STUDENT INFORMATION HANDBOOK AND SCHEME OF INSTRUCTION 2018-19

FOUR YEAR BACHELOR OF SCIENCE [RESEARCH] PROGRAM

विद्यार्थी सूचना पुस्तिका और शिक्षण योजना २०१८-१९

चार साल के विज्ञान स्नातक कार्यक्रम

INDIAN INSTITUTE OF SCIENCE
भारतीय विज्ञान संस्थान

IISc
INDIAN INSTITUTE OF SCIENCE

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PREFACE

We are delighted to welcome you to the 2018-19 academic session of the Bachelor of Science (Research) & Master of Science Programs of the Indian Institute of Science (IISc). The Student Information Handbook & Scheme of Instruction presents information relevant to the structure of these programs and the courses offered in the programs. It also provides detailed information about the facilities available to you and the rules and regulations related to the life of an undergraduate student on the IISc campus. Please read the Handbook carefully and feel free to contact us or your subject Coordinator/ Faculty Advisor if you have any additional questions.

Our best wishes for a productive, exciting and pleasant academic year.

Cordially,

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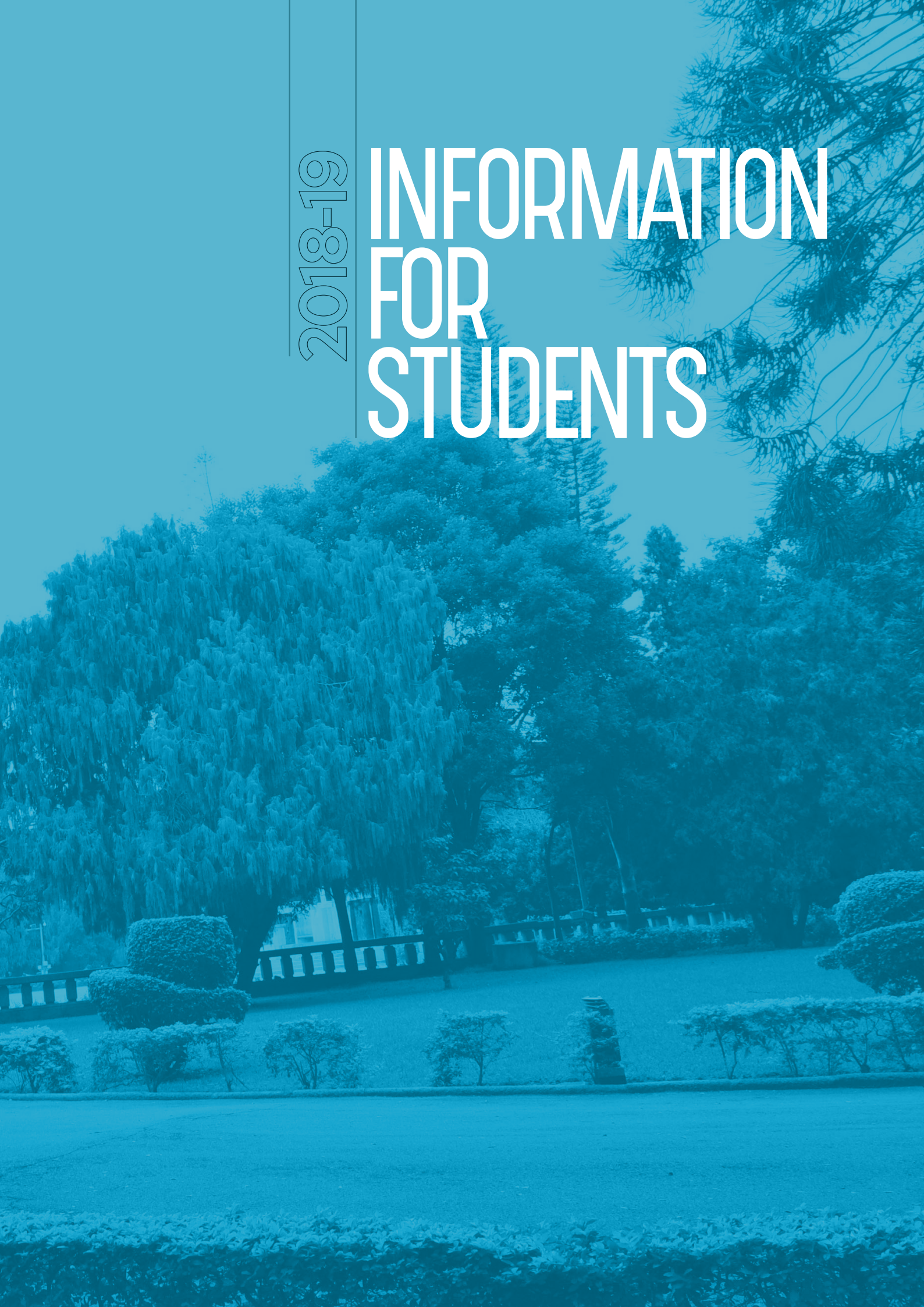


ACADEMIC EVENTS

REGULAR TERMS

I TERM	II TERM	SUMMER TERM
01 AUGUST - 12 DECEMBER 2018	01 JANUARY - 26 APRIL 2019	01 MAY - 30 JUNE 2019

COURSE REGISTRATION

I TERM	II TERM	SUMMER TERM
01 - 03 AUGUST 2018	01 - 04 JANUARY 2019	01 - 03 MAY 2019

MID-SESSION RECESS

13 DECEMBER - 31 DECEMBER 2018

VACATION

01 MAY - 31 JULY 2019

TERMINAL EXAMINATIONS

I TERM	II TERM	SUMMER TERM
03 - 12 DECEMBER 2018	17 - 26 APRIL 2019	28 JUNE 2019

EXPANSIONS FOR THE ABBREVIATIONS USED

TGPA : TERM GRADE POINT AVERAGE
CGPA : CUMULATIVE GRADE POINT AVERAGE
SUGCC : SENATE UNDERGRADUATE CURRICULUM COMMITTEE
UGCC : UNDERGRADUATE CURRICULUM COMMITTEE

01

BACHELOR OF SCIENCE (RESEARCH) PROGRAM

1.1 BASIC STRUCTURE

The four-year Bachelor of Science (Research) Program is organized into eight semesters. The following major disciplines are available in the Bachelor of Science (Research) Program:

- Biology
- Chemistry
- Earth & Environmental Sciences
- Materials
- Mathematics
- Physics

Each student is required to take a specified number of core courses in the first three semesters. The course work during these three semesters consists of a common program for all students, independent of the future discipline. This will include courses in engineering, humanities and interdisciplinary areas for a well-rounded learning experience. At the end of the third semester, each student will be assigned a major discipline (from the list given above) based on her/his preferences and CGPA. While a student specializes in a major discipline, she/he can also broaden her/his knowledge and skills by taking courses in other disciplines. Students who take a sufficient number of courses in a discipline other than the chosen major will qualify for a minor in that discipline.

1.2 FACULTY ADVISOR

In the first three semesters, the Dean and the Associate Deans will be advising the students. Each student will be assigned a Faculty Advisor at the beginning of the fourth semester. The Faculty Advisor may be consulted about all matters (academic as well as non-academic) that may be of concern to the student. The Faculty Advisors will do their best to promote the development and growth of the students in their scientific career.

1.3 REGISTRATION FOR COURSES AND COURSE LOAD

1.3.1 Registration for courses will be done in consultation with the Faculty Advisor/Subject Coordinator.

1.3.2 All students must complete a total of 131 credits (basic courses in biology, chemistry, mathematics and physics in the first three semesters: 36 credits; engineering courses: 19 credits; humanities courses: 9 credits; major – courses and project: 52 credits; minor or assortment of courses: 15 credits). The course load during the first three common semesters is fixed. From the fourth semester, a student must register for a minimum of 16 credits and a maximum of 19 credits if the student's CGPA is <6 (8-point scale)/<7 (10-point scale) and 23 credits if the student's CGPA ≥ 6 (8-point scale)/≥7 (10-point scale). Students with TGPA (in the preceding semester) or CGPA < 6.0 (8-point scale) / <8.0 (10-point scale) are not allowed to register for more than 19 credits in the subsequent semester. The final semester is devoted to a research project.

1.4 DROPPING OF COURSES

1.4.1 A student may drop a course, after consultation with her/his Faculty Advisor and the course Instructor, provided that the total number of credits carried in the term is not less than the minimum number of credits stipulated in Section 1.3. If the course is dropped on or before 15th October in Term I and 1st March in Term II, the course will not be listed in the final transcript. Dropping of excessive courses is permitted on or before 15th November in Term I and 1st April in Term II; however, the dropped course will be recorded in the final transcript with a W (Withdrawn) grade marked against it.

1.4.2 A student may register again for a course (in consultation with Faculty Advisor) which she/he has dropped in a previous term.

1.4.3 After a student has passed a course, she/he cannot register again for it, or take an equivalent course in order to improve the grade. Such re-taking for grade improvement arises only when she/he gets a failing F grade; the details of this are discussed in Section 1.8.

1.5 CONTINUOUS ASSESSMENT

1.5.1 Evaluation is based on continuous assessment, in which sessional work and the terminal examination contribute equally to the final grade.

1.5.2 Sessional work consists of class tests, mid-term examination(s), home-work assignments etc., as determined by the Instructor. Absence from these or late submission of home-work will result in loss of marks. Attendance in the mid-term examination is compulsory. If a student does not attend the examination, she/he shall be considered to have obtained zero marks in it. Absence on medical grounds, certified by the Chief Medical Officer of the Institute, may be condoned, and the

student may be permitted to take a substitute examination as decided by the instructor. In such a case, medical certificate issued by the Chief Medical Officer of the Institute along with a leave letter must be submitted to the UG office within one week after the end date in the certificate in support of her/his absence promptly. Those applications submitted later will not be considered.

1.5.3 The distribution of 50% sessional marks among home-work, class tests, mid-term examinations etc., will be announced by the Instructor at the beginning of the course. After the terminal examination has been graded, the 50% contribution from it is added to the sessional marks, to get the total marks. The marks are then converted to grades, based on cut-offs that are decided by the Instructor. Only the grade is reported; the marks are retained internally by the Instructor. There are 7 grades (10-point scale), designated A+, A, B+, B, C, D, F and 6 grades (8-point scale), designated S, A, B, C, D, F, with corresponding grade points given below. All grades except F are passing grades. To get a passing grade in a course that has both theory and laboratory components, a student must secure at least 20% marks in both theory and laboratory parts. The following new grade and grade point scale (based on 10 point scale) came into effect from the academic year 2016-17. Students of the earlier batches would continue to be graded as per the old grading system on 8 point scale.

10 POINT SCALE	A+	A	B+	B	C	D	F
	10	9	8	7	6	5	0
8 POINT SCALE	S	A	B	C	D	F	
	8	7	6	5	4	0	

1.5.4 The Grade Point Average (GPA) is computed from the grades as a measure of the student's performance. The Term GPA (TGPA) is based on the grades of the current term, while the Cumulative GPA (CGPA) is based on the grades in all courses taken after joining the program. The contribution of each course to the GPA is the product of the number of credits and the grade point corresponding to the grade obtained. For instance, if it is a 3 credit course, and the student gets a B grade (which corresponds to 7 grade points, from the table above), then the contribution of the course to the total grade points is equal to 3 x 7, or 21. To get the TGPA, one adds the grade point contributions of all the courses taken in the term, and divides this total by the number of credits. The CGPA is similarly calculated, the only difference being that one considers the grade point contributions of all the courses taken in all the terms. The TGPA and CGPA are rounded off to the first decimal place.

1.6 TERMINAL EXAMINATIONS

1.6.1 Terminal examinations are held during the last fortnight of each semester and during the last week of the Summer Term. The Time Table will be notified in advance. The graded answer scripts of the terminal examination will be made available to the students on a specified date within one week from the date of the terminal examination. Requests for changes in the grading of the terminal examination papers can be made only when the graded papers are shown to the students.

1.6.2 Attendance of the terminal examination is compulsory. If a student does not attend the examination, she/he shall be considered as having obtained zero marks in it, and will get an F grade. Absence on medical grounds, certified by the Chief Medical Officer of the Institute, may be condoned, and the student may be permitted to take substitute examination(s) within a prescribed period. In such a case, medical certificate issued by the Chief Medical Officer of the Institute along with a leave letter must be submitted to the UG office within three working days after the end date in the certificate in support of her/his absence promptly. Those applications submitted later will not be considered.

1.7 ACADEMIC CRITERIA FOR CONTINUATION

1.7.1 The student should not have obtained more than four F grades at any given time during the period of studentship. If a fifth F grade is obtained without clearing the four existing F grades, she/he shall leave the Institute.

1.7.2 In the first term, the TGPA should not be below 4.5 (10-point scale)/3.5 (8-point scale), and in subsequent terms the CGPA should not go below 5.0 (10-point scale)/4.0 (8-point scale). If this condition is not satisfied, the student shall leave the Institute.

1.8 HANDLING OF 'F' GRADES

1.8.1 Since the F grade is a failing grade, a student cannot graduate until she/he clears each F grade by taking a make-up examination, by repeating the same course or by taking a substitute course, as decided by the UGCC and SUGCC. Make-up examinations of all courses will be held in the last week of the summer vacation.

1.8.2 If the F grade is obtained in a core course, it must be cleared by taking a make-up examination in the same course or by repeating the same course, as decided by the UGCC and SUGCC. For an elective, the UGCC can specify an appropriate alternative course as the substitute course.

1.8.3 If a student clears an F grade by taking a make-up examination, the highest grade she/he can get in that course is C (10-point scale)/C (8-point scale). A student who fails the make-up examination must repeat the course. If the student gets an F grade in the repeated course or in the specified substitute course, the student shall leave the Institute.

1.8.4 Such repetition of courses is permitted only to clear F grades. Students are not permitted to retake courses in which they have obtained any higher grade.

1.8.5 Both the F grade that was initially obtained and the higher grade that was obtained in the subsequent taking of the course will be reflected in the transcript.

1.8.6 Even if F grades are subsequently cleared, the student will not be eligible for the award of Distinction.

1.8.7 When an F grade is obtained, it is used for the computation of the TGPA and the CGPA. When the F grade is subsequently cleared, it will no longer be included in computing the TGPA of the term in question, and the grade from the repeated or substitute course will replace it in the subsequent CGPA computations.

1.8.8 Make up exams will be held only once, in the month of July for courses offered in that particular academic year. Registration for the summer term is mandatory for students opting to appear for make-up exams. To be eligible to appear for make-up examinations, 80% attendance must have been satisfied during the regular term.

1.9 PROJECT

1.9.1 Each student registers for a project at the end of the sixth semester. Each student will carry out the project under a Project Advisor who is chosen based on the student's interests. The Project Advisor also becomes the Faculty Advisor from this stage.

1.9.2 Minimum Project Pass Grade: The minimum pass grade is D (10-point scale)/D (8-point scale). This policy change will be effective from the academic year 2018-'19. If a student secures an F grade in the project, she/he fails the program and must leave the Institute. Should there be a need for extension of the project, prior approval from the Dean need to be obtained on or before April 15, 2019. In such cases, an application forwarded by the project advisor and the subject coordinator is to be submitted.

1.9.3 Internship to be undertaken in a laboratory/institute outside the institute in connection with the project, has to be proposed by the primary project advisor at IISc in the form of an application to the Dean with details of the work to be carried out by the student. A period not exceeding one semester may be permitted based on the application. A specific recommendation by the primary project advisor at IISc has to be made. No exemptions will be given for compulsory courses during the period of absence. Project credits will have to be registered for that semester before leaving for internship.

1.10 FINANCIAL SUPPORT FOR INTERNATIONAL CONFERENCES

Requests for partial financial support to attend and present papers at international conferences could be made by students in the fourth year (Bachelor's program) or in the fifth year (Master's program).

Following conditions should be met in order to apply:

1.10.1 CGPA should be 8.0 or more (10-point scale)/6.5 or more (8-point scale) in Bachelor's or Master's program.

1.10.2 Student seeking financial support should be the first author of the paper to be presented in the conference.

1.10.3 A specific recommendation by the research advisor should be submitted.

1.10.4 Conference should have been scheduled before 30th April of that particular year.

1.11 DEGREE REQUIREMENTS

1.11.1 Normally, students have to complete the Bachelor of Science (Research) program in 8 terms. However, in special circumstances, a student may be permitted an extension, so as to complete all requirements for the degree within a maximum of 12 terms. Further, the core courses need to be cleared within a maximum of 6 terms. Summer terms are not counted for this purpose.

1.11.2 The computation of the final CGPA is done only if the student clears all courses successfully within the period specified.

1.11.3 A student must complete the specified course requirements of 131 credits of the relevant degree program with a minimum CGPA of 5.0 (10-point scale) / 4.0 (8-point scale) in the course work and at least a D (10-point scale) / D (8-point scale) grade in the project work.

1.12 CLASSIFICATION OF AWARDS

1.12.1 Successful completion of the course can carry any one of the following awards: First Class with Distinction and First Class. The CGPA requirements for each award are given below:

CGPA	Award
8.5 and above (10-point scale) (7.0 and above-8-point scale)	First Class with Distinction
6.0 and above (10-point scale) (4.8 and above-8-point scale)	First Class

1.13 ATTENDANCE

1.13.1 Attendance in all classes (lectures, tutorials, laboratories, etc) must be at least 80% of the total number of classes. Students with less than 80% attendance in a course at the time of the mid-term examination will not be allowed to take the examination. A student will be debarred from appearing in the terminal examination of a course if her/his attendance in the course for the semester falls below 80%. A shortage of attendance may be condoned by the Dean only in exceptional circumstances.

1.14 BREAK IN STUDIES

1.14.1 Students may be permitted a break in studies on medical grounds with the prior written permission of the UGCC. The break may be for a maximum period of one year.

1.14.2 Request for a break in studies should be submitted at least a month in advance, and must be accompanied by a certificate from the Chief Medical Officer (CMO) of the Institute. It should be forwarded through the Faculty Advisor.

1.14.3 Resumption of studies requires a fitness certificate from the CMO of the Institute.

1.14.4 To maintain the studentship status, the student should pay tuition and all other fees even during the break period.

1.15 PRIVILEGES AND RESPONSIBILITIES

1.15.1 All students are bound by the rules and regulations framed by the Institute.

1.15.2 Full Time Students: During the tenure of their studentship, full-time students are eligible for the following:

- Residence in the Hostel as per hostel rules, subject to availability
- Membership of the Gymkhana
- Participation in the activities of the Students' Council
- Assistance from the Students' Aid Fund (SAF)
- Leave privileges as may be applicable from time to time
- Limited assistance through the Special Medical Care Scheme

1.16 GENERAL

On all matters connected with their course work and the prescribed requirements for the degree, students are advised to seek the guidance of the Faculty Advisor or the Dean of Undergraduate Studies.

02 MASTER OF SCIENCE PROGRAM

2.1 BASIC STRUCTURE

Undergraduate students who fulfil the requirements towards the Bachelor of Science (Research) degree at the end of the fourth year with no pending backlog course(s) to be cleared in the final semester have an option to continue for a fifth year to register for a Master of Science degree. The fifth year is organized in two semesters. Students are required to take a specified number of courses (as outlined in Table below) and complete a research project in their major discipline. A project report has to be submitted which will be evaluated and graded. All other guidelines as laid out for the Bachelor of Science (Research) program will be applicable for the Master of Science program as well.

2.2 MAJOR DISCIPLINE REQUIREMENTS

Discipline	Credit Remarks	Classroom Courses	Project Credits	Others
Biology	12	Mandatory courses to be fulfilled	20	
Chemistry	12	Min. of 6 credits (200 or 300 level) from within chemical sciences division + 6 credits (200 or 300 level) from any division OR all 12 credits from the chemical sciences division	20	
Earth & Environ Sciences	12	Mandatory courses to be fulfilled	20	

Discipline	Credit Remarks	Classroom Courses	Project Credits	Others
Materials	12	Any 4 courses from Materials Engineering or Materials Research Centre or some other equivalent courses as per Student's Handbook	20	
Math	30	Mandatory courses to be fulfilled	0	2 (seminar course)
Physics	12	Mandatory courses to be fulfilled	20	

2.3 CREDIT CARRYOVER

Credits fulfilled over and above 131 in the Bachelor's degree could be considered towards Master's degree provided the following conditions are met:

a. A maximum of 12 credits completed over and above 131 in the Bachelor's degree and belonging to the subject area of the student's major discipline could be considered towards the Master's degree.

b. If the 12 credits taken in excess of the required 131 in the Bachelor of Science (Research) program are those of mandatory course credits required to be fulfilled in the Master's program, then the student will only have to fulfill project credits in the fifth year.

c. If the excess 12 credits (fulfilled in the Bachelor's program) do not include any compulsory courses (as prescribed by the respective discipline for the Master' degree program) then the student is required to fulfill the compulsory course credits in the fifth year.

d. No exemptions will be given for compulsory courses.

e. Students wishing to exercise credit carry over must submit a form with course details duly forwarded by the subject coordinator for approval before 3rd August 2018.

2.4 CLASSIFICATION OF AWARD

CGPA	8.5 and above (10-point scale); 7.0 and above (8-point scale)
Award	First Class with Distinction

2.5 MANDATORY COURSE REQUIREMENTS

BIOLOGY

Students are required to fulfil the 'mandatory 12 credits' by choosing courses from the following 'basket of courses'.

If they took some/ all of these courses in their Bachelor's program itself, then they can fulfil the 'mandatory 12 credits' by taking the remaining courses from this basket AND/ OR other departmental courses.

a) UB 304L Experiments in Neurobiology (0:1)
b) RD 201 Genetics (2:0) OR UB 305 Genetics (2:1)
c) MC 207 Molecular and Cellular Biology (3:0) OR {UB 206 Basic Molecular Biology (2:0) plus BC 201 Cell Biology (2:0)}
d) MB 207 DNA-protein interactions, regulation of gene expression, nanobiology (2:0) OR MB 303 Elements of Structural Biology (3:0)
e) NS 201 Fundamentals of Systems and Cognitive Neuroscience (3:0) OR NS 202 Fundamentals of Molecular and Cellular Neuroscience (3:0)
f) EC 204 Evolutionary Biology (2:1) OR EC 203 Principles of Ecology (3:0)
g) MC 203 Essentials in Microbiology (3:0) OR BC 206 Essentials in Immunology (2:0)

UB 500: Master's Project (0:20)

CHEMISTRY

Minimum of 6 credits (200 or 300 level) from within the Chemical Sciences Division and 6 credits (200 or 300 level) from any division OR all 12 credits (200 or 300 level) from within the Chemical Sciences Division.

UC 500: Master's Project (0:20)

EARTH & ENVIRONMENTAL SCIENCES

Any 4 courses (12 credits) from Departments/Centres participating in the E & ES program or some other equivalent courses as per Student's handbook.

UES 500: Master's Project (0:20)

MATERIALS

The choice of 4 courses (12 credits) should be as follows:

Core courses*:
MT 202: Thermodynamics and Kinetics
MT 241: Structure and Characterization of Materials
Any one out of the following soft core courses:
MT 203 3:0 Materials Design and Selection

MT 209 3:0 Defects in Materials
MT 220 3:0 Microstructural Engineering
MT 231 3:0 Interfacial Phenomena in Materials Processing
MT 245 3:0 Transport Processes in Process Metallurgy
MT 253 3:0 Mechanical Behavior of Materials
MT 260 3:0 Polymer Science and Engineering – I

Any one course offered in Materials Engineering or Materials Research Centre
*Those who have already taken MT 202 and/ or MT 241 in their Bachelor's program, must substitute the same from the above list of soft core courses

UMT 500: Master's Project (0:20)

MATHEMATICS

Following mandatory courses to be fulfilled:
MA 399: Seminar
MA 223: Functional Analysis: Tirthankar Bhattacharyya
MA 232: Introduction to Algebraic Topology: Basudeb Datta
MA 242: Partial Differential Equations: A. K. Nandakumaran

PHYSICS

Following mandatory courses to be fulfilled:
Condensed Matter Physics I: PH 208: Manish Jain
Electromagnetic Theory: PH 206: Anindya Das
Fundamentals of Astro Physics: PH 217: B. Nath/TDS
Nuclear and Particle Physics: P/HE 215: Jyothsna Komaragiri

Among the 12 credits in the fifth year there should be at least 6 credits at 300 level. The 5th year course(s) can be from any department with the permission of the respective instructors and Physics coordinator

UP 500: Master's Project (0:20)

03

DISCIPLINE, ATTENDANCE AND LEAVE RULES

3.1 DISCIPLINE

3.1.1 Students are expected to dress and conduct themselves in a proper manner.

3.1.2 All forms of ragging are prohibited. If any incident of ragging comes to the notice of the authorities, the student concerned shall be given the opportunity to explain. If the explanation is not found to be satisfactory, the authorities can expel her/him from the Institute.

3.1.3 If a student is found under the influence of any form(s) of intoxication (other than the prescription medication), she/he would be expelled from the Institute.

3.1.4 The students are expected to conduct themselves in a manner that provides a safe working environment for women. Sexual harassment of any kind is unacceptable and will attract appropriate disciplinary action. Further details can be obtained from the website: http://www.iisc.ac.in/icash/.

3.2 LEAVE

3.2.1 A student is governed by the following leave rules:

3.2.1.1 To obtain leave, prior application will have to be submitted to the Dean of Undergraduate Studies through the Faculty Advisor stating fully the reasons for the leave requested for along with supporting document(s). Such leaves will be granted by the Dean.

3.2.1.2 Absence for a period not exceeding two weeks in a semester due to

unavoidable reasons for which prior application could not be made may be condoned by the Dean of Undergraduate Studies provided she/he is satisfied with the explanation.

3.2.1.3 The Dean of Undergraduate Studies may, on receipt of an application, also decide whether the student be asked to withdraw from the courses for that particular semester because of long absence.

3.2.1.4 The leave of absence as per 3.2.1.1 and 3.2.1.2 will not be condoned for attendance.

3.2.1.5 All students are entitled to take leave for the full summer term at the end of the second semester.

3.2.2 Leave of absence on medical grounds: Up to 21 days in a semester for extended sickness normally requiring hospitalization. If the medical leave exceeds 21 days, the Dean of Undergraduate Studies may, on receipt of an application, also decide whether the student be asked to withdraw from the courses and drop the semester because of long absence.

3.2.2.1 Women research scholars can avail of maternity leave for 135 days once during the tenure of studentship. Discipline, Attendance and Leave Rules.

3.2.2.2 For leave under 3.2.2 above, a Medical Certificate and a subsequent Fitness Certificate (for resumption of studies) are required. These are to be issued by the CMO of the Institute.

3.2.2.3 A combination of different types of leave is not normally permitted.

3.2.3 With regard to leave, the year is reckoned as follows: from the date of commencement of the session, irrespective of the date of joining.

3.2.4 Students permitted to attend approved conferences may be considered to be on duty.

04

CODE OF ETHICS AND CONDUCT

4.1 At the time of admission, each student is required to sign a statement accepting the code of ethics and conduct, and giving an undertaking that:

(a) she/he will complete her/his studies in the Institute; and

(b) if for any legitimate reasons, she/he is forced to discontinue studies, she/he will do so only on prior intimation to and permission from the Deans.

4.2 If a student commits a breach of the code of conduct, she/he will be asked to leave the Institute and will not be eligible for:

4.2.1 Re-admission as a student for a period of three years; and

4.2.2 Issue of grade card or certificate for the course studied or work carried out by him/her as a part of the program for which she/he was admitted.

4.3 On account of misconduct or unsatisfactory work, the Deans may withdraw the scholarship at any time and/or decide that the scholarship has to be refunded from the date of the last award.

4.4 In various phases of research, project work, course work and other academic activities, one is faced with issues of integrity and conflict of interest. Behavior of all Institute faculty, students and research workers must be in conformance with the Academic Integrity policy that is given in the next Section.

05

ACADEMIC INTEGRITY

5.1 Cases of ethical lapses emanating from institutions of scientific research are increasingly being reported in the news. In this context, we have created a set of guidelines to maintain academic integrity. A flourishing academic environment entails individual and community responsibility for doing so. The three broad categories of improper academic behavior that will be considered are: I) plagiarism, II) cheating and III) conflict of interest.

5.2 Cases of ethical plagiarism are the use of material, ideas, figures, code or data without appropriate acknowledgement or permission (in some cases) of the original source. This may involve submission of material, verbatim or paraphrased, that is authored by another person or published earlier by oneself. Examples of plagiarism include:

(a) Reproducing, in whole or part, text/sentences from a report, book, thesis, publication or internet.

(b) Reproducing one's own previously published data, illustrations, figures, images, or someone else's data, etc.

(c) Taking material from class-notes or downloading material from internet sites, and incorporating it in one's class reports, presentations, manuscripts or thesis without citing the original source.

(d) Self plagiarism which constitutes copying verbatim from one's own earlier published work in a journal or conference proceedings without appropriate citations.

The resources given in Subsection 5.7 explains how to carry out proper referencing, as well as examples of plagiarism and how to avoid it.

5.3 Cheating is another form of unacceptable academic behavior and may be classified into different categories:

(a) Copying during exams, and copying of homework assignments, term papers or manuscripts.

(b) Allowing or facilitating copying, or writing a report or exam for someone else.

(c) Using unauthorized material, copying, collaborating when not authorized, and purchasing or borrowing papers or material from various sources.

(d) Fabricating (making up) or falsifying (manipulating) data and reporting them in thesis and publications.

5.4 Some guidelines for academic conduct are provided below to guard against negligence as well as deliberate dishonesty:

(a) Use proper methodology for experiments and computational work. Accurately describe and compile data.

(b) Carefully record and save primary and secondary data such as original pictures, instrument data readouts, laboratory notebooks, and computer folders. There should be minimal digital manipulation of images/photos; the original version should be saved for later scrutiny, if required, and the changes made should be clearly described.

(c) Ensure robust reproducibility and statistical analysis of experiments and simulations. It is important to be truthful about the data and not to omit some data points to make an impressive figure (commonly known as "cherry picking").

(d) Lab notebooks must be well maintained in bound notebooks with printed page numbers to enable checking later during publications or patent. Date should be indicated on each page.

(e) Write clearly in your own words. It is necessary to resist the temptation to "copy and paste" from the Internet or other sources for class assignments, manuscripts and thesis.

(f) Give due credit to previous reports, methods, computer programs etc with appropriate citations. Material taken from your own published work should also be cited; as mentioned above, it will be considered self-plagiarism otherwise.

5.5 CONFLICT OF INTEREST:

A clash of personal or private interests with professional activities can lead to a potential conflict of interest, in diverse activities such as teaching, research, publication, work on committees, research funding and consultancy. It is necessary to protect actual professional independence, objectivity and commitment, and also to avoid an appearance of any impropriety arising from conflicts of interest. Conflict of interest is not restricted to personal financial gain; it extends to a large gamut

of professional academic activities including peer reviewing, serving on various committees, which may, for example, oversee funding or give recognition, as well as influencing public policy. To promote transparency and enhance credibility, potential conflicts of interests must be disclosed in writing to appropriate authorities, so that a considered decision can be made on a case-by-case basis. Some additional information is available also in the section below dealing with resources.

5.6 INDIVIDUAL AND COLLECTIVE RESPONSIBILITY:

The responsibility varies with the role one plays.

5.6.1 Student Role: Before submitting a project report to the subject coordinator, the student is responsible for checking the report for plagiarism using software that is available on the web (see resources below). In addition, the student should certify that they are aware of the academic guidelines of the Institute, have checked their document for plagiarism, and that the project report is original work. A web-check does not necessarily rule out plagiarism.

5.6.2 Faculty Role: Faculty should ensure that proper methods are followed for experiments, computations and theoretical developments, and that data are properly recorded and saved for future reference. In addition, they should review manuscripts and theses carefully. Apart from the student certification regarding a web-check for plagiarism for project reports, the Institute will provide some commercial software at SERC for plagiarism checking. Faculty members are encouraged to use this facility for checking reports and manuscripts. Faculty members are also responsible for ensuring personal compliance with the above broad issues relating to academic integrity.

5.6.3 Institutional Role: A breach of academic integrity is a serious offence with long lasting consequences for both the individual and the institute, and this can lead to various sanctions. For students, the first violation of academic breach will lead to a warning and/or an "F" course grade. A repeat offence, if deemed sufficiently serious, could lead to expulsion. It is recommended that faculty bring any academic violations to the notice of the subject coordinator. Upon receipt of reports of scientific misconduct, the Director may appoint a committee to investigate the matter and suggest appropriate measures on a case to case basis.

REFERENCES

1. National Academy of Sciences article "On being a scientist,"http://www.nap.edu/openbook.php?record_id=4917&page=R1
2. http://www.admin.cam.ac.uk/univ/plagiarism/
3. http://www.aresearchguide.com/6plagiar.html
4. https://www.indiana.edu/~tedfrick/plagiarism
5. http://www.files.chem.vt.edu/chem-ed/ethics/index.html
6. http://www.ncusd203.org/central/html/where/plagiarism_stoppers.html
7. http://sja.ucdavis.edu/files/plagiarism.pdf
8. http://web.mit.edu/academicintegrity/
9. http://www.northwestern.edu/provost/students/integrity/
10. http://www.ais.up.ac.za/plagiarism/websources.htm#info
11. http://ori.dhhs.gov/
12. http://www.scientificvalues.org/cases.html

06

TUITION AND OTHER FEES

Students are required to pay the fees prescribed by the Institute during the period of studentship. These are liable to changes from time to time. The details of the fees in force are given below:

6.1 FEES PER ANNUM:

6.1.1 BACHELOR OF SCIENCE (RESEARCH) STUDENTS (GENERAL/OBC)

FEE DETAILS	**INR** (₹)
Tuition Fee	10,000
Gymkhana Fee	1200
Other Academic Fee	3700
Statutory Deposit	7500
Library Deposit	7500
Students' Emergency Fund	300
Group Mediclaim Policy Premium	1060
TOTAL	31,260
HOSTEL DEPOSIT	20,000

6.2 FEE PAYMENT SCHEDULE FOR THE SESSION 2018-19

BACHELOR OF SCIENCE (RESEARCH) STUDENTS (GENERAL/OBC)

	INSTALLMENT (I)	INSTALLMENT (II)	INSTALLMENT (III)
Tuition Fees (INR)	2000	4000	4000
Other Fees (INR)	6200	--	--
TOTAL (INR)	8260	4000	4000

DUE DATES

PERIOD	DUE DATE
I Installment (1 August – 31 October)	15/08/2018
II Installment (1 November-31 December)	14/11/2018
III Installment (1 January-31 July)	16/01/2019

BACHELOR OF SCIENCE (RESEARCH) STUDENTS (SC/ST)

FEE DETAILS	AMOUNT (INR)
Tuition Fee	Fully waived
Gymkhana Fee	1,200
Other Academic Fee	3700
Students' Emergency Fund	300
Group Mediclaim Policy Premium	1,060
TOTAL (IN RS.)	6,260

(Due Date: August 16, 2018)

6.2.1 PENALTIES

6.2.1.1 Fees are payable on or before the dates noted above. If the due date falls on a holiday, it can be paid on the next working day without a fine. A fine of Rs. 20/- per week shall be levied for all students who default and do not pay the fees before the prescribed date.

6.2.1.2 If a student fails to pay tuition and other fees by the due date, any one or more of the following penalties will be levied:

(a) Overdue charges of Rs. 20/- per week or part thereof;
(b) Stoppage of scholarship and/or loss of attendance for the period of non-payment or delay in payment;
(c) Withdrawal of permission to take the examinations or to continue research; and
(d) Cancellation of registration to continue as a student at the Institute.

6.3. DEPOSITS (REFUNDABLE)

STATUTORY DEPOSIT: RS. 7,500/- | LIBRARY DEPOSIT: RS. 7,500/-

6.3.1 The deposits are to cover liabilities such as:
(a) Damage of apparatus or other property
(b) Wastage of materials
(c) Fines
(d) Hostel and dining hall dues
(e) Loss of Books and
(f) Other dues.

6.3.2 A request for refund of Statutory and Library deposits is to be submitted in the prescribed forms at the time of leaving the Institute. The form may be obtained either from the Undergraduate Office or from the Finance Section (Unit V-C). A student should submit the request through the Dean of the Undergraduate Program before leaving the Institute, to obtain a refund of the deposits.

6.4. CONCESSIONS

6.4.1 Students belonging to SC and ST communities are exempted only from tuition fees.

07

STUDENTS' ASSISTANCE

7.1 STUDENTS' AID FUND

7.1.1 Each student shall contribute to the Fund a sum of at least Rs. 50 per annum. Donations are also received from other sources.

7.1.2 The Fund is administered by a Committee constituted by the Director. This Committee may also prescribe operational rules for sanction of assistance from the Fund from time to time. A guarantee from one or both the parents or guardian is required before the assistance can be sanctioned.

7.1.3 Assistance in the form of loans from the Fund is available to poor students to:

a) Meet tuition fees;
b) Purchase books, instruments and stationery necessary for the pursuit of their courses or research project;
c) Meet other expenses connected with their work and for their maintenance at the Institute as may be approved by the Committee; and
d) Meet hostel, dining hall, medical expenses, etc.

7.1.4. No payment shall be made by way of scholarships or prizes to students.

7.1.5. This assistance in the form of loans will be as reimbursement of expenditure incurred on different items. The amount will be recovered in equal installments. The number of installments will be decided at the time of sanctioning the loan.

7.1.6 Requests for assistance should be made to the Academic Section in the prescribed form.

7.2 FINANCIAL ASSISTANCE FOR MEDICAL CARE

7.2.1 Students can get limited assistance to meet the cost of expenditure incurred in case of hospitalization, from the Students' Medical Care Fund, formed out of contributions made by the students and a matching grant made by the Institute.

7.3 Medical Insurance: Students are required to sign up for the mandatory Group Medical Insurance

08

JRD TATA MEMORIAL LIBRARY

The Library was established in 1911, and was renamed the JRD Tata Memorial Library in May 1994. It is one of the best scientific and technical libraries in India. The library aims to develop a comprehensive collection of documents that are useful to the faculty, students and research scholars in their educational and research activities.

The library has a total collection of about 5 lakh documents, which includes books and monographs, bound volumes and periodicals, theses, standards, technical reports, Indian patents and non - book materials like CD ROMs, floppy disks etc. It receives over 1700 current periodicals.

Books and journals are available at the main library building. Technical reports, standards and theses are available at the library building.

The Digital Information Service Centre (DISC) is located on the left wing of the first floor of the annexe building. CD-ROM database access facilities are provided here. Digital library services have been started. As part of the digital library, the digitization of institute theses and the rare books collection initiative have been started.

Computer systems are provided at various locations to help access the Online Public Access Catalogue (OPAC) of the library. Users can also access the Online Catalogue from their respective departments, through the library homepage (URL http://www.library.iisc.ac.in).

The following information can be accessed
1. Information about the library
2. Weekly list of books and journals received in the library
3. List of current journals received
4. Complete journal holdings
5. List of journals received by the five IITs
6. Web access to the Online Catalogue (OPAC)

The creation of barcode labels for new books is in progress.

ACCESS TO ELECTRONIC RESOURCES

The library provides access to the following e-resources through the INDEST consortium and also on its own subscription. Some of the full-text resources include Elsevier Science (Science Direct), Springer Verlag (LINK), and ACM, ASCE, ASME, IEEE (IEL). It also gives access to back-files of Elsevier Science, Wiley Interscience, IOP, APS. Bibliographic and citation databases like Compendex, INSPEC, Web of Science can also be accessed.

WORKING HOURS

MONDAY-SATURDAY: 0800 TO 2300 HRS.

SUNDAY: 0900 TO 1700 HRS.

GENERAL HOLIDAYS: 1000 TO 1600 HRS.

CIRCULATION RULES AND PROCEDURES

WHAT MAY BE LOANED
a) Books
b) Series Publications
c) Reference Books (except Handbooks, Dictionaries, Encyclopedias, etc.)

WHAT MAY NOT BE LOANED:
a) Annual Reports
b) Handbooks
c) Dictionaries
d) Encyclopedias

LOAN PERIOD
a) Books (General) 14 days
b) Periodicals (bound/series/references) 48 hours

09

HEALTH CENTRE

Medical services to students are provided at the Health Centre. It has out-patient and in-patient facilities served by Medical Officers and nursing staff. Specialists in the areas of eye, dental and psychiatric care including an Ayurvedic consultant visit the Health Centre regularly. In addition, there is a doctor on duty to look after emergency cases at night.

Diagnostic facilities like a clinical laboratory, an X-ray facility, ECG and ultrasonography are available. Cases requiring other specialist services are referred to appropriate centres/ hospitals.

All the regular students of the Institute are covered by the "Students Health Care Scheme" which permits reimbursement of medical expenses incurred as per norms. Students are to undergo a medical examination at the time of joining.

10

HOSTEL AND DINING HALLS

Adequate accommodation is available for all the registered students of the Institute in the hostels.

There are four dining halls: Vegetarian 'A', Composite 'B', 'C' and 'D' (both vegetarian and non-vegetarian).

Charges towards Hostel facilities (for each month) are given below:

	Gen/OBC	**SC/ST**
	INR	INR
Room Rent (Single)	400.00	200.00
Room Rent (Double)	200.00	100.00
Establishment	200.00	200.00
Amenities	200.00	200.00
Elec. & Water	200.00	200.00
TOTAL	1200.00	900

Additional Mess Amenities – Rs.1000 for all

11

STUDENTS' COUNCIL

www.iisc.ac.in/scouncil
scouncil@tejas.serc.iisc.ac.in

OFFICE BEARERS

CHAIRMAN
Vivek Sharma, CPDM

GENERAL SECRETARY
Gaurav Solra, UG

SECRETARY
ACADEMIC AFFAIRS
Shaunak Handa, DoMS

SECRETARY
AMENITIES & HOSTELS
Jeevesh Kumar, DESE

SECRETARY
WOMEN'S AFFAIRS
Apurva K Ram, UG

SECRETARY
UG AFFAIRS
Abhay Gupta, UG

The Students' Council (SC) is the representative body of the entire student community of the Institute. It is the interface between the students and the administration and works with both entities to identify and address concerns that affect the students directly and indirectly. The SC represents the interests of the students and participates in discussions and decisions that affect the student community.

The SC aims at the all-round development of students and organizes several extra-curricular events throughout the year in association with the Gymkhana and the various activity clubs on campus.

SC also coordinates the student volunteer effort for Institute events that are organized periodically.

It also provides students an opportunity to be a part of the activity, motivated by a sense of social responsibility and aiming to give something back to society.

Three Office bearers are elected for a period of one year. Nominated members constitute the steering and executive committees of the SC. Two representatives from each of the departments are members of the Council. Additionally, the following committees are also constituted by the Students Council.

- Academic - All issues relating to courses, academic resources
- Amenities - Deciding on new on-campus amenities and monitoring the quality of existing ones
- Communications - Media interface and dissemination of information to students
- Cultural - Organizing and promoting intra and inter-institute cultural events
- Social Initiatives - Organizing volunteer activities and drives and coordinating the efforts of the students and student groups in execution
- Support Network, Health - Counseling Center, Women's Cell and the Health Center

12 RECREATIONAL FACILITIES

12.1 GYMKHANA

The Gymkhana is the center of cultural activity at the Institute. It has a cricket ground, tennis, volleyball, basket ball courts and a cinder track. An indoor badminton court, table tennis, billiards, karate, shaolin-chu-kung-fu, taek-wondo, chess and carom, are a few among the many facilities in the Gymkhana. Athletic and recreational facilities at the Gymkhana comes as a break to regular work schedules at the Institute. It also provides a conducive atmosphere for interaction between students and staff.

The Gymkhana also has a good gymnasium with facilities like Home Gym, a Hercules multi trainer and wall bar equipment.

Attached to the Gymkhana is a small well-kept swimming pool where coaching classes are also conducted during the summer.

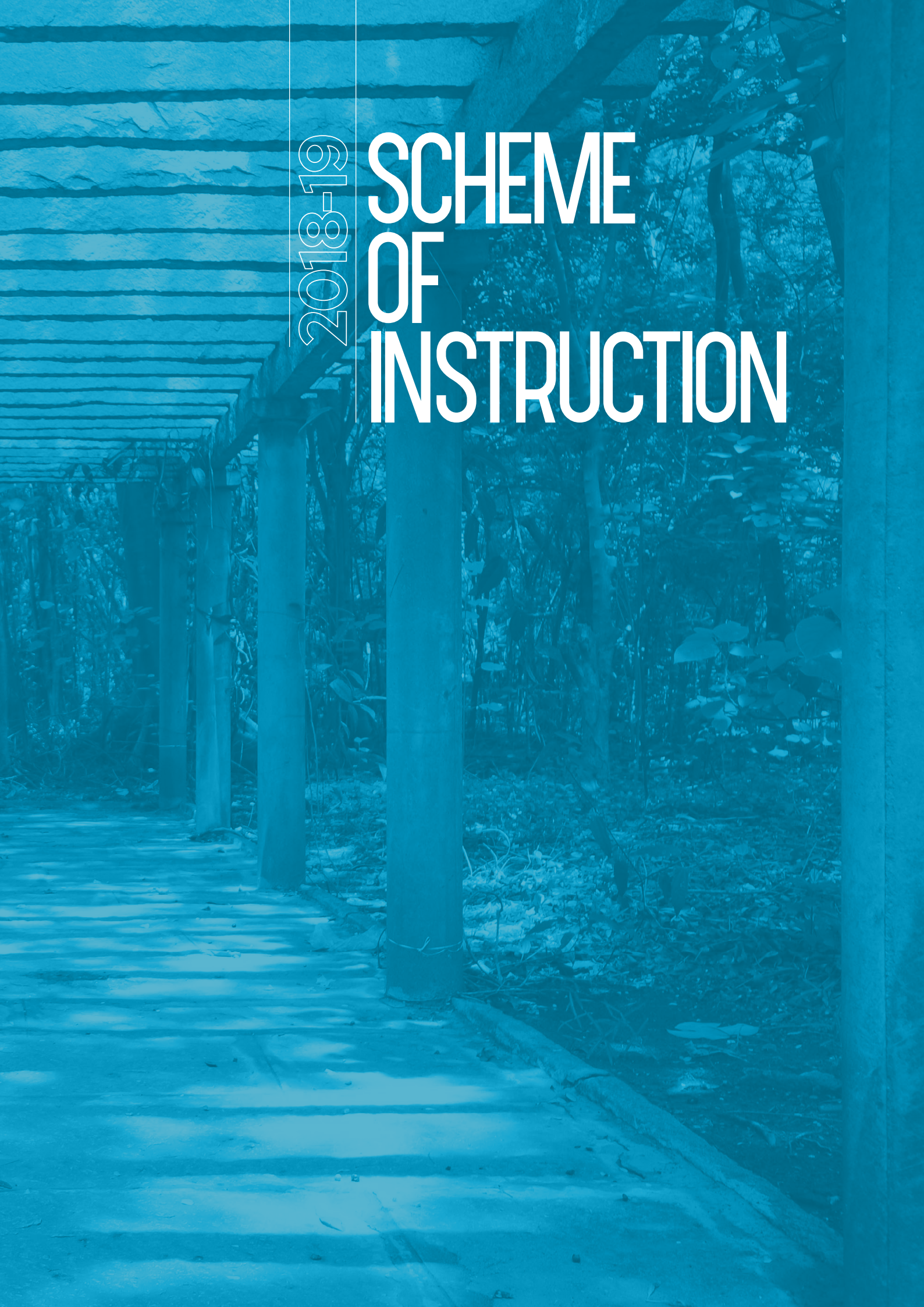
The Gymkhana subscribes to about 14 magazines in English at its Ranade Library, apart from making available about 10,000 books to readers. The music room in the Gymkhana houses a stereo system and record player, with a good collection of records. There is a separate TV lounge. An indoor Students' Auditorium where cultural activities can be organized is available as a facility.

There is also an open-air auditorium. The Film Club regularly screens popular and classic films in its main hall for the benefit of the members. The Gymkhana organizes inter-departmental, inter-collegiate and inter-university tournaments in sports, games and cultural events. A dark room facility for the Photography Club situated at the Gymkhana caters to the needs of camera-loving members.

A snack parlor, which serves coffee, snacks and soft drinks to the members, is also situated in the Gymkhana premises.

12.2 GENERAL FACILITIES

12.2.1 Other general facilities at the Institute include banks, xerox centers, travel agencies, bookstores and a cafe and tea kiosk.



2018-19

SCHEME OF INSTRUCTION

BIOLOG

UG INSTRUCTORS:
Vatsala P. G., Narmada Khare, Neha Bahl, Abhijeet Bayani, Padma Priya, Jean Cletus

SEMESTER 1 (AUGUST)

UB 101 AND UB 101L (2:1)

UB 101: INTRODUCTORY BIOLOGY I
(ORGANISMAL BIOLOGY AND THE MOLECULAR BASIS OF LIFE)

Introduction to the world of living organisms; levels of biological organisation; the scientific method and causation in biology; diversity of life on earth; Evolution: history and evolution of life on earth; mechanisms of evolution; the evidence for evolution and natural selection; adaptation, speciation and diversification; phylogenetics: sex and sexual selection. Animal Behaviour: classical experiments in ethology; asking and answering questions in behavioural ecology. Populations, Communities and Ecosystems: population growth, species interactions, food-webs, material and energy flow in ecosystems. Ecology and global change; why biodiversity matters.

Introduction to chemical evolution, thermodynamic principles and biological macromolecules (water, lipids, carbohydrates, nucleic acids, proteins, enzymes). Placing biomolecules in the cellular context: cell as a unit of life and the site for life processes. Central themes of metabolism, general principles underlying the design of metabolic pathways, elementary enzymology, pathway integration and regulation.

UB 101L

Understanding methods and concepts in evolution, ecology and behaviour by observing, describing and quantifying; experimental manipulations; representing and interpreting data; titration of amino acids, estimation of reducing and non-reducing sugars, estimation of proteins, DNA, RNA, lipids. Techniques like thin layer chromatography for lipids, melting curves for DNA and SDS-PAGE for proteins.

INSTRUCTORS: **Rohini Balakrishnan, Sumanta Bagchi, Jayanta Chatterjee and Nagasuma Chandra**

SUGGESTED BOOKS:

1. Campbell Biology (9th/ 10th editions. By JB Reese, LA Urrey, ML Cain, SA Wasserman. Pearson Global Editions. ISBN 10: 0321739752; ISBN 13: 9780321739759, 2010/ 2013.
2. Ernst Mayr, This is Biology: The Science of the Living World, Harvard University Press, 1997.
3. Jerry A. Coyne, Why Evolution is True, Viking Penguin, New York, USA, 2009.
4. Jonathan Weiner, The Beak of the Finch, Vintage Books, New York, USA, 1995.
6. Sean B. Carroll, The Serengeti Rules: The Quest to Discover How Life Works and Why it Matters, Princeton University Press, New Jersey, 2016.
7. Wilson, E. O., Life on Earth.Freely available at: http://eowilsonfoundation.org/e-o-wilson-s-life-on-earth.
8. Wilson, E. O. The Future of Life, Alfred A.Knopr, 2002.
9. Lodish, H., Berk, A., Kreiger, C. A., Scott, M. P., Bretscher, A., Ploegh, H. and Matsudaira, P., Molecular Cell Biology, W. H. Freeman Publishers, 6th Edition, 2008.
10. Krebs, J. E., Goldstein E. S., and Kilpatrick, S. T., Lewin's Genes X, Jones and Bartlett Publishers, 10th Edition, 2011.
11. Nelson, D. L. and Cox, M. M., Lehninger Principles of Biochemistry, W. H. Freeman Publishers, 5th Edition, 2009.
12. Berg, J. M., Tymoczko, J. L. and Styrer, L., Biochemistry, W. H. Freeman & Co., 6th Edition, 2006.
13. Voet, D. and Voet, J. G., Biochemistry, Wiley, 4th Edition, 2010.

SEMESTER 2 (JANUARY)

UB 102 AND UB 102L (2:1)

UB 102: INTRODUCTORY BIOLOGY II
(MICROBIOLOGY, CELL BIOLOGY AND GENETICS)

Introduction to the microbial world and its diversity; importance of microbes in exploration of basic principles of biology; bacterial growth and its modulation by nutrient availability in the medium; structure and function of a bacterial cell; structure of cell wall; isolation of auxotrophs; introduction to viruses – life cycles of temperate and lytic bacteriophages, structure and function of extra-chromosomal elements and their applications in molecular microbiology.

Introduction to cell biology, eukaryotic cells and their intracellular organization; introduction to the light microscopes and other methods of studying intracellular organelles; further studies on endoplasmic reticulum, Golgi apparatus, lysosomes, mitochondria, nucleus (organization and function), plasma membrane structure and its function, the cytoskeleton, the cell cycle.

Mendelian genetics (segregation and independent assortment); introduction to polytene and lampbrush chromosomes; sex determination and sex linkage in diploids; cytoplasmic inheritance; pedigrees, markers, mapping and genetic disorders; gene frequencies and Hardy- Weinberg principle; and introduction to various model organisms.

UB 102L

Light microscopy, identification of microorganisms, staining techniques (Gram's, acid fast), bacterial plating, tests for antibiotic resistance, cell media and tissue culture; cell counting, immunostanining for actin, microtubules, DNA and identifying interphase and various mitotic phases; Drosophila crosses using red eye and white eye mutants, observation of Barr body in buccal mucosa cells, preparation of mitotic/polytene chromosomes from Drosophila larvae; and karyotyping using human metaphase plate photos.

INSTRUCTORS: **Dipshikha Chakravortty, Sachin Kotak and Arun Kumar**

SUGGESTED BOOKS

1. Berg, J. M., Tymoczko, J. L. and Styrer, L., Biochemistry, W. H. Freeman & Co., 6th Edition, 2006.
2. Stanier, R. Y., Adelberg, E. A. and Ingraham, J. L., General Microbiology, MacMillan Press, 5th Edition, 2007.
3. Alberts, B., Molecular Biology of the Cell, Garland Science, 5th Edition, 2008.
4. Strickberger, M. W., Genetics, Prentice-Hall, India, 3rd Edition, 2008.
5. Daniel, H., Essential Genetics: A genomics perspective, Jones & Bartlett, 3rd Edition, 2002.
6. Strachan, T. and Read, A. P., Human Molecular Genetics, Garland Science, 3rd Edition, 2004.

SEMESTER 3 (AUGUST)

UB 201 AND UB 201L (2:1)

UB 201: INTRODUCTORY BIOLOGY III
(MOLECULAR BIOLOGY, IMMUNOLOGY AND NEUROBIOLOGY)

Molecular biology (central dogma, DNA repair, replication, transcription, genetic code and translation); examples of post-transcriptional and post-translational modifications; genetic methods of gene transfer in bacteria.

Introduction to the immune system – the players and mechanisms, innate immunity, adaptive responses, B cell receptor and immunoglobulins, T cell activation and differentiation and Major Histocompatibility Complex encoded molecules.

Overview of the nervous system, ionic basis of resting membrane potential and action potentials, neurodevelopment, neurotransmitters, sensory systems, motor systems, learning and memory, attention and decision making.

UB 201L

M13 infection, plaque assay, preparation of bacterial competent cells, transformation, transduction, conjugation, β -galactosidase assay. Immune organs

and isolation of cells from lymph node, spleen and thymus; lymphocyte and macrophage activation studies, nitrite detection, ELISA and cell cycle analysis; gross anatomy of the human brain; staining of mouse brain sections; generation of action-potential; psychophysical and cognitive neurobiology experiments.

INSTRUCTORS: **Umesh Varshney, Dipankar Nandi, Deepak Nair and Sridharan Devarajan**

SUGGESTED BOOKS:

1. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Scott, M. P., Bretscher, A., Ploegh, H. and Matsudaira, P., Molecular Cell Biology, W. H. Freeman Publishers, 6th Edition, 2007.
2. Kindt, T., Goldsby, R. and Osborne, B. A., Kuby Immunology, W. H. Freeman Publishers, 6th Edition, 2006.
3. Bear, M., Connors, B. and Paradiso, M., Neuroscience: Exploring the Brain, Lippincott Williams & Wilkins, 3rd Edition, 2006.

SEMESTER 4 (JANUARY)

UB 207: GENERAL BIOCHEMISTRY (2:0)
(CORE COURSE FOR BIO MAJOR AND MINOR)

Biochemical properties of proteins and nucleic acids, basics of protein structures, protein sequencing, introduction to proteomics, protein purification and characterization strategies, methods of DNA sequencing, biological membranes and membrane proteins, structure of nucleic acids with emphasis on RNA tertiary structures and folding, protein–nucleic acid (DNA/RNA) interaction.

Basic concepts of enzymes and enzyme kinetics, mechanisms of enzyme actions, basic concepts of metabolism and its design, catabolism and anabolism, energy generation and storage, glycolysis, citric acid cycle, oxidative phosphorylation, gluconeogenesis, fatty acid metabolism, integration of metabolism etc.

INSTRUCTORS: **Mahavir Singh and Arvind Penmatsa**

SUGGESTED BOOKS:

1. Voet, D. and Voet, J. G., Biochemistry, Wiley, 4th Edition, 2010.
2. Berg, J. M., Tymoczko, J. L. and Styrer, L., Biochemistry, W. H. Freeman & Co., 7th Edition, 2011.

UB 205: INTRODUCTORY PHYSIOLOGY (2:0)
(CORE COURSE FOR BIO MAJOR)

Mammalian Physiology: Introduction to physiology, internal environment, control of internal environment by feedback systems, renal physiology, body fluids and kidneys, urine formation by the kidneys, principles of membrane transport, transporters, pumps and ion channels, cell signalling and endocrine regulation, hormonal regulation of energy metabolism, hormonal regulation of calcium metabolism, hormonal control of reproduction in males and females, pregnancy and lactation; structure of heart, cardiac muscle contraction, cardiac cycle, electric conductivity of heart, regulation of cardiac homeostasis, structure and function

of arteries and vein, blood pressure, blood flow, capillary exchange, physiology of lymphatic system.

Plant Physiology: Plant cell structure and cell wall, water uptake, photosynthesis and photorespiration, secondary metabolites, phytochrome and light signalling, hormone signalling in plants, control of flowering, stress physiology.

INSTRUCTORS: **N. Ravi Sundaresan, C. Jayabhaskaran and R. Medhamurthy**

SUGGESTED BOOKS:

1. Hall, J. E., Guyton and Hall Textbook of Medical Physiology, Elsevier, 12th Edition, 2011.
2. Jameson, J. L. and De Groot, L. J., Endocrinology, Elsevier, 6th Edition, 2010.
3. Taiz, L. and Zeiger, E., Plant Physiology, Sinauer Associates, 5th Edition, 2010.

UB 208: BASIC MOLECULAR BIOLOGY (2:0)

Genes as carriers of heredity, gene-enzyme relation, spontaneous versus adaptive mutations: origin of bacterial genetics, the transforming principle and chemical identity of the gene, DNA and heredity, biochemistry of DNA, Chargaff's rule, early models of DNA structure, the double helix and the origin of molecular biology, alternative structures of DNA, unidirectional flow of genetic information–The Central Dogma, the coding problem-elucidation of the genetic code, confirmation of DNA as a genetic material, models for replication of DNA. Gene organization in bacteria: operons and regulons, structure of bacterial promoters, RNA polymerase and initiation of transcription, repressors and activators, restriction-modification systems in bacteria, DNA topology and its homeostasis, DNA repair mechanisms, developmental systems in prokaryotes – lysogeny and sporulation. Chromosome organization in eukaryotes: histones and nucleosomes, gene regulation in eukaryotes: transcription factors and enhancers, histone modification and epigenetics, gene expression during development, regulation mediated by RNA, molecular evolution, genomics.

INSTRUCTORS: **S. Mahadevan and Tanweer Hussain**

SUGGESTED BOOKS:

1. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A. and Levine, M., Molecular Biology of the Gene, Benjamin-Cummings Publishing Company, 7th Edition, 2013.
2. Stent G. and Calendar, R., Molecular Genetics: An Introductory Narrative, W. H. Freeman & Co., 2nd Edition, 1978.

UB 206: EXPERIMENTS IN BIOCHEMISTRY AND PHYSIOLOGY (0:2)
(CORE COURSE FOR BIO MAJOR)

Expression of recombinant proteins, purification and characterization. Quantitation of proteins using biochemical assays and physico-chemical characterization of proteins by immunoasays (solid phase and Western blotting). Enzyme assays and determining specific activity of enzymes.Assessing metabolic activity of cells and their susceptibility to drugs.

INSTRUCTORS: **Sandeep Eswarappa and Deepak Saini**

SEMESTER 5 (AUGUST)

UB 301L: EXPERIMENTS IN MICROBIOLOGY AND ECOLOGY (0:2)
(CORE COURSE FOR BIO MAJOR)

There are two sets of practical experiments for Biology majors:
In the first part, students will get a hands-on experience in understanding the basic concepts of microbiology. The topics include the microbial growth curve, microbial nutritional requirements, genetic engineering techniques, plasmid isolation, creation of genetic knock out in bacteria, bacterial infection in cell culture system, estimation of infection by colony forming unit (CFU) analysis and fluorescence technique.

In the second part, students will explore key concepts in Ecology, Evolution and Behavior using field methods, laboratory manipulations and computer simulations. Students will design many of their own experiments and will utilize different modes of scientific communication, including oral presentations and documentaries. Topics include niche and population dynamics, competition and predation, trophic interactions, evolution and adaptation, natural and sexual selection, and conservation. This module also includes a mandatory field trip where students develop an independent research project.

INSTRUCTORS: **Dipshikha Chakravortty and Maria Thaker**

UB 305 AND UB 305L (2:1)

UB 305 GENETICS

History of concepts in genetics; Mendelism and its extensions; evolution of the concept of gene; chromosomal basis of genetics; gene and chromosomal mutations; Genetic recombination and repair; mobile genetic elements; dosage compensation and evolution of sex chromosomes; sex determination; telomeres; epigenetics; Population Genetics.

UB 305L

(1) Examining the diversity and genetic variability in nature by collecting different species of Drosophila.
(2) Practical handling of *Drosophila melanogaster* - observation of wild type and mutants, setting up of crosses.
(3) Learning about various patterns of inheritance of traits and the genes responsible for them.
(4) Examining naturally occurring differences in phenotypes by observing quantitative traits.
(5) Learning about factors affecting natural selection by following traits over generations.
(6) Observing chromosomes in dividing cells and specialized polytenic state.
(7) Genetics of mutants in different model organisms – *C. elegans*, Drosophila and Arabidopsis.

INSTRUCTOR: **H. A. Ranganath**

SUGGESTED BOOKS:
1. Griffiths, A. J. F., Wessler, S. R., Carroll, S. B. and Doebley, J., Introduction to Genetic Analysis, W. H. Freeman and Company, 2012.
2. Pierce, B. A., Genetics: A Conceptual Approach, W. H. Freeman and Palgrave MacMillan, 2012.

SEMESTER 6 (JANUARY)

UB 302: DEVELOPMENTAL BIOLOGY (2:0)
(CORE COURSE FOR BIO MAJOR)

Introduction, history and concepts of developmental biology; the current understanding on the mechanisms of development using model organisms including invertebrates, vertebrates and plants; general principles for the making of a complex, multicellular organismfrom a single cell; the creation of multi-cellularity (cellularization, cleavage), reorganization into germ layers (gastrulation), cell type determination; creation of specific organs, (organogenesis); molecular mechanisms underlying morphogenetic movements, differentiation, and interactions during development; fundamental differences between animal and plant development; embryogenesis in plant – classical and modern views; axis specification and pattern formation in angiosperm embryos; organization and homeostasis in the shoot and root meristems; patterning in vegetative and flower meristems; growth and tissue differentiation in plants; stem cells and regeneration; evolution of developmental mechanisms.

INSTRUCTORS: **Usha Vijayraghavan, Upendra Nongthomba and Utpal Nath**

SUGGESTED BOOKS:

1. Wolpert, L. and Tickle, C., Principles of Development, Oxford University Press, 4th Edition, 2010.
2. Gilbert, S. F., Developmental Biology, 9th edition, Sinauer Associates, 2010.
3. Slack, J. M. W., Essential Developmental Biology, John Wiley & Sons, 3rd Edition, 2012.
4. Leyser, O. and Day, S., Mechanisms in Plant Development, Willey-Blackwell, 2003.
5. Taiz, L. and Zeiger, E., Plant Physiology, 5th edition, Sinauer Associates, 2010.
6. Alberts, B., Molecular Biology of the Cell, Garland Science, 5th Edition, 2008.

UB 303L: EXPERIMENTS IN MOLECULAR BIOPHYSICS (0:1)
(CORE COURSE FOR BIO MAJOR)

UV spectroscopy of proteins (quantitation and determination of extinction coefficient), Estimation of free sulfhydryl groups in proteins by Ellman's assay, Fluorescence spectroscopy of proteins, determination of tryptophan accessibility by acrylamide quenching, CD spectroscopy of proteins and calculation of helical contents, CD spectroscopy of DNA (monitoring the role of salt and oligonucleotide sequence in the formation of G-quadruplexes), UV spectroscopy of DNA (determination of melting temperature and influence of buffer composition), computational biophysics: molecular visualization and graphics.

INSTRUCTOR: **Jayanta Chatterjee**

UB 304L: EXPERIMENTS IN NEUROBIOLOGY (0:1)

The vertebrate nervous system and its organization; demonstration of tissue sectioning techniques; preparation of primary neuronal cultures and imaging neurons; recording and manipulating activity live neurons; rate coding; macrostimulation; effect of temperature and stretch on conduction velocity; neuropharmacology – effects of nicotine MSG; measuring the somatosensory homunculus; measuring alpha rhythm and surprise potentials with EEG; building a blink interface by recording eye potentials.

. PREREQUISITE: **NS 201 or NS 202 (AUG) (3:0)**

INSTRUCTORS: **Deepak Nair, Sridharan Devarajan and Sachin Deshmukh**

SEMESTER 8 (JANUARY)

UB 400: RESEARCH PROJECT (0:16)

An independent research project will be performed by all UG-Biology major students under the supervision of faculty members within the Division of Biology, IISc. It is recommended that students initiate laboratory work during the summer-break after completing the sixth semester. The progress of the project will initially be monitored at the end of the seventh semester. Finally, the submitted project report will be graded before the end of the eighth semester as follows: faculty assessment (30% marks), independent referee (30% marks) and presentation by the students (40%). Based on the student's performance, the final grade will be determined.

INSTRUCTORS: **Faculty members in the Division of Biological Sciences, IISc**

ADDITIONAL COURSES IN SEMESTERS 5, 6, 7 AND 8:

Please see courses listed in the Scheme of Instruction for postgraduate students and select appropriate courses in consultation with the faculty advisor and UG-Biology Coordinators.

Do note that the following courses that are not part of the Division of Biological Sciences will be considered a part of UG-Biology major:

CH 248 (JAN) 3:0 MOLECULAR SYSTEMS BIOLOGY
INSTRUCTOR: **Rahul Roy**

DS 301 (AUG) 2:0 BIOINFORMATICS
INSTRUCTORS: **K.Sekar & Debnath Pal**

CH242 (AUG) 3:0 SPECIAL TOPICS IN THEORETICAL BIOLOGY
INSTRUCTOR: **Narendra M Dixit**

BE 201 (AUG) 3:0 FUNDAMENTALS OF BIOMATERIALS AND LIVING MATTER
INSTRUCTOR: **Bikramjit Basu**

* available only to the students belonging to the 2017 batch and later

CHEMIS

UG INSTRUCTORS
Moumita Koley, Srinivas Rao Amanchi

SEMESTER 1 (AUGUST)

UC 101: PHYSICAL PRINCIPLES OF CHEMISTRY (2:1)

Laws of thermodynamics, State and Path Functions, Applications to Chemistry, van der Waals equation of state, Theory of chemical reactions, 1st and 2nd order rate reactions, Bohr theory, Wave Particle Duality, Uncertainty principle, Schrödinger equation, H-atom and atomic orbitals, electron spin, Chemical bonding: covalent and ionic bonding, valence bond theory, hybridization and resonance; molecular orbital theory, Potential energy curves and intermolecular interactions; elements of spectroscopy.

INSTRUCTORS: **Upendra Harbola and S. Vasudevan**

SUGGESTED BOOKS:

1. McQuarrie, D. A. and Simon, J. D. Physical Chemistry, Viva Books.
2. Gray, H.B. 1965 Electrons and Chemical Bonding, W. A. Benjamin Inc.
3. Peter Atkins, and Julio De Paula, Elements of Physical Chemistry, 5/E, Oxford University Press, Indian Edition.
4. Ira, N. and Levine, 2008 Physical Chemistry, Tata McGraw Hill.
5. Barrow, G. M. 2007 Physical Chemistry, McGraw Hill.

SEMESTER 2 (JANUARY)

UC 103: BASIC INORGANIC CHEMISTRY (2:1)

Multi-electron atoms – periodic trends, Chemical bonding: ionic solids, CFT: d-orbital splitting, tetrahedral, square planar, cubic and octahedral crystal fields, covalent bonding, Lewis model (2 Dim), VSEPR (3 Dim) hybridization, Molecular orbital theory: heteronuclear diatomics, triatomics, Shapes of main group compounds, Acid-base chemistry: concepts, measures of acid- base strength, HSAB, Main group chemistry: carbon group compounds and noble gases.

INSTRUCTORS: **P. S. Mukherjee and K. Geetharani**

STRY

SUGGESTED BOOKS:

1. Lee, J. D. Concise Inorganic Chemistry, 5/E, Oxford University Press, Indian Edition.
2. Miessler, G. L. and Tarr, D.A. Pearson Inorganic Chemistry, Third Edition.
3. Shriver, D. F., Atkins, P. W. and Langford, C. H. Inorganic Chemistry, Oxford University Press.
4. Huheey, J. E., Keiter, E.A. and Keiter, R. L. Inorganic Chemistry, 4/E, Pearson Education Asia.

SEMESTER 3 (AUGUST)

UC 206: BASIC ORGANIC CHEMISTRY (2:1)

Nomenclature of organic compounds, Bonding and molecular structure, Aromaticity, Acids and bases, Reaction mechanism: substitution, aromatic substitution, elimination, addition and rearrangements, Oxidation-reduction, Introduction to chirality and stereochemistry, Elements of symmetry, Configurational nomenclatures, Optical activity, Chiral resolution and kinetic resolution, Stereospecific and stereoselective reactions and mechanisms, Conformation of acyclic and cyclic systems.

INSTRUCTORS: **A. T. Biju and T. K. Chakraborty**

SUGGESTED BOOKS:

1. Solomons, T. W. G. and Fryhle, C. 2009 Organic Chemistry, John Wiley & Sons.
2. McMurry, J. E. 2007 Organic Chemistry 7th edition, Thomson.
3. Bruice, P. Y. Organic Chemistry, 6th edition, Pearson.
4. Nasipuri, D. Stereochemistry of Organic Compounds, Principles and Applications.
5. Eliel, E. L. Stereochemistry of Carbon Compounds.

SEMESTER 4 (JANUARY)

UC 202: THERMODYNAMICS AND ELECTROCHEMISTRY (2:0)
(CORE FOR MAJORS)

Intermolecular forces and interaction potentials, Equations of state, Laws of thermodynamics, State and path functions, Intensive and extensive quantities,

Energy, Enthalpy, Specific heat, Chemical potential, Entropy, Free energy, Application to engines, Phase change, Mixtures, and chemical equilibrium, Colligative Properties, Activity and activity coefficient, Debye-Hückel theory and ionic conductivity, Nernst equation and cells, Electrode thermodynamics and kinetics, Interfacial phenomena.

INSTRUCTORS: **Anshu Pandey and Naga Phani Aetukuri**

SUGGESTED BOOKS:

1. McQuarrie, and Simon, Physical Chemistry – A Molecular approach.
2. Silbey, Alberty, and Bawendi, Physical Chemistry.
3. Berry, Rice, and Ross, Physical Chemistry.
4. Fermi, E., Thermodynamics.
5. Crow, D. R. Principles and Applications of Electrochemistry.

UC 207: INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS (2:1)
(CORE FOR MAJORS AND MINORS)

Propagation of errors in measurement, statistical analysis of data, etc., Separation Techniques: extraction and separation, principles of chromatography, Electroanalytical Techniques: voltammetry and its variants, ion selective electrodes and electrochemical techniques for analysis, Spectroscopic Techniques: atomic absorption/emission, electronic, fluoresecence, and vibrational (IR and Raman), Spectroscopy: basic principles, operation and application to chemical problems, NMR Spectroscopy, Basic principles and operation, Application of one dimensional NMR for identification of chemicals, Mass Spectrometry: Principles and Applications.

INSTRUCTORS: **H.S. Atreya and Satish Patil**

SUGGESTED BOOK:

1. Skoog, Fundamentals of Analytical Chemistry, 8th edition, West, Holler and Crouch.

UC 204: INORGANIC CHEMISTRY: CHEMISTRY OF ELEMENTS (2:0)
(CORE FOR MAJORS)

Chemistry of d-block elements: bonding – VBT, CFT, MOT, Orgel diagrams, Descriptive chemistry of metals: periodic trends, chemistry of various oxidation states of transition metals, oxidation states and EMFs of groups, Iioinorganic chemistry: metals in biological systems, heme and non-heme proteins, metalloenzymes, Chemistry of f-block elements.

INSTRUCTOR: **P. Thilagar**

SUGGESTED BOOKS:

1. Shriver, D. F. and Atkins, P.W. Inorganic Chemistry, 4th edition, ELBS.
2. Huheey, J. E., Lieter, E. and Leiter, K. Inorganic Chemistry, Harper International Edition.
3. Greenwood, and Earnshaw, Chemistry of Elements, Maxwell Macmillan.
4. Cottton, and Wilkinson, Advanced Inorganic Chemistry, Wiley International.

UC 205: BASIC ORGANIC REACTIONS (2:0)
(CORE FOR MAJORS)

Acids and bases: effect of structure, kinetic & thermodynamic acidity, general & specific acid/ base catalysis; Reactions of carbon-carbon multiple bonds: addition of halogens, hydrogen halides & interhalogen compounds, hydration, epoxidation, dihydroxylation, ozonolysis, cyclopropanation, hydrogenation; Reactions of carbonyl compounds: addition to carbonyls, oxidation, reduction, rearrangements & their applications, C–C bond forming reactions involving carbonyls; Introduction to pericyclic reactions: cycloadditions, electrocyclic reactions, sigmatropic rearrangement and group transfer reactions. Introduction to organometallic reagents: Grignard reagents, organolithium, organocopper and organozinc compounds.

INSTRUCTOR: **Santanu Mukherjee**

SUGGESTED BOOKS:

1. Norman, R. O. C. and Coxon, J. M. 1993 Principles of Organic Synthesis, 3rd edition.
2. Carruthers, W. and Coldham, I. 2004 Modern Methods of Organic Synthesis, 4th edition, Cambridge University Press.
3. Clayden, J., Greeves, N., Warren, S. and Wothers, P. 2000 Organic Chemistry, Oxford University Press.
4. Carey, F. A. and Sundberg, R. J. 2007 Advanced Organic Chemistry, Part A & Part B, 5th edition, Springer.

Pre-requisite: Successful completion of UC201

SEMESTER 5 (AUGUST)

CD 211: PHYSICAL CHEMISTRY I - QUANTUM CHEMISTRY AND GROUP THEORY (3:0)
(CORE FOR MAJORS)

Postulates of Quantum Mechanics and introduction to operators; Exactly solvable problems Perturbational and Variational Methods, Hückel model, Many electron Atoms, Slater determinants, Hartree-Fock Variational method for atoms; Molecular Quantum Mechanics, Symmetry and Group theory, Point Groups, Reducible and Irreducible Representations (IR), Great Orthogonality theorem, Projection operators, applications to molecular orbitals and normal modes of vibration and selection rules in spectroscopy.

INSTRUCTORS: **D. D. Sarma and S. Ramasesha**

SUGGESTED BOOKS:

1. Levine, Quantum Chemistry.
2. Griffiths, D., Introduction to Quantum Mechanics.
3. Cotton, F. A., Chemical Applications of Group Theory.

CD 212: INORGANIC CHEMISTRY – MAIN GROUP AND COORDINATION CHEMISTRY (3:0)
(CORE FOR MAJORS)

Main Group: Hydrogen and its compounds – ionic, covalent, and metallic hydrides, hydrogen bonding; chemistry of lithium, beryllium, boron, nitrogen, oxygen and halogen groups; chains, rings, and cage compounds; Coordination chemistry: molecular orbital theory, spectral and magnetic properties; Tanabe-Sugano diagrams; inorganic reactions and mechanisms: hydrolysis reactions, substitution reactions trans-effect; isomerization reactions, redox reactions; mixed valence systems; chemistry of lanthanides and actinide elements.

INSTRUCTORS: **E. D. Jemmis and A. R. Chakravarty**

SUGGESTED BOOKS:

1. Shriver, and Atkins,' Inorganic Chemistry by: Atkins, Overton, Rourke, Weller and Armstrong, Fifth Edition. South Asia Edition (paperback), Oxford University Press, 2010.
2. Bochmann, M., Cotton, F. A., Wilkinson, G. and Murilla, C. A. 2007 Advanced Inorganic Chemistry, 6th edition, Wiley Student Edition, NY.
3. Huheey, J. E., Keiter, E. A., Keiter, R. L. and Medhi, O. K. 2006 Inorganic Chemistry, Principles of Structure and Reactivity, 4th edition, Pearson.

CD 213: ORGANIC CHEMISTRY – STRUCTURE & REACTIVITY (3:0)
(CORE FOR MAJORS)

Stereochemistry and chirality; Conformation of acyclic and cyclic compounds including medium rings, effect of conformation on reactivity. Methods of deducing organic reaction mechanisms: Kinetic analysis, Hammond postulate, Curtin-Hammett principle. Linear free energy relationships – Hammett equation. Kinetic isotope effects. Solvent effects on reaction rates.

Reactive intermediates, classical and nonclassical carbocations, carbanions, free radicals, carbenes, nitrenes, arynes, radical ions, diradicals. Photochemistry. Concerted reactions. FMO theory, Woodward-Hoffman rules.

INSTRUCTORS: **Uday Maitra and Mrinmoy De**

SUGGESTED BOOKS:

1. Anslyn, E. V. and Dougherty, D. A. 2006 Modern Physical Organic Chemistry, University Science Books.
2. Smith, M. B. and March J. 2007 March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 6th edition, Wiley.
3. Carey, F. A. and Sundberg, R. J. 2008 Advanced Organic Chemistry, Part A, 5th edition, Plenum.
4. Lowry, T. M. and Richardson, K. S. 1998 Mechanism and Theory in Organic Chemistry, Third Edition, Addison-Wesley-Longman.

UC 301: ORGANIC & INORGANIC CHEMISTRY LABORATORY (0:1)
(CORE FOR MAJORS)

Common organic transformations such as esterification, Diels-Alder reaction, oxidation-reduction, Grignard reaction, etc. Isolation and purification of products by chromatographic techniques, characterization of purified products by IR

and NMR spectroscopy. Synthesis of coordination complexes, preparation of compounds of main group elements, synthesis of organometallic complexes. Physicochemical characterization of these compounds by analytical and spectroscopic techniques.

INSTRUCTORS: **E. N. Prabhakaran, K. Geetharani and S. Natarajan**

SEMESTER 6 (JANUARY)

CD 221: PHYSICAL CHEMISTRY II: STATISTICAL MECHANICS (3:0)
(CORE FOR MAJORS)

Review of thermodynamics, ensembles, partition functions, Classical and quantum statistics. Application to blackbody radiation, electron conduction, molecular systems, specific heats of solids, classical fluids and phase transitions.

INSTRUCTORS: **Govardhan Reddy and Binny Cherayil**

SUGGESTED BOOKS:
1. Callen, H. B., Thermodynamics and Introduction to Thermostatistics.
2. Fermi, E., Thermodynamics.
3. McQuarrie, D. A., Statistical Mechanics.
4. Chandler, D., Introduction to Modern Statistical Mechanics.

CD 222: MATERIALS CHEMISTRY (3:0)
(CORE FOR MAJORS)

Structure of solids, symmetry concepts, crystal structure. Preparative methods and characterization of inorganic solids. Crystal defects and non-stoichiometry. Interpretation of phase diagrams, phase transitions. Kinetics of phase transformations, structure property correlations in ceramics, glasses, polymers. Composites and nano-materials. Basics of magnetic, electrical, optical, thermal and mechanical properties of solids.

INSTRUCTORS: **K. K. Nanda and Prabeer Barpanda**

SUGGESTED BOOKS:
1. West, A. R. 1984 Solid State Chemistry and its Applications, John Wiley and Sons.
2. Shackelford, J. F. 1988 Introduction to Materials Science for Engineers, MacMillan.

CD 223: ORGANIC SYNTHESIS (3:0)
(CORE FOR MAJORS)

Synthetic methods, methodologies and mechanisms in reductions, oxidations of carbon-carbon and carbon-heteroatom bonds; Carbon-carbon bond-forming methodologies through ionic, radical, concerted and organometallic reaction mechanisms; Approaches to multi-step synthesis with examples of chosen natural and un-natural product synthesis, through anti-thetic analysis and logical synthesis.

INSTRUCTORS: **T. K. Chakraborty and A. T. Biju**

SUGGESTED BOOKS:

1. House, H. O. 1972 Modern Synthetic Methods, W. A. Benjamin, Inc.
2. Smith, M. B. 2002 Organic Synthesis, McGraw-Hill.
3. Corey, E. J. and Chung, 1989 Logic in Chemical Synthesis, John-Wiley & Sons.

Chosen primary literature and review articles.
PREREQUISITES: UG students having completed UC 205, CD 213; Chemistry major students

UC 302: PHYSICAL AND ANALYTICAL CHEMISTRY LABORATORY (0:1)
(CORE FOR MAJORS)

Chemical kinetics. Langmuir adsorption, chemical analysis by potentiometric and conductometric methods, cyclic voltametry, flame photometry, electronic states by UV-Visible spectroscopy, IR spectroscopy, solid state chemistry -synthesis of solids and chemical analysis. Thermogravimetry. X-ray diffraction, electrical and magnetic properties of solids. Vacuum techniques in preparative chemistry.

INSTRUCTORS: **S. Sampath, A. J. Bhattacharyya and C. Shivakumara**

SUGGESTED BOOK:

1. Vogel, A. I. 1989 Vogel's text book of quantitative chemical analysis Longman.

UC 303: BASIC ORGANOMETALLIC CHEMISTRY (3:0)
(CORE FOR MAJORS)

Structure and bonding in organometallic compounds – isolobal analogies, metal carbonyls, carbenes and NHC complexes, olefin and acetylene complexes, alkyls and allyl complexes, metallocenes. Major reaction types – oxidative addition, reductive elimination, insertion, isomerization and rearrangement reactions. Catalytic reactions: metathesis, hydrogenation, allylic activation, C-C coupling reactions, C-X coupling.

INSTRUCTOR: **B. R. Jagirdar**

SUGGESTED BOOKS:

1. Elschenbroich, Ch. 2005 Organometallics, 3rd edition, Wiley-VCH, Weinheim.
2. Gupta, B. D. and Elias, A. J. 2013 Basic Organometallic Chemistry: Concepts, Syntheses and

Applications (Second edition).

SEMESTER 7 (AUGUST)

UC 402: MOLECULAR SPECTROSCOPY, DYNAMICS AND PHOTOCHEMISTRY (3:0)
(CORE FOR MAJORS)

Energy levels of molecules and their symmetry, Polyatomic rotations and normal mode vibrations.

Electronic energy states and conical intersections (6); time-dependent perturbation theory and selection rules (6); microwave, infrared and Raman, electronic spectroscopy (12); energy transfer by collisions, both inter and intra-molecular. Unimolecular and bimolecular reactions and relations between molecularity and order of reactions, rate laws (6); temperature and energy dependence of rate constants, collision theory and transition state theory, RRKM and other statistical theories (6); photochemistry, quantum yield, photochemical reactions, chemiluminescence, bioluminescence, kinetics and photophysics (6).

INSTRUCTOR: **E. Arunan**

SUGGESTED BOOKS:
1. Levine, I. N., Molecular Spectroscopy.
2. McHale, J. L., Molecular Spectroscopy.
3. Steinfeld, J. I., Fransisco, J. S. and Hase, W. L., Chemical Kinetics and Dynamics.
4. Laidler, K. J., Chemical Kinetics.

UC 400: PROJECT (14:0)
(CORE FOR MAJORS)

The final year research project aims to introduce undergraduate students to actual research. Students perform research under the supervision of a faculty member of the chemical sciences division. The project supervisor is decided by the mutual consent of the student and the concerned faculty member. The project is evaluated at the end of the eighth semester by a committee of faculty from the division of chemical sciences. Students are required to submit a project report towards the end of the semester as well as make a short presentation emphasizing their novel findings.

INSTRUCTORS: **Faculty of Chemical Sciences**

EARTH & ENVIRONM SCIENCE

SEMESTER 4 (JANUARY)

UES 202: INTRODUCTION TO EARTH SYSTEMS (2:1)
(CORE COURSE FOR EARTH & ENV. SCI. MAJOR)

Earth surface features, concept of geomorphology, weathering phenomena, physics and chemistry of earth's interior, internal processes, tectonics through time, geological time scale, bio-stratigraphy, early Earth, rock formation, rock classification, mineralogy, basics of crystal symmetry, composition of atmosphere and origin of atmosphere, Earth-like planetary bodies, evidence of life on other planets, basics of hydrosphere and its components, physical properties of water, elementary oceanography, chemical composition of ocean, evolution of life and its diversification.

INSTRUCTOR**: Prosenjit Ghosh**

SUGGESTED BOOKS:

1. Patwardhan, The Dynamic Earth System, P. H. I. Learning Private Limited, New Delhi, ISBN -978-81-203-1496-2
2. Kump, L. R., Kasting, J. F. and Crane, R. G. The Earth System, Prentice Hall, ISBN 0-13-142059-3
3. Thompson, G. R. and Turk, J. Modern Physical Geology, Saunder College Publishing

MENTAL

UES 204: FUNDAMENTALS OF CLIMATE SCIENCE (3:0)
(CORE COURSE FOR EARTH & ENV. SCI. MAJOR)

Atmospheric structure and composition, Observations and theory of the general circulation of the atmosphere, Global energy balance, Radiative processes in the atmosphere, the greenhouse effect, natural and anthropogenic climate change, waves in the atmosphere, clouds, weather systems, tropical dynamics and monsoons, ocean circulation.

INSTRUCTORS: **Arindam Chakraborty and G. Bala**

SUGGESTED BOOKS:

1. Hartmann, D. L. 1994. Global Physical Climatology, Academic Press
2. Wallace, J. M. and Hobbs, P. V. Atmospheric Sciences: An Introductory Survey, Academic Press
3. Peixoto, J. P. and Oort, A. H. Physcs of Climate. American Institute of Physics, New York

UES 206: EXPERIMENTAL METHODS IN ENVIRONMENTAL CHEMISTRY (1:2)
(CORE COURSE FOR EARTH & ENV. SCI. MAJOR)

Characterization of Water Quality - Electrical conductivity, pH, Chlorides, Sulphates, Alkalinity, Hardness. Characterization of pollutants in water - Estimation using spectroscopic and chromatographic techniques;EDetermination of dissolved and suspended solids in water samples, determination of turbidity of water samples; Determination of chlorine in bleaching powder; Determination of the optimum dosage of coagulant for coagulation of suspended solids in water sample; Estimation of total coliforms by MPN and Membrane Filtration Method;

Soil surface sorption properties - Cation exchange capacity, organic content, grain size distribution, pore water salinity; Sampling and measurement techniques in air quality - Gaseous pollutants and particulates, air quality standards, Instrumental techniques for gas analysis.

INSTRUCTORS: **Sudhakar Rao and P. Raghuveer Rao**

SUGGESTED BOOKS:

1. APHA, 1999. Standard methods for the examination of water and wastewater. American Public Health Association, 20th edition, Washington DC
2. SP 36: Part 1: 1987 Compendium of Indian standards on soil engineering: Part 1- Laboratory testing of soils for civil engineering purposes

SEMESTER 5 (AUGUST)

UES 302: DESIGN PRINCIPLES IN ENVIRONMENTAL ENGINEERING (2:0)
(CORE COURSE FOR EARTH & ENV. SCI. MAJOR)

Laws of conservation: mass, energy and momentum balances. Fundamentals of chemical reaction engineering: thermodynamics, stoichiometry and kinetics of chemical reactions, chemical reactors – stirred tank and plug flow reactors.

Design for waste water treatment processes: physical unit operations such as sedimentation and filtration, chemical and biological treatment processes. Design for air pollution control: gas-liquid interactions, absorption and adsorption processes, particulate emission control.

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INSTRUCTORS: **S. Dasappa and Laxminarayan Rao**

SUGGESTED BOOKS:

1. Davis, M. and Masten, S. 2004. Principles of Environmental Engineering, McGraw Hill
2. Davis, M. and Cornwell, D. 2006. Introduction to Environmental Engineering, McGraw Hill
3. Mihelcic, J. and Zimmerman, J. B. 2010. Environmental Engineering: Fundamentals, sustainability and Design, John Wiley
4. Spellman F. R. and Whiting, N. E. 2005. Environmental Engineer's Mathematics Handbook, CRC Press

UES 306 SURFACE & GROUNDWATER QUALITY (3:0)
(CORE COURSE FOR EARTH & ENV. SCI. MAJOR)

Basic characteristics of water quality, stoichiometry and reaction kinetics. Mathematical models of physical systems, completely and incompletely mixed systems. Movement of contaminants in the environment. Water quality modeling in rivers and estuaries - dissolved oxygen and pathogens. Water quality modeling in lakes and ground water systems.

INSTRUCTOR: **M Sekhar**

SUGGESTED BOOKS:

1. Chapra, S.C., Surface Water Quality Modeling, McGraw Hill, 1997
2. Tchobanoglous, G., and Schroeder, E.D., Water Quality, Addison, Wesley, 1987

UES 303: INTRODUCTION TO GEOCHEMISTRY (2:1)
(ELECTIVE)

Geochemical Fundamentals/Chemistry Review, The Elements; basic principles of inorganic chemistry, periodic properties, thermodynamics and chemical reactions, solubility, Aquatic Chemistry, pH-pE, Biology and redox, Organic Chemistry; High temperature Geochemistry - Planetary geochemistry, Age and Origin of the Solar System, Planet formation, differentiation of the Earth, igneous processes, Radiogenic isotope geology/ Geochronology; Low temperature Geochemistry - The hydrologic cycle and Sedimentary geochemistry, Chemical Processes, Photosynthesis/respiration, Aquatic Microbial Biochemistry in rain, rivers, lakes, estuaries, Chemical weathering, soil formation, geochemistry of clays, the oceans, marine chemistry, primary productivity, Gaia, Marine Sediments: a record of environmental global history, light isotope geochemistry, Global Climate: Present and Future, atmospheric CO.

Lab component: It will involve exposure to instrumental methods which include (a) titration (b) chromatography using liquid and gas columns (c) analyses of cation and anion using Ion Chromatography, towards chemical analysis of rock samples, measurement of soil moisture contents, geo-chemical characterization of rock samples and determination of CO2 concentrations in air.

INSTRUCTOR: **Prosenjit Ghosh**

SUGGESTED BOOKS:

1. Walther, J. V. 2009. Essentials of Geochemistry, Jones and Bartlett Publishers 2nd edition
2. Gill, R. 1995. Chemical Fundamentals of Geology, Springer, 2nd edition

UES 304: INTRODUCTION TO BASIC GEOLOGY (2:1)
(ELECTIVE)

Classification of rocks; geology of southern India: tectonic concepts; the earth structures and its significance; shear/suture zones - identification, interpretation and implications, fluid influence in shear zones; petrological, geochemical and geochronological: methods, approaches and inferences, origin-exhumation-weathering; the rock cycle, landforms, element mobility and interactions; linking rocks/mineral chemistry to tectonics with Indian examples.

Laboratory component: Sample preparation of rock specimens, petrological observation of rock and mineral thin sections.

INSTRUCTOR: **K. Sajeev**

SUGGESTED BOOKS:

1. Vernon, R. H. and Clarke, G. 2008. Principles of Metamorphic Petrology, Cambridge University Press
2. Vernon, R. H. 2004. A Practical Guide to Rock Microstructure, Cambridge University Press
3. Rollinson, H. R. 1993. Using Geochemical Data: Evaluation, Presentation, Interpretation, Longman Publishing Group
4. Condie, K. C. 2004. Earth as an Evolving Planetary System, Academic Press; 1st edition
5. Pluijm, B. A. V. D. and Marshak, S. 2003. Earth Structure: An Introduction to Structural Geology and Tectonics, W. W. Norton & Co. Inc., 2nd edition
6. Philpotts, A. R. 2003. Petrography of Igneous and Metamorphic Rocks, Waveland Press, Inc

UES 310: EXPERIMENTAL METHODS IN SOLID WASTE MANAGEMENT (1:2)
(CORE)

Solid waste characterization – Water leach test, Toxicity Characteristic Leach Procedure; Pollutant sorption capacity characterization – Kinetics & adsorption isotherms, Distribution coefficients; Pollutant transport – Column experiments to evaluate transport and partitioning in vadose and saturated zones, Diffusion coefficients. Laboratory determination of soil permeability for contaminant flow; Chemical solidification of contaminated wastes – Lime and cement stabilization, Leaching and compressive strength measurements.

INSTRUCTORS: **Sudhakar Rao and P. Raghuveer Rao**

SUGGESTED BOOKS:

1. US EPA Publication SW-846: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, 1996
2. BIS Compendium on Engineering Properties of Soils

SEMESTER 6 (JANUARY)

CE 207 (JAN) 3:0 GEO-ENVIRONMENTAL ENGINEERING
(ELECTIVE)

Sources, production and classification of wastes, Environmental laws and regulations, physico-chemical properties of soil, ground water flow and contaminant transport, contaminated site characterization, estimation of landfill quantities, landfill site location, design of various landfill components such as liners, covers, leachate collection and removal, gas generation and management, groundwater monitoring, end uses of landfill sites, slurry walls and barrier systems, design and construction, stability, compatibility and performance, remediation technologies, stabilization of contaminated soils and risk assessment approaches.

INSTRUCTOR: **G L Sivakumar Babu**

SUGGESTED BOOKS:

1. Sharma, H.D., and Reddy, K.R., Geoenvironmental Engineering: Site Remediation, Waste Containment and Emerging Waste Management Technologies, John Wiley & Sons, Inc., Hoboken, New Jersey, 2004
2. Rowe, R. Kerry, Quigley, Robert M., Brachman, Richard W. I., and Booker, John R. Barrier Systems for Waste Disposal Facilities, 2nd edn 2004. Spon Press, Taylor & Francis Group, London
3. Tchobanoglous, G., Theisen, H. and Vigil, S.A., Integrated Solid Waste Management - Engineering Principles and Management Issues, McGraw Hill (1993)

UES 309: WASTEWATER TREATMENT (3:0)
(ELECTIVE)

Wastewater generation patterns/sources - quantification and quality issues, Pathogens and microbiological risks from wastewater; Pollution Indicators - physical, chemical, biological and microbiological; Water Testing - Physico-chemical properties, Biological and microbiological characteristics. Microbial Metabolism with respect to waste water remediation and water treatment;

Organic Matter Removal - Anaerobic and Aerobic methods, Modeling activated sludge processes; Nitrogen, Phosphorus and Pathogen removal from wastewater, Aquatic and water Toxicity and toxicology, Physico-chemical basis and processes for aeration, mixing, settling, microbial killing processes. Sludge physical properties, settling properties, characterization, remediation, treatment and disposal. Membrane Bio-reactors, Anaerobic Wastewater Treatment reactor designs, Hybrid reactors, Biofilm Reactors, Anaerobic biofilm reactors. Micro-biological and Phyto-remediation techniques. Grey and black water recycling, needs, Groundwater pollution, sources and mechanisms, sustainability issues, in-situ and ex-situ bioremediation.

INSTRUCTOR: **Hoysall Chanakya**

SUGGESTED BOOKS:

1. APHA, 1999. Standard methods for the examination of water and wastewater, American Public Health Association, 20th edition, Washington DC
2. Tchobanoglous, G., Burton, F. L and Stensel, H. D. 2003. Wastewater engineering, treatment and re-use (Revised), Metcalf & Eddy Incorporation, Tata McGraw-Hill Publishing Company limited, New Delhi
3. Relevant papers from current literature

SEMESTER 7 (AUGUST)

UES 401 NATURAL HAZARDS AND THEIR MITIGATION (3:0)
(CORE COURSE FOR EARTH & ENV. SCI. MAJOR)

Definitions and basic concepts, different kinds of hazards and their causes, Geologic Hazards: Earthquakes, causes of earthquakes and their effects, plate tectonics, seismic waves, measures of size of earthquakes, earthquake resistant design concepts; Slope instability and landslides, causes of landslides, principles of stability analysis, remedial and corrective measures for slope stabilisation, Climatic Hazards: Floods, causes of flooding, regional flood frequency analysis, flood control measures, flood routing, flood forecasting and warning systems; Droughts, causes and types of droughts, effects of drought, hazard assessment and decision making; Use of GIS in natural hazard assessment, mitigation and management.

INSTRUCTOR: **Kusala Rajendran**

SUGGESTED BOOKS:

1. Hyndman, D. and Hyndman, D. 2008. Natural Hazards and Disasters, Brooks/Cole Cengage Learning
2. Bryant, E. 2005. Natural Hazards, Cambridge University Press
3. Duncan, J. M. and Wright, S. G. 2005. Soil Strength and Slope Stability, John Wiley & Sons, Inc
4. Elnashai, A. S. and Sarno, L. D. 2008. Fundamentals of Earthquake Engineering, John Wiley & Sons, Inc

CE 222 (JAN) 3:0 FUNDAMENTALS OF SOIL BEHAVIOUR (ELECTIVE)

Identification and classification of clay minerals, expansive and collapsing soils; Concepts and measurements of matric and osmotic suction, Role of inter-particle forces and suction in effective stress, Role of clay mineralogy, inter-particle forces and suction in volume change, hydraulic conductivity and shear strength of soils.

INSTRUCTORS: **M Sudhakar Rao and P Raghuveer Rao**

SUGGESTED BOOKS:

1. Mitchell, J. K. Fundamentals of Soil Behaviour, Wiley, 2005
2. Yong, R. N. and Warkentin, B. P. Soil Properties and Behaviour, Elsevier, 1975
3. Lu, N. and Likos, W. J. Unsaturated Soil Mechanics, Wiley, 2004
4. Fredlund, D.G. and Rahardjo, H., Fredlund, M.D. Unsaturated Soil Mechanics in Engineering Practice, Wiley, 2012
5. Nelson, J. D. and Miller, D. J. Expansive soils - Problems and Practice in Foundation and Pavement Engineering. Wiley- Interscience Pub., 1992

In addition to the electives listed, appropriate electives from CiE, CE, CEaS, CAOS, CES and CST can be taken by students.

SEMESTER 8 (JANUARY)

UES 400: RESEARCH PROJECT (0:16)

An independent research project will be performed by all UG-Earth & Environmental Science Major students under the supervision of faculty. It is recommended that students initiate laboratory/ computational work during the summer break post completion of the sixth semester. The progress of the project will be monitored at the end of the seventh semester by a committee comprising of project supervisor, common examiner and external examiner. The student shall submit project report at end of 8th semester and make a presentation to the committee. Based on the overall student's performance, final grade will be awarded to the research project by the committee.

INSTRUCTORS: **Faculty members involved in Earth & Environmental Science Program**

ENGINE

UG INSTRUCTORS
Hegde G. S., Vijaya Bhaskar Reddy

SEMESTER 1 (AUGUST)

UE 101: ALGORITHMS AND PROGRAMMING (2:1)

Notions of algorithms and data structures. Introduction to C programming. Importance of algorithms and data structures in programming. Notion of complexity of algorithms and the big-O notation. Iteration and Recursion. Algorithm analysis techniques. Arrays and common algorithms with arrays. Linked lists and common algorithms with linked lists. Searching with hash tables and binary search trees. Pattern search algorithms. Sorting algorithms including quick-sort, heap-sort, and merge-sort. Graphs: shortest path algorithms, minimal spanning tree algorithms, depth first and breadth first search, Algorithm design techniques including greedy, divide and conquer, and dynamic programming.

INSTRUCTORS: **Sathish Govindarajan and Viraj Kumar**

SUGGESTED BOOKS:

1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language. Prentice Hall of India, 2009.
2. Abhiram Ranade, An Introduction to Programming through C++. McGraw Hill, First Edition, 2017.
3. Robert L. Kruse, Data Structures and Program Design in C. Prentice Hall of India, 2006.
4. Steven S. Skiena, The Algorithm Design Manual. Springer, Second Edition, 2008.
5. Sanjay Dasgupta, Christos Papadimitriou and Umesh Vazirani. Algorithms. McGraw Hill, 2017.
6. Mark Allen Weiss, Data Structures and Algorithm Analysis in C. Pearson, Second Edition,2002.

ERING

SEMESTER 2 (JANUARY)

UE 102: INTRODUCTION TO ELECTRICAL AND ELECTRONICS ENGINEERING (2:1)

Ohm's law, KVL, KCL, Resistors and their characteristics, categories of resistors, series parallel resistor networks, Capacitors and their characteristics, simple capacitor networks, simple RC circuit and differential equation analysis, frequency domain analysis and concepts of transfer function, magnitude and phase response, poles, Inductors and their characteristics, a simple LR circuit and differential equation analysis, frequency domain transfer function and time constant, LRC circuit and second order differential equation, frequency domain analysis, resonance and quality factor, Introduction to Faraday's and Lenz's laws, magnetic coupling and transformer action for step up and step down, Steady State AC analysis and introduction to phasor concept, lead and lag of phases in inductors and capacitors, concept of single phase and three phase circuits, Semiconductor concepts, electrons & holes, PN junction concept, built-in potential, forward and reverse current equations, diode operation and rectification, Zener diodes, Simple Diode circuits like half-wave rectifier and full-wave rectifier, NPN and PNP bipolar transistor action, current equations, common emitter amplifier design, biasing and theory of operation, MOSFET as a switch, introduction to PMOS and NMOS.

Introduction to Op-amp concept, Characteristics of an ideal op-amp a simple realisation of op-amp using transistors, Various op-amp based circuits for basic operations like summing, amplification, integration and differentiation, Introduction to feedback concept LAB: Design of 3 transistor op-amp and its characterisation. Simple op-amp applications using 741, MOSFET circuits for some simple gates, simple combinational functions, Basic flip-flop operation and clocks in digital design, Introduction to A/D conversion, Introduction to 8051 microcontroller and assembly language programming.

INSTRUCTOR: **M. K. Gunasekaran**

SUGGESTED BOOK:

1. Paul Horowitz and Winfield Hill, The Art of Electronics, Cambridge University Press, 2nd Edition, 1989.

SEMESTER 3 (AUGUST)

UE 200: INTRODUCTION TO EARTH AND ITS ENVIRONMENT (2:0)

Nucleosynthesis, formation of planets, Minerals, rocks and bulk Earth composition; Radioactivity and age of the Earth; Mantle convection and plate tectonics; Introduction to stable isotope geochemistry; General application of stable isotopes; The Carbon cycle; The S cycle; The Nitrogen cycle; Chemical weathering and global thermostat; Short-term climate variation; Wind and oceanic circulation; Thermo-haline circulation and its role in climate change; Surficial water cycle Aqueous chemistry; Redox chemistry in aquatic environment - implication and application; Carbonate chemistry and its application; Instrumentation in environmental and low-temperature geochemistry

INSTRUCTORS: **Prosenjit Ghosh, Ramananda Chakrabarti and Sambuddha Misra**

SUGGESTED BOOKS:

1. Environmental and Low-temperature Geochemistry - Peter Ryan
2. How to Build a Habitable Planet - Langmuir and Broecker

UE 202: INTRODUCTION TO MATERIALS SCIENCE (2:0)

Bonding, types of materials, basics of crystal structures and crystallography, Thermodynamics, Thermochemistry, unary systems, methods of structural characterization, Thermodynamics of solid solutions, phase diagrams, defects, diffusion, Solidification, Solid-solid phase transformations, Mechanical behaviour: elasticity, plasticity, fracture, Electrochemistry and corrosion, Band structure, electrical, magnetic and optical materials, Classes of practical materials systems: metallic alloys, ceramics, semiconductors, composites.

INSTRUCTOR: **Kaushik Chatterjee**

SUGGESTED BOOK:

1. Callister, W. D., Materials Science and Engineering, Wiley India, 2007.

SEMESTERS 4, 5 AND 6

THE STUDENTS CAN TAKE COURSES WITHIN THE FOLLOWING POOL.
POOL OF ELECTIVE COURSES:

UE 201: INTRODUCTION TO SCIENTIFIC COMPUTING (2:1)
(SEMESTER 5/7) (AUGUST)

Number representation, stability and convergence and error analysis; Interpolation: Lagrange, Newton's Divided Difference, Neville; Root finding: Bisection, Newton-Raphson, Secant, Regula falsi, Ridders, Steffensen; Data analysis and fitting: Goodness of fit, Chi-Square test; Numerical integration and differentiation: Newton-Cotes, Gaussian quadrature, Romberg integration, Importance sampling; Numerical solution of ODEs: Euler and Runge-Kutta methods; Fourier Series and Fourier Transforms, Basics of Sampling Theory, DFT and FFT; Simple computer implementation exercises.

INSTRUCTOR: **Sashikumaar Ganesan**

SUGGESTED BOOKS:

1. Kreyszig, E. Advanced Engineering Mathematics, John Wiley & Sons, 10th Edition, 2011.
2. Press, W. H., Teukolsky, S. A., Vetterling, W. T. and Flannery, B. P. Numerical Recipes: The Art of Scientific Computing, Cambridge University Press, 3rd Edition, 2007.
3. Hildebrand, F. B., Introduction to Numerical Analysis, 2nd edition, Dover Publications, 1987, (First South-Asian Edition, 2008).
4. Burden, R. L. and Faires, J. D., Numerical Analysis: Theory and Applications, Indian Edition, Cengage Brooks, Cole Publishers, 2010.

Note: UE 201 and DS 288 are equivalent courses and UG students are expected to register for UE 201 if they wish to take one of these courses.

UE 204: ELEMENTS OF SOLID MECHANICS (3:0)
(SEMESTER 4/6) (JANUARY)

Elastic bodies. Axial and shear stresses, Hooke's Law, Stress resultants, Axially loaded members, Torsion of circular bars, Shear force, bending moment, and axial thrust, Theory of simple bending, Bending and shear stress distribution in beams, Two dimensional state of stress, Principal stresses and strains, Mohr's diagram, Pressure vessels, Combined states of stress and failure theories, Detection of beams, Statically indeterminate beams, Unsymmetrical bending, Shear centre, Buckling of columns, Energy methods, Principle of virtual work, Castigliano's theorems and applications.

INSTRUCTOR: **C. S. Manohar**

SUGGESTED BOOKS:

1. Gere, J. M. and Timoshenko, S. P., Mechanics of Materials, CBS Publishers, New Delhi, 2nd Edition, 1984.
2. Popov, E. P., Engineering Mechanics of Solids, Prentice Hall, New Jersey, 1990.
3. Utku, S., Norris, C. H. and Wilbur, J. B., Elementary Structural Analysis, McGraw-Hill, New York, 1991.
4. Crandall, S. H. and Dahl, N. C., An Introduction to Mechanics of Solids, McGraw-Hill, New York, 1959.

DIVISION OF MECHANICAL SCIENCES

DEPARTMENT OF MATERIALS ENGINEERING

Course Number	Course Title	Credits	Semester	Prerequisites	Comments
UMT 203	Materials Thermodynamics	3:0	Jan	None	No limit
MT 271	Introduction to Biomaterials Science and Engineering	3:0	Aug	None	No limit
MT 253	Mechanical Behaviour of Materials	3:0	Aug	MT 250/PD 205/ME228	No limit
MT 260/ CH 237	Polymer Science Engineering	3:0	Aug	None	No limit

DEPARTMENT OF MECHANICAL ENGINEERING

Course Number	Course Title	Credits	Semester	Prerequisites	Comments
ME 201	Fluid Mechanics	3:0	Aug (5th Sem)	UP 101, UP 202	20
ME 228	Materials & Structure Property Correlations	3:0	Aug (5th Sem)	None	15
ME 240	Dynamics & Control of Mechanical Systems	3:0	Aug	None	10
ME 271	Thermodynamics	3:0	Aug (7th Sem)	UC 202	
ME 256	Variational Methods & Structural Optimization	3:0	Jan (6th Sem)	None	Max 15 UG Students
ME 251	Biomechanics	3:0	-	-	Check with Instructor
UE 204	Elements of Solid Mechanics	3:0	Jan	-	No Limit

DEPARTMENT OF AEROSPACE ENGINEERING

Course Number	Course Title	Credits	Semester	Prerequisites	Comments
AE 221	Flight Vehicle Structures	3:0	Aug	None	Max 10 UG students
AE 224	Analysis & design of Composite Structures	3:0	Aug/Jan	None	Max 10 UG students
AE 227	Multi-body Dynamics using Symbolic Manipulators	3:0	Aug	None	Max 10 UG students
AE 259	Navigation, Guidance & Control	3:0	Aug	None	Max 10 UG students
AE 266	Introduction to Neural Network and Engineering Applications	3:0	Aug/Jan	None	Max 10 UG Students
AE 262	Guidance Theory & Applications	3:0	Jan	None	Max 10 UG students
AE 281	Introduction to Helicopters	3:0	Jan	None	Max 10 UG students

CENTRE FOR ATMOSPHERIC AND OCEANIC SCIENCES

Course Number	Course Title	Credits	Semester	Prerequisites	Comments
AS 230	Atmos. Thermodynamics	3:0	Aug	Physics	No Limit
AS 211	Observational Techniques	2:1	Aug	None	2
AS 209	Mathematical Methods in Climate Science	3:0	Aug	None	No Limit
UES 307	Introduction to Solid Earth	3:0	Jan	None	No Limit
UES 204	Fundamentals of Climate Science	3:0	Jan	None	No Limit
AS 202	GeoPhysical Fluid Dynamics	3:0	Jan	None	No Limit

DEPARTMENT OF CHEMICAL ENGINEERING

Course Number	Course Title	Credits	Semester	Prerequisites	Comments
CH 201	Chemical Engineering. Mathematics	3:0	Aug	None	Check with Instructor
CH 202	Numerical Methods	3:0	Aug	None	No Limit
CH 203	Transport Processes	3:0	Aug	None	Check with Instructor
CH 204	Thermodynamics	3:0	Aug	None	Check with Instructor
CH 237/ MT 260	Polymer Science and Engineering	3:0	Aug	None	No Limit
CH 205	Chemical Reaction Engineering	3:0	Jan	None	Check with Instructor

CENTRE FOR PRODUCT DESIGN AND MANUFACTURING

Course Number	Course Title	Credits	Semester	Prerequisites	Comments
PD 201	Elements of Design	2:1	Aug		Check with Instructor
PD 202	Elements of Solid and Fluid Mechanics	2:1	Aug		Check with Instructor
PD 203	Creative Engineering Design	2:1			Check with Instructor
PD 212	Computer Aided Design	2:1	Jan		Max No. of UGs 15
PD 216	Design of Automotive Systems	2:1			Check with Instructor
PD 217	CAE in Product Design	2:1	Aug	Strength of Materials, Numerical Methods	Max No. of UGs 15
PD 214	Advanced Materials & Manufacturing	3:0	Jan	Materials Science	Max No. of UGs 15
PD 215	Mechatronics Systems	2:1	Jan	Control Systems	Max No. of UGs 15

CENTRE FOR SUSTAINABLE TECHNOLOGIES

Course Number	Course Title	Credits	Semester	Prerequisites	Comments
ST 202	Energy Systems and Sustainability	3:0	Aug	None	Max 20 UG students
ST 201	Thermochemical & Biological Energy Recovery from Biomass	3:0	Jan	None	Max 20 UG students

SCIENTIFIC COMPUTING
Only one of CH 202/SE 288/ SE 289/UE 203 can be taken, as they are equivalent courses.

MATERIALS SCIENCE AND ENGINEERING
Only one of UMT 200/MT 250, PD 205, or ME 228 can be taken, as they are equivalent courses.

DIVISION OF ELECTRICAL SCIENCES

DEPARTMENT OF COMPUTER SCIENCE AND AUTOMATION

Course Number	Course Title	Credits	Semester	Prerequisites	Comments
E0 213	Pattern Recognition	3:1	Aug	Requires explicit consent of the instructor	
E0 220	Graph Theory	3:1	Aug	A or S in UE101 Algorithms & Programming, A or S in all Mathematics courses in the UG Program	Only fifth term or later; Max number:10
E0 224	Computational Complexity Theory	3:1	Aug	Requires explicit consent of the instructor	
E0 225	Design and Analysis of Algorithms	3:1	Aug	A or S in UE101 Algorithms & Programming, A or S in all Mathematics courses in the UG Program	Only fifth term or later; Max number:10
E0 235	Cryptography	3:1	Aug	Requires explicit consent of the instructor	
E0 251	Data Structures & Algorithms	3:1	Aug	A or S in UE101 Algorithms & Programming, A or S in all Mathematics Courses in the UG Program	Only fifth term or later; Max number:10
E0 248	Theoretical Foundations of Cryptography	3:1	Jan	Requires explicit consent of the instructor	

Course Number	Course Title	Credits	Semester	Prerequisites	Comments
E0 249	Approximation Algorithms	3;1	Jan	E0 225	
E1 254	Game Theory	3:1	Jan	A or S in UE101 Algorithms & Programming, A or S in all Mathematics courses in the UG Program	Only sixth term or later; Max number:10. Requires explicit consent of instructor.

DEPARTMENT OF ELECTRICAL ENGINEERING

Course Number	Course Title	Credits	Semester	Prerequisites	Comments
E1 251	Linear and Nonlinear Optimisation	3:0	5th or 7th Sem	Multivariate calculus, matrices & linear algebra	Max 15 UGs
E9 201	Digital Signal Processing	3:0	5th or 7th Sem	A basic orientation in Signals and Systems	Max 25 UGs

DEPARTMENT OF ELECTRICAL COMMUNICATION ENGINEERING

Course Number	Course Title	Credits	Semester	Prerequisites	Comments
E3 238	Analog VLSI Circuits	2:1	Aug	UE 102	Max 10 UG students
E7 213	Introduction to Photonics	3:0	Aug	3rd yr or 4th yr UG standing	No cap

ADDITIONAL COURSES FROM THIS DIVISION THAT ARE ALLOWED BUT REQUIRE EXPLICIT CONSENT OF THE INSTRUCTOR

Course Number	Course Title	Credits
E1 216	Computer Vision	3:1
E2 201	Information Theory	3:0
E3 214	Microsensor Technologies	3:0
E3 222 T	Micromachining for MEMS Technology	2:1
E3 253	Industrial Instrumentation	
E3 267/ IN 222	Microcontroller Applications	
E9 213	Time-Frequency Analysis	3:0
E9 282	Neural signal processing	3:0
E9 241	Digital Image Processing	2:1
E9 291	DSP System Design	2:1

DIVISION OF ELECTRICAL SCIENCES

DEPARTMENT OF COMPUTER SCIENCE AND AUTOMATION

Course Number	Course Title	Credits	Semester	Prerequisites	Comments
BE 201	Fundamentals of Biomaterials & Living Matter	3:0	Aug	None	No cap

CENTER FOR NANOSCIENCE

Course Number	Course Title	Credits	Semester	Prerequisites	Comments
NE 327	Nanoelectronics Device Technology	3:1	Aug		Check with instructor
NE 231	Microfluidics	3:0	Aug		Check with instructor
NE 201	Micro and Nano Characterization Methods	2:1	Aug		Check with instructor

DEPARTMENT OF COMPUTATIONAL AND DATA SCIENCES

Course Number	Course Title	Credits	Semester	Prerequisites	Comments
DS 284	Numerical linear algebra	2:1	Aug	None	No cap
DS 301	Bioinformatics	2:0	Aug	None	Check with instructor

HUMAN

UG INSTRUCTOR
Bitasta Das

The Humanities course as part of the Undergraduate Program offered at the Indian Institute of Science is an opportunity to bring about synergy between the Humanities and Social Sciences (or 'Human Sciences') with the Natural Sciences. With this aim in mind, IISc offers one course in Humanities in the first six semesters of the eight semester-BS Program. These courses are not designed to teach Humanities as a series of distinct disciplines but are designed to create an intellectual milieu in which the students learn science.

SEMESTER I: WAYS OF KNOWING

COURSE CODE: UH 101

INSTRUCTORS: **Bitasta Das, Bidisha Banerjee, Nithin Manayath and P. P. Sneha**

MODULE 1: ETHNOGRAPHIC METHODS

How are cultural practices and patterns reproduced and carried forward in time? Questions such as these can be explored with the help of qualitative ethnographic methods. Originating in cultural anthropology, these are now widely used across human sciences. Typically, ethnography collects empirical data about human societies, using fieldwork, participant observation, questionnaires, interviews, chain sampling, and the like to understand how social meanings are created. Of special interest to science students would be the reflexive and interpretive emphasis of ethnography, since it has a bearing on how to read and write scientific findings. The module will expose students to some key debates in this area through short readings and documentary films.

MODULE 2: PSYCHOLOGICAL METHODS

How do we understand experience of the self in a way that is not purely subjective? How do we understand the experience of other people (eg. how do we know when someone is in pain?) What is the importance of language as a medium by which these things can be comprehended? What would be the challenge to experimental sciences when language is brought into the picture? This module introduces students to some of these important debates.

ITIES

MODULE 3: HISTORICAL ANALYSIS

What is the past? Where may we draw a line differentiating the past and present: Is the past a millisecond ago or a century ago? The course will examine when and how this differentiation between past and present – and with it, the discipline and method of history – emerges. It would show that the past or present distinction is essential to the 'objectivity' of the historical method. The claim to objectivity is something that the social and human sciences share with the natural sciences. In India, postcolonial thinkers have critiqued history as a western way of knowing the past. Their contention is that professional history-writing is imbued with a "historical consciousness", which many Indians who inhabit epistemic worlds outside of the University and the social sciences do not share. For many Indians, the relationship to the 'past' may not be premised on questions of facticity, evidence, and 'truth' in the scientific sense. Is there a way of understanding the ancient Indian texts which go beyond this fact or myth dyad? The course will end with this question.

MODULE 4: TEXTUAL ANALYSIS

This module introduces students to key concepts and issues in textual analysis, a method not only adopted by students of literature but also History and other disciplines. It begins with the discussion of what a text is and the relationship of the writer to the text written by him or her. It then goes on to discuss how meaning is produced from a text and who produces it. It then returns to the problem of interpretation, discussed in the earlier modules, to focus on the reader's role in interpreting texts and generating meaning, examine how texts are, what is the role of the reader in interpreting textual meaning? In this module, students will be introduced to methods of close reading drawn from literary criticism and cultural studies.

SEMESTER II: WAYS OF SEEING

COURSE CODE: UH 102

INSTRUCTORS: **Shoba Narayanan, Arul Mani and Vijay Padaki**

This course introduces students to (a) the ways in which cultural forms and genres represent the world around us and (b) how we see and understand the world as refracted by these forms. There will be three modules. In short, this is a course about seeing and interpreting the forms that show us the world. Each module discusses a particular cultural form and also focuses on one theme.

MODULE 1: VISUAL ARTS

How do paintings represent reality? Is realism more "scientific" than other ways of presenting the world? How does technology determine the evolution of art forms? What problems did artists face in the Indian context as they adopted western styles and forms? Special focus on mythology and its representation in modern Indian art.

MODULE 2: LITERATURE

What do we need to know in order to appreciate creative writing? How do we read and interpret literary works? Where does meaning lie? How do we 'learn' from literature? Special focus on science fiction: good science and bad science, space or distance and time or history, human and non-human, science & technology, and nature.

MODULE 3: CINEMA AND THEATRE

History of cinema as a technological form, technophobic reactions to film. Audiences and spectatorship. Film as an urban, democratic form. How fiction and non-fiction films "document" reality and what they can they tell us about society, how to "read" films. Special focus on the city, as subject of cinema, and site of film production and viewing.

SEMESTER III:
WAYS OF DOING: MAPPING SCIENCE-SOCIETY RELATIONSHIP

COURSE CODE: UH 201

INSTRUCTORS: **Raghavendra Srinivas, Rajan Gurukkal, H. N. Chanakya and Namita Aavriti**

MODULE 1: ECONOMICS

The aim of this module is to introduce the study of Macroeconomics, which is concerned with the analysis of major economic problems such as unemployment, inflation, and economic growth. The module will introduce and analyse several theoretical models that are developed to address these issues. The module will highlight the fundamental differences in these theoretical models that give rise to diametrically opposite policy prescriptions as solutions for the macroeconomic problems of unemployment and economic growth. This module will also help locate various policy regimes that dominated various periods of the past century in the context of the theoretical models developed in macroeconomics.

MODULE 2: PEOPLE AND NATURE

This module will approach the theme of people and nature from different perspectives – natural science, social science, humanities, and arts. The course will discuss the evolution of our conception of nature, our understanding of our place in nature and how nature works, and our attempts to describe, appreciate, control and manipulate nature. This module will be more multidisciplinary than interdisciplinary and will attempt to showcase the significant variation across

disciplines, historical time and geographical space in our approach to nature, and the inevitable conflicts such variation generates.

MODULE 3: SUSTAINABLE DEVELOPMENT

This module will approach the gradually evolving concepts of sustainable development from the Indian to a Global perspective and in the process bring about the various societal forces (local and global) that evolve(d) the meanings of sustainability and sustainable development, emerging debates and likely conflicts into the future. Is sustainability Science? Examining how people of natural, engineering and social sciences perceive sustainability in different perspectives or domains and the potential to integrate these perspectives for completeness, S&T in championing sustainable development. Measuring sustainability and evolving indices for sustainability.

MODULE 4: LAW AND SCIENCE

Law and science in various ways are constitutive of modernity. This course will examine the foundational authority of law in violence and how this is enmeshed with the authority of science. Law and justice are often assumed to bear the same meaning, but law, unlike justice, is about the application of general norms that are blinded to the unique, particular realities of people. This is again different from laws in science that are based on experiment and observation. The functioning of law in society is based on legal fictions especially that of the "reasonable man" that is borrowed from Western legal tradition. The figure of the reasonable man is emblematic of the hierarchies and exclusions inbuilt into the legal system. In this course we will explore citizenship and gender as issues where questions of legal and scientific authority are raised, firstly biometric authentication in UID and the reliance on technology to resolve issues of poverty and crisis, secondly variance in gender or transgender described as a medical pathology by the courts.

SEMESTER IV: MAPPING INDIA THROUGH THE FOLK ARTS

COURSE CODE: UH 203

INSTRUCTOR: **Bitasta Das**

The objective of this course is to understand the seven regions of India – North, West, East, South, Central, North-East and the Islands a little better – by looking at their folk arts. The course considers the art forms, as viewed in the discipline of Folkloristics, as means of knowing the regional cultures from "inside-out rather than outside-in". The aim of this seminar course is to provide the students a broad idea of India as a "nation", its diverse regional specificities and the relevance of the folk arts in understanding the "national" and the "regional". Every year a different folk art form is focused upon which is narrative, visual or performative. The students get an opportunity to interact with folk artists and gain first-hand knowledge about various aspects of the arts. This is to enable the understanding of the synergy between artistic worldview and the contemporary social milieu. The course is useful in recognizing how meaning is produced and expressed in folk domain, and at the same time, aids the students to gain cognizance of Indian multiculturalism. The assignments given in this course is a deliberate attempt to express science through the folk arts.

SEMESTER V:
JOURNALISM FOR SCIENTISTS

COURSE CODE: UH 301

INSTRUCTOR: **Amrita Shah**

The Course will be useful in acquainting students with journalistic skills which they may apply in their own work to observe and communicate better for instance or to their field as future science reporters, perhaps or as individuals who might have to explain science to the lay person. It also seeks to provoke thoughts on the practice of journalism, its tenets, its limitations and its influence with a view to encouraging a more critical engagement with media and to position science within the media.

Class 1: What is News?
The media shapes society's perception of what is newsworthy. How does one identify an event as news?

Class 2: Reporting
News gathering methods; an analysis of samples of reportage.

Class 3: How to investigate?
Innovative or extraordinary methods used in journalism to uncover truths not available by conventional means.

Class 4: New Media
Print, television, video, satellite TV, and the small screen of the cell phone. A discussion on how technological advance affects journalism.

Class 5: Reporting Science
How is science reported in the mainstream media? Is the coverage adequate and informed?

Class 6: Science Journalism
Trends and approaches in Indian and international science magazines.

Class 7: How to research and write an article for a newspaper or magazine?
Practical tips and guidelines.

Class 8: Expressing an opinion
Constructing and presenting a point of view as in a column or a review.

Class 9:The Art of the Interview
Practical tips and guidelines on conducting interviews.

Class 10: Ethics and Dilemmas
The media is both a public service and a business. What are the conflicts and compromises that journalists face?

Class 11: Preparing to write a book
Early steps in turning an idea into a book: laying the ground and writing a proposal.

Class 12: Class Discussion possibly with Guest Speaker on dealing with the newsroom

Class 13: Class Exercise in reading news or anchoring media debates, and so on

Class 14: Concluding Discussion
Elaborating points of interest raised in earlier classes and answering queries.

SEMESTER VI: INTRODUCTION TO GOVERNANCE

COURSE CODE: UH 302

INSTRUCTOR: **Uday Balakrishnan**

The semester-long program on Introduction to Governance is to enable students to develop an appreciation of key issues and challenges in governance in India, while gaining an insight into how the Government of India works and relates to the people. It will be largely interactive and to facilitate this (i) Select reading material will be given ahead of each session. Additionally, a selection of books will be available for students to refer in the library at the Centre for Contemporary Studies, IISc. Some, if not all of the sessions, are expected to be supplemented by experts drawn from the top echelons of public administration, the judiciary, and politics. Evaluation is based on group projects and individual assignments emerging from each covering a range of contemporary issues that engage us as concerned citizens of our country.

Class 1: Introduction to the semester and assignment of Group projects

Class 2: The challenge of good governance in a democracy, followed by presentations of Group project 1: People Power as driver of change in Governance

Class 3: Overview of the Indian Constitution, followed by Group project 2: Examining the 42nd Amendment to the Indian Constitution – was it necessary?

Class 4: How the Indian Parliament works, followed by Group project 3: Evaluating the 15th – latest following the 2009 elections – Lok Sabha.

Class 5: Understanding Indian bureaucracy and making it work for you, followed by presentations of Group Project 4: Is IT cutting through red tape?

Class 6: Affirmative Action, followed by Group Project 5: Ambedkar and the Empowerment of the historically discriminated in Indian society – an appreciation.

Class 7: Important aspects of India's Internal & External Security, followed by Group Project 6: Challenging the State – a short account of peoples' struggles since Independence.

Class 8: Development as a Political Process thee Amartya Sen-Jagdish Bhagwathi debates, followed by Group Project 7: Is Democracy handicapping Development in India?

Class 9: The evolving role of Indian Judiciary.

Class 10: Corruption and the Indian State followed by Group project 8: Experiencing Graft – Sharing a collection of personal experiences from within the IISc student community.

Class 11: The Alternative – The AAP phenomena – Challenging an established political model, followed by Group project 9: Contrasting the JP Movement's Total Revolution with Anna Hazare or APP movement.

Class 12: International interdependence – an appreciation of the UN system followed by Group project 10: Challenging isolation in an increasingly globalising and interdependent world.

MATERI

UG INSTRUCTORS
Avadhani G. S., Srinivasa Reddy

SEMESTER 4 (JANUARY)

UMT 202: STRUCTURE OF MATERIALS (2:1)
(CORE FOR MATERIALS MAJORS AND MINORS)

Elements of bonding, structures of simple metallic, ionic and covalent solids; Coordination polyhedra, projections of structures, stacking; Lattices, symmetry operations, stereographic projection; Structure and thermodynamics of point defects and solid solutions, non-stoichiometry, ordered structures; Dislocations and slip, twinning and interfaces.

INSTRUCTORS: **N. Ravishankar and S. Karthikeyan**

SUGGESTED BOOKS:

1. Kelly, A. and Groves, G. W., Crystallography & Crystal Defects, Addison Wesley
2. Barrett, C.S. and Massalski, T. B., Structure of Metals, Pergamon
3. West, A. R., Introduction to Solid State Chemistry, John Wiley

UMT 203: MATERIALS THERMODYNAMICS (3:0)
(CORE FOR MATERIALS MAJORS + SOFT CORE FOR MATERIALS MINORS)

First law, enthalpy, thermochemistry; Second law, entropy, statistical interpretation; Helmholtz and Gibbs free energies, chemical potential; Solution thermodynamics; Conditions for equilibrium, phase rule, phase diagrams; Chemical reactions and equilibria; Surfaces and interfaces.

INSTRUCTORS: **T. A. Abinandanan**

SUGGESTED BOOKS:

1. DeHoff, R. T. 2006. Thermodynamics in Materials Science, Taylor & Francis
2. Gaskell, D. R. 2003. Introduction to the Thermodynamics of Materials (4th Ed), Taylor & Francis

ALS

UMT 205: MECHANICAL PROPERTIES OF MATERIALS (3:0)
(CORE FOR MATERIALS MAJORS + SOFT CORE FOR MATERIALS MINORS)

Structures, vector mechanics (statics) and types of loads; Introductory concepts in stress and strain and their transformation; Linear elasticity in single and poly-crystals and in amorphous solids; Stresses in constrained systems – thermal and misfit stresses; Viscoelasticity and hyperelasticity in polymers; Stress concentration; Fracture mechanics and toughening mechanisms; Introduction to plastic deformation; Uniaxial stress-strain curve and flow instabilities; Effect of strain, strain-rate and temperature of flow stress; Continuum-based yield criteria; Plastic deformation mechanisms – slip, twinning and diffusion; Introduction to dislocation theory – slip systems, critical resolved shear stress, strengthening mechanisms; Creep and fatigue.

INSTRUCTOR: **S. Karthikeyan**

SUGGESTED BOOKS:
1. Beer, F. P., Johnston, E. R., DeWolf, J. T., and Mazurek, D.F. 2014. Mechanics of Materials, 7th edition, McGraw Hill
2. Hosford, W. 2010. Mechanical Behavior of Materials, 2nd edition, Cambridge University Press
3. Courtney, T. H. 2001. Mechanical Behavior of Materials, 2nd edition, Tata McGraw Hill
4. Ward, I. M. and Sweeney, J. 2012. Mechanical Properties of Solid Polymers, 3rd edition, Wiley

SEMESTER 5 (AUGUST)

UMT 301: MATERIALS KINETICS (3:0)
(CORE FOR MATERIALS MAJORS + SOFT CORE FOR MATERIALS MINORS)

Point defects, Fick's laws of diffusion, concept of jump frequency, activation energy, Kirkendall effect, solidification, nucleation, constitutional supercooling, sintering, interfaces, grain growth, solid state transformations, JMA theory, GP zone, Spinodal decomposition, ordering and martensitic transformations, effect of stress and electric current.

INSTRUCTORS: **Aloke Paul and C. Srivastava**

SUGGESTED BOOKS:
1. Reed-Hill, R. E. and Abbaschian, R. 2009. Physical Metallurgy Principles, Cengage
2. Porter, D. A. and Easterling, K. E. 2009. Phase Transformations in Metals and Alloys, Taylor and Francis

UMT 302: INTRODUCTION TO MATERIALS PROCESSING (2:1)
(CORE FOR MATERIALS MAJORS + SOFT CORE FOR MATERIALS MINORS)

Metals: Principles of extraction of metals, hydrometallurgy, electrometallurgy, pyrometallurgy. Solidification processing.

Ceramics: Synthesis of ceramic powders, consolidation, sintering.

Polymers: Introduction to polymer science and engineering, polymer synthesis, introduction to polymer processing.

INSTRUCTORS: **K.A. Natarajan, B. Basu and P. C. Ramamurthy**

SUGGESTED BOOKS:
1. Alcock, C. B. 1976. Principles of Pyrometallurgy, Academic Press, London
2. Venkatachalam, S. 1998. Hydrometallurgy, Narosa, New Delhi
3. Kingery, W. D., Bowen, H. K. and Uhlmann, D. R. 1976. Introduction to Ceramics, Wiley
4. Billmeyer, F. W. Textbook of Polymer Science
5. Gowarikar, V. R., Vishwanathan, N. V. and Sreedhar, J., Polymer Science

UMT 312: MECHANICAL TESTING AND FAILURE OF MATERIALS (2:1)
(CORE FOR MATERIALS MAJORS)

Overview of solid mechanics, Introduction to instrumentation, controls and data acquisition, Mechanical testing techniques: Tensile and compression, hardness, fatigue, impact, creep, fracture.

INSTRUCTORS: **P. Kumar and R. Ravi**

Suggested Book: Dieter, G. E. 1988. Mechanical Metallurgy, McGraw-Hill

SEMESTER 6 (JANUARY)

UMT 309: FUNCTIONAL PROPERTIES OF MATERIALS I (3:0)
(CORE FOR MATERIALS MAJORS + SOFT CORE FOR MATERIALS MINORS)

Brief review of the fundamentals of quantum mechanics, statistical mechanics, electrostatics and electrodynamics; Energy bands in crystals, density of states, electric conduction in metals and alloys, thermoelectric phenomenon and applications, semiconductors and devices, electrical properties of polymers, ceramics, dielectric and amorphous materials, classical and quantum mechanical description of optical properties, lasers, LEDs, photonics, magnetic phenomenon and applications, thermal properties of materials.

INSTRUCTOR: **B. Sahoo**

SUGGESTED BOOKS:
1. Kittel, C., Introduction to Solid State Physics, McGraw-Hill
2. Solymar, L. and Walsh, D., Lectures on Electrical Properties of Materials
3. Omar, M. A., Elementary Solid State Physics
4. Hummel, R. E., Electronic Properties of Materials

UMT 310: INTRODUCTION TO MATERIALS MANUFACTURING (2:1)
(CORE FOR MATERIALS MAJORS)

Processing of metallic materials: Principles of hot, warm and cold working of metallic materials; Fundamentals of metal forming processes – rolling, forging, extrusion, wire drawing and sheet metal forming, defects in forming; Introduction to metal casting and joining; Powder processing of metallic and ceramic Materials: powder production, compaction and sintering.

Polymer processing: Basic concepts of compounding and processing; concept of master batches; classification and type of additive for plastics: antioxidants, light stabilizers, UV stabilizers; Processing techniques: Basics of various processing techniques, Extruders: single screw and twin screw extruders, film blowing, fiber spinning, thermoforming; Molding: Injection molding, blow molding, compression molding, injection stretch blow molding, gas and water assisted injection molding.

INSTRUCTORS: **S. Suwas, S. Bose and G. S. Avadhani**

SUGGESTED BOOKS:
1. Grover, M. P. 2011. Introduction to Manufacturing Processes, Wiley
2. Dieter, G. E. 1988. Mechanical Metallurgy, McGraw-Hill
3. Billmeyer, F. W. Textbook of Polymer Science, 3rd Edition
4. Gowarikar, V. R., Vishwanathan, N. V. and Sreedhar, J., Polymer Science

UMT 311: FUNCTIONAL PROPERTY CHARACTERIZATION LABORATORY (0:1)
(CORE FOR MATERIALS MAJORS)

Resistivity measurement by different methods, four probe method, determination of B-H curve, Curie point measurement Hall effect experiment, magnetostriction measurement, measurement of dielectric constant as function of temperature, Seebeck effect, efficiency of solar Cell.

INSTRUCTOR: **S. Dasgupta**

SEMESTERS 7 AND 8 (AUGUST AND JANUARY)

UMT 401: FUNCTIONAL PROPERTIES OF MATERIALS II (3:0)
(CORE FOR MATERIALS MAJORS)

Crystal chemistry, point defects and associated thermodynamic equilibria, microstructural control (texture, porosity and grain size), energy levels (band structure in metals and semiconductors, junctions, electrical double layers), thermodynamic relationships, symmetry dependence and tensorial representation of properties; Introduction to properties: dielectric (piezoelectric, ferroelectric, pyroelectric), magnetic (ferro-, ferri-, magnetostriction), electrical conductivity (ionic and electrical), thermoelectricity; Specific examples of systems: piezoelectric, ferro -electric and -magnetic materials (domain structure, poling, influence on endurance, soft and hard materials), Actuator materials, Energy conversion devices (common batteries, fuel cells, supercapacitors).

INSTRUCTOR: **V. Jayaram**

SUGGESTED BOOKS:

1. Kingery, D.W., Bowen, H.K., Uhlmann, D.R, Introduction to Ceramics, Wiley (2nd Ed.)
2. Solymar, L. and Walsh, D. Electrical Properties of Materials, Oxford University Press (8th ed.)
3. Newnham, R.E. 2004. Properties of Materials, Oxford University Press
4. Hench, L.L, West, J.K. 1990. Principles of Electronic Ceramics, Wiley
5. West, A.F., Solid State Chemistry and its Applications, Wiley (2nd ed.)

UMT 400: BACHELOR OF SCIENCE (RESEARCH) PROJECT (0:13)

INSTRUCTORS**: Faculty from Department of Materials Engineering OR Materials Research Centre**

ELECTIVES

An indicative list of graduate-level elective courses is given below; specific recommendations will be made at the beginning of each semester.

FOR THE THIRD YEAR:

Fundamentals of Biomaterials and Living Matter (Bio-Engineering)
Introduction to Biomechanics of Solids (Bio-Engineering)
Defects in Materials (MT)
Corrosion Technology (MT)
Polymer Science and Engineering-I (MT)
Topics in Basic and Applied Electrochemistry (IPC)
Phase Transformations (MT)
Interfacial Phenomena in Materials Processing (MT)
Fracture (MT)
Solidification Processing (MT)
Defects and Materials Properties (MRC)
Functional Materials Lab (MRC)
Introduction to Biomaterials (MRC)
Thin Films, Nanomaterials and Devices: Science and Engineering (MRC)

FOR THE FOURTH YEAR:

Semiconductor Devices and Integrated Circuit Technology (CeNSE)
Crystal Growth and Thin Films (CeNSE)
Elements of Solid and Fluid Mechanics (CPDM)
Design and Selection of Materials (MT)
Defects in Materials (MT)
Modeling and Simulations in Materials Engineering (MT)
Introduction to Biomaterials Science and Engineering (MT)
Electron Microscopy (MRC)
Computational Modeling of Materials (MRC)
Nanostructured Materials (MRC)
Solidification Processing (MT)
Fracture (MT)

MATHEM

SEMESTER 1 (AUGUST)

UM 101: ANALYSIS AND LINEAR ALGEBRA I (3:0)

One-variable Calculus: Real and complex numbers; Convergence of sequences and series; Continuity, intermediate value theorem, existence of maxima and minima; Differentiation, mean value theorem,Taylor series; Integration, fundamental theorem of calculus, improper integrals; Linear Algebra: Vector spaces (over real and complex numbers), basis and dimension; Linear transformations and matrices.

INSTRUCTOR: **Arvind Ayyer**

SUGGESTED BOOKS:

1. Apostol, T. M. 2007. Calculus, Volume I, 2nd edition, Wiley, India.
2. Strang, G. 2006. Linear Algebra and its Applications, 4th Edition, Brooks/ Cole.

SEMESTER 2 (JANUARY)

UM 102: ANALYSIS AND LINEAR ALGEBRA II (3:0)

Linear Algebra continued: Inner products and orthogonality; Determinants; Eigenvalues and Eigenvectors; Diagonalisation of symmetric matrices.

Multivariable calculus: Functions on R^n, partial and total derivatives; Chain rule; Maxima, minima and saddles; Lagrange multipliers; Integration in R^n, change of variables, Fubini's theorem; Gradient, Divergence and Curl; Line and surface integrals in R^2 and R^3; Stokes', Green's and Divergence theorems. Introduction to Ordinary Differential Equations; Linear ODEs and canonical forms for linear transformations.

MATICS

INSTRUCTOR: **Apoorva Khare**
SUGGESTED BOOKS:

1. Apostol, T. M. 2007. Calculus, Volume II, 2nd edition, Wiley, India.
2. Strang, G. 2006. Linear Algebra and its Applications, 4th edition, Brooks/ Cole.
3. Artin, M. 1994. Algebra, Prentice Hall of India.
4. Hirsch, M., Smale, S. and Devaney, R. L. 2004. Differential Equations, Dynamical Systems, and an Introduction to Chaos, 2nd edition, Academic Press.

SEMESTER 3 (AUGUST)

UM 201: PROBABILITY AND STATISTICS (3:0)

Basic notions of probability, conditional probability and independence, Bayes' theorem, random variables and distributions, expectation and variance, conditional expectation, moment generating functions, limit theorems. Samples and sampling distributions, estimations of parameters, testing of hypotheses, regression, correlation and analysis of variance.

INSTRUCTOR: **Manjunath Krishnapur**

SUGGESTED BOOKS:

1. Ross, S., Introduction to Probability and Statistics for Engineers and Scientists, Academic Press; 4th ed. (2009)
2. Freedman, Pisani and Purves, Statistics, Viva Books; 4th ed. (2011)
3. Feller, W., An Introduction to Probability Theory and its Applications - Vol. 1, Wiley; 3rd ed. (2008)
4. Ross, S., A First Course in Probability, Pearson Education; 9th ed. (2013)
5. Athreya, S., Sarkar, D. and Tanner, S., Probability and Statistics (with Examples using R), Unfinished book, last Compilation April 25th 2016, available at http://www.isibang.ac.in/~athreya/psweur/index.html

SEMESTER 4 (JANUARY)

UM 203: ELEMENTARY ALGEBRA AND NUMBER THEORY (3:1)
(CORE COURSE FOR MATHEMATICS MAJOR AND MINOR)

Set theory: equivalence classes, partitions, posets, axiom of choice/Zorn's lemma, countable and uncountable sets.

Combinatorics: induction, pigeonhole principle, inclusion-exclusion, Möbius inversion formula, recurrence relations. Number theory: Divisibility and Euclid's algorithm, Pythagorean triples, solving cubics, infinitude of primes, arithmetic functions, fundamental theorem of arithmetic, congruences, Fermat's little theorem and Euler's theorem, ring of integers modulo **n**, factorisation of polynomials, algebraic and transcendental numbers.

Graph theory: Basic definitions, trees, Eulerian tours, matchings, matrices associated to graphs.

Algebra: groups, permutations, group actions, Cayley's theorem, dihedral groups, introduction to rings and fields.

INSTRUCTOR: **Vamsi Pingali**

SUGGESTED BOOKS:

1. Childs, L., A Concrete Introduction to Higher Algebra, Springer
2. Bona, M., A Walk Through Combinatorics: An Introduction to Enumeration and Graph Theory, World Scientific
3. Burton, D. M., Elementary Number Theory, McGraw Hill
4. Niven, Zuckerman, H. S. and Montgomery, H. L., An Introduction to the Theory of Numbers, 5th edition,Wiley Student Editions
5. Fraleigh, G., A First Course in Abstract Algebra, 7th edition, Pearson

UM 204: INTRODUCTION TO BASIC ANALYSIS (3:1)
(CORE COURSE FOR MATHEMATICS MAJOR AND MINOR)

Basic notions from set theory, countable and uncountable sets. Metric spaces: definition and examples, basic topological notions. The topology of R^n: topology induced by norms, the Heine-Borel theorem, connected sets. Sequences and series: essential definitions, absolute versus conditional convergence of series, some tests of convergence of series. Continuous functions: properties, the sequential and the open-set characterizations of continuity, uniform continuity. Differentiation in one variable. The Riemann integral: formal definitions and properties, continuous functions and integration, the Fundamental Theorem of Calculus. Uniform convergence: definition, motivations and examples, uniform convergence and integration, the Weierstrass Approximation Theorem.

INSTRUCTOR: **Gautam Bharali**

SUGGESTED BOOKS:

1. Tao, T. 2014. Analysis I, 3rd edition, Texts and Readings in Mathematics, vol. 37, Hindustan Book Agency
2. Tao, T. 2014. Analysis II, 3rd edition, Texts and Readings in Mathematics, vol. 38, Hindustan Book Agency
3. Apostol, T. M., Mathematical Analysis, 2nd edition, Narosa

SEMESTER 5 (AUGUST)

MA 212: ALGEBRA PART I (3:0)
(CORE COURSE FOR MATHEMATICS MAJOR AND MINOR)

Part A: Groups (definitions, basic examples), normal subgroups, quotients, three isomorphism theorems, center of a group, centralizer/normalizer of a subset, symmetric

groups and Cayley's theorem, group actions; Sylow theorems as an application.

Part B: Rings and ideals, basic definitions, quotient rings, Chinese remainder theorem, maximal and prime ideals, unique factorization, UFD, PID and ED, polynomial rings, modules; basic definitions; Structure theorem for finitely generated modules over PID, basic definitions of fields, algebraic and transcendental extensions, finite fields, characteristic, any finite field has order p^n.

INSTRUCTOR: **Pooja Singla**

SUGGESTED BOOKS:

1. Lang, S. 2002. Algebra, revised third edition, Springer-Verlag, (Indian Edition Available)
2. Artin, M. 1994. Algebra, Prentice-Hall of India
3. Dummit, D. S. and Foote, R. M. 2001. Abstract Algebra, John Wiley & Sons
4. Hungerford, T. W. 2004. Algebra, Springer, India
5. Herstein, I. N. 1995. Topics in Algebra, John Wiley & Sons

MA 219: LINEAR ALGEBRA (3:1)
(CORE COURSE FOR MATHEMATICS MAJOR)
(MATHEMATICS MINORS NEED TO TAKE EITHER MA 219 OR MA 200)

Vector Spaces: Basis and dimension, direct sums. Determinants: Theory of determinants, Cramer's rule.

Linear transformations: Rank-nullity theorem, algebra of linear transformations, dual spaces. linear operators, eigenvalues and eigenvectors, characteristic polynomial, Cayley-Hamilton theorem, minimal polynomial, algebraic and geometric multiplicities, diagonalization, Jordan canonical form.

Symmetry: Group of motions of the plane, discrete groups of motion, finite groups of SO(3).

Bilinear forms: Symmetric, skew symmetric and Hermitian forms, Sylvester's law of inertia, spectral theorem for the Hermitian and normal operators on finite dimensional vector spaces.

Linear groups: Classical linear groups, SU and SL (R).

INSTRUCTOR: **R. Venkatesh**

SUGGESTED BOOKS:

1. Artin, M. 1994. Algebra, Prentice-Hall of India
2. Herstein, I. N. 1972. Topics in Algebra, Vikas Publications
3. Strang, G. 1988. Linear Algebra and its Applications, Third Edition, Saunders
4. Halmos, P. 1987. Finite Dimensional Vector Spaces, Springer-Verlag (UTM)

MA 200: MULTIVARIABLE CALCULUS (3:1)
(CORE COURSE FOR MATHEMATICS MAJOR)
(MATHEMATICS MINORS NEED TO TAKE EITHER MA 219 OR MA 200)

Functions on R^n, directional derivatives, total derivative, higher order derivatives and Taylor series. The inverse and implicit function theorem, integration on R^n,

differential forms on R^n, closed and exact forms. Green's theorem, Stokes' theorem and the Divergence theorem.

INSTRUCTOR: **Kaushal Verma**

SUGGESTED BOOKS:
1. Rudin, W. 1986. Principles of Mathematical Analysis, McGraw-Hill
2. B. V. Limaye and S. Ghorpade: A Course in Calculus and Real Analysis, Springer

MA 231: TOPOLOGY (3:1)
(CORE COURSE FOR MATHEMATICS MAJOR)
Note: This can be taken either in Semester V or Semester VII.

Open and closed sets, continuous functions, the metric topology, the product topology, the ordered topology, the quotient topology. Connectedness and path connectedness, local path connectedness. Compactness. Countability axioms. Separation axioms. Complete metric spaces, the Baire category theorem. Urysohn's embedding theorem. Function. Topological groups, orbit spaces.

INSTRUCTOR: **Harish Seshadri**

SUGGESTED BOOKS:
1. Armstrong, M. A. 2004. Basic Topology, Springer, India
2. Janich, K. 1984. Topology, Springer-Verlag, UTM
3. Munkres, K. R. 2005. Topology, Pearson Education
4. Simmons, G. F. 1963. Topology and Modern Analysis, McGraw-Hill

SEMESTER 6 (JANUARY)

MA 213 ALGEBRA PART II (3:1)
(CORE COURSE FOR MATHEMATICS MAJOR)
Note: This can be taken either in Semester VI or Semester VIII.

Part A: Introduction to categories and functors, direct and inverse limits, localization of rings, fraction field of an integral domain, I-adic completion of rings, tensor products, short exact sequences of modules, Noetherian rings and modules; Hilbert basis theorem, Jordan Holder Theorem, Artinian rings; Artinian implies Noetherian, Krull-Schmidt Theorem.

Part B: Splitting fields, normal and separable extensions, application to finite fields: existence and uniqueness, Fundamental Theorem of Galois Theory, Primitive Element Theorem.

INSTRUCTOR: **Soumya Das**

SUGGESTED BOOKS:
1. Lang, S. 2002. Algebra, revised third edition, Springer-Verlag, (Indian Edition Available)
2. Artin, M. 1994. Algebra, Prentice-Hall of India
3. Dummit, D. S. and Foote, R. M. 2001. Abstract Algebra, John Wiley & Sons
4. Atiyah, M. and MacDonald, R., Commutative Algebra
5. Herstein, I. N. 1995. Topics in Algebra, John Wiley & Sons

MA 222: ANALYSIS II (3:1)
(CORE COURSE FOR MATHEMATICS MAJOR)
Note: This can be taken either in Semester VI or Semester VIII.

Construction of the Lebesgue measure, measurable functions, limits theorems. Lebesgue integration.
Different notions of convergence and convergence theorems. Product measures and the Radon-Nikodym theorem, change of variables, complex measures.

INSTRUCTOR: **E. K. Narayanan**

SUGGESTED BOOKS:
1. Tao, Terence. An Introduction to Measure Theory, AMS
2. Hewitt, E. and Stromberg, K. 1969. Real and Abstract Analysis, Springer
3. Royden, H. L. 1988. Real Analysis, Macmillan
4. Folland, G. B., Real Analysis: Modern Techniques and their Applications, 2nd edition, Wiley

MA 224: COMPLEX ANALYSIS (3:1)
(CORE COURSE FOR MATHEMATICS MAJOR)

Complex numbers, complex-analytic functions, Cauchy's integral formula, power series, Liouville's theorem. The maximum-modulus theorem. Isolated singularities, residue theorem, the Argument Principle, real integrals via contour integration. Mobius transformations, conformal mappings. The Schwarz lemma, automorphisms of the disc. Normal families and Montel's theorem. The Riemann mapping theorem.

INSTRUCTOR: **S. Thangavelu**

SUGGESTED BOOKS:
1. Ahlfors, L. V. 1979. Complex Analysis, McGraw-Hill
2. Conway, J. B. 1978. Functions of One Complex Variable, Springer-Verlag
3. Gamelin, T. W. 2001. Complex Analysis, UTM, Springer

MA 241: ORDINARY DIFFERENTIAL EQUATIONS (3:1)
(CORE COURSE FOR MATHEMATICS MAJOR)

Basic Concepts: Phase space, existence and uniqueness theorems, dependence on initial conditions, flows.

Linear Systems: The fundamental matrix, stability of equilibrium points, Sturm-Liouville theory. Nonlinear systems and their stability: The Poincare-Bendixson theorem, perturbed linear systems, Lyapunov method.

INSTRUCTOR: **Thirupathi Gudi**

SUGGESTED BOOKS:
1. Coddington, E.A. and Levinson, N. 1972. Theory of Ordinary Differential Equations, Tata McGraw-Hill
2. Birkhoff, G. and Rota, G. -C. 1989. Ordinary Differential Equations, Wiley
3. Hartman, P. 1982. Ordinary Differential Equations, Birkhauser
4. A. K. Nandakumaran, P. S. Datti and Raju K. George. 2017. Ordinary Differential Equations; Principles and Applications, Cambridge-IISc Series

SEMESTER 7 (AUGUST)

The coursework for this semester comprises five electives.
See below for the list of electives offered by the Department of Mathematics.

SEMESTER 8 (JANUARY)

The work for this semester consists of one elective course and the undergraduate project.

UM 400 (0:13)

The undergraduate project carries 13 credits.
See below for the list of electives offered by the Department of Mathematics.

ELECTIVES OFFERED IN AUGUST - DECEMBER SEMESTER

MA 223:
Functional Analysis (3:0)
Instructor: Tirthankar Bhattacharyya

MA 232:
Introduction to Algebraic Topology (3:0)
Instructor: Basudeb Datta

MA 242:
Partial Differential Equations (3:0)
Instructor: A. K. Nandakumaran

MA 261:
Probability Models (3:0)
Instructor: Siddhartha Gadgil

MA 361:
Probability Theory (3:0)
Instructor: Srikanth Iyer

MA 335:
Introduction to Hyperbolic Manifolds (3:0)
Instructor: Subhojoy Gupta

MA 266:
Mathematical Finance - 1 (3:0)
Instructor: Mrinal K. Ghosh

MA 310:
Introduction to Algebraic Geometry - 1 (3:0)
Instructor: Abhishek Banerjee

MA 370:
Hermitian Analysis (3:0)
Instructor: Gadadhar Misra

MA 394:
Techniques in discrete probability (3:0)
Instructor: Riddhipratim Basu (ICTS)

ELECTIVES OFFERED IN JANUARY - APRIL SEMESTER

MA 229:
Calculus on Manifolds (3:0)
Instructor: Subhojoy Gupta

MA 340:
Advanced Functional Analysis (3:0)
Instructor: Tirthankar Bhattacharyya

MA 366:
Mathematical Finance - 2 (3:0)
Instructor: Mrinal K. Ghosh

MA 311:
Introduction to Algebraic Geometry - 2 (3:0)
Instructor: Abhishek Banerjee

MA 384:
Mathematical Physics (3:0)
Instructor: Kaushal Verma

MA 385:
Classical Groups (3:0)
Instructor: Pooja Singla

MA 319:
Algebraic Combinatorics (3:0)
Instructor: Arvind Ayyer

MA 326:
Fourier Anaysis (3:0)
Instructor: E.K. Narayanan

LIST OF ELECTIVES OFFERED BY THE DEPARTMENT OF MATHEMATICS

(Detailed information about electives will be posted on http://math.iisc.ac.in/course-list.html)

P.S.: More electives may be available; please contact the department.

PHYSICS

UG INSTRUCTORS
Mallikarjunaiah K. J., Praveena Mullapudi,
Nagaraja Kodihalli Keerti

SEMESTER 1 (AUGUST)

UP 101: INTRODUCTORY PHYSICS I – MECHANICS, OSCILLATIONS AND WAVES (2:1)

Kinematics, laws of motion. Circular motion, work. Kinetic and potential energy. Line integrals. Conservative forces. Friction, terminal velocity in air. Systems of particles. Conservation of linear momentum. Scattering in one and two dimensions. Angular momentum. Moment of inertia. Rotation about one axis. Precession of gyroscope. Central force. Reduction of two- body problem to one-body problem and effective one-body potential. Planetary motion and Kepler's laws. Simple pendulum, damped and forced, resonance. Coupled oscillators, normal modes. Small oscillations. Transverse waves on a string. Linear superposition, interference, beats. Fourier series. Sound waves in air. Doppler effect.

INSTRUCTORS: **Sriram Ramaswamy, Asha Bharadwaj and K. Ramesh**

SUGGESTED BOOKS:

1. Kittel, C., Knight, W. D., Ruderman, M.A., Helmholz, A. C. and Moyer, B. J. 2011. Mechanics, Berkeley Physics Course: Volume 1, 2nd edition.
2. Kleppner, D. and Kolenkow, R. J. 2007. An Introduction To Mechanics (Special Indian Edition).

SEMESTER 2 (JANUARY)

UP 102: INTRODUCTORY PHYSICS II – ELECTRICITY, MAGNETISM AND OPTICS (2:1)

Introduction, review of vector algebra, vector calculus: gradient, divergence, curl, Gauss' theorem and Stokes' theorem, Laplacian etc. Coulomb's law, electric field, electrostatic potential, uniqueness theorem, conductors, capacitance, method of images, bound charges and dipole moment density, energy stored in electric fields. Magnetostatics: electric currents, Biot-Savart law, Ampere's law, magnetic fields of straight wires, circular loops and infinite solenoids, vector potential, magnetic dipole moment and bound currents. Lorentz force and Faraday's law,

inductance, energy stored in a magnetic field. Linear dielectric and magnetic materials, charge conservation, displacement current, Maxwell's equations and gauge invariance, classical wave equation and plane monochromatic waves, energy of EM waves and Poynting's theorem.

INSTRUCTORS: **Vibhor Singh, U. Chandini and Dipanvita**

SUGGESTED BOOKS:

1. Purcell, E. M. 2011. Electricity and Magnetism, Berkeley Physics Course - Volume 2, 2nd edition, Tata McGraw Hill.
2. Griffiths, D. J. 2003. Introduction to Electrodynamics, 3rd edition, Prentice-Hall of India.

SEMESTER 3 (AUGUST)

UP 201: INTRODUCTORY PHYSICS III - THERMAL AND MODERN PHYSICS (2:1)

Temperature, The First Law of Thermodynamics, Kinetic Theory of Gases and Maxwell-Boltzmann Statistics, Heat Engines, Entropy and the Second Law of Thermodynamics, Relativity, Introduction to Quantum Physics, Basics of Quantum Mechanics, Atomic, Molecular and Solid State Physics, Nuclear Physics, Particle Physics and Cosmology.

INSTRUCTORS: **V.B. Shenoy, K.P. Ramesh, J. Krishnamurthy and Pramita**

SUGGESTED BOOKS:

1. Serway, and Jewett, Physics for Scientists and Engineers (7th Edition).
2. Young, and Freedman, University Physics (12th Edition).
3. Halliday, Resnick and Walker, Fundamentals of Physics, Extended (8th Edition).
4. Harris Benson, University Physics, Revised Edition.
5. Kenneth Krane, Modern Physics, Second Edition.

SEMESTER 4 (JANUARY)

UP 202: INTERMEDIATE MECHANICS, OSCILLATIONS AND WAVES (2:1)
(CORE COURSE FOR PHYSICS MAJOR)

Special theory of relativity. Lorentz transformations. Energy-momentum relation. Lorentz four-vectors. Motion in non-inertial frames. Fictitious forces. Coriolis force. Focault pendulum. Basic scattering theory. Vibrations of particles on a circle and a line. Orthonormal basis. Wave equation. Fourier transform. Phase space. Hamiltonian equations, fixed points and stability. Nonlinear equations. Chaos. Logistics map and period doubling. Fluid mechanics. Euler equation. Bernoulli's equation. Waves in fluids. Gravity waves. Viscosity. Navier-Stokes equation. Basic ideas about turbulence. Elasticity. Strain and stress tensors. Elastic modulii. Bending of rods. Waves in solids.

INSTRUCTORS: **Arnab Rai Choudhuri, K.P. Ramesh and K. Ramesh**

SUGGESTED BOOKS:

1. Kleppner, D. and Kolenkow, R. J. 2007. An Introduction to Mechanics (Special Indian Edition).
2. Rana, N. C. and Jog, P. S. 1991. Classical Mechanics, Tata McGraw-Hill, New Delhi.
3. Landau, L. D. and Lifshitz, E. M. Fluid Mechanics and Theory of Elasticity (Vols. 6 and 7 of Course of Theoretical Physics).

UP 203: INTERMEDIATE ELECTROMAGNETISM AND THE QUANTUM PHYSICS OF RADIATION (2:1)
(CORE COURSE FOR PHYSICS MAJOR)

Electromagnetic Waves: Wave equation from Maxwell's equations, polarization, energy and momentum in EM waves, propagation in linear media, reflection and refraction, Snell's law and Fresnel's equations, Brewster angle and total internal reflection. EM waves in conductors, skin depth, simple theories for dispersion of EM waves. Wave guides and coaxial cables, optical fibers. Geometrical optics: Fermat's principle, Snell's law, reflection and refraction at spherical surfaces, convex and concave mirrors and lenses, real and virtual images.

Physical Optics: Coherence, Young's two-slit experiment, multiple slits, diffraction grating, wavelength resolution and fringe visibility, Newton's rings, Michelson and Fabry-Perot interferometer, diffraction from rectangular and circular apertures, Airy disc and resolving power of microscopes.

Quantum optics: Photons, spontaneous and stimulated emission, Einstein A and B coefficients and relation to the Planck distribution, rate equations for absorption and emission, two-level and three-level systems, population inversion and light amplification, optical resonators and the basic working principle of a laser, examples of lasers: Ruby, He-Ne, semiconductor etc.

INSTRUCTORS: **Tarun Deep Saini, Abhijit Ray and R. Ganesan**

SUGGESTED BOOKS:

1. Griffiths, D. J. 2003. Introduction to Electrodynamics, 3rd edition, Prentice-Hall of India.

2. Hecht, E. and Ganesan, A. R. 2008. Optics, 4th edition, Pearson.
3. Ghatak, A. and Thyagarajan, K. 1991. Optical Electronics, Cambridge University Press.

UP 204: INTERMEDIATE THERMAL PHYSICS AND THE PHYSICS OF MATERIALS (2:1)
(CORE COURSE FOR PHYSICS MAJOR AND MINOR)

Review of kinetic theory and thermodynamics, Free energies, Phases and phase transitions, Vander Walls gas and the liquid gas transition, Thermodynamics of magnetic systems, Ensembles and rules of Statistical Mechanics, the ideal Maxwell-Boltzmann gas, the ideal Fermi gas, the ideal Bose gas, Crystal Structure, Lattice Vibrations, Band theory of electrons in crystalline solids, Thermal properties of crystalline solids.

INSTRUCTORS: **Prerna, H. R. Krishnamurthy, Suja Elizabeth and Shwetha Bhat**

SUGGESTED BOOKS:

1. Callen, H. B. Thermodynamics and Introduction to Thermostatistics (2nd edition), Wiley Student Edition.
2. Reif, F. Statistical Physics, Berkeley Physics Course Volume 5, Tata McGraw Hill.
3. Kittel, C. Introduction to Solid State Physics, 5th/6th/7th edition, Wiley International.

SEMESTER 5 (AUGUST)

PH 201: CLASSICAL MECHANICS (3:0)
(CORE COURSE FOR PHYSICS MAJOR)

Newton's laws, generalized co-ordinates. Lagrange's principle of least action and equations. Conservation laws and symmetry. Integrable problems, elastic collisions and scattering. Small oscillations including systems with many degrees of freedom, rigid body motion. Hamilton's equations. Poisson brackets. Hamilton Jacobi theory. Canonical perturbation theory, chaos, elements of special relativity. Lorentz transformations, relativistic mechanics.

INSTRUCTOR: **Rajeev Kumar Jain**

SUGGESTED BOOKS:

1. Goldstein, H. 1989. Classical Mechanics, 2nd edition, Narosa, New Delhi.
2. Landau, L. D. and Lifshitz, E. M. 1976. Mechanics, Pergamon, UK.
3. Rana, N. C. and Jog, P. S. 1991. Classical Mechanics, Tata McGraw-Hill, New Delhi.

PH 203: QUANTUM MECHANICS I (3:0)
(CORE COURSE FOR PHYSICS MAJOR)

Historical foundations. Wave function for a single particle. Hamiltonian. Schrodinger equation.
Probability current. Wave packets. One-dimensional problems: step, barrier and delta-function potentials. Tunneling, scattering and bound states.

Harmonic oscillator, operator approach. Matrix formulation of quantum mechanics. Hermitian and unitary operators. Orthonormal basis. Momentum representation. Uncertainty relations. Postulates of quantum mechanics. Heisenberg representation. Ehrenfest's theorem. Three-dimensional problems. Rotations, angular momentum operators, commutation relations. Spherical harmonics. Hydrogen atom, its spectrum and wave functions. Symmetries and degeneracies. Spin angular momentum. Spin-1/2 and two-level systems. Addition of angular momentum. Spin-orbit and hyperfine interactions. Time-independent perturbation theory. Stark and Zeeman effects. Variational methods, ground state of helium atom.

INSTRUCTOR: **Diptiman Sen**

SUGGESTED BOOKS:

1. Cohen-Tannoudji, C., Diu, B. and Laloe, F. 1977. Quantum Mechanics, Vol.1, John Wiley.
2. Landau, L. D. and Lifshitz E. M. 1974. Quantum Mechanics, Pergamon, NY.
3. Shankar, R. 2010. Principles of Quantum Mechanics, Springer.
4. Schwabl, F. 1995. Quantum Mechanics, Springer.

PH 205: MATHEMATICAL METHODS OF PHYSICS (3:0)
(CORE COURSE FOR PHYSICS MAJOR)

Linear vector spaces, linear operators and matrices, systems of linear equations. Eigen values and Eigen vectors, classical orthogonal polynomials. Linear ordinary differential equations, exact and series methods of solution, special functions. Linear partial differential equations of physics, separation of variables method of solution. Complex variable theory; analytic functions. Taylor and Laurent expansions, classification of singularities, analytic continuation, contour integration, dispersion relations. Fourier and Laplace transforms.

INSTRUCTOR: **B. Ananthanarayan**

SUGGESTED BOOKS:

1. Mathews, J. and Walker, R. L. 1973. Mathematical Methods of Physics, Benjamin, Menlo Park, California.
2. Dennery, P. and Krzywicki, A. 1967. Mathematics for Physicists, Harper and Row, NY.
3. Wyld, H. W. 1976. Mathematical Methods for Physics, Benjamin, Reading, Massachusetts.

PH 211: GENERAL PHYSICS LABORATORY (0:3)

Diffraction of light by high frequency sound waves, Michelson interferometer, Hall effect, band gap of semiconductors, diode as a temperature sensor, thermal conductivity of a gas using Pirani gauge, normal modes of vibration in a box, Newton's laws of cooling, dielectric constant measurements of tri-glycerine selenate, random walk in porous medium.

INSTRUCTORS: **Srimantha Middey, D.V.S. Muthu, Sarathlal and Vasant Natarajan**

SEMESTER 6 (JANUARY)

PH 202: STATISTICAL MECHANICS (3:0)
(CORE COURSE FOR PHYSICS MAJOR)

Basic principles of statistical mechanics and its application to simple systems. Probability theory, fundamental postulate, phase space, Liouville's theorem, ergodicity, micro-canonical ensemble, connection with thermodynamics, canonical ensemble, classical ideal gas, harmonic oscillators, paramagnetism, Ising model, physical applications to polymers, biophysics. Grand canonical ensemble, thermodynamic potentials, Maxwell relations, Legendre transformation. Introduction to quantum statistical mechanics, Fermi, Bose and Boltzmann distribution, Bose condensation, photons and phonons, Fermi gas, classical gases with internal degrees of freedom, fluctuation, dissipation and linear response, Monte Carlo and molecular dynamics methods.

INSTRUCTOR: **Chethan Krishnan**

SUGGESTED BOOKS:

1. Pathria, R. K. 1996. Statistical Mechanics, Butterworth Heinemann, Second edition.
2. Reif, F. 1965. Fundamentals of Statistical and Thermal Physics, McGraw Hill.
3. Landau, L. D. and Lifshitz, E. M. 1980. Statistical Physics, Pergamon.

PH 204: QUANTUM MECHANICS II (3:0)
(CORE COURSE FOR PHYSICS MAJOR)

Time-dependent perturbation theory. Fermi golden rule. Transitions caused by a periodic external field. Dipole transitions and selection rules. Decay of an unstable state. Born cross-section for weak potential scattering. Adiabatic and sudden approximations. WKB method for bound states and tunneling. Scattering theory: partial wave analysis, low energy scattering, scattering length, Born approximation, optical theorem, Levinson's theorem, resonances, elements of formal scattering theory. Minimal coupling between radiation and matter, diamagnetism and paramagnetism of atoms, Landau levels and Aharonov-Bohm effect. Addition of angular momenta, Clebsch-Gordon series, Wigner Eckart theorem, Lande's g factor. Many particle systems: identity of particles, Pauli principle, exchange interaction, bosons and fermions. Second quantization, multielectron atoms, Hund's rules. Binding of diatomic molecules. Introduction to Klein-Gordon and Dirac equations, and their non-relativistic reduction, g factor of the electron.

INSTRUCTOR: **Tanmoy Das**

SUGGESTED BOOKS:

1. Landau, L. D. and Lifshitz, E. M. 1974. Quantum Mechanics, Pergamon, NY.
2. Cohen-Tannoudji, C., Diu, B. and Laloe, F. 1977. Quantum Mechanics (2 Vols.), John Wiley.

UP 400 0:16

This is a 16 credit project course of six months duration and is compulsory for the completion of the BSc Research course. The student can choose any faculty

of his or her choice from any of the three departments: Physics, Centre for High Energy Physics (CHEP), Instrumentation and Applied Physics (IAP) with mutual consent and take up an advanced topic of research either in the experimental or theoretical stream. At the end of the term, the student will submit a hard copy of the report with proper binding. The viva-voce examination will be conducted with two examiners and evaluated accordingly.

CO-ORDINATOR**: K. P. Ramesh**

UP 500 0:20

This is a 20 credit project course of six months duration and is compulsory for the completion of the MSc course. The student can choose any faculty of his or her choice from any of the three departments: Physics, Centre for High Energy Physics (CHEP), Instrumentation and Applied Physics (IAP) with mutual consent and take up an advanced topic of research either in experimental or theoretical stream. At the end of the term, the student will submit a hard copy of the report with proper binding. The viva-voce examination will be conducted with two examiners and evaluated accordingly.

CO-ORDINATOR: **K. P. Ramesh**

OPTIONAL COURSES FOR PHYSICS MAJOR

COURSE NUMBER	GP	TITLE	FACULTY
PH 206	3:0	Electromagnetic Theory	Animesh Kuleyi
PH 207	1:2	Analog Digital and Microprocessor Electronics -1	K. Rajan
PH 208	3:0	Condensed Matter Physics -1	Aveek Bid/ Srimanta Middey
PH 212	0:3	Experiments in Condensed Matter Physics	Anindya Das/ DVS Muthu
PH 213	0:4	Advanced Experiments in Condensed Matter Physics	R. Ganesan/ P.S. Anil Kumar
PH 217	3:0	Fundamentals of Astrophysics	Biman Nath/ TarunDeep Saini
PH 320	3:0	Condensed Matter Physics II	Sumilan Banerjee
PH 322	3:0	Molecular Simulation	Prabal K. Maiti
PH 325	3:0	Advanced Statistical Physics	Rahul Pandit
PH 330	0:3	Advanced Independent Project	Faculty
PH 231	0:1	Workshop practice	Vasant Natarajan
PH 340	4:0	Quantum Statistical Field Theory	Subrato Mukerjee

COURSE NUMBER	GP	TITLE	FACULTY
PH 350	3:0	Physics of Soft Condensed Matter	
PH 351	3:0	Crystal Growth, Thin Films and Characterization	Suja Elizabeth and Anil Kumar
PH 352	3:0	Semiconductor Physics and Technology	Ramesh Mallik
PH 354	3:0	Computational Physics	Manish Jain
PH 359	3:0	Physics at the Nanoscale	Arindam Ghosh and Ambarish Ghosh
PH 362	3:0	Radiative Process in Astrophysics	K.N. Nagendra (IIA) and M. Sampoorna (IIA)
PH 364	3:0	Topological Phases of Matter (Theory and experiment)	Aveek B/ Tanmoy Das
PH 365	3:0	Galaxies and Interstellar Medium	Nirupam Roy
PH 371	3:0	General Relativity and Cosmology	Banibrata M
HE215	3:0	Nuclear and Particle Physics	Jyothsna Komaragiri
HE 316	3:0	Advanced Mathematical Methods in Physics	Sachin Vaidya
HE 322	3:0	QCD and Collider Physics	Biplob Bhattacharjee
HE 386	3:0	Experimental high energy physics	Somnath Choudhury
HE 391	3:0	Quantum Mechanics III	Apoorva Patel
HE 392	3:0	Standard Model Particle Physics	Aninda Sinha
HE 395	3:0	Quantum Field Theory 1	Prasad Hegde
HE 396	3:0	Quantum Field Theory 2	Sudhir Vempati
HE 398	3:0	General Relativity	Justin David
AA 363	3:0	Fluid Mechanics and Plasma Physics	

OPTIONAL COURSES FOR PHYSICS MAJOR

COURSE NUMBER	GP	TITLE	FACULTY
IN 232	3:0	Concepts in solid state physics	Chandni U
IN 210	3:0	Wave propagation in periodic media	Abha Misra
IN 229	3:0	Advanced Instrumentation Electronics	Atanu Kumar Mohanty
IN 302	3:0	Classical and Quantum Optics	Partha Pratim Mondal
IN 201	3:0	Analytical Instrumentation	Asokan S, Siva Umapathy
IN 244	2:1	Optical Metrology	Sai Siva Gorthi
IN 270	3:0	Digital Signal Processing	Mondal T K
IN 234	3:0	High Vacuum Technology and Applications	Mohan Rao G
IN 267	3:0	Fluorescence Microscopy and Imaging	Partha Pratim Mondal
IN 229	3:0	Advanced Instrumentation Electronics	Atanu Kumar Mohanty
IN 228	3:0	Automatic System Control Engineering	Mondal T K
IN 268	2:1	Microfluidic Devices and Applications	Sai Siva Gorthi
IN 227	3:0	Control Systems Design	Jayanth G R
IN 223	3:0	Plasma Processes	Mohan Rao G
IN 271	3:0	Cryogenic Instrumentation and Applications	Upendra Behera
IN 214	3:0	Semiconductor Devices and Circuits	Sanjiv Sambandan
IN 212	3:0	Advanced Nano/Micro Systems	Abha Misra
IN 222	3:0	Microcontrollers and Applications	Ramgopal S
IN 224	3:0	Nanoscience and Device fabrication	Asha Bhardwaj

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