Preface

We are delighted to welcome you to the 2015-16 academic session of the four-year Bachelor of Science (Research) programme of the Indian Institute of Science (IISc). The "Student Information Handbook & Scheme of Instruction" presents all relevant information about the structure of the Bachelor of Science (Research) programme and the courses offered in the programme. It also provides detailed information about the facilities available to you and the rules and regulations related to the life of an undergraduate student in the IISc campus. Please read the Handbook carefully and feel free to contact me or your Faculty Advisor if you have any question that is not answered in it.

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

Cordially,

Umesh Varshney,
Dean, Undergraduate Programme

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II Term : 1 January - 30 April 2016
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I Term : 02 December - 11 December 2015
II Term : 20 April - 29 April 2016
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EXPANSIONS FOR THE ABBREVIATIONS USED

TGPA : Term Grade Point Average
CGPA : Cumulative Grade Point Average
SUGCC : Senate Undergraduate Curriculum Committee
UGCC : Undergraduate Curriculum Committee

1. Bachelor of Science (Research) Programme

1.1 Basic Structure

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

- Biology
- Chemistry
- 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 programme 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 major one will qualify for a minor in that discipline. The major/minor disciplines taken by the student will be mentioned in her/his degree certificate.

1.2 Faculty Advisor

Each student will be assigned a Faculty Advisor at the beginning of the first 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. A new Faculty Advisor in the area chosen by a student as major will be identified at the beginning of the fourth semester.

1.3 Registration for Courses and Course Load

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

1.3.2 All students must complete a total of 131 credits (basic courses on 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. 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 dropping occurs on or before 15th October in Term I, 2nd

March in Term II and 1st June in the Summer Term, the course will not be listed in the final transcript. Students with CGPA less than 6.0 are not allowed to take more than 19 credits in the subsequent semester. Dropping is also permitted on or before 14th November in Term I, 1st April in Term II and 16th June in the Summer Term; 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 as having 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.

1.5.3 The distribution of the 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 6 grades, designated S, A, B, C, D, F, with the corresponding grade points as 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.

Grade	Grade Points
S	8
A	7
B	6
C	5
D	4
F	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 programme. 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 6 grade points, from the table above), then the contribution of the course to the total grade points is equal to 3 x 6, or 18. 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.

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 3.5, and in subsequent terms the CGPA should not go below 4.0. 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. 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.

1.9 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 C. If a student secures an F grade in the project, she/he fails the programme and must leave the Institute. A student who secures a D grade will be given an opportunity to re-do the project and improve the grade. The period of this extension of project work has to be approved by the SUGCC on the recommendation of the UGCC and the project supervisor.

1.10 Degree Requirements

1.10.1 Normally, students have to complete the Bachelor of Science (Research) programme 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.

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

1.10.3 A student must complete the specified course requirements of 131 credits of the relevant degree programme with a minimum CGPA of 4.0 in the course work and at least a C grade in the project work.

1.11 Classification of Awards

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

CGPA	Award
7 and above	First Class with Distinction
5.0 and above	First Class
4.0 to 4.9	Second Class

(See also Section 1.8.6)

1.12 Attendance

1.12.1 Attendance in all classes (lectures, tutorials, laboratories, etc) must be at least 80 percent of the total number of classes. The attendance records of all students in each course will be reviewed after every four weeks. Students who are not attending the minimum fraction of classes in a course will be warned by the instructor of the course. Guardians of these students will be informed and a list of their names will be posted on the UG notice board. Students with less than 80 percent 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 percent. A shortage of attendance may be condoned by the Dean in exceptional circumstances.

1.13 Break in Studies

1.13.1 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.

1.13.2 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.

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

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

1.14 Privileges and Responsibilities

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

1.14.2 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

1.15 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.

2. Discipline, Attendance and Leave Rules

2.1 Discipline

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

2.1.2 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.

2.1.3 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://biochem.iisc.ernet. in/~bchss/policy.htm

2.2 Leave

2.3.1 A student is governed by the following leave rules.

2.3.1.1 To obtain leave, prior application shall 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 leave will be granted by the Dean.

2.3.1.2 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.

2.3.1.3 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.

2.3.1.4 The leave of absence as per 2.3.1.1 and 2.3.1.2 will not be condoned for attendance.

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

2.3.2 Leave of absence on medical grounds: Up to 30 days a year for extended sickness normally requiring hospitalization.

2.3.2.1 Women students can avail of maternity leave for 135 days once during the tenure of studentship.

2.3.2.2 Medical leave for periods of less than 7 days is not permitted.

2.3.2.3 For leave under 2.3.1.2 and 2.3.1.3 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.

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

2.3.3 No carry-over of leave is permitted. Any unused leave will automatically lapse at the end of the year.

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

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

3. Code of Ethics and Conduct

3.1 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.

3.2 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:

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

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

3.3 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.

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

4. Academic Integrity

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

4.2 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 4.7 explain how to carry out proper referencing, as well as examples of plagiarism and how to avoid it.

4.3 Cheating is another form of unacceptable academic behaviour 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.

4.4 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 13 citations. Material taken from your own published work should also be cited; as mentioned above, it will be considered self-plagiarism otherwise.

4.5 *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.

4.6 Individual and Collective Responsibility: The responsibility varies with the role one plays.

4.6.1 *Student roles:* 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.

4.6.2 *Faculty roles:* 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.

4.6.3 *Institutional roles:* 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. In the case of a student 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.

4.7 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

5. 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:

5.1 Fees per annum:

5.1.1 Bachelor of Science (Research) Students (General/OBC)

Fee Details	Rs
Tuition Fee	10,000
Gymkhana Fee	720
Students' Emergency Fund	200
Other Academic Fees	2,380
Total	**13,300**

5.2 Fee Payment Schedule for the Session 2015-'16

Bachelor of Science (Research) Students (General/OBC)

Installment	Tuition Fees (in Rs.)	Other Fees (in Rs.)	Total (in Rs.)
I	4,000	3,300	7,300
II	3,000	-	3,000
III	3,000	-	3,000

Due Dates

Period	Due Date
I Installment (1 August – 31 October)	15/08/15
II Installment (1 November-31 December)	14/11/15
III Installment (1 January-31 July)	16/01/16

Bachelor of Science (Research) Students (SC/ST)

Fee Details	Rs
Tuition Fee	Fully waived
Gymkhana Fee	720
Students' Emergency Fund	200
Other Academic Fees	2,380
Total	**3,300**

Due Date: August 15, 2015

5.2.1 Penalties

5.2.1.1. 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.

5.2.1.2. 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.

5.3. Deposits (Refundable)

Statutory Deposit : Rs. 2,000/-
Library Deposit : Rs. 2,000/¬-

5.3.1 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
(f) Loss of Books and
(g) Other dues.

5.3.2. 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 Programme before leaving the Institute, to obtain a refund of the deposits.

5.4. Concessions

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

6. Students' Assistance

6.1 Students' Aid Fund

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

6.1.2. 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.

6.1.3. 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.

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

6.1.5. 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.

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

6.2 Financial Assistance for Medical Care

6.2.1 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. J R D Tata Memorial Library

The Library was established in 1911, and was renamed "J R D 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 annexe building located opposite to the NCSI 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.ernet.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 Inter-science, 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:

7.1. What may be loaned:

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

7.2. What may not be loaned:

(a) Annual Reports (b) Handbooks
(c) Dictionaries (d) Encyclopedias

7.3. Loan Period

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

8. 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.

9. Hostels 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
	Rs.	Rs.
Room Rent (Single)	267.00	135.00
Room Rent (Double)	133.50	67.50
Establishment	133.00	66.00
Amenities	133.00	66.00
Elec. & Water	133.00	66.00
Total	**799.50**	**400.50**

Refundable deposits for all categories of students : Rs. 6500/-

10. Student's Council

Office Bearers

Chairman: Amiya Banerjee, CeNSE

General Secretary: Wasimakram Binnal, MS

Secretary - Women's Affairs: Pratibha Yadav, CES

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 - Counselling Center, Women's Cell and the Health Center

URL: http://www.iisc.ernet.in/scouncil
Email: scouncil@tejas.serc.iisc.ernet.in

11. Recreational Facilities

11.1 Gymkhana

11.1.1 The Gymkhana is the centre 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 come 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 parlour, which serves coffee, snacks and soft drinks to the members, is also situated in the Gymkhana premises.

11.2 General Facilities

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

Scheme of Instruction
2015 - 16

BIOLOGY

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; diversity of life on earth; history and evolution of life on earth; mechanisms of evolution; genetic basis of natural selection; measuring the rate of natural selection; organisms and their environment; adaptation; behaviour and ecology; biological species diversity; environmental degradation, conservation and management; the future of life on earth.

Concepts of pH/pKa, structures of water, amino acids, peptides and proteins; chemistry of DNA, RNA, proteins, lipids and carbohydrates; elementary enzymology and molecular biology; introduction to various model organisms; cell as a unit of living organisms, cellular organelles; structure and function, organization of cytoskeleton and nuclei, ER-Golgi modifications, Vesicle-mediated protein transport, endocytosis and exocytosis, mitochondria and respiration.

UB 101L

Methods of describing, observing, counting and estimating the abundance, diversity and behaviour of living organisms; light microscopy, sample preparation and examination, identification of microorganisms, staining techniques, fluorescence microscopy to examine intracellular compartments; cell fractionation and centrifugation methods, isolation of intracellular compartments by differential centrifugation techniques, nuclei, mitochondria, RER etc. Basics of cell culture methods; cell counting, culture media preparation; titration of amino acids, estimations of reducing non-reducing sugars, proteins, DNA, RNA, lipids, paper chromatography/TLC, SDS-PAGE, isoelectric focusing, DNA melting curves.

Instructors: Raghavendra Gadagkar and Dipankar Chatterji

Suggested Books:

1. Carson, R. 1967 Silent Spring, Fawcett World Library, New York.
2. Dawkins, R. 1986 The Blind Watchmaker, Longman Scientific & Technical, England.
3. Gadagkar, R. 1997, 1998 Survival Strategies – Cooperation and Conflict in Animal Societies, Harvard University Press and Universities Press, Cambridge, Massachusetts, USA and Hyderabad, India.
4. Sadava, D., Hillis, D. M., Craig Heller, H. and Berenbaum, M. 2009 Life, The Science of Biology, 9th edition, W. H. Freeman.
5. Wilson, E. O. 2002 The Future of Life, Alfred A. Knopf.
6. Wilson, E. O. Life on Earth, Freely available at: http://eowilsonfoundation.org/e-o-wilson-s-life-on-earth.
7. Lodish, H., Berk, A., Kreiger, C. A., Scott, M. P., Bretscher, A., Ploegh, H. and Matsudaira, P. 2008 Molecular Cell Biology, W. H. Freeman, 6th edition.
8. Krebs, J. E., Goldstein E. S., and Kilpatrick, S. T. 2011 Lewin's Genes X, 10th edition, Jones and Bartlett Publishers.
9. Nelson, D. L. and Cox, M. M. 2009 Lehninger Principles of Biochemistry, 5th edition, W. H. Freeman.
10. Berg, J. M., Tymoczko, J. L. and Styrer, L. 2006 Biochemistry, 6th edition, W. H. Freeman & Co.
11. Voet, D. and Voet, J. G. 2010 Biochemistry, 4th edition, Wiley.

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

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, emotions and disorders of the nervous system.

Instructor: **Shyamala Mani**

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** and **Shyamala Mani**

Suggested Books:

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

Semester 4 (January)

UB 202: General Biochemistry (2:0)
(Core Course for BIO Major and Minor)

Protein sequencing methods, introduction to proteomics, MALDI and ESI-MS, protein purification and characterization strategies, methods of DNA sequencing, protein co-operativity (using myoglobin and hemoglobin as examples), 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 **D. N. Rao**

Suggested Books:

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

UB 204: 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. 2011 Guyton and Hall Textbook of Medical Physiology, 12th edition, Elsevier.
2. Jameson, J. L. and De Groot, L. J. 2010 Endocrinology, 6th edition, Elsevier.
3. Taiz, L. and Zeiger, E. 2010 Plant Physiology, 5th edition, Sinauer Associates.

UB 205L: Experiments in Biochemistry and Physiology (0:2)
(Core Course for BIO Major)

Expression of recombinant proteins, purification and characterization; isolation and characterization of proteins, quantitation of proteins using biochemical assays and physico-chemical characterization of proteins; purification of Immunoglobulin G from rabbit antiserum; characterization of antibodies by immune-asays; solid phase, liquid phase and Western blotting; enzyme assays and determining specific activity of enzymes.

Instructors: **Anjali Karande** and **Deepak Saini**

UB 206: Basic Molecular Biology (2:0)

Genes as carriers of heredity, gene-enzyme relation, spontaneous versus adaptive mutations: origins of bacterial genetics, the transforming principle and the chemical identity of the gene, DNA and heredity, biochemistry of DNA, Chargaff's rule, early models of DNA structure, the double helix and the origins 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 the 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.

Instructor: **S. Mahadevan**

Suggested Books:

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

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 in 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 behaviour through field observations, manipulative experiments and computer simulations. Topics will include diversity and distributions of organisms, competition and predation, species interactions, sexual selection and mate choice, habituation and adaptation, learning and memory, as well as natural selection and evolutionary history. There will also be a three-day trip to a national park, where students will design and conduct their own independent field-based research project.

Instructors: **Dipshikha Chakravortty** and **Maria Thaker**

UB 305 and UB 305L (2:1)

UB 305 Genetics

Evolution of Genetics: Mendelian genes to synthetic genomes; an overview of model systems; Mendelism; extensions of Mendelism; evolution of the concept of gene; an overview of Genetic Chemistry; Cytogenetics of chromosomal mutations; variations in number and rearrangement; gene mutations; basic features and phenotypic effects; genetic recombination and repair; mobile genetic elements in Prokaryotes and Eukaryotes; genome imprinting & epigenetics; molecular basis of sex determination and dosage compensation in Caenorhabditis, Drosophila and man; population genetics and speciation.

UB 305L

(1) Genetics of Mutants: (a) Drosophila (b) Zebra fish (c) Arabidopsis (2) Chromatographic analysis of eye pigments in the mutants of Drosophila (3) Mitotic (human), meiotic (mouse/grasshopper) and polytene chromosomes (Drosophila) (4) Collection of Drosophila species from wild/nature to study sympatric diversity of species and pattern of genetic variability (5) Experiments to demonstrate different patterns of inheritance: Genetic crosses and analysis of P1, P2, F1, F2 & test cross progeny (6) Generation of new mutations in Drosophila – this will go till the end of course – students need to characterize a mutation based on what they learn in theory and practical classes (7) Experiments on natural selection and genetic drift (8) Quantitative characters: Acrostichals and Sternopleurals bristles in Drosophila: Mean, Standard deviation, t-test (9) Experiments with Genome - Nucleic acids: Isolation of genomic DNA, restriction digestion profiles, PCR.

Instructor: **H. A. Ranganath**

Suggested Books:

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

Semester 6 (January)

UB 302 (formerly UB 204): 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 organism from a single

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

UB 303L: Experiments in Molecular Biophysics (0:1)

(Core Course for BIO Major)

UV spectroscopy of proteins (quantitation and determination of extinction coefficient). Fluorescence spectroscopy of proteins. UV spectroscopy of DNA (determination of melting temperature and influence of buffer composition). CD spectroscopy of proteins and calculation of helical contents. CD spectroscopy of DNA and monitoring conversion of B-form DNA [poly(dG-dC)] to Z-form DNA in high salt. Mass spectroscopy of proteins (determination of mass and MS-MS analysis). Study of protein oligomerization by dynamic light scattering. Estimation of free sulfhydryl groups in proteins by DTNB titration and its validation by mass spectroscopy and iodoacetamide labeling.

Instructors: **Jayanta Chatterjee**

UB 304L: Experiments in Neurobiology (0:1)

The vertebrate nervous system and its organization; theory and demonstration of stereotactic surgery in rodents; demonstration of tissue sectioning techniques; preparation of primary neuronal cultures and imaging neurons; theory and demonstration of neuronal activity; introduction to behavioural measurements and statistical analysis.

Prerequisite: NS 201 (AUG) (3:0)

Instructors: **Vijayalakshmi Ravindranath** and **Shymala Mani**

Semester 8 (January)

UB 401: Research Project (0:16)

An independent research project will be performed by all UG-Biology major students under the supervision of faculty. It is recommended that students initiate laboratory 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. 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 (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.

CHEMISTRY

Semester 1 (August)

UC 101: Physical Principles of Chemistry (2:1)

Bohr theory, Wave Particle Duality, Uncertainty principle, Schrödinger equation, H-atom and atomic orbitals, electron spin, Pauli principle and many electron atoms. Chemical bonding: covalent and ionic bonding, valence bond theory, hybridization and resonance; molecular orbital theory. Homonuclear and heteronuclear diatomics, potential energy curves and intermolecular interactions; elements of spectroscopy, van der Waals equation of state; theory of chemical reactions.

Instructors: K. L. Sebastian, Atanu Bhattacharya and Moumita Koley

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 & noble gases.

Instructors: P. S. Mukherjee and Moumita Koley

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: Mrinmoy De, T. K. Chakraborty, K. R. Prabhu and Anuradha Mukherjee

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.

Prerequisite: None

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.

Instructor: Anshu Pandey

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 Anuradha Mukherjee

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; bioinorganic chemistry: metals in biological systems, heme and non-heme proteins, metalloenzymes; Chemistry of f-block elements.

Instructor: A. R. Chakravarty

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 (AUG)

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

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 **P. Thilagar**

Suggested Books:

1. Shriver, and Atkins,' Inorganic Chemistry by: Atkins, Overton, Rourke, Weller and Armstrong, Fifth Edition. South Asia Edition (paper back), 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/S. Chandrasekhar**

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.

Current Literature

Prerequisites: Successful completion of UC201 and 205 for UG

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. Physico-chemical characterization of these compounds by analytical and spectroscopic techniques.

Instructors: **K. R. Prabhu**, **P. Thilagar**, **S. Natarajan** and **A. Srinivasan**

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.

Instructor: **Govardhan Reddy**

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.

Instructor: **Bikramjit Basu**

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: N. Jayaraman and T. K. Chakraborty

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, C. Shivakumara and A. Srinivasan

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: A. G. Samuelson

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 401: 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: A. G. Samuelson

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).

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.

ENGINEERING

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.

Instructor: V. Susheela Devi

Suggested Books:

1. Kerninghan, B. W. and Ritchie, D. M. 2009 The C Programming Language, Prentice Hall of India, New Delhi.
2. Dromey, R. G. 2006 How to Solve it by Computer, Pearson Education India.

3. Kruse, R. L. 2006 Data Structures and Program Design in C, Prentice Hall of India, New Delhi.
4. Skiena, S. S. 2008 The Algorithm Design Manual, Springer, Second Edition.

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 Opamp concept, Characterisitics of an ideal opamp a simple realisation of opamp using transistors, Various OPAMP based circuits for basic operations like summing, amplification, integration and differentiation, Introduction to feedback concept LAB: Design of 3 transistor opamp and its characterisation. Simple OPAMP 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. Horowitz, and Hill, Art of Electronics, Second Edition.

Semester 3 (August)

UE 200: Introduction to Earth and its Environment (2:0)

Evolution of earth as habitable planet, Evolution of life through geological times, Exploring the earth and its environment, Origin of gravitational and magnetic fields, Plate tectonics, how it works and shapes the earth, Internal geosystems; earthquakes and volcanoes, Climate changes through time, Basic geological process and their relation to natural resources, Natural hazards and human environment.

Groundwater occurrence and recharge process, Groundwater movement and hydrology, Groundwater as resource, Quality and contamination, Modeling and managing groundwater systems.

Natural resources and projection to future,Solid waste management, Environmental threats, Sustainable development, Biodiversity and its significance.
Field visit to environmentally sensitive area.

Instructors: Kusala Rajendran and M. Sekhar

Suggested Books:

1. Grotzinger, J. and Jordan, T. H. 2010 Understanding Earth, Sixth Edition, W. H. Freeman.
2. Younger, P. L. 2007 Groundwater in the Environment: An Introduction, Blackwell Publishing.
3. Mihelcic, J. R. and Zimmerman, J. B. 2010 Environmental Engineering: Fundamentals, Sustainability & Design, Wiley.
4. Bharucha, E. 2004 Text book for Environmental Studies, UGC, New Delhi.

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. 2007 Materials Science and Engineering, Wiley, India.

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 4/6) (January)

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: S. Raha

Suggested Books:

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

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. Castiglianos theorems and applications.

Instructors: C. S. Jog, Ananth Ramaswamy and C. S. Manohar

Suggested Books:

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

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	Thermodyamics	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 Cli Sci	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	GeoPhys Flu. Dyn.	3:0	Jan	Diff. equations	No limit

Department of Chemical Engineering

Course Number	Course Title	Credits	Semester	Prerequisites	Comments
CH 201	Chemical Engg 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
PD216	Design of Automotive Systems				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 251	Data Structures & Algorithms	3:1	Aug	A or S in UG 101 Algorithms & Programming A or S in all Mathematics Course in the UG Programme	Only fifth term or later; Max number:10
E0 222	Automata Theory & Computability	3:1	Aug	A or S in UG 101 Algorithms & Programming A or S in all Mathematics Course in the UG Programme	Only fifth term or later; Max number:10
EI 254	Game Theory	3:1	Jan	A or S in UG 101 Algorithms & Programming A or S in all Mathematics Course in the UG Programme	Only sixth term or later; Max number:10

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

SERC

Course Number	Course Title	Credits	Semester	Prerequisites	Comments
SE 301	Bioinformatics	2:0	Aug		Check with instructor

Additional courses from this division that are allowed but require explicit consent of the instructor

Course Number	Course Title	Credits
E0 224	Computational Complexity Theory	3:1
E0 229	Foundations of Data Science	
E0 235	Cryptography	3:1
E1 213	Pattern Recognition and Neural Networks	3:1
E1 216	Computer Vision	3:1
E1 254	Game Theory	3:1
E2 201	Information Theory	3:0
E3 214	Microsensor Technologies	3:0
E3 222	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

INTERDISCIPLINARY PROGRAMS

BioEngineering

Course Number	Course Title	Credits	Semester	Prerequisites	Comments
BE 201	Fundamentals of Biomaterials and 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

EARTH & ENVIRONMENTAL 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 phenmena, 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 in other planet, basics of hydrosphere and its component, physical property of water, elementary oceanography, chemical composition of ocean, evolution of life and its diversification.

Instructor: Prosenjit Ghosh

Suggested Books:

1. Patwardhan, P. H. I. The Dynamic Earth System, 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.

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. Determination of dissolved and suspended solids in water samples, determination of turbidity of water samples.
Determination of chlorine in bleaching powder, Determine 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.

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: G. Bala and Arindam Chakraborty

Suggested Books:

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

Semester 5 (August)

UES 301: Environmental Hydrology
(3:0, Core Course for Earth & Env. Sci. Major)

Basic concepts, definition and scope of environmental hydrology, hydrological cycle and energy budget, Hydro-meteorological processes, watershed hydrology; hydrology of forests, wetlands and urban areas, climate change, hydrological impacts of environmental change; hydrogeology, water quality issues in surface and groundwater.

Instructor: V. V. Srinivas

Suggested Books:

1. Ward, A. D. and Trimble, S. W. 2004 Environmental Hydrology, Lewis Publishers.
2. Singh, V. P. (Ed.), 1995 Environmental Hydrology, Water Science and Technology Library, Vol. 15.
3. Chow,V. T., Maidment, D. R. and Mays, L. W. 2010 Applied Hydrology, Tata McGraw-Hill Edition.

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.

Instructor: Jayant M. Modak

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 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 Pres.
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, Elective)

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)

UES 306: Surface and Groundwater Quality
(3:0, Core Course for Earth & Env. Sci. Major)

Hydrologic cycle, Water and chemical budgets; sources and types of water pollution, Water quality standards, fate and transport in aquatic systems, rivers and streams, lakes & reservoirs, wetlands, estuaries; groundwater flow and geologic controls on flow, Vadose zone hydrology, contaminant transport in groundwater, modeling environment.

Instructor: M. Sekhar

Suggested Books:

1. Chin, D. A. 2006 Water Quality Engineering in Natural Systems, Willey InterScience.
2. Bedient, P. B., Rifai, H. S. and Newell, C. J. 1994 Ground Water Contamination: Transport and Remediation. Prentice Hall, Englewood Cliffs, NJ, USA.

UES 307: Introduction to Solid Earth
(3:0, Elective)

History of the Earth: Introduction to Earth history, origin of the Earth and solar system; origin and evolution of life, mass extinctions, interpretation of the geological record of Earth history; measurement of geological time, historical development of concepts.

The Dynamic Earth: Introduction to the dynamic Earth, Gravity and Magnetic fields, thermal structure and heat flow, Radioactivity, internal structure of the earth. Continental drift and plate tectonics, earthquakes, volcanoes, mountain-building processes; igneous and metamorphic processes; surface processes, erosion, soil, and sediment formation, important morphological features on the earth, interactions among the lithospheric, hydrospheric, atmospheric, and biospheric systems.

Instructor: Kusala Rajendran

Suggested Books:

1. Fowler, C. M. R. 2005 The Solid Earth: An introduction to Global Geophysics, Cambridge University Press.
2. Keary, P. and Vine, F. 1996 Global Tectonics, Blackwell Science.
3. Siever, R., Grotzinger, J., Jordan, T. and Freeman W. H. U2003 Understanding Earth, Frank Press, 4th edition.

UES 308: Landfill Engineering
(3:0, Elective)

Physico-chemical and engineering properties of soil, Ground water flow and contaminant transport, Criteria for landfill site location, Design of landfill components such as liners, covers, leachate collection and removal, Gas generation and management, Principles and methods of monitoring ground water quality and quantity, End uses of landfill sites, Risk assessment approaches, Contaminated site characterization and remediation technologies, Environmental laws and regulations.

Instructor: G. L. Siva Kumar Babu

Suggested Books:

1. Rowe, R. K., Quigley, R. M., Brachman, R. W. I. and Booker, J. R. Barrier 2004 Systems for Waste Disposal Facilities, 2nd edition, Spon Press, Taylor & Francis Group, London.
2. 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.
3. Tchobanoglous, G., Theisen, H. and Vigil, S. 1993 Integrated Solid Waste Management - Engineering Principles and Management Issues, McGraw Hill.

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, Ground water 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.

Instructors: K. S. Nanjunda Rao and V. V. Srinivas

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.

UES 402 Green Chemistry

(2:0, Elective)

Introduction and principles of green chemistry, Tools of green chemistry-alternative starting material, alternative target/product, Process analytical chemistry, Evaluation of methods to design safer chemicals, Reaction types, yield and atom economy, Examples of green chemistry, Solid acids and bases as catalysts, Organocatalysis, Catalysis and Green chemistry, Catalysis in novel reaction media, Enatoselective catalysis, Future trends in green chemistry.

Instructor: K. R. Prabhu

Suggested Books:

1. Anastas, P. T. and Warner, J. C. 2000 Green Chemistry: Theory and Practice, Oxford University Press.
2. McDonough, W. and Braungart, M. 2002Cradle to Cradle: Remaking the Way We Make Things, New York: North Point Press.

3. Sheldon, R. A., Arends, I. and Hansfeld, U. 2007 Green Chemistry and Catalysis, Wiley-VCJ Verlag GmbH & Co. KGaA. Weinreim, Germany.

Semester 8 (January)

UES 403 Solid Waste Management

(3:0, Elective)

Classification and characterization of solid wastes, The RCR (recover, recycle and reuse) principle, Handling and treatment of MSW (municipal solid waste), Biological treatment, Thermal treatment, Landfill, Integrated waste management, Sludge generation from treatment of industrial waste waters, Physico-chemical characterization of sludge, Sludge handling, treatment and disposal options, Siting, operation and maintenance of Toxic Substances Disposal Facilities (TSDFs), Surface and ground water control, Closure and post closure care of land-fills, Treatment of hazardous wastes: Air stripping, Soil vapour extraction, Carbon absorption, Steam stripping, Stabilization and solidification, Thermal methods – combustion, liquid injection incinerators, Biological methods – conventional treatment, In-situ bio-remediation.
Toxicology and risk assessment: Toxic effects, dose-response relationships, carcinogens, ecotoxicology, risk, exposure and toxicity assessment, risk characterization, ecological risk assessment.
Environmental, legal and public health aspects of solid waste management.

Instructor: J. R. Mudakavi

Suggested Books:

1. McDougall, F., White, P., Franke, M. and Hindle, P. 2001 Integrated Solid Waste Management- Life Cycle inventory, Blackwell Publishing.
2. Wentz, C. A. 1989 Hazardous Waste Management, McGraw-Hill International Editions, Singapore.
3. Kiely, G. 1998 Environmental Engineering, Mc-Graw Hill International Edition.
4. Dawson, G. W. and Mercer, B. W. 1981 Hazardous Waste Management –John Wiley.
5. Lagrega, M. D., Buckingham, P. L. and Evans, J. C. 1994 Hazardous Waste Management, McGraw Hill International Edition.

HUMANITIES

The Humanities course at Indian Institute of Science-Undergraduate Programme 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 programme. 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.

August- December 2015

Semester I: Ways of Knowing

Course Code: UH 101

Instructors: Bitasta Das, Nithin Manayath, Lakshmi Arya and P. P. Sneha

Module 1: Cultural analysis

What do we understand by the word "culture"? When does something become "cultural"? What does "culture" entail in everyday conversations and practices? Through visual and material

artifacts, this module will unpack ways in which we understand culture in our everyday life. By doing so, we see how a society's culture and its politics are closely related. We familiarize ourselves with key concepts related to the analysis of culture and how the discipline of Cultural Studies approaches culture as an object of study.

Texts and Readings for classroom discussion:

Raymond Williams, "Culture" and "Native," in Keywords: A Vocabulary of Culture and Society.

Raymond Williams, "The Analysis of Culture" in John Storey ed. Cultural Theory and Popular Culture: A Reader.

Raymond Williams, "Masses" and "Popular", in Keywords: A Vocabulary of Culture and Society.

Horkheimer and Adorno, "The Culture Industry: Enlightenment as Mass Deception".
John Fiske, "Understanding Popular Culture", in Reading the Popular.

Stuart Hall, "Cultural Studies and its Theoretical Legacies", in Lawrence Grossberg, Cary Nelson, Paula Treichler (eds.) Cultural Studies.

Module 2: 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 the human sciences. Typically, ethnography collects empirical data about human societies, using fieldwork, participant observation, questionnaires, interviews, chain sampling, etc. 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 up scientific findings. The module will expose students to some key debates in this area through short readings and documentary films.

Texts and Readings for classroom discussion:

Clifford Geertz, "Thick Description" and "Notes on the Balinese Cockfight,"in The Interpretation of Cultures.

James Clifford, "On Ethnographic Authority."

Kirin Narayan, "How Native is a 'Native Anthropologist'?.

Laura Nader, "Ethnography as Theory."

Module 3: Historical analysis

What is the past? Where may we draw a line differentiating 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/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 goes beyond this fact/myth dyad? The course will end with this question.

Texts and Readings for classroom discussion:

Constantin Fasolt. 2004. 'A Dangerous Form of Knowledge', in The Limits of History. Chicago and London: The University of Chicago Press. 3-29.

Pierre Nora. 1989. 'Between Memory and History: Les Lieux de Memoire', in Representations, No. 26, Spring, 1989.

Ashis Nandy. 2002. 'History's Forgotten Doubles' in The Romance of the State and the Fate of Dissent in the Tropics. New Delhi: Oxford University Press. 82-109.

Dipesh Chakrabarty. 1992. 'Postcoloniality and the Artifice of History: Who Speaks for "Indian" Pasts?', Representations, No. 37, 1-26. Winter, 1992

Partha Chatterjee and Anjan Ghosh. (eds.), History and the Present, Delhi: Permanent Black, 2002.

A.K. Ramanujan. 1999. "Three Hundred Ramayanas: Five Examples and Three Thoughts on Translation" in Vinay Dharwadker (ed.) The Collected Essays of A.K. Ramanujan. Delhi: Oxford University Press. 131 – 160.

S.N. Balagangadhara. 2014. What do Indians Need? A History or the Past? 7th Maulana Abdul Kalam Lectures at the Indian Council of Historical Research, New Delhi.

Module 4: Textual analysis:

This module introduces students to key concepts and issues in textual analysis, a method 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? Students will be introduced in this module to methods of close reading drawn from literary criticism and cultural studies.

Texts and Readings for classroom discussion:

Excerpt from: James Jeans, "The Mysterious Universe"in G.H Hardy ed., The Oxford Book of Modern Science Writing.

Excerpt from: C.P Snow, Foreword to "A Mathematician's Apology" in G.H Hardy, The Oxford Book of Modern Science Writing.

Jonathan Culler, "Language, Meaning and Interpretation" Literary Theory: A Very Short Introduction (New York: Oxford University Press) 2000, pp 55 – 68.

Peter Childs & Roger Fowler, "Context", "Intertextuality", "Author", "Reader" The Routledge Dictionary of Literary Terms; (New York: Taylor & Francis) 2006.

Tony Bennett & Lawrence Grossberg, "Text" New Keywords: A Revised Vocabulary of Culture and Society (Malden: Blackwell Publishing) 2005, pp. 345-347

Alan Mckee, "What is Textual Analysis", Textual Analysis: A Beginner's Guide (London: Sage Publications) 2003, pp 1-33
Roland Barthes, "From Work to Text" and "Death of the Author" in Image-Music-Text.

Michel Foucault, "What is an Author?" in Paul Rabinow ed., The Foucault Reader.

Semester III: Ways of Doing: Mapping Science-Society Relationship

Course Code: UH 201

Instructors: Raghavendra Srinivas, Rajan Gurukkal, H. A. Chanakya and Namita Avatri

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 analyze 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.

Texts and Readings for classroom discussion:

Bhaduri, A Bhaduri, Amit . Macroeconomics: The Dynamics of Commodity Production.

Gandolfo, G. Economic Dynamics, Springer-Verlag.

Tu, P.N.V. Dynamical Systems: An Introduction to with Applications in Economics and Biology.

Lecture notes

Module 2: People and Nature

This module will approach the theme of people and nature from several natural science, social science, humanities and arts perspectives. The course will discuss the evolution of our conception of nature, our understanding of our place in nature, our understanding of 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.

Texts and Readings for classroom discussion:

Alfred W. Crosby, Ecological Imperialism: The Biological Expansion of Europe, 900-1900, Cambridge University Press, 2004.

Clive Ponting, A New Green History of the World: The Environment and the Collapse of Great Civilizations, Penguin Books, rev.ed. 2007.

Gilbert F. LaFreniere, The Decline of Nature: Environmental History and the Western Worldview, Paper Back ed. Oak Savanna Publishing, Corvallis, Oregon, 2012.

Donella H. Meadows, Jorgen Randers, Dennis L. Meadows, The Limits to Growth: The 30-Year Update, Chelsea Green Pub., Vermont, 2004.

Emilio F. Moran, People and Nature: An Introduction to Human Ecological Relations, Wiley-Blackwell, 2006.

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 /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.

Texts and Readings for classroom discussion:

Before the law, Franz Kafka "Reasonable man, reasonable woman, reasonable expectations", Usha Ramanathan http://www.ielrc.org/content/a9906.pdf

Michel Foucualt, Excerpt on biopolitics from lectures "Society must be defended"
NALSA v. Union of India http://supremecourtofindia.nic.in/outtoday/wc40012.pdf(judgment accepting transgender as citizen).

"Digital Delivery of Services: The Indian Landscape." IN The Wake of Aadhaar: The Digital Ecosystem of Governance in India. Bangalore: CSCS, 2013. E-book. (excerpt).

Selvi and another v. State of Karnataka 5 May 2010 http://indiankanoon.org/doc/338008/ (judgment on validity of scientific evidence in Indian law).

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 thought on the practice of journalism, its tenets, its limitations and its influence with a view to encouraging a more critical engagement with media but also 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/anchoring media debates and so on

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

Readings:

Sainath, P. "The Trickle Up Down Theory; Or, health for the millions." In Everybody Loves a Good Drought, (New Delhi: Penguin Books), 2000, pp.23-27.

Verghese, B G. "The Making of a Marwari Tamil". In Warrior of the fourth estate : Ramnath Goenka of the Express, (New Delhi : Viking), 2005, pp.24-30.

Morris, James. "The Conquest of Everest, 29 May 1953". In John Carey. The Faber Book of Reportage, (Faber & Faber), 1996, pp.660-662.

Wenner, Jann. "Bruce Springsteen". In Jann Wenner & Joe Levy. The Rolling Stone Interviews (New York : Back Bay Books), 2008, pp.13-19.

Wolfe, Tom. "Selections". In The new journalism, (E W Johnson; Picador), 1990, pp.40-42.

Mehta, Vinod. "Introduction". In Lucknow boy : a memoir, (New Delhi : Penguin Viking), 2011, pp.vii-xxi.

Hype, Hypocrisy & Television in Urban India (Vikas, New Delhi 1997) by Amrita Shah

Vikram Sarabhai-A Life (Viking-Penguin, 2007) by Amrita Shah

January- April 2016

Semester II: Ways of Seeing

Course Code: UH 102

Instructor: S. V. Srinivas

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.

General introduction: Reinforcement of concepts and theories introduced in Semester I: archive, text, author, reader, and interpretation.

Theory texts used by instructor:
Roland Barthes, Image-Music-Text and Raymond Williams, Keywords.

Module 1: 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/distance and time/history; human and non-human; science & technology and nature.

Readings circulated to students:

Issac Asimov, Selections from I, Robot: "Introduction," "Robbie," "Runaround" and "Reason"
Satyajit Ray, "Diary of a Space Traveller" and "Bonku Babu's Friend"
Vandana Singh, Selections from The woman who thought she was a Planet: "Woman who thought she was a planet," "Hunger" and "Tetrahedron."

Module 2: 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.

Text used by Instructor:

John Berger, Ways of Seeing
Readings circulated to students:
Gulammohammed Sheik, "Mobile Vision: Some Synoptic Comments"
Walter Benjamin: "Work of art in the age of mechanical reproduction."

Module 3: Films

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.

Texts used by instructor:

Ashish Rajadhyaksha, "Phalke Era: The Conflict of Traditional Form and Modern Technology" and Walter Benjamin, Selections from The Arcades Project.
Readings circulated to students:
Ranjani Mazumdar, "The Panaromic Interior" from Bombay Cinema: An Archive of the City.
Films:
DG Phalke, Shri Krishna Janma (1918); Fritz Lang, Metropolis (1927) and Dziga Vertov, Man with a Moving Camera (1929).
[A professional editor will be invited to class to introduce students to the basics of video editing before they begin working on their projects].

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—through 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". The students will get an oppourtunity to interact with folk artists and gain first-hand knowledge about various aspects of the folk arts to understand the synergy between artistic worldview and the contemporary social milieu. The course will be useful in recognizing how meaning is produced and expressed in folk domain and at the same time, aid the students to gain cognizance of Indian multiculturalism.

Class Plan

Class 1: Nation and the Folk: In the introduction class the relationship between a nation and its folk arts will be explored. Focusing on India the class will probe into the different art forms- classical, folk, tribal and popular.

Class 2: Folk-Philosophy: Here the deeper meaning of folk expressions will be taken on board. An Indian folk philosopher's work will be discussed.

Class 3: Design and Learning to make a folk art: This will be a theoretical class on design followed by a workshop on making a folk art.

Class 4: Survival and Renovation: Tracing its history, the changes that folk arts go through over the time for survival and sustenance will be illustrated.

Class 5: Copyright and Archiving: In this class the need to protect the folk arts against the threats from globalization will be foregrounded.

Class 6: Gender Question: The gender equations within the artists and the relationship with the art will be discussed in this class.

Class 7: Folk Arts and the Market Economy: How the market situation affects the folk arts and artists will be elaborated in this class.

Class 8: Art Criticism: This class will understand the basics of art criticism.

Class 9: Critical Writing: Here the students will engage with and learn few techniques of critical art writing.

Class 10: Field trip: Observation of local folk art performance.

Readings:

Dundes, Alan. Essays in Folkloristics. University of Michigan. 1978.
Pattanayak, D.P, Claus, Peter and Handoo, Jawahar lal. Indian Folklore. Volume II. Mysore. Central Institute of Indian Languages. 1981.
Pattanayak, D.P and Claus, Peter. Indian Folklore. Volume I. Mysore. Central Institute of Indian Languages. 1981.
Dundes, Alan. Interpreting Folklore. Indiana University. 1980.
Bronner, Simon J. The Meaning of Folklore: Analytical Essays of Alan Dundes. Logan, Utah. Utah State University Press. 2007.
Dorson, M Richard. Folklore and Folklife. Chicago. University of Chicago Press. 1972.
Dorson, M Richard. Folklore in the Modern World. Mouton Publishers. 1978.
Alexander Haggerty Krappe. Science of Folklore. Kessinger Publishing. 1930.
Anderson, Benedict. Imagined Community Reflection On The Origin And The Spread Of Nationalism. New York. Verso. 1991
Bhabha, Homi. K (ed.). Nation and Narration. New York. Routledge. 1990.
Handoo, Jawahar lal. Folklore an Introduction. Mysore. Central Institute of Indian Languages. 1989.

Semester VI: Introduction to Governance

Course Code: UH 302

Instructor: Uday Balakrishnan

The semester long programme on Introduction to Governance is to enable the participants to develop an appreciation of key issues and challenges to 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 (a) additionally, a selection of books will be available for consultation in the library of 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 Plan

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

Class 2: The challenge of good governance in a democracy followed by presentation 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 presentation 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.

Class7: 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/ APP movement.

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

Readings:

The Economic and Political Weekly
The Economist
The Hindu

Extracts from books:

Ivan Illich's De-schooling Society, Small is beautiful by E.F.Schumacher
Everyone love a good Drought by P.Sainath
Lords f Poverty Graham Hancock
An Eye to India by David Selbourne
The essential writings of Mahatma Gandhi edited by Judith M Brown
The Judgement- the inside story of the Emergency in India by Kuldip Nayar
India Unbound by Gurucharan Das
Patrick French's India A Portrait

MATERIALS

Semester 3 (August)

UMT 101 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: K. Chatterjee

Suggested Book:

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

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.

Instructor: 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.

UMT 204 Electronic Properties of Materials (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: R. Ranjan

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.

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.

Instructor: T. A. Abinandanan

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. Polymer synthesis. Growth and processing of thin films.

Instructors: S. Subramanian 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. Braun, D., Cherdron, H., Rehahn, M., Ritter, H. and Voit, B. 2010 Polymer Synthesis: Theory and Practice: Fundamentals, Methods, Experiments, Springer.

UMT 303 Mechanical Behaviour of Materials (3:0)
(Core for Materials Majors + Soft core for Materials Minors)

Introduction to basic concepts of Stress and Strain; Engineering stress-strain response vs. True stress-strain response, Elastic and viscoelastic behavior, dislocations, plastic flow in

single crystals, strengthening mechanisms, composites, noncrystalline materials, fracture and toughening mechanisms of ceramics and polymers, creep and fatigue, environmental effects.

Instructor: S. Karthikeyan

Suggested Book:

1. Courtney, T. H. 2001 Mechanical Behavior of Materials, 2nd edition, Tata McGraw Hill.

Semester 6 (January)

UMT 307 Manufacturing Processes (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: Basic 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 308 Mechanical Characterization (1:1)
(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:

1. Dieter, G. E. 1988 Mechanical Metallurgy, McGraw-Hill.

Core for the Fifth Year

The fifth year masters option requires taking courses for 12 credits (6 core + 6 electives), and doing a masters project for 20 credits. The 6 core credits are to be taken from the list of courses recommended at the beginning of the year.

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)
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 and fifth 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)
Science of Materials Processing (MT)
Introduction to Biomaterials Science and Engineering (MT)
Electron Microscopy (MRC)
Computational Modeling of Materials (MRC)
Nanostructured Materials (MRC)

MATHEMATICS

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: Gautam Bharali

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; Eigen values and Eigen vectors; Diagonalisation of Symmetric matrices. Multivariable calculus: Functions on Rn Partial and Total derivatives; Chain rule; Maxima, minima and saddles; Lagrange multipliers; Integration in Rn, change of variables, Fubini's theorem; Gradient, Divergence and Curl; Line and Surface integrals in R2 and R3; Stokes, Green's and Divergence theorems.
Introduction to Ordinary Differential Equations; Linear ODEs and Canonical forms for linear transformations.

Instructor: Kaushal Verma

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: Srikanth Iyer

Suggested Books:

1. Ross, S. 2005, A First Course in Probability, Pearson Education Inc., Delhi, Sixth edition.
2. Ross, S. 2010 Introduction to Probability and Statistics for Engineers and Scientists, Elsevier, Fourth edition.
3. Feller, W. 2009 An Introduction to Probability Theory and Its Applications, Wiley, India, Third edition.
4. Hogg, R. V. and Ledolter, J. 1987 Engineering Statistics, Macmillan Publishing Company, New York.

Semester 4 (January)

UM 202: Introduction to Basic Analysis (3:0)

(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: Siddhartha Gadgil

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.

UM 203: Elementary Algebra and Number Theory (3:0)

(Core Course for Mathematics Major and Minor)

Divisibility and Euclid's algorithm; Fundamental theorem of arithmetic; Infinitude of primes; Congruences; (Reduced) residue systems, Application to sums of squares; Chinese Remainder Theorem; Solutions of polynomial congruences, Hensel's lemma; A few arithmetic functions (in particular, discussion of the floor function); the Mobius inversion formula; Recurrence relations; Basic combinatorial number theory (pigeon-hole principle, inclusion-exclusion, etc.); Primitive roots and power residues, Quadratic residues and the quadratic reciprocity law, the Jacobi symbol; Some Diophantine equations, Pythagorean triples, Fermat's descent, examples; Definitions of groups, rings and fields, motivations, examples and basic properties; polynomial rings over fields, factorisation of polynomials, content of a polynomial and Gauss' lemma, Eisenstein's irreducibility criterion; Elementary symmetric polynomials, the fundamental theorem on Symmetric polynomials; Algebraic and transcendental numbers (an introduction).

Instructor: Basudeb Datta

Suggested Books:

1. Burton, D. M., Elementary Number Theory, McGraw Hill.
2. Niven, Zuckerman, H. S. and Montgomery, H. L., An Introduction to the Theory of Numbers, 5th edition, Wiley Student Editions.
3. Fraleigh, G., A First Course in Abstract Algebra, 7th edition, Pearson.

Semester 5 (August)

MA 212: Algebra 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 transcedental extensions, Finite fields, characteristic, any finite field has order pn.

Instructor: Abhishek Banerjee

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 & amp, Sons.

MA 219: Linear Algebra (3:0)
(Core Course for Mathematics Major and Minor)

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, Eigen values and Eigen vectors, 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 S0(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, SU2 and SL 2(R).

Instructor: Harish Seshadri

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 221: Analysis I (3:0)
(Core Course for Mathematics Major and Minor)

Review of Real and Complex numbers systems, Topology of R, Continuity and differentiability, Mean value theorem, Intermediate value theorem. The Riemann-Stieltjes integral. Introduction to functions of several variables, differentiablility, directional and total derivatives. Sequences and series of functions, uniform convergence, the Weierstrass approximation theorem.

Instructor: S. Thangavelu

Suggested Books:

1. Rudin, W. 1986 Principles of Mathematical Analysis, McGraw-Hill.
2. Royden, H. L. 1988 Real Analysis, Macmillan.

MA 231: Topology (3:0)
(Core Course for Mathematics Major)

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: Siddhartha Gadgil

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 II (3:0)
(Core Course for Mathematics Major)

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: Mousumi Mandal

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 & amp; Sons.
4. Atiyah, M. and MacDonald, R., Commutative Algebra.
5. Herstein, I. N. 1995 Topics in Algebra, John Wiley & amp, Sons.

MA 222: Analysis II (3:0)
(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: A. K. Nandakumaran

Suggested Books:

1. Hewitt, E. and Stromberg, K. 1969 Real and Abstract Analysis, Springer.
2. Royden, H. L. 1988 Real Analysis, Macmillan.
3. Folland, G. B., Real Analysis: Modern Techniques and their Applications, 2nd edition, Wiley.

MA 224: Complex Analysis (3:0)
(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: Gautam Bharali

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: ODE (3:0)
(Core Course for Mathematics Major)

Basics concepts: Phase space, existence and uniqueness theorems, dependence on initial conditions, flows.

Linear systems: The fundamental matrix, stability of equilibrium points, Sturm-Liouvile 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-Hil.
2. Birkhoff, G. and Rota, G. -C. 1989 Ordinary Differential Equations, Wiley.
3. Hartman, P. 1982 Ordinary Differential Equations, Birkhaeuser.

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

List of electives offered by the Department of Mathematics

(Detailed information about electives will be posted on http://www.math.iisc.ernet.in/newcourse.htm)

ELECTIVES OFFERED IN THE AUGUST-DECEMBER SEMESTER

MA 215: Introduction to Modular Forms
Instructor: Jaban Meher

MA 223: Functional Analysis (3:0)
Instructor: T. Bhattacharyya

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

MA 242: Partial Differential Equations (3:0)
Instructor: M. K. Ghosh

MA 227: Nonlinear Dynamics
Instructor: Thirupathi Gudi

MA 261: Probability Models
Instructor: Arvind Ayyer

MA 361: Probability Theory
Instructor: Manjunath Krishnapur

MA 368: Topics in Probability and Stochastic Processes
Instructor: Manjunath Krishnapur

MA : Introduction to Dynamical Systems
Instructor: G. Rangarajan and Janaki Balakrishnan (NIAS)
(Subject to approval from SCC)

ELECTIVES OFFERED IN THE JANUARY-APRIL SEMESTER

MA 229: Calculus on Manifolds (3:0)
Instructor: Gadadhar Misra

MA 313: Algebraic Number Theory
Instructor: Dilip Patil

MA 317: Introduction to Analytic Number Theory (3:0)
Instructor: Soumya Das

MA 319: Algebraic Combinatorics
Instructor: Arvind Ayyer

MA 320: Representation Theory of Compact Lie Groups (3:0)
Instructor: S. Thangavelu

MA 364: Linear and Nonlinear Time Series Analysis
Instructor: G. Rangarajan

MA 314: Introduction to Algebraic Geometry
Instructor: Umesh Dubey

MA 315: Lie Algebras and Their Representation
Instructor: E. K. Narayanan

PHYSICS

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: **Subrato Mukerjee, Prasad V. Bhotla** 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's 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: **Tarun Deep Saini** and **R. C. Mallik, IAP**

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: **P. S. Anil Kumar, K. P. Ramesh** and **G. R. Jayanth**

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: **Biplob Bhattacharjee, K. P. Ramesh** and **R. Ganesan**

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 disperion of EM waves. Wave guides and coaxial cables, optical fibres 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, difraction 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: **Prerna Sharma, S. M. Victor** and **K. Ramesh**

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, Van der 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: **H. R. Krishnamurthy** and **Prasad V. Bhotla**

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: **Banibrata Mukhopadhyay**

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. Tunnelling, 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: Tanmoy Das

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: Vasant Natarajan, Aveek Bid, K. S. R. Koteswara Rao and D. V. S. Muthu

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: Arnab Rai Choudhuri

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: B. Ananthanarayan

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.

Optional Courses for Physics Major

Course Number	GP	Title	Faculty
PH 206	3:0	Electromagnetic Theory	Anindya Das
PH 207	1:2	Analog Digital and Microprocessor Electronics	K. Rajan and M. N. Ramanuja
PH 208	3:0	Condensed Matter Physics I	Manish Jain
PH 209	2:1	Analog and Digital Electronics Lab	K. Rajan and M. N. Ramanuja
PH 212	0:3	Experiments in Condensed Matter Physics	K. S. R. K. and Suja Elizabeth
PH 213	0:4	Advanced Experiments in Condensed Matter Physics	Arindam Ghosh, Ambarish Ghosh and R. Ganesan
PH 217	3:0	Fundamentals of Astrophysics	Biman Nath and Tarun Saini
PH 231	0:1	Workshop practice	Vasant Natarajan
PH 320	3:0	Condensed Matter Physics II	Vijay Shenoy
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 340	4:0	Quantum Statistical Field Theory	

PH 347	2:0	Bioinformatics	S. Ramakumar and K. Sekar
PH 350	3:0	Physics of Soft Condensed Matter	Jadeep K. Basu
PH 351	3:0	Crystal Growth, Thin Films and Characterization	Suja Elizabeth and P. S. Anil Kumar
PH 352	3:0	Semiconductor Physics and Technology	V. Venkataraman
PH 359	3:0	Physics at the Nanoscale	A. K. Sood and Arindam Ghosh
PH 362	3:0	Matter at Low Temperatures	Ambarish Ghosh