 hrs.
100— 0	1	2 hrs.	— —	—	—	— —	—	—
200— 0 0—100	1	3 hrs.	200—100	1	3 hrs.	200—200	1	3 hrs.
150—100	1	3 hrs.	—	—	—	—	—	—
— —	—	—	100—100	1	2 hrs.	50— 0	1	3 hrs.
— —	—	—	— —	—	—	0—150	—	—
0—100	—	—	0—100	—	—	0—100	—	—
950—550	7		850—650	7		800—700	7	
100— 0	1		100— 0	1		100— 0	1	
0—100			0—100			0—100		

Subject No.		Subjects for the Final Examination	Hours per Week					
			First Term		Second Term		Third Term	
Ge	502	Geomorphology and Photogeology ...	2	0	2	2	1	6
Ge	512	Silicate Analysis	—	—	0	6	—	—
Ge	513	Sedimentary Petrology and Sedimentation	2	6	1	3	3	0
Ge	522	Stratigraphy II	2	0	2	0	2	0
Ge	525	Mineral Economics	—	—	1	0	—	—
Ge	532	Ore Genesis and Metallic Mineral Deposits	3	6	3	6	3	3
Ge	536	Prospecting (Geophysical, Geochemical and Geological)	2	1	2	1	2	0
Ge	550	Field Geology IV (8 weeks) ...	—	—	—	—	—	—
Min	516	Drilling Method and Elements of Mining	1	0	1	0	1	0
Ge	551	Mining Geology	1	0	—	—	1	0
Ge	552	Geology Seminar	0	1	0	1	0	1
Ge	554	Technical Report Writing ...	—	—	0	1	—	—
Ge	555	Proejct and Thesis	—	—	—	—	0	10
		*Elective (any one)	3	3	—	—	—	—
		Viva Voce	—	—	—	—	—	—
			16	17	12	20	13	20
		Option	2	0	2	0	2	0
			18	17	14	20	15	20
		Physical Training	—	—	—	—	—	—

*Elective (Any one)
Ge 464 Nuclear Geology 3—3
Ge 557 Clay Mineralogy 3—3

YEAR (Applied Geology)

Marks 1st term	No. of Papers for exam.	Duration of exam. papers	Marks 2nd term	No. of papers for exam.	Duration of exam. papers	Marks 3rd term	No. of papers for exam.	Duration of exam. papers
100— 0	1	2 hrs.	100—100	1	2 hrs.	50—200	1	3 hrs.
— —	—	—	0—200	—	—	— —	—	—
100—200	1	2 hrs.	50—100	1	2 hrs.	150— 0	1	3 hrs.
100— 0	1	2 hrs.	100— 0	1	2 hrs.	100— 0	1	3 hrs.
— —	—	—	50— 0	1	2 hrs.	— —	—	—
100—200	1	3 hrs.	150—200	1	3 hrs.	150—100	1	3 hrs.
100— 50	1	2 hrs.	100— 50	1	2 hrs.	100— 0	1	3 hrs.
— —	—	—	— —	—	—	0—200	—	—
100— 0	1	2 hrs.	50— 0	1	2 hrs.	50— 0	1	3 hrs.
— —	—	—	— —	—	—	50— 0		
0— 50	—	—	0— 50	—	—	0— 50	—	—
— —	—	—	0— 50	—	—	— —	—	—
— —	—	—	— —	—	—	0—300	—	—
150—100	1	3 hrs.	— —	—	—	— —	—	—
0—150	—	—	0—150	—	—	— —	—	—
750—750	7		600—900	7		650—850	6	
100— 0	1		100— 0	1		100— 0	1	
0—100			0—100			0—100		

Viva Voce	0—200
Thesis	0—300

Subject No.		Subjects for the Final Examination	Hours per Week					
			First Term		Second Term		Third Term	
Ma	503	Statistical Methods	2	3	—	—	—	—
Ge	525	Mineral Economics	—	—	1	0	—	—
Ge	535	Geology of Petroleum	3	2	—	—	—	—
Ge	554	Technical Report Writing ...	—	—	0	1	—	—
Ge	560	General Geophysics II	3	0	2	0	3	0
Ge	562	Theory of Fields II	4	0	—	—	—	—
Ge	570	Electrical and Electromagnetic Methods	0	4	4	6	4	6
Ge	563	Theory of Elastic Waves	4	0	—	—	—	—
Ge	580	Seismic Methods	0	3	4	6	4	3
Ge	575	Well Logging	—	—	2	3	2	3
Ge	595	Geophysics Seminar I	0	1	0	1	0	1
Ge	596	Field Geophysics II (8 weeks) ...	—	—	—	—	—	—
Ge	598	Project and Thesis	0	3	0	3	0	6
		Viva Voce	—	—	—	—	—	—
			16	16	13	20	13	19
		Option	2	0	2	0	2	0
			18	16	15	20	15	19
		Physical Training						

Viva Voce ... ... 0—200
Thesis ... ... 0—300

YEAR (Exploration Geophysics)

Marks 1st term	No. of Papers for exam.	Duration of exam. papers	Marks 2nd term	No. of papers for exam.	Duration of exam. papers	Marks 3rd term	No. of papers for exam.	Duration of exam. papers
100— 75	1	2 hrs.	— —	—	—	— —	—	—
— —	—	—	50— 0	1	2 hrs.	— —	—	—
150— 75	1	3 hrs.	— —	—	—	— —	—	—
— —	—	—	0— 50	—	—	— —	—	—
150— 0	1	3 hrs.	100— 0	1	2 hrs.	150— 0	1	3 hrs.
200— 0	1	3 hrs.	— —	—	—	— —	—	—
0—150	—	—	200—200	1	3 hrs.	200—200	1	3 hrs.
200— 0	1	3 hrs.	— —	—	—	— —	—	—
0—100	—	—	200—200	1	3 hrs.	200—100	1	3 hrs.
— —	—	—	100—100	1	2 hrs.	100—100	1	3 hrs.
0— 50	—	—	0— 50	—	—	0— 50	—	—
— —	—	—	— —	—	—	0—200	—	—
0—100	—	—	0—100	—	—	0—200	—	—
0—150	—	—	0—150	—	—	— —	—	—
800—700	5		650—850	5		650—850	4	
100— 0	1		100— 0	1		100— 0	1	
0—100			0—100			0—100		

**INDIAN INSTITUTE OF TECHNOLOGY
KHARAGPUR**

DISTRIBUTION OF MARKS
(For each Examination)

5-Year Integrated B.Sc./M.Sc. Degree Courses in Applied Geology and Exploration Geophysics

Examination		First Term Marks	Second Term Marks	End-Sessional Marks	Maximum Marks	Weighted Max. Marks
First	...	1500	1500	1500	3000	3000
Second	...	1500	1500	1500	3000	3000
B.Sc.	...	1500	1500	1500	3000	6000
Fourth	...	1500	1500	1500	3000	3000
Final	...	1500	1500	1500	3500	6500

+ *Viva-Voce* 200
+Thesis 300

SCHEDULE XXVIII

REGULATION NO. 34

Subjects of Instruction

5-Year Integrated course leading to B.Sc./M.Sc. Degrees

CHEMISTRY (Ch)

114. Chemistry I (4-1).

Elementary idea of atomic nucleus and fundamental particles. Cathode ray, electron and its e-m, X'ray, radioactive rays, atomic number, Mosley's work, isotopes, isobars. Mendeleef and Bohr's periodic table: group displacement law.

Electronic theory of valency, metallic bond, van der Waals bond, coordination bond, partial ionic character of covalent bond, molecular dipole. Werner's coordination theory, double and complex salts, ionic hydration.

Faraday's laws and Avogadro number. Electronic Theory of Oxidation and Reduction. Electrochemical series.

Volumetric and gravimetric compositions of H_2O, NH_3, N_2O, NO, SO_2, CO, CO_2, CH_4, C_2H_4 and C_2H_2. Chemical calculations involving volume to volume and weight to volume conversions.

Acids, bases and amphoteric oxides. Theory of acids and bases.

Ideal gas laws and molar gas constant. Kinetic theory of gases, specific heats of gases. Van der Waals equation, molecular weight and thermal dissociation, critical phenomena, continuity of state, liquefaction of gases.

Reversible reactions, law of mass action and chemical equilibrium in homogeneous and heterogeneous systems. Le Chatelier's principle and its applications.

Characteristic features of different types of solutions including distillation of binary liquid mixtures. Extraction, solubility curves and fractional crystallisation.

Osmotic pressure, lowering of vapour pressure, elevation of boiling point, depression of freezing point. Experimental determination of molecular weights of solutes, abnormal colligative properties.

A condensed syllabus covering the preparation and properties of aliphatic and simple alicyclic compounds.

Hydrogen, water, hydrogen peroxide, ozone, inert gases.

Study of the following elements and their compounds.

Elements of group IA, IB, IIA, IIB (excluding francium and radium). Halogens, Oxygen, Sulphur (excluding thionic acids) and nitrogen.

Metallurgy, uses and alloys of Na, K, Cu, Ag, Au, Mg, Ca, Sr, Ba, Zn, Cd, Hg, Al, Sn, Pb, As, Sb, Bi, Fe, Ni.

115. Chemistry Lab. I (0-3).

Qualitative analysis of mixtures containing not more than three radicals.

Acid radicals:—CO_3, Cl, Br, I, F, SO_4, SO_3, S_2O_3, S, NO_3, NO_2, PO_4, AsO_4, BO_3, CrO_4.

Basic radicals:—Na, NH_4, K, Cu, Ag, Ba, Ca, Sr, Mg, Zn, Cd, Hg, Al, Pb, Sn, Cr, Mn, Fe, Co, Ni, As, Sb, Bi.

Quantitative analysis:—Acidimetry and alkalimetry. Determination of hardness of water. Standardisation of permanganate by oxalic acid.

214. Chemistry II (3-1).

Elements of thermodynamics (1st and 2nd laws). Thermochemistry.

Electrochemistry—Arrhenius's theory of Electrolytic dissociation, degree of dissociation, Vant Hoff's factor. Important electrolytic processes.

A condensed syllabus covering the preparation and important properties of aromatic compounds. Heterocyclic compounds (pyrole and pyridine only).

Manufacture of the following:—

Cement, ceramics, glass and refractories.

Study of the chemistry of the following elements and their compounds:—

B, Al, C, Si, Sn, Pb, N, P, As, Sb, Bi, Cr, Mn, Fe, Co, Ni.

Study of groups I, II, III, IV, V, and VII. Study of the following elements and their compounds:—

Au, Be, Rare earths, Si, Ti, Zr, V, Co, Ni, Pt.

215. Chemistry Laboratory II (0-3).

Volumetric estimation of Fe, Cu, Ca, Ag.

Gravimetric estimation of Fe and Ba.

Estimation of Cu and Fe or Ca and Fe in a mixture.

314. Physical and Analytical Chemistry (2-0).

Thermodynamics, 1st and 2nd laws. Phase rule as applied to Geology.

Advanced topics in Electrochemistry.

Chemical kinetics treated in advanced level. Artificial transmutation of elements and related topics.

Principles of permanganometry, dichromatometry, iodometry and argentometry, etc.

Gravimetric and Silicate analysis.

Instrumental analysis.

Use of complexing agents in analysis.

CHEMICAL ENGINEERING (ChE)

434. Mineral Dressing & Ore beneficiation (2-3) First Term.

Recovery of minerals from ore. Equipments used for grinding and size separation. Methods of concentration. Flow sheet of important ore dressing operations.

(For Geologists)

436. Testing of Solid Fuels (0-3). Third Term.

Proximate Analysis, ultimate analysis, calorific value, washability of coal, coking properties of coal.

(For Geologists)

CIVIL ENGINEERING (CE)

113. Drawing and Descriptive Geometry (0-4).

Lettering, scales, Mathematical Curves, Lines and Planes, isometric and oblique views, orthographic Projections, conventions and dimensioning, sketching and elementary drawing.

Representation of plane figures and solids, edge views, and true shapes, location of planes, inclination of planes, distances of lines and planes, intersection of planes, sections, inter penetration of bodies, development of surfaces, determination of shadows and perspective drawings.

214. Surveying (1-3). Second and Third Terms.

Principles and Practice of chain and compass surveying and plotting, plane table surveying; two and three point problems. Use and adjustment of instruments; levelling; contours and sections; setting out buildings, measurement of earth work. Planimeter, its theory and use. Field practice.

ELECTRICAL ENGINEERING (EE)

401. Electrical Technology (2-3). Second and Third Terms.

Introductory study of magnetic & electric fields and circuit parameters. Production of e.m.f. Construction and principles of operation of transformer, alternator and D. C. machines. Current, voltage, power and energy meters. Measurement of inductances and capacitances (Bridge methods).

(For Geophysicists)

ELECTRONICS & ELECTRICAL COMMUNICATION ENGINEERING (Comm)

407. Electron Tubes and Circuits (2-3).

A. C. Circuits. Four terminal network, attenuators, filters. Thermoionic valves, Characteristics. Rectifiers and power supplies. Amplifiers. Feedback amplifiers, principle of A. G. C. Oscillators. Modulation and demodulation, amplitude and frequency modulation. Bi-stable multivibrators. Oscilloscopes and applications. Transistors, transistor circuits, applications.

(For Geophysicists)

GEOLOGY & GEOPHYSICS (Ge)

(*a*) *Geology*

101. Introduction to Earth Sciences (1-0).

The Earth Sciences—their nature, materials, processes and methods. The challenges of the profession. Field Tour (7 days)—Visit to mines, projects etc.

201. Principles of Geology (2-2).

This course introduces all the main disciplines of Geology. It deals with the origin, evolution, physical behaviour and chemical constitution of the earth, and also with the common properties of earth materials. The laboratory part of the course includes basic problems of structural geology and hand-specimen identification of rocks.

210. Crystallography & Mineralogy (2-3).

Introduction. Symmetry concepts, representation methods of crystal symmetry. Crystallographic measurements, constructions and calculations. Seven systems and thirtytwo classes of crystals. Internal symmetry of crystals.

Atomic structure, chemistry and physics of minerals. Systematic study of important minerals,

222. Paleontology I (2-2).

Nature and significances of fossil record. Elements of taxonomy. Systematic invertebrate palaeontology, with emphasis on stratigraphically important fossil groups. Introduction to palaeobotany.

250. Field Geology I (3 to 4 weeks).

Mapping in a relatively simple area with uncomformity, dykes, faults etc. Tape and compass survey.

310. Optical Crystallography (2-6). First Term.

Elementary principles of optics. Isotropism and anisotropism. The polarizing microscope. Behavior of uniaxial and biaxial crystals in plane polarized and convergent polarized light. Optic dispersion. Introduction to the universal stage.

312. Petrology (2-0), First term; (2-6), Second and Third Terms.

Forms of igneous bodies, classification of igneous rocks, silicate melt equilibria, reaction principle. Variation in associated igneous rocks, crystallization of basaltic and granitic magmas. Description and genesis of the common rock types. Origin of magmas.

Metamorphism and its agents, structures & textures of metamorphic rocks. Metamorphic zones and metamorphic facies. Evaluation of some common metamorphic rocks. Metasomatism and metamorphic differentiation.

Processes of sedimentation, characters of sedimentary rocks. Classification and description of important sedimentary rock types. Rock cycle.

314. Rock Forming Minerals (1-0).

Structure, crystal chemistry, physical properties (mainly optical), and an elementary consideration of phase relations of the important rock-forming mineral groups.

322. Stratigraphy I (2-0).

Introduction to general principles of stratigraphic analysis and correlation. Details of the principal stratigraphic units of India, comparison of these with corresponding units of the European type areas and other important regions.

330. Economic Geology (2-0).

Materials and processes of formation of minerals and mineral deposits. Geology of the important mining districts in India in relation to the origin and characteristics of mineral deposits.

331. Economic Geology Lab (0-3).

Study of the important ores and non-metallic minerals and ore associations with special reference to India.

340. Structural Geology (2-3).

Introduction. Principles of rock deformation. Description and genesis of folds, faults, joints, foliation, lineation and salt domes. Principles of magmatectonics. Introduction to major crystal structures.

350. Field Geology II (4 weeks).

Mapping in a metamorphosed Precambrian terrain with significant lithologic variation and having a relatively simple structure. Plane table survey.

412. Igneous and Metamerphic Petrology (3-6).

Introduction. Physico-chemical principles in igneous Petrology. Processing and presentation of the composition data of igneous rocks. Systematic petrology of igneous rock clans. Petrology of the mantle.

415. Geochemistry (3-0) 2nd term.

Composition of the earth, geochemical classification and distribution of elements, meteorites. Thermodynamics and its application in geochemistry. Principles of crystal chemistry. Phase rule and its applications. Geochemistry of a few important elements.

420. Pal-eontelogy II (2-0) 1st term ; (2-3) 2nd term ; (2-6) 3rd term.

Part A—Vertehrate pal-eonotology : introduction to comparative vertebrate anatomy, systematic discussion of major fossil vertebrate groups. Organic evolution : discussion of concepts, evidences, processes, and trends.

Part B—Micropal-eontology : morphology of principal kinds of microfossils, with emphasis on Foraminifera and Ostracoda ; stratigraphic applications.

433. Non-Metallic Mineral Deposits (1-3) 1st and 2nd terms ; (2-3) 3rd term.

Importance of non-metallic minerals in industry with special reference to Five-Year Plans in India. Chief Non-Metallic deposits of the world. Detailed study of the Indian deposits : production, mining, beneficiation, reserve, marketing, etc. Non-metallic mineral industry in India. Import and export. Conservation of non-metallic minerals and furture of the non-metallic industry in India.

434. Geology of Coal (1-3) 2nd Term and (1-0) Third term.

Characters and correlation of coal seams and coal measure formations. Properties, classification and origin of coal. Indian coal fields.

435. Geology of Petroleum (3-2) 1st Term.

Origin and occurrence of petroleum in different types of traps. Sedimentary and tectonic habitat of oil with special reference to India. Laboratory problems on subsurface methods.

437. Ground Water Geology (2-0) 1st Term.

Study of hydrologic cycle. Geology and occurrence of groundwater. Quantitative geohydrology : pumping, determination of permeability and groundwater inventory. Development of groundwater well types and yield. Quality of water. Occurrence of groundwater in India.

438. Engineering Geology (2-0) 2nd and 3rd terms.

Geologic implications of engineering problems. Principles of rock mechanics and soil mechanics in relation to geology. Geology as applied to various civil engineering projects as dams, reservoirs, canals, tunnels, high ways, bridges and buildings. Stability of slopes and beaches. Landforms and soils in engineering geology.

440. Structural Geology and Tectonics (2-3) First and Second Terms, (2-0) Third Term.

Behaviour of materials in experimental deformation. Hypotheses of rock flowage and fracture. Principles of petrofabrics. Structural analysis in different scales.

Geotectonics elements : their characteristics and inter-relation in space and time. Special aspects of orogenic deformation. Mechanics and periodicity of orogeny. Himalayan and Alpine orogenesis. Epeirogenesis. Special characters of ocean basis, Isostasy. Distribution of continents and oceans.

450. Field Geology III (6 to 8 weeks).

(*a*) Mapping in a structurally complex area with emphasis on detailed structural analysis (3 weeks).

(*b*) Sedimentary facies mapping with detailed environmental analysis. Measurement of stratigraphic sections (2 weeks).

(*c*) Prospecting and underground mapping (1 week).

(*d*) Theodolite survey (1 week).

502. Geomerphology and Photogeology (2-0) First Term, (2-2) Second Term, (1-6) Third Term.

Description and genesis of the prominent types of landforms. Critical study of all dynamical agents. Laboratory study of regional geomorphology from topographic sheets.

Introduction to photogrammetry and photo interpretation. Study of air photo of all prominent landforms and rock types. Techniques of preparation of geologic maps from air photos.

512. Silicate Analysis (0-6) Second Term.

Structure, properties and identification of clay minerals. Origin and occurrence of clays.

513. Sedimentary Petrology and Sedimentation (2-6) First Term, (1-3) Second Term, (3-0) Third Term.

Study of textures, structures, Classification and description of sedimentary rocks.

Study of environmental factors, processes of sedimentation and classification and description of environments of recent sediments. Tectonics in relation to sedimentation and sedimentary facies.

522. Stratigraphy II (2-0).

Stratigraphic procedures. Problems of correlation. Facies concept. Elements of ecology and palaeoecology. Stratigraphic distribution of chief fossil groups. Palaeogeographic realms. Important topics from world stratigraphy.

525. Mineral Economics (1-0) Second Term.

Importance of minerals in national economy. Pattern of mineral relationship ; Economic features of the mining industry : International flow of minerals: National mineral policy: Mineral Concession Rules: Mineral Policy and the Five-Year Plans in India.

532. Ore Genesis and Metallic Mineral Deposits (3-6) First and Second Terms, (3-3) Third Term.

Geochemical principles and processes involved in ore deposition: Mineral equilibria at high and low termperature and their bearing on problems of ore deposition—Sulphide and oxide systems ; Metallogeny in relation to stratigraphy and tectonics: Detailed study of the different genetic types of iron, manganese, copper, gold, silver, lead, zinc, chromium and radioactive mineral deposits of the world: Laboratory investigation of ore specimens.

535. Geology of Petroleum (3-2) First Term ; same as Ge 435 (For Geophysicists).

536. Prospecting (Geophysical, Geochemical and Geological) (2-1) First and Second Terms, (2-0) Third Term.

Suitability and application of the various geological, geophysical and geochemical methods for prospecting for minerals, oil and natural gas and water,

550. Field Geology IV (8 weeks).

(*a*) Field work for geochemical prospecting course (1 week).

(*b*) Field work for project and thesis (7 weeks approximately).

551. Mining Geology and Drilling Methods (2-0) First Term, (1-0) Second and Third Terms.

Relation of Geology to mining: Geological consideration structure and occurrence of mineral deposits in relation to prospecting. exploration, development and exploitation: Examination and development of prospect: Geological work in an operating mine: Reserve estimation: Elements of mining engineering: Techniques of drilling—equipments, procedure, logging, etc.

552. Geology Seminar (0-1).

Review of topics and papers on General and Applied Geology. Each student is required to give a talk once a term.

554. Technical Report Writing (0-1) Second Term.

Discussion on various types of research and professional reports and their preparation.

555. Project and Thesis (0-10) Third Term.

A thesis project based on individual work on any chosen topic in Applied Geology.

557. Clay Mineralogy (3-3) First Term.

Structure, properties and identification of clay minerals. Origin and occurrence of clays.

(b) Geophysics

360. General Geophysics I (2-0).

The earth as a planet. Elements of Spherical astronomy. The shape and size of the earth. Introduction to gravity and isostasy. Forces within the earch. Introductory seismology and internal constitution of the earth. Elements of geomagnetism.

370. Applied Geophysics (3-0) First and Second Terms, (2-2) Third Term.

Principles of different geophysical methods applied to geological problems and prospecting. A quick survey without going into details of interpretation and field techniques. Principles of geophysical instruments with demonstrations in the field.

462. Theory of Fields I (4-0) First Term.

Concept of the physical field. Different kinds of field in Geophysics. Fields due to several point sources, continuous distributions, and double layers. Fields within attracting masses. Lines of Force. Potential.

Conservative fields. Geometry of equipotential surfaces. Potential and field of line mass/charge. Logarithmic potential. Prismatic bodies. Application of solid angles. Templates. Application of vector calculus in potential theory. Laplace and Poisson equations. Their applications in cartesian, spherical and cylindrical coordinates. Consideration of flow-fields. Green's stratum. Green's theorem. Green's function. Boundary value problems. Introduction to the solution of Laplace's equation.

464. Nuclear Geology (3-3) First Term.

Fundamentals of Nuclear Physics. Radioactivity. Radioactive series. Instrumental techniques for detection and measurement of radioactivity. Radioactivity in various types of rocks. Radioactive minerals and their prospecting. Radioactivity and geological time scale. Experimental work on radioactive measurements. Determination of percentage uranium and thorium in unknown sources. Standardization of sources.

465. Radioactive Methods (2-3) Second Term, (1-0) Third Term.

Surveying and prospecting of radioactive minerals. Different cases of gamma ray emmission from standard shaped ore bodies. Nuclear measurements. Emulsion techniques. Energy discrimination. Pulse analysers.

Experimental practice in radioactive measurements. Handling of Geiger, scintillation and proportional counters and ionisation chambers. Activity of atomic minerals. Assaying of radioactivity in ores. Experiments on autoradiography.

490. Gravity and Magnetic Methods (0-3) First Term, (4-3) Second Term, (4-6) Third Term.

Theory of potentials applied to gravity and magnetic methods of exploration. Modern instruments used in gravity and magnetic survey. Magnetic properties of rocks. Gradient and curvature of fields. Ambiguity of potential fields. Resolution of bodies. Indirect methods of interpretation. Anomalies due to bodies of simple and irregular shapes. Residuals and derivatives. Analytical continuation. Combined analysis of gravity and magnetic fields. Analog methods and model studies.

Laboratory problems on the calibration of instruments, computation of anomalies, geometrical constructions. Preparation of residual and derivative maps, upward and downward continuation.

496. Field Geophysics I (6 weeks) Field Term.

Field training in gravity, magnetic and radioactive methods of prospecting. Students will undertake field problems, process and interpret the data and submit a report in professional form.

560. General Geophysics II (3-0) First and Third Terms, (2-0) Second Term.

Continuation of Ge 460. Detailed discussions on dimensions and figure of the earth. Isostatic compensation. Structure of oceans, water masses, current systems. Tides. Physics of the atmosphere. Thermal history of the earth. Problems of heat flow. Geotectonic problems. Terrestrial magnetism and electricity.

562. Theory of Fields II (4-0) First Term.

Continuation of Ge 462. Different methods of solution of Laplace equation. Use of Legendre, Bessel and other special functions in potential problems. Numerical, experimental and graphical methods of solution.

Basic concepts and equations in electromagnetic theory. Maxwell equations. Boundary conditions. Electromagnetic potentials. Electromagnetic waves. Plane, cylindrical and spherical waves. Electromagnetic energy. Propagation characteristics.

563. Theory of Elastic Waves (4-0) First Term.

Introduction. Elastic deformations and stresses and their relationship. Velocities and motions associated with body waves. Wave surfaces. Amplitude and energy. Wave equation and its solutions. Kirchoff's solution and its relationship to Huygens' principle. Rays and their properties. Change in velocity and its effect on rays. Reflection and Refraction of waves. Head-wave. Seismic pulses and their analysis. Imperfect elasticity and effects. Rayleigh waves. Love and other complex waves. Experimental studies on waves. Small scale field studies. Laboratory studies of rock properties.

570. Electrical and Electromagnetic Methods (0-4) First Term, (4-6) Second Term, (4-3) Third Term.

Classification. Electrical equivalents of geological bodies. Electrical properties of rocks and minerals. General theory of stationary current distribution in a stratified medium. Theory of resistivity sounding. Effect of anisotropy. Qualitative and quantitative interpretation of resistivity curves. Theory of resistivity profiling. Discussions of contacts, veins, spherical and cylindrical bodies. Interpretation, field procedures and planning.

Sources of electromagnetic field used in prospecting. Theory of electromagnetic wave propagation in a layered earth. Electrotelluric and magnetotelluric methods. Field due to a long cable. Turam method, field procedures, interpretation. Electromagnetic profiling with dipoles. Qualitative and quantitative interpretation. Short discussion of some modern developments.

Laboratory measurements of electrical properties of rocks and minerals. Model experiments in electrical and electromagnetic prospecting. Theoretical computation. Interpretation of field data.

575. Well Logging (2-3) **Second and Third Terms.**

Theory and applications of different geophysical methods used in bore holes. Electrical, radioactive, sonic, thermal and other forms of logging. Construction of departure and response curves. Qualitative and quantitative interpretation of well log data. Determination of reservoir parameters. Optimum log combination, field practices.

Laboratory measurements on core samples. Interpretation of various types of field logs and the use of Schlumberger and other interpretation charts.

580. Seismic Methods (0-3) First Term, (4-6) Second Term; (4-3) Third Term.

Review of basic principles. Reflection and Refraction from multi-layered media. Graphical and Analytical methods of interpretation. Veolcity, its importance and determination. Velocity change and velocity functions. Multiple reflection. Field techniques and survey plans. Seismic Instrumentation and recent developments.

Laboratory work on the study of components of the seismic equipment, the equipment as a whole and interpretation of field data.

595. Geophysics Seminar (0-1).

Review of topics and papers on General and Applied Geophysics. Each student is required to give a talk once a term.

596. Field Geophysics II (8 weeks) Field term.

Field training in electrical and seismic methods of prospecting. Students will undertake field problems, process and interpret the data and submit a report in professional form.

598. Project and Thesis (0-3) **First and Second Terms,** (0-6) **Third Term.**

A student is required to take up an independent investigation in some branch of Geophysics at the beginning of the Fifth year under the guidance of a teacher. A properly supervised and accepted technical report on the investigation has to be submitted at the end of the year.

HUMANITIES AND SOCIAL SCIENCES (Hu)

111. English (2-2).

The object of the programme is to teach students how to express themselves in good, simple, and correct English and to help them develop a taste for literature.

TUTORIAL PROGRAMME

1st Term

The main rules of syntax ; the sentence ; its structure ; punctuation ; paragraph ; no formal grammar lessons are given ; correct use is taught through composition.

2nd Term

Precis-writing ; letter-writing ; comprehension test etc.

3rd Term

Paraphrasing ; imaginative writing ; Report writing ; dialogue, diary, etc., writing short notes on topical issues.

Anthologies of essays and poems and a modern play will be chosen as text for the lecture classes. The text will be changed from time to time.

113. Principles of Government (1-0).

1. Society, State, and Government. Relation between the State and the Individual. Citizenship : rights and duties. Functions of government ; Spheres and purposes of the state ; Dictatorship *vs.* Democracy ; Welfare State.

2. Structore of Government ; Constitution of India with reference to some modern constitutions.

3. World Order and the U. N.

211. English (1-1).

TUTORIAL PROGRAMME

Advanced prose composition including precis writing ; discussion and review of important books ; summarising technical reports.

In the lecture classes two books will be discussed in detail ; one, preferably a prose play by an outstanding playwright in the first two terms and the other, one or two long poems or a number of poems by different poets, or short stories or essays.

212. Logic (1-0).

The province of logic : Nature, Scope and Utility of logic ; the fundamental concepts of logic. The relation of logic to psychology, grammar and mathematics.

Logic and language : Words and Terms ; Denotation and Connotation and distribution of terms : Classification of terms. Propositions and sentences (classification of propositions, opposition of propositions).

Deductive inference. Nature and Implication : Immediate and Mediate. Immediate Inference : Conversion and Obversion. Mediate Inference : Syllogism (Pure categorical).

Inducive Inference : Problem, nature and methods. Relation between Induction and Deduction. Grounds of Inductive Inference : Formal and Material. Formal Grounds ; Uniformity of Nature and Causality. their Definition and nature. Material Grounds ; Observation and Experiment : their explanation and illustrations. Inductive procedure and methods : Hypothesis. Introduction to the theory of probability and its relation to Induction.

411. Elementary French (2-1).

Basis and essentials of French language : graduated course to cover pronunciation and elements of grammar, reading of varied matter, literary and scientific, to lay the foundation of vocabulary for facilitating further independent reading of scientific journals and writings. Practice in hearing and speaking French may be supplemented by audio-visual devices (French records, pictures, etc.).

Introduction to the more general technical terms and to the easier texts of technical books of Geology and Geophysics.

412. Elementary German (2-1).

Basis and essentials of German language : graduated course to cover pronunciation and elements of grammar, reading of varied matter, literary and scientific, to lay the foundation of vocabulary for facilitating further independent reading of scientific journals and writings. Practice in hearing and speaking German may be supplemented by audio-visual devices, (German records, pictures, etc.).

Introduction to the more general technical terms and to the easier texts of technical books of Geology and Geophysics.

413. Elementary Russian (2-1).

Basis and essentials of Russian language: graduated course to cover pronunciation and elements of grammar reading of varied matter, literary and scientific, to lay the foundation of vocabulary for facilitating further independent reading of scientific journals and writings. Practice in hearing and speaking Russian may be supplemented by audio-visual devices (Russian records, pictures etc.).

Introduction to the more general technical terms and to the easier texts of technical books of Geology and Geophysics.

MATHEMATICS (Ma)

114. Mathematics I (6-2).

Function. Limits, Continuity. Differentiation. Rolle's theorem. Mean value theorems. Higher derivatives. Total differential. Integration. Hyperbolic functions. Ordinary differential equation of first order and higher order linear differential equation with constant coefficients.

Analytical geometry of two dimensions. Homogeneous equation of the second degree, classification of conics. Tangents, Polar coordinates. Analytical geometry of three dimensions. Planes, straight lines and simple conicoids.

Argand diagram. De Moivre's theorem. Summation of trigonometrical series. Gregory's series. Inter-relation of trigonometric and hyperbolic functions.

Determinants of second and third order. Linear transformations. Matrices. Cramers rule. Polynomials. Division algorithm. Transformations of polynomial equations. Carden's solution of the cubic equation. Horner's method.

214. Mathematics II (4-1).

Sequence. Series. Convergence tests. Power series. Functions of two or more variables. Partial derivatives. Definite integrals. Calculations of length, area, volume, surface, centre of gravity. Elementary treatment of asymptotes, nodes, cusps. Some well known curves. Curvature. First order partial differential equations. Fourier series.

System of coplaner forces. Frames, virtual work, centre of gravity, stability. Uniform string under gravity. Moments. Couples. Friction.

Motion in a straight line. Velocity and accleration in polar and intrinsic coordinates, free and constrained motions. Central orbits. Collision of elastic bodies. Projectiles. Motion in a resistive medium. Motion in a circle.

314. Advanced Calculus and Differential Equations (3-0).

Elementary properties of vectors. Scalar and vector product. Multiple products. Differentiation of vectors. Geometry of a space curve. Gradient. Divergence. Curl. Divergence theorem. Stoke's theorem. Delta operator. Multiple application of delta. Laplacian. Orthogonal curvilinear coordinates. Special coordinate systems. Coordinate transformations, tensors. Contravariant and Covariant tensors. Addition, multiplication, and contraction of tensors. Differentiation of tensors, symbols.

Formation of differential equations. Series solutions of homogeneous second order equations. Some functions defined by differential equations. Trigonometric and hyperbolic functions. Bessel functions. Modified Bessel functions. Kelvin functions. Some useful properties of these functions. Legendre and Associated Legendre functions.

414. Methods of Applied Mathematics (4-0). First Term, (3-0). Second and Third Terms.

Complex variable. Elementary functions. Analytic functions, Cauchy-Riemann equations. Cauchy's integral theorem. Cauchy's integral formula. Taylor series. Laurent series. Singularities. Residues. Contour integration. Conjugate functions. Conformal mapping. Some simple transformations.

Fourier series. Fourier integral. Harmonic analysis. Orthogonal functions. Solutions of partial differential equations of Physics. Laplace equation. Diffusion equation. Wave equations. Elements of integral equations, Introduction to Fourier and Laplace transform.

Some concepts and definitions in the theory of matrices. Solution of linear algebraic equations. Graffe's root-square method. Interpolation formulas. Numerical differentiation and integration. Finite difference and error distribution methods as applied to ordinary and partial differential equations. Programming on analogue computer. Fortran language in the use of a digital computer.

MINING ENGINEERING (MIN)

516. Drilling Methods and Elements of Mining (2-0). First Term, (1-0). Second and Third Terms.

Drilling Methods

Simple hand methods, percussive and rotary methods for prospecting and miscellaneous purposes; drilling for petroleum; deviation of boreholes ; difficulties in boring; borehole surveying and logging; directional drilling.

Elements of Mining

Historical background; mine development; explosives and blasting; support, mining methods; mine valuation.

PHYSICS (Ph)

114. Physics I (4-1).

Review of elementary principles of mechanics ; circular motion, moment of inertia, conservation of energy and momentum, collision of elastic bodies, simple harmonic motion, simple and concical pendulums, torsoinal oscillations ; balance ; production and measurement of loss pressure ; Law of gravitation, Kepler's law, measurement of g ; elasticity and elastic properties of matter ; units and dimensions.

Nature of sound, velocity of sound and its measurement ; properties of waves, progressive and stationary waves ; damped and forced vibrations ; intensity ; pitch and quality ; musical sound and noise ; principle of sound analysis ; Doppler's principle ; ultrasonics ; sound recording and reproduction.

Geometrical optics. Fermat's principle ; thick lens, prinçipal points, combination of lenses ; spherical and chromatic abberations ; velocity of light, Doppler's principle ; optical instruments ; emission and absorption spectra ; photometry, colour and vision.

Thermal expansion ; change of state, hygrometry, transmission of heat ; sp. heat of gases ; isothermal and adiabatic changes ; mechanical equivalent of heat, first law of thermodynamics.

Various types of cells ; electrolytic conduction ; Ohm's law and Kirchoff's law ; electrical measurements and instruments ; thermoelectricity ; review of electrostatics and magnetostatics ; Ganss's theorem and its application.

115. Physics Laboratory I (0-3).

Simple experiments pertaining to subject matter covered in Ph 114.

214. Physics II (3-1).

Flow of liquids and Bernonllies theorem ; surface tension ; viscosity ; kinetic theory of matter ; production and measurement of low pressure.

Equation of state of perfect and real gases ; M—B velocity distribution, transport phenomena ; thermal conduction and convection ; reversible process ; Carnot's theorem ; entropy and second law of thermodynamics ; Maxwell's relations and their applications ; theory of radiation.

Wave theory of light-Huyghen's principle ; interference and diffraction phenomena ; polarisation. Fresnel's theory ; Kerr and Faraday effects.

Electromagnetism, electromagnetic induction ; Ballistic galvanometer, fluxmeter ; L.C.R. circuits, alternating current ; dielectric polarisation ; Maxwell's electromagnetic induction ; magnetic properties of matter.

215. Physics Laboratory II (0-3).

Simple experiments pertaining to subject matter covered in Ph. 214.

314. Atomic and Nuclear Physics (2-0).

Discharge through tubes ; measurement of e and e/m of the electrons ; thermoionic emission ; positive rays and measurement of q/m ; isotopes and mass spectroscope ; quantum theory of radiation ; photoelectricity ; compton scattering ; structure of atoms, Hydrogen and Alkali-spectra ; Pauli's exclusion principle, periodic classification of elements theory of sp. heat of solids ; dielectric polarisation ; dia—, para—and Ferromagnetism, x-rays and crystal structure ; qualitative discussion of :—fluorescence and phosphorescence, Zeeman effect, piezoelectricity and ultrasonics, etc ; introduction to nuclear physics :— ray spectra, nuclear structure, binding energy, instruments for measurements ; Cosmic rays, age determination.

315. Physics Laboratory III (0-3).

Advanced experiments pertaining to subject matter covered in Ph 114 and Ph 214.

414. Physics of Solids (2-0).

Structure of matter, classification of solids and general nature of the properties of different types of solids, molecular forces ; crystal lattice, lattice imperfections, dislocations ; structure sensitive properties of solids, lattice vibrations ; elastic and thermal properties of crystals ; an elasticity, plastic flow ; internal friction ; properties of matter under high pressure ; dual aspect of matter, De Broglie's hypothesis, matter wave, elements of electron diffraction ; Schrodinger's wave equation—one dimensional cases only ; elements of solid state physics—electrical properties of matter—conductors and semiconductors ; descriptive discussion of the free electron and hand theory of solids, effective mass, positive holes ; brief discussion about the metal semiconductor junctions, rectification, transistor action and related phenomena.

(For Geophysicists)

415. Physics Laboratory IV (0-3).

Advanced experiments pertaining to subject matter in Ph 114 and Ph 214.

(For Geophysicists)

PART IV

REGULATIONS

SCHEDULE OF COURSES AND SUBJECTS OF INSTRUCTION FOR 2-YEAR M.TECH., M. C. P. AND M. R. P. DEGREE COURSES AND 1-YEAR D. I. I. T. COURSES

SCHEDULE XXIX

REGULATION NO. 35

Admission to the Postgraduate Courses

(*a*) *Minimum Educational Qualifications* :

(*i*) Master of Technology (M.Tech.) Degree—

A person seeking admission to any of the postgraduate courses in engineering and technology leading to the Degree of Master of Technology must have a Bachelor's Degree in the appropriate branch of engineering and technology and should preferably have industrial or professional experience of one year or have qualifications deemed equivalent by the Senate.

(*ii*) Master of City Planning (M.C.P.) Degree and Master of Regional Planning (M.R.P.) Degree:

A person seeking admission to any of the two Postgraduate courses leading to the Degree of Master of City Planning and the Degree of Master of Regional Planning must have respectively a Bachelor's Degree in Architecture or Civil Engineering ; or a Bachelor's degree in Architecture or Civil Engineering or Master's Degree in Economics or Geography or Statistics or Social Sciences, or have qualifications deemed equivalent by the Senate.

(*iii*) Postgraduate Diploma (D.I.I.T.):

A person seeking admission to any of the postgraduate courses leading to the Postgraduate Diploma (D.I.I.T.) should either have a Master's Degree in the appropriate branch of Science or Arts or a Bachelor's Degree in engineering or technology appropriate to the specialisation on which he wishes to enter upon, or have qualifications deemed equivalent by the Senate.

Minimum educational qualifications for admission to the various postgraduate courses shall be as may be decided by the Senate from time to time ; at present for—

A. *M.Tech. Degree Courses*: in—

(*i*) Agricultural Engineering (Farm Machinery & Power ; Soil & Water Conservation Engineering).

A First Class Bachelor's Degree in Agricultural or Mechanical or Civil Engineering or its equivalent.

(*ii*) Chemical Engineering (Chemical Engineering Plant Design & Fabrication ; Combustion Engineering and Fuel Economy ; Petroleum Refinery Engineering & Petrochemicals).

A First Class Bachelor's Degree in Chemical Engineering. For Combustion Engineering & Fuel economy Mechanical Engineering graduates are also eligible.

(*iii*) Civil Engineering (Advanced Hydraulic Engineering ; Harbour Engineering ; Highway Engineering ; Public Health Engineering ; Soil Mechanics & Foundation Engineering ; Structural Engineering).

A First Class Bachelor's Degree in Civil Engineering.

(*iv*) Electrical Engineering (Control System Engineering ; Electrical Machines ; Power System Engineering).

A First Class Bachelor's Degree in Electrical Engineering. For Control System Engineering, Electrical Communication Engineering graduates are also eligible.

(*v*) Electronics & Electrical Communication Engineering (Industrial Electronics ; Ultra High Frequency & Microwave Engineering).

A First Class Bachelor's Degree in Electronics and Electrical Communication Engineering or its equivalent.

(*vi*) Mechanical Engineering (Foundry Engineering: Heat Power—with specialisation either in I.C. Engines and Gas Turbines or Refrigeration and Air Conditioning or Steam Power

Plant. Industrial Engineering and Operations Research; Machine Design; Mechanical Handling Science and Technology; Mechanism and Vibration; Production Science and Technology).

A First Class Bachelor's degree in Mechanical Engineering. (First Class graduates in Electrical, Electrical Communication, Mining and Metallurgical Engineering of this Institute are also eligible for admission to the Industrial Engineering and Operations Research specialisation. First class graduates in Metallurgical Engineering are also eligible for admission to the Foundry Engineering specialisation).

(*vii*) Metallurgical Engineering (Physical Metallurgy; Process Metallurgy).

A First Class Bachelor's Degree in Metallurgical Engineering, First Class M.Sc. in Physics or Chemistry with three years' experience in a Metallurgical establishment are also eligible for admission to this course.

(*viii*) Mineral Engineering.

A First Class Bachelor's Degree in Mining Engineering or its equivalent.

(For admission to the Industry based courses practical or Industrial experience of at least one year is essential).

B. *Master of City Planning and Master of Regional Planning courses* in—

(*i*) Master of City Planning: A First Class Bachelor's Degree in Architecture or Civil Engineering.

(*ii*) Master of Regional Planning: A First Class Bachelor's Degree in Architecture or Civil Engineering, or a First Class Master's Degree in Economics or Geography or Statistics or Social Sciences.

(For admission to these courses professional experience of at least one year is essential).

C. *Postgraduate Diploma* (*D.I.I.T.*) *Courses* in—

(*i*) Applied Botany: A First Class Master's Degree in Botany or Agriculture or its equivalent.

(*ii*) Farm Management Technology: A First Class Master's Degree in Agriculture, or Agronomy or Agricultural Economics or its equivalent.

(*iii*) Soil Technology: A First Class Master's Degree in Agriculture or Soil Science ot its equivalent.

(*iv*) Dairy Engineering: A First Class Bachelor's Degree in Agricultural or Chemical or Electrical or Mechanical Engineering or its equivalent.

(*v*) Applied Chemistry: (*a*) *High Polymer & Rubber Technology*: A First Class Master's Degree in Chemistry or Applied Chemistry, or Bachelor of Science Degree in Chemistry with Physics and Mathematics as subsidiary subjects with considerable experience as Chemist in a Polymer or Rubber industry.

(*b*) *Synthetic Drugs & Fine Chemicals*: A First class Master's Degree in Organic Chemistry with Physics and Mathematics as subsidiary subjects in B.Sc. course.

(*c*) *Technical Gas Reactions & High Pressure Technology*: A First Class Master's Degree in Physical or Applied Chemistry with Physics and Mathematics as subsidiary subjects in B.Sc. course or a first class Bachelor's Degree in Chemical Engineering.

(*vi*) Structural Steel Design: A First Class Bachelor's Degree in Civil Engineering.

(*vii*) Concrete Technology and Design: A First Class Bachelor's Degree in Civil Engineering.

(*viii*) Electric Traction : A First Class Bachelor's Degree in Electrical Engineering.

(*ix*) Applied Geology : A First Class Master of Science Degree in Geology with some field experience.

(*x*) Exploration Geophysics : A First Class Master of Science Degree in Geophysics or a First Class Master of Science Degree in Physics with at least one year's research and/or field experience in Exploration Geophysics or a First Class Master of Science Degree in Physics with Geology as one of the subjects in B.Sc. course.

(*xi*) Geochemistry : A First Class Master of Science Degree in Geology with Mathematics as one of the subjects in B.Sc. course.

(*xii*) Industrial Psychology & Industrial Relations : A First Class Master's Degree in Psychology or Industrial Relations or Economics or Sociology or a First Class Bachelor's Degree in Engineering.

(*xiii*) Applied Mathematics (Magneto Fluid Dynamics ; Non-Linear Mechanics ; Plasticity & Rheology) : A First Class Master's Degree in Mathematics or a First Class Bachelor's Degree in Engineering.

(*xiv*) Industrial Physics : A First Class Master of Science Degree in Physics or Applied Mathematics or a First Class Bachelor's Degree in Electrical or Mechanical or Electrical Communication Engineering.

(*xv*) Planning : A First Class Bachelor's Degree in Civil Engineering or Architecture.

(*b*) *Age Limit :* To be eligible for admission to any of the Postgraduate courses a candidate, on the 1st October of the year of admission, must have completed 20 years of age.

(*c*) *Standard of Physical Fitness :*To be eligible for admission to any of these courses a candidate must fulfil the prescribed standard of physical fitness as given below :

Height	—	1.6 metre
Weight	—	46 Kilogram
Chest Measurement	—	76 cm. with satisfactory limit of expansion.
Vision	—	*Better eye* 6/9 or 6/6 ; *Worse eye* 6/9 or 6/12 Corrected with glass. Eyes should be free from congenital or other diseases.
Hearing	—	Normal.
Good general health and build.		
Heart & Lungs	—	There should be no abnormality.
Hernia, Hydrocele, Varicocele, Piles	—	Presence of any of these is a temporary disqualification to be rectified before joining.

Opinion of the Institute Medical Officer in regard to fitness of a candidate shall be final and there shall be no appeal.

SCHEDULE XXX

REGULATION NO. 36

Entrance Test for Admission to the Post-graduate Courses

1. A preliminary selection of candidates shall be made by Admission Committee after scrutiny of applications including mark sheet, Grade card and testimonials, and only those who Prima-facie satisfy the minimum requirements will be called for the entrance test, the scope of which shall be determined by the Admission Committee. The entrance test, written and/or oral, shall be held at the Institute on a date to be fixed by the Senate.

2. Admission to these courses shall be made in order of merit on the results of the entrance test.

SCHEDULE XXXI

REGULATION NO. 37

Courses and Duration

A. *Degree of Master of Technology* (*M.Tech.*)

1. The Institute shall provide postgraduate courses leading to the Degree of Master of Technology (M. Tech.) with specialisation in any of or all the branches listed in Schedule xxix (Regulation No. 33) as the Senate may decide from time to time taking into consideration the accommodation, staff position and other facilities available.

2. For persons with adequate academic preparation and requisite industrial and/or professional experience the curricula for the Degree of Master of Technology in the branches listed in Schedule XXIX shall extend over a period of two academic years. The first academic year shall consist of four terms of approximately three months, each, of which the first three terms shall be devoted mainly to course work in lecture classes, laboratory, workshops, field and drawing classes at the Institute: the fourth term of about three months shall be devoted to industrial or professional training either in industry or at the Institute depending on the specialisation. The second academic year shall consist of not less than nine months but ordinarily not more than twelve months during which a student shall devote himself to research or design or project work at the Institute or in an establishment recognised for the purpose, under the guidance of supervisor or supervisors to be appointed by the Head of the Department.

3. A person who, in the opinion of the Admission Committee, needs a preparatory course may be required to spend a preparatory academic session or part thereof and qualify in the prescribed test or tests before he is permitted to enter upon the postgraduate curriculum for the Degree of Master of Technology.

4. A member of the teaching staff of the Institute permitted to enter upon the Postgraduate curriculum on part-time basis shall be required to devote not less than three academic years to qualify for the Degree of Master of Technology.

B. *Degree of Master of City Planning* (*MCP*) *and Degree of Master of Regional Planning* (*MRP*)

1. The Institute shall provide postgraduate courses leading to the Degree of Master of City Planning (MCP) and the Degree of Master of Regional Planning (MRP) as the Senate may decide from time to time taking into consideration accommodation, staff position, and other facilities available.

2. For a person with adequate academic background and requisite professional experience, the curriculum for the Degree of Master of City Planning and the Degree of Master of Regional Planning shall extend over a period of two academic years. The first academic year shall consist of three terms of approximately three months each of which shall be devoted mainly to course work in the lecture classes, laboratories and studies of the Institute and the fourth term of approximately two months shall be devoted to practical training in a Planning Office. The second academic year shall also consist of four terms, the first two or three terms of approximately three months each shall be devoted mainly to course work in the lecture classes, laboratories and studios of the Institute. During the third and/or the fourth terms, of about three months a student shall devote himself to design or thesis work at the Institute under the guidance of a Supervisor to be appointed by the Head of the Department.

3. A person who, in the opinion of the Admission Committee needs a preparatory course, may be required to spend a preparatory academic session or part thereof and qualify in the prescribed tests before he is permitted to enter upon the curriculum for the Degree of Master of City Planning or the Degree of Master of Regional Planning.

4. A member of the teaching staff of the Institute permitted to enter upon the postgraduate curriculum on a part-time basis, shall be required to devote not less than three academic years to qualify for the Degree of Master of City Planning or the Degree of Master of Regional Planning.

C. *Postgraduate Diploma* (*D.I.I.T.*)

1. The Institute shall provide Postgraduate Diploma courses in any of or all the specialised branches mentioned above and those listed in Schedule XXIX (Regulation 33) as may be decided by the Senate from time to time taking into consideration the staff position, accommodation and other facilities available.

2. For a person with adequate academic preparation and requisite industrial and/or practical experience the curriculum for the Postgraduate Diploma course shall extend over a period of one academic year of twelve months consisting of four terms of approximately three months each, of which the first three terms shall be devoted mainly to course work in lecture classes, laboratories, workshops, field and drawing classes at the Institute, while in the fourth term a student shall be required to undergo some practical training in industries or at the Institute as may be prescribed for a particular course and submit a dissertation or a project report and also submit himself to an oral examination.

3. A person who, in the opinion of the Admission Committee, needs a preparatory course may be required to spend a preparatory academic session or part thereof and qualify in the prescribed test/s before he is permitted to enter upon the curriculum for the Postgraduate Diploma.

4. A member of the teaching staff of the Institute permitted to enter upon the curriculum for the Postgraduate Diploma on part-time basis shall be required to devote not less than two academic years of twelve months each to qualify for the Diploma.

SCHEDULE XXXII

REGULATION NO. 38 (P. G)

Graduation Requirement

A. *General Regulations :*

1. A student shall not be permitted to appear at any of the examinations for the degree of Master of Technology (M.Tech.), or the Degree of Master of City Planning (M.C.P.) or the Degree of Master of Regional Planning (M.R.P.) or the Postgraduate Diploma (D.I.I.T.) unless he has been regular in attendance in all lecture classes, laboratories, guided studies, drawing office, workshop classes, field work, studios or factory training, and he has satisfied the class teachers and he has conducted himself well within and outside the class rooms and he has been regular, diligent and methodical in his studies and has indepently and satisfactorily performed the home and sessional assignments and has regularly submitted these for scrutiny by the teachers.

2. A candidate for the Degree of Master of Technology or the Degree of Master of City Planning or the degree of Master of Regional Planning shall be required to qualify for the degree within a period of not more than four years of study at the Institute, provided that a member of the teaching staff of the Institute permitted to undergo the course on a part-time basis may do so within a period of not more than five years.

3. A candidate for the Postgraduate Diploma shall be required to qualify for the Diploma within a period of not more than three years of study at the Institute, provided that a member of the teaching staff of the Institute permitted to undergo the course on a part-time basis may do so within a period not exceeding four years.

B. *Degree of Master of Technology*:

1. The curriculum for the Degree of Master of Techno ogy shall consist of subjects as set forth in the Schedule for Postgraduate courses. (Schedule XXIX).

2. The scope of the subjects of instruction shall be as detailed in the Schedule for Postgraduate courses. (Schedule XXIX). In each subject of examination there shall be written paper or papers and/or sessional assignments, as prescribed.

3. Each subject carries a certain number of units to indicate the number of contact hours per week, that is, the number of hours per week a student has to spend on it in class, laboratory, etc. under the supervision of a teacher. (Usually, one unit corresponds to one hour of lecture, tutorial or seminar per week or two to four hours of laboratory, field or drawing office per week).

4. A student preparing for the Degree of Master of Technology is expected, during the first academic year, to take up course work of not less than twelve units per term and not more than eighteen units per term during the first three terms. To be eligible for the Degree, a student is, however, required to complete satisfactorily at least 48 units, industrial or professional training during the fourth term of the first academic year being reckoned as 12 units.

While research or project work shall not carry any unit as such the thesis or dissertation shall be graded.

5. A member of the teaching staff of the Institute preparing for the Degree of Master of Technology may not ordinarily be permitted to take more than half the number of units of course work per term as prescribed for a particular course.

6. The Senate shall determine in respect of each subject of study the relative proportion of lecture and/or practical, laboratory work, and shall also determine in respect of several examinations for the Degree, the standard of examination and the conditions for admission thereto.

7. No candidate may present himself for examination in any subject until he has completed the prescribed course of instruction to the satisfaction of the teachers concerned. In the event of unsatisfactry progress and poor performance in an examination a postgraduate student may be required to leave the Institute.

8. The examination for the Degree of Master of Technology shall be taken in five sections comprising three terminal examinations each covering term's work during the first three terms, report on the industrial or professional training during the fourth term of the first academic year and the final thesis and viva-voce examination at the end of the second academic year. The Viva-voce examination shall cover the student's work for the entire course and shall include examination in defence of the thesis and/or Project report or Design work submitted by him.

9. Special Senate instructions specifying the standard of examination shall be kept with the Registry to be available to the Senate and the Board of Examiners only.

10. **Scholastic Requirement.**

The quality of student's work in the various subjects of study shall be determined by a system of grades as given below:—

"A" denotes Excellent
"B" denotes Good
"C" denotes Fair
"F" denotes Failed

The grade "F" in a subject may be removed only by repeating the subject in which case a fresh grade without credit may be awarded. Not only the new grade but also the original grade "F" shall appear in the Grade Card which shows all the subjects taken and the respective grades obtained.

11. A student who has secured the required credit point average in the first academic year shall be eligible to submit (in triplicate) and in the approved for his thesis on the research, or design or project work carried out during the second academic year on a date to be fixed by the Senate. The thesis shall be examined separately by the Supervisor and the Additional examiner to be appointed by the Senate. Both the examiners shall be required to report separately on the thesis and forward their recommendation to the Registry which shall place the reports before the Board of Examiners. The Head of the Department, the Additional examiner and the supervisor(s) shall constitute the viva-voce Board which should include one or two other teachers also. The Board shall test the depth and breadth of knowledge of the candidate in the special field and also in the allied field of study and grade the quality of the thesis or Design or project report and performance of the candidate in the viva-voce examination, and make recommendation to the Board of Examiners. A candidate whose thesis has been found to be unsatisfactory by the Additional examiner will not normally be eligible to appear at the viva-voce examination. In the event of a thesis or Design or Project report being found unsatisfactory the candidate shall be required to resubmit the work after due modification along the line of criticism made by the examiner within a time limit as may be fixed by the Senate.

12. A student securing requisite average credit in the course work, industrial/professional training report, thesis and viva-voce examination shall be deemed to have qualified for the Degree of Master of Technology.

13. A candidate shall be deemed to have passed the Master of Technology Degree Examination provided he has secured on the total of the three terminal examinations the requisite minimum standard in each of the written papers and sessional assignments, on the industrial or professional training report, and in the thesis design examination and in the viva-voce examination, and secured the minimum credit point average.

14. Subject to the provisions of the Ordinances and Regulations the Degree of Master of Technology (M. Tech.) shall be conferred on candidates who have studied on the prescribed curriculum for not less than two academic years, the subjects as set forth in Schedule XXXIII and have reached the minimum standard in the examination in one of the subjects listed in Schedule XXIX.

15. For the Degree of Master of Technology the graduate shall receive a Diploma wherein shall be set forth the branch and the subject of specialisation in respect of which the Degree has been awarded.

16. A student failing to secure the minimum credit point average on the overall total of the first three terms may be allowed to repeat in part or in full as may be decided by the Senate. In the event of a student failing to secure the minimum credit on the Industrial or professional training in the fourth term he shall be required to undergo further industrial or professional training during the next academic year.

17. A student who has been admitted to the Master of Technology Degree course but decides to proceed instead, to the Postgraduate Diploma course or has been found, in the opinion of the Head of the Department, more suitable for the Postgraduate Diploma course rather than for the Master of Technology Degree course, would be required to submit a formal application for permission to take the Postgraduate Diploma course. Ordinarily, such applications should be made at the beginning of the third term. If the application for the change is granted then the student shall be assigned a project work for the fourth term and he shall be required at the end of the first academic year to submit a dissertation on his project work and submit himself to an oral examination for the Postgraduate Diploma in the subject of his specialisation.

18. The Senate shall be competent, on the recommendations of the Board of Examiners, to deviate from the prescribed Ordinances and Regulations relating to the examination and consider special cases of students not covered by the Ordinances and Regulations subject to the approval of the Board of Governors.

C. *Degree of Master of City Planning and Degree of Master of Regional Planning:*

1. The curriculum for the Degree of Master of City Planning and the Degree of Master of Regional Planning shall consist of subjects as set forth in Schedule XXXIII.

2. The scope of the subjects of instruction shall be as detailed in Schedule XXXIII. In each subject for examination there shall be written paper or papers and/or sessional assignments as prescribed.

3. Each subject carries a certain number of units to indicate the number of hours a student spends on it under the supervision of a teacher. (Usually one unit corresponds to one hour of lecture, tutorial or seminar per week, or two to four hours of laboratory or studio work per week).

4. A student preparing for the Degree is expected to take up a minimum of 10 units of work per term and normally not more than 18 units. To be eligible for the Degree a student is required to complete satisfactorily at least 90 units, of which about 10 units shall be counted towards Thesis or Design including Viva-voce examination.

5. A member of the teaching staff of the Institute preparing for any of the Degrees may not ordinarily be permitted to take more than half the number of units of course work per term as prescribed for a particular course.

6. The examinations for the Degree of Master of City Planning and the Degree of Master of Regional Planning shall be taken in eight sections comprising three terminal examinations each covering the term's work in each of the two academic years, the report on the practical training in the fourth term of the first academic year, and the final thesis or design and Viva-voce examination. The Viva-voce examination shall cover the students' work for the entire course and shall include examination in defence of the thesis or design work submitted by him.

7. Other relevant Regulations for the Degree of Master of Technology shall, in general, apply to these Degree courses also.

D. *Postgraduate Diploma* (*D.I.I.T.*)

1. The curriculum for the Postgraduate Diploma (D.I.I.T.) shall consist of subjects as set forth in the Schedule for Postgraduate Diploma courses (Schedule XXIX) each of which shall be studied by attendance in lectures, tutorials, seminars, laboratory, drawing office, field work and workshop classes, as prescribed in the Schedule. In addition, each candidate shall be required to submit in duplicate, for examination in the prescribed form a dissertation and/or a project report on a problem that will be assigned to him not later than in the second term by the Head of the Department. He may, in the preparation of the dissertation and/or project work, take guidance from the supervisor who shall be appointed for the purpose by the Head of the Department.

2. The scope of the subjects of instruction shall be as detailed in Schedule for Postgraduate Diploma courses (Schedule XXIX). In each subject for examination there shall be written paper or papers and/or sessional assignments, as prescribed.

3. Each subject carries a certain number of units to indicate the number of hours per week a student spends on it under the supervision of the teacher. (Usually, one unit corresponds to one hour of lecture, tutorial, or seminar per week; or, two to four hours of laboratory, field or studio work per week).

4. A student preparing for the Postgraduate Diploma is expected to take up a minimum of 12 units of work per term and, normally, not more than 18 units. To be eligible for the Diploma, a student is required to complete satisfactorily at least 48 units of which a minimum of 12 units can be counted towards dissertation or project report including Viva-voce examination.

Students preparing for the Postgraduate Diploma in Applied Geology, Exploration Geophysics and Geochemistry are expected to take up a minimum of 24 units of course work. The balance should be on field work, project report or dissertation and Viva-voce Examination.

5. A member of the teaching staff of the Institute preparing for the Postgraduate Diploma (D.I.I.T.) may not ordinarily be permitted to take more than half the number of units of course work per term as prescribed for a particular course.

6. The examination for the Postgraduate Diploma shall be taken in four sections comprising three terminal examinations each covering the term's work and the final dissertation and Viva-voce examination. The Viva-voce examination shall cover the student's work for the entire session and shall include examination in defence of his dissertation and/or field or project report submitted by him.

7. Other relevant Regulations for the Degree of Master of Technology shall, in general, apply to the Postgraduate Diploma courses also.

SCHEDULE XXXIII

REGULATION NO. 39

Schedule of Courses for M.Tech, M.C.P., M.R.P. and

D.I.I.T. Courses

AGRICULTURAL ENGINEERING (AgE)

The Department of Agricultural Engineering offers a postgraduate course of two-year duration leading to the degree of Master of Technology in Agricultural Engineering with specialisations in (*a*) Farm Machinery and Power ; (*b*) Soil and Water Conservation Engineering.

The Department also offers postgraduate courses of one-year duration leading to the Diploma of Indian Institute of Technology (D.I.I.T.) in the following fields : (*c*) Applied Botany; (*d*) Dairy Engineering; (*e*) Farm Management Technology; (*f*) Soil Technology.

A. Course work for the M.Tech. degree course.

Common subjects for both the specialisations.

FIRST YEAR

Subject No.	Subjects	Units per Term 1st	2nd	3rd.
AgE 601	Dimensional Analysis	2	—	—
AgE 623	Irrigation Equipment Design	—	—	2
AgE 667	Soil Physics for Agr. Engineers	—	2	—
AgE 693	Seminar	1	1	1
Ma 684	Vector Analysis and Matrices	3	—	—
Ma 685	Theory of Complex Variables	—	2	—
Ma 686	Ordinary and Partial Differential Equations ...	—	3	—
Ma 687	Operational Methods	—	—	2
	SECOND YEAR			
AgE 641	Instrumentation in Agricultural Engg.	2	—	—
AgE 642	Research Methods in Agricultural Engg.	2	—	—
AgE 693	Seminar	1	1	1
Ma 641	Numerical Methods and High Speed Computations ...	—	2	—
Ma 644	Statistical Methods	2	—	—
	Thesis/Project	9 to 12 months.		

(a) For Farm Machinery and Power specialization

Subject	No.	Subject	Units per term 1st	2nd	3rd
AgE	611	Advanced Farm Power	2	—	2
AgE	612	Farm Machinery Design	3	2	3
AgE	613	Farm Machinery Testing	—	2	—
AgE	614	Agricultural Process Equipment Design	2	—	—
AgE	615	Dairy Engineering	—	—	2
AgE	616	Tractor Design Principles	—	—	2
ME	6681	Analysis of Stresses	—	3	—
ME ME	6271 6281	Production Engineering I & II	3	3	—
ME	6191	Industrial Engineering	—	—	3
		*Special Topics	(Units to be arranged)		
AgE	692	Design and Testing Project	(Units to be arranged)		
		Industrial Training—12 units in the fourth term.			

(b) For Soil and Water Conservation Engineering specialization

AgE	621	Soil Conservation Structures Design	2	2	2
AgE	622	Irrigation Engineering	3	3	—
AgE	624	Head Water Hydrology for conservation	2	—	—
AgE	625	Upstream Flood control	—	2	—
AgE	626	Conservation Planning in River Valley Projects ...	—	—	2
AgE	627	Farm Drainage Systems Design	—	—	3
AgE	678	Agronomy, Forestry and Agrostology in Soil Conservation	2	2	—
AgE	679	Arid Zone Conservation	—	2	—
CE	621	Fluid Mechanics I	3	—	—
CE	609	Soil Mechanics and Foundation Engg. I.	3	—	—
CE	626	Dams and Dam Construction III	—	—	3
		*Special Topics	(Units to be arranged)		
AgE	692	Design and Testing Projects	(Units to be arranged)		

Industrial Training—12 units in the fourth term.

B. *Course work for Postgraduate Diploma Courses in Applied Botany, Dairy Engineering, Farm Management Technology and Soil Technology*

(c) Applied Botany

Subject	No.	Subject	Units per term 1st	2nd	3rd
AgE	651	Genetics	2	2	2
AgE	652	Plant Breeding	2	2	2
AgE	653	Plant Breeding Laboratory	2	2	2
AgE	654	Cytogenetics	1	1	—
AgE	655	Biochemical Cytology	1	1	1
AgE	656	Cytology Laboratory	2	2	2
AgE	673	Advances in Agronomy	—	2	—
AgE	674	Crop Ecology	—	—	2
AgE	677	Principles of Agronomy	2	—	—
Ma	643	Statistical Methods for Agriculture and Biology ...	2	2	2
		*Special Topics (Units to be arranged)			
AgE	693	Seminar	1	1	1
AgE	694	Research, Thesis and Viva-Voce 12-16 units in fourth term.			

(d) Dairy Engineering

AgE	631	Dairy Plant Equipment	3	3	—
AgE	632	Dairy Plant Design	—	—	3
AgE	633	Dairy Plant Layout & Installation	—	3	—
AgE	634	Dairy Product Processing	2	2	—
AgE	635	Dairy Technology and Quality Control	3	3	3
AgE	641	Instrumentation in Agricultural Engineering	2	—	—
ChE	602	Chemical Engineering Science II (Heat Transfer) ...	2	—	—
ChE	654	Boiler Technology I	—	2	—
Ma	614	Engineering Mathematics	2	2	—
ME	6191	Elements of Industrial Engineering	—	—	3
ME	6434	Refrigeration Applications and Cold Storage of Products ...	—	—	4
AgE	693	Seminar	1	1	1
		Special Topics (Units to be arranged)			

Fourth Term

Industrial training for 3 months—12 units.

(e) Farm Management Technology

Subject	No.	Subject	Units per term 1st	2nd	3rd
AgE	602	Instrumentation and Measurements	—	2	—
AgE	603	Techniques of Research	—	—	2
AgE	604	Agricultural Land Development	2	—	—
AgE	607	Soil Conservation	—	2	—
AgE	608	Irrigation and Drainage	—	—	2
AgE	609	Farm Power and Machinery Management	2	2	2
AgE	610	Farm Produce Storage	—	2	—
AgE	662	Soil Physics Principles	2	—	—
AgE	666	Irrigated Soils	—	—	2
AgE	671	Farm Organization and Management	2	2	—
AgE	672	Economics of Mechanised Farming	—	—	2
AgE	673	Advances in Agronomy	—	2	—
AgE	674	Crop Ecology	—	—	2
AgE	675	Plant Protection Technology	3	—	—
AgE	676	Marketing of Farm Produce	—	—	2
Ma	681	Mathematics for Soil Technologists	2	2	—
		*Special Topics	(Units to be arranged)		
AgE	693	Seminar	1	1	1
AgE	694	Research, Thesis and Vive-Voce	12-16 units in fourth term.		

(f) Soil Technology

AgE	602	Instrumentation and Measurements	—	2	—
AgE	603	Techniques of Research		—	2
AgE	605	Farm Survey and Drafting	2	2	—
AgE	606	Mechanical Properties of Soils	—	—	2
AgE	607	Soil Conservation	—	2	—
AgE	608	Irrigation and Drainage	—	—	2
AgE	661	Advanced Soils	2	—	—
AgE	662	Soil Physics Principles	2	—	—
AgE	663	Soil Physics Laboratory	2	2	—

(f) Soil Technology—contd.

Subject No.		Subject	Units per term 1st	2nd	3rd
AgE	664	Physical Edaphology	—	2	—
AgE	665	Soil Survey	—	—	2
AgE	666	Irrigated Soils	—	—	2
AgE	677	Principles of Agronomy	2	—	—
Ma	681	Mathematics for Soil Technologists	2	2	—
ME	6272	Mechanical Technology	3	—	—
Ph	671	Physics for Soil Technologists	2	—	—
		*Special Topics (Units to be arranged)			
AgE	693	Seminar	1	1	1
AgE	694	Research, Thesis and Viva-Voce 12-16 units in the fourth term			

*C. Special Topics (Units to be arranged)

AgE	617	Farm Machine Analysis	—	—	—
AgE	618	Farm Power Analysis	—	—	—
AgE	628	Micromeritics	—	—	—
AgE	629	Advanced Theory of Flow of Water in Soils	—	—	—
AgE	657	Molecular Genetics	—	—	—
AgE	658	Radiation Biology	—	—	—
AgE	659	Cellular Ultrastructure	—	—	—
AgE	660	Advanced Cell Biology	—	—	—
AgE	668	Tillage Physics	—	—	—
AgE	670	Mineral Nutrition of Plants	—	—	—
AgE	680	Agriculture in World Economy	—	—	—
AgE	681	Chemicals and Plant Growth	—	—	—

ARCHITECTURE AND REGIONAL PLANNING (Ar)

The department offers two-year Postgraduate Courses leading to the degree of Master of City Planning (M.C.P.) and the degree of Master of Regional Planning (M.R.P.).

FIRST YEAR

(Common to both the courses)

Subject	No.	Subject	Units per term 1st	2nd	3rd
Ar	601	Planning Principles I	2	2	2
Ar	602	Housing and Community Facilities I	1	1	—
Ar	603	Transportation I	1	1	—
Ar	604	Local Self-Government	—	—	1
Ar	605	Geography (Physical and Urban)	—	2	2
Ar	606	Planning Problems—I (Studio)	7	7	—
Ma	683	Data Analysis and Programming	1	1	—
		Intenship in a Planning Office—Summer Term (2 months)—3 units.			
		(a) For Master of City Planning Course only			
Ar	607	History of Towns	1	1	—
Ar	608	Housing and Community Facilities—II	—	—	1
Ar	609	Transportation—II	—	—	1
Ar	610	Architectural Design	—	1	1
		or			
CE	657	Municipal Engineering (to be chosen depending on student's background) ...	—	1	1
Ar	625	Economic Geography	2	—	—
Ar	606	Planning Problem I (Field Survey and Studio work) ...	—	—	7
		(b) For Master of Regional Planning Course only			
Ar	611	Development of Planning Thought	1	1	—
Ar	612	Theory of Resource use	—	1	1
Ar	614	Planning Problems—I (Studio)	—	—	7

SECOND YEAR

(Common to both the courses)

Subject	No.	Subject	Units per term 1st	2nd	3rd
		*Elective (any one)	1	—	—
Hu	716	Urban and Rural Sociology	1	—	—
Hu	717	Economics of Development	1	—	—

**Elective Subjects*

Ar 715 Demography
Ar 716 Aerial Photogrammetry
Ar 717 Village Development

(a) For Master of City Planning Course only

Hu	713	Urban Land Economics	—	—	1
Ar	701	Planning Principles II	2	2	2
Ar	702	Landscape Design	1	1	—
Ar	704	Planning Legislation and Administration	—	2	2
Ar	706	Planning Problems IIA (Studio)	7	7	7
		**Elective (any one)	—	—	1

***Elective Subjects*

Ar 718 Urban Renewal
Ar 719 Town Design
Ar 720 Metropolitan Area Planning
Ar 721 Regional Planning
Ar 722 Planning Legislation

Thesis (Summer Term) ... ... 10 units

(b) For Master of Regional Planning Course only

Ar	709	Regional Geography of India	1	—	—
Ar	710	Regional Planning and Analysis	2	2	2
Ar	711	Theory of Industrial Location	1	1	—
Ar	712	Public Administration and Legislation	—	1	1
Ar	713	Workshop	—	—	1
Ar	714	Planning Problems—IIB (Studio)	7	7	6
		Thesis (Summer Term)	10 units		

APPLIED CHEMISTRY (Ch)

The Department offers one-year Postgraduate course leading to the Postgraduate Diploma (D.I.I.T.) with following specialisations.

(A) High Polymer and Rubber Technology
(B) Synthetic Drugs and fine chemicals
(C) Technical Gas Reaction and High Pressure Technology

(A) High Polymer and Rubber Technology

Subject No.		Subjects	Unit per term 1st	2nd	3rd
Ch	610	Physical Chemistry of High Polymer	2	2	1
Ch	611	High Polymer Technology	1	1	—
Ch	612	Rubber Technology	2	4	4
Ch	613	Rubber Physics	0	0	1
Ch	614	Chemistry of Rubber	0	1	0
Ch	615	Mechanical behaviour of high polymers	1	1	1
ME	6272	Mechanical Technology	3	—	—
ME	6572	Engineering Drawing	3	—	—
Ch	605	Physical Organic Chemistry	1	1	1
ME	6192	Statistical quality control	—	3	—
ME	6181	Plant Management	—	—	3
		*Elective—any one	3	3	3
		Total ...	16	16	14
		****Elective Subjects***			
ChE	621	Chemical Engineering	—	—	—
Ch	606	Advanced Chemistry	—	—	—
		Factory Training/Research/Project Report—Units to be arranged—Fourth term.			

(B) Synthetic Drugs and fine Chemicals

Subject	No.	Subject	Unit per term 1st	2nd	3rd
Ch	616	Advanced Organic Chemistry	2	2	2
Ch	617	Heterocyclic Chemistry	1	1	1
Ch	605	Physical Organic Chemistry	1	1	1
Ch	618	Synthetic Drugs	2	5	4
Ch	619	Natural Drugs	—	—	2
ME	6272	Mechanical Technology	3	—	—
ME	6572	Engineering Drawing	3	—	—
ChE	621	Chemical Engineering	3	3	3
		Total ...	15	12	13

Factory Training/Research/Project Reoprt—units to be arranged—Fourth term.

(C) Technical Gas Reactions and High Pressure Technology

Ch	601	High Pressure Technique	3	2	2
Ch	602	Technical Gas Reactions	1	3	3
Ch	603	Chemical Kinetics and Thermodynamics	1	1	1
Ch	604	Catalysis	—	2	2
Ch	605	Physical Organic Chemistry	1	1	1
Met	624	Metallurgy	—	—	2
ME	6272	Mechanical Technology	3	—	—
ME	6572	Engineering Drawing	3	—	—
		*Elective—any one	3	3	3
		Total ...	15	12	14
		**Elective Subjects*			
ChE	621	Chemical Engineering	—	—	—
Ch	606	Advanced Chemistry	—	—	—

Factory Training/Research/Project Report—Units to be arranged—Fourth term.

CHEMICAL ENGINEERING (ChE)

The Department of Chemical Engineering offers postgraduate course of 2-year duration leading to the degree of Master of Technology (M.Tech.) in Chemical Engineering with specialisation in:

(*a*) Chemical Engineering Plant Design and Fabrication ;
(*b*) Combustion Engineering and Fuel Economy ;
(*c*) Petroleum Refinery Engineering and Petro-chemicals.

Common for all specialisations.

Subject	No.	Subjects	Units per term 1st	2nd	3rd
ChE	601	Chemical Engineering Science I (Fluid Dynamics) ...	3	—	—
ChE	602	Chemical Engineering Science II (Heat Transfer) ...	2	—	—
ChE	604	Chemical Engineering Science III (Mass Transfer) ...	—	4	—
ChE	607	Trnasport Phenomena	2	—	—
ChE	611	Advanced Thermodynamics	2	—	—
ChE	612	Advanced Applied kinetics and Reactor Design ...	—	2	1
ChE	620	Material Technology	—	1	—
ChE	625	Instrumentation and Process Control	—	—	2
ChE	656	Steam Utilisation	1	—	—
ChE	661	Engineering Economics	—	—	2
ChE	666	Course Project/Seminar	—	1	1
Ma	614	Mathematics	2	2	—
Ma	646	Statistics	—	—	2
Ma	647	Computational Techniques	—	—	2
		Total ...	12	10	10

Note: Mechanical Engineering graduates taking up "Combustion Engineering and Fuel Economy" specialization shall be required to take ME 668 Analysis of stresses 3 units in the 1st term in place of ChE 604, Chemical Engineering Science III (Mass Transfer), and one of the following subjects—4 units in the 3rd term—in place of ChE 612, "Advanced Applied kinetics and Reactor Design".

ME 6431—Gas Turbines and Compressors.
ME 6432—Internal Combustion Engines.
ME 6436—Steam Turbines.
ME 6438—Nuclear Power Station.

(a) For Chemical Engineering Plant Design & Fabrication specialization:

Subject	No.	Subjects	Units/term 1st	2nd	3rd
ChE	616	Process Development and Equipment Design	—	3	3
EE	691	Utilization of Electric Power	—	2	—
ME	6571	Machine Elements Design I	3	—	—
ME	6271	Production Engineering I	3	—	—
ME	6281	Production Engineering II	—	3	—
		Total ...	6	8	3

(b) For Combustion Engineering & Fuel Economy specialization:

ChE	631	Fuel Technology I	3	—	—
ChE	632	Fuel Technology II	—	2	—
ChE	633	Fuel Technology III	—	—	2
ChE	650	Combustion Engineering I (Furnaces)	—	2	—
ChE	651	Flame Physics	—	1	—
ChE	653	Combustion Engineering II (Combustion Principles) ...	—	—	2
ChE	654	Boiler Technology I	—	2	—
ChE	655	Boiler Technology II	—	—	2
		Total ...	3	7	6

(c) For Petroleum Refinery Engineering and Petrochemicals specialization:

ChE	640	Gas Chemical Technology	2	2	—
ChE	641	Petrochemical Processes	—	—	2
ChE	645	Petroleum Refinery Engineering	1	3	3
ChE	652	Petroleum Refinery Equipment Design	1	1	1
		Total ...	4	6	6

CIVIL ENGINEERING

The Department offers 2-year Postgraduate Course leading to the degree of Master of Technology with following specializations:

(A) Structural Engineering.
(B) Advanced Hydraulic Engineering.
(C) Soil Mechanics and Foundation Engineering.
(D) Highway Engineering.
(E) Public Health Engineering.
(F) Harbour Engineering.

(a) Structural Engineering

Subject No.		Subjects	Units per term 1st	2nd	3rd
CE	601	Advanced theory of Structures	2	—	—
CE	602	Advanced strength of Materials	2	—	—
CE	603	Stability of Structures	—	2	—
CE	604	Experimental stress Analysis	—	—	2
CE	660	Elasticity & Plasticity	2	2	2
Ma	614	Engineering Mathematics	2	2	—
Ma	644	Statistical Methods in Engineering	—	—	2
Ma	647	Computational Techniques	—	—	2
Comm	653	Introduction to Electronics	2	—	—
Ph	691	Physical Measurements	—	2	—
		Total ...	10	8	8

Subject No.		*Electives*	2 to 6 units	4 to 8 units	4 to 8 units
CE	605	Concrete Technology	2	—	—
CE	606	Advanced Reinforced Concrete Design	2	—	—
CE	607	Steel Design I	—	2	—
CE	608	Steel Design II	—	—	2
CE	609	Soil Mech. and Foundation Engineering I	3	—	—
CE	610	Soil Mechanics and Foundation Engineering II ...	—	2	—
CE	611	Prestressed Concrete I	2	—	—
CE	612	Prestressed Concrete II	—	2	—
CE	613	Shell Structures I	—	2	—
CE	614	Shell Structures II	—	—	2
CE	615	Bridge Engineering I	—	2	—
CE	616	Bridge Engineering II	—	—	2

(b) Advanced Hydraulic Engineering

Subject	No.	Subject	Units per term 1st	2nd	3rd
CE	621	Fluid Mechanics I	3	—	—
CE	622	Fluid Mechanics II	—	3	—
CE	623	Fluid Mechanics III	—	—	3
CE	624	Dams and Dam Construction I	3	—	—
CE	625	Dams and Dam Construction II	—	3	—
CE	626	Dams and Dam Construction III	—	—	3
CE	627	Water Power Engineering I	—	3	—
CE	628	Water Power Engineering II	—	—	3
CE	629	Advanced Hydraulics I	3	—	—
CE	630	Advanced Hydraulics II	—	2	—
CE	631	Advanced Hydraulics III	—	—	3
CE	632	Advanced Hydraulics Laboratory	1	—	—
Ma	614	Engineering Mathematics	2	2	—
		Total ...	12	13	12

		Electives	Upto 4 units	Upto 3 units	Upto 4 units
CE	604	Experimental Stress Analysis	—	—	2
CE	609	Soil Mechanics and Foundation Engineering I ...	3	—	—
CE	610	Soil Mechanics and Foundation Engineering II ...	—	2	—
CE	633	Irrigation and Drainage	—	2	—
CE	634	Flood Control	—	—	3
CE	635	Construction	—	—	3
Ma	644	Statistical Methods in Engineering	—	—	2
Ma	647	Computational Techniques	—	—	2
Comm	653	Introduction to Electronics	2	—	—
Ph	691	Physical Measurements	—	2	—

(c) Soil Mechanics and Foundation Engineering

Subject	No.	Subject	Units per term 1st	2nd	3rd
CE	641	Advanced Soil Mechanics I	3	—	—
CE	642	Advanced Soil Mechanics II	—	3	—
CE	643	Foundations I	—	2	—
CE	644	Foundations II	—	—	3
CE	645	Soil Mechanical Laboratory I	2	—	—
CE	646	Soil Mechanical Laboratory II	—	1	—
CE	660	Elasticity and Plasticity	2	2	2
Ge	614	Engineering Geology	—	2	2
Ma	614	Engineering Mathematics	2	2	—
Ma	644	Statistical Methods in Engineering	—	—	2
		Total ...	9	12	9

		Electives	3 to 7 units	upto 4 units	3 to 7 units
CE	601	Advanced Theory of Structures	2	—	—
CE	602	Advanced Strength of Materials	2	—	—
CE	604	Experimental Stress Analysis	—	—	2
CE	605	Concrete Technology	2	—	—
CE	606	Advanced Reinforced Concrete Design	2	—	—
CE	615	Bridge Engineering I	—	2	—
CE	616	Bridge Engineering II	—	—	2
CE	626	Dams and Dam Construction III	—	—	3
CE	652	Design of Highways II	—	2	—
Ge	610	Clay Mineralogy	—	—	2

(d) Highway Engineering

Subject	No.	Subject	Units per terms 1st	2nd	3rd
CE	651	Design of Highways I	2	—	—
CE	652	Design of Highways II	—	2	—
CE	653	Design of Highways III	—	—	4
CE	654	Transportation Planning and Economics I	2	—	—
CE	655	Transportation Planning and Economics II	—	2	—
CE	656	Transportation Planning and Economics III	—	—	2
CE	609	Soil Mechanics and Foundation Engineering I ...	3	—	—
CE	610	Soil Mechanics and Foundation Engineering II ...	—	2	—
CE	660	Elasticity and Plasticity	2	2	2
Ma	614	Engineering Mathematics	2	2	—
Ma	644	Statistical Methods in Engineering	—	—	2
		Total ...	11	10	10

		Electives	1 to 5 units	2 to 6 units	2 to 6 units
CE	604	Experimental Stress Analysis	—	—	2
CE	605	Concrete Technology	2	—	—
CE	606	Advanced Reinforced Concrete Design	2	—	—
CE	611	Prestressed Concrete I	2	—	—
CE	612	Prestressed Concrete II	—	2	—
CE	615	Bridge Engineering I	—	2	—
CE	616	Bridge Engineering II	—	—	2
Ge	614	Engineering Geology	—	2	2

(e) Public Health Engineering

Subject	No.	Subject	Units per term 1st	2nd	3rd
CE	661	Water Supply and Design	2	2	3
CE	662	Sewerage and Design	2	2	3
CE	663	General Sanitation	—	1	—
CE	664	Epidemiology	—	—	1
CE	665	Sanitary Engineering Laboratory	1	1	1
CE	666	Pumping Machinery	2	—	—
CE	667	Engineering Seminar I	1	—	—
CE	668	Engineering Seminar II	—	1	—
CE	669	Engineering Seminar III	—	—	1
Ch	621	Chemistry of Water and Sewage	2	1	1
AgE	691	Micro-Biology for Civil Engineers	—	2	2
Ma	648	Statistical Methods for Municipal Engineers	2	2	—
		Total ...	12	12	12

		Electives	upto 4 units	upto 4 units	upto 4 units
CE	606	Advanced Reinforced Concrete design	2	—	—
CE	611	Prestressed concrete I	2	—	—
CE	612	Prestressed concrete II	—	2	—
CE	621	Fluid Mechanics I	3	—	—
CE	622	Fluid Mechanics II	—	3	—
CE	623	Fluid Mechanics III	—	—	3
CE	624	Dams and Dam Construction I	3	—	—
CE	626	Dams and Dam Construction III	—	—	3
CE	629	Advanced Hydraulics I	3	—	—
CE	631	Advanced Hydraulics III	—	—	3
CE	655	Transportation Planning and Economics II	—	2	—
CE	670	Principle of Economic Construction	—	1	—
Ge	613	Ground Water Geology	2	—	—
Ar	601	Planning Principles I	—	2	—
Comm	653	Introduction to Electronics	2	—	—
Ph	691	Physical Measurements	—	2	—
Ma	647	Computational Techniques	—	—	2

(f) Harbour Engineering

Subject No.		Subject	Units per term 1st	2nd	3rd
CE	681	Hydrographic Surveying	2	—	—
CE	682	Wind Waves and Tides	3	—	—
Gr	661	Introduction to Physical Oceanography	—	2	—
Ma	614	Engineering Mathematics	2	2	—
CE	683	Harbour Engineering I	—	3	—
CE	684	Harbour Engineering II	—	—	3
CE	621	Fluid Mechanics I	3	—	—
CE	622	Fluid Mechanics II	—	3	—
CE	623	Fluid Mechanics III	—	—	3
CE	685	Port Facilities and Administration	—	—	2
CE	632	Advanced Hydraulic Laboratory	1	—	—
CE	686	Seminar in Harbour Structures	—	—	2
		Total ...	11	10	10

		Electives	Units per term 1st	2nd	3rd
CE	629	Advanced Hydraulics I	3	—	—
CE	630	Advanced Hydraulics II	—	2	—
CE	609	Soil Mechanics and Foundation Engineering I ...	3	—	—
CE	610	Soil Mechanics and Foundation Engineering II ...	—	2	—
CE	606	Advanced Reinforced Concrete Design	2	—	—
CE	643	Foundations I	—	2	—
CE	604	Experimental Stress Analysis	—	—	2
CE	605	Concrete Technology	2	—	—
CE	635	Construction	—	—	3
Ma	644	Statistical Methods in Engineering	—	—	2
Comm	653	Introduction to Electronics	2	—	—
Ph	691	Physical Measurements	—	2	—
Ma	647	Computational Techniques	—	—	2

In addition, the department also offers 1-Year Postgraduate courses in (A), Structural Steel Design (B), Concrete Technology and Design leading to Postgraduate Diploma (D.I.I.T.)

(a) Structural Steel Design

Subject	No.	Subject	Units per term 1st	2nd	3rd
CE	601	Advanced Theory of Structures	2	—	—
CE	602	Advanced Strength of Materials	2	—	—
CE	603	Stability of Structures	—	2	—
CE	607	Steel Design I	—	2	—
CE	608	Steel Design II	—	—	2
CE	615	Bridge Engineering I	—	2	—
CE	617	Bridge Engineering III	—	—	2
CE	618	Advanced Structural Analysis	—	—	2
CE	619	Industrial Building	2	—	—
CE	671	Structural Design and Drawing I	—	2	—
CE	672	Structural Design and Drawing II	—	—	2
Ma	614	Engineering Mathematics	2	2	—
		Total ...	8	10	8

		Electives	Units per term 1st	2nd	3rd
CE	605	Concrete Technology	2	—	—
CE	609	Soil Mechanics and Foundation Engineering I ...	3	—	—
CE	610	Soil Mechanics and Foundation Engineering II ...	—	2	—
CE	613	Shell Structures I	—	2	—
CE	614	Shell Structures II	—	—	2
CE	651	Design of Highways I	2	—	—
CE	652	Design of Highways II	—	2	—
Ma	644	Statistical Method in Engineering	—	—	2

(b) Concrete Technology and Design

Subject	No.	Subject	Units per term 1st	2nd	3rd
CE	605	Concrete Technology	2	—	—
CE	606	Advanced Reinforced Concrete Design	2	—	—
CE	611	Prestressed Concrete I	2	—	—
CE	612	Prestressed Concrete II	—	2	—
CE	613	Shell Structures I	—	2	—
CE	614	Shell Structures II	—	—	2
CE	615	Bridge Engineering I	—	2	—
CE	616	Bridge Engineering II	—	—	2
CE	618	Advanced Structural Analysis	—	—	2
CE	620	Design and Drawing	2	2	2
Ma	614	Engineering Mathematics	2	2	—
		Total ...	10	10	8

		Electives	Units per term 1st	2nd	3rd
CE	607	Steel Design I	—	2	—
CE	608	Steel Design II	—	—	2
CE	609	Soil Mechanical and Foundation Engineering I ...	3	—	—
CE	610	Soil Mechanical and Foundation Engineering II ...	—	2	—
CE	635	Construction	—	—	3
CE	651	Design of Highways I	2	—	—
CE	652	Design of Highways II	—	2	—
CE	660	Elasticity and Plasticity	2	2	2
Ma	647	Computational Techniques	—	—	2

ELECTRICAL ENGINEERING

The department offers 2-year Postgraduate course in Electrical Engineering leading to the degree of Master of Technology (M.Tech) with the following specialisations:

(a) Electrical Machines.
(b) Control System Engineering
(c) Power System Engineering.

FIRST YEAR

(a) Electrical Machines

Subject	No.	Subject	Units per term 1st	2nd	3rd
EE	611	Advanced Machine Theory	2	2	2
EE	612	Power System Stability	—	2	2
EE	613	Electromagnetic Fields	2	2	2
EE	614	Tensor Analysis of Electrical Machines	—	—	4
EE	615	Energy Conversion	2	2	—
EE	616	Principles of Automatic Control	3	3	3
EE	617	Electrical Engineering Materials	4	—	—
EE	619	Laboratory	2	2	2
Ma	613	Mathematical Methods in Engineering	2	2	—
Ma	641	Numerical Methods and High-speed Computation ...	—	2	2
		Total ...	17	17	17

Industrial Training during Fourth Term—12 units.

FIRST YEAR

(b) Control System Engineering

EE	621	Control System I	3	3	3
EE	622	Control System II	3	3	3
EE	623	Control System Components	3	3	3
EE	629	Laboratory	2	2	2
Comm	652	Electronic Circuits and Applications	3	3	3
Ma	613	Mathematical Methods in Engineering	2	2	—
Ma	633	Analogue Computation and Simulation	—	2	2
		Total ...	16	18	16

Industrial Training during Fourth Term—12 units.

FIRST YEAR

(c) Power System Engineering

Subject	No.	Subject	Units per term 1st	2nd	3rd
EE	631	Advanced Machine Theory	2	2	—
EE	632	Power System I	4	4	4
EE	633	Power System II	—	2	2
EE	634	High-voltage Engineering	—	—	4
EE	635	Energy Conversion	2	—	—
EE	636	Principles of Automatic Control	3	3	3
EE	639	Laboratory	2	2	2
CE	638	Water Power Engineering	3	—	—
Ma	613	Mathematical Methods in Engineering	2	2	—
ME	6381	Steam Power Engineering	—	3	—
		Total ...	18	17	17

Industrial Training during Fourth term—12 units.

The department also offers one-year Postgraduate course leading to the Postgraduate Diploma (D.I.I.T.) in "Electric Traction".

Electric Traction

Subject	No.	Subject	Units per term 1st	2nd	3rd
EE	641	Fundamentals of Electric Traction	3	—	—
EE	642	Electrical Equipment	2	2	2
EE	643	Power Supply	2	2	2
EE	644	Electric Locomotives	—	2	2
Comm EE	650 645	Communications and Signalling	—	2	2
EE	646	Principles of Automatic Control	2	2	2
EE	649	Laboratory	2	2	2
CE	657	Track Surveying and Overhead Equipment	—	2	2
ME	6571	Machine Elements Design	3	—	—
Ma	657	Mathematics (including Analogue Computation and Simulation)	2	2	2
		Total ...	16	16	16

Project work during Fourth term—12 units.

ELECTRONICS AND ELECTRICAL COMMUNICATION ENGINEERING

The Department of Electronics and Electrical Communication Engineering offers a 2-year Postgraduate course leading to the degree of Master of Technology in Electronics and Electrical Communication Engineering with specializations in

(*a*) Industrial Electronics.

(*b*) Ultra High Frequency and Microwave Engineering.

FIRST YEAR

Subject	No.	Subject	Unit per term 1st	2nd	3rd
Ma	635	Mathematics	4	—	—
Ph	661	Physics	2	2	2
Comm	601	Fields and Waves	4	—	—
Comm	602	Circuit Theory	4	—	—
Comm	603	Electronic Control and Servo-mechanism	—	3	4
		Or			
Comm	604	U. H. F. and Microwave Technique	—	3	4
Comm	605	Communication Theory	—	3	—
Comm	606	Semiconductor Electronics	—	3	—
Comm	607	Active networks	—	3	—
Ph	662	Physics of Materials	—	—	2
		*Electives (any two)	—	—	6
Com	620	Laboratory	2	2	2
		*Elective Subjects		Units per term	
Comm	608	Audio Engineering		3	
Comm	609	Radar Engineering		3	
Comm	610	Network Synthesis		3	
Comm	611	Theory of Communication Systems		3	
Comm	612	Gas Discharge and Plasma		3	
Comm	613	Switching and computation		3	
Comm	614	Antennas		3	
Comm	615	Radiowave Propagation		3	
Comm	616	Television		3	
Comm	617	Non-Linear Control Systems		3	
Comm	618	Microwave Devices and Applications		3	
Comm	619	Pulse Techniques		3	

Industrial Training — about 3 months (Fourth term).

SECOND YEAR

Research and/or Design work — 9 to 12 months.

Geology and Geophysics

The Department of Geology and Geophysics offers the following one-year Postgraduate Courses leading to the Postgraduate Diploma (D.I.I.T.).

(*a*) Applied Geology.
(*b*) Exploration Geophysics.
(*c*) Geochemistry.

(a) Applied Geology

A student is required to take a minimum of 48 units(*) of which not less than 24 units should be devoted to course work and not less than 12 units to field, project and thesis work.

Course	No.	Subject	Units
Ge	602	Photogeology	3
Ge	610	Clay Mineralogy	3
Ge	611	Advanced Sedimentation	3
Ge	622	Selected Topics in Precambrian Stratigraphy	3
Ge	625	Mineral Economics	1
Ge	630	Selected Topics in Ore Deposition	3
Ge	632	Studies in Metallic and Non-metallic deposits	6
Ge	633	Subsurface Geologic Methods	4
Ge	634	Coal Geology	3
Ge	635	Petroleum Geology	3
Ge	636	Selected Topics in Exploration and Prospecting Methods and Mining Geology	6
Ge	637	Selected Studies in Groundwater Geology	4
Ge	638	Selected Studies in Engineering Geology	6
Ge	639	Exploration Planning	1
Ge	640	Selected Topics in Post-Precambrian Stratigraphy ...	3
Ge	641	Selected Topics in Structural Geology of Ore Deposits ...	4
Ge	642	Hydrology	2
Ge	650	Field Geology	Units by arrangements
Ge	652	Seminar	3
Ge	655	Thesis/Project	Units by arrangements
Ge	656	Geotecnics	4
Ge	657	Special Studies	Units by arrangements
Ge	678	Reservoir Geophysics	3

***Students may have to take some pre-requisites, without credit, if necessary.**

(b) Exploration Geophysics

A student is required to take a minimum of 48 units of which not less than 24 units should be devoted to course work and not less than 12 units to field, project and thesis work. The student may have to take some pre-requisites, without credit, if necessary.

Course No.		Subject	Units
Ge	621	Principles of Ore Deposition	2
Ge	635	Petroleum Geology	2
Ge	660	Tectonophysics	4
Ge	662	Theoretical Geophysics (selected topics)	4
Ge	663	Advanced Seismology	4
Ge	664	Nuclear Geophysics	2
Ge	666	Physics of Solids	4
Ge	668	Mathematical Methods in Geophysics	6
Ge	672	Petrophysics (selected topics)	2
Ge	675	Subsurface Geophysical Methods (selected topics) ...	4
Ge	678	Reservior Geophysics	3
Ge	682	Surface Geophysical Methods (selected topics)	6
Ge	684	Analysis and Interpretation of Geophysical Data ...	6
Ge	685	Exploration Planning and Case Histories	2
Ge	686	Geophysical Instrumentation	4
Ge	692	Special Studies	Units by arrangements
Ge	695	Geophysics Seminar II	3
Ge	696	Field Geophysics III	Units by arrangement
Ge	698	Research and Thesis	Units by arrangement

(c) Geochemistry

A student is required to take a minimum of 48 units of which not less than 24 units should be devoted to course work and not less than 12 units to field, project and thesis work.

Course No.		Subject	Units
Ge	610	Clay Mineralogy (2 terms)	5
Ge	612	X-ray Crystallography (Theory and Laboratory) ...	4
Ge	615	Introductory Geochemistry	2
Ge	616	Theoretical Petrology	3
Ge	617	Geochemistry I	3
Ge	618	Geochemistry II	3—4
Ge	626	Inorganic Chemistry for Geochemists	2—4
Ge	627	Physical Chemistry for Geochemists	2
Ge	628	Analytical Chemistry for Geochemists (mainly laboratory)	6—8
Ge	630	Selected Topics in Principles of Ore Deposition ...	3
Ge	632	Studies in Metallic and Non-metallic Mineral Deposits ...	4—6
Ge	635A	Geology and Geochemistry of Petroleum	3
Ge	636A	Geological Prospecting	2
Ge	643	Geochemical Prospecting (Theory)	2
Ge	644	Geochemical Prospecting (field and laboratory) ...	3
Ge	652	Seminar	3
Ge	655	Thesis/Project	Units by arrangement
Ge	665	Nuclear Geology	3
Ge	667	Special Studies	Units by arrangement

HUMANITIES & SOCIAL SCIENCES

The Department offers one-year Postgraduate Course leading to the Postgraduate Diploma in Industrial Psychology and Industrial Relations.

			Units per term 1st	2nd	3rd
Hu	601	Introductory Psychology	3	—	—
Hu	602	Industrial Economics	3	—	—
Hu	603	Psychology of Industrial Relations	3	—	—
Hu	604	Social Psychology (Group Dynamics)	2	—	—
Hu	605	Selection and Placement of Personnel	—	2	—
Hu	606	Physiology of Work	—	2	—
Hu	607	Labour Movement and Labour Organisation	—	3	—
Hu	608	Industrial Hygiene	—	3	—
Hu	609	Consumer Research and Mass Media	—	—	3
Hu	610	Government Labour Policy and Labour Legislation in India	—	—	2
Hu	611	Research Methodology	—	—	3
Hu	612	Personnel Administration	—	—	3
Hu	613	Labour Welfare and Social Security	—	—	1
Hu	614	Laboratory Practical	1	1	1
Hu	615	Project Work: 14 units, 4th term	—	—	—

MATHEMATICS

The Department offers a one-year Postgraduate course in Mathematics leading to the Postgraduate Diploma (D.I.I.T.) with the following specializations:

(*a*) Non-linear Mechanics.
(*b*) Plasticity and Rheology.
(*c*) Magnetofluiddynamics.

(Common to all specializations)

Subject	No.	Subject	Units per term 1st	2nd	3rd
Ma	626	Partial Differential Equations	2	—	—
Ma	618	Advanced Techniques in Mathematics	2	2	—
Ma	641	Numerical Methods and High Speed Computation ...	—	2	2
Ma	642	Theory of Probability and Statistical Methods	—	2	2
Ma	612	Mechanics of Continuous Media	4	2	—
ME	6572	Engineering Drawing	3	—	—

A (For Non-linear Mechanics specialization)

Subject	No.	Subject	Units per term 1st	2nd	3rd
Ma	611	General Mechanics	—	2	—
CE	636	Hydraulics Lab. I	2	—	—
CE	637	Hydraulics Lab. II	—	2	—
Ma	620	Selected topics in non-linear mechanics	—	—	4
Ma	631	Transition theory in continuous media	—	—	2
Ma	619	Non-linear vibrations and Gyrostatics	—	—	4
Ma	680	Theory of Shells and Plates	—	—	2
		Total ...	14	12	16

B. (For Plasticity and Rheology specialization)

Ma	628	Mechanical Properties of Materials	—	2	—
CE CE	609 610	Soil Mechanics and Foundation Engineering I and II ...	2	2	—
Ma	620	Selected topics in non-linear mechanics	—	—	4
Ma	631	Transition theory in continuous media	—	—	2
Ma	621	Selected topics from Rheology and Plasticity	—	—	4
Ma	680	Theory of Shells and Plates	—	—	2
		Total ...	14	12	16

C. (For Magnetofluiddynamics specialization)

Ma	627	Classical Theory of Electrodynamics	—	2	—
Ph	681	Physics	2	2	—
Ma	629	Selected topics from Magnetofluid dynamics	—	—	4
Ma	630	Theory of Hydromagnetic stability and Wave Motion ...	—	—	2
Ma	632	Plasma Dynamics and Relativistic fluid dynamics ...	—	—	4
Ma	612	Mechanics of Continuous Media (Gas Dynamics) ...	—	—	2
		Total ...	14	12	16
		Seminar, Dissertation and *Viva-voce* (Fourth Term) ...	—	—	14

MECHANICAL ENGINEERING

The Department offers 2-year Postgraduate course leading to the Degree of Master of Technology with following specialisations:—

(a) Foundry Engineering.
(b) Heat Power with specialisation either in I. C. Engines and Gas Turbines or Refrigeration and Air Conditioning or Steam Power Plants.
(c) Industrial Engineering and Operations Research.
(d) Machine Design.
(e) Mechanical Handling Science and Technology.
(f) Mechanism and Vibration.
(g) Production Science and Technology.

(a) Foundry Engineering

			Units per term 1st	2nd	3rd
Ma	613	Mathematical	4	—	—
Met/Ph	622	Material Technology*	4	—	—
ME	6211	Production Engineering	4	—	—
Ma	652	Engineering Statistics	4	—	—
ME	6021	Foundry Technology-I	—	4	—
ME	6125	Industrial Engineering	—	4	—
ME	6323	Fluid Mechanics and Heat Transfer	—	4	—
ME	6626	Analysis of Stresses	—	4	—
ME	6031	Foundry Metallurgy	—	—	4
ME	6032	Foundry Equipments and Controls	—	—	4
ME	6033	Foundry Technology-II	—	—	4
ME Ch	6034 622	Chemistry of Sands, Clays and Binders	—	—	4

*For graduates in Metallurgical Engineering ME 6512—Machine Element Design (4 units) instead of Met/Ph 622.

(b) Heat Power

			Units per term 1st	2nd	3rd
Ma	613	Mathematical	4	—	—
ME	6311	Advanced Engineering Thermodynamics-I	4	—	—
ME	6312	Heat Transfer-I	4	—	—
ME	6313	Advanced Fluid Mechanics	4	—	—
ME	6321	Advanced Engineering Thermodynamics-II	—	4	—
ME	6322	Heat Transfer-II	—	4	—
ME	6623	Advanced Strength of Materials	—	4	—
ME	6624	Instruments and Controls	—	4	—

(b) Heat Power—(Contd.)

		Electives (Any one of the following groups)	Units per term 1st 2nd 3rd
[1]ME	6331	Gas Dynamics	4
ME	6431	Gas Turbines and Compressors	4
ME	6432	I. C. Engines	4
ME	6433	Combustion, Fuels and Lubricating Oils	4
[2]ME	6332	Air-Conditioning	4
ME	6333	Low Temperature Refrigeration	4
ME	6434	Refrigeration Applications and Cold Storage of Products ...	4
ME	6435	Refrigeration Units	4
[3]ME	6436	Steam Turbines	4
ME	6437	Steam Generators	4
ME	6438	Nuclear Power Stations	4
ME	6439	Fuels and Combustion	4

(c) **Industrial Engineering and Operations Research**

			Units per term 1st	2nd	3rd
Ma	652	Engineering Statistics	4	—	—
ME	6111	Advanced Engineering Economics	4	—	—
ME	6112	Work Study-I	4	—	—
ME	6211	Production Engineering	4	—	—
ME	6121	Design and Operation of Controls in Industry-I ...	—	4	—
ME	6122	Operations Research	—	4	—
ME	6123	Work Study-II	—	4	—
ME	6124	Principles and Practice of Management	—	4	—
ME	6131	Design and Operation of Controls in Industry-II ...	—	—	4
ME	6132	Design and Operation of Controls in Industry-III ...	—	—	4
ME	6133	Factory Planning and Plant Engineering	—	—	4
ME/Hu	6134	Personnel Management and Industrial Relations ...	—	—	4

(d) Machine Design

			Units per term 1st	2nd	3rd
Ma	613	Mathematic	4	—	—
Met/Ph	622	Material Technology	4	—	—
ME	6611	Machine Vibrations	4	—	—
ME	6612	Theory of Elasticity and Plasticity	4	—	—
ME	6621	Mechanisms	—	4	—
ME	6622	Experimental Stress Analysis	—	4	—
ME	6623	Advanced Strength of Materials	—	4	—
ME	6624	Instruments and Controls	—	4	—
ME	6531	Design for Fatigue and Creep	—	—	4
ME	6532	Design of Gears and Hydraulic Drives	—	—	4
ME	6533	Design of Machines and Machine Tools	—	—	4
ME	6631	Theory of Lubrication and Bearings	—	—	4

(e) Mechanical Handling Science and Technology

			Units per term 1st	2nd	3rd
Ma	613	Mathematic	4	—	—
Met/Ph	622	Material Technology	4	—	—
ME	6511	Structural Design of Handling Equipment-I	4	—	—
ME	6611	Machine Vibrations	4	—	—
ME	6125	Industrial Engineering	4	—	—
ME	6521	Structural Design of Handling Equipment-II	4	—	—
ME	6522	Principles of Material Handling and Handling Devices ...	—	4	—
ME	6622	Experimental Stress Analysis	—	4	—
ME	6531	Design for Fatigue and Creep	—	—	4
ME	6535	Mechanics and Design of Hoisting and Lifting Equipment	—	—	4
ME	6536	Mechanics and Design of Conveyors and Elevators ...	—	—	4
ME	6537	Mechanics and Design of Special Cranes	—	—	4

(f) Mechanism and Vibration

			Units per term 1st	2nd	3rd
Ma	613	Mathematic	4	—	—
Met/Ph	622	Material Technology	4	—	—
ME	6611	Machine Vibrations	4	—	—
ME	6612	Theory of Elasticity and Plasticity	4	—	—
ME	6621	Mechanisms	—	4	—
ME	6622	Experimental Stress Analysis	—	4	—
ME	6624	Instruments and Controls	—	4	—
ME	6625	Vibration and Shock Isolation	—	4	—
ME	6531	Design for Fatigue and Creep	—	—	4
ME	6534	Cams and Tooth Outlines and Multiple Gear Drives ...	—	—	4
ME	6632	Non-linear Vibrations	—	—	4
ME	6633	Noise and Random Vibrations	—	—	4

(g) Production Science and Technology

			Units per term 1st	2nd	3rd
Ma	613	Mathematic	4	—	—
Met/Ph	622	Material Technology	4	—	—
Ma	652	Engineering Statistics	4	—	—
ME	6612	Theory of Elasticity and Plasticity	4	—	—
ME	6022	Foundry Technology	—	4	—
ME	6125	Industrial Engineering	—	4	—
ME	6221	Metal Cutting Sciences	—	4	—
ME	6222	Welding Principles and Techniques	—	4	—
ME	6231	Advanced Metrology	—	—	4
ME	6232	Machine Tool Engineering	—	—	4
ME	6233	Metal Forming Sciences	—	—	4
ME	6234	Tool Engineering	—	—	4

METALLURGICAL ENGINEERING (Met)

The Department of Metallurgical Engineering offers a 2-year Postgraduate course leading to the degree of Master of Technology in Metallurgical Engineering with specialisation in—

(a) Physical Metallurgy.

(b) Process Metallurgy.

FIRST YEAR

Subject No.		Subject	Units per term 1st	2nd	3rd
Ma	613	Mathematical methods in Engineering	2	2	—
Ma	644	Statistical methods	—	—	2
Met	601	Experimental methods in Metallurgy	1	1	1
Met	630	Seminar	1	1	1
		Total ...	4	4	4

Electives subjects as per specialisation — 8-12 units per term
Industrial training (4th term) — 12 units

SECOND YEAR

Thesis work — 9-12 months

List of Elective subjects for Physical and Process groups

Subject No.		Subject	1st	2nd	3rd
Met	603	Ferroalloy production	2	2	2
Met	604	Plant layout and Furnace design	2	2	2
Met	605	Recent trends in Ferrous Metallurgy	2	2	2
Met	606	Pyrometallurgy of Non-ferrous metals	2	2	2
Met	607	Hydrometallurgy and Electrometallurgy	2	2	2
Met	608	Recent advances in Non-ferrous Metallurgy	2	2	2
Met	609	Physical Metallurgy	3	3	3
Met	610	X-Ray Metallography and Electron diffraction ...	3	3	3
Met	611	Physics of Metals	2	2	2
Met	612	Dislocation theory and mechanism of plastic flow ...	2	2	2
Met	613	Magnetic materials	—	—	2
Met	614	High temperature materials	1	1	1
Met	615	Mechanical working of metals-theory and applications ...	2	2	2
Met	616	Powder Metallurgy	2	2	2
Met	617	Diffusion in metals	2	2	2
Met	618	Advanced Phase diagrams	2	2	2
Met	619	Theory of Metallurgical Processes	3	3	3
Met	620	Metallurgy of rare metals and Atomic Energy metals ...	2	2	2
Met	621	Foundry Science and Engineering	3	3	3
Met	625	Corrosion	—	2	2
Ph	692	Quantum Mechanics	2	2	2

MINING ENGINEERING (Min.)

The Department offers a Two-year Postgraduate course leading to the degree of Master of Technology (M.Tech.) in Mineral Engineering.

FIRST YEAR

Subject No.		Subjects	Units per term 1st	2nd	3rd
Ch	623	Physical Chemistry	2	1	—
Ch	624	Assaying and Analysis of Minerals	2	1	—
ChE	667	Fluid Dynamics	3	—	—
ChE	668	Fluid Handling	—	2	—
ChE	669	Principles of Heat and Mass Transfer	—	2	—
ChE	670	Advanced Mineral Dressing	3	3	3
ChE	671	Mineral Dressing Laboratory	2	—	—
ChE	672	Coal Preparation	—	2	3
ChE	673	Surface Phenomena	—	2	—
ChE	674	Process Control	—	—	1
ChE Min	675 611	Plant Design and Ore Processing	—	1	4
ChE	676	Applied Heat and Mass Transfer in Mineral Engineering ...	—	—	2
Comm	654	Electronics	2	—	—
Ge	658	Techniques of Mineral Investigation	2	2	—
Ma	614	Engineering Mathematics	2	2	—
Ma	646	Statistics	—	—	2
Min	612	Advanced Mineral Economics	—	—	2
		Total ...	18	18	17
		Industrial Training	(Fourth Term)		

SECOND YEAR

Research/Project Work ... ... 9 to 12 months

PHYSICS AND METEOROLOGY (Ph.)

The Department of Physics and Meteorology offers one-year Postgraduate Course leading to the Postgraduate Diploma (D.I.I.T.) in Industrial Physics.

Subject No.		Subject	Units per term 1st	2nd	3rd
Ph	601	Applied X-Rays	2	2	2
Ph	602	Solid State Technology	2	2	2
Ph	603	Experimental Methods in Physics	2	2	2
Ph	604	Industrial Physics Laboratory	3	3	3
		*Electives—units to be arranged	3 to 9 units per term.		

		*Elective Subjects (to be selected in consultation with the Department)	Total Units
Comm	602	Circuit Theory	4
Comm	603	Electronic control and Servo-mechanism	7
Comm	605	Communication Theory	3
Comm	606	Semiconductor Electronics	3
Comm	613	Switching and computation	3
Comm	618	Microwave devices and applications	3
EE	602	Electrical Technology	6
Ma	613	Mathematical Methods in Engineering	4
Ma	618	Advanced Techniques in Mathematics	4
Ma	642	Theory of Probability and Statistical Methods	4
ME	6272	Mechanical Technology	3
ME	6572	Engineering Drawing	3
Met	624	Engineering Physical Metallurgy	2
Ph	605	Applied Optics	6
Ph	606	Mathematical Physics	6
Ph	607	Nuclear Radiation and their applications	6
Ph	693	Imperfections in Solids...	2 to 6
Ph	694	Special topics in Theoretical Physics	2 to 6
Ph	695	Special topics in Crystal Physics	2 to 6
Ph	696	Quantum Mechanics III	2 to 6

Project or Thesis—Units to be arranged (Fourth Term).

SCHEDULE XXXIV

REGULATION NO. 40

Subjects of instruction for M.Tech, M.C.P., M.R.P. and D.I.I.T. Courses

AGRICULTURAL ENGINEERING (AgE)

601. Dimensional Analysis in Agricultural Engineering 2 units (2-0), First Term.

Dimensions of physical entities. Method of conversion from one system of units to another. Types of equations—theoretical and empirical. Dimensional homogeneity. General principles of dimensional analysis and their application to problems in Agricultural Engineering. Planning of experiments. Reduction of variables. Dimensionless numbers and their importance. Principles of model studies. Geometric, kinematic and dynamic similarity.

602. Instrumentation and Measurements 2 units (1-3) Second term.

Requirements of an optimum measurement system. Elementary description of commonly used transducers and terminating devices. Principles of design of instrumentation for research.

Selection, maintenance and use of the common instruments used for measurement of length, mass, force, pressure, fluid flow, temperature, humidity rainfall, soil properties and runoff.

603. Techniques of Research 2 units (1-3) Third term.

Experimental error and uncertainty. Test sequence. Checking and rejection of data. Reduction of variables. Data analysis and presentation.

604. Agricultural Land Development 2 unit (2-0) First term.

Jungle clearing ; rooting ; rough levelling, land grading, levelling. Bund construction, road layout, irrigation and drainage channels, fencing, farm buildings, water resources. Selection of farm machinery and power in relation to type of job for land development. Economic of the operation for land development.

605. Farm Survey and Drafting 2 units (0-6) ; First and Second terms.

Principles and practice of chain and compass syrveying and plotting. Plane table survey. Levelling. Use of planimeter. Theodolite surveying and tacheometry. Field practice.

Sketching and elements of engineering drawing.

606. Mechanical Properties of Soils 2 units (2-0), Third term.

Definition and classification of soils. Surface properties of soil particles. Capillarity and surface tension. Permeability. Frost and its effects.

Elastic and plastic deformations in soil. Relation between pressure and void ratio, primary and secondary consolidations. Shearing resistance of soil, Coloumb's Law, Mohrs' Circle of stress. Tests for shear strength.

Earth pressure, active and passive pressures of cohesionless soil. Rankine's method. Wedge theory. Stability of earth slopes. Practical problems.

607. Soil Conservation 2 units (2-0) ; Second Term.

Causes of soil damage. Precipitation. Runoff and its measurement. Hydrographs. Biological and mechanical methods of soil erosion control. Spillways. Flood control. Conservation planning. Soil conservation Organisation.

608. Irrigation and Drainage 2 units (2-0), Third Term.

Engineering and agricultural phases of irrigation. Sources, storage, conveyance and distribution of irrigation water. Measurements. Planning of irrigation projects. Irrigation methods. Ground water. Surface and subsurface drainage..

609. Farm Power and Machinery Management 2 units (1-3).

Comparative study of tractors, engines, electric motors and animals as sources of farm power. Types of prime movers available in the market. Principles of operation, troubles, repairs, maintenance and adjustments of engines, tractors and electric motors. Elementary study of wind and water power.

Role of farm machinery in increasing production per capita, production per hectare and reduction of cost of production. Classification of farm machinery. Power and energy requirements of farm machinery. Operation troubles, repairs and maintenance and adjustments of common implements and machines available for mechanised farming.

Workshop requirements for a mechanised farm. Study of basic workshop operation and mechanical tools. Specialised workshop equipment needed for common repairs done on tractors, engines and farm machinery. Workshop management.

610. Farm Produce Storage : 2 units (2-0) Second Term.

Loss in storage, causes, detection and control of infestation. Modern construction of storage structures, modern methods of handling stores, moisture control, disinfection and preservation. Comparative studies of economics of farm and central storage structures.

611. Advanced Farm Power 2 units (2-0) First and Third terms.

Mechanization of Indian Agriculture, its meaning, objective and scope. Characteristics for farm machinery engineering. Farm machinery as a tool of increasing agricultural production. Place of farm machinery in Indian Agriculture. Factors affecting field capacity. Factors affecting cost of using and method of calculation of cost of operation. Cost determination surveys. Power and energy requirement of crops.

Tractor engines. Performance, speed, torque and power characteristics. Governors and governing. Fuel and oil consumption. Problems connected with transmission, traction, hitching and starting. Hydraulic controls and their operation. Efficiency of tractor operation. Tractor testing.

612. Farm Machinery Design. 3 units (2-3), First and third Terms, 2 units (1-3) Second Term.

Basic principles of design of machines, implements and tools. Performance design of Farm Machinery. Principles of kinematics and theory of machines as applied to Farm Machinery. Design of various machine parts for strength and wear. Selection of materials and manufacturing processes for economic manufacture of Farm Machinery. Design office practice.

613. Farm Machinery Testing : 2 units (1-3), Second Term.

Mechanics of tillage. Forces acting on ploughs, harrows and cultivators. Factors affecting the performance of tillage implements. Types and methods of tests on individual farm implements.

614. Agricultural Process Equipment Design : 2 units (2-0) First Term.

Basic physical and engineering principles involved in processing and handling of agricultural materials. Short, long and medium distance transfer. Horizontal and vertical movement. Size reduction, cleaning and sorting, grading, mixing, pelleting, metering, drying, heating, cooling, threshing, winnowing, crushing. Description and design of important processing and transport equipment. Application of time motion study to agricultural processing and transport. Cost analysis.

615. Dairy Engineering. 2 units (2-0), Third Term.

Physical and chemical properties of milk and milk products. Description, operation, use, selection, installation and maintenance of equipment used in dairies. Electric motors, pumps, pipes and fittings, boilers, refrigerators and cold storage, pasteurizers, homogenizers, evaporting and drying equipment, can-washing and sterilizing equipment. Bottle cleaning and bottle equipment. Ice cream freezers, Cream separators, butter, cheese making equipment.

616. Tractor Design Principles. 2 units (2-0), Third Term.

Thermodynamic and mechanical design of tractor engines. Considerations in selection of engines for variors types of tractors. Principles of design of transmission, chassis, steering, hitches, and controls.

617. Farm Machine Analysis. 3 units. One Term.

Detailed theoretical and practical analysis of physical phenomena such as tillage, fertilizer application, puddling, threshing, harvesting, farm product processing and of farm machines from design and operation standpoints. Research trends in Farm Machinery.

618. Farm Power Analysis. 3 units. One Term.

Detailed theoretical and practical design and operation analysis of farm power units. Research trends in farm power.

621. Soil Conservation Structures Design. 2 units (1-3).

Biological and mechanical control measures. Types of temporary and permanent gulley control structures, their function and adaptability for soil and water conservation purposes in India. Hydrologic, hydraulic and structural aspects of design of structures, surplussing arrangements and outlets for bund and terrace systems.

622. Irrigation Engineering. 3 units (2-3) First and Second Terms.

Sources and storage of irrigation water. Diversion works, open wells and tube-wells. Engineering of gravity and lift irrigatiion. Design of farm conveyance and distribution systems. Measurement of water supply. Basic soil-water-plant relationships, consumptive use. Scheduling of irrigation. Application methods. Theoretical and practical design and lay-out of surface and sprinkle irrigation systems. Irrigation efficiencies. Irrigation equipment and structures.

623. Irrigation Equipment Design. 2 units (2-0) Third Term.

Water lifts operated by human and animal power. Design of don, Persian wheel and chain pump.

Positive displacement and turbo pumps. Steady state analysis. Derivation of flow and torque equations. Optimization of efficiencies. Experimental determination of performance co-efficients. Testing of pumps and analysis of data.

624. Headwater Hydrology for Conservation. 2 units (1-3) First Term.

Precipitation : intesity, duration, distribution and frequency of typical storms. Analysis of storm data at a point and in an area.

Runoff : as a function of precipitation, infiltration, evaporation, surface detention and storage. Analysis and synthesis of runoff hydrograph by unit graph theory as applied to small watersheds. Limitations of unit graph theory and practice.

Flood Routing : the simplified equation, flood routing through reservors and retarding basins. Theoretical and graphical methods. Special problems in soil conservation work.

625. Upstream Flood Control : 2 units (1-3) Second Term.

Causes and characteristics of upstream floods, damage and cost-benefit of flood control measures. Policy and legislation. Methods of headwater flood control. Maximum flood flow determination, reducing flood flows. Watershed treatment, afforestation, grass zones, conservation management of arable and waste land. Principles of land use planning, land capability classification. Flood control reservoirs, detention, storage, multipurpose reservoir. Principles of design using flood routing procedure. Increasing channel capacity, channel improvement, cut-offs, levees, retards, dikes. Sedimentation and its control. Effect of upstream control measures on upstream and downstream hydrographs and hydrology.

626. Conservation Planning in River Valley Projects. 2 units (2-0) Third term.

Soil conservation as a design factor. Estimation of erosion. Deposition and flood damage. Watershed problem analysis. Sediment production at site ; sediment transportation.

River regime. Reservoir sedimentation rates and patterns. Aerial photographs in watershed planning. Erosion foci. Land treatment measures. Channel improvement measures. Evaluation of conservation works.

627. Farm Drainage Systems Design. 3 units (2-3), Third Term.

Movement of water in soil. Physics of land drainage. Theory and design of surface and sub-surface farm drainage systems.

628. Micromeritics. 3 units. One Term.

Particle shape, structure, magnitude and measurement, specific surface. Area and activity relationships, behaviour of particles in fluids, lyophobic and lyophyllic colloid behaviour, electrokinetic and electrostatic phenomena. Dynamics of small particles, size distribution, microscopic, sedimentation, elutriation, centrifugal, dialytic, ultrafiltration and sieve methods for size analysis. Diffusion of particles, surface properties chemical, optical sonic, and electrical properties of particles. Suspensions, gels, viscosity, plasticity and rigidity properties of two, and three-phase mixtures, Theories of fine grinding, homogenising and crushing, Transport theories of particles in fluids, flow through packings ; behaviour of particulate mixture under pressure, sampling and separation of particulate matter from fluid streams.

629. Advanced Theory of Flow of Water in Soils. 3 units One Term.

Saturated flow : equations of steady and unsteady flow. Derivation of ellipse equation and its application. Theory and application of heat flow equations to saturated flow problems. Boundary conditions and approximate solution of drainage problems. Relaxation method applied to changing water table.

Radial flow equations. Graphical solution for storage co-efficient and co-efficient of transmissibility of acquifers. Partial penetration problems. Prediction of well discharge and drawdown. Combination of wells. Comparison of wells of different characteristics. Safe yield of well.

Unsaturated flow : Recent advances in theories of unsaturated flow problems. Klute's equation, Phillip's equation. Comparison of diffusion type equations with hydraulic equations.

Approximate solutions of one-dimensional, two-dimensional, and three-dimensional flow problems. Rate of advance of water in irrigation beds. Numerical analysis. Modern research trends.

631. Dairy Plant Equipment 3 units (2-3) First and Second Trems.

Metals for dairy equipment ; principles of operation, construction and maintenance of dairy plant equipment such as : Milk receiving equipment, canwashers ; separator ; clarifiers ; filters ; storage tanks ; transport equipment ; homogenizers ; heat exchangers, heaters and coolers ; pasteurizers ; vacuum treatment equipment ; temperature, pressure indicating and recording instruments ; bottle filler and cappers ; bottle washers ; icecream freezer, evaporator ; drum dryer, spray drying ; butter churning equipment, equipment for ghee and other Indian indigenous products ; cheese and casein equipment. Water supply system for dairy and dairy farm ; pumping, storage, distribution and drainage. Dairy waste and effluent disposal.

632. Dairy Plant Design—*3* units (2-3) Third Term.

Applications of the principles of engineering and mechanics to the selection and design of equipment for dairy process industry. Design, cost estimation and selection of dairly plant equipment such as heat exchangers coolers and heaters, pressure vessels, storage and transport tanks etc. Dairy process design based on unit operations controlled by such factors as form, utility, cost and reproductibility.

633. Dairy Plant Layout and Installation—3 units (2-3) Second Term.

Selection of site and arrangement of dairy plants. Space requirements, arrangements of receiving, processing and storage areas. Installation of plants and maintenance procedures.

Design of dairy and other buildings, dairy cattle housing design with respect to various requirement. Illumination of dairy building. Design of illumination system. Electrical wiring in dairy building. Automation in dairy with the help of electricity. Indian electricity rules. Stand by plants—their necessity. Diesel and steam generating sets. Safety charts and first aid.

634. Dairy Porduct Processing—2 units (2-0) First and Second Terms.

Engineering processing for food sterilization, steam process engineering, process calculations.

Dehydration, theory of drying process and drying producers involved in dairy product processing.

Various processes involved in manufacture of different milk products.

Process conditioning, cost analysis, manual operation economy.

635. Dairy Technology and Quality Control 3 units (2-3).

Position of dairy industry in India and its relation to rural economy. Dairy development programme—dairy organisation and trade milk production and demand for milk, organization of milk supply. Agricultural geography and climates of India. Principles, practices and economics of soil management and crop production ; fodder crops and pasture grasses.

Improved and indigenous breeds of milch cattle, their distribution requirements, economics. Feeds and feeding of animals. Clean milk production methods and equipment.

Chemistry of milk including composition and its effect on metals. Physical properties of milk. Properties of milk constituents. Protein and non-protein constituents of milk.

Chemistry of milk products such as : cream, butter, ice-cream, sour milk, condensed and dried milk, cheese and ghee.

Growth and reproduction of bacteria, yeast and moulds, their importance.

Types of bacteria in milk. Sources of contamination and its control. Physical and chemical changes produced. Common milk borne diseases and methods of controlling them. Methods of testing milk. Use of starter culture of milk products. Sanitizing and sterilizing dairy utensils and equipment.

641. Instrumentation in Agricultural Engineering. 2 units (1-3) First Term.

Fundamental principles of measurement. Basic standards and accuracy of measurements. Principle of electronics use in instrumentation.

Principles of operation and use of the instruments for measuring length, mass, time, velocity, power, pressure, fluid flow and strain.

Instrumentation for temperature, humidity, heat, rainfall, soil properties and runoff.

642. Research Methods in Agricultural Engiheering. 2 units (1-3) First Term.

Methodological considerations. The scientific method. Theoretical scientific, and rational empirical approach. Considerations in planning and layout of experiments. Materials, equipment and techniques. Execution and report.

Experimental design and analysis : Efficient design of measurement, testing, survey and prediction problems. Idealised, functional discrete and continuous variation models, sequential experiments, reduction of variables and experimental error. Correlation, regression, curve-fitting, input-output methods. Data processing. Theoretical distribution. Statistical analysis. Testing of hypotheses, significance tests and experimental error. Statistical inference and interpretation of results.

Research techniques : Methods of measurement, advanced analytical methods for investigation of physical, mechanical, electrical, organic, inorganic and biological factors. Use of automatic controls and recorders. Use of calculating machines and computers.

651. Genetics 2 units (2-0).

Mendelism, interaction of factors. Cytological parallelism. Linkage and Linkage maps. Sex determination. Mutation. Chimera and graft hybrid. Cytoplasmic inheritance. Bichemical mutation—genetic control of pigmentation in flowering plants, antigens, protein structure, etc. Basic patterns of sexuality in fungi-Somatic recombination in *Aspergillus*. Conjugation and genetic recombination in bacteria. Transformation, lysogeny and transduction. Fine structure of gentic region of bacteriophase. Molecular basis of gene action and mutation. Genetic coding.

652. Plant Breeding 2 units (2-0).

Nature of crop varities and mode of reproduction. Chromosome mechanism in heredity. Introduction and selection. Techniques of selfing and corssing. Inbreeding, recombination breeding hybridvigour. Back crosses, and interspecific and intergeneic crosses. Breeding of cereals and forage crops. Breeding for disease and insect resistance. Inheritance of characters in various cultivated plants. Methods of selection for special characters. Strain building, Field plot techniques. Induction of polyplaidy Mutation breeding—spontaneous and chemicals, and radiation induced mutation. Chromo-some substitution and anellploid analysis.

653. Plant Breeding Laboratory 2 units (0-8).

Field study of variability in cross polinated, self polinated and vegetatively propagated crop plants. Introduction and selection methods.

Methods of emasculation and pollination in important crop plants and other plants of economic interest. Hybridization technique. Back cross method, multiple cross method. Inter-specific and intergenetic crosses. Selection methods in mass population and hybrid progenies. Methods for induction of mutations through polyploidy, chemical agents and ionizing radiation. Handling of raw polyploids, Screening procedures in mutation breeding. Breeding methods of disease resistance. Collection amd maintainance of genetic stocks, maintainance of records. Methods of seed testing and certification. Planning of experimental designs and analysis of results.

654. Cytogenetics 1 unit (1-0) First and Second Terms.

Cytological basis of mendelism. Crossing over and chiasma formation Evaluation of Karyotype. Role of aberrations and ploidy in evaluation. Genetics of species formation. Cultivated plants charomosome analysis, origin, evaluation and cytogenetical studies.

655. Biochemical Cytology 1 unit (1-0).

Elementary composition of plants. Role of carbon Molecular geometry Macromolecules and biological activity. Macromolecule and heredity. Appraches to cell biology. Ultrastructure of cellular components. Chromosome—structure, duplication, movement. Chemical constituents of cell. Metabolic pattern of nucleus and cytoplasm. Control of cellular functions.

656. Cytology Laboratory 2 units (0-8).

Study of living cell. Study of cytoplasmic components. Study of chromosome structure. Application of pretreatment chemicals. Study of karyotype. Staining of various cellular components with Feulgen. Light green, Pyronin-methyl green, Azure blue, Fast green. Alkaline phosphatase and Sakaguchi reaction. Induction of polyploidy by colchicine, gammexane, caffeine, acenaphthene. Mitotic index. Effect of irradiation and chemical mutagens. Study of salivary gland chromosomes. Study of pollen and pollen germination. Enzymological methods of cell chemistry. Autoradiographic methods for cell biology. Ultrathin sectioning and techniques for electron microscopy for ultrastructure research.

657. Molecular Genetics 3 units—One Term.

Molecular basis of heredity—macromolecules and he-redity—deoxyribonucleic acid and proteins. Replication of DNA—conservative, semi-conservative and dispersive. Fine structure of genetic region of bacteriophage.

Molecular basis of gene action and information transfer. Genetic control of protein synthesis. Concept of genetic codes. Models of genetic information transfer. Molecular explanation of spontaneous and induced mutations.

658. Radiation Biology 3 units. One Term.

Various kinds of radiations. Primary and secondary effects. Action of radiation on water and yield of radicals. Initial effects of ionizing radiation on cells and tissues. Direct and indirect action theories. Target Theory—application. Effects of radiation on chromosomes—genetic effects of radiation. Radiomimetic chemicals. Radiation Biology and health physics—effects of chronic and acute-irradiation on human heings—problems of radioactive fallout.

659. Cellular Ultrastructure 3 Units (3-0) One Term.

Construction and operation of Electron Microscope—electron beam, lens system, resolution, depth of focus, contrast and image formation. Techniques for biological material —replica technique and ultrathin sectioning. Fixation, embedding, staining and metal binding. Techniques of electron histochemistry and electron autoradiography.

Ultrastructure of origin and development, and function of mitochondrion, golgi body, chloroplast, lysosome, endoplasmic reticulum, nuclear and cell memberance, cell wall. Role of double-layered membrane and fine particles in unit biological functions. Ultrastructure of mitosis—chromosome, spindle, centriole, centrometre. Ultrastructural aspects of cellular differentiation in root apex, sporogenous tissue, microsporocytes, embryo and cancer cells.

660. Advanced Cell Biology 3 Units (3-0)—One Term.

Mitotic index, mitotic cycle, S period and rate of DNA synthesis. Patterns of cell growth and variations of DNA, RNA, and protein synthesis and enzyme activity during cell cycle. Disruption of mitotic cycle by various agents. Energy requirements for cell division. Genetic and metabolic control of nucleic acid and protein synthesis. Intracellular regulation of mitosis and meiosis.

Problems of cellular differentiation—role of nucleic acids and histones in differentiation. Antimetabolites and inhibitors of protein synthesis—their effects on cellular structure and function.

661. Advanced Soils 2 units (2-0) First Term.

Soil climate in tropics. Soil morphology. Soil genesis ; weathering, clay formation and mineral associations in tropics. Soil organic matter : humification and nitrification in tropics. Modern system of soil clarification. Classification of tropical soils. Materitic, podzolic, margalitic. Saline and alkali types of tropical soils. Micronutrients. Methods of assessing soil fertility including radio tracer technique. Indian Soils and problems of their low fertility and management for increasing yields.

662. Soil Physics Principles 2 units (2-0) First Term.

Mechanical composition. Colloidal Clay ; nature and surface behaviour. Soil-water systems : hydration, viscosity, consistency, puddlability. Soil water : properties, concepts, constants, movement, measurement and management. Soil air : functions, air capacity, measurement and management. Soil temperature : sources, conductance, factors effecting and control : Soil colour : occurence, causes, classification and soil evaluation. Physical properties of soil and wind and water erosion.

663. Soil Physics Laboratory 2 units (0-6) First and Second Terms.

Methodology and technique of physical characterisation of soil. Surface area., Soil colloids. Mechanical analysis. Particle and bulk density. Shrinkage, pore space, consistency constants. Aggregate analysis. Air permeability. Soil organic matter in relation to Soil Structures. Soil moisture measurements ; tension : electrical resistance etc. Soil moisture desorption curves, hydraulic conductivity. Infiltration capacity, capillary conductivity. Electrical conductivity, soil dispersion, and erodibility study. Thermal properties of soil. Modulus of rupture. Irrigation and drainage water analysis.

664. Physical Edaphology 2 units (2-0) Second Term.

Soil as a physical system. Soil skeleton, structure, crusts etc. Soil tilth, soil cultivation, dynamic properties of soil and implement design. Mechanical impedence and plant growth. Soil water and plant growth. Soil water system, soil water storage and movement, irrigation, drainage, soil moisture stress and plant growth : draught and tolerance and efficiency of water use by plant. Soil aeration and plant growth ; soil processes and properties affected by aeration;

effect on plant growth and water absorption. Soil temperature. Factors affecting the plant growth processes.

665. Soil Survey 2 units (0-6) Third Term.

Methods. Field study of soil characters. Development and morphology of soils. Description and identification of soil profiles. Mapping and classifying soils. Preparation of soil report. Interpretation of survey data in terms of land capability classes and land use planning.

666. Irrigated Soils 2 units (2-0) Third Term.

Problems of irrigated soils. Arid soils. Soil types and irrigation practice. Plant and soil water. Osmotic pressure and effect of salts, Evaluating land for classification. Evaluating irrigation needs of soil. Quality of irrigation water. Irrigation effects on soils. Management of saline and alkali soils.

667. Soil Physics for Agricultural Engineers. 2 units (1-3) Second Term.

Physical properties of soil affecting fluid flow, tillage soil and water conservation and implement design. Soil temperature. Measurements of physical properties.

668. Tillage Physics 3 units. One Term.

Soil reactions to tillage machinery. Soil compaction ; influence on soil, air and water interrelationships, Crop responses. Root behaviour and nutrient uptake. Seed-plant soil relations. Soil cultivation. Tillage specifications and evaluation.

670. Mineral Nutrition of Plants 3 units One term.

Physiology of the plant cell, water relation of plant cell, loss of water from plant, absorption of water, internal water relation : soil as a medium for plant growth, mineral composition of plant, soil as source of mineral elements. Absorption of minerals, symptoms in mineral deficiency. Nutrient uptake in relation to growth, photosynthesis, respiration carbohydrate and nitrogen metabolism. Physiological effect of light and temperature on growth. Physiological basis of yield.

671. Farm Organisation and Management 2 units (2-0) First and Second Terms.

Terms : Characteristics of farming as a business ; Factors affecting types of mechanised farming. Selection of crops ; crip machinery and live-stock for a mechanised farm. Livestock housing and power management.

Farm budgeting : utilisation of labour and power and equipment ; research methods, Special problems in farm planning.

672. Economics of Mechanized Farming 2 units (2-0) Third Term.

Principles of production—Economics applied to agriculture with emphasis on profitable combinations of factors of production. Cost of production of farm enterprises. Resource combination and cost minimisation.

673. Advances in Agronomy 2 units (2-0) Second Term.

Plant climate—Modification of micro-climate by agricultural operations. Crop adaptation and climate, modern concept of crop management tillage method. Technique in agronomic research.

674. Crop Ecology 2. units (2-0) Third Term.

The environmental requirements of crop plants and their physiological basis ; adequacy of the environment provided by crop land in India as a function of management, soil and climate. The distribution and yield of selected crops as a function of environment.

675. Plant Protection Technology 3 units (3-0) First Term.

The mechanism of infection—the effects of adaphic and climate factors. The resistance mechanisms in plants. The sources of infection, transmission of pathogens and epidemiology of infectious diseases, prophylaxis against infections.

Principles of chemical protection. Mode of action of insecticides and fungicides. Inorganic vegetable and synthetic organic plant protection chemicals. Application equipment, methods of application.

676. Marketing of Farm Products 2 units (2-0) Third Term.

The demand and supply for farm products. Effects of unstable production and birdging gap between producer and consumer. Marketing principles and functions. Buying and selling, Risking, Financing, storage, Transportation, Standardization etc. Marketing agencies and their characteristics. Grades, values and prices. Reducing marketing costs. The effects of changes in distribution costs. Reducing risks in marketing agencies, increasing labour efficiency and other technological improvements in marketing.

677. Principles of Agronomy. 2 units (2-0) First term.

Agricultural Geography and climate of India. Principles, practices and economics of soil management and crop production. Dry farming and conservation farming.

Plant climate. Modification in micro-climate by agricultural operation. Crop adaptation and climate. Modern concept of tillage methods. Crop management and techniques in agronomic research.

The environmental requirements of crop plants and their physiological bases ; adequacy of the environment provided by crop land in as a function of management, soil and climate. The distribution and yield of selected crops as a function of environment.

Soil moisture measurements ; tension ; electrical resistance etc. Soil moisture desorption curves, hydraulic conductivity. Infiltration capacity, capillary conductivity. Electrical conductivity, Soil dispersion, and erodibility study. Thermal properties of soil. Modulus of rupture. Irrigation and drainage water analysis.

678. Agronomy, Forestry and Agrostology in Soil Conservation 2 units (2-0) First and Second Terms.

Agronomic causes and effects of erosion and its control. Principles, practices and economics of conservation farming. Co-ordinated plan for soil conservation. Drainage. Reclamation of saline, alkaline, water-logged, and acid soils.

Role of plants, trees, pastures and grasses in soil and water conservation. Selection of plant material, planting, maintenance.

679. Arid Zone Conservation 2 units (2-0) Second Term.

Definition of arid zone. Its extent and importance. Evolution of aridity. Climatology and hydrology of arid regions. Special problems of arid zone. Reclamation and control of arid regions. Biological and mechanical measures. Aspects of surface and ground water development. Vegetative Measures : range management and other vegetative techniques. Water spreading. Water-logging and soil salinity in relation to irrigation.

680. Agriculture in World Economy 3 units One Term.

Present position of agriculture and future demands. Contribution made by agriculturally progressive countries in relation to world economy. Future work for arable farming : irrigated and non-irrigated. The ways and means of achievement.

681. Chemicals and Plant Growth—3 Units (3-0)—One Term.

Plant growth as a process and its regulation factors involved in this regulation. Growth-regulating products and bio-synthesis and their classification—auxins, gibberellins, kinins, vitamins, pigments and growth-inhibiting compounds, anti-transpirants including germination inhibitors and toxins.

Chemistry of commonly used fertilizers, herbicides, insecticides, and plant growth regulators—their classification, preparation and general properties.

Mechanism of action of bio-synthetic and synthetic plant growth regulators. Structure—activity relationship of such compounds.

691. Microbiology for Civil Engineers 2 Units (1-2) Second and Third Terms.

Introduction. Scope of microbiology. Structure of microbes. Various groups of organisms. Morphology, life cycle and classification. Classification for bacteria. Characters of various orders.

Plankton, limnology, rheology, Bacteria in water. Bacteriology of water supplies. Pathogenic bacteria. Diseases carried by water. Bacterial counts and interpretations. Tests for bacteria. Self purification of streams. Significance of Algae in water supplies. Growth and death of bacteria. Disinfection : Principles and methods.

692. Design Testing Project (Units to be arranged).

693. Seminar 1 unit (0-1).

Seminar talks to be prepared given by the candidates.

694. Research 6 units. Thesis 4 units, Viva Voce 4 units. Fourth Term (for DIIT).

Research problem to be selected in consultation with the Department and research work to be carried out.

695. Any Specific Topic (Units to be arranged).

Industrial Training : 12 units during the Fourth Term. (For M. Tech.).

ARCHITECTURE AND REGIONAL PLANNING (Ar)

601. Planning Principles I—2 units.

Objectives of town and country planning—planning at local, regional and national level-factors, influencing the growth of settlements—classification of towns and villages.

Comprehensive plan—its goals and objectives—its contents, Physical and socio-economic surveys—Assessment of the planning problems and presentation of survey findings.

Land Use :

Determinants : Residential, trade & commerce, industry, recreation, and transportation —study of Development Plans for selected towns—Implementation of Plan—Programming —Citizen participation—Feedback.

Planning of new towns—Chandigarh, Brasilia, Hook Town and other studies.

Planning in existing towns—redevelopment and renewal. Problems of Indian villages and their development—Community Projects and N. E. S. Blocks.

602. Housing and Community Facilities I—1 unit—First and Second terms.

Housing through the ages—problems of congestion, slums, and renewal. Qualitative and quantitative aspects of housing demand.

Economics of housing—market, rent, subsidy.

Types of housing—Communities facilities—Field studies.

Objectives of housing policy—mobilisation of resources of housing and community facilities.

Institutional financing of housing—cooperative housing societies—Private investors—State guarantees—capital and rent subsidies.

603. Transportation—I. 1 unit—First and Second terms.

Goals for transportation : Urban & Regional Transportation—Transportation as a function of land use.

Movement of persons, goods, services : Assessment : Types of Survey : Data Analysis & Programming : Transportation Co-ordination. Alternative Systems of Transportation.

Economics of Transportation : Freight Policies : Priorities for Transportation in a Developing Economy : Choice of Technology.

Case studies to illustrate High capacity movement on Roads, Railways, Mass-transit.

604. Local Self-Government—1 unit—Third Term.

Types of local self-governments—Historical development of Panchayatraj-Panchayats, Municipalities, corporations, Districts Boards—their functions and powers—Financial resources —duties of executive authorities and the elected bodies—various sections in the local authority office—committee system.

controls by State Governments.

Improvement Trusts.

605. Geography (Physical and Urban)—2 units—Second and Third Terms.

Land forms, classification and nature. Land form evolution agents of weathering, erosion, deposition and their work.

Elements and controls of climate—areal variation in distribution, Broad climatic pattern.

Soils : Their formation and distribution,. correlation of climate, soil and vegetation.

Physical geographic region.

Geography and Urbanism : Scope and status, Urban places. The rise and growth of cities. Basis physical and economic.

Functional classification—cities as central places. Size and spacing of cities. Nature of a city structure. Internal arrangement of land-uses. Residential, industrial and commercial structure of cities. Urban fringe, blight and renewal. The theory of the city. Dynamic process of urbanisation. Megalopolis.

606. Planning Problem I—7 units—First and Second Terms common for City and Regional Planners—7 units also in Third Term for City Planners.

Field surveys and studio work relating to metropolitan and regional planning.

Environmental design studio—an interdisciplinary programme meant to acquaint the student with the activities taking place in any environment, the scales of representation, the presentation techniques, maps, charts, and other tools.

Urban Planning Studio : methods of survey and analysis, Problems of urban areas such as land sub-division, sector lay-outs, transportation, relation between various activities, preparation of comprehensive plans.

607. History of Towns—1 unit—First and Second Terms.

Primitive settlements—Planning theories in ancient Hindu scriptures—Mohenjodaro and Harappa—Early examples from Egypt, Mesopotamia, Greek and Roman periods—Medieval Towns—Piazzas—Renaissance period—Haussmann's work in Paris—Cammillo Sitte's ideas —Industrial Revolution and its effects—theories of Ebnezer Howard, Tony Garnier, Patrick Geddes, Lewis Mumford, Corbusier and others—Growth of Planning Legislation—contemporary trends in planning.

608. Housing and Community Facilities—II—1 unit—Third Term.

Residential Areas—Design standards—Planning of dwelling units—space between buildings—merits and demerits of different housing types—climatology—ventilation, etc. standards for community facilities.

609. Transportation—II—1 unit—Third term.

Place & Function of Transportation—Development & History—Transportation Systems—Hierarchy.

Layout & Design of Roads, Railways, Waterways—Junctions, Terminals, Parking, Layout of Airport—Location with reference to settlements.

Study of U.S., European & Indian standards.

610. Architectural Design—1 unit—Second and Third Terms.

Brief study of historic as well as contemporary styles of Architecture—use of small scale problems of familiar subject matter to establish basic concepts through harmonious relationship between use and form, structure and space, materials and appearance.

Design of houses and flats-orientation-basic design features of public buildings, offices and factories—study of architectural elements contributing to the environmental quality of the neighbourhood, school, playgrounds and parks, shopping and community centre.

611. Development of Planning Thought—1 unit—First and Second Terms.

Historical Survey : Early settlements.

Development of planning treated as the capacity of the community to make adequate changes in land-use.

Ancient Planning : Indus Valley—Harappa and Mohenjodaro, Egypt, Mesopotamia, Greece and Rome. The city state of Greece.

Medieval Planning : Fortifications, the nobles and the church, the medieval place. Changes brought about by trade and commerce.

Renaissance Planning : Planning on the grand scale, development of urban design, the Place and the Piazza, Garden design.

Industrial Revolution : Social reform, large centres of manufacture and large centres of trade, commerce, administration and transport. The emergence of resource regions as regions of activity.

Contemporary developments in transport and communications, utilities and services *vis-a-vis* population movements. Socio-economic aspects of growth of population. Formation of metropolitan areas. Rural-urban migration.

Contribution of Ebenezer Howard, Landuse surveys of Britain and their impact on national and regional planning. Industrial location and regional analysis.

The Rowse concept of global planning and the United Nations concept of Area Planning. Planning for growth and development.

612. Theory of Resource use—1 unit—Second and Third Terms.

Classification of resources : Basis of resource evaluation : The principle of conservation of resource : allocation of resources for the activities of man-international, regional and area groupings : Elements of regional resource development with particular reference to Water, Power, Agriculture, Forestry, Minerals, Manpower : Case Studies of Regional Resource Development : Correlation between Regional Economical and Regional Physical—objectives, priorities and programmes : Concept of regional income : Regional growth interpreted as a consequence of regional resource development barriers and constraints.

Impact of modern methods of transportation and communications on land planning : Industry, its changes and adaptations—consequences of automation, diversification and improved methods of management. New sources of power. Scope of technology in answering the developing needs of the community.

614. Planning Problem I-A—7 units—Third Term for Regional Planners only.

Regional aspects of urban area : collection of regional data on transport, land-use, resources, industries and population. Presentation of the data on map leading to the preparation of regional Plan.

625. Economic Geography—2 units—First Term.

Man's physical environment—social, economic and political consequence of geographical conditions, physical features, climate, *etc.* and their effect on urban and rural communities.

The regional distribution of world's resources—industries and population. Analysis of the distribution and comparative importance of manufacturing, mining, forest, agriculture and trade in relation to such factors as power resources, raw materials, climate, land forms, centres of population and world trade routes. Economic geography of India and its relation to town planning.

701. Planning Principles II—2 units.

Metropolitan Region—Delineation—evolving metropolitan framework—special problems of the central areas and suburbs—Housing, Industry, Recreation and Transportation Structure—Migration from rural areas—Decentralisation policies—Hierarchy of town centres—Satellite townships and green belt.

Concept of region—types of regions—Hierarchy of communities—delineation of regions—physical, economic and social survey—contents of regional plans—studies of specific projects like the T.V.A., D.V.C. & Zuder Zee—River Valley Projects in India and their role in regional development—National Planning—Critical study of Five year Plans and theirimp act on the regions.

702. Landscape Design—1 unit—First and Second Terms

Types of landscape and its development at various planning levels—role of man in changing the landscape—survey and reconstruction of survey.

Outline history of development of parks and gardens in various countries and their contrition to present day landscape.

Parks and open spaces system—Regional, National and District Parks—Types of recreational—Development of recreational areas and water front development.

Plant materials with special reference to roadside planning—Shelterbelts, *etc.*—National highway, parking areas.

Effect of various natural resources on landscape—treatment of derelict, industrial waste lands and erosion control. Climatic factors which affect man's environment—planting for micro-climatic effects.

Principles of plant ecology—study of plant communities—Regional Landscape Development.

704. Planning Legislation and Administration—2 units—Second and Third terms.

Brief survey of development of planning legislation in U.K., U.S.A. and India : Fundamental Rights under the constitution in relation to police powers and eminent demand and land acquisition procedure—basis for determining compensation—special powers for dealing with slums.

Planning agencies at national, State and local levels—their functions and relationship—contents and preparation of Development Plans—meaning of development—control over development—appeals—detailed planning schemes—betterment levy and compensation—arbitration—execution of planning schemes—control over advertisements—preservation of trees and special buildings.

Building by-laws—zoning laws—planning provisions in the municipal acts—Improvements Trusts and their scope.

706. Planning Problems IIA—7 units.

Surveys and studio work relating to metropolitan and regional planning.

709. Regional Geography of India—1 unit—First Term.

Land forms, climate, vegetation and soil. The people : settlement pattern—village and towns. The economy agrarian, mining and industrial.

The Regions of India, regional delineation—physiographic, river-valleys, rural, metropolitan, economic, commercial and trading, and planning region. Broader aspects of such regions. The analysis of regions and regional economic development.

710. Regional Planning and Analysis—2 units.

Study of the major influence of natural resources, climate, and topography on the location and character of settlements. Study of the problems relating to population, transport, industry, agriculture, commerce, etc. in the Indian Five Year Plans : Regions and national development. National Resources Planning Board and other studies.

Types and characteristics of regions. Single purpose and multipurpose regions such as resource regions, river valley regions, climatic regions, soil regions, population regions, transportation regions, metropolitan regions, etc. process of regional delineation. Methods and types of regional surveys and analysis. Barriers and constraints. Water, power and transportation treated as determinants for regional development. Impact studies, Identification of the problems of region.

Study of the planning aspects of a river valley region, an industrial region or a metropolitan region taken up as an illustration of the principles of regional planning. Decision making in regional planning. Nature of the Regional Planning Authority.

Introduction to regional science. Industrial complex analysis of selected industry groups. Studies in location and space economy.

711. Theory of Industrial Location—1 unit—First and Second Terms.

The economic theories of location—Weber, Losch, Hoover, Isard, Access as a basic factor in location—factors of industrial location, barriers and constraints for location. Industrial location analysis—industrial complexes, comparative cost approach, labour and similar co-efficients, localisation, specialisation, diversification and factor analysis with particular reference to regional delineation. Correlation between resources evaluation, industrial development and location of industry. Case studies of iron and steel, petro-chemicals, coal-based activities, port-terminal activities.

712. Public Administration and Legislation—1 unit—Second and Third Terms.

Government at the national level : The Constitution of India : The national, state, district and rural organisations. Other statutory organisation : The Planning Commission : Relation between the national and the State Organisation. Inter-state relations. Outline of planning law in the U.K. and other Commonwealth Countries—Adequacy of planning legislation in India—a critical review of the Town Planning Acts in India. Comparison with U.S. practice.

The Planning function in Government—powers to delegate responsibilities in the decision making process : Flexibilities of the system to handle new functions. Critical review of existing methods of data collection, policy formulation and project implementation.

Methods of financing and programming of development plans, public participation. Case-study of a project in India to demonstrate the role of the public administrator in Regional Planning.

713. Workshop—1 unit—Third Term.

A study of a regional plan through extensive reading, seminars, discussions and field visits leading to a critical evaluation of the plan. Typical workshop courses may be offered on the Damodar Valley Region and the Calcutta Metropolitan Region.

714. Planning Problems IIB—7 units—First and Second Terms. 6 units—Third Term (for Regional Planners only).

Regional Studio

Resource surveys : water, power, transportation, population, Socio-economic correlations.

Delineation processes : Urban-rural continuum, study of a sub-region, preparation of a development plan for a sub-region. Metropolitan—metropolitan area planning—megalopolis—preparation of a functional plan in a metropolitan area. Inter-state problems coming up in regional delineation—river valley projects. Preparation of a programme for a regional development plan.

APPLIED CHEMISTRY (Ch)

601. High Pressure Technique 3 Units First Term. 2 Units Second and Third Terms.

Selection of materials for high pressure work for service at ordinary low and high temperatures. Design and construction of pressure vessels. Thin-walled cylinders, gas storage cylinders. Thick cylinder. Theories of elastic failure. Compound cylinders. Autofrettage. Joints and closures. Piping, valves and fittings. Sight glasses and windows. Electrical leads. Flow meters. Design and construction of chemical autocaves, Catalytic circulatory plants.

P-V-T relationships of gases and liquid. Specific heats of gases, Viscosity of gases and liquids, etc., at high pressure.

602. Technical Gas Reaction. 1 Unit First Term. 3 units Second and Third Terms.

Industrial gases, Tonnage oxygen. Economics of the manufacture of oxygen. Uses and scope of high pressure in chemical synthesis. Synthesis of ammonia, methanol and higher alcohols. Fischer-Tropsch and allied synthesis. Hydrogenation of coal, tar and oils by the Bergius process. Synthesis of urea, polymerization of olefines etc. Recent advances in the high pressure chemistry of carbon monoxide and acetylene.

603. Chemical Kinetics and Thermodynamics. 1 Unit.

Order of reaction, classification of reaction, chain reactions. Maxwells law of distribution of velocities and kinetics of homogeneous gas reaction. Theories of reaction rates, Reaction in solution, kinetics of heterogeneous reaction, acid base catalysis. Effect of temperature and pressure on chemical equilibrium. Nernst heat theorem, the third law of thermodynamics and its applications to chemical systems. Free energy and entropy calculations.

604. Catalysis. 2 units Second and Third Terms.

The structure of surface. Electron microscope and electron diffraction, X-ray diffraction. Differential thermal analysis, magnetic susceptibility, etc. Adsorption and measurement of surface area. Catalysis and heterogeneous reaction. Technique of adsorption measurements by the B.E.T. method. Surface area measurement, Differential thermal analysis of catalyst powders.

605. Physical Organic Chemistry 1 Unit.

The application of the electronic theory and theory of resonance in organic chemistry. Application of wave mechanical picture to the structure of benzene. Reaction mechanisms. Resonance energy and its determination. Application of dipole moment, dissociation constant studies, ultraviolet and infrared spectroscopy to the structure of organic compounds.

606. Advanced Chemistry. 3 Units.

Kinetic theory, Maxwell's law of distribution of velocities, characteristic equations of actual gases, theory of corresponding state, liquefaction of gases.

Kinetics of chemical reactions. Classification of chemical reactions, active molecules, energy of activition, the mechanism of chemical changes. Chain reactions, typical atomic reactions, ionic reactions important industrial reactions in the gaseous and liquid systems.

Electrochemistry. Outline of the theory of complete dissociation, concentration cells, standard electrodes, Potentio-metric and conductometric titrations, measurement of pH decomposition potential, electro analysis, polarisation, Colloids and surface chemistry.

Radio activity, theoretical and applied. Atomic structures elements of quantum theory, valency, atomic number, isotopes and periodic tables.

Double and complex salts. Corrosion. Application of physico-chemical methods to analysis.

Selected topics in organic chemistry.

610. Physical Chemistry of High Polymers 2 units First and Second Terms, 1 unit Third Term.

General introduction, kinetics of addition polymerisation, (emulsion, ionic etc.) and copolymerisation, Molecular weight determination, distribution of molecular weight and Chain length, Thermodynamics of High Polymer solutions.

Lab : Study of the kinetics of polymerisation of styrene (vinyl acetate) in bulk, solution and emulsion, determination of mol. wt. of the heterogeneous sample by viscosity measurements, fractionation of the hetero sample and determination of mol. wl. by viscosity and osmotic pressure measurement, copolymerisation of styrene with butadiene (vinyl acetate) condensation of phenol with formaldehyde and effect of different fillers.

611. High Polymer Technology 1 unit First and Second Terms.

(i) Techniques and manipulation in polymer industry including methods of polymerisation, processing, compounding and moulding.

(ii) Thermoplastics and Thermosetting resins. Principles of the manufacture and utilisation of Phenol formaldehyde, urea formaldehyde, Melamin formaldehyde, alkyd and epoxy resins, poly amides poly esters, cellulose derivatives, polyurethane, polyethylene, polypropylene, polystyrene, polyvinyl chloride, polymethylmethacrylate, polyvinyl acetate, polyvinyl alcohol, Acrylate resins.

612. Rubber Technology 2 units First Term, 4 units. Second and Third Terms.

Historical introduction, Plantation industry, manufacture & gradation of Natural Rubber, Properties of latex and raw rubber, manufacture & Technology of Reclaim and other compounding ingredients, manufacture and Technology of Styrenebutadiene rubber nitrile rubber, neoprene, butyl rubber, and other synthetic rubbers, compounding of latex.

Study of the elementary processes : Cutting, mixing, calendering, frictioning, spreading, moulding and vulcanisation with particular emphasis on machineries used.

Study of the manufacturing process involved in preparation of foot wears, hot water bottles, hoses, conveyer and transmission belts, buffer springs, tyres, foam rubber and other latex products.

Rubber Lab : Determination of acetone extract, free and total sulpher and rubber hydrocarbon. Preparation of mixes to illustrate the effect of various compounding ingredients on the plasticity, curability and mechanical properties of elastomer.

613. Rubber Physics : 1 unit Third Term.

Structure of elastomers by X-ray, infrared and electron microscope, Kinetic theory of rubber elasticity.

614. Chemistry of Rubber. 1 unit Second Term.

Composition of rubber, determination and distribution of moleculer weight of rubber, reactivity of rubber towards heat, light, air etc. Cyclisation and hydrochlorination of rubber, Chemistry of mastication, ageing and Vulcanisation of rubber.

615. Mechanical Behaviour of High Polymers : 1 unit.

Ideal elastic deformation, viscous flow, engineering definition of various mechanical properties, effect of relaxation, stress strain behavior of high polymeric solids. Anomalous flow of liquids, molecular theory and Rheological behaviour, Testing procedure and equipment.

(*ii*) Elastic modulus and tensile strength, static structural considerations, creep, stress concentration and notch effects, factors affecting binder filler product.

(*iii*) Dynamic stress, Impact resistance, behaviour under cyclic stress, fatigue endurance.

Electrical, thermal and optical properties of High Polymers :

(*i*) Volume resistance, surface resistance, electrical break down, dielectrics, anomalous dispersion, dielectric heating.

(*ii*) Heat resistance, thermal conductivity, and expansion.

(*iii*) Colour and constitution of organic compounds, bifringence, stability of optical properties, safety glass.

616. Advanced Organic Chemistry. 2 units.

Organic reactions, their application in synthetic organic chemistry. Bond making and bond breaking processes. Application of Lithium aluminium hydride, polyphosphoric acid, hydriodic acid, periodic acid, leadtetracetate, aluminium isopropoxide etc. in organic chemistry.

617. Heterocyclic Chemistry. 1 unit.

Five membered rings with one hetero atom, pyridine, bicyclic rings, containing one nitrogen, two nitrogen, three nitrogens and four nitrogens atoms. Preliminary molecular orbital treatment and its application to correlate their properties.

618. Synthetic Drugs 2 units First Term, 5 units Second term, 4 units Third Term

Relation of chemical structure and biological activity, pharmacological study of drugs (adsorption, distribution, excretion, toxicity and metabolism) Chemotherapeutic classification. Anaesthetics, Analgesics, Antimalarials, Drugs for the treatment of Cancer, Vitamins, Sulphonamides, Antibiotics, Antihistaminics, Sedatives, Hormones, Tranquillizing drugs, etc.

619. Natural Drugs. 2 units. Third Term.

Historical development of medicinal chemistry ; introduction to natural alkaloids, their isolation, elucidation of structure, synthesis. Proteins and amino acids, synthesis of peptides and sequence study. Nucleic acids *etc.*

621. Chemistry of water and Sewage. 2 units First Term, 1 unit Second and Third Terms.

General organic chemistry, insecticides, detergents, Elements of water chemistry solutions and solubility, solution of ionised solutes, solubility constant. Elements of electrochemistry, Oxidation—Reduction potentials, complex reactions, catalysis, colloids, application to sanitary Engineering problems, Corrosion control. Industrial Wastes.

(For Public Health Engineers)

622. Chemistry of Sands, Clays, and Binders. 4 units. Third Term.

Classification of clay minerals, origin of clays. Structure and properties of sands and clays. Bonding mechanism—clays, silicates and organic Binders.

Polymerisation and oxidation.

Minerology of sands, minerological testing. Indian sands and clays.

(For Foundry Engineers)

623. Physical Chemistry. 2 units. Fiyst Term and 1 unit. Second Term.

Review of Atomic structure. Crystal structure with special reference to minerals, Properties of solids, elementary thermodynamics of chemical reactions, electrochemistry, elements of chemical kinetics, physical and chemical adsorption, Colloid Chemistry and phase rule.

(For Mineral Engineers)

624. Assaying and analysis of minerals. 2 units First Term and 1 unit Second Term.

Dry assaying processes, fire assaying of gold, silver, tin etc. Wet assaying of minerals of iron, lead, zinc, copper, cobalt, manganese, chromium, tin etc. Silicate analysis. Microchemical tests. Colorimetry, Polarograph, Differential Thermal Analysis.

Laboratory Work.

(For Mineral Engineers)

CHEMICAL ENGINEERING (ChE)

601. Chemical Engineering Science I (Fluid Dynamics). 3 units (3-0). First Term.

Introduction. to mementum theorem.

Viscous flow of Newtonian fluids, and concept of shear stress.

Multidirectional flow, continuity equation. Equations of motion, isothemal viscous flow around a sphere and stoke's law.

Macroscopic mechanical energy balance, potential flow and Bernoulli theorem.

Energy balance in the flow of compressible fluids, gas flow at high velocity.

Boundary layer theory, turbulent diffusion, universal velocity profile.

Non-Newtonian fluid flow, shear stress, consistency measurement and pipe line design.

Dimensional analysis in fluid flow problems and similarity criteria.

Properties and dynamics of particles.

Size and surface area of particles in two-phase flow. Pressure drop across banks of tubes.

Fixed, fluidized and moving beds, pneumatic conveyance of solids. Three phase flow systems.

602. Chemical Engineering Science II (Heat Transfer). 2 units (2-0) First Term.

Heat transfer by conduction in unsteady state. Heat transfer through furnace wall.

Heat transfer by convection, equations for calculating heat transfer coefficients. Design of different types of heat exchangers—extended surfaces and multipass. Optimization of heat exchangers. Unsteady convective heat transfer. Condensation of vapours, heat transfer in boiling liquids.

Radiation : Mechanism of heat transfer by radiation, allowance for non-black substance, mean beam length, calculation of gas emissivity. Heat transmission in boilers. Design of furnace by different methods. Waste heat recovery by heat regenerator, recuperator and pebble heater. Design of rotary dryers and kilns in chemical and process industries.

604. Chemical Engineering Science III (Mass transfer) 4 units (4-0) Second Term.

Diffusion and mass transfer, molecular transport properties, mass transfer in gas- liquid and liquid-liquid systems under laminar and turbulent flow conditions. Interphase mass transfer mechanism. Different theories—film, penetration and surface renewal.

Distillation : Theory and calculation of multi-component mixtures and non-ideal systems. Tray hydraulics. Azeotropic, extractive, molecular and vacuum distillation. Design of different types of distillation columns.

Gas Absorption : Design and calculations for absorption and stripping of gases, gas-liquid distribution and wetting of tower packings. Absorption with chemical reactions.

Extraction : Extraction of solids and liquids. Design and calculations for co-current and counter-current liquid—liquid extraction systems.

Water cooling : Design of different types of water cooling towers.

Drying : Design and calculations of rotary and spray dryers and kilns.

607. Transport Phenomena. 2 units (2-0). First Term.

Viscosity, thermal conductivity and diffusivity. Mechanisms of momentum, energy and mass Transport. Velocity, temperature and concentration distribution in laminar flow. Equations of change for isothermal, non-isothermal and multicomponent systems. Velocity, temperature and concentration distribution with more than one variable. Turbulent flow. Interphase transport. Macroscopic balances.

611. Advanced Thermodynamics. 2 units (2-0). First Term..

General equations for equilibrium, thermodynamic functions. Equations of state for single fluids, and solutions. Generalised equation of state and its applications.

Two-phase equilibria. Thermodynamics of fluid flow and power plant cycles. Chemical reaction equilibrium.

Simple and complex reactions.

Thermodynamic properties from molecular structure.

612. Advanced Applied Kinetics and Reactor Design. 2 units (2-0) Second Term, 1 unit (0-3) Third Term.

Second Term

Kinetic analysis of rate data from isothermal, batch and flow reactors.

Heterogeneous catalytic reactions, common properties of a solid catalyst and their evaluation, kinetics of chemisorption processes, formulation of rate expressions, experimental techniques, interpretation of rate data.

Uncatalysed heterogeneous reactions, selections of a model, development of rate expressions.

Third Term

Application of kinetics to reactor design for simple homogeneous reactions, adiabatic and programmed reactors, selection of reactor for complex reactions, multiple reactor systems, process optimization.

Non-ideal flow, residence time distribution, dispersion model.

Heat and mass transfer in a single catalyst pellet and in a catalyst bed. Process optimization for catalytic reactors.

Empirical methods for reactor design.

616. Process Development and Equipment Design. 3 units (0-8). Second and Third Terms.

A course involving the development of a practical process for the manufacture of an assigned product. It includes literature survey, laboratory investigation, pilot plant study, process design, selection of equipment, design of equipment and manufacturing cost estimation. Optimization problems.

620. Material Technology. 1 unit (1-0) Second Term.

Crystal structure of pure metals, grain formation in metals, nucleation and grain growth. Structure of ceramic and organic materials and their effect on properties.

Phase equilibrium diagram. Multiphase alloys—non-equilibrium relationship.

Steel : Isothermal transformation diagram and transformation on continuous cooling.

Hardening of steel hardenability. Heat treatment of important non-ferrous alloys.

Effect of phases on micro and macro-structure of alloys. Effect of high and low temperature on ferrous and non-ferrous alloys.

Causes of corrosion-cracking of metals, types of corrosion and its prevention.

Study of metals and alloys with reference to their application in chemical industry.

Non-metals and their uses.

621. Chemical Engineering. 3 units (2-3).

Introduction to Unit Operations. Flow of fluids, fricition in pipes and fittings, pumps and compressors, measurement of flow. Heat transfer by conduction, convection and radiation, heat exchangers and evaporators. Diffusional operations, distillation, absorption etc. Elementary treatment of other unit operations.

(For Applied Chemistry)

625. Instrumentation and Process Control. 2 units (1-3). Third Term.

Block and signal flow diagrams. Mathematical formulation of control problems. Different methods of analyses. Laplace transformation and its application. Measuring and error-detecting devices, controllers, final control elements and transmission devices in chemical process industries.

Open loop response of simple systems. Characteristics of feed back elements, controllers, valves and transmitters. Frequency response analysis, stability, quality and optimum controller settings in a control system. Examples of feed forward control, cascade control and multivariable control systems. Design of some simple control systems.

Process dynamics of heat exchangers, level and flow control systems, distillation column and chemical reactors.

631. Fuel Technology I (solid fuel) 3 units (3-0). First Term.

Coal, its formation, occurrence, petrography, methods of sampling, analysis, classification. Recent concept of the chemical constitution of coal. Physical properties of coal, storage and processing of coal with special emphasis on coal washing, blending and deterioration. Coking and non-coking coals. Selection of coal for coking coals in India.

632. Fuel Technology II (Coal carbonisation and liquid fuels). 2 units (2-0) Second Term.

Coal carbonisation processes. Study of design and construction of H.T. coke oven. Factors influencing the operation of coke ovens. Coking properties with special references to metallurgical coke, domestic coke, etc. By-products recovery. Low-temperature carbonisation of coal.

Petroleum : Occurrence, classification and composition, standard tests, Octane and cetane number of fuels. Thermal and catalytic cracking processes, reforming of petroleum hydro-carbons, production of gasoline by polymerization and alkylation of hydro-carbon gases. Petroleum processing in India.

Synthetic liquid fuels and chemicals from coal by hydrogenation and Fischer-Tropsch synthesis. Alternative fuels *e.g.* power alcohol and methane.

633. Fuel Technology III (gaseous fuels). 2 units (2-0) Third Term.

Classification of gaseous fuels, their composition, analysis, calorific value, methods of manufacture, purification and storage. Theory of gasification reactions. Operation and control of producer and water-gas plants. Extensive problem work dealing with mass and energy balances in gasification plants. Recent development on complete gasification of coal with oxygen and steam. Design problems on modern gas generators.

640. Gas Chemical Technology. 2 units (2-0) First and Second Terms.

Elementary composition and physical characteristics of crude petroleum. Chemical composiion of crude oil and its products. Modern methods of separation and analysis of petroleum hydrocarbons. Physical and chemical principles of oil refining relating to deep thermal and catalytic reactions.

Theory of catalytic reactions. Chemical treatment of gas, liquid and solid hydro-carbons. Treatment of gas and liquid hydro-carbons for production of high octane motor fuel and fuel components. Treatment of oil fractions for production of petro-chemicals.

641. Petro-chemical Processes. 2 units (2-0) Third Term.

Development of petrochemical industries in different countries.

Studies on production of petrochemical raw materials, paraffins, olefins, aromatics, acetylenes and synthetic gas by partial oxidation, cracking and reforming, etc. of petroleum feed stocks.

Process details including reaction kinetics, operating variables and special design problems in production of typical petrochemicals for synthetic polymers, plastics, rubbers, fibres, explosives detergents, oxo-compounds, etc.

645. Petroleum Refinery Engineering. 1 unit (1-0) Fiast Term, 3 units (3-0) Second and Third Terms.

First Term

Properties of crude oil and its fractions, their importance for evaluation and designing of refinery equipments.

Characteristics and classification of crude oil and oil products. Evaluation and preparation of crude oil for processing (desalting, dehydration and stabilisation) and designing.

Principles of distillation and rectification as applied to petroleum refinery operations. Distillation of crude and heavy oils.

Second Term

Destructive distillation of crudes. Fundamentals of thermal cracking, thermal cracking under low and high pressures.

Catalytic cracking processes, their theory and factors governing the catalytic cracking process. Typical industrial processes for manufacture of high quality gasolenes and aromatics. Technological schemes of catalytic reforming units.

Destructive hydrogenation of heavy oil residues. Processing of hydrocarbon gases. Desulfurisation of gases. Basic methods of gas fractionation, *e.g.* rectification, absorption and adsorption.

Alkylation of isobutenes with butylene, alkylation of benzene with propylene and ethylene. Polymerisation of butylene and propylene fractions. Hydrocracking and its application for middle distillates.

Third Term

Refining of light oil products involving use of sulphuric acid, alkali and hydrorefining. Refining of lubricants with selective solvents. Deasphaltisation and dewaxing of lubricants. Refining of lubricating oils by adsorbents.

Methods of improving the quality of lubricants with additive agents. Manufacture of special products and utilisation of the residual stock of refining.

650. Combustion Engineering I. 2 units (2-0) Second Term.

Theory of combustion and its applications to problems of design and operation of equipment for efficient utilisation of fuel. Ignition, propagation and stabilisation of flames in gases. Ignition of fuel beds. Radiation from fires, fly ash and fusion. Mechanism of combustion—single droplet combustion and spray combustion.

651. Flame Physics I. 1 units (1-0) Second Term.

Elements of optics as related to flame physics.

Flame processes and their optical properties, with reference to premixed reactants. Kinetic concepts, detonation, flame propagation. Non-steady states, ignition quenching, limits of inflammability. Diffusional flames and high intensity combustion Spectroscopy of flames.

Schiliren, shadow, interferometry and diffraction mapping methods of study of flames, their principles and application to flame study and interpretation of records.

Physical measurements of burning velocity. Flame temperature by sodium line reversal method, two colour method.

Suction pyrometer, pneumatic pyrometer, hot wire method and ionisation method. Flame temperature calculation, measurement of luminosity by Schmidt method. Heat flow meters. Total radiation pyrometer.

652. Petroleum Refinery Equipment Design. 1 unit (0-3).

Estimation of physical properties of petroleum and petroleum products.

Material and energy balances for typical petroleum refinery operations, straight run distillation, thermal and catalytic cracking, reforming and alkylation, etc.

Process and equipment design for various refinery operations.

653. Combustion Engg. II. 2 units (2-0) Third Term.

Mechanism of combustion and design of pulverised coal burners. Study of various fuel burning units. Design and constructions of fuel and electrically heated furnaces used in metallurgical and process industries. Applications of the principles of fluid flow, heat transmission and combustion in furnace design.

654. Boiler Technology I (Boiler Engineering). 2 units (2-0) Second Term.

Design and installation of various types of boilers, economisers, air preheaters, superheaters and desuperheaters. Modern boiler furnaces and feeding mechanisms for burning fuels, blow down technique, back fires and ash disposal. Saturated, superheated and high pressure steam for power generation and process work. Water treatment, corrosion and its prevention.

655. Boiler Technology II (Power Station Practice). 2 units (2-0) Third Term.

Detailed examination of modern power plants. Study of various steam cycles influencing power plant economy, thermodynamics, economic and operating problems. Testing of boilers and heat balance studies. Instrumentation and automatic control in boiler plant operation. Advanced problem work.

656. Steam Utilisation. 1 unit (1-0) First Term.

Distribution of steam in a chemical plant. Power and process steam, principles of steam economy.

661. Engineering Economics. 2 units (2-0) Third Term.

Industrial labour and legislations. Resources and industries of India. National planning. Design, management and economic control of factory. Business Organisation. Organisation structure and management. Cost accounting, principles of costing and accounting. Planning for production. Plant layout. Job evaluation and incentives. Inspection and quality control. Economics of manufacturing alternatives, break even chart, job estimates.

666. Course Project. 1 unit (0-3) Second and Third Terms.

Every student will present a detailed survey including experimental investigation and calculations of an assigned problem and also present a critical review of the same which will be followed by discussions.

667. Fluid Dynamics. 3 units (3-0), First Term.

Elements of boundary layer theory. Mechanics of viscous and turbulent flow. Enegry balance. Dimensional analysis for fluid flow problems. Flow of non-Newtonian suspensions.

Particle dynamics.

Two phase and three phase flow. Fixed, fluidised and moving beds. Principles of pneumatic and hydraulic conveyance. Laboratory work.

(For Mineral Engineers)

668. Fluid handling. 2 units (2-0), Second Term.

Handling of homogeneous fluids and slurries, pumps, compressors, blowers, ejectors, etc., their design, construction and operation. Thermodynamics of fluid flow. Laboratory work.

(For Mineral Engineers)

669. Principles of Heat and Mass Transfer. 2 units (2-0), Second Term.

Mechanism of heat transfer. Conduction. Fourier's law, steady state conduction, log mean areas, conduction in unsteady state. Convection film concept, overall coefficients. Dimensional analysis. Radiation. Kirchoff's law. Design calculation for heat exchangers, heaters, etc. Pyrometry. Principles of diffusion and molecular transport properties. Drying. Extraction.

(For Mineral Engineers)

670. Advanced Mineral Dressing. 3 units (3-0).

Unit operations used in comminution and mechanical separation of minerals—physical principles involved and application to design of equipment. Principles relating to particle size distribution, surface area measurement, fracture of material and energy distribution during comminution. Design and construction of various comminution and screening equipments.

Application of hydrodynamic behaviour of solid and liquid systems and solid, liquid and gaseous systems. Unit operations covering classification, gravity concentration, hydrocyclones, etc.

Dust separation—gravitational and inertial separation, cyclones, filtration, electrostatic separation etc. Jigging and film sizing—their principles and design considerations. Magnetic and electrostatic separation.

Principles of flotation and its application to typical systems. Physical variables affecting design and operation of continuous flotation process.

Dewatering processes. Filtration, batch and continuous filtering equipment.

Theories of filtration and washing. Centrifuges.

Briquetting and pelletisation.

(For Mineral Engineers)

671. Mineral Dressing Laboratory. 2 units (0-6), First Term.

Laboratory experiments on the topics covered in ChE 670.

(For Mineral Engineers)

672. Coal Preparation. 2 units (2-0), Second Term and 3 units (3-0), Third Term.

Origin and distribution of mineral matter in coal. Washability curves. Meyers curves. Grindability index of coal. Mechanical beneficiation, classification by differential settling rate. Heavy medium separations. Principles of solid suspensions. Coal jigs and other types of washers. Design calculations on heavy medium washers, jigs and hydroclones as applied in coal washing. Efficiency of washing. Tromp and other efficiencies. Laboratory work and Project Report.

(For Mineral Engineers)

673. Surface Phenomena. 2 units (2-0), Second Term.

Physico-chemical properties of interface and their utilisation in mineral dressing processes. Theory of surface tension. Theory of insoluble film at interface, surface-free energy of solids. Theory of physical and chemical adsorption. Application of these theories to frothing, collection, stabilisation of mineral suspensions.

(For Mineral Engineers)

674. Process Control. 1 unit (1-0), Third Term.

Control systems, block diagrams and functions, mathematical formulation of control problems. Devices for measurements and control of variables in mineral dressing operations like pressure, flow, concentration, sizes, etc.

(For Mineral Engineers)

675. Plant Design and Ore Processing. 1 unit (1-0), Second Term and 4 units (4-0), Third Term.

Ore handling equipments. Conveyors and elevators. Pneumatic and hydraulic transport. Storage stockpiling of materials. Design of mineral dressing plants, selection and layout of major equipments. Cost analysis. Economics of mineral benefication.

Study of major mineral benefication plants in India. Project work on Plant design.

(For Mineral Engineers)

676. Applied Heat and Mass Transfer in Mineral Engineering. 2 units—Third Term.

Dewatering, drying, humidification, dehumidification, chemical extraction, electrochemical concepts, cynidation, leaching, ion exchange, continuous and batch processes.

Roasting, sintering, calcination, chlorination etc., their particular application to gold and uranium bearing materials.

The following two subjects will be taught in the 2nd year of P.G. (ChE) course for which there is no examination.

(1) Recent Developments in Chemical Engineering. Recent developments in the field of mass, momentum and energy transfer, rockets and rocket fuels, nuclear reactors, new experimental techniques, etc.

(2) Computer Programming :

Fortran programming techniques and application to chemical engineering problems.

(For Mineral Engineers)

CIVIL ENGINEERING (CE)

601. Advanced theory of Structures. 2 units (1-2), First Term.

Analysis of Statically indeterminate structures by classical and numerical procedures. Continuous beams, frames and arches. Response of Beams and frames to dynamic loading. Analytical, numerical and graphical procedures for calculating deflection of frames. Secondary stresses.

602. Advanced Strength of Materials. 2 units (2-0), First Term.

Relationship between stress and strain, strain energy, rupture, yield and fatigue, theories of failure, pressure between elastic bodies, bending of beams, torsion, beams on elastic foundation, stresses in thick cylinders.

603. Stability of Structures. 2 units (2-0), Second term.

Buckling of columns, Stability of built up columns and column with varying stiffness, lateral buckling of beams, stability of frame works, effective length of compression members in trusses, stability of web plate girder, buckling of plates.

604. Experimental stress analysis. 2 units (1-2), Third Term.

Introduction to some of the common experimental methods of analysing stress distributions, photo elasticity, Eney's & Beggs's deformeter, electrical resistance strain gauge, the brittle lacquer method.

605. Concrete Technology. 2 units (1-3) First Term.

Admixture and addition in concrete ; design of concrete mixes,—brief review of early theories, compressive strength laws, theories of aggregate grading, modern methods of mix design, light weight concret, quality control of concrete—causes and measurement of variation control procedures, non-destructive testing of concrete.

606. Advanced Reinforced Concrete Design. 2 units (1-2) First Term.

Review of elastic design methods. Creep and shrinkage phenomena and problems related thereof ; Ultimate load method of design of reinforced concrete members and structures ; R. C. arches.

607. Steel Design I. 2 units (2-0) Second Term.

Elastic and plastic design principles as applied in design of multistoreyed buildings, industrial building and bridge members ; design of rigid frames by plastic theory including influences of secondary effects (Viz. shear, axial force, local buckling etc.,) ; current design specifications for steel structures other than bridges—discussion and criticism, design of tall buildings for wind and earthquake forces.

608. Steel Design II. 2 units (2-0) Third Term.

Discussion and criticism of current design code for steel bridge structure, basic design principles for plate girder—type, truss—type and long span bridges, design of bridge bearings, design specifications for light-gauge steel structures, light-gauge sections and their use ; Aluminium alloys.

609. Soil Mechanics and Foundation Engineering I·3 units (2-3) First Term.

Comprehensive study of physical characteristics of soils, basic principles of soil behaviour under stress applications, Flow through soils, Earth pressure theories, Soil Laboratory exercises.

610. Soil Mechanics and Foundation Engineering-II. 2 units (2-0). Second Term.

Sub-surface soil conditions ; Selection of the type of foundation ; settlement analysis, principles and design of foundations—spread footing, rafts and piles.

611. Prestressed Concrete I. 2 units (2-0) First Term.

Methods, materials and allowable stresses ; elastic design of simple beams for flexure and shear ; critical span ; losses in prestressing force ; Design of anchorage zones ; composite beams ; General design considerations.

612. Prestressed Concrete II. 2 units (2-0) Second Term.

Analysis and design of indeterminate structures, concordant and transformed profile, secondary moments, ultimate load method of design.

613. Shell Structures I. 2 units (1-2) Second Term.

Differential equation of circular cylindrical shells, review of various theories, Edge disturbances, Extension to the analysis of cylindrical containers ; shell reinforcements, approximate design methods.

614. Shell Structures II. 2 units (1-2) Third Term.

General theory of thin elastic shell of double curvature, differential equations ; comparison with cylindrical shells, membranse theory and its application to special surfaces.

615. Bridge Engineering I. 2 units (1-2) Second Term.

Review of Bridge Codes (I.R.C. & I.R.S.) ; bridge foundations (well, caisson, pile and open). piers and abutments, bridge approaches, bridge economics, bridge bearings.

616. Bridge Engineering II. 2 units (1-2) Third Term.

R.C. Superstructure (Slab and different types of girder bridges —Cantilever and continuous spans—Arch bridges) prestressed concrete bridges ; introduction to long span steel bridges and composite structures ; Launching and erection of bridge spans.

617. Bridge Engineering III. 2 units (1-2) Third Term.

Steel superstructure, cantilever and continuous spans arch bridges, long span steel bridges, fabrication and erection problems.

(For D.I.I.T. Structural Steel Design)

618. Advanced Structural Analysis. 2 units (1-2) Third Term.

Application of matrix methods to structural analysis of indeterminate structures, grid-works & space frames.

(For D.I.I.T., in Structural Steel Design and Concrete Technology and Design)

619. Industrial Buildings 2 units (2-0) First Term.

Bunkers, silos, water tanks and containers, Gantries, large span roofs, High strength bolts and its design principles and uses in Industrial Buildings. Trussed roof with monitors ; Design of economic roofing for Industrial buildings, factory bays etc. Design of cantilever pseudo floor construction and Composite construction used in Industrial buildings. (for D.I.I.T. in Struct. Steel Design).

620. Design and Drawing. 2 units (0-6) All Terms.

Guided design and preparation of detailed drawings for specific structures pertaning to subjects CE 606, CE 611 & 612, CE 613, 614 and CE 615 and 616.

(For D.I.I.T., in Concrete Technology and Design)

621. Fluid Mechanics I. 3 units (2-2) First Term.

Principles of Flow & Generalised Equations of Motion, Principles of Energy, Continuity & Momentum ; Circulation & vorticity ; Irrotational motion, Velocity Potential, Stream Function, Theory & Use of Flow net, Force Potential, Problems of Afflux.

622. Fluid Mechanics II. 3 units (2-2) Second Term.

Dimensional Analysis & similitude, Typical applications ; One Dimensional Method of flow Analysis, Fundamental Equations of viscous Flow, Navier-Stokes equations, Problems in Laminar motion ; General Concept of Fluid Turbulence, Momentum transport & Reynolds Stresses, Mixing length & velocity distribution in Turbulent Flow ; Boundary Layer concepts.

623. Fluid Mechanics III. 3 units (2-2) Third Term.

Surface resistance, Universal Laws of Resistance, Resistance in Smooth & Rough Pipes, Boundry Layer Separation, Vortex, Trail & Form Resistance, Drag characteristics of Immersed bodies, Conformal Transformations, Rankine Bodies, Kutta Joukowsky Profiles ; Elementary theory of Lift & Propulsion, Lift & Drag of Aerofoil, Sediment Transportation.

624. Dams and Dam Construction I. 3 units (2-2) First Term.

River Valley Project Planning, Multipurpose Projects, Gravity Dams low and high, Stability analysis, Gravity analysis, Twist analysis, Spillways, Gates, Openings in Dams, Grouting, Contraction Joints, Low Dams on Permeable foundations, Principles of design of regulators, Dam appurtanances, Outlet structures.

625. Dams and Dam Construction II. 3 units (2-2) Second Term.

Arch Dams—Design by cylinder theory—Types and classifications. Trial load method for design of arch dams, Double curvature arch dams.

R.C. Buttress Dams—types and classification. Design of Flat Slab type Buttres Dam, Hollow gravity or pier head Dams, Temperature Control of Concrete, Masonry versus concrete for Dams, River Diversion and Coffer Dams, Instrumentation in Concrete Dams.

626. Dams and Dam Construction III. 3 units (2-2) Third Term.

Earth Dame—Stability of slopes, design for seepage flow, other design criteria, Uplift pressure and settlement studies.

Rock fill Dams—classification and design criteria, Timber and Steel dam, Spillways—Special Tpзes—Siphon, Shaft, Chute and side channel types, criteria for the choice of the type of a Dam.

627. Water Power Engineering I. 3 units (2-2) Second Term.

Water Power development, Market & Load Studies, Types of hydro plants. Planning hydro-electric projects, Economic implications. Reservoir operation. Power House layouts, Civil Engineering Works, Hydraulic machines, Electrical Machines, Plant accessories, auxiliaries.

628. Water Power Engineering II. 3 units (2-2) Third Term.

Intakes, Tunnels, Penstocks, High pressure valves, Relief valves. Draft tubes, Tailraces, Water hammer, Surge tank, pressure control, control & Governing Design of hydropower facilites, single & Co-or-dinated plants Switch yards & Transmission Towers.

629. Advanced Hydraulics I. (Applied Hydrology). 3 units (2-2). First Term.

Climate, Precipitation, Measurement & analysis of data, Storm studies, & Transposition ; Runoff, Evapo-transpiration, Infiltration, stream flow—hydrographic analysis, Runoff distribution, unit hydrograph.

630. Advanced Hydraulics II (Hydraulics of Open channels). 2 units. (2-0). Second Term

Open channel flow, Types & states of flow, Velocity & pressure distribution, uniform flow, Establishment, Design of channels & water courses, Gradually varied flow, Back water & Drop down curves, Gravity waves, Hydraulic Jump, Surges, Tidal Bore, River model Techniques.

631. Advanced Hydraulics III (River and Canal Structures). 3 units (2-2). Third Term.

Weirs and Barrages on pervious foundations, Design, Khosla's Theory, Canal structures : canal intakes & Head Regulators. Drops & flumes, Navigation locks, River Diversions during construction, spillways & stilling Basins—Hydraulic design, River and Canal protective works, lining, Rivetment & Pitching, spurs & Groynes, Scour & silting around River & canal structures.

632. Advanced Hydraulic Laboratory. 1 unit (0-3). First Term.

Discontinuous flow problems in open channels, Gradually varied flow problems, Flow studies by Analogy models ; seepage flow problems. Model studies of flow over spillways, Weirs, Transitions, Gravity Waves, use of various hydraulic measurement instruments, steady or transient conditions.

633. Irrigation and Drainage. 2 units (2-0). Second Term.

Land classification. Types of crops & water requirements ; quality of water, special irrigation methods, Tubewell and sprinkler irrigation, Design exercise, Arid zone problems.

Land Drainage—Surface & subsurface drainage, Design of drainage system, Tidal outfall works, Land reclamation.

634. Flood control. 3 units (2-2). Third Term.

Estimation of spillway design storm, spillway design flood, flood routing through reservoirs & channels, Reservoir operation & flood forecasting, Flood protection measures, & practice, Reservoir silting, Flood control & multipurpose projects planning, Flood damages and benefit studies.

635. Construction. 3 units (3-0). Third Term.

Earth moving equipments, Quarrying & Transport, Concreting plant, Drilling, sheet piling & cofferdam—construction, Caisson & Well sinking, underwater construction problems, Tunnelling, works organisation, construction schedules & economics.

636. Hydraulics Laboratory I. 2 units (0-3). First Term.

Orficers and Mouthpieces—Notches and weirs—Pitot tubes and current Meters—Ventury Meters and Orifices Meters—Experiments on pipe Friction Losses.

(For D.I.I.T. in Non-Linear Mechanics)

637. Hydraulics Laboratory II. 2 units (0-3). Second Term.

Analogy Model Studies of two and three Dimensional Flows—Flow through porous Media—Open channel Flows : Gradually varied flow, Rapidly varied flow and Hydraulic Jump, Energy Dissipation—Gravity waves—Hydraulic Models.

(For D.I.I.T. in Non-Linear Mechanics)

638. Water Power Engineering. 3 units (2-3) First Term.

Types of Hydro Power plants. Reservoir Capacity, Design of Penstock, Anchor Block, surge tank and forebay structures. Types of hydraulic turbines and their characteristics. Turbine governors and governing. Safety devices. Testing of turbines—General principles of design of power house and turbine foundatihn.

641. Advanced Soil Mechanics I. 3 units (3-0) First Term.

Physicals and mechanical properties of soils, their identification and classification. Capillary phenomenon and soil moisture. Soil compaction, moisture—density strength relationship.

Permeability, Darcy's law, Flow net and their properties Seepage problem in dams, uplift and stability, piping and filters, drainage problems, Ground water flow towards wells.

642. Advanced Soil Mechanics II. 3 units (3-0) Second Term.

Theory of consolidation, shear strenth of soils, earth pressure theories, stability of slopes, elastic stresses in soil mass, soil stabilisation.

643. Foundations I. 2 units (2-0) Second Term.

General survey, different exploration methods, sampling and disturbances, sampling tools and equipments, stress strain characteristics of disturbed and undisturbed soil samples, special problem associated with sampling—ground water, proximity of existing foundations, exploration data and interpretation of results.

644. Foundations II. 3 units (2-2) Third Term.

Bearing capacity of soils, planning of foundations, settlement calculations, design of foundations, spread footings, rafts, piles, caissons and wells, design of conduits and tunnels, Foundation construction methods.

645. Soil Mechanics Laboratory I. 2 units (1-3) First Term.

646. Soil Mechanics Laboratory II. 1 unit (0-3) Second Term.

Laboratory testing of physical and mechanical properties of soils.

651. Design of Highways I. 2 units (2-1) First Term.

General features of highway design, vehicle characteristics affecting road design, traffic conditions affecting road design, Grades, curves, camber and super-elevation. Intersection at grade and grade separations, drainage of roads, roadside improvements.

652. Design of highways II. 2 units (2-1) Second Term.

Structural design of pavements, critical review of the different methods of design of flexible and rigid pavements.

653. Design of Highways III. 4 units (2-4) Third Term.

Highway materials, Geology of road aggregates, general discussion on the properties, testing and use of bituminous and non-bituminous materials, soils and aggregates, mix design methods, technique of soil stabilisation, laboratory testing procedures and exercises.

654. Transportion Planning and Economics I. 2 units (2-1) First Term.

Planning and location of highways, Historical development of Highways, highway system in India, road statistics, benefits of improved highways, financing of highways, Central road fund.

Reconnaissance, principles of photogrammetry, and its use in the location of highway routes, preparation of highway projects.

655. Transportation planning and Economics II. 2 units (2-1). Second Term.

Urban roads, layout of roads in built-up areas, choice of pavement types and their relative economics. Treatment of intersection ; drainage problems, traffic control, traffic surveys, street lighting, road furniture.

656. Transportation Planning and Economics III. 2 units (2-1). Third Terms.

Airports, growth of air transportation and development of airports, present air craft types and characteristics, classification of airports, Survey preceding airport location, studies of a proposed site, layout and design of an airport and its phased development, airport lighting system and control, operation, choice of pavement types, grade requirements and earthwork calculations, surface and subsurface drainage, air-port buildings and facilities.

657. Municipal Engineering. 2 units (1-0) Second and third terms.

Introduction and Scope of the subject

Ground water and surface water resources, their utilisation—estimating demand for water-treatment of water—distribution system—consumption.'

Sewerage and sewage disposal estimation of quantities of flow—layout of sewerage system and design criteria sewage treatment plants.

Refuse collection and disposal—provision of services in industrial estates.

(For City Planners)

658. Track Surveying and Overhead Equipment. 2 units (2-0) Second Third Terms.

Theodolite, curve-setting, transition curves, route surveying, longitudinal and cross-sections, and earthwork measurements.

Design of overhead and supporting equipment, wind effects overhead structures, and foundations.

(For Electrical Engineers)

660. Elasticity and Plasticity. 2 units (2-0).

Analysis of stress and strain, Field equation, Two dimensional problems, Application of complex variable methods, Torsion and flexure, Variational principles and their application, Boussinesq solution for concentrated loads, Application to Engineering problems. Bending of plates, Elastic waves, Non-linear elasticity, Deep Beams and their applications. Stress space, stress strain relations for strain hardening materials, Elastic plastic transition, Ideal plasticity, Limit analysis, criteria of flow and fracture, Homogeneous plastic flow including strain hardening. Application of plastic theory to Engineering problems.

661. Water supply and Design. 2 units (1-2) First and Second Terms 3 units (2-2) Third Term.

Water Supply systems—estimate for the requirements of water—the development and conservation of sources of water supply—Ground water—yield and development—Design, specification and construction of intake works, storage works, pumping stations, etc. Transmission and distribution of water supply to buildings—Principles of economic design.

Standards of water quality for public and industrial use-Examination of water and their significance—Principles of sedimentation—chemical treatment, filtration, aeration, disinfection, destruction of aquatic growths and removal of odours tastes. Corrosion control and incrustation control, softening, Removal of iron and manganese, objects methods of treatment. Design and construction of sediment and coagulation tanks, slow and rapid sand filters, aeration, ferrisation, softening and disinfection units.

662. Sewerage and Design. 2 units (1-2) First and Second Terms : 3 units (2-2) Third Term.

Sewerage systems—Estimate of waste waters—Flow in sewage and their appurtenances —layout and hydraulic design of sewerage systems—Design of sewage pumping station and equipment—Construction and maintenance of drains and Sewers. Drainage of buildings, Composition of Sewage—Examination of waste water and their significance—B.O.D., Sedimentation of Sewage, chemical treatment, biological flocculation and precipitation of water —suldge treatment and disposal—Self purification of water—Disposal by dilution and irrigation gas analysis—industrial waste-water disposal.

663. General Sanitation. 1 Unit (1-0) Second Term.

Refuse collection and disposal including incineration, Heating, Ventilation, air conditioning, dust, smoke and noise control.

Illumination—natural and artificial, street lighting Milk and Food Sanitation.

Pest Control.

Industrial Hygiene.

Rural Sanitation problems—including composting.

Market, School, Eating Establishments, Slaughter houses, Swimming Pool, disinfection etc.

Sanitary Survey & reporting.

Malaria Engineering.

Principles of Town planning and Housing.

664. Epidemiology. I unit (1-0) Third Term.

Origin and spread of more common diseases such as Malaria, Small-pox, Cholera, Typhoid, Plague etc. Relation between environment and health. Port health and quarantine.

665. Sanitary Engineering Laboratory, 1 unit (0-6).

Mineral and Routine analysis of water and sewage.

Treatment plant control experiments.

666. Pumping Machinery. 2 units (2-0) First Term.

General requirements—theory of suction lift and energy expand in pumping—various types of pumps design, utility and limitations, choice of pumps—pump control—electric motors-location of motors and control—location of pumping station—surge control operation and maintenance.

667. Engineering Seminar I. 1 unit (1-0) First Term.

668. Engineering Seminar II. 1 unit (1-0) Second Term.

669. Engineering Seminar III. 1 unit (1-0) Third Term.

Literature studies on Industrial waste, Biological waste treatment and unit processes like settling, filtration etc.

670. Principles of Economic Construction. 1 unit (1-0) Second Term.

General problems, Methods of comparing costs, capitalisation and annual expenses, Methods of calculating depreciation. Income, return and yield—Financing Endowment principles, Engineering economic analysis—Economic comparison of manual & Mechanical labour, Economic size of pipes—Economic characteristics of power using equipment and pipe line—pipe net work—Cost of construction, and treatment for water supply and sewage works.

671. Structural Design and Drawing I. 2 units (0-4) Second Term.

Guided design and drafting assignments as related to Steel Design (CE 607).

(For D.I.I.T. in Structural Steel Design)

672. Structural Design and Drawing II. 2 units (0—4) Third Term.

Guided design and drafting assignments as related to Steel Design II (CE 608).

(For D.I.I.T. in Structural Steel Design)

681. Hydrographic Surveying. 2 Units (1-2) First Term.

Shore line and stream survey. Determination of shore line and high and low water marks. Ocean shore line survey. Running survey from ship. The sextant—description, principles and use. Subsequeous survey—Surveys for docks and harbours. Soundings-sounding lines and rods. Taking and fixing positions of soundings—the three point problem. Location of point by simultaneous observations with two theodolites. Soundings in rivers or narrow waters. River surveys. Tide gauges—automatic tide and river gauges. Signals, Beacons and Buoys. Electric soundings—Echo soundings. Radio acoustic method of locating ship. Locating ship by radar. Plotting of hydrographic maps. Elementary theory-aerial photography—Reductions of levels to true mean sea level.

Principles underlying piloting and celestial navigation. Study of piloting including use of compass, log fathometer. Use of Navigation charts and light lists. Use of Greenwich Hours angle for time data. Latitude sights. Line of position sights. Use of chronometer and sextant as applied to navigation.

682. Wind Waves and Tides. 3 Units (2-2) First Term.

Characteristics of ocean waves. Generation of waves by wind. Oscillatory waves. Translatory waves. Conoidal waves. Trochoidal waves. Effect of boundary resistance on waves. Effect of variable channel cross section and sloping bed on waves. Transformation of waves in Shallow water. Breaking of waves. Reflection, diffraction, refraction and wave induced currents. Open channel surges. Surges in harbours and closed basins. Wave forecasting and hind casting. Wave measuring apparatus. Model experiments.

Tides, Pulse of earth. Equilibrium theory. Tidal theory. Analysis and Prediction of tides. Tidal streams. Tidal energy.

683. Harbour Engineering I. 3 Units (2-2) Second Term.

Form of accommodations—tidal versus dock accommodation. History of early docks. Design of tidal accommodation. Factors affecting depth and size of harbours in relation to ships, trade etc. Docks, quays, turning areas, tidal basins etc. Dock and wharf walls. Stability analysis of sheet pile wharves. Wharves on clay foundations. Design and construction of jetties, slipways, drydocks and graving docks. Pumping and drainage machinery at dry docks.

684. Harbour Engineering II. 3 Units(2-2) Third Term.

Design and construction of Seawalls, breakwaters and moles. Locks and Lockgates—types of gate anchorages and other fittings, gate operating machinery, principles of design. Sea canals—features of Suez, and Panama canals. Location, design and construction of lighthouse structures. Dredging-purpose, types of dredgers, disposal of dredged material and cost of dredging. Techniques of underwater construction.

685. Port Facilities and Administration. 2 units (2-0) Third Term.

Layout and facilities of ports with special reference to type of cargo. Dock and wharf buildings—Transit sheds, ware-houses and other buildings. Cargo handling—appliances and methods. Transportation within the port boundaries. Factors making for rapid turn around and reduction of cargo handling costs.

Organisation and Management—Natural importance of harbours. Management and working of harbour undertakings of State ownership, municipal ownership, company ownership, port commissioner or port trustee ownership. Advantages, and disadvantage Internal organisation—Functions in board and out-board of ships, piloting, dredging, buoying, dry docking, customs etc.—Function and duties of various departments.

Administration—Indian Practice. Continental practice. Port of London system, London and Indian dock system. System of small ports. Department and organisation to deal with air, and inland transport. Importance of separation of engineering and general stores. Port planning and port charges, Accountancy and cost keeping. Dock labour. Passenger traffic working—safety measures, hygiene, comfort etc.

686. Seminar in Harbour Structures. 2 Units (0-2) Third Term.

Case histories and current advanced topics in harbour engineering.

ELECTRICAL ENGINEERING (EE)

611. Advanced Machine Theory. 2 Units.

Synchronous Machines : Generalised machine analysis. Machine constants. Effects of saturation. Power-angle characteristics. Damper circuits. Sudden short-circuit of alternators. Transformers : Multi-winding transformers. Unbalanced operation. Transient phenomena. Induction Machines: Application of generalised machine theory. Unbalanced operation. Transients. D.C. Machines : Transients in d.c. machines.

Mechanical forces on short-circuit. Design of magnetic circuit and windings. Harmonics and their elimination. Deep-bar and multi-cage rotor induction machines. Recent developments. Application of computers in solving machine problems.

612. Power System Stability. 2 Units, (Second and Third Terms).

Basic concepts of stability. Stability criteria, steady-state and transient power limits of synchronous machines. Effects of saliency and saturation. Swing equation and its solution. Methods of improving stability. Stability of drives. Excitation systems.

613. Electromagnetic Fields. 2 Units.

Fundamentals of magnetostatics. Scalar and Vector Potentials. Boundary surfaces. Permeance curves. Field-plotting. Solution of Laplace's and Poisson's equations. Numerical and graphical methods. Time-varying fields. Application to performance of machines.

614. Tensor : Analysis of Electrical Machines. 4 Units, (Third Term).

The algebra of N-way Matrices and compound n-Matrices. Transformation theory and the laws of transformation. Symmetrical components. Phase-shift transformers. Maxwell's Theory. Polyphase machines. Speed control systems. Small oscillations and hunting of machines.

615. Energy Conversion. 2 Units, (First and Second Terms).

Basic science of energy conversion. Thermo-electric and thermionic energy convertors. Magneto-hydro-dynamic energy conversion. Solar and Fuel cells. Nuclear energy and power generation.

616. Principles of Automatic Control. 3 Units.

Review of linear system analysis. Multiple-loop and multiple-input feed-back control systems. Effects of non-linearity on the performance of control systems. Transducers, signal-conditioning equipments, and machines used in control systems. Automatic voltage control of generators and speed control of motors. Automatic control of power plants.

617. Electrical Engineering Materials. 4 Units (First Term).

Insulating materials and gaseous dielectrics and their behaviour in static and alternating fields. Magnetic properties of materials. Conductors and semi-conductors. Junction rectifiers and transistors.

619. Laboratory. 2 Units.

Experiments covering 611 to 617.

621. Control System I. 3 Units.

Control system and block diagram representation. Transfer functions of open and closed loop systems. Transient and frequency response. Stability. Compensation networks. Non-linear systems. Analysis by numerical, graphical, and analytical methods. On-off systems.

622. Control System II. 3 Units.

Behaviour of second order systems. Root loci-applications to the analysis and synthesis of systems. Describing function analysis to non-linear systems. Z-transform. Sampled-data systems.

623. Control System Components. 3 Units.

Measuring and telemetering techniques for electrical and non-electrical quantities. Signal transducers and auxiliary circuitry. Standardisation. Transient and steady-state performance characteristics of magnetic and rotating amplifiers. D.C. and A.C. servomotors. Tacho-generators. Mechanical, pneumatic and hydraulic components. Programme controllers.

629. Laboratory. 2 Units.

Experiments covering 621 to 623.

631. Advanced Machine Theory. 2 Units (First and Second Terms).

Synchronous Machines : Generalised machine analysis. Machine constants. Effects of saturation. Power-angle characteristics. Damper circuits. Sudden short-circuit of alternators. Transformers : Multi-winding transformers. Unbalanced operation. Transient phenomena. Induction Machines : Application of generalised machine theory. Unbalanced operation. Transients. D.C. Machines : Transients in d.c. machines.

632. Power System I. 4 Units.

Power System Analysis : Network theory and equivalent circuits. Symmetrical and other components. Fault analysis. Self and mutual impedances of parallel conductors. Bundled conductors. Transmission circuits with distributed constants. Equivalent circuits for parallel transmission lines. Cable impedance and characteristics.

Power Transmission and Power System Stability : Generalised theory of power transmission. Circle diagrams. Power limits of synchronous interconnector. Regulation and losses of transmission lines. Basic concepts of stability. Stability criteria. Steady-state and transient power limits of synchronous machines. Effects of saliency and saturation. Swing equation and its solution. Methods of improving stability. Stability of drives. Excitation systems. Application of computers in solving power system problems.

633. Power System II. 2 Units (Second and Third Terms).

Interconnection of power systems and load flow. Voltage, load, and frequency control. Phenomena of power system synchronisation. Supervisory control and load despatch. Relays, their construction, characteristics, and application. System protection and instrumentation. Principles of high-voltage a.c. and d.c. transmission. Current converters. Economic aspects of high-voltage transmission systems. Determination and application of load graphs. Choice of plant and economical aspects of plant design, operation, and maintenance. Project planning and system layout design. Tariffs.

634. High-voltage Engineering. 4 Units (Third Term).

Generation of high direct, alternating and impulse voltages and their measuring techniques. Origin, characteristics and behaviour of travelling waves. Lightning phenomena. Transients due to switching. System over-voltages and protective devices. Grounding of power system neutrals. Insulation coordination. Coordination of power and communication networks. Corona and its effects. High-voltage switchgear. Behaviour of arc and methods of extinction. Contact phenomena. Circuit-breaker testing.

635. Energy Conversion. 2 Units (First Term).

Basic science of energy conversion. Thermo-electric and thermionic energy converters. Magneto-hydro-dynamic energy conversion. Solar and Fuel cells. Nuclear energy and power generation.

636. Principles of Automatic Control. 3 Units.

Review of linear system analysis. Multiple-loop and multiple-input feed-back control systems. Effects of non-linearity on the performance of control systems. Transducers, signal-conditioning equipment and machines used in control systems. Automatic voltage control of generators and speed control of motors. Automatic control of power plants.

639. Laboratory. 2 Units.

Experiments covering 631 to 636.

641. Fundamentals of Electric Traction. 3 Units (First Term).

Types of electric traction. Adhesion. Mechanics of train movement. Traction motors and control. Traction drives. Weight transfer. Estimation of speeds. Multiple-unit operation. Diesel-electric traction.

642. Electrical Equipment. 2 Units.

Transformers : Multi-circuit transformers. Excitation and impedance characteristics. Transient phenomena. Mechanical forces. Thermal characteristics. Unbalanced operation. Design of transformers. Traction Motors and Auxiliary Machines : Transients in traction motors. Converters. Rotating amplifiers. Design of traction machines. Rectifying Equipment : Mercury—arc rectifiers, ignitrons, silicon rectifiers and inverters.

643. Power Supply. 2 Units.

Train operating charts. Calculation of maximum demand, energy consumption and load-factor. Economic calculations of supply systems. Protective relays. Conduction properties of rails and pantographs. Earth-return. Protection of underground installations against corrosion. Design and spacing of sub-stations. Supervisory control.

644. Electric Locomotives. 2 Units (Second and Third Terms).

Stability of electric locomotives. Vibrations. Oscillations of traction drive gear. Interaction between wheels and rails. Dynamics of overhead contact wire. Performance and rating tests on electric locomotives. Application of computers for solving traction problems.

645. Signalling. 2 Units (Third Term).

Outline of the principles of block system and colour signalling such as track circuits, interlocking methods and automatic block signalling. Automatic train control.

646. Principles of Automatic Control. 2 Units.

Block diagram representation of control systems. Transfer function of open and closed-loop systems. Transient and frequency response. Stability analysis. Root-locus techniques. Compensation. Analysis of non-linear systems. Principles of automatic starting, braking and control of traction motors. Layout of power and control circuits. Speed control of traction motors.

649. Laboratory. 2 Units.

Experiments covering 641 to 646.

691. Utilisation of Electric Power. 2 Units (Second Term).

Transformers, motors and motor starters. Measuring instruments. Distribution and utilisation of power in chemical plants.

(For Chemical Engineers).

692. Electrical Technology. 2 Units.

Circuit theory, measuring instruments and measurements. Principles of operation of electrical machines and transformer.

(For Industrial Physicists).

ELECTRONICS AND ELECTRICAL COMMUNICATION ENGINEERING (Comm)

601. Fields and Waves. 4 Units, First Term.

Solution of static electric field problems—Laplaces equation, Graphical method, complex potentials. Concept of electric and magnetic sources, current sheets. Electromagnetic potential functions. Study of plane waves. Reflection and refraction at a plane surface. Uniqueness theorem, Duality principle, Babinet principle, Image theory, Equivalence principle, Induction theorem, Reciprocity relations, Reaction concept ; illustrations of above. Wave transformation from one co-ordinate system to another. Scattering of waves for simple problems. Radiation—Kirchhoff's method, retarded potentials, multipole expansion. Numerical methods in electromagnetic problems.

602. Circuit Theory. 4 Units First Term.

Network matrices and topology, generalised network equations ; Applications of Fourier Integrals and Laplace Transforms including signal analysis and transmission. Transient solutions including Transmission lines and filters : Convolution Integral—impulse method of solutions, Z-transforms, numerical techniques : Four terminal networks—matrices : Network functions, Nyquist and Bode plots, approximations, integral relations : Realizability criteria : Simple synthesis of immittances and transfer functions.

603. Electronic Control and Servomechanism. 3 Units, Second Term and 4 Units, Third Term.

Basic theory of automatic control, Servo elements and their equivalent networks. Block diagram analysis. Different types of servo amplifiers and their theories of operation. Magnetic amplifier. Some typical examples of electronic control, *e.g.* speed control of motors. Welding control, temperature control etc.

A.C. and D.C. servomechanism. Different methods of servo analysis. Stability considerations. Servo compensation. Root locus and design in the S-plane. Control system synthesis. Statistical considerations in servo design.

604. U.H.F. and Microwave Technique. 3 Units, Second Term. 4 Units, Third Term.

Guided wave propagation—analysis of rectangular circular, coaxial, elliptic, biconical, helix, dielectric rod and slab, radial and surface wave waveguides. General analysis of cylindrical waveguides. Model expansion. Alternative mode sets—its use. Resonators—modes, frequencies, and Q. factor. Concept of transverse resonance—ridged waveguide. Orthogonality of fields. Special parallel—plate linew *e.g.* microstrip. Perturbational and Variational methods. Rumsey's reaction concept—its use. Network formulation of a wave-guide circuit—analysis of one and two-port microwave networks. Periodic guiding structures, space harmonics. Artificial dielectrics, Kirchhoff—Huygens principle, Radiation from an aperture—horn, paraboloid and metal lens. Radomes, Scanning methods.

605. Communication Theory. 3 Units, Second Term.

Information and Entropy : Properties of Discrete signals—optimum coding methods, intersymbol influence ; Code capacity, Language capacity and Channel Capacity : Message through noisy Channels, Redundancy—error correcting codes ; Bandwidth and speed of signalling, sampling theorem and corollaries ; signalling speed ; power requirements, error probability and threshold. S/N ratios in digital systems ; Continuous signals—properties of ergodic ensembles and random noise, Entropy, Rate of transmission and capacity. Information efficiency in analogue and digital modulation systems—comparisons.

606. Semiconductor Electronics. 3 Units, Second Term.

Electronic properties of semiconductor materials : energy distribution, Fermilevel ; current flow in semiconductors ; theory of p-n junctions ; thermoelectric, optical and magnetic effects ; surface properties ; Semiconductor devices ; semiconductor diodes ; SCR ; junction transistor—direct current theory and small signal theory ; noise considerations ; transistors in high frequency and switching circuits ; special structures of transistors ; tunnel diodes and related devices, other semiconductor devices.

607. Active Networks. 3 Units, Second Term.

Active elements—negative impedance converters, gyrators ; Two-port networks—matrices, signal flow graphs, root loci, stability and physical realizability ; Feedback theory, synthesis of Feedback amplifiers and serve systems—single loop and multiloop : Design of Pulse amplifiers ; bandpass and wideband amplifier, D.C. amplifiers. Nonlinear and Time varying networks.

608. Audio Engineering (Electives). 3 Units, Third Term.

Vibrating systems—uniform strings, bars and membranes, Plane and spherical waves of sound. Free and forced vibrations. Sound propagation and transmission. Radiation from spheres and pistons. Analogy between electro-mechanical acoustic systems. Helmholtz resonator ; acoustic filters.

Electro-acoustic transducers and instruments—their operation, design characteristics and measurements. Recording and reproduction of sound. Stereophonic systems ; high fidelity systems. Hearing and speech—essential characteristics.

Architectural acoustics—normal modes, reverberation and articulation. Sound absorption and insulation, noise control and measurements. Studio and auditorium design.

Studio and control room equipment, Limiter amplifier, Broadcast programme sources, Monitoring.

Ultrasonics and its industrial applications. Recent developments.

609. Radar Engineering (Elective) 3 Units, Third Term.

Introduction, radar equation, Radar transmitter, microwave transmitting tubes (only functional approach), modulators ; Radar receivers, noise considerations, R. F. amplifiers, crystal mixers, displays, Duplexers ; Detection of Radar signal in presence of noise ; Radar antennas, effect of broad-band signal on antenna patterns, Radomes ; CW and FM radar, the Doppler effect, Airborne Doppler navigation, multiple frequency CW radar ; Moving Target Indicator and Pulse-Doppler radar ; Tracking radar sequential lobing, conical scan, monopulse, range tracking ; Radar beacons, extraction of information from radar signals, phase and amplitude measurements, angular accuracy ; propagation of radar waves, radiation hazards ; clutter, weather and interferences, electronic. counter measures (ECM and ECCM) ; detailed study of one modern radar system.

610. Network Synthesis (Elective). 3 Units, Third Term.

Properties of Physical networks and their inter-relations-two-terminal networks and four terminal networks ; Approximation in frequency domain and time domain ; Synthesis of two terminal RLC networks ; Synthesis of four terminal ladder, lattice and Bridge-T networks; Insertion loss theory ; Special equalizers and filters ; Synthesis with active elements—negative impedence converters, Tunnel diodes and gyrators.

611. Theory of Communication Systems (Elective) 3 Units Third Term.

Theory and technique of Modulation and multiplexing—quantization and code transmission ; Efficient modulation systems—analogue and digital ; Comparison of multiplexing methods—S/N ratios, information efficiency ; Representation and design of signals, coding and decoding ; Statistical dynamics-stationary random processes, linear carrelation, optimum filtering and optimum prediction ; Statistical decision theory and communications—reception of Radar signals ; communication using Satellites.

612. Gas Discharge and Plasma (Elective) 3 Units Third Term.

Introduction of Kinetic theory of gases, ionization and deionizations ; emission of electrons by ionic bombardment ; Townsend discharge, glow discharge, arc discharge ; gas-discharge lamps ; High frequency field gas ionisation.

Plasma physics ; thermonuclear plasma ; Pinch effect, magnetic confinement of plasma ; oscillations ; e.m. wave interaction with plasma ; ionic and plasma Propulsion ; thermionic energy conversion ; elementary theory of magnetohydrodynamics.

613. Switching and Computation (Elective). 3 Units Third Term.

Analogue computers ;Operational amplifier as an adder and an integrator, Solution of linear equations ; Function generators and function multipliers ; solution of nonlinear equations Digital Computers : Organisation in digital computers, elements of programming, FORTRAN.

Switching : Boolean algehra, minimisation technique, sequential switching circuits. Logical design of Digital Computers ; Arithmatic unit, number systems and codes control unit, memory devices, input-output equipment. High speed switching circuit : Basic Building blocks, realizability and speed of operation, A-D converters.

614. Antennas (Elective). 3 Units Third Term.

Antenna problem—pattern, gain, impedance, bandwidth and polarisation. Mode theory of antennas. Hallen's method. Input impedance, Mutual impedance between linear antennas. Linear antenna arrays—effect of lossy ground, pattern synthesis. Continuous sources—effect of amplitude and phase distribution. Directivity, gain and effective area—examples. Study of typical antennas e.g. Long wire, Rhombic, special antennas for direction-finding, Yagi, Folded dipole, Turnstile, special antennas used for T.V. and F.M. Helix, Log-periodic, Equiangular spiral, Dielectric rod, slot, Horn, Paraboloid, Lons, etc. Circularly polarised antennas. Surface wave antennas. Application of these antennas in L.F., M.F., H.F., U.H.F. and in microwave region. Radome. Antenna measurements.

615. Radio Wave Propagation (Elective). 3 Units Third Term.

Basic considerations in radio wave propagation. Characteristics of wave propagation in different frequency ranges. Ground wave propagation ; Sommerfeld's equation ; surface waves. Space wave propagation ; effects of ground reflection. Sky wave propagation : Propagation of waves through an ionised medium ; magneto-ionic theory, Application of ionospheric data to radio communication. Physics of the ionosphere : formation of ionospheric layers, structure and properties of different regions. Ionospheric measurements. Tropospheric and duct propagation. Scatter propagation. Design considerations for long-distance radio transmission. Recent developments in propagation techniques.

616. Television (Elective). 3 Units Third Term.

Television systems—Methods of visual presentation and electrical transmission of visual information. Scanning, Synchronization and image analysis-linear scanning, inter-laced scanning, vertical and horizontal resolution and relation between resolution and viewing distance. Different types of camera tubes—their merits and demerits. Video signal transmission and amplification. Studio equipments for picture and sound channel and related circuitry. Transmitter antenna feeding arrangement and antenna system. Essential feature of a T.V. receiver —R.F. and I.F. amplifier, audio signal filter circuit. Synchronizing pulse separation. C.R. tube beam deflection circuit, Auxiliary projection unit. H. V. power supply system. Principles of color television, color television reception. T.V. channels and standards. Recent developments.

617. Non-linear Control System (Elective). 3 Units Third Term.

Inherent nonlinearities in physical systems and their effects on control problems. Describing function method of analysis, Calculation of describing function ; Application to different non-linear problems : Describing function in synthesis. Phase plane method of analysis—Application to different control problems. Limitations. Other methods of solving non-linear equations. Statistical theory for nonlinear system. Elements of time-varying parameters. Stability considerations—(i) classical methods ; (ii) second method of Liapunov. Sampled-data control system. Optimization of control systems. Introduction to adaptive control systems. Recent developments.

618. Microwave Devices and applications. (Elective) 3 Units Third Term.

Microwave circuit elements and components. Application of gyromagnetic materials, Ferrite devices, Gyrator networks. U.H.F. and Microwave filters. Theory of operation of U.H.F. and Microwave oscillators and amplifiers—triode, tetrode, klystron, magnetron, carcinotron, TWT, Low noise amplification MAVAR, MASER, LASER Microwave links. Optical techniques. Radio astronomy, Elements of microwave spectroscopy. Microwave frequency standards. Recent Developments.

619. Pulse Techniques (Elective) 3 Units Third Term.

Linear wave shaping—pulse transformer, delay line, Nonlinear wave-shaping—multivibrators, blocking oscillator, trigger circuits and comparators, counters, multiplexing and demultiplexing. Analogue to digital and Digital to analogue converters, comb filters ; applications to T.V., Radar, Computers and Telemetry.

650. Communications. 2 Units Second Term.

Principles of transistors, saturable reactors and magnetic ampliffiers. Interference between power and communication circuits. Brief descriptive outline of the telephone and telecommunication arrangements.

(For Electrical Engineers)

652. Electronic Circuits and Applications. 3 Units.

Servo, d.c., differential and operational amplifiers employing electron tubes. Pulse generators and high power R.F. oscillators. A.M. and F.M. modulators and demodulators. Periodic sampling and demodulation. Pulse modulation. Phase sensitive detectors. Relay amplifiers and thyratron amplifiers for motor loads. Transistors and transistor circuits. Voltage, current and power amplification. Transistor oscillators choppers, and a.c. to d.c. convertors. Regulated power supplies employing tubes and transistors. Noise and noise generators.

(For Electrical Engineers)

653. Introduction to Electronics. 2 Units First Term.

Electron emission—different methods of emission ; Fundamentals of Vacuum tubes and their applications. Audio Frequency voltage amplifiers ; Simple analysis of R-C coupled amplifier ; transformer coupled amplifier, R.F. Voltage amplifier ; Basic principles and applications.

Principles of power amplifiers, oscillators and power supplies ; Principles and simple application of C.R.T. and V.T.V.M. Gas analysis, temperature measurement and liquid level measurement.

(For Civil Engineers)

654. Electronics. 2 Units First Term.

Principles of Thermionic Emission ; Vacuum and gas tubes ; Transister theory and characteristics ; Simple applications of thermionic tubes and transistors ; Transducers ; Simple control problems and related topics.

(For Mineral Engineers)

GEOLOGY AND GEOPHYSICS (Ge)

(a) Applied Geology

602. Photogeology. 3 Units.

Introduction to aerial photographic technique. Study of air photos of all prominent land forms. Interpretation of terrain conditions etc. from air photos. Techniques of preparing geologic maps from aerial photographs. Prerequisite. Ge 502.

610. Clay Mineralogy. 3 units.

Structure, properties and identification of clay minerals. Origin and occurrence of clay. Industrial and engineering applications of clays.

611. Advanced Sedimentation. 3 Units.

Detailed study of different agents and environments of sedimentation.

613. Ground Water Geology. 2 Units (2-0) First Term.

Study of hydrologic cycle. Geology and occurrence of groundwater, Quantitative geohydrology : pumping, determination of permeability and groundwater inventory. Development of groundwater well types and yield. Quality of water. Occurrence of groundwater in India.

(For Civil Engineers).

614. Engineering Geology. 2 Units (2-0) Second and Third Terms.

Geologic implications of engineering problems. Principles of rock mechanics and soil mechanics in relation to geology. Geology as applied to various civil engineering projects as dams, reservoirs, canals, tunnels, high ways, bridges and buildings. Stability of slopes and beaches. Landforms and soils in engineering geology.

(For Civil Engineers).

621. Principles of Ore Deposition. 2 Units.

A generalised review of the theories of ore genesis ; Foremation of minerals ; Formation of mineral deposits ; Controls in mineral localisation.

622. Selected topics in Pre-cambrian Stratigraphy. 3 Units.

Special stratigraphic methods for Pre-cambrian rocks. Precambrian stratigraphy of Singhbhum, Mysore, Rajasthan, Madhya Pradesh and other important areas. Precambrian palaeogeography.

625. Mineral Economics. 1 Unit.

Management of mineral production. Trade routes, transportation costs. Export and import policies. The mineral policy of the Government of India. Geopolitics.

630. Selected topics in ore deposition. 3 Units.

Mode of occurrence and theory of origin of the main types of ore deposits. Geochemical approach to the problem of ore genesis. 'Controls' of ore localisation.

632. Studies in metallic and non-metallic deposits. 6 Units.

Intensive studies on the occurrence, distribution, geology, genesis and exploitation of metallic and industrial non-metallic minerals, with special reference to Indian deposits. Intensive laboratory work, assaying, mineral investigation, testing for their suitability for standard specifications.

633. Subsurface geologic methods. 4 Units.

Advanced techniques of investigation and interpretation of complex geologic features in the field. Physical, electrical and mechanical methods of logging. Subsurface mapping. Different techniques of subsurface correlation.

634. Coal Geology. 6 Units.

Genesis, composition and rank of coals. Structural features of coal seams. Coal economics. Major coal producing areas of India and the world. Petrography of coal.

635. Petroleum Geology. 3 Units.

Geographic occurrence of petroleum. Study of reservoir rock and pore space. Porosity and permeability of reservoir rocks. Reservoir traps : structural, stratigraphic and combination types. Origin, migration and accumulation of petroleum. Structure of some typical oil fields, Indian and foreign. Laboratory : preparation and interpretation of fence diagrams, isopach maps, structure contour maps and facies map etc.

635A. Geology & Geochemistry of Petroleum. 3 Units.

The geology part is common with ApGe D.I.I.T. course. Chemical composition and origin of petroleum. Prospecting for petroleum by different methods.

636. Selected topics in Exploration & Prospecting methods and in Mining Geology. 6 Units.

(A) *Geological*: geological prospecting for minerals—sampling, estimation of ore reserve. Report writing.

(B) *Geophysical*: review of the basic principles of Gravity, Magnetic, Electrical and Seismic methods. Integration of geology and geophysics. Mining and oil geophysics—choice of methods. Limitations.

636A. Geological Prospecting. 3 Units.

Geological prospecting for minerals. Sampling. Estimation of ore reserve. Report writing.

637. Selected studies in Groundwater Geology. 4 Units.

Study of hydrologic cycle. Geology and occurrence of groundwater. Quantitative geohydrology ; pumping, determination of permeability and groundwater inventory. Development of groundwater : well types and yield. Quality of water. Occurrence of groundwater in India. Groundwater report writing.

638. Selected Studies in Engineering Geology. 6 Units.

Application of geology in different engineering problems as dam and reserviors, highways and air fields, tunnels, beach and harbour protection, construction materials, subsurface exploration, landslides etc. Terrain interpretation and other uses of aerial photographs. Utilisation of soil mechanics principles in engineering geology problems. Study of case histories. Military Geology. Engineering geology report writing.,

639. Exploration planning. 1 Unit.

Plans for different types of survey. Organisation, cost, personnel, duration and field technique. Party programme. Safety and other regulations.

640. Selected topics in post-Precambrian Stratigraphy. 3 Units.

Stratigraphic details of significant areas of Palaeozoic; Mesozoic and Tertiary rocks. Problems of interregional correlation. Stratigraphic record as key to environment. Palaeogeographic regions. Coal and petroleum-bearing stratigraphic units.

641. Selected topics in Structural Geology of ore deposits. 4 Units.

Localisation of syngenetic and epigenetic ore bodies in rock structures of different scales. Examples of structural contrals of ore deposits from well-worked districts of the world. Time relations between formation of different structural elements and the origin of the ore-forming fluids.

642. Hydrology. 2 units.

Hydrologic Cycle. Rainfall. Evaporation. Transporation. Runoff. Stream flow. Basin characteristics. Water Control works. Groundwater.

650. Field Mapping (at least two weeks of professional training and project based on roughly 8 weeks of field work and 10 weeks of laboratory work).

652. Seminar. 3 Units.

Presentation of a published paper, summarising some papers or presenting original work in the form of a talk. Each student is required to give a talk once a term.

655. Thesis/Project.

656. Geotechnics. 4 Units.

Elementary principles of soil mechanics. Soil classification. Stresses and shear in non-cohesive and cohesive soils.

Mechanical properties of rocks, porosity, adsorbed water, unit weight of rocks, compressive and tensile strength of rocks ; compression of rocks, moduli of elasticity and compression.

657. Special studies. Units by arrangement.

Advanced study on some selected topics of geology under the guidance of a teacher.

658. Techniques of Mineral Investigation. 2 Units—First Term. 2Units—Second Term.

Principles and techniques of investigation of opaque minerals in reflected light.

Identification of ore minerals, their texture and paragenesis.

Ore microscopy as an aid to ore-dressing : Examination of milling and flotation products at all stages.

Coal petrography.

X-ray diffraction, flame photometry, spectro-chemical analysis and fluoroscopic investigation of minerals.

(For Mineral Engineers).

(b) Exploration Geophysics

660. Tectonophysics. 4 Units.

Tectonic framework of the earth's crust. The pattern, space and time relations of mountain chains and island arcs. Structural features of continents and ocean basins. Analytical treatment of the forces leading to the deformation of the earth's crust.

661. Introduction to Physical Oceanography. 2 Units—Second Term.

Physical properties of Sea Water. Physical observations. Temperature observations. Water sampling devices. Current measurements. Draft method. Flow method. Distribution of variables. Heat budget of oceans. Radiation. Exchange of heat between atmosphere and sea. Evaporation from sea. Dynamic computations. Dynamics of ocean currents, wind currents, turbulence, atmospheric boundary layer problems. Thermodynamics of ocean currents. General distribution of salinity, temperature and density. Interaction between atmosphere and the oceans. Description of marine environments, nature of sea bottom, chemical and biological relationships in the sea. (For Civil Engineers).

662. Theoretical Geophysics. 4 Units.

Selected topics in theory of fields as applied to geophysical problems. Theory of electromagnetic and seismic wave propagation in the earth. Assigned reading according to student's need. Contents of the course may vary from year to year.

663. Advanced Seismology. 4 Units.

Brief review on earthquakes and seismic waves. Seismic rays in an earth model. Velocity distribution from travel-time curves. Amplitude of surface motion and energy of the waves. Interpretation of seismograms for various types of earthquakes.

664. Nuclear Geophysics. 2 Units.

Continuation of Ge 464. Selected topics of Radiation Physics and their application to geophysical problems including investigations within bore holes. Recent developments.

665. Nuclear Geology. 3 Units.

Fundamentals of nuclear physics. Radioactivity. Radioactive Series. Instrumental techniques for detection and measurement of radioactivity. Radioactivity in rocks. Radioactive minerals and their prospecting. Radioactivity and geological time scale. Experimental work on radioactive measurements. Determination of percentage U and Th in unknown sources. Standardization of sources.

666. Physics of Solids. 4 Units.

Elements of theory of solids. Various physical properties of the solids. Experimental methods of measuring different physical properties. Properties of semiconductors, transistors and thermisters.

668. Mathematical methods in Geophysics. 6 Units.

Special functions. Partial differential equations. Boundary value problems. Complex variables. Integral transforms. Intergral equations. Numerical methods and computation. Applications to Geophysical problems.

672. Petrophysics. 2 Units.

Analysis of physical properties of rocks. The mechanical, electrical, magnetic, elastic, thermal and nuclear properties of rocks under various geological and physical conditions. Assigned reading. Laboratory and field measurements. Integration and relationship among various physical properties.

675. Subsurface Geophysical Methods. 4 Units.

Selected topics in well-logging in its various aspects. Recent developments in field procedure and technique. Subsurface mapping.

678. Reservior Geophysics. 3 Units.

Physical & chemical properties of reservior fluids. Reservior forces and energies. Mechanics of fluid flow in porous media. Reserve estimates. Production and recovery.

682. Surface Geophysical Methods. 6 Units.

Selected advanced topics in Gravity, Magnetic, Electrical and Seismic methods of geophysical prospecting. Recent developments.

684. Analysis and Interpretation of Geophysical data. 6 Units.

Computation and interpretation of Gravity, Magnetic, Electrical, Seismic and Well-log data. Handling of actual field data. Preparation of reports.

685. Exploration Planning and Case Histories. 2 Units.

Planning for geophysical exploration in oil industry, mining and other projects. Integration of various exploration methods. Typical case histories.

686. Geophysical Instrumentation. 4 Units.

Theory of instrumentation in all branches of exploration geophysics. Laboratory work including design and construction of basic instruments.

692. Special Studies. (Units by arrangement).

Advanced studies on some selected topics of general or exploration geophysics under the guidance of a teacher.

695. Seminar II. 3 Units.

Review of topics and papers on Geophysics. Each student is required to give a talk once a term.

696. Field Geophysics III. (Units by arrangement).

698. Research and Thesis (Units by arrangement.)

A student is required to take up an independent investigation in some branch of Exploration Geophysics under the guidance of a teacher. A properly supervised and accepted technical report on the investigation has to be submitted.

Facilities for research exist in the following lines :

(a) Petrophysics

(b) Gravimetry and Magnetometry

(*c*) Geoelectricity and Prospecting

(d) Applied Seismology & Prospecting

(*e*) Radiometry

(*f*) Geophysical Instrumentation and Models.

(g) Theoretical Geophysics.

(*c*) Geochemistry

612. X-ray Crystallography—4 Units.

Theory and practice of X-ray diffraction methods as applied to minerals and rocks.

615. Introductory Geochemistry. 2 Units.

Elements of cosmochemistry. Introduction to distribution of elements with emphasis on the lithosphere. Principles of thermodynamics and crystal chemistry and their application to geochemistry.

616. Theoretical Petrology. 3 Units.

Thermodynamics, Crystal Chemistry and silicate phase equilibria, their application to petrology.

617. Geochemistry I. 3 Units.

Abundance and distribution of elements. Detailed consideration of the geochemistry of lithosphere—geochemical processes.

618. Geochemistry II. 4 Units.

Phase equilibria in systems of importance to economic geology and petrology, e.g., in common carbonate, sulphide and oxide systems.

626. Inorganic Chemistry for Geochemists. 2-4 Units.

Discussion of the chemistry of Li, Be, B, rare earth elements, Ti, Zr, Si, Ge, V, Mo, W, U, Mn, Ni, Co, Fe, Al.

627. Physical Chemistry for Geochemists. 2 Units.

Thermochemistry, Chemical Kinetics, Solutions,

Electrochemistry, Colloids.

628. Analytical Chemistry for Geochemists. 6-8 Units.

Chemical analysis of ores, rocks, and minerals.

643. Geochemical Prospecting (Theory). 2 Units.

Principles of accumulation and dispersion of elements in rocks. Soil formation, primary and secondary dispersion patterns. Geochemical anomaly. Common methods of prospecting methods, especially Diphenylthiocarbozone methods, in semiquantitative estimation of Cu, Pb, Zn, Ni, W, Mn, Cr. etc.

644. Geochemical Prospecting (Field / Lab.). 3 Units.

Soil sampling in an unknown area. Semiquantitative estimation of the elements concerned. Processing and interpretation of obtained data.

667. Special studies in Geochemistry. Units by arrangement.

Advanced study on some selected topic in geochemistry under the guidance of a teacher.

655. Thesis/Project

HUMANITIES AND SOCIAL SCIENCES (Hu)

601. Introductory Psychology. 3 Units (3-0) First Term.

Use of basic psychological concepts from everyday life to give the student a practical understanding of the behaviour of people in organisations—Study of principles underlying motivation, perception, personality etc.

602. Industrial Economics. 3 Units (3-0) First Term.

Characteristics of Indian Industrial Structures—Market structure—Economic planning —Principles of Governmental control and regulation of industry—Industrial revolution— Public sector and private sector—Standards and cost of living etc.

603. Psychology of Industrial Relations (including Human Relations). 3 Units (3-0) First Term.

Broad treatment of industrial relations problems like supervision, wage incentives, industrial conflicts etc. with emphasis on their psychological aspects.

604. Social Psychology (Group Dynamics). 2 Units (2-0) First Term.

Study of influence of the group on the individual personality—Group formation and group standards in an industrial setting—Study of Principles underlying leadership management, organised group effort etc.

605. Selection and Placement of Personnel. 2 Units (2-0) Second Term.

Selection and Placement of Workers. Matching of workers' abilities with job requirements—job analysis—Traditional selection procedure and its drawbacks. The application form and psychological problems of learning—Psychological tests—Interview and its technique—Usefulness of Board and person to person interview—Training—Placement of handicapped.

606. Physiology of Work. 2 Units (2-0) Second Term.

Nature of human work—variation in production and their psychological and physiological causes—Means of counteracting fatigue factors by proper adjustment of hours of work, rest pauses, environmental conditions of work, human engineering and its practical aspects.

607. Labour Movement and Labour Organisation. 3 Units (3-0) Second Term.

History and development of the Indian labour movement—National trade union organisations—The employers' organisation—Discussion of their policies and practices—A comparison of origin, development and present status of labour movements in selected countries with particular emphasis on England, Russia and United States. Industrial Conflict and Union-management relations—characteristics and trends of industrial co-operation. Worker's participation—problems of collective bargaining etc.

608. Industrial Hygiene. 3 Units (3-0) Second Term.

Human physiology with special reference to central nervour system, voluntary and involuntary musculature—automomic nervous system etc.—General problems of industrial hygiene—its physiological, psychological and chemical aspects. Discussions of chemical hazards like lead, Physiological hazards of heavy work and psychological hazard like accident—proneness, monotony etc.

609. Consumer Research and Mass Media. 3 Units (3-0) Third Term.

Discussion of underlying principles—Study of attention, interest, desire, Psychology of volition and other processes involved in response to advertisement—Application of these principles. Public opinion—market research, propaganda etc.

610. Governmental Labour Policy and Labour Legislation in India. 2 Units (2-0) Third Term.

The India Government's labour policy before and after 1947. General characteristics of labour legislation in a welfare state—Study and discussion of Specimen aspects of the Factory Act—Industrial conciliatory machinery like the Industrial Tribunal etc.

611. Research Methodology. 3 Units (3-0) Third Term.

Techniques of ranking, rating paired-comparison, attitude measurement etc. Present day procedure of sampling, interview design, question formulation, interviewing—Their application to merit rating, for measuring job-satisfaction and morale and securing worker's opinions and attitudes regarding diverse issues. Psychometrics—Statistical methods like mean, mode, mediam standard deviation, correlation-analysis, analysis of variance, elements of factor analysis etc.

612. Personnel Administration. 3 Units (3-0) Third Term.

Objectives and methods of personnel administration. Discussion of post-war trends in personnel administration—Discussion of specific personnel problems in connection with Works Committee, Joint Productivity Council, Grievance procedure etc.

613. Labour Welfare and Social Security. 1 Unit (1-0) Third Term.

Labour welfare—welfare work by government—Social service agencies—special aspects—suggestions. Social Security—origin and growth in India—various social security measures—Social security and developmental Planning.

614. Laboratory Practical. 1 Unit (0-2).

615. Project work. 14 Units Fourth Term.

713. Urban Land Economics.—1 Unit—Third Term.

Institution property—an over-all survey of land as a resource and demand for land due to various activities of main characteristics of urban land—forces in estate market—supply and demand—competition for land uses.

Land values—existing use—value and development—value variation trends—effects of land—uses and planning proposals on land values—betterment levy and compensation. Principles of variation of properties.

Economics of redevelopment and evaluation of alternative Schemes—density pattern for city. Public revenue and expenditure in relation to land development—Metropolitan explosion and agricultural interests.

716. Urban and Rural Sociology.—1 Unit—First Term.

Introduction and scope of the subject—General characteristics of modern society as contrasted with rural society.

Demography and migration.

Development of modern cities—city as political, economic and cultural centre.

The ecological patterns of urban development—the social and institutional structure of urban communities—characteristics of highly developed cities with special emphasis on the problems of social control in urban society—Agencies of social and control in rural community.

717. Economics of Development.—1 Unit—First Term.

Introduction to finance administration in State and Central Governments ; Budget Fiscal Policy of the Government National Income and employment, current economic problems —Revenue and expenditure programmes of Government Short-term and long term programming and financing of public works.

Growth of Urban Economy.

Industrial location policies—Economic base of a settlement—Economics of public borrowings—public undertaking—India's Five year Plans—Economic development in relation to regional planning.

MATHEMATICS (Ma).

611. General Mechanics. 2 Units (2-0), Second Term.

Rigid dynamics, three dimensional statics, Lagrange's equation and related topics.

612. Mechanics of Continuous Media. 4 Units, First Term, 2 Units Second and Third Terms.

The Fundamentals and Applications of the theory of elasticity and fluid mechanics. Fundamental equations of gasdynamics, theory of characteristics, simple waves, Riemann's transformation for one dimensional unsteady case, shock formation, Prandtl-Meyer flow, Hodograph transformation, Elements of viscous compressible fluids.

613. Mathematical Methods in Engineering. 2 Units (2-0), First and Second Terms or 4 Units, one term.

Vector and Tensor Analysis, Complex Variables, Fourier series and integrals. Operational methods based on Laplace Transform. Curve fitting. System of linear equations. Matrices, Numerical and Graphical methods of solution of linear and differential equations. Finite difference equations, Iteration and Relaxation method, Partial differential equations of Engineering Sciences, Special functions.

614. Engineering Mathematics. 2 Units (2-0), First and Second Terms.

Vector and Tensor Analysis. Matrices, Ordinary and Partial Differential equations of Applied Mathematics together with boundary value problems. Theory of complex variable and conformal Mapping. Potential Theory and its application to Engineering problems.

618. Advanced Techniques in Mathematics. 2 Units, First and Second Terms.

Tensors, Transforms, Selected Special Functions.

619. Non-linear Vibration. 4 Units (4-0), Third Term and Gyrostatics.

Ordinary non-linear differential equations, The simple pendulum, Non-linear spring control with and without viscous damping, Simple gyroscopic phenomenon, Tops, Gyrocompass, Ship stabilizers, applications to aircrafts and stability effects.

620. Selected Topics in Non-linear Mechanics. 4 Units (4-0), Third Term.

Non-linear problems in elasticity and fluid mechanics arising out of (1) Body stress equations, (2) Boundary conditions, (3) Strain components, (4) Stress strain relations.

621. Selected Topics in Plasticity and Rheology. 4 Units (4-0) Third Term

Foundations of the theory of plasticity, Elasto-plastic problems, Plane Plastic strain, Theory of slipline field, Two dimensional problems, Axially symmetric problems, Elements of Rheology, Time-dependent fluids, Rheopectic and Thixotropic fluid.

626. Partial Differential Equations. 2 Units (2-0), First Term.

Classification of Partial differential equations and their solutions, Power series solutions and existence theorems, Characteristics surfaces, Bicharacteristics, Discontinuities and singularities, Initial value problems and Boundary problems.

627. Classical Theory of Electrodynamics. 2 Units (2-0), Second Term.

Motion of charged particles in Electric and Magnetic Fields. The first order orbit theory. The Adiabatic Invariants in the Motion of charged particles, Applications of the First order orbit theory, The Magnetic Mirror Machine.

628. Mechanical Properties of Materials (2-0), 2 Units, Second Term.

Relation of structure to mechanical behaviour of bodies, Real Engineering materials, Ideal materials, mechanical properties of Ideal plastic bodies, Work-hardening bodies.

629. Selected topics from Magnetofluiddynamics. 4 Units (4-0), Third Term.

Fundamental equations of Magnetohydrodynamics and their applications, Hydromagnetic effects in Boundary layer theory and Heat transfer problems.

630. Theory of Hydromagnetic stability and Wave Motion, 2 Units (2-0), Third Term.

Study of Hydromagnetic rotational and Thermal instability and some related problems.

631. Transition theory in continuous media. 2 Units (2-0), Third Term.

The fundamentals of transition theory and its application to cylinders under uniform pressure, bending of a rectangular sheet and torsion of a circular cylinder.

632. Plasma Dynamics and Relativistic fluid dynamics. 4 Units, Third Term.

633. Analog Computation and Simulation. 2 Units (2-0), Second and Third Terms.

Operational amplifiers, Design principles. Integral and diffential equations. Non-linear elements like function multipliers function generators, Servo-mechanical models, Commercial computers,

635. Mathematical Methods. 4 Units (4-0), First Term.

Matrices—bilinear and quadratic forms. Tensors. Analytic functions, Saddle point and branch cut techniques, Conformal transformation. Roots of complex polynomials. Eigen functions and eigen values. Fourier and Laplace transform. Probability theory, Numerical methods.

641. Numerical Methods and High Speed Computation. 2 Units, Second and Third Terms.

Numerical differentiation and integration, Numerical solution of algebraic equations, Numerical solution of ordinary, partial and integral equations, Harmonic analysis, Elements of programming on Analog and Digital computers.

642. Theory of Probability and Statistical Methods. 2 Units, Second and Third Terms.

Probability : Fundamental theorems on probability, Bayes' theorem, Expectation, Runs and renewal theory, Markov chains and stochastic processes. Entropy and Information.

Statistical Methods : Summarisation of data, characteristics of frequency distribution, Moments and Cumulants, Binomial, Poisson and Normal distributions, Bivariate and multivariate normal distributions, Correlation and Regression, Sampling Theory of estimation and tests of significance.

643. Statistical Methods for Agriculture and Biology. 2 Units.

Frequency distribution, Histogram, Measures of location and Measures of dispersion, Co-efficient of variation, Binomial, Poisson and Normal distributions.

Sampling methods. Standard errors, Tests of significance. Contingency tables, χ^2-tests of (*i*) goodness of fit, (*ii*) homogeneity and (*iii*) independence estimation of linkage. Correlation and regression. Uniformity trials, Replication, Randomisation and local control, Randomised block and latin squares. Factorial experiments. Plot and strip plot designs, Use of ancillary information. Analysis of covariance. Missing plot technique.

644. Statistical Methods. 2 Units, Third Term.

Elements of probability and statistics. Regression and correlation. Tests of significance. Sampling theory. Theory of Storage. Statistical methods in the problem of structures, Statistics in the study of draughts and flood flows.

646. Statistics for Chemical Engineers. 2 Units, Third Term.

Probability theory and statistical methods, Design and analysis of experiments, Principles of sampling.

Statistical methods in exposure trials, rubber evaluation, drug manufacture, plastic research. Small particles. Statistical Quality Control Methods. Control charts and Sampling Inspection, Cost and Quality considerations.

647. Computational Techniques. 2 Units, Third Term.

Interpolation formulae, numerical differentiation and integration. Methods of curve fitting. Calculus of variations. Mathematical programming. Application of computers to engineering problems.

648. Statistical Methods for Municipal Engineers. 2 Units, First and Second Term.

Treatments of raw data. Frequency distributions, and Diagramatic representation. Mean, Mode and Median. Standard deviation and other measures of dispersion. Skewness and Kurtosis. Bivariate data—correlation and regression. Index numbers. Municipal and Public Health Statistics. Mechanical Processing of data, Census statistics, Life Tables.

652. Engineering Statistics. 4 Units, First Term.

Frequency Distributions. Statistical Parameters. Probability. The Binomial Distribution. The Normal Distribution. Sum of Squares of Normal Variates. Goodness of Fit. Sampling Inspection Schemes. Theory of Errors, The Method of Least Squares. Correlation, The Analysis of Variance, The Principle of Maximum Likelihood, Probit Analysis,

657. Mathematics (including Analogue Computation and Simulation). 2 Units, Second and Third Terms.

Vector and Tensor analysis. Fourier series and Integrals. Operational Methods based on Laplace transforms. Operational Amplifiers. Design principles. Integral and differential equations. Non-linear elements like function multipliers and function generators. Servo-mechanical models. Commercial computers.

(For Electric Traction students).

680. Theory of Shells and Plates. 2 Units (2-0), Third Term.

The Applications of the fundamental equations of Shells and Plates to some problems of practical interest.

681. Mathematics. (For Soil Technologists and Farm Management Technologists). 2 Units, First and Second Terms.

Simple properties of Trigonometric functions Limits, Continuity, Differentiation of simple functions, Successive differentiation, Integration of simple functions. Ordinary differential equations.

682. Selected Topics in Statistics. (Units to be determined by the needs of Research Workers).

Statistical Methods in Research : Frequency curves and their characteristics, Correlation and Prediction Problems, Analysis of Multivariate Data. Data Processing Systems. Quality Control Methods. Operational Techniques.

683. Data Analysis and Programming. 1 Unit, First and Second Terms.

Introduction to statistical methods—Data, Variables and attributes—concept of population and sample—presentation techniques—figures, diagrams and tables—frequency distribution, measures of average and scatter, Correlation and regression.

Elements of probability—binomial and normal distributions—methods of estimation—sample survey—Census—Vital statistics, Time-series, Index no., use of calculating machines.

Allocation models, linear programming, the assignments problems, computation techniques. Introduction to waiting time models. The theory of games related to urban economic phenomena. Storage and interpretation of data by use of computers. Other simulation techniques.

684. Vector Analysis and Matrices. 3 Units, First Term.

Introduction and definitions. Addition and subtraction of vectors. Product of two or more vectors. Scalar and vector fields. Differentiation and integration of vectors. Application of vectors to problems in mechanics.

Introduction to matrix algebra, Determinants, Inverse matrix, Rank and equivalence of matrix, Characteristic equation of matrix. Application of matrices.

685. Theory of Complex Variables. 2 Units, Second Term.

Complex numbers, Functions, Limits and continuity. Cauchy Riemann equations with reference to complex differentiation and integration. Cauchy's integral formula and related theorems. Infinite series—Taylor's and Laurent's. The residual theorem and its application. Conformal mapping and its physical applications.

686. Ordinary and Partial Differential Equations. 3 Units, Second Term.

Elementary methods of solving ordinary differential equations. Linear differential equations and their applications. Partial differential equations, definitions and derivatives. Partial differential equations of first, second and higher order. Applications of partial differential equations to physical and engineering problems, Non-linear differential equations.

687. Operational Methods. 2 units, Third Term.

Laplace transform—definition and notation. Inverse Laplace transform—related theorems. Properties of Laplace transforms. Applications of L-transform to differential equations. Applications to integral and difference equations. Applications to boundary value problems.

MECHANICAL ENGINEERING (ME)

6021. Foundry Technology (I). 4 Units Second Term.

Mechanics of flow in moulds—Design of Gating and Risering systems.

Design of patterns, Moulds and mould forming. Foundry Sands—testing and control.

Design of cupola and refractories.

6022. Foundry Technology. 4 Units Second Term.

Mechanism of solidifications. Fluid flow of metals. Heat transfer. Design of pattern equipment, gating risering. Sands, clays and binders. Foundry equipment. Melting processes and controls. Finishing and treatment of castings. Inspection and quality control.

6031. Foundry Metallurgy : 4 Units Third Term.

Solidification of castings—Mechanism and influence on production of sound castings. Slag Metal reactions, gases in metal. Cast irons—Inoculation, Alloy cast irons, Malleable irons. S.G. Irons, Cast steels, Alloy steels, Coper base alloys, Nickel base alloys, Zinc base alloys. Titanium alloys.

6032. Foundry Equipments and Controls. 4 Units—Third Term.

Design of Foundry Machines—Moulding, core making, sand conditioning, etc. (Detail design of any one of the machines). Baking ovens and Heat Treatment furnaces. Instruments and controls for foundry equipments.

6033. Foundry Technology II. 4 Units Third Term.

Operation of melting furnace, Control of melts. Special casting processes. Cast weld constructions, Finish treatment of castings. Casting defects and inspection radiography, ultrasonics, etc. Principles of casting design.

6034. Chemistry of sands, clays and binders. 4 Units Third Term.

Classification of clay minerals. Origin of clays.

Structure and properties of sands and clays. Bonding Mechanism-Clays, silicates and *Organic Binders. Polymerisation and Oxidation.* Minerology of sands, minerological testing. Indian Sands and clays.

6111. Advanced Engineering Economics. 4 Units First Term.

Depreciation, tax, investment, incentive, valuation of plant and machinery. Economics of plant replacement. Economic analysis in plant selection and manufacturing. Short term capital management—cost analysis, costing and budgetary control. Long term capital management—raising and control of funds.

6112. Work Study-I. 4 Units First Term.

Analyses of process, operation and motions. Human Engineering—physiological factors. Design of workplace and equipment.

Psychological and physiological fatigue. Micromotion and memomotion analysis. Allowances—personal, process and fatigue. Machine interference. Activity and performance sampling.

6121. Design and Operation of Controls in Industry—I. 4 Units Second Term.

Analysis and decision for production target. Production Planning. Design and operation of internal communication control for production—Control of inventory. Distribution planning and control.

6122. Operations Research : 4 Units Second Term.

Characteristics and scope of O.R. Formulation of the problem, some mathematical and statistical concepts : matrices, theory of sets, convex and concave functions, linear vector space, numerical methods, probability theory and stochastic processes. Methodology of O.R. : linear and non-linear programming, simplex method, queuing theory, theory of games, sequencing theory and mathematical programming. Inventory and production control, priority scheduling, replacement, engineering design, information processing, network analysis. Design of experiments in operations research.

6123. Work Study—II. 4 Units Second Term.

Evaluation of different methods of performance rating. Precision time measurement—marstochron, electric timer. Predetermined fundamental motion time standards, standard data. Comparative analysis of different work measurement techniques. Machine interference. Time standards—and wage incentives—basis ; effect of rating, allowances and variation of time standards.

6124. Principles and Practice of Management. 4 Units Second Term.

Theories of management : traditional and modern. Organisation : planning, theories and design. Communication and Coordination : authority and behavioural approach. Policy formulation and decision making process. Management audit.

6125. Industrial Engineering : 4 Units Second Term.

Analysis of process, operations and motion. Micromotion and memomotion study. Fatigue and compensatory allowances. Activity sampling. Stop watch time study. Production planning. Design and operation of control for production. Inventory control. Plant layout and internal transport.

6131. Design and Operation of Controls in Industry—II. 4 Units Third Term.

Design and development of a product for manufacturing economy and quality. Concept of producibility. Standardisation, Simplification and Diversification.

Quality specifications, theory of dimensional chains and product-reliability. Quality in manufacture : various decision schemes and setting of process—average.

Acceptance of quality : various sampling techniques and their o.c. curves. Analysis for the selection and design of optimum scheme. Organising for quality.

6132. Design and Operation of Controls in Industry—III. 4 Units Third Term.

Productivity—concepts and measurements. Productivity analysis and controls—personnel, inventory, equipment, capital, control of internal transport and mechanisation and cybernetics in management control, automation, administration of wages plans.

6133. Factory planning and plant engineering. 4 Units Third Term.

Planning for physical facilities. Balancing of productive capacity and material flow control. Theories of plant location. Plant layout : traditional and O.R. approach. Internal transport and its effective utilisation. Plant maintenance.

6134. Personnel Management and Industrial Relations. 4 Units Third Term.

Personnel planning—labour market, recruitment, training, placement. Job evaluation and merit rating, employee health, safety and welfare. Human relation group dynamics, morals and motivation, industrial disputes—voluntary and compulsory settlement, trade unionism and collective bargaining. Labour legislation.

6181. Plant Management. 3 Units—Third Term.

Management principles. Organisational structures. Wage and wage—administration. Management Controls : labour, material, equipment, cost. Productivity and envioronment factors. Plant services : power, steam, fuel, water, waste disposal, internal transport. Plant maintenance. Personnel management.

6191. Elements of Industrial Engineering. 3 Units Third Term.

Management of engineering functions. Design and operations of organisation structure. Planning for production : product design and development. Analysis and evaluation of process layout, plant layout and materials handling. Production planning and controls. Work study and productivity. Job evaluation and incentives. Plant and safety engineering. Preventive maintenance. Inspection and quality control. Economic analysis in manufacturing : Job estimates Preparation of quotations. Economics of manufacturing alternatives. Break even chart.

6192. Quality Control. 3 Units Second Term.

Product quality : concept, standards, economy. Quality measurement and analysis. Control of quality : incoming material, process, in process material and finished products. Statistical methods : elements of probability, control charts, sampling inspections, correlations and regression analysis. Organisation for quality control.

6211. Production Engineering. 4 Units First Term.

Machinability of metals. Evaluation of production process : chip and chipless machining, metal forming. Economics and development of recent methods. Consideration of design of tooling for joblot and quality production. Elements of automation in machining.

6221. Metal Cutting Sciences. 4 Units Second Term.

Theory of metal cutting—Kinetics of cutting forces, chip formation, heat transfer, temperature distributions, vibrations and chatter. Mechanism of tool-wear. Tool life,. Economics of metal removal. Surface finish and dimensional accuracy. Cutting fluids. Recent developments in metal cutting.

6222. Welding Principles and Techniques. 4 Units Second Term.

Gas, arc and resistance welding. Modes of heating and heat transfer. Combustion of gases. Arc phenomenon. Weldability. Welding metallurgy. Filler metal and metal transfer. Recent developments in welding. Design of welded joints and weld specifications. Welding Standards. Inspection and testing of welds. Estimates and costing.

6231. Advanced Metrology. 4 Units Third Term.

Theory of dimensional chains and accuracy analysis, Theory of fits and tolerances. Precision linear and angular measurement—mechanical, electrical, optical and pneumatic. Inspection of gears, threads, profiles. Inspection of cracks and internal faults, splines and serrations. Surface analysis and interferometry. Automatic measurement and quality control in process, post process. Design of inspection programme. Principles of designing gauges and instruments.

6232. Machine tool engineering. 4 Units Third Term.

Kinematics of machine tools. Drives. Stepped and stepless regulations. Control—selective and preselective mechanical, hydraulic and electrical. Design of beds, columns, tables, guides, etc. Rigidity and vibration. Inspection—geometrical, kinematic and dynamic accuracy. Automation and programme control.

6233. Metal forming sciences. 4 Units Third Term.

Theory of plastic flow of metals. Forgeability and formability Hot and cold working processes and their capabilities. Design and manufacture of dies. Modern developments.

6234. Tool Engineering. 4 Units Third Term.

Design of form tools, reamers, milling cutters, broaches and form generating tools, Tooling of automatics. Jigs and fixtures. Standardisation.

6271. Production Engineering—I. 3 Units First Term.

Metal forming processes and their comparative studies. Common Heat treatment processes. Foundry : ferrous and non-ferrous castings, design of castings, gating and risering systems. Introduction to modern casting processes. Defects and inspection of castings. Economics of foundry production. Welding : Weld design and specifications. Welding metallurgy. Defects and inspection of welds. Forging of metals : Forging plant and equipment. Press working of metals : forming of sheet metal. Common press-working equipment.

6272. Mechanical Technology. 3 Units First Term.

Introduction of manufacturing processes : foundry, forging, press-work, machining, and welding. Metrology : measurement of lengths and angles. Basic types of machine tools : lathe, shaper, planer, milling machine, drilling machine, grinding machine. Cutting tools : single point cutting tools and cutting fluids ; grinding wheels.

6281. Production Engineering II. 3 Units Second Term.

Common production machine tools and their operations. Cutting tool design and manufacture. Elements of jigs and fixtures. Elements of the design of press tools and forging dies. Precision measurements : limits and fits, limit gauges. Measuring devices used in general shop work. Non-destructive testing. Manufacturing planning of engineering components.

6311. Advanced Engineering Thermodynamics I. 4 Units First Term.

Review of basic concepts, and analysis of the laws of thermodynamics. Study of equations of state and thermodynamic properties of gases, vapours and mixtures. Thermo-dynamic functions and their relationships. Chemical potentials. Heterogeneous systems. Heat effects of chemical processes.

6312. Heat Transfer I. 4 Units First Term.

The mathematical theory of heat conduction with application to steady and non-steady heat flow for various boundary conditions and configurations. Graphical solutions of transient heat conduction problems. Application of relaxation method. Application of analogs. Heat transfer due to radiation.

6313. Advanced Fluid Mechanics. 4 Units First Term.

Incompressible flow without friction. Continuity and momentum equations. Flow past bodies. Infinite and finite wing theory.

Compressible flow. Isentropic flow with area change. Shock flow in one dimension. One-dimensional flow with friction and heat transfer. Gas injection and combustion.

Flow with friction. Navier-Stokes equations, and exact solutions, Boundary layer theory, laminar and turbulent ; boundary layers ; drag ; boundary layer control.

Applications to fluid machinery, lubrication, propulsion system and aerodynamics.

Laboratory exercises.

6321. Advanced Engineering Thermodynamics—II. 4 Units Second Term.

Principles of psychrometry, and its applications. Introduction to non-reversible thermodynamics : application of the Gibbs' entropy equation. Entropy generation in a system. Onsager's reciprocal relations. Concept of stationary states. Analysis of some cross phenomena like thermal diffusion, heat transfer due to diffusion, and thermoelectric effects.

6322. Heat Transfer—II. 4 Units Second Term.

Heat transfer due to forced and free convection. Heat transfer in boiling and in condensation. Application of dimensional analysis to convective heat transfer. Design of heat transfer equipment.

6323. Fluid Mechanics and Heat transfer. 4 Units Second Term.

Incompressible flow without friction. Basic concepts of compressibility. Theory of fans, blowers and compressors. Flow through porous media.

Analysis of steady and non-steady heat conduction problems. Heat transfer due to radiation. Heat transfer in forced and free convection.

6331. Gas Dynamics. 4 Units Third Term.

Potential flow. Theory of small perturbations. Hodograph transformations. Pressure correction formulae. Method of characteristics. Shock flow in two dimensions. Transonic flow.

6332. Air Conditioning. 4 Units Third Term.

Physiological principles. Factors affecting human confort. Industrial process requirements. Apylication of psychrometry to heat and mass transfer problems. Ventilation requirements. Cooling load estimates, selection of cooling apparatus, and design of air distribution systems.

Fans—laws and characteristics and drive selection. Elementary acoustics. Typical air conditioning equipment and evaporative coolers with automatic controls and acessories considered in relation to particular problems.

6333. Low Temperature Refrigeration. 4 Units Third Term.

Thermodynamic analysis of systems for low temperatures. Measurement of low temperatures. Methods of producing low temperatures—multistage vapour compression systems—cascade systems—Special refrigerants for low temperature applications—liquefaction of gases. Low temperature distillation processes for separation of gaseous mixtures. Industrial application of low temperatures.

6381. Steam Power Engineering. 3 Units Second Term.

Fuels : Position in India—combustion principles, problem in burning low grade fuels.

Steam generators and auxiliary plants, steam turbines, condensers, fuel and ash handling equipment, oil and water circulation system, cooling towers. Nuclear steam power plant.

Performance, testing and control of steam generators and turbines. Layout of typical steam power plant. Economics of steam power.

6431. Gas Turbines and Compressors. 4 Units Third Term.

Open and closed cycles, effect of variables, turbojet analysis and characteristics, thrust augmentation.

Axial and radial inflow turbines, axial and centrifugal compressors, combustion chambers, heat exchangers.

Blade stresses, vibration and cooling, dynamic similarity and noise, materials.

Characteristics of gas turbines for application to aircraft, automobile, locomotive, marine, etc.

6432. Internal Combustion Engines. 4 Units Third Term.

Thermodynamic analysis of air-standard cycles, fuel-air and actual cycles. Effect of operating variables on engine performance, fuel, cooling, lubricating and ignition systems. Torque analysis, balancing, vibration and noise. Governors and controls, characteristic features of engines for Marine, Aircraft, Locomotive, Industrial, Automobile and General purpose. Altitude performance and supercharging of engines, Dual fuel engines. Testing, fault finding, servicing, production and specifications of engines. Design of an engine.

6433. Combustion, Fuels and Lubricating oils. 4 Units Third Term.

Combustion of solid, liquid and gaseous fuels, combustion theories, reaction kinetics, heat and mass transfer. Pre-flame reactions, flame propagation, stability and quenching, combustion in reciprocating engine, gas turbines and jet engines. Measuring techniques. Molecular structure, rating, heating value and characteristics of fuels, atomaistion of fuel, specification of fuels. Aviation and rocket fuels.

Lubricating oil characteristics, friction and wear, solid, liquid, gaseous lubrication. Testing and specification of lubricating oils.

6434. Refrigeration Applications and Cold storage of Products. 4 Units Third Term.

Application of artificial cold in modern industries and construction work. Refrigeration requirements in food and chemical industries. Refrigerated transport. Investigation of deep freezing. Ice manufacture and practical applications of ice. Conditions for storage of various perishable goods. Application of inert gases for prolonged storage of products.

Calculation of heat gains through insulation, product loads and air infiltration. Warehouse design. Maintenance of refrigeration systems and conditioned chambers.

6435. Refrigeration Units. 4 Units Third Term.

Air cycles and their applications. The vapour compression cycle including its many modifications and different applications. Details of the different components of vapour compression systems—compressors, condensers, evaporators and expansion devices. Steam jet systems. Absorption systems. Auxiliary equipment and automatic controls for refrigerating systems.

6436. Steam Turbines : 4 Units Third Term.

Industrial and power station turbines. Staging arrangements. Multi-cylinder arrangements.

Construction details. Materials, manufacture and assembly Supervisory and control instruments. Lubrication system.

Special problems of large steam turbines. High pressure, high temperature expansion. Blade vibration. Design of condensers and accessories.

6437. Steam Generators. 4 Units Third Term.

Advanced power plant cycles, Station heat balance. Development of modern steam generators. Problems of increasing preasure, temperature and capacity. Design of radiant furnace, super-heater elements and heat recovery units. Auxiliary equipment. Special problems of materials, fabrication, transportation and erection. Operational problems.

6438. Nuclear Power Stations. 4 Units Third Term.

Survey of world power resources. Importance of nuclear power with special reference to India. Economics of nuclear power.

Basic concepts of nuclear physics. Chain reactions. Conditions for criticality, Reactor elements and types. Calculation of critical sizes for different configurations.

Reactor heat transfer, Reactor instrumentation and control.

Engineering properties of special materials. Analysis of power cycles incorporating nuclear heat sources and various working media. Layout of nuclear power stations.

Special operational problems.

6439. Fuels and Combustion. 4 Units Third Term.

Fuels for steam generation. Efficient utilisation of low grade fuels. Fuel handling and storage.

Combustion principles—combustion of solid, liquid and gaseous fuels.—combustion equipment—suspended combustion in radiant furnaces.

Steam power plant layout—Standard methods of testing fuels. Analysis of combustion products.

6511. Structural Design of Handling Equipment—I. 4 Units First Term.

Analysis of stresses and strains in three dimensions. Curved Beams ; Beam columns ; Torsion of non-circular members ; Buckling of column and plates ; Stress concentration. Analysis, basic principles and design of crane structures ; Detailed study of plane frames, influence line diagrams due to travelling loads, elastic deformation of framed structures. Assumptions of various types of loads and dead weights of different structures. Calculation of the allowable maximum stresses. Construction of lattices and plate structures of rivetted and welded types.

6512. Machine Elements Design. 4 Units First Term.

Clutches, couplings, belt, rope and chain drives, gear drives, Packings and seals. Thick cylinders and rotors, cover plates, bearings, Hook's Joints, Weldments, Curved Beams.

6521. Structural Design of Handling Equipment II. 4 Units Second Term.

Analysis of forces of determinate, indeterminate and redundant framed structures. Detailed force analysis and design of overhead travelling crane structures. Analysis of forces and detailed design of the jib of fixed and luffing types of rotary jib cranes. Design of structures pertaining to derricks, gantries and columns.

6522. Principles of Material Handling and Handling Devices 4 Units Second Term.

Principles of materials handling, classifications of the materials handling equipment—their characteristics and application principles, packaging and storage of materials, operation analysis and study of travel diagrams and flow process charts. Preparation of a new proposal.

6531. Design for Fatigue and Creep. 4 Units Third Term.

Fluctuating stresses and basic concepts of fatigue failures. Typical S-N diagram and endurance limit. Relation between endurance limit and tensile strength. Different stress cycles and effect of mean stress of the cycle on endurance limit. Influence of cycle frequency, temperature on fatigue strength. Size effect, stress concentration. Effect of surface treatment and residual stresses on fatigue strength. Corrosion fatigue and fretting corrosion. Influence of under-stressing and overstressing on fatigue strength, non-propagating fatigue cracks. Mechanical behaviour of materials at elevated temperatures. Short time tensile strength, effect of time and temperatures on tensile strength. Mechanisms of creep in metals. Long time creep test of metals and utilisation of creep data in Engineering design. Design of members under creep subjected to uniaxial and multiaxial loads.

6532. Design of Gears and Hydraulic Drives. 4 Units Third Term.

Ordinary trains. Exact and approximate design. Planetary trains. Reducers. Hoists Multiple speeds, speed series. geared types, automotive, screw cutting speed variators.

Hydro-kinetic drive, fluid coupling, torque convertor, fluid dynamometer.

Hydro-static drive, positive displacement pumps and motors, controlling valves like relief valve, by-pass valve, throttle valve, direction control valve, etc., filters, hydraulic servo-motor, different hydraulic circuits. speed control, hydraulic copying devices.

6533. Design of Machines and Machine Tools. 4 Units Third Term.

Individual finished designs by students of selected machine components applying the fundamentals covered in the other courses and also taking into account such factors as form, utility, cost and reproducibility.

Design of machine tool elements. Kinematics of machine tools, rigidity. Machine tool controls.

6534. Cams and Tooth outlines and multiple gear drives. 4 Units Third Term.

Cams : choice of motion for follower. Determination of the basic cam dimensions by analytical and graphical methods. Choice of pressure angles. Analytical and graphical methods of determination of cam profiles for various follower motions.

Tooth gearing—plane gearing, involute and cycloidal gearing, non-circular gears, space gearing, Bevel gearing, cylindrical gears with screw type teeth, worm gearing with cylindrical form of worm, cycloidal worm gearing. Kinematics and design of multiple gear drives.

6535. Mechanics and Design of Hoisting and Lifting Equipment. 4 Units Third Term.

Kinematics and dynamic analysis of the various component mechanism and design procedure of : (*a*) screw jacks, pulley blocks, winches and hoists, (*b*) hand operated and electric overhead travelling cranes and telphers, (*c*) stationary and travelling rotary jib cranes with fixed and level-luffing arrangements, (*d*) portal and semi-portal cranes, (*e*) tower cranes, derrick cranes, and mobile cranes, etc.

6536. Mechanics and Design of Conveyors and Elevators. 4 Units Third Term.

Kinematics, dynamics analysis and design procedures of various component mechanisms of (*a*) Scraper Apron, Plate and Belt conveyors (*b*) Belt and Chain Bucket elevators, (*c*) Screw and ribbon conveyors (*d*) Overhead Chain trolley conveyors, (*e*) vibrating rough conveyors and (*f*) Pneumatic conveyors.

6537. Mechanics and Design of Special cranes. 4 Units Third Term.

Kinematic analysis, functioning principles and design precedure of different constituent members of Underslung slewing cranes, Locomotive cranes, Ladle cranes, Ingot moulding cranes, Charging cranes, Stripper and soaking pit cranes, Annealing cranes, Scrap yard cranes and various types of Cable cranes.

6571. Machine Elements Design. 3 Units First Term.

(Same as ME 6512 but LDF of one unit only to suit the particular course).

6572. Engineering Drawing. 3 Units First Term.

Drawing standards and practice orthographic and Isometric projection. Freehand sketching, Drawing of machine elements, Reading of blue prints of detail and assembly drawing of machines.

6611. Machine Vibrations. 4 Units First Term.

Kinematics of vibration of single, two and multi-degree freedom systems, .vibration, forced vibration, vibration with and without damping, transient and steady state vibration. Solutions of vibration problems by : classical method, energy method, Lagrange equation, numerical method, matrix method and phase plane method. Vibrations of continuous systems.

6612. Theory of Elasticity and Plasticity. 4 Units First Term.

Analysis of stress and strain. Elastic stress-strain relationships. Two-dimensional problems in rectangular and polar coordinates. Simple problems in 3 dimensions.

Energy methods. Solutions by complex variables. Torsion of prismatic bars.

Plastic deformation and plastic stress strain relationships. Yield criteria. Problems in plastic flow of ideally plastic materials. Application to bars, beams, tubes, rotating discs, *etc*. Problems in plastic flow of strain-hardening materials.

6621. Mechanisms. 4 Units Second Term.

Classifications and analysis of mechanisms. Theory and properties of Robert's law. Space mechanisms, centre point curve, circle point curve, Euler-Savary equation, inflection circles. Polynoial and parametric techniques. Complex number and matrix algebra methods in kinematic synthesis. Synthesis of mechanisms.

6622. Experimental Stress Analysis. 4 Units Secohd Term.

Fundamental concepts in strain measurement. Photoelastic method of stress analysis-two and three dimensional. Mechanical and electrical strain gagues, strain rosettes and strain indicators. Brittle coating and grid methods. Methods of analogy.

6623. Advanced Strength of Materials. 4 Units Second Term.

Three dimensional stresses, theories of failure. Stresses and deformation in thick walled cylinders, Compound cylinders, stresses and deformation in rotating discs of constant and varying thickness—analytical and graphical solutions. Unsymmetric bending, Shear centre, Curved beams circumferential and radial stresses, deformation of curved machine members, stresses and deformation in closed rings and links. Beams on continuous elastic support. Theory of thin shells. Beam-columns-analytical and graphical-solutions. Bending of flat plates—stresses and deformation in circular and rectangular plates. Contact stresses—point and line contacts. Stress concentration due to geometric discontinuities.

6624. Instruments and controls. 4 Units Second Term.

Design principles of instruments for measuring temperature, pressure, level of liquid, velocity of flow, mechanical displacement, velocity and acceleration, etc. Accuracy and sensitivity. Dynamic behaviour of the Instruments.

Principles of feed back controls. Concept of error Dynamics of mechanical control systems. Transient and frequency responses. Stability criterion.

Application of the theory to the problems of designing automatic controls for temperature, pressure, level of liquid, mechanical dimensions, etc.

6625. Vibration and Shock Isolation. 4 Units Second Term.

Absorbers ; transmissibility, isolation, shock mounting. Dampers : friction, hysteresis magnetic, Construction, materials and measurements.

6626. Analysis of Stresses. 4 Units Second Term.

Three dimensional stresses, Theories of failure. Elements of elasticity theory. Stresses in thick cylinders, curved beams and of symmetrically loaded beams. Thermal stresses.

Introduction to methods of experimental stress analysis. Strain gauge and Brittle lacquer methods. Residual stresses and their determination.

6631. Theory of Lubrication and Bearings. 4 Units Third Term.

Hydrostatic lubrication. The generalised Reynolds' equation and its application to analysis of sliders, tilting pad, journal bearings, partial bearings, thrust bearings, externally pressurised bearings and dynamic loading.

Heat balance in bearings.
Theories of dry friction and boundary lubrication.
Effect of materials and lubricants on wear.

6632. Non-Linear Vibrations. 4 Units Third Term.

Non-Linear systems. Undamped, amped, self-excited, forced and parametrically excited non-linear vibration of single and two-degree of freedom and continuous systems. Isolators and non-linear characteristics, Stability theory and criteria of non-linear systems.

6633. Noise and Random Vibations. 4 Units Third Term.

Classification, sources, and measurements of noise in machines. Elimination and control of noise. Nature of random vibration as against complex vibrations. Notions of stochastic processes of mechanical origin. Power spectral densities, band width, acceleration density and mean square acceleration. Sources of random excitation and response of single-degree of freedom systems and multi-degree of freedom systems under random excitation. Minimization of damage from random vibration Instrumentation for random vibration analysis.

6681. Analysis of Stresses. 3 Units Second Term.

(Same as 6626 but LDF of 1 unit only to suit particular course).

METALLURGICAL ENGINEERING (Met.)

601. Experimental Methods in Metallurgy. 1 Unit.

Methods of obtaining high temperatures, temperature control, in furnaces, controlled atmosphere, vacuum systems, vacuum melting and casting, heat treatment techniques, powder metallurgy, preparation of pure metals and single crystal, advanced microscopic techniques, phase contrast, interference fringes, lineal analysis, point counting, electron microscopy and diffraction, use of strain gauge. Different methods of measuring activity of solid and liquid alloys, disfusion measurements, internal friction measurements and their uses in Physical Metallurgy. Film characteristics and microdensitometry, microradiography. Thin film techniques for transmission electron microscopy.

603. Ferroalloy production. 2 Units.

Basic concepts of thermodynamic principles governing carbothermic, silicothermic, and aluminothermic reduction of oxides. Role of ferroalloy industry in Iron & Steel making. Technology of some typical ferroalloy production incorporating recent advances in technology.

604. Plant layout and Furnace design. 2 Units.

General plant layout in an integrated steel plant-functional relationship among different units. Impact of modern improvements of the technology on the layout of an integrated steel plant. Essential features of design of Iron & Steel making units—blast furnace, converters, open hearth furnaces, recent advances in the theories of design of such units. Suitability and limitations of application of operational data in design.

605. Recent trends in Ferrous Metallurgy. 2 Units.

Critical appraisal of improved techniques in Iron & Steel making to increase productivity of units and quality of product, based on recently developed technology. High top pressure operation of blast furnace fuel injection in blast furnace, oxygen steel making in converters, open hearths and other units, vacuum and continuous castings, casting under pressure, application of tracer techniques.

606. Pyrometallurgy of Non-ferrous metals. 2 Units.

Theoretical aspects of roasting and sintering, sintering machines and its design, non-ferrous blast furnaces and reverberatory furnaces, thermodynamics of blast furnace and reverberatory furnace smelting, theoretical foundations of slag and matte formation, constitution of slags, matte-slag equlibria, converter processes, design of converters, thermodynamics of converting, refining techniques—theoretical aspects, electrosmelting process.

607. Hydrometallurgy and Electrometallurgy. 2 Units.

Leaching process—temperature and kinetics, leachants, high temperature and high pressure leaching of sulphide and oxide ores, oxidative leaching. Metal recovery from leach liquors—ion exchange methods, high temperature and high pressure reduction by molecular gases, H_2, CO, SO_2, use of catalysts, homogeneous catalytic reactions. Reversible and irreversible electrode processes in aqueous solutions and melts, electrocnductivity and transport phenomena, decomposition potential in melts, their determination, polarization, metal recovery from molten electrolyte, electrode efficiency.

608. Recent advances in Non-ferrous Metallurgy. 2 Units.

Application of oxygen in non-ferrous metallurgy, modern processes for roasting, smelting, refining in non-ferrous metallurgy, fluidised bed roasting, flash roasting, cyclone smelting, zone refining, hydrogen reduction of oxides, metallothermic reductions *etc*.

609. Physical Metallurgy. 3 Units.

Thermodynamical consideration of liquid-solid and solid-solid reactions in metals and alloys, application to phase diagrams and important alloy systems, kinetics of nucleation and growth in such transformations, application to precipitation phenomena. Decomposition of Austenite—Pearlitic, Bainitic and Martensitic reactions, modern theories, pro-eutectoid precipitation—growth and morphologies, review of recent work, tempering of plain carbon and alloy steels—precipitation of different types of carbides, effect of stress, precipitation phenomena in important non-ferrous alloys. Grain boundary, polygonised boundary, surface free energy, importance of dihedral angles—critical review of recent work.

The approach is primarily theoretical rather than descriptive—a substantial amount of reading to be assigned.

610. X-Ray Metallography and Electron diffraction. 3 Units.

Review of topics covered in the undergraduate level, different X-Ray diffraction methods, reciprocal lattice, intensity of diffraction lines, absent reflection and structure determination. Fourier method, effect of particle size, shape, strain, and stacking faults on diffraction lines, Applications—orientation determination of single crystals and its application in plasticity methods, powder methods, precision parameter determination, phase boundary, percentage of small quantities of other pahses in a structure. Low angle scattering—structure of precipitation handed alloys, stress measurements, preferred orientation. Image formation and contrast from crystals, kinematical theory of diffraction contrast, effect of beam divergence, absorption etc., elements of electron optics, deflection in electrostatic and magnetic fields, magnetic lenses, sperical and chromatic aberration, resolving power, depth of field and focus, magnetic electron microscope—general description, electron gun, condenser, objective and projection lenses, calibration of microscope, selected area of diffraction, preparation of specimens, application.

611. Physics of Metals. 2 Units.

Review of topics of the undergraduate level, crystal structure, electrical and magnetic properties, transition metals, resonating valence bond theory, anti-ferromagnetism semiconductors. Specific heat of metals, different theories formation of vacant atomic sites, long and short range order, anti-phase domain. General alloy theory—factors operative, size factor, and influence of ionic radii alloy structures, applications, theory of electron componnd super lattice formation, lattice spacing and effect of electron energy, effect of compound formation on solid solubilities in binary and ternary systems, application to commercial alloys. Anelastic phenomena in metals and alloys, stress-induced ordering, effect of cold work, point defects etc., Anisotropy of metals and alloys, modulus of elasticity and other properties, effects on phase transformations and plastic flow.

612. Dislocation theory and Mechanism of plastic flow. 2 Units.

Development of the theory, stresses due to edge and scre dislocations, strain energy of dislocations, interaction of dislocations, Lomer-Cottrell Barrier, partial dislocations, dislocation climb, jog formation, effect of solute atom on the energy of dislocation. Mechanism of plastic flow in single and polycrystalline metal, critical stress for dislocation movement, effect of crystal structure on crystallography of twinning, deformation bands. Stacking faults and their energy, energy stored in cold worked metal recovery, recrystallisation, and sub-boundary formation, energy of grain boundary. Deformation during creep and fatigue, anelasticity, internal friction in metals and alloys, Snoek's effect, stress induced ordering, Bauschinger effect, fracture—types of fracture, including cleavage, creep and fatigue, theories of fracture, brittle failure. Precipitation hardening, role of dislocations and precipitates, effect of plastic deformation.

613. Magnetic meterials. 2 Units, Third Term.

Experimental methods for evaluating the magnetic properties Theory of ferromagnetism and paramagenetism, magnetostriction. Preparation of ferromagnetic meterial by powder metallurgy methods. Different types of ferromagnetic materials and their uses.

614. High temperature materials. 1 Unit.

Creep and fracture at elevated temperature, metallurgical variables incluencing properties of heat resistant alloys production and fabrication of heat resistant alloys, selection of high temperature materials for aircraft, gas turbines, steam power plant etc.

615. Mechanical working of metals—theory and applications. 2 Units.

Review of the topics of undergraduate level, detailed study of rolling, wire-drawing, extrusion, deepdrawing. Internal stress developed in different forming operation and its measurement. Critical review of the different theories of rolling, and their application, calculation of rolling load, torque, and their experimental measurement, power requirement in a rolling mill. Modern physical methods in control and inspection, optical methods, non-destructive testing, dimensional measurement, instrumentation of plant.

616. Powder Metallurgy. 2 Units.

Physical and chemical methods for production of metal powders. Compacting and sintering of alloy powder compacts and resulting properties of the finished compacts. Problems of adhesion, diffusion, recrystallisation, and grain growth as applicable to the field. Recent advances in powder metallurgy, dispersion strengthening, theories of compacting and sintering. Powder Metallurgy products—Cermets, Porous bearings, etc., industrial application of powder products with special reference to materials available in India.

617. Diffusion in metals. 2 Units.

Formal basis of diffusion theory, mechanism of diffusion, diffusion in alloys and Kirkendall effect, grain boundary and surface diffusion, migration of grain boundaries, diffusion and high temperature oxidation of metals, gas-metal diffusion and internal oxidation, diffusion of sintering.

618. Advanced Phase diagrams. 2 Units.

Determination and interpretation of complex phase diagrams with emphasis on ternary systems. Familiarity with conventions used in representation of phase equilibria Development of space perception with the help of mechanica aids like three-dimensional models, applications to important industrial alloys.

619. Theory of Metallurgical Processes. 3 Units.

Thermodynamics and kinetics of combustion processes—solid and gaseous fuels. Thermal decomposition of carbonates, oxides, sulphides, thermodynamics and kinetics of reduction of iron oxides by solid carbon and gaseous reducing agents. Slags—chemical and mineralogical compositions—structure of molten slags—modern theories—general character of slag-metal reactions in oxidising melts. Solutions—ideal and non-ideal, real and regular solutions—structure of molten metals. Elements of the theory of deoxidation. Gases in steel. Fundamentals of the kinetics of metallurgical processes—zero, first and second order reactions. Collision and absolute reaction rate theory, application of absolute reaction rate theory to heterogeneous systems.

620. Metallurgy of rare metals and atomic reactor metals. 2 Units.

General introduction to the rare metalls and atomic reactor metals—classification of rare metals—survey of technological methods of obtaining rare and atomic reactor metals from their ores—metallurgy of W, Mo, V, Ti, Zr, Nb, Ge, U, Th, etc., properties of the metals and their compounds, fields of application of Physico-Chemical aspects of the reduction of the compounds, reduction by carbon, hydrogen, metallothermic reduction, production of compact and ductile metal by metallotheramic method, electrosmelting.

621. Foundry Science and Engineering. 3 Units.

Molding materials and sand compactions, special methods of molding and coremaking, solidification, risering and gating, gases in metals, mold-metal reactions, physical chemistry of melting and metallurgical control, metallurgy of cast iron and other casting alloys, malleable and ductile iron, special foundry practices.

Met 622. Material Technology. 4 Units, First Term.

(a) Crystal structure of pure metals, grain formation in metals, nucleation and grain growth, cold working of metals, deformation mechanisms, role of dislocations, effect of cold working on properties, annealing, structure of alloys, solid solutions etc., binary and ternary diagrams of simple systems, study of Fe-C, Cu-Zn, Cu-Sn, Cu-Ni, Al-Cu, Al-Mg systems, heat treatments and properties, T-T-T diagrams and their uses, low alloy structural steels, heat treatment of alloy steels in general, special steels—stainless steel, special tool steel, spring steels, Hadfield Mn steel, alloys for high temperature use.

(b) Structure of atom, periodic classification of metallic and non-metallic elements, electronic configuration of important elements and its influence on the properties, bonds in metals and non-metals, free electron theory and Zone theory of metals, applications, electrical and thermal conductivity of metals, dia and para magnetism, specific heat of metals with special reference to those in transition group, ferromagnetism and magnetic materials, different types of bands in solids and their distinctive properties, Fermi energy, band theory of solids.

(For Mechanical Engineers).

624. Engineering Physical Metallurgy. 2 Units, Third Term.

The origin of a metallic structure by the freezing of a liquid *e.g.* grain formation, equiaxed and columnar grains, dendrites, behaviour of insoluble impurities during grain formation and effect on the properties of metals. Elastic and plastic deformation of single crystal and polycrystalline meterials. Recovery, recrystallisation and grain growth of deformed material. Grain refinement, cold working and hot working, finishing temperature, elements of dislocation theory. Binary alloys—structural changes with temperature, equilibrium phase diagrams, different methods used to determine the phase boundaries, thermal analysis, metallographic, electrical resistivity, X-Ray diffraction, magnetic analysis, dilatometry. Eutectic reaction structure of eutectic alloys, complete solid solubility and effect of incomplete diffusion during free zing cored dendritic structures, elimination of coring, partial solid solubility, structures of partially soluble alloys by slow cooling and rapid cooling, Widmansttatten structure, intermetallic compounds, peritectic reaction, some typical cases, ternary diagrams. Study of important ferrous and non-ferrous alloys.

(For Chemists and Physicists).

625. Corrosion. 2 Units, second and Third Terms.

Fundamental background with emphasis on special topics like Pourbaix diagrams, kinetics of corrosion processes, inhibitors, passivation, potential time, and polarization studies. Stress corrosion, environment effect and material aspect, role of stress and corroding media, minor impurity in materials. Hydrogen embrittlement, accelerated testing, modern methods of corrosion studies. Oxidation of metals and alloys, mechanism of oxidation processes, alloying elements, effect on the rate processes.

630. Seminar. 1 Unit.

MINING ENGINEERING (Min.)

611. Plant Design and Ore Processing. **1 Unit—Second Term and 4 Units—Third Term.**

Ore handling equipment—Conveyors and elevators ; Pneumatic and hydraulic transport. Storage and stockpiling of minerals. Design of mineral dressing plants, selection and layout of major equipment. Cost analysis. Economics of mineral beneficiation.

Study of major mineral beneficiation plants in India.

Project work on plant design.

612. Advanced Mineral Economics. 2 Units—Third Term.

Study of Mineral market, Trends of production and consumption.

World and Indian mineral resources.

Mineral conservation—its need and enforcement.

Optimum exploitation of mineral resources for industrial development.

Sampling—theory and techniques.

Theories of mine valuation, taxation.

PHYSICS AND METEOROLOGY (Ph.)

601. Applied X-rays. 2 Units (2-0).

Design aspects of X-ray generators and detectors. Group theory of Crystal systems. Dynamical theory of X-ray diffraction. Diffuse scattering. Study of lattice disorders. Flourescence analysis. Advances in X-ray optics including spectroscopy. Advances in Crystal structure analysis including electron and neutron diffraction.

602. Solid State Technology. 2 Units (2-0).

Characterization of materials for Solid State Physics, Crystal growing, Zone refining, Semiconductor Physics, Review of Modern Theories of Solids.

Experimental Techniques and applications of Semi-conductor Devices, Thermoelectric Refrigeration, surface properties, thin films and catalyses on Semiconductors.

603. Experimental Methods in Physics. 2 Units (2-0).

Kinematical method in design of experiments, High vacuum Technique, electronic measurements, Servo Mechanism, Low temperature Physics, experimental spectroscopy, high temperature—production, measurement and control, electric and magnetic measurements.

604. Industrial Physics Laboratory. 3 Units (0-9).

605. Applied Optics. 2 Units (2-0).

Optical instruments, construction and design. Illumination and photometry. Applications of interferometry, polarimetry etc. Principles of spectroscopy. Flame and combustion spectra.

606. Mathematical Physics. 2 Units (2-0).

General theory of a system of linear equs. Vector spaces. Transformations of vector spaces. Various kinds of matrices, orthogonal unitary Hermitian etc. Eigenvalues of matrices.

General theory of partial differential equations of the first order, the theory of characteristics, Dependence of solutions on initial data, Methods of solution. Part diff. equ. of the second order with constant coeff. in particular, Laplace's equ. wave equ. and the equ. of heat conduction. Green's functions. Separation of Laplace's equ. in cylindrical and spherical coord. The Bessel and Legendre functions. Polynomials of Legendre, Hermite, Laguerre. The hypergeometric and the Gamma function, quadraric form, Tensors. Fourier series and integrals. Laplace transformation. Elements of group theory. Complex variables, Cauchy's theorem. Contour integration. Taylor's theorem. Analytic continuation. Branch points of a multivalued fn. Elements of the theory of integral equations.

607. Nuclear Radiations and their applications. 2 Units (2-0).

Experimental techniques in Nuclear Physics and Nuclear Instrumentation, Mass spectrometry, Nuclear reactions and models, Selected topics in nuclear physics *e.g.* coulomb excitation, Stripping reactions, copallations etc.

622. Material Technology. 4 units., First Term.

Atomic structure, energy-levels for electrons in atoms, electronic configuration of important elements. Bonds in solids, Crystal structure and anisotropy of physical properties of solids. Sp. heat of solids, temperature variation and sp. heat of transition elements. Thermal radiation. Free electron theory of metals, Fermi energy. Electrical and thermal conductivity of metals. Formation of energy-bands, effective mass, and holes, semiconductivity, Magnetic Properties of Solids.

(For Mechanical Engineers)

661. Physics. 2 Units.

Basic concepts of Physics. Thermal radiation-Quantum theory, Bohr's theory, Photo-electric phenomenona, Compton-effect. Wave mechanics, Quantum numbers, exclusion principle. Properties of X-rays, emission and absorption spectra, scattering by electron, atoms and crystals, electron diffraction. Electronic configuration of atoms and periodic table. Stark effect and Zeeman effect. Atoms in electromagnetic fields, dispersion relations, transition probability and life-time, band-width of spectral lines. Formation of molecules, molecular spectra. Electron in a potential well, tunnelling effect harmonic oscillator. Electron in a periodic potential, band theory. Brillouin Zones, effectivemass, holes. Free electron theory of metals and its important applications, Fermi-Dirac statistic, Fermi-level and Fermi-surface. Semiconductivity, impurity-states, life-time and recombination process. Metal-metal and metal semiconductors contacts surface-states, rectification, transistors.

(For Electrical Communication Engineers)

662. Physics of materials. 2 Units, Third Term.

Introduction to crystal structures of solids, classification of solids, nature of binding and general characteristics of the physical properties of crystals. Lattice defects, structure-sensitive properties, energy levels of real crystals. Dielectric properties, molecular mechanism of polarisation, electronic, atomic and orientational polarisation, dipole relaxation and dielectric losses, Mossotti catastrophe and local fields short discussion of Piezo-electricity and Ferro-electricity, conduction and dielectric breakdown, Dia-, para-, Ferro-, Antiferromagnetism, magnetic properties of metals and semi conductors, Ferrites. Electrical properties of ionic solids, metals and semi conductors. Thermal and optical properties of simple solids, phonons and excitons. Energy-transfer inside solids and related phenomena.

(For Electrical Communication Engineers)

671. Physics. 2 Units. First Term.

General properties of liquids and gases, elements of kinetic theory of gases and transport phenomena, motion of liquid, Bernoulli's equation, viscosity, conductivity and diffusion. Electrical measurements of A.C. and D.C.

(For Soil Technologists)

681. Physics. 2 Units. First and Second Terms.

Kinetic theory and transition to mechanics of continua, advanced topics in general properties of matter ; Maxwell's equations and its relation to circuits, selected topics in modern physics ; experiments involving interferometry, spectroscopy, measurement of fundamental physical constants, and physical constants of solids.

(For Mathematicians)

691. Physical measurements. 2 Units. Second Term.

Principle of measurement, measurement of fundamental physical quantities.

Measurement of particle size, sq. surface of powders and colloids, Thermal measurements —temp. measurement and control, thermal conductivity ; Measurement of electrical quantities —current, voltage, resistance, inductance, capacitance, Q ; Measurement of transients ; Non-distructive test of materials by ultrasonics, X-ray diffraction interferometry etc. special measurements.

(For Civil Engineers)

692. Quantum Mechanics for Metallurgists. 2 Units.

Review of the basic postulates and working rules of Quantum Mechanics—Their applications to Solid Physics and Metallurgy.

693. Imperfections in Solids. 2-6 Units.

2 to 6 units by arrangement, on some of the following or related topics : Lattice vibrations, Order disorder phenomena, radiation damage, Theory of dislocation, study of X-ray diffraction, line broadening, colour centres, structure of liquids, structure and properties of amorphous substances, low angle scattering etc.

694. Special topics in Theoretical Physics. 2-6 Units.

2 to 6 units by arrangement, on some of the following or related topics : Functional analysis with applications, Lie group with applications, groups with special reference to Elementary particles, continuous groups, dispersion relations, Fourier integrals and integrals transforms etc.

695. Special topics in Crystal Physics. 2-6 Units.

2 to 6 units by arrangement, on some of the following or related topics : Crystal Morphology and Crystallometry, Derivation and determination of space and point groups, direct methods on crystal structure determination, physical properties of crystals, Optical properties of crystals, crystal elasticity, cohesion in crystals, properties of thin films, theory of semi-conductors etc.

696. Quantum Mechanics III. 2-6 Units.

2 to 6 units by arrangement, on some of the following or related topics : Dirac Formalism, Hartree Fock Method, Interaction of radiation with matter, Quantum Mechanics on Solid State Physics, valency problems and molecular orbitals, Relativistic Field Theory, Elementary particles etc.

PART V

REGULATIONS

RESEARCH FACILITIES, RESEARCH TRAINING.
DEGREE OF DOCTOR OF PHILOSOPHY (Ph.D.)
DEGREE OF DOCTOR OF SCIENCE (D.Sc.)

SCHEDULE XXXV

REGULATION No. 41

Research Facilities and Training

Doctorate Degrees

1. The Institute shall provide facilities for research and training in Research Methods in the various disciplines in the different teaching departments. A duly qualified candidate may supplicate for the following Research Degrees of the Institute:

(*a*) Doctor of Philosophy (Ph.D.) and

(*b*) Doctor of Science (D.Sc.).

2. A research student or a member of the staff of the Institute may register for the Degree of Doctor of Philosophy in any of the subjects mentioned below:

(*i*) Aeronautical Engineering, (*ii*) Botany, (*iii*) Soil Science, (*iv*) Agronomy, (*v*) Agricultural Engineering, (*vi*) Architecture, (*vii*) Planning, (*viii*) Chemical Engineering, (*ix*) Chemistry, (*x*) Civil Engineering, (*xi*) Electrical Engineering, (*xii*) Electronics and Electrical Communication Engineering, (*xiii*) Geology, (*xiv*) Geophysics, (*xv*) Geo-Chemistry, (*xvi*) Psychology, (*xvii*) Mathematics, (*xviii*) Statistics, (*xix*) Mechanical Engineering, (*xx*) Metallurgical Engineering, (*xxi*) Mining Engineering, (*xxii*) Naval Architecture, (*xxiii*) Physics, (*xxiv*) Meteorology or in any other subject as the Senate may decide taking into consideration the facilities available.

3. In order to supplicate for the Degree of Doctor of Philosophy, a research student must have a Bachelor of Technology or Bachelor of Architecture or Master of Science Degree of the Institute or qualification deemed equivalent and must have devoted at least three years on study and research from the date of registration for the Degree except that a candidate who has either received the degree of Master of Technology of this Institute in the appropriate branch or possesses equivalent qualification may be allowed to supplicate for the Degree of Doctor of Philosophy after two years of research training at the Institute. In exceptional cases, the Senate may reduce the minimum period to two years also for a candidate who has received the postgraduate Diploma (DIIT) of the Institute.

4. The Senate may, however, grant special dispensation to a teacher of the Institute in recognition of his previous work elsewhere and his contribution to the advancement of engineering, technology or science and reduce the prescribed period, provided he has put in a minimum of one year's work at the Institute.

5. The Senate may permit a candidate to submit his thesis three months earlier than the stipulated date if the Doctoral Scrutiny Committee recommends that the work has been completed in all respects to its satisfaction.

6. A candidate who has obtained a degree of Doctor of Philosophy of a recognised University or a Master's Degree in the appropriate branch of engineering, technology, science and arts may offer himself for the degree of Doctor of Science provided he has devoted not less than five years to research in the subject of his specilization.

SCHEDULE XXXVI

REGULATIONS No. 42

Admission to Research Training

(*a*) *Educational Qualifications*: Admission to Research Training course shall be made on the result of an Entrance test as laid down in Schedule XXXVII on the recommendation of an Admission Committee of the department concerned with at least two teachers from allied departments.

Candidates seeking admission to Research training in Engineering and Technological subjects must have a Bachelor's Degree in engineering or technology preferably with some industrial/teaching/research experience or a Master's Degree in engineering or technology.

Candidates seeking admission to Research Training in Science subjects must have a Master's Degree in the appropriate branch of Science or qualifications deemed equivalent.

(b) *Age Limit*: To be eligible for admission to Research Training, a candidate should be below 27 years of age on the date of his joining the training. Director may, however, relax the age limit provided he is satisfied that the candidate is otherwise suitable for Research Training.

(c) *Standard of Physical Fitness*: To be eligible for admission to these courses a candidate should fulfil the prescribed standard of physical fitness as given below:

Height	... 1.6 metre
Weight	... 46 Kilogram
Chest Measurement	... 76 cm. with satisfactory limit of expansion.
Heart and lungs	... There should be no abnormality.

Hernia, Hydrocile, Varicocele and Piles are temporary disqualification to be rectified before joining.

Vision	... Better eye		Worse eye	
	6/9	or	6/9	Corrected
	6/6		6/12	with glass.

Eyes should be free from congenital or other diseases.

Decision of the Institute Medical Officer in regard to the fitness of a candidate shall be final and no appeal to a higher authority shall be allowed.

SCHEDULE XXXVII

REGULATION No. 43

Graduation Requirement

DEGREE OF DOCTOR OF PHILOSOPHY (*Ph. D.*)

1. A candidate for the Degree of Doctor of Philosophy must comply with the requirements as prescribed in Schedule XXXVI.

2. *Registration*: [A candidate desirous of entering on the curriculum for the Degree shall apply to the Registry in the prescribed form with prescribed fee stating his proposed 'major field of study'. Registration shall ordinarily be made on the basis of a written test or interview or both as may be decided by the Doctoral Scrutiny Committee after considering the application. Registration with retrospective effect earlier than six months from the date of application shall not, ordinarily, be permissible.] On the recommendation of a Doctoral Scrutiny Committee the Senate may permit a teacher of the Institute to supplicate for the Degree on getting himself registered six months prior to submission of thesis provided he fulfils all other requirements.

3. *Supervisor*: The Head of the Department shall recommend for each candidate a supervisor from amongst the members of the teaching staff who shall be responsible for guiding the candidate in his study and research. The Supervisor is required to report periodically to the Head of the Department on the progress of the candidate. In special cases joint supervision even by teachers of more than one department may be permissible.

In the case of a member of the academic staff of the Institute having sufficient experience in the field of his specialisation, the appointment of a supervisor shall not be obligatory and he may be permitted by the Senate to work independently on the recommendation of Doctoral Scrutiny Committee.

4. *Minimum Period of Research*: After registration, a candidate shall be required to devote a minimum period of three years to advanced study and research except as otherwise provided in Schedule XXXV, of which a minimum of twelve months must be spent in residence at the Institute.

On the recommendation of the Supervisor(s) and the Doctoral Scrutiny Committee, a candidate may, as a special case, be permitted by the Senate, to conduct a part of his research work in the field or in recognised establishments.

5. *Language Requirement*: A candidate shall be required to show proficiency by examination or otherwise in one of the foreign languages (besides English), namely, French, German, Russian, as may be decided by the Senate at the time of registration. The proficiency shall be attained preferably within one year of registration.

6. *Qualifying Examination*: Any time prior to submission of the thesis a candidate shall be required to show evidence of advanced study, by oral or written examination or otherwise, as may be decided by the Senate on the recommendation of the Doctoral Scrutiny Committee, in three subjects, equivalent to a minimum of 12 units of postgraduate course; of these, two shall be chosen from his field of study and one from any allied field. The Senate may, however, on the recommendation of the Doctoral Scrutiny Committee, grant exemption in one or more subjects if the candidate has previously acquired proficiency in those subjects. A candidate may, if considered necessary, attend with prior permission an appropriate postgraduate course at the Institute without payment of any additional fee. It is expedient that every candidate should meet these requirements as soon as possible after registration.

7. *Synopsis*: A candidate who, in the opinion of the Supervisor(s) has made adequate progress in his research may apply for permission to the Head of the Department to submit the thesis enclosing two copies of the synopsis of the thesis. The synopsis shall be considered by the Doctoral Scrutiny Committee. In the case of a member of the academic staff permitted to work independently he may apply for permission to the Head of the Department to submit two copies of the synopsis of the thesis.

8. *Submission of Thesis*: A candidate shall be required to submit through the Head of the Department in triplicate or quadruplicate as the case may be and in the approved form his thesis within a maximum period of two months from the date of submission of the synopsis.

9. *Thesis Examination*: If the Doctoral Scrutiny Committee is of the opinion that the synopsis is of the required standard, it shall recommend to the Senate a panel of names of at least five specialists to adjudicate upon the thesis under consideration. The Senate shall then appoint three or four examiners—one of whom shall be the supervisor, if any. These examiners shall constitute the Board of Examiners. The Senate shall also appoint a Viva-voce Board comprising the Supervisor, one Examiner and the Head of the Department and at least two teachers from allied Departments. In case, all the Examiners are foreigners an Indian Specialist shall be appointed as the second member of the viva-voce Board. In the case of a member of the staff of the Institute permitted to work independently the Board of Examiners and the Viva-Voce Board shall include, in the place of Supervisor, a senior teacher of the Institute in the allied field of specialisation or an outside expert to be appointed by the Senate on the recommendation of the Doctoral Scrutiny Committee. All correspondence with the Examiners shall be made by the Registry. The names of the members of the Board of Examiners shall be kept strictly confidential.

Constitution of Viva Voce Board

10. The thesis shall be examined separately by two or three external examiners and the supervisor or the third/fourth examiner, as the case may be. Each examiner shall report separately on the thesis and forward his recommendation to the Registry which shall place the reports together before the Doctoral Scrutiny Committee.

11. *Viva-voce examination*: Reports of the examiners shall be final. On receipt of the reports from the Registry, the Doctoral Scrutiny Committee shall consider them and recommend, if the reports are unanimous and favourable, that the candidate be required to appear before the Viva-voce Board appointed for the purpose. The Viva-voce Board shall test the depth and breadth of knowledge of the candidate in the special field of research or Design or Development and also in allied fields of study. The Viva-voce Board shall report on the competence of the candidate and submit its recommendation for consideration of the Doctoral Scrutiny Committee which shall place before the Senate the reports of the Examiners of the thesis and of the Viva-voce Examination.

12. In case the two External Examiners of the Thesis differ in their opinion on the merit of the Thesis the Senate, may on the recommendation of the Doctoral Scrutiny Committee, refer the Thesis to a third External Examiner whose veredict shall be deemed as final.

13. If the majority of the examiners report that the thesis is not up to the standard for the Degree, the Senate may, on the recommendation of the Doctoral Scrutiny Committee, permit submission of a revised thesis on payment of the prescribed fee after a suitable time to be fixed by

the Senate. In no case, however, resubmission of a work without modification along the line of criticism made by the examiners of the thesis shall be allowed, nor shall there be a case of resubmission of a thesis rejected for the second time.

14. If the members of a Viva-voce Board are not satisfied with the oral examination, the Senate may, on the recommendation of the Doctoral Scrutiny Committee, and of the Viva-voce Board permit the candidate to appear again.

15. *The standard of the Thesis*: The thesis shall be a piece of research work characterised either by discovery of facts or fresh approach towards interpretation of facts and theories or an independent design or development. It should bear evidence of the candidate's capacity for practical examination and judgment and also his ability to carry out independent investigation, design or development.

16. The thesis shall have a preface in which the candidate shall state whether the thesis is based on the discovery of new facts by him or of new relations of facts observed by others or whether it constitutes mainly an exhaustive study and criticism of the published work of others or a design or development work undertaken, and how it contributes to the advancement of knowledge in the particular field of research chosen. The candidate shall further forward a statement indicating the sources from which his information has been derived and the extent to which he has based his work on the work of others and shall indicate which portion or portions of his thesis he claims as original. Where a candidate presents a joint-work, he shall state clearly the portion which is his own contribution as distinguished from the portion contributed by his collaborator. The candidate may also submit copies of original publication in support of his candidature.

17. Before the thesis is sent to the examiners including the Supervisor for examination the synopsis as incorporated in the thesis and the preface should be scrutinised by the Doctoral Scrutiny Committee and approval of the Chairman of the Senate taken.

18. A thesis submitted for the degree of Doctor of Philosophy shall not be one for which a Degree, or Diploma, has already been awarded.

19. Nothing contained in these Regulations shall preclude a candidate from publishing, either independently or jointly with others, the results of the work incorporated in his thesis, at any time before submitting the thesis for examination provided that three copies of the paper shall be submitted with the thesis.

20. Subject to the provisions of the Ordinances and Regulations the Degree of Doctor of Philosophy (Ph.D.) in engineering, technology, science and arts shall be conferred on a candidate who has undertaken research work for a period as laid down in Schedule XXXV and has attained the requisite standard in the particular field of study as approved by the Senate.

21. *Requirement for the Degree*: A candidate shall be deemed to have attained the requisite standard for the Degree of Doctor of Philosophy, if in the thesis and subsequent Viva-voce test he has given evidence of originality, a thorough grasp in the special field of research or design or development and a fair knowledge in the allied fields of study.

22. On the recommendation of the Doctoral Scrutiny Committee and after considering the reports of the Board of Examiners and of the Viva-voce test the Senate shall decide whether the candidate may be recommended to the Board of Governors for the award of the Degree of Doctor of Philosophy.

23. Under special circumstances, the Senate may authorise its Chairman to recommend, to the Board of Governors, a candidate for the award of the Degree of Doctor of Philosophy, if the reports of the Board of Examiners and the Viva-voce Board are unanimous and favourable and are approved by the Doctoral Scrutiny Committee, and report the case to the Senate at its subsequent meeting.

24. The Senate may, on the recommendation of the Doctoral Scrutiny Committee, deviate from the prescribed Ordinances and Regulations relating to registration, submission of the thesis and its adjudication and consider special cases of candidates on merits.

25. For the Degree of Doctor of Philosophy in any branch of study the graduate shall receive a Diploma wherein shall be set forth the branch in which he has qualified.

SCHEDULE XXXVIII

REGULATION No. 44

Graduation Requirement

Degree of Doctor of Science (D.Sc.)

1. The Senate shall determine in respect of a candidate for the Degree of Doctor of Science the eligibility for submitting the thesis on the recommendation of the Doctoral Scrutiny Committee set up for the purpose and after considering the synopsis of the thesis.

2. After the synopsis of the thesis has been found to be of the required standard, the Doctoral Scrutiny Committee shall recommend to the Senate a panel of names for appointment as examiners to adjudicate upon the thesis.

3. The Senate shall appoint, ordinarily from the panel of names recommended by the Doctoral Scrutiny Committee, at least three experts to examine the thesis and adjudicate upon the merit of the thesis.

Ordinarily acceptance of a thesis for adjudication is contingent on important parts of it having been published either as a book or in Journals of standing.

4. A candidate for the degree of Doctor of Science shall, on the recommendation of the Doctoral Scruitiny Committee and with the approval of the Senate, submit for examination, in triplicate or quadruplicate as the case may be, a thesis or a published memoir of work. When published papers are submitted these should be as documents to which reference has been made in a brief but comprehensive account in the form of a thesis. The thesis shall be a record of original research undertaken by the candidate and actually carried out by him, It shall be accompanied with a declaration signed by him that the work has been done and the thesis prepared by him for the D.Sc. degree.

5. Each Examiner shall be required to examine the thesis independently and forward his report with recommendations separately to the Registry. All the reports together shall first be considered by the Doctoral Scrutiny Committee which shall make recommendations thereon to the Senate.

6. Ordinarily, a candidate for the Degree of Doctor of Science shall not be required to appear at a Viva-voce Examination unless the examiners make a special recommendation to that effect.

7. Subject to the provisions of the Ordinances and Regulations, the Degree of Doctor of Science shall be conferred on a candidate when the Senate is satisfied that the thesis is of distinction as a record of original research undertaken by the candidate or of an important engineering work or applied art designed by himself or an original contribution to learning and that the Examiners' reports are unanimous and favourable.

8. If any one of the Examiners do not consider the thesis to be of the standard for the Degree of Doctor of Science but recommend that the thesis be accepted for the degree of Doctor of Philosophy, the Doctoral Scrutiny Committee shall consider the recommendations of the examiners after obtaining a written consent from the candidate that he is agreeable to be considered for the degree of Doctor of Philosophy and send their recommendations to the Senate. In such a case, it shall be necessary for the candidate to appear at the Viva-voce Examination by a Viva-voce Board constituted for the purpose.

9. In the event of a thesis being found inadequate by the examiners the Senate may, on the recommendation of the Doctoral Scrutiny Committee, permit resubmission of revised thesis on payment of the prescribed fee, after a period to be fixed by the Senate.

10. For the Degree of Doctor of Science in any branch of study the graduate shall receive a Diploma wherein shall be set forth the branch in which he has qualified.

11. The Senate shall be competent, on the recommendation of the Doctoral Scrutiny Committee to deviate from the prescribed Ordinances and Regulations and consider special cases of candidates on merits.

SCHEDULE XXXIX

REGULATION No. 45

Admission

Intake, Eligibility, Reservation of Seats

A. Admission:

1. Admission shall not ordinarily be granted except to the First Year of the undergraduate and postgraduate courses of studies. On the recommendation of the Admission Committee, a student with advanced academic background may be admitted at a higher stage of the course.

B. Annual Intake:

1. The number of students to be admitted to the under-graduate and post-graduate courses and for Research Training shall be, as may be fixed by the Board of Governors from time to time, either on its own initiative or on the recommendation of the Senate. On the recommendation of the Admission Committee, students in excess of the number, fixed for a particular Branch or Course, may be admitted, provided that such admission shall not create teaching difficulties and entail lowering of the standard of education, that there are seats in the Halls of Residence, and that this shall not adversely affect admission in future years.

2. A member of the teaching staff possessing requisite qualifications and having adequate preparation for undergoing a postgraduate course may be permitted to enter upon the curriculum for postgraduate Degree or Diploma on a part-time basis, but the number of such part-time students shall not, ordinarily, exceed twenty-five per cent of the regular students admitted to a course.

C. Eligibility:

1. For admission to the Institute a person shall fulfil the requirements regarding age and academic qualifications as may be prescribed by the Senate from time to time and shall be medically fit, the fitness to be judged by the Institute medical staff in accordance with the prescribed medical standards.

2. On the recommendation of the Admission Committee a foreign student or an Indian student who may be residing outside India at the time of the Entrance Examination or test may be granted admission without a written and/or oral test.

D. Reservation of Seats:

1. Twenty percent of admission to the undergraduate courses may be kept reserved for candidates belonging to the Scheduled Castes and Scheduled Tribes—fitfeen percent for Scheduled Castes and five per cent for Scheduled Tribes—provided they possess requisite qualifications as prescribed in Schedule I and qualify in the Entrance Examination. On the advice of the Senate the Board of Governors may permit relaxation of the qualifying standard in favour of such candidates.

2. A proportion of seats, as may be fixed by the Board of Governors from time to time may also be kept reserved for qualified candidates belonging to the States where, in the opinion of the Board of Governors, adequate facilities for studies in appropriate branches of study do not exist.

3. When qualified candidates in the above categories are not available the reserved seats shall be deemed open to be filled on general competition.

Sen Reg. 10 (AS) - P14
20 (4) - P187
32 (AS) - P243.

SCHEDULE XL

REGULATION No. 46

National Cadet Corps, Physical Education and Social Service

A. National Cadet Corps:

1. Fresh enrolment to the National Cadet Corps shall be made every year within two weeks of the commencement of the session. A senior member of the teaching staff of the Institute nominated by the Director shall be associated with the enrolment of the Cadets.

2. The Cadets shall be subject to the discipline of the National Cadet Corps.

B. Physical Education and Social Service:

1. The Institute shall provide facilities for Physical Education or Social Service for all undergraduate students.

2. Fresh enrolment shall be made every year within two weeks of the commencement of the session.

3. During the Third, Fourth and Fifth sessions a student belonging to an undergraduate course shall be encouraged to take part in Physical education or Social Service Programme as may be organised by the Institute and may receive such additional credit over and above his total marks in the obligatory subjects in the Examination as may be decided by the Senate from time to time.

SCHEDULE XLI

REGULATION No. 47

Examination results, Grade Card and Cross List

A. Undergraduate courses:

1. A student may obtain, on application with requisite fee as prescribed in the Statutes a Grade Card indicating his performance in the various examinations and a Cross List indicating the subject(s) of his failure in an examination.

2. The results of each examination shall be considered by the Board of Examiners. The marks secured by the students in the First and Second Terminal Examinations may be announced by the Head of the Department after these are considered by the Board of Examiners. The marks of the End-Sessional, Viva-Voce and Thesis examinations shall not be given out.

B. Postgraduate Course:

1. A Postgraduate student may obtain, on application with the requisite fee as prescribed in the Statutes, a Grade Card indicating his performance in the various examinations.

2. The result of each examination shall be considered by the Board of Examiners. The grades obtained by a student in the Terminal Examinations and Industrial Training may be announced by the Head of the Department after these are considered by the Board of Examiners.

SCHEDULE XLII

REGULATION No. 48

Scholarships, Fellowships, Free-studentships and Practical Training Stipends

1. The value of Institute Scholarships and Fellowships shall be as prescribed in the Statutes.

2. All Institute Scholarships, Fellowships and Free-studentships, shall be awarded in accordance with the Rules framed by the Senate. Other Scholarships and like awards shall be made in terms of the endowment or the rules of the respective awarding authorities,

3. The Senate may constitute each year a "Scholarship Committee or Committees" to make recommendations to the Senate for the award of Scholarships and free studentships both to the new entrants and to the students who are already at the Institute.

4. **Undergraduate Scholarships:**

(*a*) The Scholarships for the students belonging to all undergraduate courses and post-graduate courses leading to the Master of Science Degree shall be awarded on merit and on consideration of merit as well as means.

(*b*) Unless otherwise decided by the Board of Governors the merit Scholarships shall be awarded to seven per cent of the students admitted each year and the merit-cum-means Scholarships to a further eighteen percent of the students.

(*c*) The Scholarships shall be awarded on the results of written examination, and written examination and Means Test, provided that if no written Entrance Examination is held for admission to any of the courses the award shall be made on the results of the First Terminal Examination which the students take at the Institute after admission.

(*d*) In recommending the award of merit-cum-means Scholarships, the Scholarship Committee will take into consideration the examination results, examine the documents the applicant may submit for such Scholarships and interview the applicant.

(*e*) The Scholarship Committee shall also consider the results of the Institute Examinations of the students who have been in residence at the Institute, with or without scholarships in the preceding academic session and recommend to the Senate for:

(*i*) award of fresh merit scholarships on the results of the Institute examination;

(*ii*) renewal or discontinuance of merit-cum-means Scholarships;

and

(*iii*) award of merit-cum-means Scholarships against vacancies.

All awards shall be subject to the following stipulations:

The Institute scholarships shall be open only to the regular students of the Institute. The Scholarships may be withdrawn at any stage by the Senate without assigning any reason.

The merit scholarships awarded to new entrants shall be tenable for one academic year and, thereafter, fresh award shall be made on the results of the subsequent Institute examinations. In the case of students following the same curriculum during the first year, award of merit scholarship during the second year shall be made in order of merit of the First examination and not branchwise. Thereafter, the merit scholarships shall be awarded branchwise each year to 7 per cent of the students in the respective branches.

Subject to good conduct and satisfactory performance in the examinations as may be laid down by the Senate the merit-cum-means scholarship shall be tenable for the duration of the course of study.

(*f*) The following conditions shall be complied with in regulating the award, its continuance or otherwise, leave of absence etc.

(*i*) Scholarships will not be awarded to a student who has failed or been allowed to repeat the class.

(*ii*) All scholarships shall be liable to forfeiture partially or wholly or be withheld temporarily in case of misconduct, irregular attendance, neglect of work in classes, laboratories, studios, workshops, or on field, or unsatisfactory performance in an examination.

(*iii*) A scholar has to refund the amount of scholarship if he leaves the Institute on his own accord before the conclusion of the session during the tenure of the Scholarship.

(*iv*) If an Institute scholar is awarded any other stipend or scholarship he may draw in full such stipend or scholarship, provided the total amount from all sources including the Institute does not exceed Rs. 1,500/- per annum; otherwise, he shall cease to enjoy the the Institute scholarship. Fresh award of the vacated scholarships shall be made.

(*v*) Leave of absence without loss of scholarship upto 15 days in a year for reasons other than illness may be authorised by the Director. Director may also, under exceptional circumstances, grant leave in excess of it.

Absence on account of illness upto 10 days in an academic year, when certified by the Institute medical officer, will entail no loss of scholarship.

Director may, in addition, in special cases, grant short leave of absence in combination with holidays or vacation.

(*vi*) Institute and Hall dues shall be the first charge on the Scholarship and shall be deducted at the source and the balance, if any, paid to the Scholar. Payment of Scholarship shall not be made except to the holder who must present himself personally at the office and give a receipt in the prescribed fee book.

5. **Free Studentships:**

All Institute scholarshipholders in the Undergraduate courses shall enjoy free tuition. In addition, 10 percent of the students shall be awarded free studentship on grounds of means.

6. **Postgraduate Scholarships:**

(*a*) All postgraduate students of the Institute shall be eligible to Institute postgraduate scholarships unless the Admission Committee recommends admission without Scholarship or the postgraduate student is a deputed student.

Students admitted to a course preparatory to a postgraduate course shall not ordinarily be entitled to any Institute Scholarship.

(*b*) Postgraduate Scholarship shall be awarded for one year in the first instance renewable at the end of it if the course is of duration longer than one year.

(*c*) If a postgraduate student is awarded an Institute Scholarship it shall be permissible for him to draw Scholarship from other sources provided the total amount received by the Scholar including the Institute Scholarship, does not exceed the amount of the Institute Scholarship. In case it does, the Institute Scholarship may be suitably reduced.

(*d*) Postgraduate students, who are in receipt of salary from and/or are sponsored and supported by any organisation, are not ordinarily permitted to draw Institute Scholarship.

7. **Research Scholarships:**

(*a*) All Research Scholarships shall be awarded by the Senate on the recommendation of the appropriate Admission Committee.

(*b*) Research scholarships shall, ordinarily, be tenable for a period not exceeding three years, subject to satisfactory progress and good conduct. The award will, however, be made for one year at a time. On the special recommendation of the Head of the Department Research Scholarship may be renewed by the Director for short periods beyond 3 years.

8. **Post-Doctoral Fellowships:**

Post-Doctoral Fellowships shall, ordinarily, be awarded by the Senate on the recommendation of a Special Committee set up for the purpose. It shall be tenable for a period of 2 years, subject to satisfactory progress and good conduct, the award being made for one year at a time. On the special recommendation of the Head of the Department, a Fellow may be permitted by the Director to enjoy the Fellowship for further period.

9. **General conditions for Postgraduate Scholarships, Research Scholarships, and Post Doctoral Fellowships:**

(*a*) A Research Scholar or a Post-Doctoral Fellow shall report to the Head of the Department regularly on his progress and submit an annual report on his work for consideration of the Director.

(*b*) Post-Doctoral Fellowships, Research Scholarships and Postgraduate Scholarships are terminable without any notice within 3 months of the award on grounds of unsuitability or poor progress.

(*c*) Fellowships/Scholarships shall be liable to forfeiture partially or fully or be withheld temporarily in case of misconduct or unauthorised absence or unsatisfactory progress.

(*d*) No student enjoying Scholarship or Fellowship may apply for employment without the prior permission of the Director.

(*e*) A Postgraduate student or a Research Scholar or a Post-Doctoral Fellow enjoying the Institute Scholarship or Fellowship shall be required to refund the entire amount of money paid to him as Scholarship or Fellowship in the event of his leaving the Institute without completing the course of study or before the end of one year from the date of award or renewal.

A Research Scholar/Post-Doctoral Fellow if appointed to any post at the Institute or to a teaching or research post elsewhere with prior approval of the Director, shall not be required to refund the Scholarship/Fellowship drawn by him.

(*f*) Research Fellows, Research Scholars and Post-graduate students may be allowed by the Director, leave of absence for reasons other than illness, for a maximum period of 15 days in a year without loss of Fellowship/Scholarship. Director may also, under exceptional circumstances, grant leave in excess of it.

Absence on account of illness up to 10 days in an academic year, when certified by the Institute medical officer, will entail no loss of scholarship.

Director may, in addition, in special cases, grant short leave of absence in combination with holidays or vacation.

(*g*) Payment of Fellowship/Scholarships shall be made only to the recipients of the award who must present themselves at the Cash Section on the specified date and give a receipt as required under the Rules.

(*h*) Institute and Hall dues shall be the first charge on the Fellowships/Scholarships and shall be deducted at the source, the balance, if any, shall be paid to the Scholar.

10. **Practical Training Stipends:**

Practical Training Stipend shall be awarded by the Senate on the recommendations of the Training and Placement Committee to selected graduates who may apply for it on consideration of merit and means to enable them to take one year of practical training subject to the conditions that

(*i*) the stipendiary does not receive during the same period a sum exceeding Rs. 250.00 per month including the Institute stipend.

(*ii*) The stipendiary shall conform to the rules of the establishment where he receives training and submit such practical training reports as may be prescribed by the Institute.

REGULATION No. 49

Medals and Prizes

1. The Senate may constitute each year a Medals and Prizes Committee for award of medals and prizes.

2. The following medals and prizes instituted by the Board and endowment shall be awarded each year for the Undergraduate courses of study:

A. Medals:

(*i*) *Institute Medal*:

President of India Gold Medal: One gold medal named 'President of India Gold Medal' may be awarded to the best student among the B.Tech. and B.Arch. graduates of the year. The award shall be made by the Board of Governors on the recommendation of the Senate. In lieu of the Gold Medal the Board may make the award in any other form.

(*ii*) *Endowment Medal*:

Dr. Bidhan Chandra Roy Gold Medal: One Gold Medal named 'Dr. Bidhan Chandra Roy Gold Medal' may be awarded to a graduate adjudged to be the best all-rounder in a particular session. The award shall be made out of the interest of the fund created for the purpose on the recommendations of the Senate. In lieu of the Gold Medal the award may be made in any other form, as may be decided by the Senate.

B. Institute Prizes:

(*i*) Every year three general proficiency prizes of values shown below, be awarded to students in each branch of the undergraduate courses:

1st Prize of the value of Rs.	100
2nd Prize of the value of Rs.	50
3rd Prize of the value of Rs.	25

provided that the number of students in the branch exceeds 50 ; only two prizes (1st and 2nd prizes) when the number is smaller but exceeds 25 and only one prize (1st prize) when the number is 25 or less.

(*ii*) Two prizes each of the value of Rs. 50 in the 1st and 2nd year for proficiency in workshop practice.

(*iii*) One prize of the value of Rs. 25 for each of the optional subjects.

(*iv*) One prize of the value of Rs. 25 for the Humanities subjects in each class (all branches together).

(*v*) One prize of the value of Rs. 100 for design, project work and thesis and sessional work for each branch of study in the Final year class.

(*vi*) One prize of the value of Rs. 200 to be awarded every year to the undergraduate student of the Institute who enter an English essay competition held by the Department of Humanities and is adjudged to be the best writer of the essay.

Endowed Prizes:

'Sarat Memorial Prize', out of an endowment from a donor who wishes to remain anonymous to be awarded to a women graduate adjudged to be the best undergraduate passing out during an academic year. The award shall be made on the recommendation of the Senate.

SCHEDULE XLIII

REGULATION No. 50

Senate Committees

(*Ordinance XI*)

The Senate shall constitute each year the following Committees at appropriate time, as mentioned below:

1. Advisory Committee.

The Senate shall constitute each year, within March, an Advisory Committee for each of the teaching departments comprising educationists and experts from research and industrial organisations and the academic staff of the Institute. The Committee shall advise on curricula, syllabi, the standard of instruction and research and other matters for the efficient working of the departments.

2. Admission Committee (Undergraduate courses).

The Senate shall constitute each year, within August, an Admission Committee for the following session. The Entrance Examination for admission to the undergraduate courses shall be conducted by the Committee. The Committee shall recommend to the Director panels of names for appointment of papersetters, scrutineers, code-markers and decoders, tabulators, and others for the Entrance Examination as also for the Interview Boards. The Chairman of the Committee shall submit a report on the Entranee Examination and admission for the consideration of the Senate.

3. **Admission Committees (Postgraduate Courses).**

The Senate shall constitute each year, within April, an Admission Committee for each of the Departments offering Postgraduate courses to consider applications for admission to the postgraduate courses. The Committee shall hold an Entrance Test written and/or oral and/or practical for final selection of students for the Postgraduate courses and also recommend the award of scholarships.

4. **Admission Committees (Research).**

The Senate shall constitute each year an Admission Committee, within March, for each of the Departments to scrutinise the applications from candidates seeking admission to carry out research at the Institute. The Committee shall consider applications and recommend conditions under which the applicants may be granted facilities for research and also recommend award of Institute Research scholarship.

See Reg 42 (a) Para I (P. 385)

5. **Post-Doctoral Fellowship Committee.**

The Senate shall constitute each year before August a Committee with the Director as Chairman for the award of Institute Post-Doctoral Fellowships.

6. **Scholarship Committees.**

The Senate shall constitute each year, within April, a Scholarship Committee for the following session to make recommendations for the award of Undergraduate scholarships of the Institute. Admission Committees for the Postgraduate courses and Research shall also recommend award of scholarships to Postgraduate students and Research scholars.

7. **The Examination Committee.**

The Senate shall constitute each year before April an Examination Committee for the following session. The Examination Committee shall be responsible for the conduct and supervision of all undergraduate examinations. The Committee shall, in consultation with the Heads of Departments and the Registry, frame the time-tables for the examinations, make seating arrangements, arrangements for supervision and invigilation. The Chairman of the Committee shall submit a report on each examination for consideration of the Senate.

8. **Boards of Examiners (Bachelor's Degree Examination).**

The Senate shall constitute each year, before August, a Board of Examiners for each examination for the Bachelor's Degree. The Head of the Department concerned shall be the Chairman of the Board of Examiners. It shall appoint paper-setters, examiners, scrutineers, and tabulators for each examination and shall consider the results of the examinations and make recommendations to the Senate in the prescribed manner.

9. **Examination Results Review Committee.**

The Senate may constitute each year, before August, a Committee to review the results of the undergraduate examinations, as reported by the various Boards of Examiners and recommend norms for consideration of the Senate.

10. **Boards of Examiners (Postgraduate Degree and Diploma Examination).**

The Senate shall constitute each year, before August, a Board of Examiners for each of the postgraduate courses. The Head of the Department shall be the Chairman of the Board of Examiners. It shall appoint papersetters, examiners, scrutineers and tabulators for each examination and shall consider the results of the examinations and make recommendations to the Senate in the prescribed manner.

11. **Doctoral Scrutiny Committees.**

The Senate shall constitute a Doctoral Scrutiny Committee for each application for candidature for a Doctorate Degree. The Head of the Department concerned shall be the Chairman and the Committee shall comprise Professors in the Department, Supervisor or Supervisors and other experts in the Department and at least two teachers from allied departments. The application for registration for a Doctorate Degree shall be considered by the Doctoral Scrutiny Committee and its recommendations submitted for the consideration of the Senate. The Committee shall also consider the synopsis of the thesis to be submitted by the candidate and recommend a panel of names to the Senate for appointment as examiners. While considering the synopsis the Committee shall ensure that the candidate has complied with the requirements as stipulated by the Senate at the time of registration. The Doctoral Scrutiny committee shall also consider the reports of the Board of Examiners on the thesis and also of the Viva-Voce Examination of the candidate and make suitable recommendations for consideration of the Senate.

12. **Training and Placement Committee.**

The Senate shall constitute each year, within April, for the following session a Committee to arrange for the practical training of the students—both undergraduate and postgraduate and to render assistance to find them employment. The Committee shall also recommend award of Practical Training stipends.

13. **Medals and Prizes Committee.**

The Senate shall constitute each year, before April, a Committee for the following session to recommend award of Medals and Prizes.

14. **Convocation Committee.**

The Senate shall constitute each year, within July, a Convocation Committee for making arrangements for holding the Annual or Special Convocation.

15. **Conduct and Discipline Committee.**

The Senate shall constitute each year, within April, a Committee for the following year to examine cases of violation of the code of conduct and recommend suitable disciplinary measures.

16. **Social and Welfare Committee.**

The Senate shall constitute each year, before April, a Committee comprising a senior teacher as Chairman, and the Chairman of the Council of Wardens, the President and the, Vice-President of the Technology Students' Gymkhana, and two representatives of the Gymkhana one representative from each Hall of Residence, as members. The Committee shall advise, on the general welfare of the students and examine the cases of student(s) involved in any social offence and recommend suitable disciplinary action or punishment.

17. **Library Committee.**

The Senate shall constitute each year, in April, a Library Committee which shall be responsible for general supervision of the Library. The Librarian shall be the ex-officio Member-Secretary of the Committee.

18. **Workshops Committee.**

The Senate shall constitute each year, before July, a Committee to advise on the working of the Workshops and recommend measures for improvement. The Superintendent of Workshops shall be the Member-Secretary of the Committee.

19. **Central Instruments Services Section Committee.**

The Senate shall constitute each year, before July, a Committee to advise on the working of the Central Instruments Services Section and recommend measures for improvement.

20. **Journal and Publications Committee.**

The Senate shall constitute each year, before March, a Committee which shall be responsible for bringing out the Institute Journal and other publications of the Institute.

21. **Ordinances Review Committee.**

The Senate may appoint a Standing Committee to review the existing Ordinances and Regulations and make recommendations for any changes for the consideration of the Senate.

Secretary of the Committees.

The Deputy Registrar or Assistant Registrar (Academic) shall be ex-officio Secretary of all the Committees constituted under Ordinance XI other than the Library Committee, the Journal and Publications Committee, the Workshops Committee, the Central Instruments Services Section Committee.

SCHEDULE XLIV

REGULATION No. 51

Educational Tours

1. It shall be incumbent on every student studying for the B.Tech., B.Arch., B.Sc. and M.Sc. Degrees to participate in the educational tours arranged for them. Exemption from the tour may be granted by the Head of the Department concerned on medical grounds.

2. Tours subsidised by the Institute will be arranged by the Head of the Department and ordinarily not more than twice for the 5-year and 5½-year B.Tech. and B.Arch. students and not more than once for B.Sc. and M.Sc. students. These tours shall, normally, be arranged in continuation of or within the Puja vacation of the Institute and the duration shall not exceed 2 weeks. Tours, as far as possible, should be intensive rather than extensive.

3. Each undergraduate student shall submit to the Department for examination within a fortnight from the date of conclusion of the tour a report on the tour undertaken by him. Students exempted from the tour may be assigned special work in lieu thereof.

4. Normally, one teacher will look after a party of 25 undergraduate students and the teacher accompanying the party shall be treated as being on duty.

5. Educational tours for the M.Tech., D.I.I.T., M.R.P., M.C.P. students may be arranged by the Department concerned.

6. The subsidy per student to partially meet conveyance charges shall not exceed Rs. 20.00 per tour.

RULES

RULES

RULE No. 1

Advertisement

Admission to undergraduate and postgraduate courses and research training shall be advertised each year through such newspapers and advertising media as the Director may decide.

RULE No. 2

Admission

1. A candidate shall have to produce documents to the satisfaction of the Admission Committee that his guardian is in a position to pay regularly tuition and other fees, boarding, lodging and other charges payable for the entire course of study at the Institute.

2. He is to give an undertaking to comply with the Institute Rules and Regulations relating to residence, discipline, health and hygiene.

No one shall be admitted who is unwilling to be inoculated and vaccinated annually as public health measure in accordance with the Rules framed by the Institute from time to time.

3. He shall fulfil all other requirements for admission as prescribed in the Ordinances and Regulations.

RULE No. 3

Application Fees

Applications for admission to all courses, both undergraduate and postgraduate, and also to research training must be accompanied with the requisite fees, as prescribed in the Statutes. The present rates of fees are:

(*i*) For admission to all undergraduate courses and the M.Sc. Degree courses ... ... Rs. 15.00
(Payable with the application as application and registration fee).

(*ii*) For admission to the postgraduate courses leading to the M.Tech., M.C.P., and M.R.P. Degrees and Postgraduate Diplomas ... Rs. 5.00
(Payable with the application as registration fee).

(*iii*) For admission to Research Training ... ... Re. 1.00
(Payable with the application).

RULE No. 4

Travelling Allowance for Appearing at Interview

1. Candidates called for interview and medical examination and/or written/practical test for admission to the undergraduate or postgraduate courses are not eligible to receive any travelling expenses.

2. Candidates appearing for interview at the Institute for research scholarship may be paid only single 3rd class railway fare bothways from the nearest railway station.

RULE No. 5

Exemption from payment of Seat Rent in the Hall of Residence including charges for Water and Electric Supply

Students, Scholars and Fellows may be granted exemption from payment of seat rent in the Hall of Residence including charges for water and electric supply for the period of their stay outside the Institute for practical training or field work which forms a part of the curriculum and is arranged by the Institute, provided they hand over charge of the rooms to the Warden concerned before they leave for such training or field work—when the period of such training is one month or more.

They are, however, required to meet their lodging expenses at the place of practical training of field work.

RULE No. 6

Withdrawal from the Institute

A student may discontinue his studies and withdraw from the Institute with prior permission. A student desirous of leaving the Institute shall be required to submit an application in the prescribed form at least fifteen days before the contemplated date of leaving stating therein the reasons for leaving. He shall be required to obtain clearance certificate from the Department(s) concerned, the Library, the Warden and the Accounts Section and submit the same to the Accounts Officer before permission may be granted to him for leaving the Institute. His name will then be removed from the rolls.

Failure to comply with these requirements shall render a student liable to pay all the dues till the date of formal removal of his name from the Institute Rolls and the payment of caution money, etc., shall be withheld till the dues are cleared.

RULE No. 7

Issue of Migration Certificate

A student desirous of joining another Institution either before the completion of the course or on completion of the course may be issued a migration certificate in the prescribed form on payment of the fee as laid down in the Statutes and submission of a formal application.

RULE No. 8

Issue of Grade Card

1. A graduate may obtain, on application to the Registry with the prescribed fee and two passport size photographs, a Grade Card indicating his performance in the examinations he has taken at the Institute.

2. A student may obtain, on the recommendation of the Head of the Department concerned even before graduation, on application to the Registry with the prescribed fee and two passport size photographs, a Grade Card indicating his performance in the examinations that he had taken.

3. Duplicate Grade Card may be issued on application to the Registry on payment of the prescribed fee.

RULE No. 9

Issue of Diploma

1. A graduate shall present himself at the first Convocation held after he becomes eligible for Degree or Diploma and receive it in person. It may also be issued to him if he is unable to attend the Convocation ; in that case he has to apply for it to the Registry with the fees as prescribed in the Statutes for receiving the Diploma in absentia.

2. In the event of loss of a Diploma a duplicate may be issued with the permission of the Director on payment of the prescribed fee.

RULE No. 10

Issue of Cross List

A student failing in any complete examination may be supplied with a Cross List showing the subject(s) of failure on payment of the prescribed fee.

RULE No. 11

Rechecking of Answer Scripts

A student may get any one of his answer scripts rechecked on application to the Registry along with the prescribed fee, provided such application is made within 15 days of the announcement of the results.

RULE No. 12

Disposal of Old answescripts, rejected applications and sundry papers

Answer scripts of all examinations, rejected applications for admission, etc. shall be preserved for a period of one year ; thereafter, these shall be disposed of.

RULE No. 13

Fees payable to Additional Examiners

(*a*) *Undergraduate courses including M.Sc.*

Each Additional Examiner for the Undergraduate courses (including M.Sc.) shall be paid a sessional fee of Rs. 300 and travelling allowance in accordance with the provisions made in the Statutes.

(*b*) *Postgraduate courses.*

An Additional Examiner for a Postgraduate course shall be paid remuneration at the rate of Rs. 25 per thesis or dissertation or Project report subject to a minimum of Rs. 50 for evaluation of thesis or dissertation or Project report, in addition he shall be paid a sessional fee of Rs. 100 and Travelling Allowance in accordance with the provisions made in the Statutes.

RULE No. 14

Library Rules

1. The Library shall remain open on all days including Sundays but excluding closed holidays at such hours as may be fixed by the Director from time to time.

2. The Library may be used by all students including research and special students during the hours the library is open.

3. Undergraduate and postgraduate students can take out on loan two books at a time from the Library. A student taking short term course can take out two books through the Department to which he is attached.

4. All members of the Academic staff and the Officers of administration may take out on loan 10 volumes at a time. For the purposes of this rule Academic staff includes Research Scholars/Fellows and Research Assistants.

5. Other members of the staff of the Institute can take out two books only at a time.

6. Apprentices attached to this Institute may take out one book at a time on furnishing a deposit of Rs. 10.00.

7. All important reference books such as Encyclopaedia, Dictionary, Directory, Handbook, Calendars, illustrated books, valuable books, rare publications which cannot be replaced and books in the Reserved Section shall not ordinarily be issued.

8. Books and journals can be issued on inter library loan system on the basis of reciprocity.

9. Each volume shall be considered as a separate book for the purpose of issue.

10. Books taken out of the Library must be returned to the Library and must not be transferred to any one else.

11. Latest issues of journals may be taken out by the respective Heads of Departments for reference by the members of the staff, if and when required.

12. The period of loan will be one whole term for members of the staff excepting for students, apprentices and for persons covered by paragraph five unless required by others.

13. The period of loan for students, apprentice and for persons covered by paragraph five will be 14 days. Books may be recalled earlier, if necessary.

14. After the expiry of the specified time, books may be reissued to a student for a further period of 7 days provided there is no other requisition for them. The retention of books beyond this extended period shall not be permitted.

15. A student defaulter will be charged ten paise per volume per day if the volume is not returned when due.

16. Sub Libraries may be set up in every Department with a maximum limit of 100 volumes including journals taken out on loan from the Main Library, the Heads of Departments being responsible for their management and proper safeguard.

17. All materials must be returned to the Library at the end of the academic year.

18. Verification of stock will be carried out once a year and in the month of May or June and for this purpose no books shall be issued for a fortnight.

19. Library Bulletin containing the latest additions to the Library will be forwarded to the Departments regularly.

20. New books and latest issue of journals will not normally be issued for one month after receipt.

21. Personal belongings such as books, attache cases, umbrellas should not be brought inside the Library without permission.

22. Spitting and smoking inside the Library are strictly prohibited.

23. Borrowers are requested to keep the books and journals issued to them clean, protect them from rain and not in any way injure and deface them. Any damage caused to the book will have to be made good. Borrowers must at once report any defect in the books and journals issued in order that they may not be charged. The borrower shall be required to replace or to pay the cost of the replacement of any book or journal lost by him while it is in his custody.

24. Silence should be strictly observed in the Reading Rooms.

25. For any serious breach of library discipline the offender may be expelled from the Library and his privilege of using the Library withdrawn.

26. Any Rule may be added, amended or deleted by the Library Committee with the approval of the Director.

RULE No. 16

Rules for the Regulation of the Halls of Residence.

1. The management of a Hall of Residence shall be the joint responsibility of the Warden and the Assistant Wardens or the Lady Superintendent. The Warden or the Lady Superintendent shall be the principal authority and executive in all matters relating to students' residence, welfare, discipline and messing, as well as administration and security of the common properties of the Institute and the Hall of Residence. He or she shall be responsible to the Deputy Director for the proper maintenance and management of the Hall of Residence and the mess attached to it.

2. The Wardens, the Assistant Wardens and the Lady Superintendent of the Halls of Residence together shall constitute a Council of Wardens which shall, within the rules, take decisions on matters of common interest to all Halls of Residence and act thereon and shall make supplementary rules and bye-laws for the administration of the Halls of Residence and their messes. Such rules, however, shall be subject to review by the Chairman of the Senate.

The Deputy Director and the President of the Students' Gymkhana shall be ex-officio members of the Council of Wardens.

3. The Warden or the Lady Superintendent shall constitute one or more Committees comprising elected and nominated student-representatives to assist him or her in matters relating to the health, hygiene, general welfare and corporate life of the students of the Hall and in the running of the mess.

4. All staff employed in the Hall of Residence are employees of the residents of the Hall concerned. They are, however, under the administrative control of the Warden or the Lady Superintendent.

5. The Warden or the Lady Superintendent on behalf of the residents of the Hall shall have the power to appoint or employ out of the mess fund of the Hall such staff as may be required for room service, service in the dining hall, common rooms and determine in each case the remuneration to be paid and to terminate their services for sufficient reasons.

6. The Warden or the Lady Superintendent shall, in consultation with such Committee or Committees as he or she may think fit, ensure that—

(*a*) there is no wastage of food nor any lavish expenditure on entertainment;

(*b*) there is no undue expenditure of electricity and water;

(*c*) the kitchen, pantry, lavatories, bathrooms, etc. are inspected regularly and kept clean and in hygienic condition;

(*d*) the rooms for general use, the corridors and the surrounding ground are kept neat and clean;

(*e*) consumable articles are purchased at the most economical rate consistent with quality, and rules are framed and observed so as to run the messes with the utmost economy; quantities purchased and vouchers for payments are properly checked and the accounts audited systematically and regularly.

7. The Warden or the Lady Superintendent shall ensure that the students in his or her charge observe the rules framed for their guidance and behave with decorum.

He or she may, in exercise of his or her authority, take disciplinary action against a student for breach of rules or indecorous behaviour and impose penalties such as withdrawal of privileges, fines, expulsion from the Hall, under intimation to the guardian and the Registry.

8. All men students shall reside in and shall be members of the Hall of Residence meant for men students to which they are assigned; all men research students shall reside in the Hall of Residence specially provided for them.

All women students and women research students shall reside in the Hall of Residence meant for women students.

With prior permission of the Deputy Director part-time women students and scholars may also be permitted to stay in the Hall of Residence meant for women students. Such admission shall, however, not interfere with the studies and other activities of the regular inmates of the Hall.

Such allottees may be asked by the Lady Superintendent to vacate the Hall at 15 days' notice.

9. There shall be a roll call every evening by the Prefect and absentees shall be reported to the Warden.

No boarder shall leave Kharagpur without the prior permission of the Warden or the Lady Superintendent.

10. The mess of each Hall of Residence shall function as a single unit and shall not, under any circumstances, be sub-divided into regional, communal or any other kind of groups or sub-groups. Only two types of meals should be served, *viz.*, vegetarian and non-vegetarian.

11. No student shall come into residence in any Hall nor give up residence in the Hall nor leave the Institute without the prior permission of the Warden or the Lady Superintendent.

12. A student shall keep to the hours set down for the meals, study and rest. He or she is expected to be in his or her room before 8 p.m. and he or she may not remain outside the precincts of the Hall after 9 p.m. without the prior permission of or leave of absence from the Warden or or the Lady Superintendent.

13. For overnight leave of absence or leave for a longer period from the Hall the student shall apply to the Warden or the Lady Superintendent in time stating the reasons therefor and he or she shall not leave the Hall till leave has been sanctioned by the Warden or the Lady Superintendent. Application for leave of absence for a longer period should be supported by the Head of the Department concerned. All such permission shall be entered in the Register to be kept with the Warden or the Lady Superintendent. Such Register shall be available for inspection by the Dy. Director or an officer deputed by him.

14. A student shall reside in the room allotted to him or her and may shift to any other room only under the direction or permission of the Warden or the Lady Superintendent of the Hall.

15. A student shall be responsible for the furniture and fittings of the room allotted to him or her and shall, when shifting from or vacating that room, hand over the furniture and fittings intact to the Warden of the Lady Superintendent or any other person duly authorised by him or her. No furniture may be removed from the room without the permission of the Warden or the Lady Superintendent.

16. A student shall be required to make his or her room available whenever required for repairs, maintenance, disinfection or inspection by the Warden or the Lady Superintendent or any other person authorised by the Warden or the Lady Superintendent. A student shall be required to vacate his or her room when leaving for the summer and Puja Vacations.

17. No extra electric connections shall be taken from the points already existing in any room, nor shall any additional fittings be installed, without the specific permission of the Warden or the Lady Superintendent in each case.

18. When the use of additional electrical appliances, such as, an additional light or a small table fan, is permitted, the student shall pay the cost of an extra point and charges for electricity consumed at a rate as may be fixed by the Institute. The fixture shall not be removed when the student vacates the room permanently.

19. At the time of admission to a Hall of Residence for the women students, the father or the guardian of a boarder may appoint, in writing, on the prescribed form, a local guardian whose appointment will be subject to the approval of the Dy Director. The local guardian should ordinarily be a resident in this campus or at a place within a radius of five miles of the Institute.

20. Every student shall deposit at the time of his or her admission to the Institute, Hall caution money of Rs. 30.00 to cover any damage to or loss of Hall property and any other outstanding Hall dues. The balance of Hall caution money after deduction of outstanding dues shall be refundable to the student on his or her leaving the Institute. Claims for refund of the balance of the caution money shall be lodged with the Registry of the Institute by the student within four years of his or her leaving the Institute.

21. Every student shall, in addition, be required to pay a mess advance of Rs. 150.00 on admission to the Institute, which is refundable or adjustable at the time of leaving the Institute.

22. Institute dues (tuition fees, seat rent, and other charges) shall not be accepted unless a student has cleared the Hall dues, or he or she has been specifically exempted by the Warden or the Lady Superintendent in writing from paying or deferring payment of these.

23. A student failing to clear his outstanding dues of the preceding month on the expiry of the fixed date of the succeeding month, may be liable to be removed from the Hall of Residence and the Institute under intimation to Registry. The defaulter may be permitted to resume residence at the discretion of the Warden or the Lady Superintendent, on payment of the arrears and a readmission fee of Rs. 5.00.

24. The boarders shall not keep any guest in the Hall. In exceptional circumstances, guests of a boardes may be allowed to stay for a day or two only with the prior permission of the Warden or the Lady Superintendent. Female gusets may be permitted to stay only in the Women's Hall of Residence and male guests in the Hall of Residence for men students.

25. The guest fee shall be an amount as may be fixed by the Warden or the Lady Superintendent. No special party or entertainment shall be held in the students' rooms or public halls except with the prior permission of the Warden or the Lady Superintendent.

26. A student may be permitted on application to change his residence from one Hall to another at the end of an academic session but before the commencement of the following academic session. Only in exceptional cases shall a student be permitted to change his or her residence from one Hall to another during the academic session. Such transfer shall not be permitted except on the last day of the month.

27. For purposes of taking transfer a student shall apply through the Warden or the Lady Superintendent of the Hall of Residence, where he or she is a resident, to the Warden or the Lady Superintendent of the Hall of Residence to which he or she wishes to move and shall lodge his or her application with the former at least one week before the end of a month. The transfer will be decided on jointly by the two Wardens or Lady Superintendents concerned ; the notification is to be issued by the Dy. Registrar, with intimation to the Halls of Residence, Cash Section, Accounts Section, Academic and other administrative sections of the Institute.

28. All students shall comply with the rules and supplementary rules and bye-laws as may be framed from time to time. Ignorance of any of these shall not be accepted as an excuse for its non-observance on the part of a boarder.

SENATE INSTRUCTIONS

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1. Additional Examiners.

(*a*) *Undergraduate courses*:

1. There shall be one Additional Examiner for each branch of study (including Humanities) in which a Bachelor's Degree is provided. The Additional Examiner should be associated with the work of examinations at all stages including the *Viva-Voce* examination.

2. For the B.Tech. and B.Arch. Degree *Viva-Voce* examination, there shall be a second Additional Examiner who should be a distinguished engineer or architect practising the profession.

3. The Additional Examiners are expected to take part in the setting and moderation of question papers or reviewing these and also to advise on the standard of examination. They should be available at the Institute to review the question papers, the work of the students in lectures, tutorials and other classes. The Institute will expect them to deliver a lecture or two for the benefit of the members of the department concerned. They are also expected to tender such advice as they consider necessary for the improvement of the work of the department.

4. The Additional Examiner shall be expected to send to the Director a report on the work of the students and the department and make such recommendations as he may think fit.

(*b*) *Postgraduate courses*:

1. One Additional Examiner shall, ordinarily, be appointed for each postgraduate course of study unless otherwise decided by the Senate.

2. As a member of the Board of Examiners each Additional Examiner will be associated with the work of setting and moderation of question papers or reviewing these, valuing answer-scripts, conducting *Viva-Voce* examination and examining thesis/dissertation/project report; these should be made available to him 15 days before the *Viva-Voce* examination.

3. The Additional Examiner shall be expected to review the work of the students and teachers in lectures and other classes and deliver a lecture or two at a seminar specially organised for the benefit of the staff and students.

4. The Additional Examiner shall send to the Director a report on the work of the students and the Department and make such recommendations as he may think fit.

2. Membership of the Doctoral Scrutiny Committee (Ph.D. Degree).

1. No member of the staff of the Institute who has registered for the Degree of Doctor of Philosophy of the Institute but has not been admitted to the Degree shall be appointed a member of the Doctoral Scrutiny Committee or a Supervisor.

2. A member of the staff who has acted as supervisor or as a member of the Doctoral Scrutiny Committee may, however, supplicate for the Degree of Doctor of Science.

3. The Doctoral Scrutiny Committee for the Degree of Doctor of Science (D.Sc.) shall be under the Chairmanship of Director.

3. Maximum period for submission of thesis.

A candidate shall be required to supplicate for the Degree of Doctor of Philosophy within a period of not more than 6 years from the date of his registration,

Provided that a candidate failing to fulfil this requirement may be permitted to re-register on payment of fresh registration fee and on condition that he shall submit the thesis within a maximum period of 2 years from the date of fresh registration.

4. Requirement for Submission of Thesis.

A research student may not apply for permission to submit his thesis unless—

(*i*) he has been regular in his work;

(*ii*) he has satisfied his Supervisor about his progress;

(*iii*) he has fulfilled all the requirements as stipulated by the Senate at the time of his registration.

5. Submission of Thesis.

The thesis shall be written in English and shall be submitted in triplicate either typewritten or printed.

Two copies of all accepted theses shall be retained by the Institute, one in the Library and the other in the Department concerned.

6. Period for submission of Report on adjudication of Thesis.

The Examiners of a thesis shall be expected to forward their reports with their recommendations preferably within two months after receiving the thesis.

7. Notice for Viva-Voce Examination.

On favourable and unanimous report from the adjudicators of a thesis a candidate for the Degree of Doctor of Philosophy shall be required to appear before a *Viva-Voce* Board appointed for the purpose. The candidate shall ordinarily be given one month's notice to appear before the *Viva-Voce* Board.

8. Academic Session.

1. The academic session for the undergraduate courses shall commence on the 1st July unless it is a Sunday or holiday declared by the Board of Governors in which case it shall commence on the next working day. The academic session shall end on 30th June of the following year. The Senate may, however, under special circumstances, fix a date for the commencement of the session for a particular course.

2. The academic session for the postgraduate courses and the Special Three-Year courses for the B.Tech. Degree shall commence on the 1st August or soon thereafter as the Senate may decide. The academic session shall, normally, conclude on 31st July of the following year unless otherwise decided by the Senate.

3. The academic year for a research worker working for a doctorate degree shall normally commence from the date he joins the Institute.

9. Length and Duration of Term.

The Terms and the dates of examinations shall, ordinarily, be announced by the Senate in January each year for the following academic session.

10. Last Date for Joining the Course.

A student shall not be permitted to join the Institute or resume residence after the expiry of a fortnight from the date of commencement of the academic session. In exceptional cases, the Director may, with the approval of the Senate, permit a student to join later after recording reasons and with the appropriate stipulation that granting of such permission to take up residence shall not imply relaxation of requirements in respect of attendance, standard of examination, class, promotion or graduation.

11. Institute Examinations

A. Undergraduate Courses:

(*a*) *Paper-setting*

1. The Registry shall issue necessary instruction to the Papersetter through the Head of the Department concerned. The Head of the Department shall arrange for the moderation of the question paper and send it to the Deputy Registrar, by name, in a sealed cover within the date to be fixed by the Senate, normally, six weeks before the commencement of the Terminal examinations and eight weeks before the End-Sessional examination. All sketches in the question papers shall be drawn on separate tracing paper with Indian Ink.

2. Security shall be observed in the printing of question papers.

(*b*) *Putting Code Numbers on Answerscripts*

3. Code numbers shall be put down on answerscripts of the End-Sessional examination and the examination to decide scholarships.

(*c*) *Evaluation of Answerscripts.*

4. Answerscripts shall be evaluated by the examiners appointed for the purpose and the work of evaluation shall, ordinarily, be completed within 10 days from the date of receipt of the scripts from the Examination Office.

(*d*) *Submission of Marks.*

5. Each examiner shall submit within the scheduled date to the Head of his department mark sheets, in triplicate, under his signature together with the relevant answerscripts.

(*e*) *Scrutiny of Answerscripts and Mark Sheets.*

6. The Head of the Department shall arrange for the scrutiny of answerscripts and marksheets. The scrutinised mark sheets shall bear the signature of the scrutineer, and, these shall be sent by the Head of the Department to the Head of the Department concerned with tabulation in sealed covers within 12 days from the date of the examination. Answerscripts, marksheets, and tabulation sheet shall be sent to the Examination Office after the results of a particular examination are approved by the Senate.

(*f*) *Tabulation of Results.*

7. Two tabulators shall be appointed for each examination. Marks shall be tabulated in the prescribed form and carried out independently by two tabulators under the overall supervision of the Chairman of the Board of Examiners. Tabulators shall jointly draw up a summary of the results in the prescribed form. In considering the results the Board of Examiners shall be guided by the Special Senate Instructions on the standard of examination.

8. The results shall be considered by the Board of Examiners for report to the Senate in the prescribed manner.

9. The Senate shall consider the results, decide promotion, detention in a class or removal from the Institute and also make recommendations to the Board of Governors for the award of Degrees to the students who have passed in the final examination.

B. Postgraduate Courses:

(*a*) *Paper-setting.*

1. The Registry shall issue necessary instructions to the paper-setter through the Head of the Department concerned. The Head of the Department shall arrange for the moderation of the question paper and send it to the Deputy Registrar, by name, in a sealed cover within the date to be fixed by the Senate, normally, 6 weeks before the commencement of the examination. All sketches in the question papers shall be drawn on a separate tracing paper with Indian Ink.

2. Security shall be observed in the printing of question papers.

(*b*) *Evaluation of Answerscripts.*

3. Answerscripts shall be evaluated by the Examiners appointed for the purpose and the work of evaluation shall be completed within five days of the examination.

(*c*) *Submission of Grades.*

4. All examiners shall submit to the Head of the Department concerned the grades obtained by each student, in duplicate, together with relevant answerscripts within a prescribed time.

(*d*) *Scrutiny of Answerscripts and Grade Sheets.*

5. The Head of the Department shall arrange for the scrutiny of answerscripts and grade sheets. The scrutinised grade sheets shall bear the signature of the scrutineer, and, these shall be sent by the Head of the Department to the Head of the Department concerned with tabulation

in sealed covers within 7 days from the date of the examination. Answerscripts, grade sheets and tabulation sheet shall be sent to the Examination Office after the results of a particular examination are approved by the Senate.

(*e*) *Evaluation of Thesis/Dissertation/Project Reports.*

6. All theses/dissertations/project reports shall be evaluated by the Additional Examiner or Examiners appointed by the Senate and the teacher guiding the thesis or dissertation or/project work. The theses/dissertations/project reports shall be submitted for evaluation within the date to be fixed by the Senate for each session. The Head of the Department shall arrange to send the theses/dissertations/project reports to the Additional Examiner for evaluation well in time so that the results are available at the time of the *Viva-Voce* examination.

(*f*) *Tabulation of Results.*

7. Two tabulators shall be appointed for each examination. Grades shall be tabulated in the prescribed form and carried out independently by two tabulators under the overall supervision of the Chairman of the Board of Examiners. Tabulators shall jointly draw up a summary of the results in the prescribed form. In considering the results the Board of Examiners shall be guided by the Special Senate Instructions on the standard of examination.

8. The results shall be considered by the Board of Examiners for report to the Senate in the prescribed manner.

9. The Chairman of the Board of Examiners shall place before the Senate the report of the Board of Examiners. The Senate shall decide whether a particular student shall be allowed to proceed to the next term or be promoted to the Second year class as the case may be. The Senate shall also consider the results, pass orders or make recommendation to the Board of Governors for the award of the Degrees and Diplomas to the successful students.

12. Instructions for the guidance of the Officer-in-Charge of Examinations.

1. The Senate shall appoint for each academic session an Officer-in-Charge of Examinations from among the members of the academic staff.

2. The Officer-in-Charge shall be responsible for the conduct of all undergraduate examinations.

3. He shall act as the ex-officio convenor of the Examination Committee, which shall draw up the time-table for all the examinations and also the Invigilation list. He shall also make necessary seating arrangements in the Examination Halls.

4. Before the commencement of each examination the Officer-in-Charge of Examinations shall be provided with a list of students who are to appear at the examination and also a list of optional subjects taken by them including a statement showing the number of sutdents with their roll numbers appearing at each of the optional subjects.

5. Before the commencement of the examination the Officer-in-Charge of Examinations shall have a list of students who have defaulted in paying their dues. He shall not admit any student who does not possess valid admit card for the particular examination issued under the signature of the Deputy Registrar and countersigned by the Warden concerned. In doubtful cases, the Officer-in-Charge of Examinations may allow a student to take the examination and shall immediately refer the matter to the Deputy Registrar.

6. The question papers for each examination shall be handed over to the Officer-in-Charge of Examinations in sealed covers at least one hour before the commencement of the examination. Blank answer books, supplementary sheets, graph papers, drawing sheets, log tables and other tables and sundry stationery for the examination shall also be placed with the Officer-in-Charge of Examinations.

7. The Officer-in-Charge of Examinations shall be in overall charge for the smooth conduct of the examination. He will be assisted in this work by one of the senior teachers to be designated as Professor-in-Charge for each session of the examination.

8. Ordinarily, one invigilator shall be appointed for every 25 examinees, but the Officer-in-Charge of Examinations shall have the discretion to appoint additional invigilators.

9. For the End-Sessional examination and the examination to decide scholarships the Officer-in-Charge of Examinations shall arrange to put down code numbers on each answerscript by teachers specially appointed for the purpose by the Examination Committee.

10. The Registry shall provide adequate number of attendants for the smooth conduct of the examination.

11. On reference from the Teacher-in-Charge of Examination Hall the Professor-in-Charge of the session may, after checking the manuscript and consulting the paper-setter concerned, if needed, announce necessary correction in the question paper and report to the Officer-in-Charge of Examinations.

12. The Officer-in-Charge of Examinations shall arrange to get the answerscript serially arranged and checked against the attendance sheet. Answerscripts shall then be securely packed and sealed and despatched to the examiner concerned. The Officer-in-Charge shall forward to each examiner together with the answerscripts two copies of the question paper and the required number of blank marksheet.

13. On receipt of a report from the Teacher-in-Charge of the Hall about adoption of unfair means the Professor-in-Charge shall forward it to the Chairman of the Discipline Committee along with the relevant papers under intimation to the Deputy Registrar.

13. Instructions for the guidance of the Invigilators.

1. Invigilators shall report to the Officer-in-Charge of Examinations half-an-hour before the commencement of the examination. They shall take charge of the packets of question papers, answer scripts, log tables and other stationery required for the examination.

2. An invigilator, who, for illness or other unavoidable reasons, is unable to be present should take leave of absence with 24 hours' notice to the Head of the Department and the Officer-in-Charge of Examinations. In case of sudden indisposition he may send intimation to the Officer-in-Charge of Examinations well in time to enable the latter to make alternative arrangement in consultation with the Head of the Department concerned.

3. Invigilators shall make sure that instructions for the guidance of the examinees are strictly followed by all examinees. They shall distribute the answerscripts in the Examination Hall 10 minutes before the start of the examination.

4. Invigilators shall distribute the question papers 5 minutes before the commencement of the examination. They should ensure that each examinee makes proper entries on the cover page of his answerscript. On the conclusion of the examination they shall collect the answers scripts and arrange them according to roll numbers and hand them over to the Teacher-in-Charge of the Hall, who will make them over to the Officer-in-Charge of Examinations along with the surplus question papers, answerscripts and other stationery.

5. Inviligators shall put their initials with date on each answerscript, supplementary sheet, drawing sheet and graph sheet issued to the examinees.

6. Invigilators shall check the admit cards of all the students and submit a report to the Officer-in-Charge of Examinations for the first three days only.

7. Invigilators shall note the roll numbers of the candidates present at the examination and submit them to the Teacher-in-Charge of the Hall after the examination.

8. Invigilators shall remain in the Examination Hall during the time allotted to each paper and shall not leave the Hall without the permission of the Teacher-in-Charge of the Hall. Invigilators shall also bring to the notice of the Teacher-in-Charge of the Hall any complaint or difficulty pointed out by any examinee regarding the question paper set for the examination.

9. An invigilator shall report to the Teacher-in-Charge of the Hall any case of indecorum or suspected malpractice. The Teacher-in-Charge of the Hall shall then take necessary action in accordance with the instructions issued by the Senate from time to time. He shall also inform the Professor-in-Charge of the session and the Officer-in-Charge of Examinations.

14. Instructions for the guidance of the students appearing at the examination.

1. The Examination Halls shall be opened on each day half-an-hour before the time specified for the commencement of the examination and the students shall be in their respective seats at least 15 minutes before the commencement of the examination. As a special case a student may be allowed to enter the Examination Hall with the permission of the Teacher-in-Charge within 15 minutes after the examination has started. No extension of time shall be granted to a student on grounds of his late arrival in the examination hall.

2. No student shall be allowed to enter the Hall unless he produces the valid admit card.

3. No student shall be allowed to leave the Hall during the first half hour of the examination. Thereafter, he may do so after handing over the answerscript, question paper and other examination materials personally to the Teacher-in-Charge.

4. Each student shall occupy the seat particularly assigned to him and under no circumstances shall be allowed to change seat unless instructed to do so by the Invigilator concerned.

5. Students shall write their answer on both sides of the answer-scripts but must not write on the back of the cover page.

6. Students shall write their names and/or Roll Numbers only in the places specially provided for on the cover page. They shall write their names and Roll Numbers only at the bottom righthand corner of the drawing sheet.

7. They shall remain in their seats till the answer-scripts are collected by the invigilator at the end of the examination hour. They may, however, submit their answerscripts at any time to the Teacher-in-Charge and only then leave the Hall.

8. Drawing and graph sheets and log tables shall be supplied by the Institute and no student shall bring with him any book, note, loose paper, etc. Students shall, however, be allowed to use their own instrument boxes. For examination in Freehand Drawing, no instruments of any kind shall be used not even scales. A student should come provided with his pen and ink.

9. For open book examination, only books and/or notes as specified on the question papers shall be allowed.

10. Students shall not tear off any page from the answer-script. In case a page in found torn, the matter shall immediately be brought to the notice of the Invigilator.

11. For non-observance of the code of conduct a student shall be liable to disciplinary action in terms of Ordinance VII.

12. To smoke in an examination hall, making noise, etc. are social offences and invite action under Ordinance VII.

15. Procedure for Admission.

A. Submission of Application.

Applications for admission to the undergraduate and postgraduate courses and for research training must be made on the prescribed application form and must be sent to the Deputy Registrar or Assistant Registrar (Academic) of the Institute by a date as may be announced each year in the advertisement inviting applications for admission to the various courses.

B. Enclosures with Application.

All applications must be accompanied with:

(*a*) three recent Passport size photographs of the candidates duly attested (must accompany each application);

(*b*) (i) for undergraduate courses including M.Sc. Crossed Indian Postal Orders for Rs. 15 payable to the Indian Institute of Technology, Kharagpur at Kharagpur Technology P.O. as application and registration fee;

(ii) for Postgraduate courses—

A Crossed Postal Order of Rs. 5/-

(iii) for Research Scholars of Re. 1/-

(there must not be any over-writing on the Postal Orders. Candidates shall carefully check that the Postal Orders bear the legible date-stamp of the issuing Post Office in the appropriate space on the right-hand side and the signature of the issuing Postmaster at the appropriate space. A Postal Order defective in any way shall be treated as invalid and an application accompanied with a defective Postal Order may be rejected without any reference to the applicant).

(*c*) If the candidate has already passed the prescribed qualifying examination, copies of pass certificates (final or provisional) and mark-sheet or grade card, duly attested by the Head of the Institution last attended, must accompany the application. If the candidate has appeared or is due to appear at the prescribed qualifying examination before the stipulated date or if the pass certificate or the mark-sheet or the grade card has not been received by the candidate, attested copies of these shall have to be produced at the time of interview and medical examination. In such a case, however, an appropriate certificate from the Head of the Institution from which he has appeared or will appear at the qualifying examination shall have to be submitted with the application. Only attested copies of pass certificates, mark-sheets or grade cards relating to the Public Examination other than the qualifying examination (*viz*. High School Matriculation, I.Sc. examination etc.) shall have to be enclosed with the application.

(*d*) A document duly attested by the Head of the Institution last attended showing the age of the candidate as recorded in School (This is essential).

(*e*) A candidate belonging to a Scheduled Caste or a Scheduled Tribe shall be required to produce a certificate from the Head of the Institution last attended to that effect.

(*f*) A self-addressed stamped envelope (23 Cm × 10 Cm or 9″ × 4″) with 70 P postage stamp affixed on it and with the words "Registered Post" superscribed on it for sending the Admit Card (essential in the case of applicants due to appear at the written Entrance Examination).

Note: If these documents are not enclosed, the applications will not be entertained. Originals of certificates mentioned in (*c*), (*d*) and (*e*) above should not be sent. The Institute does not undertake the responsibility of returning original certificates if enclosed with the applications.

C. Declaration of Guardian.

Applications without the signed declaration of father or guardian in the column as may be provided in the Application Form accepting the financial responsibility of the applicant shall be regarded as incomplete.

D. Admit Card for the written Entrance Examination.

Applicants for the 5 and 5½-year B.Tech. and B.Arch Degree courses who fulfil all requirements in respect of educational qualification, age limit and physical fitness and have completed the application in all respects and submitted the same within the time limit shall be asked to appear at the written Entrance Examination, at the centre of their choice or at any other centre near their place of residence. Admit Cards for the Entrance Examination will be issued so as to reach the candidates usually within one week before the date of commencement of the examination.

E. Interview and Medical Examination.

Candidates successful in the written examination shall be required to appear, at their own expense, at an interview and medical examination at the Institute situated in the Zone in which the centre of Entrance Examination is located. The authorities of the Institute may, however, ask a candidate to appear for the interview at any other Institute.

The interview and the medical examination of candidates for admission to the 5 and 5½-year B.Tech. and B.Arch. Degree courses are normally held in the 3rd and 4th weeks of June unless otherwise decided by the Institute.

Written test and/or interview and medical examination for admission to other courses shall be held on dates as may be decided by the Institute.

F. Selection for a course of study.

Preference for a particular course as mentioned in the application will be given due consideration but the final selection for a course shall be made by the Institute taking into consideration previous attainment, performance in the Entrance Examination, aptitude and suitability of the candidate and availability of seats for the particular course. Decision of the Institute shall be final and no application for change of course shall be entertained.