HANDBOOK OF INFORMATION

POSTGRADUATE PROGRAMME

2016-17

INDIAN INSTITUTE OF TECHNOLOGY ROPAR
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CONTENTS

CONTENTS

CONTENTS

1. Introduction

1.1. Background

The Indian Institute of Technology Ropar is one of the eight IITs set up by the Ministry of Human Resource Development (MHRD), Government of India in 2008. In keeping with the spirit of the IIT system, this institute is committed to providing state-of-the- art technical education in a variety of fields, and also to facilitating transmission of knowledge using the latest developments in pedagogy. The institute started operating from the transit campus, i.e., the premises of the Government Polytechnic College for Girls (Ropar) from August 18, 2009. The transit campus of IIT Ropar has all the required facilities such as class rooms fitted with multimedia, faculty rooms and an administrative wing. The four hostels (three for boys and one for girls) on campus have modern mess halls. Faculty recruitment, creation of laboratories and other support facilities are in full swing. The institute will be relocated to its main campus next year. The main campus is spread over an area of 500 acres and is situated on the banks of the Satluj River.

1.2. Departments, School and Centre

Each course is offered by an academic unit which could either be a department, school and centre. The various departments, school and centre and their two letter codes are given below. Some courses are offered jointly by multiple academic units and are classified as interdisciplinary courses; their codes are also given in Table 1.

Table 1.2.1. Academic Departments and School

Name of Academic Unit (alphabetical order)	Code
Centre for Bio-Medical Engineering	BM
Civil Engineering	CE
Centre for Materials & Energy Engineering	MS
Chemistry	CY
Computer Science and Engineering	CS
Electrical Engineering	EE
Humanities and Social Sciences	HU
Mathematics	MA
Mechanical Engineering	ME
Physics	PH

1.3. Programmes Offered

IIT Ropar offers a variety of academic programmes for students with a wide range of backgrounds. Admission to many of these programmes are based on the students' performance in national level tests / entrance examination followed by interviews at IIT Ropar in some cases.

The programmes offered by IIT Ropar are presently classified as post graduate and PhD programmes. This classification is based primarily on entry/admission qualification of students rather than the level of degree offered. For all postgraduate programmes, students are admitted after they have obtained at least a college level Bachelor's degree. As this course of study would indicate, there is considerable overlap in courses for senior undergraduate students and junior postgraduate students. The various programmes and their specializations are listed below.

Table 1.3.1. Postgraduate Programmes

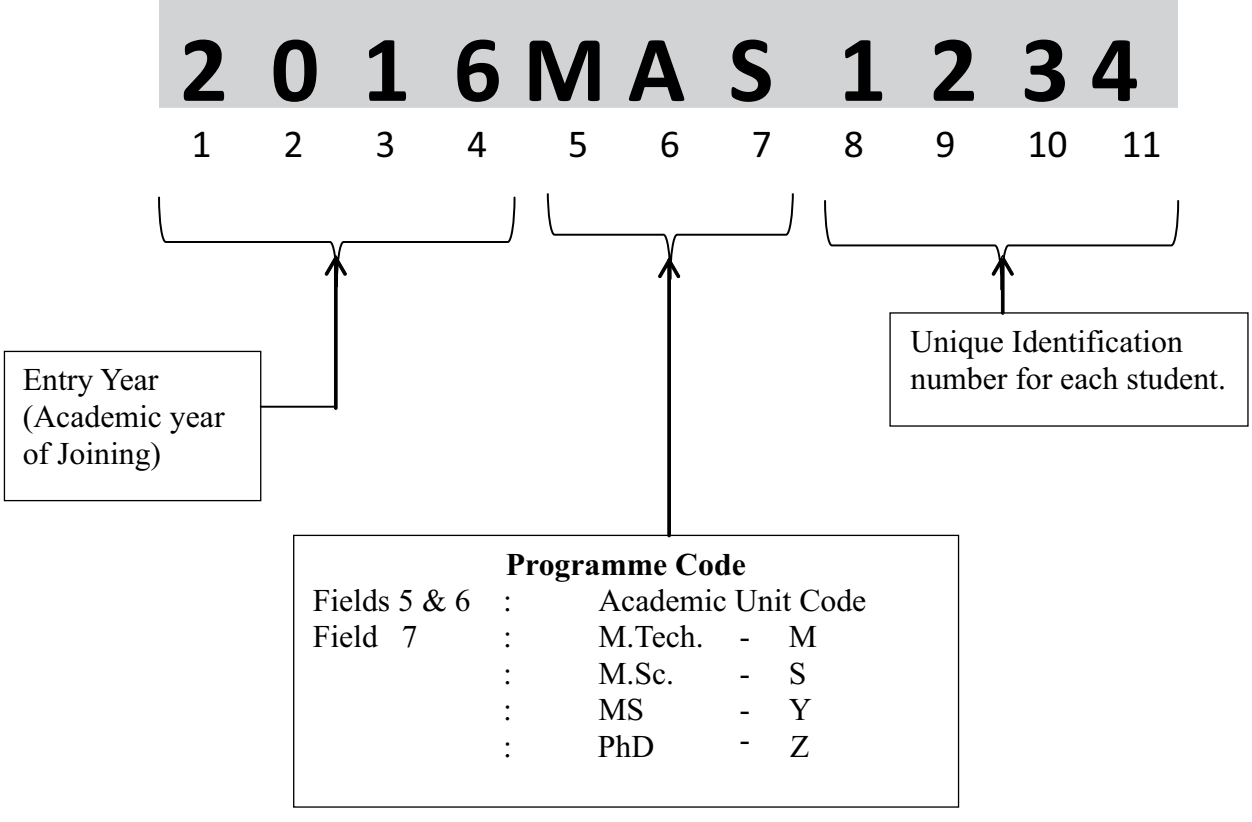
Departments	Degree	Credits
Chemistry	M.Sc.	87
Computer Science & Engineering	MS Research	58
Electrical Engineering	MS Research	60
Mathematics	M.Sc.	81
Physics	M.Sc.	88
Mechanical Engineering	M. Tech.	62

Table 1.3.2. PhD Programmes

Departments
Centre for Biomedical Engineering
Centre for Material & Energy Engineering
Department of Civil Engineering
Department of Chemistry
Department of Computer Science and Engineering
Department of Electrical Engineering
Department of Humanities and Social Sciences
Department of Mathematics
Department of Mechanical Engineering
Department of Physics

1.4. Student's Entry Number

The entry number of a student consists of eleven alpha-numerals.



In case of a programme change, the three alphabets (fields 5, 6 and 7) will be changed. However, his / her unique numeric code will remain unchanged. Such students will have two entry numbers, one prior to programme change and one after the change. At any time, though, only one entry number that corresponds to the student's present status will be in use.

Postgraduate Programmes

2. Postgraduate Programmes

2.1. Academic System

The overall academic system for IIT Ropar, Punjab has been designed to provide a science-based engineering education with a view to producing quality engineers and scientists. The curriculum provides broad-based knowledge and simultaneously builds a temper for life-long learning and exploring. The Postgraduate programme begins with a set of science and general engineering courses which are reflected in the course plan for the first year. These courses provide a foundation for further discipline-specific courses. The medium of instruction at IIT Ropar is English.

The main goals of the postgraduate programmes are to develop scientific and engineering manpower of the highest quality to cater the needs of industry, R&D organizations and educational institutions and to enable students to have awareness and sensitivity to the needs and aspirations of society. The programmes have been structured in such a way that interested students can upgrade to the MS or PhD programme.

The current Academic year begins in July and ends in May of the following year. For the academic year 2016-2017, the 1st semester starts on 20th July 2016. The detailed schedule of the activities and academic deadlines shall be given in the semester schedule that will be available before the start of the semester.

2.2. Academic Programmes

Currently, the following PG programmes are being offered:

1. M. Sc. in Chemistry
2. M. Sc. in Physics
3. M. Sc. in Mathematics
4. MS (Research) in Computer Science Engineering
5. MS (Research) in Electrical Engineering
6. M. Tech. in Mechanical Engineering

2.3. General Eligibility Criteria for PG Programmes

a) **M.Sc. in Chemistry:** Bachelor degree with Chemistry as one of the subject and should have passed Mathematics at the Higher Secondary (10+2) level. Candidate meeting with this requirement must also have valid JAM score.

b) **M.Sc. in Mathematics:** Bachelor degree with Mathematics as a subject for at least two years/four semesters. Candidate meeting with this requirement must also have valid JAM score.

c) **M.Sc. in Physics:** Bachelor degree with Physics for three years/Six Semesters and Mathematics Statistics for at least two years/four semesters. Candidate meeting with this requirement must also have valid JAM score.

Note:- For programmes of Physics, Chemistry and Mathematics candidate must have at least 55% aggregate marks without rounding off (taking into account all subjects, including Languages and Subsidiaries, all years combined) for Un-Reserved/OBC Category Candidates and at least 50% aggregate marks without rounding off (taking into account all subjects, including Languages and Subsidiaries, all years combined) for SC/ST and PwD Category Candidates in the qualifying degree.

d) **MS (Research) in Computer Science and Engineering:** Candidates with B.Tech./ B.E/ M.Sc. / MCA in Computer Science and Engineering related area with an excellent academic record with valid GATE score in CS/IT.

e) **MS (Research) in Electrical Engineering:** A Candidates with a Bachelor's degree in Electrical Engineering (Electrical and Electronics Engineering)/ Electronics Engineering (Electronics and Communication Engineering) / Computer Science & Engineering or equivalent with a valid GATE score.

f) **M.Tech. in Mechanical Engineering :** Candidates with B. Tech./B.E or M. Sc. in the appropriate area with valid GATE score in Mechanical Engineering.

Note:- For MS (Research)/ M.Tech programme, IIT B.Tech. Graduates with a CGPA score of 8.0 or above on a scale of 10 [SC/ST: 7.5 CGPA] are eligible to apply without GATE score.

2.4. Admission Procedure

The candidates can apply for admission to various PG programmes as given :-

Sr. No.	Programme	Selection Procedure
1.	M.Sc. in Mathematics M.Sc. in Physics M.Sc. in Chemistry	To apply for admission to a desired programme, a candidate is required to qualify JAM (Joint Admission Test for M.Sc.) and also satisfy the Minimum Educational Qualifications (MEQs) and Eligibility Requirements (ERs) of the respective academic programme. For further information, candidates can visit the JAM website.
2.	M.Tech. in Mechanical Engineering	To apply for admission in this programme the candidates are required to apply online to IIT Ropar and also satisfy the Minimum Educational Qualifications (MEQs) and Eligibility Requirements (ERs). Eligible candidates will be called for counselling For further information, please visit : **www.iitrpr.ac.in**
3.	MS (Research) in Computer Science & Engineering / Electrical Engineering	To apply for admission in this programme, candidates are required to apply online to IIT Ropar and also satisfy the Minimum Educational Qualifications (MEQs) and Eligibility Requirements (ERs). Eligible candidates will be called for entrance test followed by interview. For further information, please visit: **www.iitrpr.ac.in**

2.5. Credit System

2.5.1. Credit System

Education at the Institute is organized around the semester-based credit system. The prominent features of credit system are a process of continuous evaluation of a student's performance/progress and the flexibility to allow a student to progress at an optimum pace suited to his/her ability or convenience. This feature is subject to the fulfillment of the minimum requirements for continuation.

A student's performance/progress is measured by the number of credits that he/she has earned, i.e., completed with a pass grade. Based on the course credits and grade obtained by the student, the grade point average is calculated. A minimum grade point average is required to be maintained for satisfactory progress and continuation in the programme.

All programmes are defined by the total credit requirement and a pattern of credit distribution over courses of different categories. Details are given below.

(a) Course credits assignment

Each course, except a few special courses, has a certain number of credits assigned to it depending upon its lecture, tutorial and practical contact hours in a week. This weighting also indicates the academic expectation that includes in-class contact and self-study beyond class hours. A few courses are without credit and are referred to as non-credit (NC) courses.

Lectures and Tutorials: One lecture or tutorial hour per week per semester is assigned one credit.

Practical/Laboratory: One laboratory hour per week per semester is assigned half credit.

For each lecture or tutorial credit, the self study component is 1 hour/week.

(b) Earning credits

At the end of every course, a letter grade is awarded in each course for which a student had registered. On obtaining a pass grade, the student accumulates the course credits as earned credits. A student's performance is measured by the number of credits that he/she has earned and by the weighted grade point average.

(c) Course coordinator

Every course is usually coordinated by a member of the teaching staff of the Department which is offering the course in a given semester. This faculty member is designated as the Course Coordinator. He/she has the full responsibility for conducting the course, coordinating the work of the other members of the faculty as well as teaching assistants involved in that course, holding the tests and assignments, and awarding the grades. For any difficulty related to a course, the student is expected to approach the respective course coordinator for advice and clarification. The distribution of the weight for tests, quizzes, assignments, laboratory work, workshop and drawing assignment, term paper, etc. that will be the basis for award of the grade in a course will be decided by the course coordinator of that course and generally announced at the start of the semester.

2.5.2. Grading System

The grading reflects a student's own proficiency in the course. While the relative standing of the student is clearly indicated by his/her grades, the process of awarding grades is not necessarily based upon evaluating the performance of the class based on some statistical distribution. The course coordinator and the associated faculty for a course formulate appropriate procedures to award grades that are reflective of the student's performance vis-a-vis the instructor's expectation.

The credit system enables continuous evaluation of a student's performance, and allows the students to progress at an optimum pace suited to individual ability and convenience. This is subject to the fulfilling of the minimum requirements for continuation.

The grades and their description, along with equivalent numerical points wherever applicable are listed below:

Table 1: Grades with their description

Grade	Grade Points	Description
A	10	Outstanding
A (-)	9	Excellent
B	8	Very good
B (-)	7	Good
C	6	Average
C (-)	5	Below average
D	4	Marginal
E	2	Poor
F	0	Very poor
NP	-	Audit Pass
NF	-	Audit Fail
U	-	Unsatisfactory
X	-	Continued
I	-	Incomplete
W	-	Withdrawal
S	-	Satisfactory completion
Z	-	Course continuation

2.5.3. Description of Grades

A grade

The 'A' grade stands for outstanding achievement. The minimum percentage for the award of an 'A' grade is 80%. However, individual course coordinators may set a higher performance requirement.

B grade

The 'B' grade refers to very good/good performance.

C grade

The 'C' grade stands for average performance. This average performance refers to "average" as per instructor's expectations in a holistic sense and not on the average marks.

D grade

The 'D' grade stands for marginal performance, i.e., it is the minimum pass grade in any course. The minimum percentage for the award of 'D' grade is 30%, however, individual course coordinators may set a higher marks requirement.

E and F grades

The 'E' and 'F' grades denote poor and very poor performance, and indicate failing a course. An 'F' grade is also awarded in case of poor attendance (see Attendance Rules). A student has to repeat all the core courses in which he/she obtains either an 'E' or an 'F' grade, until a pass grade is obtained. In case of the elective courses in which either an 'E' or an 'F' grade has been obtained the student may take the same course or any other course from the same category. An 'E' grade in a course makes a student eligible to repeat the course in the summer semester, if the course is offered. Further, 'E' and 'F' grades secured in any course stay permanently on the grade card. These grades are not counted in the calculation of the CGPA; however, these are counted in the calculation of the SGPA.

NP and NF grades

The 'NP' Grade denotes completion of the Audit course. The NF grade denotes Audit fail. These grades are awarded in a course that the student opts to audit. Only an elective course can be audited until one week after the mid semester examination. The Audit Pass (NP) is awarded if the student's attendance is above 75% in the class and he/she has obtained at least a 'D' grade. The Course Coordinator can specify a higher criterion for audit pass at the beginning of the semester. If either of these requirements is not fulfilled, an audit fail (NF) is awarded. The grades obtained in an audit course are not considered for the calculation of SGPA or CGPA.

I grade

The 'I' grade denotes incomplete performance in any L (lecture), P (practical), V (special module) category courses. It may be awarded in case of absence on medical grounds or other special circumstances, before or during the major examination period. The student should complete all requirements within:

(i) 10 days of the last date of the Major Tests; the request is to be made to the Head of the Department of the student's programme who will notify the same to the concerned course coordinators, OR

(ii) With the permission of the Dean (Academics) the period can be extended to the first week of the next semester. Upon completion of all course requirements, the 'I' grade is converted to a regular grade (A to F, NP or NF). The 'I' grade does not appear permanently in the grade card. Requests for an I-grade should be made at the earliest but not later than the last day of the major tests.

For (ii), the request is to be made to the Dean (Academics). A student may be considered for the award of an 'I' grade in a course only if the attendance in the course is 75%.

Attendance in the course for which an I-grade is being sought will be certified by the course coordinator of the course.

W grade

The 'W' grade is awarded in a course where the student has opted to withdraw from the course. Withdrawal from a course is permitted until one week after the Mid Semester Examination. The W grade stays on the grade card.

X grade

The 'X' grade is awarded for incomplete work typically in projects-type course based on request by the student.

S and Z grades

The 'S' grade denotes satisfactory performance and completion of a course. The 'Z' grade is awarded for non-completion of the course requirements, and if it is a core course, the student will have to register for the course until he/she obtains the 'S' grade. The specific courses in which S/Z grades are awarded are introduction to the Programme, NCC/NSO/NSS, and Introduction to Humanities and Social Sciences, Practical Training, Professional Practices.

2.5.4. Evaluation of Performance

The performance of a student will be evaluated in terms of two indices, viz. the Semester Grade Point Average (SGPA) which is the Grade Point Average for a semester, and Cumulative Grade Point Average (CGPA) which is the Grade Point Average for all the completed semesters at any point in time.

The Earned Credits (E.C.) are defined as the sum of course credits of courses in which students have been awarded grades between A to D; for PG students, credits from courses in which an NP or an S grade has been obtained are also added.

Points earned in a course = (Course credits × Grade Point) for courses in which A -F grade has been obtained.

The SGPA is calculated on the basis of grades obtained in all courses registered for in the particular semester, except the audit courses and the courses in which an S/Z grade has been awarded.

$$\text{SGPA} = \frac{\text{Points secured in the semester}}{\text{Credits registered in the semester, excluding S/Z and audit grade courses}}$$

The CGPA is calculated on the basis of all pass grades, except the courses in which S/Z grade has been awarded, obtained in all completed semesters.

$$\text{CGPA} = \frac{\text{Cummulative points secured in all passed courses (A-D)}}{\text{Cummulative earned credits, excluding S/Z and audit grade courses}}$$

An example of these calculations is given below:

Table 2(a). Typical academic performance calculations-I semester

Course no.	Course credits	Grade awarded	Earned credits	Grade Points	Points secured
(column 1)	(column 2)	(column 3)	(column 4)	(column 5)	(column 6)
MALXXX	5	C	5	6	30
CYLXXX	4	C(-)	4	5	20
PHLXXX	4	A	4	10	40
PHLXXX	2	B	2	8	16
MELXXX	4	E	0	2	08
TTNXXX	2	S	2	–	–

Credits registered in the semester (total of column 2) = 21
Credits registered in the semester excluding S/Z and audit grade course = 19
Earned credits in the semester (total of column 4) = 17
Earned credits in the semester excluding S/Z grade courses = 15
Points secured in this semester (total of column 6) = 114
Points secured in this semester in all passed courses
(Total of column 6 & A–D grade) = 106

$$\text{SGPA} = \frac{\text{Points secured in the semester}}{\text{Credits registered in the semester, excluding S/Z and audit grade course}} = \frac{114}{19} = 6.000$$

$$\text{CGPA} = \frac{\text{Cummulative points secured in all passed courses (A-D)}}{\text{Cummulative earned credits, excluding S/Z and audit grade courses}} = \frac{106}{15} = 7.067$$

Semester performance: Earned credits (E.C.) = 17 SGPA = 6.000
Cumulative Performance: Earned credits (E.C.) = 17 CGPA = 7.067

Table 2(b). Typical academic performance calculations-II semester

Course no.	Course credits	Grade awarded	Earned credits	Grade Points	Points secured
(column 1)	(column 2)	(column 3)	(column 4)	(column 5)	(column 6)
MALXXX	5	B	5	8	40
EELXXX	4	A(-)	4	9	36
CYLXXX	4	W	—	—	—
CYPXXX	2	B(-)	2	7	14
MELXXX	4	C	4	6	24
AMKXXX	4	A	4	10	40
HUNXXX	1	S	1	—	—

Credits registered in the semester (total of column 2) = 24
Credits registered in the semester excluding S/Z & audit grade courses = 23
Earned credits in the semester (total of column 4) = 20
Earned credits in the semester excluding S/Z & audit grade courses = 19
Points secured in this semester (total of column 6) = 154
Points secured in this semester in all passed courses
(Total of column 6 & A-D grade) = 154
Cumulative points earned in all
passed courses = 106 (past semesters) + 154 (this sem.) = 260

$$\text{SGPA} = \frac{\text{Points secured in the semester}}{\text{Credits registered in the semester, excluding S/Z and audit grade courses}} = \frac{154}{19} = 8.105$$

$$\text{CGPA} = \frac{\text{Cummulative points secured in all passed courses (A-D)}}{\text{Cummulative earned credits,excluding S/Z and audit grade courses}} = \frac{106+154}{15+19} = 7.647$$

Cumulative earned credits = 17 (past semesters) + 20 (this semester) = 37

Semester Performance: Earned credits (E.C.) = 20 SGPA = 8.105
Cumulative Performance: Earned credits (E.C) = 37 CGPA = 7.647

2.5.5. Course Numbering Scheme

Every course runs for the full length of the semester. At the beginning of the semester, a student registers for the courses that he/she wants to study and at the end of the semester a grade is awarded. On obtaining a pass grade, the student earns all the credits associated with the course while a fail grade does not get any credit; partial credits are not awarded. Each course is associated with a certain number of credits.

(a) Codes for the nature of the course

The nature of the course corresponding to the third alphabet in the course code is as follows:

Code	Description
L	Lecture Courses (Other than lecture hours, these courses can have Tutorial and Practical Hours, e.g. L-T-P structures 3-0-0, 3-1-2, 3-0-2, 2-0-0 etc.)
P	Laboratory based courses (where performance is evaluated primarily on the basis of practical or Laboratory work with LTP structures like 0-0-3, 0-0-4, 1-0-3, 0-1-3, etc.)
N	Introduction to the Programme or to Humanities and Social Sciences, etc.
T	Thesis
S	Seminars

(b) Level of the course

The first digit of the numeric part of the course code indicates the level of the course as determined by the prerequisite course and/or by the maturity required for registering for the course.

2.6. Registration and Attendance

2.6.1. Registration

Registration is a very important procedural part of the academic system. The registration procedure ensures that the student's name is on the roll list of each course that he/she wants to study. No credit is given if the student attends a course for which he/she has not registered. Registration for courses to be taken in a particular semester will be done according to a specified schedule before the end of the previous semester. The student must also take steps to pay his/her dues before the beginning of the semester by a demand draft or by making use of internet banking facility of SBI through the intranet. Students who do not make payments by a stipulated date will be de-registered for the particular semester. In absentia registration or registration after the specified date will be allowed only in rare cases at the discretion of the Dean (Academics)In case of illness or absence during registration, the student should intimate the same to his/her course adviser and Dean (Academics)A student must meet his/her adviser within the first week of the new semester for the confirmation of his/her registration. The registration record should be preserved until the semester grade card is received.

Various activities related to registration are listed below. The relevant dates are included in the Semester Schedule that is available before the start of the semester.

2.6.2. Registration and Student Status

Registration by a student confirms his/her status as a student at the Institute. Failure to register before the last date for late registration will imply that the student has discontinued studies and his/her name will be struck-off the rolls.

Every registered student is considered as a full-time student at the institute. They are expected to be present at the Institute and devote full time to academics.

2.6.3. Advice on Courses

At the time of registration, each student must consult his/her faculty adviser/programme coordinator to finalize

the academic programme, keeping in view factors, such as, minimum/maximum numbers of total and lecture credits, past performance, backlog of courses, SGPA/CGPA, pre-requisite, work load and student's interests, amongst others. Special Provisions exist for academically weak students.

2.6.4. Registration Validation

Before the first day of classes, every student is required to be present on campus and validate his/her registration. The updated registration record will be available on the website and the hard copy will be available with the student's adviser. Students who do not do registration validation will not be permitted to add/drop courses.

2.6.5. Late Registration

Late registration is permitted under the following conditions:

- A student, who was not on campus during the period of registration in the previous semester, needs to complete the registration process on or before the first day of the semester before the commencement of classes;

OR

- For reasons beyond his/her control, if a student is not able to register or send an authorized representative with a medical certificate, he/she may apply to the Dean (Academics) for late registration. Dean (Academics) may consider and approve late registration in genuine cases on payment of an extra fee called late registration fee. Late registration is permitted until one week after the start of the semester.

2.6.6. Add, Drop, Audit and Withdrawal from Courses

a. **Add/Drop:** A student has the option to add a course (s) that he/she has not registered for, or drop a course (s) for which he/she has already registered for. This facility is restricted to the first week of the semester.

b. **Audit:** A student may apply for changing a credit course to an audit one within one week of the end of the mid semester examination. Audit is not allowed in any 1st year course and also for any core course. The credit of the courses which are audited will not be counted in the final degree requirements.

c. **Withdrawal:** A student who wants to withdraw from a course should apply within one week of the end of the mid semester examination. A withdrawal grade (W) will be awarded in such cases.

2.6.7. Semester Withdrawal

If a student is absent for more than 20 teaching days in a semester on medical grounds, he/she may apply for withdrawal for that semester, i.e., withdrawal from all courses registered in that semester. Application for semester withdrawal must be made as early as possible at least before the start of the major tests. Partial withdrawal from the courses registered in a semester is not allowed.

2.6.8. Registration and Fees Payment

Every registered student must pay the stipulated fees in full before the specified deadlines. In the event that a student does not make these payments, he/she will be de-registered from all courses and his/her name will be struck-off from the roll list.

2.6.9. Registration Record

In addition to web-based entries related to registration, the student should ensure that the same are entered on the Registration Record. Queries related to registration will be considered only when accompanied by the original Registration Record. This record must be preserved until the semester grade card is received by the student.

2.6.10. Continuous Absence and Registration Status

If a student is absent from the Institute for more than four weeks without notifying the Head of the Department

or the Dean (Academics) his/her registration will be terminated and the name will be removed from the Institute rolls.

2.6.11. Attendance Rules

All students must attend every lecture, tutorial and practical class.

However, to account for late registration, sickness or other such contingencies, the attendance requirement will be a minimum of 75% of the classes actually held.

If a student has less than 75% attendance in a course during the semester, in lectures, tutorials and practical's taken together (as applicable), the course coordinator may award an 'F' grade in that course irrespective of his/her performance in the tests.

For the purpose of attendance calculation, every scheduled lecture, tutorial or practical class will count as one unit irrespective of the number of contact hours.

An M.Tech. or MS (Research) student irrespective of the source of assistantship, must attend at least 75% of classes in each course in which he / she is registered. In case his/her attendance falls below 75% in any course during a month, he/ she will not be paid assistantship for that month. Further, if his/ her attendance again falls short of 75% in any course in any subsequent month in that semester, his/her studentship and assistantship will be terminated. For the above purpose, if 75%works out to be a number is not a whole number; the immediate lower whole number will be treated as the required 75% attendance.

Attendance record will be maintained based upon roll calls (or any equivalent operation) in every scheduled lecture, tutorial and practical class. The course coordinator will maintain and consolidate attendance record for the course (lectures, tutorials and practical's together, as applicable)

2.6.12. Leave Rules

A full time M.Tech. or MS (Research) student during his/her stay at the Institute will be entitled to leave for 30 days (including leave on medical ground), per academic year. Even during mid-semester breaks, and summer and winter vacations, he/she will have to explicitly apply for leave. The leave will be subject to approval of the Head of Department / Associate Dean (PG) and a proper leave account of each student shall be maintained by the Department /School concerned.

The M.Sc. student during his/her stay at the Institute will be entitled to avail summer/winter vacation.

2.7. Rules and Regulations

2.7.1. Absence during the Semester

(a) A student must inform the course Instructor / HOD / Supervisor immediately of any instance of continuous absence from classes.

(b) A student who is absent due to illness or any other emergency, up to a maximum of two weeks, should approach the course coordinator for make-up quizzes, assignments and laboratory work.

(c) A student who has been absent from mid semester examination due to illness should approach the course coordinator for a make-up test immediately on return to class. The request should be supported with a medical certificate from institute's medical officer. A certificate from a registered medical practitioner will also be acceptable for a student normally residing off-campus provided registration number of the medical practitioner appears explicitly on the certificate.

(d) In case of absence on medical grounds or other special circumstances, before or during the major examination period, the student can apply for I-grade. 75% attendance in a course is necessary for being eligible for an I-grade in that course. An application requesting I-grade should be made at the earliest but not later than the last day of major tests. The application should be made to the Head of the Department of the student's programme who will grant approval depending on the merit of the case and inform the course coordinators and UG section. The student should complete all the course requirements within ten days from the last day of the Major Tests. The I-grade will then be converted to a proper grade (A to F, NP or NF).

(e) In special situations arising due to the inability to be present at the institute during the stipulated period, in (d) above, the period for conversion of I grade can be extended to the first week of the next semester.

Approval for this extension can be granted by the Dean (Academics) on recommendations of the concerned Head of the Department and the course coordinators. A request to this effect must be included in the application for I-grade.

f) In case of the period of absence on medical grounds is more than 20 working days during the semester, a student may apply for withdrawal from the semester, i.e., withdrawal from all courses registered that semester. Such application must be made as early as possible and latest before the start of the major tests. No applications for semester withdrawal will be considered after the major tests have commenced. The Dean (Academics) depending on the merit of the case, will approve such applications. Partial withdrawal from courses registered in a semester is not allowed.

(g) If a student is continuously absent from the institute for more than four weeks without notifying the Dean (Academics)/HOD, his/her name will be removed from institute rolls.

2.7.2. Measures for Helping SC/ST Students

A number of measures exist for helping students belonging to SC and ST categories. A senior faculty member is appointed as adviser to SC/ST students for advising them on academic and non-academic matters. Financial measures for helping SC and ST student are also available.

2.8. Curriculum and Structure of the PG Programmes

2.8.1. Credit Structure

The total earned credit requirements for PG programme among the various categories is given below in Table 1.

Category	Structure	Credit Requirement
Electrical Engineering (MS- Research)	Course Work Research Work	20 40
	Total	**60**
Mechanical Engineering (M.Tech.)	Project Work Elective Core Course Soft core	32 06 18 06
	Total	**62**
Computer Science and Engineering(MS-R)	Course work Research Work	18 40
	Total	**58**
Mathematics (M.Sc.)	Core Elective Project Work Seminar(compulsory)	49 15 15 02
	Total	**81**
Chemistry (M.Sc.)	Core Elective Project Work	56 06 25
	Total	**87**
Physics (M.Sc.)	Core Elective Project Work	62 09 17
	Total	**88**

2.8.2. Minimum CGPA Required for M.Sc., MS & M.Tech. Degree

The Minimum CGPA for the award of M.Sc. & M.Tech. is 5.0.
The minimum CGPA for the award MS degree is 7.0.

2.8.3. Special Requirements

Every student will be required to make presentations in various courses and if the Department so feels, the student can be asked to take a regular course on this aspect for credit.

2.9. Performance Requirements and Monitoring

2.9.1. Maximum Period for Completing Degree Requirements

The maximum permitted duration of each programme is determined in terms of number of registered regular semesters, herein after called registered semesters. Any semester in which a student has registered for a course will be called registered semester subject to the following:

(a) Only the first and second semesters of an academic year can be registered semesters. The summer semester will not be considered as a registered semester.

(b) A semester when a student has been granted withdrawal or granted leave will not be considered as a registered semester.

(c) The semester when a student is suspended from the Institute on disciplinary grounds will not be counted towards the number of registered semesters.

The summer semesters falling in between the permitted registered semesters shall be available for earning credits. After the student has registered for the maximum permissible number of registered semesters, the subsequent summer semesters will not be available for earning credits.

2.9.2. M.Sc. Continuation and Probation Guidelines

Continuation:

(a) After 1st semester, if a student earns more than 75% of the required credits with SGPA $\geqslant$ 5.0 then he/she can continue in the 2nd semester by taking all courses.

Probation:

(a) After 1st semester, if the total earned credits is less than 75% of the required credits or having SGPA < 5.0, then he/she will be placed in probation.

(b) After 1st year, if the total earned credits is less than 75% of the required credits or having CGPA < 5.0, then he/she will be placed in probation.

(c) After 1st year, if a student complete atleast 50% of required credits with CGPA < 5.0, then he/she will be placed on probation and will be recommended for slow-paced programme. Maximum duration of the programme is 3 years.

(d) After 1st year, if a student does not complete minimum of 50% of required credits and with CGPA > 5.0, then he/she will be placed on probation and will be recommended for slow-placed programme.

(e) Students in probation are allowed to take a maximum of 75% of the credit of the required credits in the next semester. [Course adviser will recommend how many credits to do based on the students overall performance, SGPA/CGPA and earned credits).

(f) The registration of any student is limited to 1.25 times the average earned credits of the previous two semesters, subject to a minimum of 9 credits and a maximum of 24 credits.

Termination:

(a) After 1st year, if a student does not complete minimum 50% of the required credits and with CGPA< 5.0, then he/she will be recommended for termination.

2.9.3. M.Tech. Continuation, Probation & Fellowship Guidelines

1. A student in this program has to earn at least 6 credits with minimum SGPA of 5.0 in any semester, failing which he/she will be issued a warning and placed on probation.
2. The names of the students who are on probation for two consecutive semesters will be recommended for termination.
3. A minimum of 5.0 CGPA is required for continuation of the stipend.
4. The students who are on probation will not be entitled to receive stipend.
5. Credits earned from successful completion of Project part-1 and Project part-2 will not be considered for calculating CGPA and 'S' grade (satisfactory performance and completion of a course) or 'Z' grade (non-completion of the course requirements) will only be awarded for the project works.

2.9.4. MS(Research) Continuation guidelines

The student should maintain a CGPA of 7.00. If the CGPA of a student falls below 7.00, the student will be given a grace period of one semester to maintain the minimum requirement.

2.9.5. Conditions for Termination of Registration

If the performance at the end of first two registered semesters is very poor, then registration will be terminated.

2.10. Programme Structure

2.10.1. M. Sc. in Chemistry

Semester – I [Core]

S. No.	Course No.	Course Title	L-T-P	Credits
1	CYL411	Concise Inorganic Chemistry	3-0-0	3
2	CYL412	Concise Organic Chemistry	3-0-0	3
3	CYL414 / CYL415	An introduction to Biochemistry /Numerical Methods for Chemists	3-0-0	3
4	CYL416	Reaction rates and Chemical Thermodynamics	3-0-0	3
5	CYL417	Quantum Chemistry and Group Theory	3-0-0	3
6	CYP401	Practical – 1	0-0-6	3
7	CYP402	Practical – 2	0-0-6	3

Students can choose any one course of serial No. 03 **Total: 21**

Semester – II [Core]

S. No.	Course No.	Course Title	L-T-P	Credits
1	CYL421	Advanced Organic Chemistry	3-0-0	3
2	CYL423	Solid -State Chemistry	3-0-0	3
3	CYL424	Electrochemistry and Statistical Thermodynamics	3-0-0	3
4	CYL426	Coordination Chemistry	3-0-0	3
5	CYL427	Interpretative Molecular Spectroscopy	3-0-0	3
6	CYP403	Practical – 3	0-0-6	3
7	CYP404	Practical – 4	0-0-6	3

Total: 21

Semester – III [Core]

S. No.	Course No.	Course Title	L-T-P	Credits
1	CYL511	Instrumentation Analysis	3-0-0	3
2	CYL513	Polymer Chemistry	3-0-0	3
3	CYL514	Environmental Chemistry	3-0-0	3
4	CYL515	Bio -organic Chemistry	3-0-0	3
5	CYT530	Project -I	0-0-20	10

Dissertation with presentation for the Project -I **Total: 22**

Semester – IV [Core and Electives]

S. No.	Course No.	Course Title	L-T-P	Credits
Core				
1	CYS500	Seminar	-	2
2	CYT540	Project -II	0-0-30	15
Electives				
3	CYLNNN	Elective – 1	x-y-z	3
4	CYLNNN	Elective – 2	x-y-z	3

Total: 23

Dissertation with presentation for the Project -II (15 credits)
Elective courses including Open (Minimum 6 credits)
Minimum CGPA to pass M.Sc. degree: 5.0

Credits requirement:

Course	Semester				
	I	II	III	IV	Total
M.Sc.	21	21	22	23	**87**

List of Core Courses

S. No.	Course No.	Course Title	L-T-P	Credits
1	CYL411	Concise Inorganic Chemistry	3-0-0	3
2	CYL412	Concise Organic Chemistry	3-0-0	3
3	CYL414 / CYL415	An introduction to Biochemistry /Numerical Methods for Chemists	3-0-0	3
4	CYL416	Reaction rates and Chemical Thermodynamics	3-0-0	3
5	CYL417	Quantum Chemistry and Group Theory	3-0-0	3
6	CYP401	Practical – 1	0-0-6	3
7	CYP402	Practical – 2	0-0-6	3
8	CYL421	Advanced Organic Chemistry	3-0-0	3
9	CYL423	Solid -State Chemistry	3-0-0	3
10	CYL424	Electrochemistry and Statistical Thermodynamics	3-0-0	3
11	CYL426	Coordination Chemistry	3-0-0	3

S. No.	Course No.	Course Title	L-T-P	Credits
12	CYL427	Interpretative Molecular Spectroscopy	3-0-0	3
13	CYP403	Practical – 3	0-0-6	3
14	CYP404	Practical – 4	0-0-6	3
15	CYL511	Instrumentation Analysis	3-0-0	3
16	CYL513	Polymer Chemistry	3-0-0	3
	CYL514	Environmental Chemistry	3-0-0	3
17	CYL515	Bio -organic Chemistry	3-0-0	3
18	CYT530	Project -I	0-0-20	10
19	CYS500	Seminar	-	2
20	CYT540	Project -II	0-0-30	15

List of Elective Courses

S. No.	Course No.	Course Title	L-T-P	Credits
1	CYL604	Electronic Structure Calculations	2-0-2	3
2	CYL605	Quantum Molecular Reaction Dynamics	3-0-0	3
3	CYL611	Advances in Catalysis	3-0-0	3
4	CYL612	Molecular Recognition	3-0-0	3
5	CYL613	The Chemistry of Metal Carbon bond	3-0-0	3
6	CYL621	Advanced Quantum Chemistry	3-0-0	3
7	CYL622	Applied Electrochemistry	3-0-0	3
8	CYL623	Heterogeneous Catalysis and Interfacial Phenomena	3-0-0	3
9	CYL624	Chemistry of Natural Products	3-0-0	3
10	CYL625	Inorganic Material Chemistry	3-0-0	3
11	CYL626	Synthetic Organic Chemistry	3-0-0	3
12	CYL701	Molecular Spectroscopy	3-0-0	3
13	CYL702	Chemistry of Novel Heterogeneous Catalytic Materials	3-0-0	3
14	CYL703	Strategies in Supramolecular Chemistry	3-0-0	3
15	CYL704	Chemical Synthetic Strategy of Organic Reactions	3-0-0	3
16	CYL705	Bioconjugates: Techniques and Applications	3-0-0	3
17	CYL706	Advances in *Ab Initio* Methods	3-0-0	3
18	CYL707	Non -adiabatic Effects in Chemical Dynamics	3-0-0	3

2.10.2. M.Sc. in Mathematics

Semester - I

Sr. No.	Course Code	Course Title	L-T-P	Credits
1	MAL 411	Topics in Real Analysis	3-1-0	4
2	MAL 412	Basic Linear Algebra	3-1-0	4
3	MAL 413	Introduction to Computing	3-0-2	4
4	MAL 414	Ordinary Differential Equation	3-1-0	4
5	MAL 415	Algebra	3-1-0	4
				Total credits 20

Semester - II

Sr. No.	Course Code	Course Title	L-T-P	Credits
1	MAL 421	Topics in Complex Analysis	3-0-0	3
2	MAL 422	Partial Differential Equation	3-1-0	4
3	MAL 423	Stochastic Processes	3-1-0	4
4	MAL 424	Numerical analysis	3-0-2	4
5	MAL 425	Topology	3-0-0	3
6	MAL XXX	Elective -I	- - -	3 or 4
				Total credits 21/22

Semester - III

Sr. No.	Course Code	Course Title	L-T-P	Credits
1	MAL 511	Functional Analysis	3-0-0	3
2	MAL 512	Mathematical Methods	3-1-0	4
3	MAL 513	Optimization Techniques	3-1-0	4
4	MAL XXX	Elective – II	- - -	3 or 4
5	MAL XXX	Elective – III	- - -	3 or 4
6	MAS 500	Seminar	- - -	2
7	MAT530	Project -I	- - -	3
			Total credits	**Min: 22, Max: 24**

Semester - IV

Sr. No.	Course Code	Course Title	L-T-P	Credits
1	MAL XXX	Elective – IV	- - -	3 or 4
2	MAL XXX	Elective – V	- - -	3 or 4
3	MAT540	Project -II	- - -	12
				Total credits 18/20

List of Core Courses

Sr. No.	Course Code	Course Title	L-T-P	Credits
1	MAL411	Topics in Real Analysis	3-1-0	4
2	MAL412	Basic Linear Algebra	3-1-0	4
3	MAL413	Introduction to Computing	3-0-2	4
4	MAL414	Ordinary Differential Equation	3-1-0	4
5	MAL415	Algebra	3-1-0	4
6	MAL421	Topicsin Complex Analysis	3-0-0	3
7	MAL422	PartialDifferential Equation	3-1-0	3
8	MAL423	Stochastic Processes	3-1-0	4
9	MAL424	Numerical Analysis	3-0-2	4
10	MAL425	Topology	3-0-0	3
11	MAL511	Functional Analysis	3-0-0	3
12	MAL512	Mathematical Methods	3-1-0	4
13	MAL513	Optimization Techniques	3-1-0	4

List of Elective Courses

Sr. No.	Course Code	Course Title	L-T-P	Credits
1	MAL603	Topics in Numerical Analysis	3-0-2	4
2	MAL604	Water Wave Theory	3-0-2	4
3	MAL605	Nonlinear Dynamics	3-0-0	3
4	MAL606	Fields and Galois Theory	3-0-0	3
5	MAL607	Commutative Algebra	3-0-0	3
6	MAL608	Operator Theory	3-1-0	4
7	MAL609	Mathematics of Financial Derivatives I	4-0-0	4
8	MAL610	Measure Theory	3-1-0	4

2.10.3. M.Sc. / MS in Physics

Semester - I

Sr. No.	Course Code	Course Title	L-T-P	Credits
1	PHL411	Classical Mechanics	3-1-0	4
2	PHL412	Mathematical Physics	3-1-0	4
3	PHL413	Quantum Mechanics -I	3-1-0	4
4	PHL414	Electromagnetic Theory	3-1-0	4
5	PHL415	Electronics & Lab	2-0-6	5
				Total 21

Semester - II

Sr. No.	Course Code	Course Title	L-T-P	Credits
1	PHL421	Quantum Mechanics -II	3-1-0	4
2	PHL422	Statistical Mechanics	3-1-0	4
3	PHL423	Atomic and Molecular Physics	3-1-0	4
4	PHL424	Nuclear and Particle Physics	3-1-0	4
5	PHL425	Condensed Matter Physics	3-1-0	4
6	PHP420	Physics Lab -I	0-0-8	4
				Total 24
Physics Lab -I: Experiments related to Solid State Physics, Modern Physics, and Nuclear Physics.				

Semester - III

Sr. No.	Course Code	Course Title	L-T-P	Credits
1	PHL511	Modern Optics	3-1-0	4
2	PHL512	Experimental Methods	3-0-2	4
3	PHL513	Numerical Methods and Programming	2-0-6	5
4	PHL5xx	M.Sc. Elective -I/MS Elective -I	3-0-0	3
5	PHP510	Physics Lab -II	0-0-8	4
6	PHT530	M.Sc. Project -I	- - -	3
7	PHL5xx/6xx	MS Elective -II	3-0-0	3
		MS Open Elective -I	3-0-0	3
				Total 23 (M.Sc.)
Physics Lab -II: Experiments related to Optics, Electromagnetism, and Spectroscopy.				

Semester - IV

Sr. No.	Course Code	Course Title	L-T-P	Credits
1	PHL5xx/6xx	M.Sc. Elective -II/MS Elective -III	3-0-0	3
2	PHL5xx/6xx	M.Sc. Elective -III/MS Elective -IV	3-0-0	3
3	PHT540	M.Sc. Project -II	---	10
4	PHS500	M.Sc. Seminar + Viva Voce	---	4
5		MS Open Elective -2	3-0-0	3
6	PHT522	MS project	---	4
7	PHS533	MS Seminar	---	3
8	PHL523	*Advanced topics in Physics for MS students	3-0-0	3
				Total M.Sc. (20)/MS (19)
*The course details would be provided by the instructor before the course registration.				

Semester - V (MS Program)

Course name	L-T-P	Credits
MS Thesis minor presentation at the end of fifth semester **PHT598**	---	16
Progress of MS Students is evaluated by the committee constituted by the department. Student is also required to submit a seminar report to the committee members before the presentation.		

Semester - VI (MS Program)

Course name	L-T-P	Credits
MS Thesis defense at the end of sixth semester **PHT599**	---	26
MS Thesis is evaluated by an intradepartmental committee constituted by the department.		

List of Core Courses

Sr.No.	Course code	Course name	L-T-P	Credits
1	PHL 411	Classical Mechanics	3-1-0	4
2	PHL412	Mathematical Physics	3-1-0	4
3	PHL413	Quantum Mechanics -I	3-1-0	4
4	PHL414	Electromagnetic Theory	3-1-0	4
5	PHL415	Electronics & Lab	2-0-6	5
6	PHL421	Quantum Mechanics -II	3-1-0	4
7	PHL422	Statistical Mechanics	3-1-0	4
8	PHL423	Atomic and Molecular Physics	3-1-0	4
9	PHL424	Nuclear and Particle Physics	3-1-0	4
10	PHL425	Condensed Matter Physics	3-1-0	4
11	PHP420	Physics Lab -I	0-0-8	4
12	PHL511	Modern Optics	3-1-0	4
13	PHL512	Experimental Methods	3-0-2	4
14	PHL513	Numerical Methods and Programming	2-0-6	5
15	PHP510	Physics Lab -II	0-0-8	4
16	PHT530	M.Sc. Project -I	- - -	3
17	PHT540	M.Sc. Project -II	---	10
18	PHS500	M.Sc. Seminar + Viva Voce	---	4
19	PHT522	MS project	---	4
20	PHS533	MS Seminar	---	3
21	PHL523	Advanced topics in Physics for MS students	3-0-0	3
22	PHT598	MS Thesis minor presentation	---	16
23	PHT599	MS Thesis defense at the end of sixth semester	---	26

List of Elective Courses

Sr.No.	Course code	Course name	L-T-P	Credits
1	PHL 551	Nano -Optics	3-0-0	3
2	PHL552	Physics of Nanomaterials & Nanotechnology	3-0-0	3
3	PHL553	Surface & Interfacial Forces	3-0-0	3
4	PHL554	Nonlinear Optics	3-0-0	3
5	PHL555	Nuclear Reaction & Instability	3-0-0	3
6	PHL556	Particle & Radiation Detectors	3-0-0	3
7	PHL557	Data Reduction & Measurement Technique	3-0-0	3
8	PHL558	Nuclear Scattering & Heavy lon Reactions	3-0-0	3
9	PHL559	Physics of Low Dimensional Systems	3-0-0	3
10	PHL560	Semi conductor Physics	3-0-0	3
11	PHL610	Quantum Optics I: Fundamentals	3-0-0	3
12	PHL611	Introduction to Quantum Computations & Communication	3-0-0	3
13	PHL612	Thin Film Science & Technology	3-0-0	3
14	PHL614	Laser Physics	3-0-0	3
15	PHL615	Introduction to Quantum Information	3-0-0	3
16	PHL616	Quantum Optics II: Basic Applications	- - -	3
17	PHL617	Ion Beam Fundamental & Patterning	3-0-0	3
18	PHL618	Linear & Non Linear Laser Spectroscopy	3-0-0	3
19	PHL619	Particle Physics	3-0-0	3
20	PHL620	Nuclear Models	3-0-0	3
21	PHL621	Super conductivity & Magnetism	3-0-0	3

2.10.4. M.Tech. in Mechanical Engineering

1st Semester (15 Credits)	**2nd Semester (15 Credits)**
Math – 1(core 1)	Lab. 1(core 4)
Math – 2(core 2)	Core 5
(Core -3)	Core 6
(Soft Core – 1)	Elective 1
(Soft Core – 2)	Elective 2
Weekly Seminar (Non Credit)	English/ Communication skills (NC)
	Weekly Seminar (NC)
Thesis supervisor to be decided after mid sem of 1 st sem	
3rd Semester (16 Credits)	**4th Semester (16 Credits)**
Project part – 1	Project part -2
Weekly Seminar (NC)	Weekly Seminar (NC)

Table 1. List of Course for M.Tech. Programme

Mathematics

1. MEL632 (Math - 1) Mathematics for Engineers(3-0-0)/3 credits
2. MEL633 (Math - 2) Numerical Methods in Mechanical Engineering(3-0-0)/3credits

Manufacturing

1. MEL501 Advanced Composites: (3-0-0)3 Credits
2. MEL502 Advanced Welding Technology: (3-0-0)3 Credits
3. MEL503 Solidification Processing: (3-0-0)3 Credits
4. MEL 504 Advanced Metal Casting Technology: (3-0-0)3 Credits
5. MEL505 Industrial Robotics: (3-0-0) 3 Credits
6. MEL507 Engineering Design Optimization: (3-0-0) 3 Credits
7. MEL 511 Atomistic Simulation and Modeling of Materials: (3-0-0)3 Credits
8. MEL512 Nanocomposites-Processing, characterization and Applications: (3-0-0) 3 Credits
9. MEL514 Metallic Corrosion: (3-0-0) 3 Credits
10. MEL517 Sustainable Design and Manufacturing: (2-0-4) 4 Credits
11. MEL519 Biological Materials:(3-0-2)4 Credits
12. MEL605 Friction and Wear in Machinery: (3-0-0) 3 Credits
13. MEL606 Modern Manufacturing Processes: (3-0-0) 3 Credits
14. MEL607 Rapid Prototyping: (3-0-0)3 Credits
15. MEL507 Engineering Design Optimization: (3-0-0) 3 Credits
16. MEL613 Science of Machining: (3-0-0) 3Credits
17. MEL615 Advanced Material Characterization Techniques: (2-0-4) 4 Credits
18. MEL617 Biology for Engineers: (3-0-0) 3 Credits
19. MEL630 Modelling Techniques for Metal Forming Processes: (3-0-0) 3 Credits

20. MEL631 MANUFACTURING SCIENCE – I (3-0-0) 3 Credits
21. MEP601 Advanced Mechanical and Materials Engineering Laboratory: (0-0-6) 3 Credits
22. MEP602 Material Engineering Laboratory: (0-0-4) 2 Credits

Design

1. MEL507 Engineering Design Optimization: (3-0-0) 3 Credits
2. MEL508 Advanced Mechanics of Solids: (3-0-0) 3 Credits
3. MEL510 Rotor Dynamics and Condition Monitoring: (3-0-2) 4 Credits
4. MEL513 Introduction to Plasticity: (3-0-0) 3 Credits
5. MEL515 Bone Biology: (3-0-0) 3 Credits
6. MEL516 Orthopedic Biomechanics: (3-0-2) 4 Credits
7. MEL518 Robot Manipulators: Kinematics, Dynamics and Control: (3-0-2) 4 Credits
8. MEP501 Control Engineering Laboratory: (0-0-4) 2 Credits
9. MEL602 Finite Element Methods in Engineering: (3-0-0) 3 Credits
10. MEL603 Machine Vibration Analysis: (3-0-0) 3 Credits
11. MEL604 Vibration and Shock Isolation: (3-0-0) 3 Credits
12. MEL608 Mechatronics: (3-0-0) 3 Credits
13. MEL614 Nonlinear oscillations : (3-0-0) 3 Credits
14. MEL616 Fracture and Fatigue: (3-0-0) 3 Credits
15. MEL618 Molecular, Cellular and Tissue Biomechanics: (3-0-2) 4 Credits
16. MEL 624 Crystal Plasticity: (3-0-2) 4 Credits
17. MEL 626 Theory of Elasticity: (3-0-0) 3 Credits

Thermal

1. MEL507 Engineering Design Optimization: (3-0-0) 3 Credits
2. MEL509 Convective Heat Transfer: (3-0-0) 3 Credits
3. MEL524 Energy Conservation and Waste Heat Recovery: (3-0-0) 3 credits
4. MEL 521 Computational Fluid Dynamics: (3-0-2) 4 Credits
5. MEL 522 Air Conditioning and Ventilation: (3-0-0) 3 Credits
6. MEL 523 Refrigeration Systems (3-0-0) 3 Credits
7. MEL609 Solar Thermal Engineering: (3-0-0) 3 Credits
8. MEL610 Advanced Conduction & Radiative Heat Transfer: (3-0-0) 3 Credits
9. MEL611 Combustion Engineering: (3-0-0) 3 Credits
10. MEL612 Turbulent Flow: (3-0-0) 3 Credits
11. MEL 619 Engine Management : (3-1-0) 4 Credits
12. MEL 620 Fluid Flow and Heat Transfer in Biological Systems (3-0-0) 3 Credits
13. MEL 621 Micro and Nanoscale Heat Transfer
14. MEL 622 Engine Instrumentation and Combustion Diagnostics: (3-0-0) 3 Credits
15. MEL 623 Alternative Fuels and Advances in Engines: (3-0-0) 3 Credits
16. MEL629 Advanced Fluid Mechanics: (3-0-0) 3 Credits
17. MEL507 Engineering Design Optimization: (3-0-0) 3 Credits

Table 2.10.5. MS-Research Program in Computer Science & Engineering and Electrical Engineering

Procedures and Guidelines

Following are the details of the MS (R) programme offered by Department of Computer Science & Engineering and Department of Electrical Engineering, IIT Ropar:

Duration

Minimum Duration: Two Years

Maximum Duration: Three Years

The candidate has to carry out research work under the supervision of a faculty member from the department.

Student Supervisory Committee: A Student supervisory Committee (SSC) will be formed within 2 months of the student joining the MS (R) program. The SSC should consist of the primary supervisor of the student and two additional members. At least one of the additional member should belong to the same department. The student is allowed to have a maximum of 2 thesis co-supervisors. The head of the department will serve as ex-officio member of the SSC.

Monitoring the Progress of the Student: The Supervisor will monitor the progress of the student through written reports and/or oral presentations. The student will submit a report to the supervisor within 15 days of the end of each semester in which the student has registered for thesis credits. The supervisor recommends the number of thesis credits considered as cleared at the end of the semester.

Evaluation of Thesis: Subject to fulfilling the course credit requirements and other conditions as may be laid down from time to time, the candidate may submit by MS thesis. The Research Supervisor will recommend to the Senate a panel of five experts approved by the SSC. One expert from the panel shall be appointed as external' examiner and the supervisor(s) will be the internal examiner(s). The thesis shall be forwarded to all examiners who shall report separately on the thesis and forward their recommendation to the Associate Dean (Research). The Associate Dean (Research) will examine the reports of the thesis examiners and send them to Chairman, Senate. The reports shall thereafter be sent to the Research Supervisor for their perusal and necessary action. There may be three-possible situations arising out of the nature of the reports, and the steps to be taken appropriate to the circumstances shall be as laid down below:

(i) The examiners are unanimous in recommending the award of the degree on the basis of the thesis without any modification. This is a clear case for going in for the final requirement of viva voce.

(ii) The external examiner is recommending the award of the degree but has suggested modification and/or has asked for clarifications. The candidate in that case shall make modification and provide the clarifications as suggested within a time to be fixed by the Associate Dean (Research) which in no case shall exceed two months from the date the communication is sent to the candidate. These may be sent to the examiners, if so desired by them.

(iii) The external examiner does not recommend the award of the degree. The Dean (Research) in such a case may either ask the candidate to modify the thesis as suggested within a given time not exceeding six months and send the modified thesis to the same examiner again or recommend to the Senate to appoint another external examiner or send the thesis to him/her in its original form. The recommendation of this additional examiner, at this stage, shall be taken as final.

Once the reports of the examiners have been accepted as satisfactory the candidate will have to defend his/her thesis before a viva board is not satisfied, the candidate has to appear again before the board within the next three months. The SSC shall recommend to the Senate the award of the MS Research degree if the viva voce is satisfactory and all the other requirements have been fulfilled. After the recommendations of the SSC either for acceptance of the thesis for the MS Research degree or for its rejection/modification have been accepted by the

Senate and the Board of Governors or by their Chairman as the case may be, a copy of the reports of the examiners may be issued to the candidate at his/her request. However, the names of the examiners are not to be disclosed. On the basis of the report of the Board of Examiners, the Senate decides the student's eligibility for the award of master in Science Research degree. Nothing contained in these Regulations shall preclude a candidate from publishing/patenting either independently or jointly with the supervisor the result of work incorporated in the thesis, at any time before or after submitting the thesis for examination.

Converting from MS-R to PhD program: A minimum GPA of 8 after the first two semesters of coursework is required for a student in the MS-R program to enroll into the PhD program. There must also be a faculty member of the department willing to supervise the student. Students, however must satisfy other requirements for the admission into the PhD program. The student is allowed to join the PhD program anytime between 12-18 months after joining the MS-R program. The student must submit an application to the head of the department. The head of the department will forward the application to the SSC for its recommendation. The SSC's recommendation is then forwarded to the Dean's office. The date of conversion is the date of registration in the PhD program.

The credit and thesis requirement for the PhD program will remain the same. However the student will be allowed to transfer the course and thesis credits earned in the MS (R) program. The duration of the PhD program will still remain the same- 5 years. Fellowship will be provided to the students from the date of conversion to the PhD program according to the institute rules without any arrears.

PhD Programmes

3. For PhD Programmes

3.1. PhD Programme

The institute, apart from establishing a robust teaching environment, is keen to facilitate and support cutting-edge research in a variety of areas. This aspect will enable the students to acquaint themselves with the latest developments in their respective areas of study and to pursue their own research interests. This will also result in a constant revision of the contents of the courses that are being taught. The institute has already started its PhD programme, so that the research environment is further augmented, expanded, and made even more vibrant. The Institute offers PhD programme in a wide range of areas in Science, Engineering & Humanities and Social Sciences. The broad objective of the PhD programme is not only to keep pace with the expanding frontiers of knowledge but also to provide research training relevant to the present social and economic objectives of the country.

The academic programme leading to the PhD degree is broad based and involves a minimum course credit requirement, comprehensive examination, synopsis seminar and thesis submission. The Institute also encourages research in interdisciplinary areas through a system of joint supervision and interdepartmental group activities. The presence of highly motivated research oriented faculty members provides excellent opportunities for such programmes. The Institute undertakes sponsored research and development projects from industrial and other organizations in public as well as private sector.

Facilities for research work leading to a PhD degree are presently available in the following departments.

1. Centre for Biomedical Engineering
2. Centre for Material and Energy Engineering
3. Department of Chemistry
4. Department of Civil Engineering
5. Department of Computer Science & Engineering
6. Department of Electrical Engineering
7. Department of Humanities & Social Sciences
8. Department of Mathematics
9. Department of Mechanical Engineering
10. Department of Physics

3.2. General Eligibility Criterion for Admission

Minimum qualification required for admission to the PhD programme is given below:

1) A First class or 60% marks in Master's Degree in Engineering/Technology. Candidates meeting this requirement must also have cleared GATE examination at any point of time in their career.

OR

2) A First class or 60% marks Master's degree in Science. Candidates meeting this requirement must also have valid GATE score/CSIR / UGC / NBHM / DBT etc. award.

OR

3) Candidates with Bachelor's degree in Engineering/Technology from any of the IITs and having a CGPA/CPI score of 8.00 (out of 10.00) are exempted from GATE requirement and considered for PhD Programme through normal procedure for selection of candidates.

OR

4) Candidates with Bachelor's degree in Engineering/Technology from other than IITs with exceptionally good academic record and having a valid GATE score. Candidates must have obtained at least 60% marks (or 6.5 Grade Point out of 10).

3.2.1. Direct PhD

Minimum Eligibility Qualification:

1) For Students of Centrally Funded Technical Institutes (CFTIs)

- Studying final year B.Tech.

- No GATE or other equivalent national exam qualification required
- CGPA of at least 8.0 out of 10.0

2) For Students of Non-CFTIs
- Studying Final year B.Tech./BE
- GATE or other equivalent national exam qualification required at the time of joining (July 2016)
- CGPA of at least 8.0 out of 10.0

3.2.2. PhD – External Registration Programme (ERP)

The External Registration Programme (PhD) at IIT Ropar provides opportunities to

1) Individuals employed in R & D environment in scientific Institutions or Industries
2) Young Engineering/ Science faculty members of all Engineering colleges/Universities recognized by appropriate government agencies to pursue research degrees in Science/ Engineering.

   Registration under this program is now open in the following Department for the Session 2016-17 Semester II (January 2016)

   PhD in Engineering: CMEE, CBME, Department of Mechanical Engineering

   PhD in Science: Chemistry

Requirements

- In addition to possessing the academic qualifications mentioned in the respective departments/centers/school, an applicant should fulfill the following requirement also:

1) Professional Experience
- Should have completed full time employment of two years service as on 1st January 2016 in the current organization.

2) Organization / Educational Institution
- Organization / Educational Institution must have atleast 5 years of its existence for sponsoring candidates to ERP progamme. Only persons engaged in R & D work in Technical / Scientific Institutions/ Industries or R & D Establishment are eligible. The Organization should have adequate facilities for carrying our research.

3) Sponsorship
- Unconditional sponsorship by the employer is essential. This sponsorship should be complete in all respects as per the Institute requirements and should be obtained at the time of submitting the application itself. In the absence of this, the application will be rejected.

4) Research Supervisor from IIT Ropar

The applicant should identify a Research Supervisor from the department/school/Centre concerned at the time of submitting the application itself.

5) A. Joint Research Supervisor/Coordinator

(For candidates from R & D Organization/Industries)
- Candidate should identify a joint Research Supervisor/Coordinator from the sponsoring organization (who must be a permanent staff member)
- Willing to supervise/coordinate the research work of the candidate
- Should be from the same establishment in which the candidate is employed.

B. Joint Research Supervisor/Coordinator

(For the faculty members from Educational Institutions)
- The applicant should identify a Joint Research Supervisor/Coordinator from the educational institution (who must be a permanent staff member)
- Willing to supervise/coordinate the research work of the candidate as a supervisor.
- Should be from the same establishment/laboratory in which the candidate is employed

6) On Admission
- Candidate admitted to the program must continue to remain in the same organization and place of work

until the research work is completed. If the candidate is transferred or joins a new organization before the submission of the thesis, his/her registration shall be cancelled.

- Candidate once registered will not be permitted to retain the registration in case he/she goes abroad unless he/she completes the course work and Comprehensive Examination.
- Candidate shall invariably obtain prior permission from IIT Ropar before going abroad.

7) Residence Requirements

Candidate is required to spend a minimum of one semester at IIT Ropar right after admission (during course-work). Otherwise, the registration is liable to be cancelled. The course to be taken by the candidate during this will be finalized by the Research Supervisor from IIT Ropar as per the academic requirements in force.

8) Progress Report

The candidate should submit a report of progress of work done through the research supervisors from IIT Ropar and the organization at the end of every semester. If no report is received two times during the studentship, the registration will be terminated.

9) Selection Procedure

- Advertisement and the short-listed eligible candidates will be called for an written exam or interview or both during December 1-15, 2016.
- The final selection is based on the performance of the candidate in the written exam or interview or both.

Note:

(1) For Humanities and Social sciences: 55% marks (or a CGPA of 6.0 in 10 point scale) in Master's degree in arts. Candidates meeting this requirement must also have valid GATE score/ NET qualification.

(2) 60% is equivalent to CGPA of 6.5 in 10 point scale and 55% is equivalent to CGPA of 6.0 in 10 point scale.

(3) For SC/ST candidates 5% relaxation is allowed for the qualification requirement.
A candidate with a Bachelor's degree from any IIT and having a CGPA/CPI score of 8.00 (out of 10.0) and above are exempted from requirement of GATE qualification to apply.

3.3. Requirements for Institute Teaching Assistantship and its Terms and Conditions

All students admitted to the PhD programme are eligible for institute teaching assistantship/assistantship from other funding agencies. All institute scholars will have to possess valid GATE score/NET qualifications.

The tenure of an institute teaching assistantship shall be as per MHRD guidelines. It will be counted from the date of joining; the initial award shall be for two years and then renewed for subsequent years (subject to satisfactory progress) which is given on the recommendation of the Doctoral Scrutiny Committee "DSC" and approval of the competent authority. The extension will be granted for not more than six months at a time subject to the scholar's satisfactory performance at seminar lecture delivered to an open audience embodying the progress of the work during the last six months in the final year of fellowship. Grant of a six-monthly installment of the tenure is subject to actual requirement of the scholar's work and has to be certified by the DSC after assessing the progress of the work presented through a written report and seminar lecture.

Normally the tenure of the assistantship awarded to a scholar will terminate with effect from the day following the date of submission of thesis, provided he has not left the Institute earlier and has been working in the Department/centre till the date. However, a scholar may be allowed to draw assistantship for a further period of 3 months to complete any unfinished part of study relating to his/her research work, on the recommendation of the supervisor and approval of the competent authority.

The scholar has to be a full time student during this period.

This assistantship for the last month shall be payable subject to foregoing up to the actual date of the scholar's leaving the Institute. The disbursement of last monthly installment of assistantship shall be made, on production of a 'No Dues' certificate from the Hostel, the Library and the Department/School/Centre.

Notwithstanding anything contained in the forgoing sub-paragraphs, continuation of assistantship from month to month is subject to candidate's good conduct and continuous progress of research work to the satisfaction of the Supervisor(s), Head of the Department/center and other authorities.

3.4. House Rent Allowance (HRA)

Candidates are encouraged to stay on campus for PhD programmes. However, in case of unavailability of hostel accommodation, candidates may reside outside. Only those candidates who do not have privilege for hostel accommodation are entitled for HRA (as per government of India rules).

3.5. Leave Rule

PhD students may be granted leave on application to the Head of the Department (HoD) concerned through their respective supervisor(s). The following applies to all leave unless stated otherwise.

- Unless otherwise stated all leave will be approved by the concerned HoD upon recommendation of the supervisor(s).
- The leave application except for Medical leave/Personal leave (in case of emergency) has to be submitted to the department at least 7 working days before the requested commencement of leave.
- The maximum period of registration remains unchanged for all cases.
- Leave will be sanctioned as per calendar year. It will be granted on pro-rata basis to those students who join midway.

a) Personal leave

All Research Scholars under TA/RA/SF are entitled for leave for a maximum of 30 days per year in addition to Public Holidays. This leave can be carried over to the next year and accumulated up to 10 days.

Of the 30 days leave, a maximum of 15 days of leave is permitted in a semester. While sanctioning the leave, HoD must make sure that the TA duties have been taken care of.

b) Withdrawal for a long period (beyond 30 days)

Withdrawal beyond 30 days in an academic year may be granted to a Research Scholar in exceptional cases, by Associate Dean (Research) on the recommendation of DSC.

i) Withdrawal beyond 30 days will be without Assistantship/Scholarship.

ii) The causes of such withdrawal could be due to personal, medical or professional reasons.

iii) Withdrawal may be subject to the approval of the Head of Department / Centre / Programme Coordinator concerned on the recommendation of the supervisor(s); and a proper withdrawal account of each scholar shall be maintained by the Department/ Centre/ Programme Coordinator concerned.

iv) In exceptional circumstances the Associate Dean (Research) may, on the recommendation of the DSC grant a Research Scholar withdrawal without assistantship for a period not exceeding 12 months in the entire period of his tenure for purpose of accepting teaching / research assignment on temporary basis provided the post accepted by research scholar is in the same school or in an educational institution, R & D organization or an industry of repute. When a scholar is permitted such withdrawal without assistantship the enhancement of fellowship or comprehensive examination (in case it has not taken place yet) shall be deferred for the appropriate period. However, the date of termination of fellowship remains unchanged.

c) Duty leave

Duty leave is permissible for performing experiments, attending Schools / Seminars / Conferences / Workshops / Meetings etc. in India or abroad involving an active participation or field trips such as data collection, survey work, etc. on recommendation of the concerned supervisor(s), forwarded by the HoD and subsequent approval by Associate Dean (Research) on a case to case basis.

Before forwarding the application, the concerned HoD must ensure that TA duties have been taken care of.

d) Medical leave

Leave on medical ground, duly supported by a medical certificate, may be granted to a student for up to 10 days per year. Such leave shall not entail any loss of financial assistantship.

e) Maternity leave

Women Scholars are entitled for maternity leave at the full rate for a period of not exceeding 180 days, only once during the tenure of their studentship. This should be supported by medical certificate.

When a scholar is permitted such leave the enhancement of fellowship or comprehensive examination (in case it has not taken place yet) shall be deferred for the appropriate period. However, the date of termination of fellowship remains unchanged.

f) Paternity leave

Male Scholars are entitled for 15 days of paternity leave at a stretch only once during the tenure of their award. This should be supported by a medical certificate.

When a scholar is permitted such leave the enhancement of fellowship or comprehensive examination (in case it has not taken place yet) shall be deferred for the appropriate period. However, the date of termination of fellowship remains unchanged.

g) Vacation leave

Not applicable.

h) Absence without sanctioned leave

Absence without sanctioned leave will entail loss of financial assistantship for the period of absence, and may result in the termination of the student's programme on the recommendation of the DSC and approval of RPEC.

i) Leave for students from external funding agencies

Research scholars getting funded through external funding agencies will be governed by the institute rules. In case of any difference of policy with the funding body, the Senate takes a decision.

j) Registration and fees

A student granted academic leave for one or more semesters, should pay prescribed fees in every semester as per schedule.

3.6. Admission to the PhD Programme

All selected candidates who are Indian citizens and who do not receive any other scholarship or funding will be provided financial support by the Institute. Admission to reserved-category candidates will be as per Government of India notification.

A limited number of Research Assistantships and other financial support for attending conferences within India and abroad are available as per MHRD norms subject to the conditions prescribed in the Institute regulations.

Advertisement for admission to the PhD programme will be published on the website/newspapers (two times in a year) in the month of March for the first semester (that starts in July) of the academic year and in the month of September for the second semester (that starts in January) of the academic year.

3.6.1. Application Procedure

Interested applicants should apply online or send the application form (application form can be downloaded from the Institute website: www.iitrpr.ac.in) dully filled in the prescribed proforma through post on or before the stipulated date mentioned from time to time. The institute will not be responsible for any kind of postal delay. Applicants should explicitly mention their expression of interest to be considered for the research scholar positions as mentioned above. Please mention the name of the department in which you are applying on the top of the envelope.

3.6.2. Admission

The candidates who possess qualifications as mentioned above are eligible for admission to the PhD programme on the basis of: a) Overall academic career and b) Entrance test conducted by the Department/School/Centre.

A candidate who has obtained research scholarship on the basis of NET fellowship examination will also be evaluated on the basis of (a) and (b) above only.

3.6.3. Category of the PhD Candidates

The Institute admits PhD candidates under the following categories:

i) Institute Research Scholars

Students under this category are entitled for Institute Teaching Assistantship as per MHRD, Govt. of India norms.

ii) Govt. / Semi Govt. Fellowship Awardees (CSIR, UGC, DAE, DST, DBT, NBHM, etc.)

These candidates are financially supported under various Govt. / Semi Govt. schemes. The admission procedure and other requirements are same as applicable to Institute Research Scholars.

iii) Research Fellows under Projects/Scheme

The admission procedure and other requirements for research Fellows (JRFs/SRFs) in various projects/schemes in the institute who wish to enroll for the PhD programme are the same as applicable to Institute Research Scholars. They will be paid Assistantship/fellowships as per the norms of the project and sanctioned amount.

3.7. Procedures followed for the PhD Programme

3.7.1. Registration

A candidate who is selected for PhD the programme will be enrolled by paying the requisite fee on the stipulated date. An entry number will be allotted to the candidate after enrollment. In addition to the semester and hostel fee, candidates need to produce medical fitness certificate. The candidate has to carryout research work under a supervisor from amongst the faculty of the Institute. After the enrolment, DSC should be formed within 15 days of the enrolment. The Supervisor is the convener of the DSC and the Head of the Department is the Chairperson of the DSC. The Head of the department constitutes the DSC with the consultation of the supervisor. Three faculty members from the department of the research scholar/other departments of the institute are the members of the DSC. Convener of DSC is required to submit the DSC constitution on the prescribed format to the Dean's office. Course work taken by the candidate will be decided by the DSC members in a DSC meeting and reports are to be submitted in the prescribed format at the Dean's office by the supervisor.

3.7.2. Course Work

All candidates enrolled for the PhD programme are required to complete the following credit requirements towards course work:

Particulars	Credits Requirement
PhD in Science and HSS Departme nts for candidates with M.Sc./MA degree	15
PhD in Science/HSS Department for candidates with M.Tech./M.Phil degree	12
PhD in Science and HSS Departments for candidates with BE/B.Tech Degree	20
Ph.D in Engineering Departments with candidates having ME/M.Tech/MS degree	12
PhD in Engineering Departments with BE/B.Tech/M.Sc. degree	20

3.7.3. Comprehensive Examination

After the successful completion of course work the student needs to appear for comprehensive exam. The comprehensive examination will consist of two parts 1) Course work component 2) Research component or Open Research Seminar. The DSC will conduct this exam as per the departmental guidelines. This comprehensive exam is focused on two aspects: (A) General basic concept of subject and (B) Depth in research subject.

The comprehensive examination (Coursework component) should be completed within 18 months from the date of registration in the PhD programme. This is inclusive of the 2nd attempt for the candidate. Candidates are required to complete the course work with a minimum CGPA of 7.0 and Minimum grade in a subject should be at least 'C'. In case, a student fails in a given course, then DSC can recommend to repeat the course or recommend another course as a replacement to complete the minimum CGPA requirements.

The research component of the comprehensive examination must be completed with in 24 months from the date of registration in PhD programme. It can, however, be clubbed with the enhancement seminar. The candidate

must qualify the exam failing which he/she has to appear for another comprehensive exam within one month. If the candidate is unable to qualify the comprehensive exam, his/her registration for the PhD programme may be cancelled. Comprehensive exam result are to be submitted to the Dean's office in the prescribed format by the supervisor.

3.7.4. Monitoring of the Progress of the Research Scholar

DSC will monitor the progress of the research scholar. The research scholar needs to submit the progress report duly forwarded through research supervisor to Dean's office within 15 days of the end of each semester. If two consecutive progress reports are not submitted/not satisfactory, registration of the student shall be cancelled.

i) In case of joint supervisors, the progress report must be submitted with the signature of all the research supervisors.

ii) The Progress report is not required to submit, in case the student has proceeded on maternity leave, semester leave etc.

iii) In case the supervisor proceeds long leave, the caretaker supervisor will forward the progress report of student.

3.7.5. Confirmation of Candidacy

The candidacy of a student will be confirmed for the PhD degree after successful completion of course work and comprehensive examination. Candidacy for the PhD degree shall be effective, normally from the date of registration and shall remain valid for a period of 07 (seven) years. The candidacy of a candidate may be deferred by the DSC on account of unsatisfactory progress. A candidate is required to submit the thesis before the expiry of the registration period. In the event of the candidate failing to submit the thesis within the period, the registration shall lapse automatically.

3.7.6. Synopsis of Thesis

Prior to the submission of the thesis, the candidate will submit the synopsis of the thesis and present a seminar to an open audience in which besides others the DSC members and an external expert will be present. The choice of external expert will be done by Associate Dean (Research) as per existing norms. The seminar lecture will test the candidate's depth of knowledge and progress in his/her research. The candidate shall be allowed to submit his/her thesis for the PhD degree only when the DSC is satisfied with the work. If the DSC is not satisfied with the quality of the work or the general preparation of the candidate, the candidate will have to appear again for the seminar within a maximum period of six months. The thesis must be submitted within two months of the DSC's approval of the submission on the basis of this seminar.

3.7.7. Thesis Guidelines

Besides a soft copy (CD)/USB storage, a candidate shall submit three copies of the thesis in case of single supervisor and additional copies if there is a joint supervisor, neatly typed or printed and bound in a manner notified separately (Annexure 1). The thesis must contain, besides the test and common matters like bibliography/references and summary/conclusions:

1) A preface/introduction in which the candidate shall state whether the thesis is based on discovery of new facts or new interpretation of established facts by others, or based on exhaustive study and critical analysis of published work of others, or design, or development;
2) Biodata of the candidate within one page (i.e. name, date of birth, educational qualification, research experiences, professional experience, if any, and permanent home address);
3) An abstract of the thesis (about 500 words) with key words (about 20);
4) A certificate (in standard format from the supervisor that (a) the work has been carried out under his/her/their supervision, (b) the candidate has fulfilled all prescribed requirements and c) the thesis which is based on the candidate's own work has not been submitted elsewhere for a degree/diploma.

3.7.8. Submission of Thesis

Subject to fulfilling the course credit requirements and other conditions as may be laid down from time to time, the candidate may submit the PhD thesis (within a minimum period of two years and maximum period of seven years) from the date of registration.

On successful completion of the synopsis seminar, the Research Supervisor will recommend to the Senate a panel of ten experts, from India and/ or abroad, to examine the thesis (not more than 5 persons in the list shall be from India). Two experts, from the panel shall be appointed as 'external' examiners and the supervisor (s) will be the internal examiner (s). The thesis shall be forwarded to all examiners who shall report separately on the thesis and forward their recommendation to the Associate Dean (Research). The Associate Dean (Research)will examine the reports of the thesis examiners and send them to Chairman, Senate. The reports shall thereafter be sent to the Research Supervisor for their perusal and necessary action. There may be four situations arising out of the nature of the reports, and the steps to be taken appropriate to the circumstances shall be as laid down below:

(I) The examiners are unanimous in recommending the award of the degree on the basis of the thesis without any modification. This is a clear case for going in for the final requirement of viva voce.

(ii) The external examiners are unanimous in recommending the award of the degree but have suggested modification and/or have asked for clarifications. The candidate in that case shall make modification and provide the clarifications as suggested within a time to be fixed by the Dean (Academics) which in no case shall exceed six month from the date the communication is sent to the candidate. These may be sent to the examiners, if so desired by them.

(iii) One of the external examiners does not recommend the award of the degree and rejects the thesis while the other external examiner recommends the award. The Dean (Academics) in such a case may either ask the candidate to modify the thesis as suggested within a given time not exceeding six months and send the modified thesis to the same examiner again or recommend to the Senate to appoint another external examiner or send the thesis to him in its original form. The recommendation of this 'third' examiner, at this stage, shall be taken as final.

(iv) Both the external examiners reject the thesis. In the event of a thesis being rejected by both the external examiners the Senate may, on the recommendation of the Dean (Academics), permit submission of a revised thesis on an additional payment of the prescribed fee, after a suitable time to be fixed by the Senate. The observations and comments of the examiners, if any, may be copied and given to the candidate on request. In no case should a resubmission of the thesis without modification along the lines of criticism made by the earlier examiners, if any, may be allowed. The revised Thesis shall be referred for assessment to two external examiners selected from a new panel of ten experts recommended by the Research Supervisor In case both the experts reject the revised thesis again, the thesis will stand rejected.

Once the reports of the examiners have been accepted as satisfactory the candidate will have to defend his/her thesis before a viva voce board consisting of internal examiner & external examiner. In case the Indian 'external' examiner is not available to conduct the viva voce, the Director at his Discretion, may appoint another examiner either from the original panel of thesis examiners recommended by the Research Supervisor or advise that a faculty member from an allied Department/centre of the Institute be appointed as the additional examiner to conduct the viva voce. If the viva board is not satisfied, the candidate has to appear again before the board within the next three months.

The viva voce board shall recommend to the Senate the award of the PhD degree if the viva voce is satisfactory and all the other requirements have been fulfilled.

After the recommendations of the viva voce board either for acceptance of the thesis for the PhD degree or for its rejection/modification have been accepted by the Senate and the Board of Governors or by their Chairman as the case may be, a copy of the reports of the examiners may be issued to the candidate at his request. However, the names of the examiners are not to be disclosed.

On the basis of the report of the Board of Examiners, the Senate decides the student's eligibility for the award of the degree of Doctor of Philosophy.

Nothing contained in these Regulations shall preclude a candidate from publishing/patenting either independently or jointly with the supervisor the result of the work incorporated in the thesis, at any time before

or after submitting the thesis for examination.

3.7.9. Award of the Degree

A student who has completed satisfactorily all the prescribed requirements and has cleared all fees and dues payable to the Institute shall be eligible for the award of the PhD degree of the Institute by the Board of Governors on the recommendation of the Senate.

3.7.10. Official procedures after students join the PhD Programme

Stages	Procedures	Time domain	Concerned Authority
I	(i) Constitution of Doctoral Scrutiny Committee (ii) Submission of Registration form	Within 15 days after Registration	(i) Supervisor (ii) DSC convener to the Academic section
	The approval of the Doctoral Scrutiny Committee will be obtained and the office order will be issued thereafter.	Within a month	Academic section
	The result of the course work	Within 15 days after the end of each semester	Course instructor to the Academic section
	Within 4th semester (preferably during 18-24 months after the registration) the following is to be done The results of the comprehensive written/oral examination and the comprehensive seminar are to be provided in the requisite format. (The maximum period to clear the comprehensive examination is two years)	Before the end of fourth semester after the registration	DSC convener to the Academic section
	Confirmation of Candidacy	Within the fourth semester of enrolment	Dean office
	Progress report submission. The Student with submit the progress report which is duly signed by the Supervisor. If the progress report is not submitted (for any two consecutive semesters), candidate enrolment / registration may be cancelled.	Within 15 days after the end of each semester	To the academic section
	Promotion from JRF to SRF (for the enhancement of the scholarship) and submission of the report in the prescribed format to the Associate Dean (Research)	Within 15 days before the end of the fourth semester	DSC conducts the exam
	Synopsis presentation Thesis to be submitted (within 2 months after synopsis presentation) on the format prescribed in the PhD regulations.		DSC conducts the exam

II	On the successful completion of the synopsis seminar, the Research Supervisor will recommend to the Senate, a panel of ten experts, from India and abroad, to examine the thesis (Five Indian and five foreign experts).	Within 15 days after the synopsis presentation	Research Supervisor to the Dean office
III	Two experts (one from India and one from abroad) shall be appointed as external examiners and the supervisor (s) will be the internal examiner.		Dean Office with the consultation of Senate
	Thesis shall be forwarded to all the three appointed examiners.		Concerned assigned authority
	Acceptance of the report from the examiners		Concerned assigned authority
	Associate Dean (Research) will examine the reports of the thesis examiners and send it to the Director, Chairman, Senate. The reports shall thereafter be sent to the Research Supervisor for their perusal and necessary action.		Dean
	Once the reports of the examiners have been accepted as satisfactory the candidate will have to defend his/her thesis before a viva voce board consisting of internal examiner and external examiner.		Research Supervisor
	Submission of Viva-voce report in the prescribed format		Research Supervisor
	Record book related to research work to be submitted to the Supervisor. Thesis (Hard as well as soft copy of accepted version of thesis) should be submitted to the IIT Ropar Library.		Student to the Library
	Submission of No Dues certificate to the institute		Student to the academic section
	Issue of Provisional certificate		Associate Dean (Research)
	Degree shall be awarded at the annual convocation for the academic session.		Institute

3.8. Information on Departments, Centre and research area

3.8.1. Centre for Biomedical Engineering

Area of Research

Biomedical Imaging, Medical Devices, Biomaterials, Cancer Diagnostics and Therapy

3.8.2. Centre for Materials and Energy Engineering

Area of Research

Materials Science & Engineering, Composite Materials, Ceramics, Advanced Materials, Nanocomposites, multiscale materials modelling, nuclear materials

3.8.3. Department of Chemistry

Area of Research

Catalysis, Electronic Structure Calculations, Inorganic Chemistry, Materials Chemistry, Organic Chemistry, Organometallics, Organic Polymer Synthesis, Reaction Dynamics, Electrochemistry, Fuel Cells, Polymeric Biomaterials, Drug Delivery, PEGylation and Oligonucleotide Chemistry, Supramolecular Chemistry, Solid state Chemistry, Theoretical and Computational Chemistry. Ultracold Chemistry.

3.8.4. Department of Civil Engineering

Area of Research

PhD program has just been initiated in the area of "Modeling and Simulation of Water Resources Systems". Very soon additional research areas shall be introduced.

3.8.5. Department of Computer Science and Engineering

Area of Research

Bioinformatics, Discrete and Combinatorial Optimization, Facility location, Operations Research in Health Care, Real-time systems, Embedded Systems, High-Assurance Systems, Real-time scheduling, Parallel and Distributed Computing, Scheduling Theory, Heterogeneous Computing, Operating Systems, Theoretical Computer Science, Approximation Algorithms, Theoretical Robotics, Computational Geometry, Medical Image Processing and Analysis, Pattern Recognition, Machine Learning, Computer Vision. Cloud computing, software architecture, design patterns, web technologies, big data, knowledge discovery, distributed systems, EAI, IT security, Network science, Cryptography, Evolutionary Psychology.

3.8.6. Department of Electrical Engineering

Areas of Research

Optical Communication, Nano-Photonics and Nano-Optics, Signal Processing, Medical Image Processing, Embedded system design, DSP based system design, Wavelet analysis, VLSI Design, Renewable Energy Systems, Power Network and Optimal Power Flows, Wind Energy Resource Assessment, Wide Area Monitoring and Control of Power Systems, Power System Restructuring, Power Engineering, Power system stability, power system deregulation, Microelectronics.

3.8.7. Department of Humanities and Social Sciences

Areas of Research

English Literature: Gender Studies, Modern Fiction, Postcolonial Studies, Cultural studies, American studies;

Linguistics: Language Processing, Morphology, Optimality Theory, Phonology, Psycho/Neurolinguistics, Typology, Cognitive Sciences; Economics: Econometrics, Applied Econometrics, Macroeconomics, Banking and Finance, Industrial Economics, Panel Data Models, International Economics & Trade.

3.8.8. Department of Mathematics

Area of Research

Algebra, Analysis, Topology, Differential Equations, Mathematical Modeling, Fluid Dynamics, Dynamical Systems

3.8.9. Department of Mechanical Engineering

Areas of Research

Manufacturing Processes, Robot Motion Planning, Modular Design of Manipulators, Surface Engineering,

Thermo-fluid Engineering, Mechanical Design and Analysis, Computational and Experimental Study on Nano Materials, Nano Composites and Nano Structures. Smart Materials and Structures, Energy Harvesting. Fault diagnostics and Condition-Monitoring, Metal Forming, Deformation Analysis.

3.8.10. Department of Physics

Areas of Research

Theoretical Quantum Optics and Quantum Information; Optical Lattice, Laser-matter Interaction, Nanomechanics, Photosynthesis, Spin Systems; Theoretical Nuclear Physics, Particle Physics and Astrophysics; Neutrino Physics, Neutron Star Crusts, X-ray Astronomy, Nuclear Reaction Theory; Thin Film for Renewable Energy; Surface Patterning, Lon Beam Physics, Graphene and 2-dimensional Material, Nano Device; Nanophotonics and Meta-materials, Photonic Cavities and Nano Lasers , Optics in Energy and Bio-Systems.

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4. Course description

4.1. Department of Chemistry

M.Sc. - Core courses

CYL411 Concise Inorganic Chemistry, 3 (3-0-0)

Representative Chemistry of Main-Group Elements: Chemistry of Boron: boranes, bonding and topology of boranes, synthesis and reactivity, carboranes and metallacarboranes. Chemistry of Silicon: organosilicon compounds, silicates and aluminosilicates;Chemistry of halogens and noble gases: recent trends, CFC's and ozone layer.Theories of bonding. Crystal-field and Molecular orbital, effects of ligand-field (Spectrochemical series, consequences of d-orbital splitting). Absorption spectra of metal complexes and magnetochemistry, Reaction mechanism of transition metal complexes and electron-transfer.Unusual Compounds of Main-Group Elements and Transitional metal complexes. Organometallic Chemistry and applications of organometallics in organic synthesis; Role of metal complexes in biology and environment; Introduction of bio-inorganic chemistry: heme, non-heme, Fe-S proteins.

CYL412 Concise Organic Chemistry, 3(3-0-0)

Introduction to organic molecules:

Nature of bonding in aliphatic, alicyclic, aromatic and heterocyclic compounds; Aromaticity in benzenoid and non-benzenoid compounds. Alternant and non-alternant hydrocarbons; Nomenclature of polycyclic compounds including bridged, spiro and other special structures.

Oxidation: With Cr and Mn compounds; with peracids and other peroxides; with periodic acid, Pb(OAc)4, Hg(OAc)2 and SeO2.

Reduction: Catalytic hydrogenation; metal hydride, dissolving metal and hydrazine based reductions. Cram-Felkin-Anh model.

C-C Bond Formation: Acyloin, Aldol, Stobbe, Claisen, Knovenagel and Benzoin condensations, Darzen's glycidic ester synthesis; Dieckmann reactions, Wittig reaction, Reformatsky reaction. Acetoacetic ester and malonic ester synthesis. Acylation reactions. Enamine reactions. Gattermann aldehyde synthesis. Michael and Mannich reactions.

Carbohydrate Chemistry: Introduction, Structural elucidation and some typical reactions of mono and dischharides.

Heterocyclic Chemistry: Furan, Pyrrole, Thiophene, Pyridine, Indole, quinolines etc.

Photo and pericyclic chemistry:

Brief introduction, Norrish type I and type II cleavage, photoreduction, Patterno-Buchi reaction, cistrans isomerisation, Chemistry of vision.

Electrocyclic, Diels-Alder, Sigmatropic and Ene reactions.

Problems: Based on multistep reactions involving C-C bond formation, oxidation and Reduction (to be solved in the class and supplemented by home assignments).

CYL414 An Introduction to Biochemistry ,3(3-0-0)

Pre-requisites : Basic understanding of organic reactions, and structure and function of lipids, carbohydrates, proteins, enzymes, and nucleic acids.

Cellular, chemical, physical, and genetic foundations of life; Role of water and buffers in biological systems; Role of biomolecules, like lipids, carbohydrates, nucleic acids, and proteins, in sustaining life processes; Enzymes and catalysis of

biochemical reactions; Vitamins as coenzymes; and Common metabolic pathways and ATP synthesis.

CYL415 Numerical Methods for Chemists, 3(3-0-0)

Data analysis: Mean and standard deviation; absolute and relative errors; linear regression; covariance and correlation coefficient; Data fitting by least square; Truncation and round-off errors, Step-size dilemma, Difference table (Pascal's triangle)

Numerical Integration: Quadrature rule, Interpolating polynomials (Lagrange's), Weights, Mid-point, Trapezoidal, Simpson's rule of integration, Adams' Predictor-Corrector method. Roots of equations- Newton-Raphson and Secant methods, Bisection and False-point methods, Bracketing method.

Numerical solution of ordinary differential equations- Initial value problems, Euler's method, Taylor and Runge-Kutta methods, Modified Euler method, Error estimates. Curve fitting- Least square fit algorithm, Cubic Splines.

Matrices and Linear systems of equations: Forward, Backward substitution, LU-factorization, pivoting, Gaussian Elimination, Gauss-Jordan Elimination, Jacobi and Gauss-Seidel methods. Eigenvalue problems. Statistical analysis of data.

Vectors and vector spaces, matrices and determinants, eigen values and eigen vectors, similarity transformations, ordinary differential equations- first and second order. Solution of differential equations by power series method: solutions of Hermite, Legendre and Laguerre differential equations, Orthogonality properties and recurrence relations among special functions: associated Legendre functions and Spherical Harmonics. Introduction to Fourier series and Fourier transforms, convolution theorem.

CYL416 Reaction Rates and Classical Thermo-dynamics.,3(3-0-0)

Reaction Rates: Rates of chemical reactions, rate expressions. Methods of determining rates and orders of reactions. Theories of reactions rates and their application in photochemistry, solution kinetics, etc. Kinetics involves in complex reactions, heterogeneous catalysis, enzyme kinetics etc. Potential energy surfaces and reaction dynamics.

Classical Thermodynamics: Concepts involve in thermodynamics, laws of thermodynamics, energy, entropy, availability, partial molar properties, activity, fugacity etc. Thermodynamics involves in chemical/ionic equilibrium, and ideal/non-ideal solutions, and combustion process. Science and engineering applications including thermal analytical techniques based on thermodynamics.

CYL417 Quantum Chemistry & Group Theory, 3(3-0-0)

Review of old quantum theory. Postulates of quantum mechanics, wave functions and probabilities, operators, matrix representations, commutation relationships. Solution of the Schrödinger equation for exactly solvable problems such as particle-in-a-box, particle-in-a-ring, harmonic oscillator, rigid rotor and the hydrogen atom, including shapes of atomic orbitals; orbital and spin angular momenta; Tunneling. Valence bond and Molecular orbital theories, Hückel approximation; approximate techniques: Variational and Perturbation. Applications to Spectroscopy - atomic and molecular structure, molecular spectroscopy. Chemical applications of group theory, symmetry elements, point groups, character tables, selection rules, Woodward-Hoffman rules.

CYP401 Practical – I, 3(0-0-6)

Experiments in thermodynamics, kinetics, phase rule, electrochemistry and exposure to various spectroscopic and analytical characterization techniques.

CYP 402 Practical -2, 3(0-0-6)

Synthesis and characterization of organic compounds, isolation and estimation of proteins and DNA; and Gram staining of bacterial cultures

CYL421 Advanced Organic Chemistry 3, (3-0-0)

Pre-requisites: CYL412

Stereochemistry: Brief Introduction, Dynamic stereochemistry: Conformation and Reactivity. Various chemo, regio and stereoselective reactions.

Reactive Intermediates :

Carbenes and carbenoids

Radicals: Structure, reactivity, selectivity and

mechanisms of radicals and radical based reactions, involving various functional groups. Radical cations and radical anions.

Carbocations: Nonclassical carbocation. Sigma and pi-participation.

Mechanistic and Stereochemical Aspects of: Baeyer-Villiger, Claisen(including Johnson-Claisen, Ireland-Claisen, Eschenomser, Overman modi-fications) Cope, and oxy-Cope, Wittig rearrangements (both 1,2 and 2,3 Wittig rearrangements); ene and metalloene reactions; (2+2), (3+2) and (4+2) cycloadditions; Barton reaction.

Organometallic Chemistry: Mechanism and stereo-chemistry of various reactions. Palladium based reactions such as Heck, Stille, Suzuki, Sonogashira, Buchwald-Hartwig couplings; Tsuji-Trost C-C bond formations; Ni and Sn-catalysed reactions.

Enzymatic Reactions: Mecahnistic and stereo-chemical aspects of hydrolases (including esterases and lipases), oxidoreductases.

Green Chemistry: Concepts and applications Amino Acids and Peptides: Physical properties of amino acids, Synthesis of α-amino Acids and peptides, End group analysis of peptides.Classification and Structures of some natural products such as terpenoids, steroids, alkaloids and prostaglandins.

CYL423 Solid State Chemistry, 3(3-0-0)

Crystalline and amorphous solids; crystal systems, point groups, space groups: methods of characterizing crystal structure, types of close packing - hcp and ccp, packing efficiency, radius ratios; polyhedral description of solids; representative structure types. Preparative methods: Solid state reaction, chemical precursor method, co-precipitation, sol-gel, metathesis, self-propagating high temperature synthesis, ion exchange reactions, intercalation reactions; hydro/solvothermal and high pressure synthesis. Characterization: Thermal analysis: TGA, DTA, DSC. Properties; electrical: Band theory of solids - metals and their properties; semiconductors - extrinsic and intrinsic, Hall effect; thermoelectric effects, insulators - dielectric, ferroelectric, pyroelectric, piezoelectric and multiferroic properties. Magnetic properties: Dia, para, ferro, ferri, and antiferro magnetic types; soft and hard magnetic materials; selected magnetic materials such as spinels, garnets, perovskites, and transition metal- lanthanide compounds; magnetoresistance. Optical properties: Luminescence of d- and f- block ions; structural probes; up and down conversion materials and also, including other important properties of solids.

CYL424 Electrochemistry and Statistical Thermodynamics, 3(3-0-0)

Electrode Kinetics: Electrode/Electrolyte interface-Thermodynamics of Electrified Interfaces, The structure of Electrified interfaces, Electron transfer under an interfacial electric field -Reaction rate on over potentials Derivation of Butler-Volmer Equation and its implications, Tafel plot, Electrode kinetics involving the semiconductor/solution interface, Techniques of electrode kinetics, Multi step reactions.

Statistical Thermodynamics: The statistical method, probability of distribution, Molecular partition functions- Translational, rotational and vibrational partition functions. Internal energy and statistical entropy, Concept of ensembles, Canonical ensemble, Boltzmann distribution, Thermodynamic quantities and canonical partition function. Grand canonical ensemble, Fermi-Dirac and Bose-Einstein distributions. Partition function and their evaluation and relation with thermodynamic properties, evaluation of entropy of gases by statistical method. Real gases, intermolecular potential and virial coefficients. Debye and Einstein theory of heat capacity of solids. Structure and thermal properties of liquids, Pair correlation functions.

CYL426 Coordination Chemistry, 3(3-0-0)

Basic concepts, periodic properties, molecular symmetry, isomerism, HSAB concept, acid and bases, thermodynamic stability, step-wise and overall binding constant, chelate and macrocyclic effect. Structure, bonding and properties of: transition metal complexes, lanthanides and actinides. Theories of Bonding: VBT, CFT and their limitations; splitting of d-orbitals, CFSE of d1 to d10 system. Charge transfer transitions, colors, origin of specters, term symbols, selection rules for electronic transitions, Orgel diagram, calculations of Dq, B and Nephelauxetic effect. Inorganic reaction mechanism: substitution reactions, trans effect, water exchange, hydrolysis, inner and outer sphere electron transfer mechanism, magnetochemistry. pi acceptor ligands, details of transition metal ions, role of metal complexes in biology and environment.

CYL427 Interpretative Molecular Spectroscopy, 3(3-0-0)

Electronic spectroscopy (UV-visible, fluorescence and phosphorescence): Simple chromophoric groups, conjugated and aromatic systems. Characteristic absorption of organic and inorganic compounds. Infrared spectroscopy: Characteristic group frequencies of organic and inorganic molecules. Mass spectrometry, the production and analysis of positive ions, molecular ions, application of isotopic abundance measurements, fragmentation modes and rearrangement of ions. Mass spectra of certain chemical classes. Nuclear magnetic resonance spectroscopy of compounds containing 1H, 13C, 19F and 31P nuclei. Identification of organic and inorganic compounds using combination of spectral data.

CYP403 Practical -3, 3(0-0-6)

Experiments in inorganic, organometallic chemistry and solid-state materials synthesis, spectroscopic characterization, evaluation of absorption and emission properties of materials, solvent extractions, qualitative and quantitative inorganic analysis.

CYP404 PracticaL -4, 3(0-0-6)

Computational methods involving structure optimization, property calculation, orbital energies, potential energy surface computation and data analysis with error minimization followed by curve fitting.

CYL511 Instrumental Analysis , 3(3-0-0)

Principle, Instrumentation, Applications, Analysis and Interpretation of the data for the following techniques: AAS, XRD, Thermoanalytical techniques: Differential Scanning Calorimetry (DSC), Thermogravitry (TG), Thermo mechanical analysis (TMA): Principles instrumentation and applications Microscopy: SEM, TEM, Cryomicroscopy, AFM, confocal microscopy.

Electron Spectroscopy: X-ray photoelectron (XPS) and Auger electron spectroscopy (AES), secondary ion mass spectrometry.

CYL513 Polymer Chemistry, 3(3-0-0)

Pre-requisites: CYL412, Concise Organic Chemistry

Introduction and applications of polymers, molecular weight distributions, various experimental methods (GPC/SEC, solution viscosity, VPO, light scattering) to determine relative and absolute molecular weight distributions, chain growth and step growth mechanisms and kinetics, ionic polymerization, living polymerization, stereochemistry of polymers, free radical copolymerization (random, block, alternate and graft copolymers), kinetics and mechanisms of free radical copolymerization, polymerization conditions and polymer reactions, thermal, mechanical and solution properties of polymers, thermoplastics, thermosets and elastomers, conducting polymers, branched polymers (star, dendritic and hyperbranched polymers).

CYL514 Environmental Chemistry, 3(3-0-0)

Concepts and terms, segments of environment, cyclic pathways in the environment, the chemistry of natural water and determination of its major parameters, pollution and purification of water, chemosensors and biosensors, concepts of water treatment: toxic heavy metals, anions, surfactants, detergents, pesticides, DDT and other toxic compounds of environmental concern. Air pollution classification, Biochemical effects of hazardous air pollutant, Ways to reduce exposure, exhaust emission control, Air pollution control method, Control device and equipments, Particulate control, Vehicular emissions and control, Air pollution triggered by the conventional energy production and environment friendly method for the energy production. Meteorology transport and dispersion of air pollution: Adiabatic Lapse rate and its mathematical derivation, Atmospheric stability, Introduction to hazardous waste management and resource conservation, Atmospheric Chemistry, Solid, Liquid, other waste management.

CYL515 Bio-organic Chemistry, 3(3-0-0)

A comparison of organic reactions carried out in laboratory and in biological systems; nature of biomolecular interactions; amino acid, peptide and protein synthesis and properties; enzyme mechanisms, catalytic side chains and cofactors; stereospecificity and rate enhancement in enzyme catalysed reactions; nucleoside, nucleotide, and nucleic acid; nucleosides as therapeutic agent and target of therapeutic agent.

CYT 530 Project – I, 10(0-0-20)

Methodology in research, original work of acceptable standard. Dissertation with presentation.

CYS 500 Seminar, 2

Current topics in chemistry including related topics in project work undertaken.

CYT 540 Project – II, 15(0-0-30)

Pre-requisites: Nil

Methodology in research, original work of acceptable standard. Dissertation with presentation.

CYT 599 MS Thesis, 40 (0-0-40)

Methodology in research, original work of acceptable standard. Thesis with presentation will be evaluated by the committee.

Elective Courses (M.Sc./PhD)

CYL601 Concepts in Physical Chemistry, 3 (3-0-0)

Theory of reaction rates, Kinetics of complex reactions, Reaction kinetics in solution and surfaces, Different types of reactor system, and selection of reactor based on reactions. Thermodynamics and its usefulness, Laws of thermodynamics, Maxwell relation, Gibbs-Helmholtz equation, Van't Hoff isotherm, Clapeyron-Clausius equation, Chemical Potential, Thermodynamics of Mixing, Fugacity. Electrolytic conductance and transference, EMF of reversible cells, concentration cells, liquid junction potential, potentiometric titrations, overvoltage, and polarography. Ideal and Real solutions, Raoult's law, Colligative properties of Solution, Nernst Distribution Law, Ionic Equilibrium, Concept of pH and Solubility product. Failures of classical mechanics and introduction to quantum principles, Schrödinger equations for hydrogen atom, approximate methods. Concepts involved in solid state chemistry, Crystalline and non-crystalline materials, Metallic crystal structures of cubic and hexagonal types, Polymorphism and allotropy, Ceramic crystal structures of AX, AX2 , ABX2 and AB2X4 types, Silicate ceramics, Defect in crystal structures.

CYL602 Concepts of Organic Chemistry, 3 (3-0-0)

C-C bond formation: Alkylation of enolates, enamines and hydrazones, organometallic reagents; Grignard, organo lithium, cuprates, Umpolung, heteroatom stabilized anions, rearrangements; sigmatropic, ene reaction.

C=C bond formation: Aldol Condensation, Wittig Reaction, Peterson Olefination, Julia-Lythgoe Olefination, Carbonyl Coupling Reactions (McMurry Reaction), Tebbe Reagent, Shapiro and Related Reaction, Elimination and Dehydration, From Diols and Epoxides, From Other Alkenes-Transition Metal Catalyzed Cross-Coupling and Olefin Metathesis.

Oxidations: Metal Based Reagents; Chromium Reagents, Manganese Rgts., Silver, Ruthenium, other metals, Non-Metal Based Reagents; Activated DMSO, Peroxides and Peracids, Oxygen/ ozone, others.

Reductions: Hydrogenation, Boron Reagents, Aluminium Reagents, Tin Hydrides, Silanes, Dissolving Metal Reductions.

Functional Group Interconversions: sulfonates, halides, nitriles, azides, amines, esters and lactones, amides and lactams.

Protecting Groups: Hydroxyl groups, Ketones and aldehydes, Amines, Carboxylic Acids.

CYL603 Concepts of Inorganic Chemistry, 3 (3-0-0)

Use of electrochemistry in inorganic chemistry; some useful aspects of main group chemistry; Coordination Chemistry:- Bonding, Spectra, Magnetism, Structure and Reaction Mechanism, Supramolecular Chemistry, Molecular Magnetism; Organometallic Chemistry, Introduction to catalysis, Inorganic Chemistry of Biological systems.

CYL604 Electronic Structure Calculation, 3 (2-0-2)

Review of the basics of quantum chemistry. The Born-Oppenheimer approximation. Semi-empirical and Ab initio methods. Molecular dynamics. Variational methods. Hartree-Fock approximations. Self-consistent field method. Restricted and unrestricted Hartree-Fock. Gaussian- and Slater basis functions. Hartree-Fock-Roothaan method. Correlations: Many-body perturbation theory, Configuration interaction and Coupled-Cluster methods. Density-functional theory: Local density approximation (LDA). Beyond LDA. Hybrid methods. The Mulliken charges, Orbital population. Vibration analysis. Plane wave formalism. Potential energy surfaces and Quantum dynamics. Review of commercial and non-commercial codes for ab initio electronic structure calculations.

CYL605 Quantum Molecular Reaction Dynamics, 3 (3-0-0)

Macroscopic and microscopic processes - Cross section and impact parameter, Relationship between rate constants and cross sections, Attractive interaction potentials in bimolecular reactions, Determination of cross sections.

Potential energy surfaces - Two dimensional representations, Features on potential energy surfaces, Experimental probing of potential energy surfaces and reaction mechanisms, Molecular dynamics calculations.

Transition state theory - Partition functions and chemical equilibrium, Transition state theory (TST), Application of TST to unimolecular decomposition, RRKM theory

CYL611 Advances In Catalysis, 3(3-0-0)

Pre-requisites: Instructor decides

Basic principles involves in homogenous catalysis, heterogeneous catalysis, phase transfer catalysis, ionic liquids, electrocatalysis etc. Principles of Green chemistry. Application of catalysts in petrochemical industry, reforming and refining, value added chemicals, environmental protection, autoexhaust catalysts, fuel Cell, biodiesel production etc.; Catalysts poisoning and regeneration. Some selected category of homogenous and heterogeneous catalysts from recent literature. Mechanistic investigations using in-situ spectroscopic techniques. Analytical techniques to monitor the progress of catalytic reactions.

CYL612 Molecular Recognition, 3(3-0-0)

Supramolecular Chemistry, EDTA – a classical supramolecular host (crown ethers, lariat ethers, podands, cryptands, spherands, calyx[n]arenes), nature of non-covalent interactions, co-operativity, chelate effect, pre-organization, receptor design, synthetic strategies for receptor development cation and anion recognitions and receptors for ionpair recognition, Membrane Transport, Solvent extraction, Factors effecting the solvent extraction and membrane transport.

CYL 613 The Chemistry of Metal Carbon Bond, 3 (3-0-0)

Bonding models in compounds with M-C and M-M bonds, Applications of these compounds in catalysis and organic synthesis, organometallic polymers. Organometallic chemistry of transition metals – Introduction-donor/acceptor ligands, organometallic catalysis –Oxidative Addition and reductive elimination, Hydrogenation, Cross coupling reaction, C-H activation, Olefin Metathesis – olefin isomerization.

CYL614 Principals of Biochemistry, 3 (3-0-0)

Cellular, chemical, physical, and genetic foundations of life; Role of water and buffers in biological systems; Carbohydrates and glycoconjugates on cell surfaces; Lipids, biological membrane and transport, and biosignaling; Nucleic acids and recombinant DNA; Protein structure and function, and enzymes; Carbohydrate metabolism, electron transport, oxidative phosphorylation, photophosphorylation, lipid, amino acid, and nucleotide metabolism; Hormonal regulation and integration of metabolic pathways and metabolic disorders; Genes and chromosomes, DNA metabolism (replication, repair, and recombination), RNA metabolism (transcription), protein metabolism (translation), and regulation of gene expression.

CYL 621 Advanced Quantum Chemistry, 3(3-0-0)

Pre-requisites: CYL425 Quantum Chemistry and Group Theory

Time-independent perturbation theory, degenerate states, variational method, Hellmann-Feynman theorem. Spectra and structure of helium atom, term symbols for atoms, Hartree-Fock equations, self-consistent field method and coupling schemes. Born-Oppenheimer approximation, hydrogen molecule ion, hydrogen molecule: valence bond and molecular orbital methods, polyatomic molecules and hybridisation. Conjugated p-systems and Huckel theory, frontier orbital theory, semi-empirical CNDO and ab initio methods, configuration interaction. The concept of groups, symmetry operations and symmetry elements in molecules, matrix representations of symmetry operations, point groups, irreducible representations and character tables.

CYL622 Applied Electrochemistry, 3(3-0-0)

Conversion and Storage of Electrochemical Energy: Fuel Cells and Batteries

Corrosion: Introduction to corrosion, Forms of Corrosion, Corrosion monitoring and prevention methods

Controlled Potential techniques: Polarography, Pulse voltammetry, Stripping analysis, Flow analysis

Environmentally Oriented Electrochemistry: The

environmental Situation, Electrochemical Advantage, photoelectrochemical cells, The fixing of CO2, Removal of Wastes.

CYL623 Heterogeneous Catalysis And Interfacial Phenomena, 3(3-0-0)

Pre-requisites: Instructor decides

General aspect of catalysis at surfaces, adsorption process at solid surfaces, thermodynamics and kinetics of surface catalyzed reactions, essential steps in heterogeneous catalysis, adsorption isotherms. Introduction to solid state chemistry with respect to heterogeneous catalysis. Creation of catalytic surfaces. Destructive and non-destructive techniques for surface investigations. Catalysts deactivation and regeneration. Some well known catalytic applications of heterogeneous catalysts in petrochemical industry and fine chemical synthesis including metal mediated organic transformations.

CYL624 Chemistry Of Natural Products, 3(3-0-0)

Pre-requisites: CYL412, CYL421

Biosynthetic aspects and Synthesis of selected natural products of biological and structural importance: Discussions on synthetic methods, strategies towards these natural products mostly in chiral forms will be discussed in detail. The natural products include carbacycles and heterocyclic moieties containing structures ranging from 3-memebered to macrocyles, and complex natural products such as Taxol, rapamycin, lejimailde B etc.

CYL625 Inorganic Material Chemistry, 3(3-0-0)

Pre-requisites: CYL411 for MSc students: Concise Inorganic Chemistry

Synthesis, structure, properties, structure-property correlations and potential applications of inorganic solid state materials. Inorganic clusters, organic-inorganic hybrid materials, molecular clusters to materials. Inorganic materials for energy storage and sustainability including nanostructured materials. Porous materials: Hydrogen economy, CO2 sequestration applications. Magnetic materials: single molecule magnets, photo-luminescent materials based on lanthanide compounds, thermoelectric materials, ferroic and multiferroic compounds. Other relevant examples from the recent literature.

CYL626 Synthetic Organic Chemistry, 3(3-0-0)

Pre-requisites: CYL412, CYL421

Asymmetric Synthesis, Organo Catalysts, Metathesis and Application. Principles of retrosynthetic analysis: Linear and convergent synthesis, Synthesis under steric control, Regio- and stereoselective synthesis, Basic synthetic methods. Methodolgies for the construction of 3-7 membered homo- and hetero-cyclic rings, medium and large rings. Application in natural product synthesis.

CYL701 Molecular Spectroscopy, 3 (3-0-0)

Infrared Spectroscopy: Vibrational spectra and rotational spectra-selection rule and energy calculation, Instrumentation, Examining IR spectra, Characteristic functional group IR analysis, In-situ IR spectroscopy for the identification of reaction intermediates etc.

UV-Vis: Instrumentation, Electronic transitions, Woodward-Fisher-Scott rules, application to various organic functional groups, differentiation of position isomers, stereo-chemical factors effecting electronic spectra.

Fluorescence spectroscopy: Instrumentation, Excitation and relaxation processes, Mechanism of PET, ICT, FRET; stacking, Keto-enol tautomeriam, applications.

NMR: Instrumentation, Chemical and magnetic non-equivalence – chemical shift (factors effecting) – coupling constant – spin splitting – spin decoupling or rapidly exchangeable protons – relaxation process – NOE, 2D NMR.

X-Ray Diffraction: X-rays, Diffraction, Types of solid and order, Brief-introduction of crystal structure, Diffraction from crystalline materials-Braggs law, Practical aspect of X-ray diffraction, Crystal structure determination of cubic and hexagonal structure, Determination of Crystallite size etc.

Mass Spectroscopy: Ionization methods, Mass Analyzer, Fragmentation and Interpretation, Hyphenated MS Techniques.

CYL702 Chemistry of Novel Heterogeneous Catalytic Materials,3 (3-0-0)

Conventional synthesis methodology: precipitation and co-precipitation, sol-gel process, soft template method, hard template method etc. Concept of synthesis of zeolite, ordered mesoporous materials, pillared clays, nanoporous carbon materials and metal oxides. Synthetic methodology for supported catalysts: deposition-precipitation, ion-exchange and

impregnation, grafting and anchoring of transition metal complexes to inorganic oxides, immobilization in porous matrix. Spectroscopic techniques for the physico-chemical characterizations of materials. Selected catalytic and sensing applications of these novel materials.

CYL703 Strategies in Supramolecular Chemistry ,3 (3-0-0)

Molecular Devices, Molecule- Based Electronics, Molecular Analogues of Mechanical Machines, Crystal Engineering, Biological Inspiration for Supramolecular Chemistry, Semiochemistry in the Natural World, Biochemical Self-Assembly, Solid-State Inclusion Compounds, Network Solids, Self-Assembly, Zeolites, Metal-Organic Frameworks, Molecular Knots and Nanochemistry.

CYL704 Chemical Synthetic Strategy of Organic Reactions, 3 (3-0-0)

Cycloaddition Reactions – Principles, Mechanism (metal mediated and catalytic version), Applications, Catalytic cycles, Ligand designing for catalytic cycloaddition reaction, Click chemistry, Pauson-Khand reaction and their applications. Asymmetric catalysis, Macromolecules synthesis, Organo catalysts, Metathesis and their applications, Photon induced electron transfer reactions. Strategic application towards natural products synthesis.

CYL705 Bioconjugates: Techniques and Applications, 3 (3-0-0)

Bioconjugates, rationale for bioconjugate synthesis, comparison with prodrugs, influence of bioconjugation on pharmacokinetic properties with emphasis on drug targeting, and an overview on general use of bioconjugates in diagnostics, therapeutics, and prophylaxis

Solid-phase and solution-phase bioconjugation, chemoselectivity, role of non-degradable and degradable linkers, and chemical linkages used in bioconjugation

Biophysical techniques used for bioconjugate purification and characterization

Antibody and enzyme, protein, nucleic acid, carbohydrate and lipid, polymer conjugates, and their applications

Evaluation of bioconjugate activity in vitro and in vivo Biofunctionalization of surfaces.

CYL706 Advances in AB Initio Methods, 3 (3-0-0)

Pre-requisites: Instructor decides

Ab initio methods covering areas such as the correlation technique, Perturbation theory, the Generalized Valence Bond method, Many electron wavefunctions, Hartree-Fock Approximation, Multi-Configurations Self Consistent Field, Configuration Interaction, Coupled Cluster theory, Pair and Coupled Pair Theories, Many body Green Function.

CYL707 Non-adabatic effects in chemical dynamics, 3(3-0-0)

Pre-requisites: Instructor decides

Mathematical framework to treat electronic NACTs and their conical intersections, concepts of adiabatic and diabatic frameworks. Non-adiabatic transition: Landau-Zener-Stueckelberg Theory, Rosen-Zener-Demkov Theory, Coriolis Coupling and Dynamical state representation, Solution of linear curve crossing problem, Non-adiabatic Tunneling, Non Curve-crossing, Two-state theory for Time-dependent processes, Multi-dimensional problems, Conical Intersection, Semiclassical Methods including Trajectory Hopping method, Bound states in Continuum.

4.2. Department of Civil Engineering

PhD courses

CEL601 Modelling, Simulation and Optimization, 4 (3-1-0)

System and Models:

System and system modeling : Classification of models: physically based and black box, linear and non-linear, time - invariant and time- variant, lumped, state space and distributed; Model parameters; Direct and inverse problems; Role of optimization.

Optimization:

Linear, Non-linear and Dynamic programming; Analytical, gradient based and soft computing algorithms Regression Analysis: linear and multiple, tests of goodness of fit, parsimony criterion

Model Building:

Choice of Model Structure: A priori consideration, selection based upon preliminary data analysis, balance concept, comparing model structures,

parsimony criterion; Model calibration: Role of historical/experimental data, direct and indirect methods, validation

Simulation:

Random variable: Discrete and continuous, probability density and distribution functions, expectation and standard deviation, covariance and correlation, stochastic and Markov processes, commonly used theoretical probability distributions, fitting distribution to raw data, Chi-square and Kolmogrov- mimov's tests of the goodness of fit, Central limit theorem, algorithms for generation of realizations of random variables and stochastic processes; Monte Carlo simulation: Basic concepts, generation of realizations of forcing function, simulation of output realizations and their statistical interpretation, evaluation of definite integrals, examples.

4.3. Department of Computer Science & Engineering

MS (Research) and PhD Courses

CSL601 Computational Complexity, 3(3-0-0)

Diagonalization, Space Complexity, Time Complexity, Polynomial Hierarchy and Alternations, Boolean Circuits, Interactive proofs, Cryptography and One-way functions, Introduction to PCP Theorem and hardness of approximation. Lower Bounds for Decision Trees. Circuit Lower Bounds, Proof Complexity. Lower Bounds in Algebraic Models of Computation. Complexity of Counting. Natural Proofs. Pseudorandom Constructions: Expanders and Extractors.

CSL602 Computational Geometry,4 (3-0-2)

Duality between points and lines, Geometric Searching: Point location, Slab and Chain methods, Planar Separator methods, Multidimensional binary tree (k-D trees), Segment trees, Range trees, Iterated Search and Fractional Cascading, Convex hulls: Graham`s Scan, Jarvis's march, Divide-and-conquer algorithms. Gift-wrapping method, Convex hulls in three and more dimensions, Clustering, Closest Pair Problem, Locus Approach, Voronoi Diagrams, Computational aspects of Voronoi diagrams, Higher-order Voronoi diagrams, Euclidean Minimum Spanning Tree problem, Euclidean Traveling Salesman problem, Hidden Surface problem, Linear Programming, The rectangle intersection problem, Randomized Algorithms in Computational Geometry: Random Sampling, Incremental Construction and Backward Analysis, Combinatorial and discrete geometry.

CSL603 Machine Learning, 4(3-0-2)

Prerequisite: CSL201

Linear models for regression-maximum likelihood estimation (MLS), least squares, regularized least squares, Linear models for classification - discriminant functions, Fisher's linear discriminant, logistic regression, Bayesian learning -Bmaximum a posterior (MAP) estmation, naïve Bayes classifier, discrete and continuous attribute scenarios, Neural networks -fee -forward networks, error back propagation, regularization in neural networks, Kernel methods -radial basis function networks, support vector machines (SVM), multiclass SCMs, relevance vectors machines (RVM), Non - parametric methods - K-nearest neighbours, Parzen windows, Graphical models - Bayesian networks, Markov random fields, inference in graphical models, Combining models - boosting, bagging, committees, Model selection - performance evaluation metrics, experimental design, clustering-K-Means clustering, mixture of Gaussians, expectation maximization for mixture models (EM), Hierarchical clustering, Dimensionality reduction - principal component analysis, linear discriminant analysis.

Laboratory exercise will emphasize implementation and analysis of machine learning algorithms in matlab/R/octave.

CSL604 Artificial Neural Networks,3 (3-0-0)

Neuron models, single layer networks and unconstrained optimization methods, LMS, perceptrons, multilayer perceptrons, back-propagation, generalization and overfitting with MLP, regularization and cross-validation, optimization methods for MLPs, radial basis function networks, The self organizing map (SOM), variants of SOMs, Learning vector quantization, temporal processing with feedforward networks, hopfield network,boltzmann machine, recurrent networks, deep learning networks.

CSL611 Real-Time Systems, 4 (3-0-2)

Typical Real-Time applications, hard versus soft real-time systems, a reference model of Real-Time

systems, Real-Time scheduling, priority driven scheduling of periodic tasks, scheduling aperiodic and sporadic jobs in priority driven systems, multiprocessor scheduling, real time communication and operating systems.

CSL612 Artificial Intelligence, 4 (3-0-2)

Search methods, A*, heuristic functions, local search, search trees, game playing (minimax search), constraint satisfaction, Knowledge representation (propositional, first order), knowledge inference, planning, reasoning with uncertainty, Bayesian networks, Dempster-Shafer theory, HMMs, learning, PAC learning, artificial neural networks, inductive logic programming statistical learning.

CSL613 Algorithms in Bioinformatics, 4 (3-0-2)

Primer on molecular biology, motif finding, global and local sequence alignment, multiple sequence alignment, partial and double digest problem, genome rearrangements, phylogeny problems (large and small parsimony), RNA folding, protein folding, Comparative Genomics, SNPs, analysis of Microarray data.

CSL614 Computer System Security, 4 (3-0-2)

This course will provide a broader understanding of various security aspects relevant for personal and enterprise software systems. Some of the topics covered in this course are: Need and goals for computer security, security threats. Building blocks for cryptography: symmetric and asymmetric key cryptography, cryptographic hash functions, digital signature schemes etc, with representative applications for each. Problems in network security; kinds of attacks, PKI, key exchange protocols, example protocols such as PGP, Kerberos, IPSEC/VPN, SSL, S/MIME etc. Protocol vulnerabilities: examples of protocol vulnerabilities such as in TCP/IP, denial of service attacks etc. Tools for network security such as firewalls and intrusion detection systems. Security in operating systems: models for access control, confidentiality, integrity, and hybrid models of access control such as Bell-LaPadula, Biba, Chinese Wall etc., discretionary v/s mandatory access control, low-level protection mechanisms. Malicious code such as viruses, worms, Trojan horses; how they work and how to defend against them. We will also discuss some case studies such as Android security model, Java access control policy specifications, SELinux security model and implementation. Topics such as program flaws/bugs which have security implications such as buffer overflows, race conditions etc. will also be discussed.

CSL615 Advanced Image Processing, 4 (3-0-2)

In-depth study of advanced methods and research topics of current interest in image processing and analysis. Topics include, but are not limited to: shape representations, deformable models, statistical shape analysis, scale-space, deterministic and stochastic spatio-temporal image models, transform domain processing, robust statistics and non-linear digital filtering. Applications to image restoration, registration, enhancement, segmentation, motion estimation, image compression and tomography.

CSL631 Physics of Medical Imaging, 3 (3-0-0)

The course provides the necessary physics background that underpins day-to-day medical imaging physics activities. It is aimed primarily at new entrants to the profession, but should be of benefit to post-graduate students of postdoctoral research workers, wishing to deepen or re-establish their understanding of the physics of medical imaging. This course introduces the physics behind most of the common medical imaging modalities including x-ray, ultrasound, CT, PET, SPECT, optical imaging and MRI. There is emphasis on the physics of MR in this course as this is an active area of research in the field. Some math is required, Fourier Transform theory is helpful, but it will be reviewed in the course. The course will provide the student with a good understanding of the strengths and weaknesses of the different imaging modalities, what areas are still being developed, and the key applications of each modality.

CSL701 Approximation Algorithms,4 (3-0-2)

Combinatorial Algorithms: Set Cover, Steiner Tree, Traveling Salesman Problem, Multi-way cut, Knapsack, Bin Packing, Scheduling, Euclidean Traveling Salesman Problem. LP-based Algorithms: Set Cover, Maximum Satisfiability, Scheduling, Multi-cut and Integer Multi-commodity Flow, Multi-way Cut, Sparsest Cut, Steiner Forest, Steiner Network, Facility Location. Semidefinite Programming: Max Cut, 2-Satisfiability. Approximation of Counting problems, Hardness of Approximation.

CSL702 Randomized Algorithms, 4 (3-0-2)

Moments and Deviations, Tail Inequalities, Probabilistic Method, Markov Chains and Random Walks, Polynomial Identity Testing, Perfect Matchings, Interactive Proof Systems, Randomized Data Structures: Skip Lists, Hash tables, Universal hash functions and their applications. Randomization in Geometric Algorithms. Randomized Algorithms for Minimum Spanning Tree, Min-Cut and All-pairs Shortest Paths. Approximate Counting: Counting Perfect Marchings in bipartite graphs. Randomized Parallel and Distributed Algorithms: Maximal Independent Set. Number Theory: Randomized Primality Testing.

CSL703 Combinatorial Optimization, 4 (3-0-2)

Linear programming, Simplex Algorithm, Duality, Computational considerations for the Simplex algorithm, The primal-dual algorithm, Primaldual algorithms for maximum flow and shortest paths, Ellipsoid Algorithm, Interior-point methods, Minimum Spanning Trees, Matroids, Shortest Paths, Dijkstra's Algorithm, Maximum flow, Ford-Fulkerson Algorithm, Edmonds-Karp Algorithm, Push-Relabel maximum flow algorithms, Multi-commodity flows. Minimum Cost Flow: Primal dual algorithms, Bipartite matching, Algorithms for matching in general graphs, Weighted bipartite matching, Nonbipartite weighted matching problem, Integer programming, Total unimodularity, Gomory cuts, Cutting plane methods and branch-and -bound. NP-completeness and NP-complete problems.

CSL704 Advanced Operating Systems, 4 (3-0-2)

Topics include, but are not limited to: distributed operating systems, fault tolerance, synchronization, communication, distributed and shared memory, recent research breakthroughs in operating systems research.

CSL705 Constraint Programming, 4 (3-0-2)

Constraint satisfaction, propagation, search algorithms, global constraints, interval constraints, symmetry in constraints, constraint logic programming, applications to scheduling, planning, routing etc.

CSL706 Advanced Software Architecture, 4 (3-0-2)

This course is intended to provide the needed breadth as well as depth in software architecture concepts and practices. Such knowledge is required to build dependable complex software systems. Some of the topics that we will study in this course are: What is software architecture and its role in software engineering, Architectural styles and techniques for designing and implementing them, Models for characterizing and reasoning about architectures, Understand system qualities such as security, performance, and reliability, How to use quality specifications to drive system design, Documenting software architecture, Evaluating software architecture, Architecture reuse. Design activities will be centered around the above-mentioned topics, but in context of some practical/contemporary problem.

CSL707 Advanced Topics in Contemporary Computing Platforms, 4 (3-0-2)

Enterprise software applications today handle massive amounts of data. Their availability, scalability and other quality requirements have become much more demanding, which has lead to the overall increase in complexity of such applications. At the same time, the computing platforms also keep evolving B virtualization based and cloud computing platforms are some of the examples. Major goal of this course is to impart some experience to the students in dealing with the design issues relevant to modern enterprise class of application. Emphasis is on imparting skills that will allow students to leverage the contemporary computing platforms such as cloud to address the above issues. Design activities will be centered around the above-mentioned topics, but in context of some practical/contemporary problem.

CSL708 Advanced Topics in Internet Technologies, 4 (3-0-2)

The Internet is being used for a wide variety of application areas such as e-publishing, e-commerce, open learning etc. The goal is to give students some experience in dealing with those challenges that are unique to Internet based software systems. Some of the key topics include: Concurrency in Internet applications, Handling unpredictable load variations, Information security issues, Reliable and stateful user experience on top of unreliable connections and stateless protocols, Middleware frameworks for building Internet applications, Leveraging modern computing platforms such as cloud, Supporting multi-modal user interfaces. This course will offer

significant hands-on activities for building Internet applications. Design activities will be centered around the above-mentioned topics, but in the context of some practical/contemporary problem.

CSL709 Network Science, 4 (3-0-2)

Milgram's small world experiment (6 degrees of separation), Properties of real world networks and what do they hint? , Influence in social networks, strength of weak ties, modeling economic systems, community detection in networks, modeling the spread of epidemics in human networks, centrality measures and their applications, webgraphs: 2 pivotal results/observations, Navigation on networks.

CSL710 Algorithms Exemplified, 4 (3-0-2)

Bare essential conceptual details of the problem, Programming techniques that reap better insight into the problem, Benevolent tools that are user/programmer friendly to solve the problem: Data structures, Sorting and Searching, Techniques in Linear Algebra, Optimization Techniques, Fourier Transforms. Students who are expected to perform data analysis/programming will find the course indispensable. While 70% of the course will comprise of most frequently used tools/techniques the rest 30% will be tailored to the needs of the student in accordance to the branch/discipline he/she belongs.

CSL799 Independent Study, 4 (3-0-2)

This course will contain material that is research related, and not offered in other courses. A course outline along with details of the work to be performed one independent study can count towards the degree requirements.

CSL712 Advanced Machine Learning, 3 (3-0-0)

Advanced computational approaches to learning, Latent Models, Bayesian Inference, Exact Inference, Variational Inference, Time Series Prediction, Hidden Markov Models, Dynamic Bayesian Networks, Markov Random Fields, Kernel Methods, Advanced Neural Networks, Transfer Learning, Active Learning, Deep Learning, Collaborative Filtering, Boltzmann Machines, Feature Selection, Dimensionality Reduction, Manifold Learning, Nonnegative Matrix Factorization and Spectral Clustering.

CSL809 Special Topics in Complex Networks, 4 (3-1-0)

This is special topic course in complex networks with the emphasis on centrality measures, community detection and contagion dynamics on a complex network. The syllabus comprises of nearly 30 papers that are included in the refrences section. This course assumes that the student is familiar with all the concepts that are part of CSL 709 network science course.

CSL811 Special Topics in Social Computing, 4 (3-1-0)

Prerequisite: Network Science (CSL 709)

Introduction to social computing, Crowdsourced Platforms, Twitter Behaviour and Social Structure, data mining and knowledge discovery of social interactions, signals and data that are the byproduct of social media services such as search engines social network sites, blogs, micro-blogs, wikis, etc. The course topics include, but are not limited to: web data mining, knowledge discovery on the web, web analytics, web information retrieval, ranking algorithms, recommender systems, human computation, models and theories about social networks, large graph and link-based algorithms, social marketing, monetization of the web, security/privacy issues related to social computing.

4.4. Department of Electrical Engineering

MS (R) Courses

EEL611 Advanced Physical Electronics, 3 (3-0-0)

Review of quantum mechanics, E-k diagrams, effective mass, electrons and holes in semiconductors, band diagram of silicon, carrier concentration, carrier statistics, career transport, junction devices(P-N junction, Metal –semiconductor junctions, solar cells etc), MOS capacitor as a building block for MOSFETs (Ideal MOS, real/Non ideal MOS, band diagrams, C-V characteristics, electrostatics of a MOSCAP), MOSFET, I-V characteristics, scaling, short channel and narrow channel effects, high field effects,

Transport phenomenon in nanoelectronic devices (CNTFETs, Graphene Transistors)

EEL612 Advanced Semiconductor Devices, 3 (3-0-0)

MOS Capacitor as a building block for MOSFETs (Ideal MOS, Non-Ideal MOS), CV and IV technique MOSFET IV characteristics, Scaling, Short Channel and Narrow Channel Effects, High Field Effects, Gate oxide thickness scaling trend, SiO2 vs High-k gate dielectrics. Integration issues of high-k, Interface states, bulk charge, band offset, stability, reliability - Qbd, SOI - PDSOI and FDSOI, Vertical transistors - FinFET and Surround gate FET, Thickness measurement techniques: Contact - step height, Optical - reflectance and ellipsometry, AFM, Characterization techniques for nanomaterials: FTIR, XRD, AFM, SEM, TEM, EDAX etc., Optoelectronic devices, MESFETs, HBTs, HEMTs, MODFETs

EEL613 Topics In VlSI Fabrication Technology, 3 (3-0-0)

Overview of Semiconductor IC Process technologies. Crystal growth (Czochralski, Float Zone, polishing, gettering, challenges) Oxidation (kinetics, Deal-Grove model, rate constants, high pressure oxidation, dopant effects, two and three dimensional effects, defects). Deposition techniques (vacuum evaporation, sputtering, CVD, LPCVD). Epitaxy (including MBE, MOCVD, CBE, UHV-CVD). Diffusion (Fick's model, concentration dependent models, field effect, band-gap narrowing effect, anomalous effects). Ion implantation (Ion stopping, range distributions, damage, annealing, high energy implants). Rapid thermal annealing. Lithography (optical, e-beam and x-ray; resists). Etching (wet chemical, dry reactive ion-etching, anisotropic etches, defect delineation). Interconnect technology

EEL 614 Digital IC Design, 3 (3-0-0)

Field-effect transistors: MOS capacitor, NMOS and PMOS transistors, i-v characteristics, channel length modulation, body-effect, MOSFET biasing, capacitance in MOS transistors; MOS based circuit design: NMOS inverter and its classification, NMOS logic gates, power dissipation, dynamic behavior; CMOS logic design: CMOS inverter, static and dynamic behavior, logic gates using CMOS, minimum gate size, static and dynamic latches and registers, optimization of sequential circuits, cell-based design methodology, timing issues; Modeling of high-speed interconnects: Interconnect parameters, electrical models – lumped versus distributed, SPICE based interconnect models; MOS based memory circuits: Design of memory circuits, RAM, basic memory cell, sense amplifiers, address decoders, cascade buffers.

EEL 615 Synchrophasor Technology & ITS Applications In Power, 3 (3-0-0)

Synchrophasor Technology- basic architecture and communication requirement, Phasor and frequency estimation, wide area monitoring and control in real time : basic principles, Transient stability monitoring and control, power oscillation monitoring and control, wide area power system stabilizers, synchrophasor applications in power system protection and emergency control, hybrid state estimation, Real time monitoring and control voltage stability, fault detection and location using synchronized measurements, Model development and validation using synchronized measurements

EEL 616 HVDC and Flexible AC Transmission Systems, 3 (3-0-0)

General aspects of DC transmission, converter circuits and their analysis, DC link controls, faults and abnormal operation and protection; Mechanism of active and reactive power flow control; Basic FACTS controllers: SVC, STATCOM, TCSC, TCPAR, UPFC; Modeling of FACTS Controllers; System static performance improvement with FACTS controllers; System dynamic performance improvement with FACTS controllers

EEL 617 Transients in Power Systems, 3 (3-0-0)

Aims and Objectives, Introduction, Switching Transients, Over voltages due to switching transients - resistance switching , load switching, waveforms for transient voltage across the load and the switch, Lightning transients, Theories in the formation of clouds and charge formation, mechanism of lightning discharges and characteristics of lightning strokes, Computation of transients , Traveling wave concept, step response, Bewely's lattice diagram

EEL 618 Advances in HVDC Transmission Technology, 3 (3-0-0)

Overview of HVDC Projects World Wide

,Developments in High Voltage, High Power Fully Controlled Semiconductors, HVDC Transmission System Configurations, Back-to-back, Monopolar, Bipolar and Multi-Level HVDC Systems, Concepts of VSC-HVDC, Vector Diagram, Multi-Level VSC Topologies, PWM Technique, Differences between CSC-HVDC and VSC-HVDC systems, HVDC aided by Power Cable Transmission, Space requirements and Right of Way, Advantages of HVDC Cable Transmission over HVDC Overhead Transmission, Latest developments in Power Cable Technology for HVDC Transmission.

EEL 619 Nanotechnology and Nano-composites, 3 (3-0-0)

Aims and Objectives, Introduction, Introduction to nanoscience and nanotechnology: History, background scope and interdisciplinary nature of nanoscience and nanotechnology, Synthesis and nanofabrication, Bottom-Up and Top-Down approaches. Chemical preparation methods, Phsical Mehtods-Biological methods- Material Characterization Techniques, Nanocomposites, Composite material, Mechanical properties of Nano composite, Modeling of nanocomposites.

EEL 620 Power Cables, 3 (3-0-0)

Historical Perspective of Electrical Cables, Basic Dielectric Theory of Cable, Conductors, Electrical characteristics of Cables, Shielding of Cables, Sheaths, Jackets, armors, Standards and Specifications, Manufacturing, Installation, Splicing, Terminating and Accessories, Ampacity of Cables, Properties of Soil, Lightning Protection

EEL 621 Power Transformers, 3 (3-0-0)

Main aspects of Transformer Condition Monitoring, Thermal Modelling, Dissolved gas analysis,

Frequency response analysis, Partial discharge analysis, Drawbacks of conventional techniques,

Inaccuracy of empirical thermal models, Uncertainty in DGA, Intricate issues with winding deformities, Modelling of Transformer and Processing Uncertainty

EEL 622 Signal Processing and Applications, 3 (3-0-0)

Review of Signals and Systems, Sampling and data reconstruction processes. continuous time Fourier transform (CTFT), DTFT, Z transforms. Discrete linear systems. Frequency domain design of digital filters. Quantization effects in digital filters. Discrete Fourier transform and FFT algorithms. High speed convolution and its application to digital filtering. Applications.

EEL 623 Feature Extraction and Pattern Recognition, 3 (3-0-0)

Image Preliminaries, Wavelets and Multi-resolution Processing: Multi-resolution Expansions, Wavelet Transforms in 1-D and 2-D, The Fast Wavelet Transform, Wavelet Packets Transform. Feature Extraction: Color, Texture, Shape and structure Features in spatial and frequency domains, Corner Detection, Hough Transform, Principal Component Analysis, Linear Discriminate Analysis, Feature Reduction in Input and Feature Spaces. Pattern Recognition: The Unsupervised Clustering Algorithm, Bayes Classifier, Support Vector Machine, Neural Networks, Fuzzy Sets in Image Analysis.

EEL 624 Advanced Digital SignalProcessing, 3 (3-0-0)

Multiresolution/ multiscale analysis, Piecewise constant approximation - the Haar wavelet, Building up the concept of dyadic Multiresolution Analysis (MRA), A review of discrete signal processing, Families of wavelets: Orthogonal and biorthogonal wavelets, Daubechies' family of wavelets in detail, Journey from the CWT to the DWT, Discretization in steps, Discretization of scale - generalized filter bank, Discretization of translation - generalized output sampling, Variants of the wavelet transform and its implementational structures, The wavepacket transform, The lattice structure, The lifting scheme, An exploration of applications.

EEL 625 Computer Vision, 3 (3-0-0)

Digital Image Formation and low-level processing. Depth estimation and Multi-camera views.

Feature Extraction: Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT. Image Segmentation: Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection. Pattern Analysis:

Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non-parametric methods. Motion Analysis, Shape from X, Applications: CBIR, CBVR, Activity Recognition, computational photography, Biometrics.

PhD Courses

These courses are open for MS(R)

EEL601 Adaptive Signal Processing, 3 (3-0-0)

Introduction to discrete time stochastic processes, properties of correlation matrix and spectra, modelling of stochastic processes. AR, MA and ARMA modelling. Yule – Walker equations, Levinsons – Durbin and Schur algorithm, analysis and synthesis of lattice, joint process estimation, introduction to adaptive filters, examples from adaptive noise cancellation, equalization, echo cancellation and system identification. Methods of steepest descent , latest mean squares (LMS) algorithm, gradient adaptive lattice, block LMS algorithm, Recursive least squares formulation, filtering via orthogonal projection, Recursive least squares (RLS) based transversal and lattice filters, least squares lattice (LSL)algorithm, QR composition based adaptive filters, QRD-RLS, QRD-LSL, introduction to non linear adaptive filtering and modelling, blind deconvolution and constant modulus

EEL602 Signal Processing for wireless communications, 3 (3-0-0)

Digital modulation, Introduction to some wireless standards. Multiple Access principles (TDMA, CDMA, FDMA, OFDMA). Advanced modulation techniques. Spread spectrum: frequency hoping, direct sequence CDMA, RAKE Receiver, IS-95 CDMA uplink and downlink example, PN code coarse and fine time tracking, WCDMA introduction. Orthogonal frequency division multiplexing (OFDM). Single carrier and multiple carrier examples, Multipath mitigation techniques, frequency domain equalization.

Radio propagation Characterization

AWGN channel, Rayleigh multipath fading, Rician multipath fading, delay spread concept (fiat Vs frequency selective fading) indoor propagation measurements, outdoor propagation measurements.

Performance improvement techniques

Antenna receiver diversity techniques, switching, equal gain, maximal ratio, optimal combining, symbol timing recovery methods, equalization techniques. Linear decision feedback, MLSE, Equalization coefficient, adaptation schemes: LMS, RLS, LSL etc. Space time equalization: ML perspective, Generalized RAKE (G- RAKE), Adaptive antenna arrays: MMSE and MSINR based cost functions, Eigen – spectra investigation. Antenna transmitter diversity techniques: space – time block codes. Closed loop, MIMO

Digital Signal processing

Automatic frequency control, automatic gain control, channel quality estimation techniques, power control loops. Uplink and down link, multipath mitigation, multiuser detection in CDMA channels, Zero – forcing, MMSE and decision feedback techniques. Joint detection and single user detection in CDMA channels, Blind Channel and data estimation. MIMO-OFDM channel estimation. Joint channel and frequency offset estimation in OFDM.

EEL603 Digital Communications, 3 (3-0-0)

Baseband, narrowband and wideband signals and noise representation and characteristics of communication channels, linear and optimal filtering, baseband binary signal transmission intersymbol interference bit time recovery and errors, partial response signalling, line codes. M-ary signals orthogonal representations. Gram – Schmidt procedure, signal space concepts, bandwidth efficient digital modulation techniques, carrier synchronization. Spread spectrum techniques – codes, transmitters, receivers, performance.

EEL604 Steady State and Dynamics of Electric Machines, 5 (3-0-4)

Basic principles; Direct current machines; Reference frame theory; Symmetrical induction machines; Synchronous machines; Brushless DC machines; Operational impedances and time constants; Linearised motor dynamics; Reduced order machine dynamics; Two-phase induction machines. Experimental work includes simulation on PSCAD/EMTDC 4.2.

EEL605 Power Electronic Converters and Applications, 5 (3-0-4)

Introduction to power electronic devices, and driving

circuits; DC-DC converters; AC-DC converters; DC-AC converters; AC-AC converters; multi-level inverters; matrix converters. Simulation of converters and applications.

EEL606 Simulation and Analysis of Modern Power Systems, 5 (3-0-3)

Modern power system operation and control, static and dynamic modeling, Load flow studies, transient stability and small signal stability of large power systems, voltage stability: P-V and Q-V curves, static analysis, sensitivity and continuation power flow method, Wide area real-time monitoring systems

EEL607 Fundamentals of Power System Operation Under Restructured Environment, 3 (3-0-0)

History of electric power systems restructuring, Electricity market structures, Market clearing mechanism, Transmission open access, Transmission pricing and loss allocation, Transmission congestion management, Ancillary services and system security in deregulation, Market power and generator bidding, Reforms in Indian power sector

EEL608 Optimization and Control of Power System Operation, 3 (3-0-0)

Introduction to optimization techniques, economic load dispatch of thermal and hydro-thermal plants, loss formula, real and reactive power optimization, optimal power flow, unit commitment, power system security constrained optimization, load-frequency control, energy control centers and power system state estimation, Wide area monitoring

EEL609 Industrial Imaging Techniques, 3 (3-0-0)

Sensors: capacitive, acoustic, thermal, radiation, chemical and gas. Signal acquisition, sampling, conditioning, A/D, D/A converters, Signal Processing – time domain, frequency domain.

Principles of X-rays and ionizing radiation – generation, absorption, scattering, contrast sensitivity, intensity. X and gamma-ray interaction with materials. X-ray and gamma-ray sources. Recordnig of radiation, radiographic film, intensifying screens, fluorescent screens, raduation detectors. Radiographic techniques – including film radiography, gamma radiography, radiographic sensitivity, flaw sensitivity, interpretation, digital image processing, computerized tomography.

Infrared radiation – radiometry, emissivity, Planck's law, temperature measeurement. Heat transfer. Active and passive thermography.

Acoustic radiation principles – wave propagation, acoustic impedance, bulk and surface waves, near and far field. Ultrasonic modeling – Ultrasonic transducers – piezo-electric, magneto-restrictive. Ultrasonic measeurement systems – pulse echo, through transmission, time of flight diffraction, guided wave technology.

EEL610 Optical Engineering, 3 (3-0-0)

Electromagnetic waves: scalar and vector waves, propagation in stratified media, Light-Matter interaction: Photons and atoms, Theory of interference and interferometers, Diffraction theory, Lasers; theory of Laser oscillation, Q- switching, Mode-locking and Ultra short pulse generation Principles and devices inElectro-Optics, Acousto-Optics, Guided Wave-Optics, Holography, Speckle, Fiber and Fourier Optics, Nonlinear-Optics: physical origin of optical nonlinearities. Wave propagation in nonlinear crystals, Second Harmonic Generation, sum and difference frequencies, Parametric processes, Self-focusing, Phase Conjugation and Photore fractive effect, Ultra-fast Optics.

EEL701 Optical Fiber Communication, 3 (3-0-0)

Introduction to optical communication, Optical Fiber Waveguides, Different Fiber Types, Fiber Limitations, Dispersion, Attenuation and Nonlinearities in fibers. Optical Transmitters and Receivers, Optical Transceivers, Noise Sources in Optical communication, Light Systems, CWDM (Coarse wavelength Division Multiplexing), ITU wave Grids, DWDM (Dense Wavelength Division Multiplexing), Optical Wave Multiplexers, De-Multiplexers, Fixed OADM (Optical Add-Drop Multiplexer), ROADM (Re-configurable Optical Add-Drop Multiplexer), Dispersion Compensation, Optical Amplifiers, EDFA (Erbium Doped Fiber Amplifies), Raman Amplifiers, Optical DWDM Network Design Considerations, Optical Fiber Link Design Exercises.

EEL702 Advanced Signal Processing and Applications, 3 (3-0-0)

Discrete time signals and systems, Convolution and frequency response. Discrete time Fourier and Z –transforms. Properties, analysis of discrete time systems. The DFT, definition and properties, circular convolution calculation, FFT transform. Relationship between continuous and discrete time systems: sampling time and frequency normalization, discrete time processing of continuous time signals. Difference equation for digital filters definition and properties. FIR filters, IIR filters, Digital filter design techniques: impulse invariance, Bilinear transformation, finite difference, window design methods, introduction to multirate DSP, decimation and interpolation, polyphase decomposition , uniform DDFT filter banks, quadrature mirror filters and perfect reconstruction. Adaptive signal processing: time adaptive systems, LMS algorithm. Recursive least squares (RLS) algorithms, least square lattice (LSL) algorithm.

EEL703 Control & Instrumentation of Power Electronic Systems, 3 (3-0-0)

Review of power electronic converters; the regulation and tracking problem; feedback control principles; converter models for feedback; averaging methods and models; voltage and current mode for converters; comparator based control for rectifiers; proportional and PI control applications; small-signal analysis and linearization; control design based on linearization; hysteresis control; general boundary control; vector control of inverters; instantaneous p-q control of inverters; sensors and actuators.

EEL704 Power generation by renewable energy, 3 (3-0-0)

Importance and applicability of renewable energy sources; technology and economics of wind power; technology and economics of small hydro; technology and economics of biogas and biopower; generation of fuels from energy crops; technology and economics of solar thermal systems; technology and economics of photovoltaic systems; technology and economics of wave and tidal energy systems; energy analysis techniques; cost analysis techniques; environmental impact and its analysis.

EEL705 High Voltage Engineering, 4 (2-2-0)

Insulation system used in high voltage power equipment: gaseous, vacuum, liquid, solid and composite insulation, performance of insulation under electric stress, high voltage dielectric tests; Generation and measurement of high ac, dc and impulse voltages in test/research laboratories, generation and measurement of impulse current, digital techniques in HV measurements, calibration of HV measuring instruments and traceability of HV measurements, Resent developments in non-destructive insulation diagnostics and condition monitoring of high voltage equipments. P-Spice Simulation of HV apparatus.

EEL706 Image Acquisition and Processing, 3 (3-0-0)

Human visual system and image perception; monochrome and color vision models; image acquisition and display systems; video input/output devices; standard video formats; display and storage; 2-D signals and systems; 2D transforms; image enhancement; image restoration; Wiener filtering; image/video compression; motion compensation, motion estimation, water marking; image analysis, multi-resolution analysis, wavelet packets; image classification; morphological image processing; object recognition; color image processing. Experiments are based on MATLAB implementation of algorithms covered in the course.

EEL707 Transients in Powersystems, 3 (3-0-0)

Transient phenomena on transmission lines, method of its calculation, use of TNA, EMTP and PSPICE, lightning discharges, origin and characteristics of lightning and switching overvoltages, behavior of apparatus and line insulation under overvoltage, VFTO in GIS, protection of apparatus against overvoltages, surge arresters and insulatin co-ordination.

EEL708 Advanced Analog IC Design, 4 (3-0-2)

MOS Models for Analog Design, Small signal MOS models; Noise- analysis and feedback; Amplifier design, Single-ended and differential OTAs, design of current sources; Feedback amplifiers, multistage amplifiers, biasing and references, Equalization, Design of equalizers circuits; Design of sample and hold and comparator circuits; High-speed electrical ling design, interconnect modeling and optimization;

Lab sessions and poject assignments based on simulation of analog circuits using Cadence Design Tool.

EEL709 Computational Electromagnetics, 2 (2-0-0)

Transient fields due to finite conductivity, method of images. Images in two-layer soil, numerical methods, finite difference, finite element and charge simulation methods to solve problems of electrostatics. Hera's Existence Theorem-Continuity equation. Maxwell's Equations, Poisson's and Laplace Equations in dielectric design.

EEL710 Advanced Topics in VLSI Design, 5 (4-0-2)

High-speed link design, interconnect modeling and optimization; Low power electronic circuits; Carbon based nanoelectronics; Advances in device modeling and behavior (organic transistors, single electron transistors, RF transistors); Computer-aided-design of digital systems; Design methodologies, verification and testing; Introduction to semiconductor fabrication processes; Lab sessions and project assignments based on simulation of circuits using Cadence Design Tool, Ansys HFSS and Synopsys Tools.

4.5.Department of Humanities & Social Sciences

PhD Courses

HUL601 KANT Theoretical Philosophy, 3 (3-0-0)

This course is an invitation to read works of Kant that constitute his theoretical philosophy. These works include selections from treatises of the pre-critical period, significant portions of Critique of Pure Reason, Metaphysical Foundations of Natural Sciences, and Prolegomena to any Future Metaphysics, and a small part of Opus Postumum. The course will focus on the following issues : the nature of the critical project; transcendental arguments, deduction of categories, unity of appererption, refutation of idealism, critique of metaphysics, response to skepticism, paralogisms and so on.

Students who enroll for this course would be expected to read the original works and the required secondary material (which will be identified from time to time), write a paper (consisting of not more than 20 pages) and appear for the end-semester examination.

HUL602 KANT Practical Philosophy, 3 (3-0-0)

Perhaps, after the Greeks, no moral theory has been as influential as that of Kant. This course aims at a study of Kant's works that form the architectonic of his practical philosophy: Groundwork for the Metaphysic of Morals, Critique of Practical Reason, Metaphysics of Morals and his essay, "On the Old Saying: This May be Right in Principle But Wrong in Practice". The issues this course will address, in the course of a close reading of these texts, include: aspects of volition, autonomy, the transformation of natural law within Kant's system, categorical imperative and hypothetical imperatives, kingdom of ends formula, the doctrine of right, implications of Kant's moral theory for liberalism and so on.

Students who enroll for this course would be expected to read the original works and the required secondary material (which will be identified from time to time), write a paper (consisting of not more than 20 pages) and appear for the end-semester examination.

HUL603 HEGEL: System and Metaphysics, 3 (3-0-0)

Undoubtedly, one of the defining characteristics of German Idealism (or post-Kantian German philosophy) is the penchant for constructing encyclopedic systems that seek to encompass topics ranging from logic understood as a doctrine of categories to systematic reflections on the trajectory of word history. In this regard, no idealistic system from this period shows as much comprehensiveness as that of Hegel, which, ironically, has also been taken to task for this very feature. This course intends to understand the motivations for the architectonic of Hegel's systems in the following ways: (1) understand the methodology that Hegel employs for deduction and examine whether the moves he makes are warranted; and (2) whether the details available in the parts of the system really allow for formation of the entire system in terms of coherence. While this course will primarily consider Encyclopedia Logik as the seminal text, we shall also study the role of Phenomenology of Spirit in serving as a propaedeutic to the system.

Students who enroll for this course would be expected to read the original works and the required secondary material (which will be identified from time to time), write a paper (consisting of not more than 20 pages) and appear for the end-semester examination.

HUL604 HEGEL: Practical Philosophy, 3 (3-0-0)

Hegel's Elements of Philosophy of Right is one of the landmark in the history of political thought, along with Hobbes's Leviathan, Locke,s Two Treatises, Rousseau's Social Contract and the Second Discourse, and Mill's Considerations on Representative Government. Like the lecture courses Hegel delivered towards the end of his life, Elements is at once an attempt at a critical history of political ideas and a systematic treaties in its own right. During the course, the primary task at hand would be to identify the methodological innovations and construct a historical narrative, which, in turn, provides both a historical critique and facilitates a systematic account of the typology of freedom, state, civil society, bildung, institutions and so on.

Students who enroll for this course would be expected to read the original works and the required secondary material (which will be identified from time to time), write a paper (consisting of not more than 20 pages) and appear for the end-semester examination.

HUL605 Liberalism and its Critics, 3 (3-0-0)

Modern liberalism is founded on a theory of individual rights, anti-paternalism, negative liberty, private-public distinction, private property, democracy, and a non-partisan attitude towards lifestyle and religions. This course will consider writing of liberal thinkers such as Locke, Mill, Kant, Berlin, Rawls and Nozick, to explore the themes mentioned earlier. This course will also consider critiques of liberalisms that have been made available from a range of philosophical /political positions, such as libertarianism, egalitarianism, Marxism, cimmunitarianism and feminism. Through a contrapuntal reading of the liberal position and those of the critics, this course will aim to bring to relief the issues surrounding alleged reconciliation between liberty and equality within liberalism, the nature of the contract, the historical conception of this subject, distribution, and possibility of allowing competitive practices and so on.

Students who enroll for this course would be expected to read the original works and the required secondary material(which will be identified from time to time), write a paper (consisting of not more than 20 pages) and appear for the end-semester examination.

HUL606 Rights in History, 3 (3-0-0)

The aim of this course is to find an answer to the question: is the concept of rights a palimpsest? This course will be an attempt to understand how, I its long history and whose scattered sources of origin can be located in the writings of Stoics, the concept of right, for all its unequivocal connotations, has come to be a collection of disparate elements, comprising conceptual fragments, theories, folk reactions, crude distinctions that are useful in highly specific practical contexts, and tacit value assumptions. In answering this question, the course will focus on the possibility of thinking about rights within the framework of genealogical inquiry. Accordingly, the reading for the course will be drawn from a wide variety of sources, ranging form the writings of Stoics to that of natural law tradition, medieval political theology to issues of trade in the early modern period and the rise of various social classes.

Student who enrolls this course would be expected to read the original works and the required secondary material (which will be identified from time to time), write a paper (consisting of not more than 20 pages) and appear for the end-semester examination.

HUL607 English Syntactic Structure, 3 (3-0-0)

The aim of the course is to introduce students to the theory of Syntax in general and to the study of the syntactic structure of English in particular. The concept and notions of different elements of syntax as well as practical syntactic analysis of sentences taken from English and other languages give the students an in-depth knowledge of the function of human languages at the syntactic level. The course will begin with general concepts of grammar and other linguistic elements and move towards the precise study of syntax of English in terms of words, phrases and clauses. Examination of syntactic structures and to see how they are formed, assigned, represented and tested is the goal of this course.

HUL608 Topics in Optimality Theory, 3 (3-0-0)

Goals of linguistic theory- Theory of constraints –

Lexicon optimization – Architecture of OT grammar – Syllable structure and economy – Metrical structure – Constraint interaction – Distributional restriction – Constraint viability – Emergence of the unmarked – Learning algorithm – case studies (World languages)

HUL609 Cognitive Neurosceince of Language, 3 (3-0-0)

Introduction, Neurocognitive methods, EEG/ERP, ERP Components: ELAN, N400, LAN, P600. Neurocognitive models of language comprehension, syntactic processing, semantic processing, Phonological processing, Neurocognition of language comprehension and Indian languages.

HUL610 Self and Society, 3 (3-0-0)

The self in personality theories: Type and trait approaches, Psychoanalytic approaches, Humanistic & existential approaches.

The social self: Development of the self, Cultural roots of the self, Symbolic interaction.

The biological self: Genetic contribution to personality, The brain and self, Embodies cognition.

HUL611 Technical Communication, 3 (2-1-0)

The purpose of this course is to acquaint students with the principles of effective, audience centered technical communication. The course requires students to become familiar with the nature of communication, and discusses process of communication, non-verbal communication, business communication and barriers to communication. It also deals with global, ethical and legal aspects of communication. The course provides students with practice in writing letters, resumes and informal and formal reports. Finally, students are taught elements of style in writing and how to organize and present technical material orally in an effective manner.

HUL 612 Research Methodology and Statistics, 3 (3-0-0)

Purpose and nature of research; Research ethics

Research proposal and literature review: Defining the problem; Finding and managing information; Developing and stating hypotheses.

Data collection: Observation; Experiments; Survey; Case study; Secondary data

Measurement: Qualitative and Quantitative measurement; Scales of measurement; Reliability and validity of measurement.

Sampling, Normal distribution; Parametric and non –parametric statics; significance of statistics

Statistics: Descriptive and inferential statistics; Correlation; t ration; Regression analysis; Analysis of Variance; structural Equation Modeling

The research report; writing a thesis; writing for publication

HUL613 Corpus Linguistics, 3 (3-0-0)

Introduction, Corpus, Early phase, Chomskyan Revolution, generation different types of corpus, Types of Annotation, Multilingual corpora, Qualitative vs Quantitative analysis, Frequency counts, Statistical analysis of corpus, Use of Corpus (in speech, grammar, semantics, psycholinguistics, pragmatics, stylistics etc.), corpus based approach of language processing.

HUL614 Computational Phonology, 3 (3-0-0)

Introduction to computational phonology- Optimality Theory- Phonological complexity- Two-level phonology- Concept of Finite state transducer and cascade- Paradigms of machine learning- Evaluation algorithm for OT system- Chomsky hierarchy- Karttunen method- Probabilistic model- Speech corpora- TTS

HUL615 Literary Theory, 3 (2-1-0)

The course introduces students to literary theory and examines the relationship between theory and philosophy, the question of what literature is and does, the emergence of literary theory in the history of modern criticism, and the nature of discourse. Students are expected to become familiar with the following: Liberal humanism, structuralism, poststructuralism and deconstruction, Postmodernism, psychoanalytic criticism, feminist criticism, Marxist criticism, new historicism and cultural materialism, postcolonial criticism, stylistics, narratolory, ecocriticism and theory after 'theory'.

HUL616 Canadian Literature, 3 (2-1-0)

Poetry: The work of three significant Canadian poets will be read in this unit. Each poet is introduced as an individual first with background information to set the stage for the poetry readings. Students are responsible for reading and studying all of the poetry

in this unit. However, there is considerable choice in the assignments they must do. Within the choice, students will complete five poetry assignments by the end of the unit. Students will reflect upon, discuss and write about the images used by the poets, personal connections students make to the poem, comparisons with other poems they have read on similar themes, poetic devices.

Short Stories: Three short stories by three different writers are studied in this unit. Students will complete two formative assessment writing tasks for feedback and two summative writing tasks for evaluation. Students will read their work, be provided with notes on the story and then be asked to think specifically about themes and characters presented.

Novel Study: In this unit students will read two novels by two Canadian novelists. The questions will cause students to read between and beyond the lines and reflect on their own experiences. Polished reflective writing is the main task of this unit.

Drama: The nature of Canadian drama will be interrogated. Three Canadian plays by three Canadian dramatists will be taken up for study, and the styles and themes of the plays will be examined.

HUL617 World Literature, 3 (2-1-0)

This course will survey major world authors from a variety of countries, including the U.S and Britain. Students may read, write and discuss a variety of world literature including Russian, Australian, South American, African, Asian and others. They will attempt to identify and analyze a variety of major works of world literature and discuss the characteristics of the major periods of world literature. The students will also discuss major literary genres that have emerged, and will compare and contrast writing styles and generic forms from different periods and cultures and identify major themes of representative poetic, fictional and dramatic works. They are also expected to trace the influence of one literature upon another.

HUL618 Research Methodology in language and Literature, 3 (2-1-0)

Theoretical Background: Meaning, Nature and Scope of Research; Difference between writing a popular article and research paper; a book and a dissertation

Methodology and approaches: Selection of Research Topic; Plan of work, Thesis Statement and its Feasibility; Survey of different critical approaches, Selection of a particular approach, Micro and Macro analysis

Material Collection: Primary and Secondary Sources, Reliability of Sources

Preparatory Steps: Writing of Synopsis, Literary Survey; Collection, Listing and Organization of Material, Note making, Use of Note cards and Reference Cards

Mechanics of Writing: Single and multi Tire Division of Chapters, Writing of the Main Chapters, Preparation and Presentation of Conclusions, Presentation of References, Working Bibliography, Indexing, Indexing, Use of MLA Style Sheet.

HUL619 The Novel as a Genre, 3 (2-1-0)

Background Survey: Fiction as a Genre, the meaning of fiction, fact in fiction, types of fiction.

Development of the Novel: Storytelling and Novel, the four Wheels of the Novel Epistolary Techniques, Novel in the 19th Century.

Science and Novel: Impact of Science & Technology on the Novel, changing Social Realities and their Reflection in the novel, Science Fiction.

Modernity: Concept of Modernity in the novel, the changing concept of Time, Stream of Consciousness techniques, the changing art of characterization.

Structural Pattern: Narrative Techniques, Plot and Structure, various theories of Interpretation.

Novel as a Global Art Form: Development of the Novel as an art form in Europe, Africa, America, Australia and India; influence of localized tendencies and movements.

HUL620 Fantasy Literature and Science Fiction, 3 (2-1-0)

Historical overview of the development of fantasy and science fiction; Definitions of key terms and techniques; In each work, primary focus on theme, with attention to narrative structure and characterization; Understanding the various trends developing in the genre; Discussion of the role of fantasy and science and technology in modern life, as reflected in the works; Exploration of the fruitful connections between fantasy and science fiction and postmodernism; Comparative analyses as well as close individual readings of specific texts; Exploration of the varieties of otherness in fantasy and science fiction.

HUL621 Applied Econometrics, 3 (3-0-0)

Stages in Empirical Ecomometric Research; Introduction to Statistical and Econometric Software Packages (E-VIEWS, STATA, RATS MFIT); Working with Basic Data Handling; Misspecification; Functional Forms; Model Selection; Qualitative Data; Time Series Models and Forecasting; Panel Data Models; Discrete Choice Models, etc.

HUL622 Finacial Institutions and Corporate Finance, 3 (3-0-0)

This course will mainly covers theories of Corporate finance, Financial intermediation and Portfolio Theories.

1. Finacial Markets (10): Analysis of Financial Markets-Fundamental analysis, Technical analysis, Efficient Market Hypothesis. (Advance Level)
2. Portfolio Theories (10): Mean Variance Criterion-Systematic & Unsystematic risk/Portfolio Diversification-Simple & Markowitz Efficient Frontier & Capital Market Line/Capital Asset Pricing Model (CAPM)/Arbitrage Pricing Theory (APT).
3. Financial Intermediation (10): (a) A brief discussion of theories about necessity of financial intermediation, in general. (b) Bank Intermediary-Special role of banks, Industrial Organization approaches to banking. (c) Banking runs, role of deposit insurance, role of banking regulations, role of prudential norms. (d). A discussion of Basel Accord in this context.
4. Corporate Finance (10): (a). Theories of Capital Structure: (i) Modigliani-Miller Hypothesis revisited (ii). Agency Cost theories. (iii). Theories relating to Asymmetric Information: Pecking order hypothesis and Signaling. (iv). A flavor of other theories about capital structure. (b). Dividend policy-forms of dividends-Lintner model-dividend irrelevance hypothesis-role of taxes, transaction costs, agency problems and asymmetric information. (c) Corporate finance and product markets.

HUL623 Multiethnic Literature of the United States, 3 (2-1-0)

This course will introduce students to a selection of multiethnic literatures of the United States through a comparative framework. It will involve a close reading and analysis of both key primary texts and influential criticism and theoretical writings, including, but not limited to, postcolonialism, narratology, deconstruction and globalization. Key aims for the course are to understand the relationship between literature, ethnic populations and the culture and social aspects of immigration. The exploration of this important body of literature will be guided by two central questions: what does literature by ethnic authors tell us about processes of identity formations? How does ethnicity shape the way authors tell stories and nattate the histories of their communities? To approach these questions about the relationship between identity and storytelling, issues of history and memory, migration and displacement, and forms of belonging and non-belonging in the United States will be examined. Further, the intricate relations among race, ethnicity, nation, class, generation and gender will be scrutinized in order to come to terms with the aesthetic and political dimensions of this literature.

HUL624 Diaspora and Postcolonial Studies, 3 (2-1-0)

The course examins the historical and contemporary movements of peoples and the complex problems of identity and experience to which these movements give rise as well as the creative possibilities that flow from the movement. Diaspora in contemporary thought involves the shifting relations between homelands and host nations from the perspective of those who have moved, whether voluntarily or not. Diaspora emphasizes the inescapable lived translocal experiences of many migrant communities that exceed the boundaries of the nation-state. Questions of nostalgia, of the dynamics of co-ethnic identification, of the politics of homeland and host nation, and of the inter-generational shifts in responses to all these are central to studies of diaspora. Various forms of dislocation such as exile, diaspora and migration have been explored in both postcolonial theory and literary texts. This course will investigate how and why these phenomena have become central to postcolonial thought. Under the generalized rubric of diaspora, this course will engage with some of the following issues: the experiences of displacement and homelessness, the idelologies of home and nation, the cultures of diaspora and the politics of multiculturalism, and the new phenomena of borders and borderlands. As diaspora is a multidisciplinary field, the course will draw on

writings in various disciplines including post-structuralist theory, literary studies and cultural studies. Writers to be studied will include Edward Said, Homi Bhabha, Gloria Anzaldua, Paul Gilroy, Stuart Hall, James Clifford, Arjun Appadurai, Jacques Derrida, Deleuze and Guattari, Rey Chow, V. S Naipaul, Salman Rushdie, Vijay Mishra and Amitav Ghosh.

HUL625 Experimental Lingusitics, 3 (2-0-2)

Principles and techniques of experimental design and research in linguistics, linguistic theory and experimental questions, the development of theoretically motivated hypotheses, designing linguistic experiments, data analysis (statistical analysis), data reporting.

HUL626 Globalisation and Change, 3(3-0-0)

Nature and Dynamics of Globalisation; The Global Local Dichotomy; Globalisation and its impact on language, communication and media; Globalisation trade and economy; The role of multinational corporations and international agencies of finance; Globalisation and culture; homogenisation and dominance; Diasporic communities ethnic communities and movements; Consequences of globallisation; discontents and different Perceptions.

HUL627 Topics in Development Economics, 3 (3-0-0)

Views of development, measurement of economic development, growth vs development. Evolution of Institutions and their role in an economic development, role of financial Institutions on economic development, social networks as institutions, interaction and interdependence between formal and informal Institutions, impact of such interactions on economic development, social network as a source of informal credit and insurance. Micro finance mechanisms, peer selection, peer monitoring and dynamic incentives, solution to moral hazard, adverse selection, and costly state verification, Concept of informal sector, Evidence from developing countries, Determinants of size of informal sector & its linkage structure with the rest of the economy, role of informal sector in economic development.

HUL 628 Topics in International Economics, 3 (3-0-0)

Theories of International Trade, International Movements of Capital, the Balance of Trade and other Measures of International Transactions, the Mundell-Fleming Open Economy Model, Exchange Rate Overshooting Model, Purchasing Power Parity (PPP), Saving-Investment Dynamics, Current Account Dynamics and Real Exchange Rate, International Finance (Financial Flows, World Bank/IMF, the Role of Multinational Corporations, Foreign Direct Investment, Capital and Labour Mobility), Crises in Emerging Markets: Causes, Solutions, and Prevention, Problems Faced by Transition Economies, Challenges of Developed Countries

HUL 629 Advanced Topics in Economic Geography and Urban Economics, 3 (3-0-0)

Choice of Location, FDI and Spatial Dimension of Regional Spillover, FDI and Economic Geography, Spatial Economy and International Trade, Congestion Costs, Market Failure and Urban Sprawl, Fujita and Thisse (1996) and Fujita (1989) Model of Knowledge Spillover, Optimal City Size in a Spatial Economy, Spatial Agglomeration and Endogenous Growth

4.6. Department of Mathematics

M.Sc. - Core Courses

MAL411 Topics in Real Analysis, 4(3-1-0)

Pre-requisites: Basic Knowledge in Single variable Calculus

Metric spaces, completeness, connectedness, compactness, Heine-Borel theorem, totally bounded sets, finite intersection property, completeness of R^n, Banach fixed point theorem, perfect sets, the Cantor set. Continuous functions, relation with connectedness and compactness, discontinuity, uniform continuous functions, monotone functions, Absolutely continuous functions, total variation and functions of bounded variations. Differentiability and its properties, mean value theorem, Taylor's theorem, Riemann integral with properties and characterization, improper integral, Gamma function, Directional derivative, Partial derivative, Derivative as a linear transformation, Inverse and Implicit function theorems, multiple integration, Change of

variables.Sequence and series of functions, point wise convergence, Fejer's theorem, power series and Fourier series, uniform convergence and its relation with continuity, differentiability and inerrability, Weierstrass approximation theorem, Equi-continuous family, Arzela-Ascoli theorem.

MAL412 Basic Linear Algebra, 4 (3-1-0)

Pre-requisites: Nil

Vector spaces over fields, subspaces, bases and dimension; Systems of linear equations, matrices, rank, Gaussian elimination; Linear transformations, representation of linear transformations by matrices, rank-nullity theorem, change of basis, dual spaces, transposes of linear transformations; Determinants, Laplace expansions, cofactors, adjoint, Cramer's Rule; Eigenvalues and eigenvectors, characteristic polynomials, minimal polynomials, Cayley-Hamilton Theorem, triangulation, diagonal-lization, rational canonical form, Jordan canonical form; Inner product spaces, Gram-Schmidt ortho-normalization, least square approximation, linear functionals and adjoints, Hermitian, self-adjoint, unitary and normal operators, Spectral Theorem for normal operators; Bilinear forms, symmetric and skew-symmetric bilinear forms, real quadratic forms, positive definiteness.

MAL413 Introduction to Computing, 4(3-0-2)

Pre-requisites: Nil

Introduction: Computers as universal computing devices, bits, datatypes and operations, digital logic structure, the von Neumann model Programming: Problem solving, debugging, assembly language programming, Introduction to programming in C++

Variables and operators, control structures, pointers and arrays, functions and reference variables

Introduction to classes and templates

Developing classes for scientific applications: selected examples

Introduction to parallel processing using MPI.

MAL414 Ordinary Differential Equations, 4 (3-1-0)

Pre-requisites: Nil

Introduction: second and higher order differential equations, solutions of homogeneous and non-homogeneous equations, Method of variation of parameters.

Qualitative Properties of Solutions: Existence and uniqueness theorem, Oscillations and the Sturm Separation theorem, the Sturm Comparison theorem.

System of first order ODEs: Autonomous and non-autonomous system and stability.

Series solutions: Legendre equation and Legendre polynomials, Bessel equation and Bessel functions of first and second kinds.

Boundary Value Problems: Sturm-Liouville Boundary Value Problem, Green's Function to solve boundary value problem.

MAL415 Algebra, 4(3-1-0)

Pre-requisites: Nil

Review of basics, Permutations, sign of a permutation, inversions, cycles and transpositions, groups, subgroups and factor groups, Lagrange's Theorem, homomorphisms, normal subgroups, Quotients of groups, Cyclic groups, generators and relations, Cayley's Theorem, group actions, Sylow Theorems. Direct products, Structure Theorem for finite abelian groups. Simple groups and solvable groups, nilpotent groups; Free groups, free abelian groups. Rings, Examples (including polynomial rings, formal power series rings, matrix rings and group rings), ideals, prime and maximal ideals, rings of fractions, Chinese Remainder Theorem for pairwise comaximal ideals. Euclidean Domains, Principal Ideal Domains and Unique Factorizations Domains. Polynomial rings over UFD'; finite field and field extensions.

MAL421 Topics in Complex Analysis, 3(3-0-0)

Pre-requisites: Nil

The complex number system. Extended complex plane. Analytic functions. Cauchy-Riemann conditions. Mappings by elementary functions. Conformal mappings and Mobius Transformation.

Complex integration. Cauchy-Goursat theorem. Cauchy integral formula. The Homotopic version of Cauchy's theorem and simple connectivity. Morera's and Liouvile's theorems.Uniform convergence of sequences and series. Taylor's and Laurent's series. Singularities, zeros and Poles. Isolated singularities and residues. Cauchy residue theorem. Evaluation of real integrals.The Argument Principle and Rouche's theorem. Maximum Modulus Theorem, Schwarz's lemma.

MAL422 Partial Differential Equations, 4 (3-1-0)

Pre-requisites: Nil

Introduction to PDE. First order quasi-linear equations. Nonlinear equations. Cauchy-Kowalewski's theorem. Higher order equations and characteristics. Classification of second order equations. Riemann's method and applications. One dimensional wave equation and De'Alembert's method. Solution of three dimensional wave equation. Method of decent and Duhamel's principle. Solutions of equations in bounded domains and uniqueness of solutions. BVPs for Laplace's and Poisson's equations. Green's functions and properties. Heat equation; Maximum principle, Uniqueness of solutions of IVPs for heat conduction equation. Green's function for heat equation.

MAL423 Stochastic Processes, 4 (3-1-0)

Pre-requisites: Nil

Introduction to probability theory: Probability and counting with some applications, Probability spaces, Random variables, Probability distribution functions, Independence and joint distributions, Expectation, Variance, The weak law of large numbers, Convergence of random variables, The strong law of large numbers, The central limit theorem, Simulation.

Stochastic Processes: Poisson process, Markov chains, Kolmogorov equations, Martingales, Doob's decomposition of a stochastic process, L^(p) inequality, Random walks, Brownian motion, Stopping times, Continuous time martingales, Recurrence of Brownian motion, Feynman-Kac formula, The Ito integral for Brownian motion, Processes of bounded quadratic variation, Some applications to real-world problems.

MAL424 Numerical Analysis, 4(3-0-2)

Pre-requisites: Nil

Definition and sources of errors, solutions of nonlinear equations; Bisection method, Newton's method and its variants, fixed point iterations, convergence analysis; Newton's method for non-linear systems; Finite differences, polynomial interpolation, Hermite interpolation, spline interpolation; Numerical integration - Trapezoidal and Simpson's rules, Gaussian quadrature, Richardson extrapolation;

Differential equation Initial value problems - Taylor series method, Euler and modified Euler methods, Runge-Kutta methods, multistep methods and stability; Boundary value problems - finite difference method, collocation method.

MAL425 Topology, 3(3-0-0)

Pre-requisites: Basic Knowledge in Real Analysis

Topological spaces, Basis for a topology, Limit points and closure of a set, Continuous and open maps, Homeomorphisms, Subspace topology, Product and quotient topology.

Connected and locally connected spaces, Path connectedness, Components and path components, Compact and locally compact spaces, One point compactification Countability axioms, Separation axioms, Urysohn's Lemma, Urysohn's metrization theorem, Tietze extension theorem, Tychonoff's theorem, Completely Regular Spaces, Stone-Cech Compactification.

MAL511 Functional Analysis, 3(3-0-0)

Pre-requisites: Nil

Normed linear spaces, , , lp, Lp, $1 \leqslant p \leqslant \infty$, [a,b], dimension, linear transformations -continuity and boundedness, linear functionals-continuity, conpactness of unit ball of finite dementional spaces, equivalence of norms and continuity of linear transformations of finite dimensional spaces, dual spaces duals of ,lp, Lp, $1 \leqslant p \leqslant \infty$, separability, non-separability of l^{∞}. reflexive spaces.

Horn-Banach theorem for real and complex normed linear spaces, uniform boundedness Principle and its applications, closed graph theorem, open mapping theorem and their applications. Inner product spaces, Hilbert spaces, orthonormal basis, projection theorem and Riesz representation theorem.

MAL512 Mathematical Methods, 3(3-0-0)

Pre-requisites: Nil

Fourier Series, Generalized Fourier series, Fourier Cosine series, Fourier Sine series, Fourier integrals. Fourier transform, Laplace transform, Solution of differential equation by Laplace and Fourier transform methods. Z-transform, Hankel and Mellin transform. Perturbation methods. Calculus of Variation. Introduction to Integral Equations.

MAL513 Optimization Techniques 4(3-1-0)

Pre-requisites: Nil

Introduction to optimization, Formulation of linear Optimization problems, Convex set; Linear programming problem: Graphical method, Simplex method, Big M and two-phase Simplex method, revised simplex method, Duality: Primal-dual relationship & its economic interpretation, Dual Simplex algorithm, Sensitivity analysis; Network analysis: Transportation & Assignment problems; Integer programming problems: Formulation, Branch & Bound and Cutting Plane methods; Dynamic Programming (DP).

Non-linear Programming: Lagrange multipliers and Kuhn - Tucker conditions, Convex optimization; Numerical optimization techniques: line search methods, gradient methods, Newton's method, conjugate direction methods, quasi-Newton methods, projected gradient methods, penalty methods.

MAL603 Topics in Numerical Analysis, 4 (3-0-2)

Introduction to Error: its sources, propagation and analysis. Root finding of non-linear equations. Systems of linear and non-linear equations.

Finite difference operators, Polynomial interpolation and error analysis, Hermite interpolation, Spline interpolation, B-Splines, Numerical differentiation, Numerical integration: Trapezoidal and Simpson's rules, Newton-Cotes formula, Method of undermind coefficients and Gaussian Quadrature, Richardson Extrapolation.

Difference equations. Numerical solution of ordinary differential equations: Initial value problems: Numerical stability, Taylor series method, Euler and modified Euler methods and stability analysis, Runge-Kutta methods, Multistep methods, Predictor-Corrector method, convergence and stability. System of ordinary differential equations. Boundary Value Problems: Shooting and direct methods.

MAL604 Water Wave Theory, 4 (3-0-2)

Kinematics of Fluids in Motion: Real Fluids and Ideal Fluids, Velocity of fluid at a point, Streamlines and Pathlines, Steady and Unsteady Flows, the Velocity Potential, Vorticity Vector, The Equation of continuity. Equation of motion of a fluid: Pressure at a point in fluid at rest, Pressure at a point in a moving fluid, Euler's equation of motion, Bernoulli's equation. Viscous and inviscid fluid, the Navier-Stokes equation of motion, rotational and irrational flows.

Theory of surface wave: Equation of Motion, Wave Terminology, Analytical solution of the wave problem, Dispersion relation of the wave motion, Classification of water waves, Particle motion and Pressure, Superposition of waves, Wave reflection and standing wave, Wave energy and group velocity, Wave Refraction, Wave Diffraction. Finite amplitude waves: Mathematical formulation, Perturbation method of solution. Linear and Nonlinear diffraction theory.

MAL605 Introduction to Nonlinear Dynamics, 3 (3-0-0)

Nonlinear equations: autonomous and non-autonomous systems, phase portrait, stability of equilibrium points, Lyapunov exponents, periodic solutions, local and global bifurcations, Poincare-Bendixon theorem, Hartmann- Grobmann theorem, Center Manifold theorem.

Nonlinear oscillations: perturbations and the Kolmogorov-Arnold-Moser theorem, limit cycles. Chaos: one-dimensional and two-dimensional Poincare maps, attractors, routes to chaos, intermittency, crisis and quasiperiodicity. Synchronization in coupled chaotic oscillators. Applications: Examples from Biology, Chemistry, Physics and Engineering.

MAL 606 Fields and Galois theory, 3 (3-0-0)

Galois theory: Field Extension ,utomorphisms, Normal extension, separable and Inseparable Extension ,The fundamental Theorem of Galois theory; Some Galois Extension :Finite Fields ,Cyclotomic Extensions ,Norms and Traces ,Cyclic Extension, Hilbert Theorem 90 and group Cohomology ,Kummer Extension ;Applications of Galois Theory ;Discriminants ,Polynomials of degree 3 and 4,Rulerand Compass Constructions, Solvability by Radicals ;Infinite Algebraic Extensions, Infinite Galois Extensions, Krull topology, The Fundamental Theorem of Infinite Galois theory; Transcendental Extensions :Transcendence Bases, Linear Disjointness Affine Algebraic Function Fields, Derivation and Differentials.

MAL 607 Commutative Algebra, 3(3-0-0)

Rings and Ideals ;Rings and ring homomorphism ,Ideals, quotient rings, Zero divisors, Nil potent Element ,Units, Prime Ideals , and maximal ideals,

Nilradical and Jacobson radical, Operation on ideals, Extension and contraction ; Modules ;modules and modules homomorphism ,sub module ,Direct sum product of modules, restriction and extension of scalars ,Exactness properties of the tensor product ,algebras ,tensor product of algebra ;Rings and modules of fraction, Local Properties Extended and contracted ideals in the rings of fractions, Primary decomposition, Integral dependence, The going up theorem Integrally closed integral domains, Valuation Topologies and completion, Filtrations, Graded Rings and modules, The associated graded ring , Artin –Ress Theorem ,Dimension Theory, Hilbert function , Dimensions theory of Noetherian local rings, Regular local rings, Transcendental dimension ,Depth :M-Regular Sequences,Cohen –Macaulay Rings.

MAL 608- Operator Theory -4(3-1-0)

Operators on Hilbert spaces: Bounded linear operator on Hilbert spaces, spectrum of an operator ,weak, norm and strong operator topologies, normal , self-ad joint , unitary and compact operator and their spectra .

Diagonalization, Spectral theorem and applications: diagonilzation for a compact self-ad joint operator, spectral theorem for compact norm operator and spectral calculus, application to Strum-Liouville problem.

Positive operators: positive linear maps of finite dimensional space and their norms, Schur products, completely positive maps.

MAL 609 Mathematics of financial Derivatives –I-4(4-0-0)

Introduction to Financial Derivatives: Futures and Options; Pricing with no –arbitrage principle, Black- Scholes equation for European style options; quick introduction to stochastic process; Basic facts about Bownian Motion and Martingales with applications in finance ;Stohastic integration , Stohastic Calculus (It's Formula,Girsanov theorem, connection with PDEs);Black-Scholes formula, Greek.

MAL 610 Measure Theory, 4 (3-1-0)

Pre-requisites: Basic Knowledge in Single Variable Calculus

Sigma- rings, sigma algebra, measurable space, countability and sub- addivity of a measure, Borel measure, Labesgue outer measure, measurable sets, construction of non-measureable set, the contor set. Measurable functions and their properties, almost everywhere property, approximation of measurable functions with the simple measurable functions and step functions. Egorov's theorem and Lusin's theorem. Lebesgue integral of functions, Lesbgue integral of integral functions and its linearity, Monotone convergence theorem, Fatou's lemma, Dominated convergence theorem, Applications of convergence theorems. Singed measures, absolute continues functions and their properties, singular measures, Radon – Nikodym theorem with applications.

MAL611 Analytic number theory

The Fundamental theorem of Arithmetic, Arithmetical Functions and Dirichlet Multiplication: The Mobius function, The Euler totient function, product formula, The Dirichlet product of arithmetical Functions, Dirichlet inverses and the Mobius inversion formula, The Von-Mangoldt function, Multiplicative functions, Dirichlet multiplication, The inverse of a completely multiplicative function, Liouville's function, The divisor functions, Generalized convolutions, Formal power series, The Bell series of an arithmetical function, Bell series and Dirichlet multiplication, Derivatives of arithmetical functions, The Selberg identity; Averages of Arithmetical functions: Euler's summation Formula, Some elementary asymptotic formulas, An application to the distribution of lattice points visible from the origin, The partial sums of a Dirichlet product, Another identity for the partial sums of a Dirichlet product; Some Elementary Theorems on the Distribution Numbers: Chebyshev's functions, Prime number theorem, Some equivalent forms of the prime number theorem, Shapiro's Tauberian theorem, An asymptotic formula for partial sums, The partial sums of the Mobius function, Brief sketch of an elementary proof of the prime number theorem, Selberg's asymptotic formula.

MAL601 Differential Equations, 4 (4-0-0)

Ordinary differential equations: Phase space, existence and uniqueness theorems, The method of successive approximations, dependence on initial conditions, Boundary value problems, Green's functions, Sturm-Liouville problems.

Partial differential equations: First order partial differential equation; Cauchy problem and

classification of second order equations, Laplace equation; Diffusion equation; Wave equation; Methods of solutions (variable separable method, integral transform method).

MAL602 Advanced Analysis, 4 (4-0-

Real analysis: Metric Spaces, Completeness, Connectedness, Complete Review of Riemann Integral, Lebesgue measure, Lebesgue and convergence, LP spaces.

Complex analysis: complex-analytic functions, Cauchy's integral formula, power series, Liouville's theorem, maximum-modulus theorem, Isolated singularities, residue theorem, the Argument Principle, real integrals via contour integration. Mobius transformations, conformal mappings.

MAL701 Algebric Topology, 4 (4-0-0)

(Pre-requisite: General Topology)

Mainfolds: Indentification (quotient) spaces and identification (quotient) maps; topology n-manifolds including surfaces, Sn, RPn, CPn. and lens spaces.

Triangulated manifolds: Representation of triangulated, closed 2-manifolds as connected sums of tori of projective planes.

Fundamental group and covering spaces: Fundamental group, functoriality, retract, deformation retract; Van Kampen's Theorem, classification of surfaces by abelianizing the fundamental group, covering spaces, path lifting, homotopy lifting, uniqueness of lifts, general lifting theorem for maps, covering transformations, regular covers, correspondence between subgroups of the fundamental group and covering spaces, computing the fundamental group of the circle, RPn, lens spaces via covering spaces

Simplicial homology: Homology groups, functoriality, topological invariance, Mayer-Vietoris sequence; applications, including Euler characteristic, classification of closed trangulated surfaces via gomology and via Euler characteristic and orientability; degree of a map between oriented manifolds, Lefschetz number, Brouwer Fixed Point Theorem.

MAL702 Introduction to Knot Theory, 3 (3-0-0)

Composition of knots, Reidemeister moves, links, Invariants of knots, Surfaces and Knots: Genus and Seifert surfaces, Torus knots knots and its properties, Setelite Knots, Hyperbolic Knots, Braid theory, Alexander polynomial, Bracket polynomial, HOMFLY polynomial, Jones polynomial, Vassiliev Invariants, Knot complements and 3-Manifolds.

MAL703 Computational Partial Differential Equations, 4 (3-0-2)

Error Analysis: Introduction to Interpolation, differentiation and integration. Finite difference methods for Parabolic Equations: One space dimension, Convergence and stability analysis, two space dimensions. Elliptic Equations: Dirichlet, Neumann and Mixed problems. Hyperbolic equations: One space dimension, two space dimensions, first order equation, system of equations, Lax's equivalence theorem, Lax-Wendroff explicit method, CFL conditions, Wendroff implicit approximation. Finite Element Methods. Spectral Methods.

MAL704 Hydrodynamic Stability Theory, 4 (3-0-2)

Basic concepts of stability theory. Evolution equations and formulation of the linear stability problem. Solution of the initial value problem and normal-mode analysis. Temporal stability of viscous incompressible flow. Spatially instability of viscous incompressible flow. Some general properties of Orr-Summerfield problem. Kelvin Helmholtz Instability. Rayleigh-Taylor Instability, Rayleigh-Benard Covection. Saffman-Taylor Instability.

MAL705 Rings and Modules, 3 (3-0-0)

Artinian and Noetherian Ring, Primitive rings, Radicals, Completely reducible modules, Completely reducible ring, Semiprime rings and their properties, Projective and injective modules, Rings of endomorphism of injective modules, Classical ring of quotients, Regular Ring of quotients, Tensor product of modules exact sequence.

MAL706 Group Ring, 3 (3-0-0)

Definition of Group Ring, Basic facts in Group Ring, Augmentation ideals, Partial Augmentations, Ideals in Group Ring, Units in Group Ring, Annihilators, Semiprime Group Rings, Prime Group Rings, Chain Condition in Group Rings, Linear identity, The Delta method, Dimension Subgroup, Polynomial identities, Crossed Products, Zero divisor free Group Ring.

MAL707 Hyperbolic Conservation Laws, 4 (3-0-2)

Mathematical theory of hyperbolic conservations laws, first order wave equation, method of characteristics, Burger equation: Discontinuous solutions and expansion waves, Solutions to the Cauchy problem, Uniqueness and continuous dependence, Vanishing viscosity approximations, Hyperbolic system of PDE's: entropy, symmetrizability, constant coefficient linear systems, definition of wave types, truly non linear fields and linearly degenerate fields, Lax criterion, Riemann problem. Finite differences method, stability, consistency and accuracy of numerical schemes, conservative schemes, Lax-Wendroff theorem. Numerical schemes for scalar equations: 1-D Godunov method, finite volume method, Examples from traffic flow, gas-dynamics and magneto hydrodynamics.

MAL708 Advanced Mathematical Ecology, 4 (4-0-0)

Introduction to Modeling and simulation in Ecology; Single Species Population Dynamics: Exponential and Logistic Growth; Structured Population Dynamics; Population Dynamics of Interacting Species: The Lotka-Volterra Predator-Prey Models and simulation; Qualitative analysis: Stability and phase plane analysis; Modeling of Infectious diseases: SIR models; Qualitative analysis of epidemic models: Computation of R0, stability, equilibria; Spatial Dynamics: Metapopulation models, Diseases in Metapopulation; Adding Stochasticity to models: Sample paths and stochastic differential equations, General stochastic diffusion processes; Key models in Behavioral Ecology: Diet-choice and foraging, Evolutionarily Stable Strategies, Search and predation.

MAL709 Basic Algebraic Number Theory, 3 (3-0-0)

Localization, Integral Dependence, Discrete Valuation Rings and Dedekind Rings, Fractional Ideals and the Class group, Class numbers, Norms and Traces, Extension of Dedekind Rings, Discriminant, Ramification , Norms of ideals, Cyclotomic Fields, Lattice in Real Vector Spaces, The unit Theorem, and The Finiteness of class number; Valuations,Local Norms and the Traces and The Product Formula,;Decomposition and Inertia groups, The Frobenius Automorphism, The Artin Map of Abelian Extension ;Moduli and Ray classes, Dirichlet Series, Characteristics of Abelian grouos ,L-series and Product Representatives , Frobenius Density Theorem.

MAL 710 P-Adic Number Theory,3 (3-0-0)

Historical introduction, Bernoulli numbers, p-adic norm and p-adic numbers Hensel's Anology, Solving Congruence modulo prime power, Absolute Values on the field of rational numbers, completion with respect to p-adic norms, exploring, Hensel's Lemma, Local and Global Principles, p-adic interpolation,: A formula for Riemann zeta function at even integers .p-adic function L-function, The P-adic Riemann zeta function as a Mellin – Mazur transform, p-adic distributions, Kummer's con guence ,Bernolli distributions , Measures and integration, Leopoldt's formula for p-adic L-function, p-adic regulator ,p-adic gamma function ,p-adic di-gamma function ,p-adic Eular –Lehmer constant and their generalizations.

MAL 711 Geometric Aspects In Functional Analysis, 4 (4-0-0)

CLASSIC BANACH SPACES: Sequence spaces C○ , C, Lp , $1 \leqslant p \leqslant \infty$, particular properties of ⌊ 1 ,⌊∞ , function spaces Lp, for $1 \leqslant p \leqslant \infty$,ɕ (K); STRICT COVEXITY AND SMOOTHNESS: Strictly convex and uniform convex Banach spaces, Gateaux differentiability,Frechet differentiability duality relation between convexity and smoothness; PROXIMINAL SUBSPACES: Metric projections and their continuity properties, metric projections on Frechet and polihydral spaces, proximinality and strong proximinality – their continuity properties, preduality maps, stong proximinality via finite co-dimension.

MAL712 Virtual knot Theory, 3 (3-0-0)

Definition of virtual knots and links, definition and properties of flat virtual knots, Reidemeister moves, virtual isotopic knots, Gauss codes, surface interpretations of virtual knots, long virtual knots, parity and the odd writhe, invariants for virtual knots, Bracket polynomial, parity Bracket polynomial, Z-move, jones polynomial, Arrow polynomial for virtual and flat virtual knots and links, Virtual braids, categorical structure for the virtual braid groups,

Alexander theorem and Markov moves for virtual braids.

MAL713 Numerical Method for Mathematical Finance, 4 (3-0-2)

Time-dependent one-dimensional convection-diffusion-reaction equations in finance

Finite difference methods – theta methods:stability and convergence

Modelling (local) stochastic volatility: an example of multi-dimensional PDEs with mixed derivative terms

Splitting schemes of ADI type: Stability and convergence

Comparison with other methods: Locally one dimensional (LOD) method, IMEX method.

Numerical example

MAL714 Mathematics Of Financial Derivatives Ii ,4(4-0-0)

Risk-neural valuation

Black-scholes and beyond (Non-constant Volatility, stochastic interest rate, multi-asset options)

American options: Early exercise and free boundary problem

Exotic options: Path dependency

Introduction to interest rate theory: Models and products

Introduction to FX options: a case study

MAL715 Transcendental number theory

Liouville's theorem, Irrationality of some known constants, Transcendental Numbers, Approximation of Algebraic Numbers, Parameters for Algebraic Numbers and Polynomials, Thue's Equation, Hermite's Theorem, Lindemann's theorem, The Lindemann-Weierstrass theorem, The maximum modulus principle, Siegel's lemma, The six exponentials theorem, Estimates for derivatives, Theorems of Dyson and Gel'fond, Roth'sTheorem, The Schneider-Lang theorem, Linear Forms in the Logarithms of Algebraic Numbers, Baker's theorem and its applications, Schanuel's conjecture.

MAL716 Banach Algebras

Banach Algebras- Definition and examples; the spectrum; multiplicative linear functionals; the Gelfand transform and applications; maximal ideal spaces; Non-unital Banach Algebras. C*-algebras - Definition and examples; commutative C*-algebras; the spectral theorem and applications; polar decomposition; positive linear functionals and states; The GNS Construction; non unital C*-algebras. Topologies on B(H).

4.7. Department of Mechanical Engineering

M.Tech. Courses

MEL632 Mathematics for Engineers, 3 (3-0-0)

Properties of Vector Algebra, Vector space, subspace, basis, null and range space, invertibility and matrix representation; Cartesian Tensor notation and vector analysis; Matrices and Matrix algebra, Echelon form, orthogonalization; Eigen values and eigenvectors of a linear operator; Calculus of scalar, vector and tensor fields; Linear ODEs: Second and higher order Linear Differential equations; System of differential equations, Methods of Taylor and Frobenius, Laplace and Fourier transforms, Fourier series; Legendre and Bessel functions; Sturm Louville Problem; classification of PDEs; Analytical solution of linear PDEs.

MEL633 Numerical Methods in Mechanical Engineering, 3 (3-0-0)

Introduction to Scientific Computing, Error Analysis, Solutions of Equations of One Variable (Root Solving), Interpolation and Polynomial Approximation, Least-Squares and FFTs, Numerical Integration and Differentiation, Solution of Systems of Linear Algebraic Equations, Solution to Matrix Eigen Problems, Solution of Nonlinear Equations, Solution of Ordinary Differential Equations, Linear and Nonlinear Elliptic, Parabolic and Hyperbolic Partial Differential Equations and Integral Equations, Finite Difference and Finite Volume Discretizations, Finite Element Discretizations, Boundary Element Discretizations, Direct and Iterative Solution Methods.

Manufacturing

MEL501 Advanced Composites: (3-0-0) 3 Credits

Definition of composite materials: classification: particulate and dispersion hardened composites,

continuous and discontinuous fibre reinforced composites. Metal-matrix composites, carbon-carbon composites, molecular composites, micro and multi layer composites. Theory of reinforcement, particulate and dispersion hardening, reinforcement by continuous and discontinuous fibres; concept of microfibril; effect of orientation and adhesion. Mechanical behaviour of composites: stress-strain relationship, strength, fracture, toughness and fatigue. Properties of fibre reinforcement and matrices, production technology of composites.

MEL502 Advanced Welding Technology, 3 (3-0-0)

Physics of welding arc: characteristics of arc and mode of metal transfer. Welding fluxes and coatings: type and classification, electrode codes and their critical evaluation. Welding machine characteristics conventional and pulsed power sources, inverter type, power sources for resistance welding.,Weldability- weldability of cast iron, plain carbon and low alloy steels, determination of preheat temperature, use of Schaeffler's diagram, weldability test. Residual stress and distortion-theory of residual stresses and distortion calculation, welding codes, joint design, analysis of fracture and fatigue of welded joints- fracture, energy consideration, fracture toughness testing and its application to welded joints. Automated welding systems: microprocessor control of arc welding and resistance welding, Quality assurance in welding, welding fumes and their effect on the environment.

MEL503 Solidification Processing, 3 (3-0-0)

Plane front solidification of single phase alloys, interface stability, Czochralski growth, growth of single crystals of high perfection, cellular solidification, cellular-dendritic transition, plane front solidification of polyphase alloys, macro and micro morphology of eutectic growth. Growth of graphite in cast irons some problems in solidification of polyphase alloys, inclusions-their formation and distribution, rheocasting, Thixocasting, electroslag casting, casting of composites.

MEL504 Advanced Metal Casting Technology, 3 (3-0-0)

Casting processes, classification and their characteristics, technology of selected casting processes, clay bonded, oil bonded, synthetic resin bonded, inorganic material bonded mould and core making processes. Sand additives and mould coatings; metal mould casting processes, centrifugal and continuous casting processes solidification, gating and risering, nucleation and grain growth. Solidification of pure metals, short and long freezing range alloys. Rate of solidification, macrostructure and microstructure. Solidification contraction: gating and risering design calculations. Fluidity and its measurement. Mould metal interface reactions, cast metals and alloys, family of cast irons, melting and casting technology. Inoculation, technology of steel and non ferrous cast metals. Gases in metals, melting furnaces and refractories.

MEL505 Industrial Robotics, 3 (3-0-0)

History of development of industrial robots. Fields of application and future scope; Anatomy and structural design of robot, manipulation arm geometry, drives and control (hardware) for motions. End effectors and grippers, pickups, etc. Matching robots to the working place and conditions; interlock and sequence control. Reliability, maintenance and safety of robotic systems, application studies in manufacturing processes, e.g. casting, welding, painting, machine tools, machining, heat treatment and nuclear power stations. Synthesis and evolution of geometrical configurations, robot economics, educating, programming and control of robots.

MEL506 Surface Engineering, 3 (3-0-0)

Surface-dependent engineering properties, surface initiated engineering failures - nature and causes, surface degradation, importance and necessity of surface engineering, tailoring of surfaces of advanced materials, surface protection (physical), surface modification (chemical) techniques: classification, principles, methods, and technology, conventional surface engineering methods applicable to steel, cast iron, non-ferrous metals/alloys, ceramics and composites, advantages and limitations of conventional processes, recent trends in surface engineering including cold spraying, post-coating techniques, characterization (microstructural & compositional) and testing/evaluation of surface-properties. Technological aspects of laser surface engineering.

MEL507 Engineering Design Optimization, 3 (3-0-0)

Basic concepts. unconstrained and constrained problems. The Kuln-Tucker conditions; function of one variable; polynomial approximations, Golden section method. finding the bounds on the solution, a general strategy for minimizing functions of one variable; unconstrained functions of n variable: zero-order first-order and second-order methods, convergence criteria; constrained functions of n variables: linear programming, sequential unconstrained minimization techniques. Direct methods; approximation techniques; duality; general design applications.

MEL511Atomistic Simulation and Modeling of Materials, 3 (3-0-0)

This course uses the theory and application of atomistic computer simulations to model, understand, and predict the properties of real materials. Specific topics include: energy models from classical potentials to first-principles approaches; density functional theory and the total-energy pseudopotential method; errors and accuracy of quantitative predictions: thermodynamic ensembles, Monte Carlo sampling and molecular dynamics simulations; free energy and phase transitions; fluctuations and transport properties; and coarse-graining approaches and mesoscale models. The course employs case studies from industrial applications of advanced materials to nanotechnology. Simulations of classical force fields, electronic-structure approaches, molecular dynamics, and Monte Carlo.

MEL512 Nanocomposites-Processing, Characterization and Applications, 3 (3-0-0)

Nanocomposites-Introduction to Carbon Nano Tubes; Introduction to nanocomposites - where are they from and where are they going; Materials science of nanocomposites - understanding the pieces inside a nanocomposite part; Properties of nanocomposites - identifying the property advantages of these interesting materials; Particulates - the building blocks of nanocomposites

Structural and distribution characterization - seeing what is too small to be seen

Property characterization - realizing the performance of engineered parts; Introduction of Nano Mechanics; Nanoscale Characterization with Atomic Force Microscopy; Principles of imaging surfaces with AFM; magnitude of error, practical misconceptions; Quasistatic and dynamic modes; domains of application, pitfalls.Metrics of surface topography; examples of technological surface analysis. Compositionally sensitive methods. Shear forces, revealing crystallinity and disorder. Phases imaging for high spatial resolution on delicate samples; physical interpretations and corresponding misconceptions

Distance-dependent forces; liquid environments and chain molecule conformational states

MEL514 Metallic Corrosion, 3 (3-0-0)

Fundamentals of metallic corrosion. Forms of corrosion-uniform corrosion, intergranular corrosion, galvanic corrosion, crevice corrosion, pitting corrosion, erosion-corrosion, stress corrosion cracking (SCC), biological corrosion and high temperature corrosion (HTC). Corrosion mechanisms. HTC of alloys and coatings-formation and growth of oxide scales. Design strategies for new corrosion-resistant alloys. Corrosion and erosion-corrosion in boilers and gas turbines. Corrosion problems in the petrochemical industry and modern incinerators. Sulfidation of metallic materials. Corrosion problems in metal forming and other manufacturing processes. Oxidation of metal matrix composites. Corrosion evaluation-modern analytical techniques. Brief introduction to commonly used techniques for corrosion control.

MEL517 Sustainable Design and Manufacturing, 4 (2-0-4)

General sustainability, sustainability and its importance, environment, ecology and the planet, material life cycle, renewable and non-renewable resources, climate change, sustainability measures such as environmental impact, factors, indicators, and influences; assessment methods, Triple Bottom Line (TBL) approach; Life Cycle Assessment (LCA), method and tools, standards and directives, reporting initiatives; eco-design, eco-design principles, tools and techniques; sustainable manufacturing, processes and techniques, energy usage during manufacturing, sustainable manufacturing techniques. Laboratory experiments: analysis of products, use of sustainability tools, design of sustainable products, energy usage monitoring during machining.

MEL519 Biological Materials, 4 (3-0-2)

Nano and microstructure of biological materials, Biominerals, Proteins, Biological ceramics, Biological Polymer and polymer composite, Biological Elastomers, Functional Biological materials, Bioinspired materials.

MEL605 Friction and Wear in Machinery, 3 (3-0-0)

Introduction, surface: nature, characterization and effects, Friction: Mechanisms and types, wear Nature, mechanism and types, surface temperatures : formulation and measurements, Lubrication: Regimes, Hydrodynamic and hydrostatic lubrication, Lubricants: characterization, types and effects. Experimental methods, friction and wear of polymers and composites, Methods of improving tribologocal behaviour, Case studies.

MEL606 Modern Manufacturing Processes, 3 (3-0-0)

Theory and application of machining by abrasive jet, water jet, abrasive flow, ultrasonics thermal assistance, total form matching and low stress grinding. Electrochemical machining and grinding, polishing, sharpening, honing and turning. Electrochemical discharge grinding: electrostream and shaped tube electrolytic machining. Chemical and thermochemical machining, thermal energy methods of material processing (machining/ welding/ heat treatment) by electro-discharge, laser and electron beam, plasma arc and ion beam. Physical vapour and chemical vapour deposition and plasma spraying. High energy rate forming and electroforming.

MEL607 Rapid Prototyping, 3 (3-0-0)

Introduction to rapid prototyping (RP), need of RP in context of batch production, FMS and CIM and their application, basic principles of RP, steps in RP, process chain in RP in integrated CAD-CAM environment, advantages of RP. Classification of different RP techniques-based on raw materials, layering technique (2-D or 3-D) and energy sources, process technology and comparative study of stereo-lithography (SL) with photo polymerization SL with liquid thermal polymerization, solid foil polymerization. Selective laser sintering, selective powder binding, ballistic particle manufacturing-both 2-D and 3-D, fused deposition modelling, shape melting, laminated object manufacturing, solid ground curing, respective masking and deposition, beam interference solidification, holographic interference solidification. Special topic on RP using metallic alloy-laser engineered net shaping and electron beam melting. Rapid prototyping of small components-Micro stereo lithography, programming in RP representation of 3D model in STL format. Repair of STL files, rapid tooling.

MEL613 Science of Machining, 3 (3-0-0)

Mechanics of chip formation, chip curl. Bluntness and cutting forces. Thermal aspects of machining. Tool wear, tool life and economics of machining. Mechanics of grinding, forces and specific energy, temperature. Wheel wear and surface finish

Cutting fluid and surface roughness, Nomenclature of cutting tools, Chip control, Machine tool vibration, Mechanisms of material removal in various non-conventional machining processes.

MEL615 Advanced Material Characterization Techniques, 4 (2-0-4)

SEM: Provide an understanding of scanning electron microscopy theory and principles: SEM gun construction, Get acquainted with scanning electron microscope construction and controls. Operation of scanning electron microscopy: Electron gun parameters, Imaging parameters, Image contrast (topographic and atomic number contrasts), Environmental scanning electron microscopy, Sample preparation, High resolution SEM imaging, EDS measurements.

MEL 617 Biology for Engineers, 3 (3-0-0)

Biochemistry, Genetics, Genetics, Molecular Biology, Gene Regulation, Protein Localization, Recombinant DNA, Cell Biology, Developmental Biology, Cell Cycle/Signaling, Cancer, Virology/Tumor Viruses, Immunology, AIDS, Genomics, Nervous System, Stem Cells/Cloning, Molecular Medicine, Molecular Evolution, Human Polymorphisms and Cancer Classification, Future of Biology.

MEL630 Modelling Techniques for Metal Forming Processes, 3 (3-0-0)

Process Modelling, Plasticity Fundamentals, Uniform Energy Method, Slab Method, Slip-line Field Technique, Upper Bound Technique,

Viscoplasticity Technique, Finite Element Method

MEL631 Manufacturing Science - I, 3 (3-0-0)

Casting processes and analysis: Gating design, cooling and solidification, defects;

Forming processes and analysis: Rolling, Forging, Extrusion, Drawing, Shearing, Deep Drawing

Machining processes and analysis: Mechanics of machining, Tool life, Turning, Drilling, Milling, Multipoint machining, finish operations

Joining processes and their analysis: Principles of Welding; Solid phase, Arc, Resistance, Gas, Thermit welding.

Advanced applications in general engineering, aerospace, automobile and biomedical industries.

MEL634 Computer Integrated Design and Manufacturing Systems, 4 (2-0-4)

Manufacturing system concepts; CAD / CAM / CAE / CIM; geometric modeling; mathematical representation of curves, surfaces and solids; solid modeling, solid representation; methodology of interactive, graphical, engineering design; computer numerical controlled machines; manual and automated CNC programming; automation; automatic tool changers; modern cutting tools; coordinate measuring machine; rapid prototyping systems; group technology; flexible manufacturing systems; industrial robotics.

MEP601 Advanced Mechanical and Materials Engineering Laboratory, 3 (0-0-6)

Any twelve of the following experiments

Measurement of cutting force and Temperature in turning; Measurement of Grinding force and estimation of temperature; Assessment of residual stress in ground surface; Imparting geometry to cutting tools; Effects of tool coating on performance of drills; Effects of tool coating on performance of turning tool inserts; Assessment of micro - structural changes due to grinding; Non – traditional manufacturing; Electro jet drilling

Electro – discharge Machining; Wire – EDM; Ultrasonic Machining; Laser beam machining; Micro- machining using Excimer Laser; Electro-foaming; Chemical Machining; To characterize a given materials by XRD, SEM/EDS, TEM analysis.

MEP602 Material Engineering Laboratory, 2 (0-0-4)

Determination of eutectic phase diagram; observation of case iron microstructure; heat treatment of steels-annealing, normalization, hardening and tempering and observation of their microstructure; harden ability determination by Jominy test; heat treatment of tool steels; pack carburizing of steels; age hardening of Al-base alloys, Determination of crystal structure by X-Ray diffraction.

MEL508 Advanced Mechanics of Solids, 3 (3-0-0)

Shear centre and unsymmetrical bending. Beam columns: beams on electric foundations, curved beams, Rotating discs and thick cylinders, Virtual work; minimum potential energy; Hamilton's principle. plate theory: formulation by Hamilton's principle: bending and buckling of homogeneous and sandwich plates. Shell theory: introduction to theory of surface; formulation by Hamilton's principle; membrane, bending and buckling analysis of shells of revolution.

MEL510 Rotor Dynamics and Condition Monitoring, 4 (3-0-2) 4

Modeling of rotor-bearing system by various techniques - transfer matrix, finite element, influence coefficients and modal methods. Critical speed maps. Unbalance response and orbital analysis. Disc gyroscopic. Rotor instability due to fluid film forces, hysteretic effects and parametric excitations. Rigid rotor balancing. Influence coefficient and modal balancing techniques for flexible rotors. Balancing standards. Torsional vibration analysis of rotating machines including branched systems-response to steady state and transient excitations. Instrumentation for bending and torsional vibration measurements on rotor-bearing systems.

Maintenance Principles, FMECA, Basics of Machine Vibration, Signal Analysis, Computer aided data acquisition, Time Domain Signal Analysis, Frequency Domain Signal Analysis, Fault Detection Transducers and Monitoring, Vibration Monitoring, Field Balancing of Rotors, Condition Monitoring of Rotating Machines, Noise Monitoring, Wear & Debris Analysis, Thermography, Electric Motor Current Signature Analysis, Ultrasonics in Condition Monitoring, NDT Techniques in Condition Monitoring, Case studies.

MEL513 Introduction to Plasticity, 3 (3-0-0)

Review of Stress, Strain and Elastic Stress-Strain Relations, Isotropic Yield criteria due to Hardening

and their experimental verifications, Strain and Strain Rate Measures for Plastic Deformation, Plastic Potential and Flow Rule, Plastic Constitutive Relations (Stress-Strain Rate and Incremental Stress- Incremental Strain relations), Concept of plastic anisotropy and plastic instability, Formulation of Plasticity Problem, Approximate Methods of Analysis: Upper and Lower Bound Methods, Slip-Line Field Method, Bending of a beam with symmetric Cross-Section, Torsion of a Circular Cylinder, Hole expansion in an infinite Plate, Deep Drawing, Compression of a Cylinder (Forging), Necking of a cylinder, Wire Drawing, Bending of a circular Plate.

MEL515 Bone Biology, 3 (3-0-0)

Structure and development of the skeleton, Mesenchymal stem cells and osteoblast lineage, Transcriptional control of osteoblast differentiation, Osteocyte and bio-mechanics of bone, Osteoclastogenesis, Regulation and function of osteoclast, Bone matrix I: collagen and noncollagenous proteins, Bone matrix II: intercellular junctions and cell-cell, communication in bone, Bone remodeling and mineral homeostasis, Mechanotransduction in bone cells, Local regulators of bone: Statins and bone, Craniosynostosis, Bone Fracture Healing, Bone tissue engineering, Methods in bone research.

MEL516 Orthopedic Biomechanics 4 (3-0-2)

The Musculoskeletal System; Physiology of the Neuro-Musculoskeletal System; Loads and Motion in the Musculoskeletal System; Bone Tissue Mechanics; Soft Tissue Mechanics; Structural Analysis of Musculoskeletal Systems; Bone-Implant Systems; Bone Mechano-transduction; Biomechanics of Fracture Healing; Fracture Fixation Devices; Total Hip Replacements; Total Knee Replacements; Articulating Surfaces.

MEL 518 Robot Manipulators: Kinematics, Dynamics and Control, 4 (3-0-2) 4

Serial and parallel manipulators, Characteristics of robotic manipulators, Transformations, Forward and inverse kinematics of serial manipulators, Jacobian analysis, Trajectory planning, Forward and inverse dynamics of serial manipulators --- Newton-Euler and Lagrangian techniques, Robot control strategies. Special topics: Advance methods of motion planning, Kinematics and dynamics of parallel manipulators, Robot vision.

MEP501 Control Engineering Laboratory, 2 (0-0-4)

Laboratory experiments on the design and use of Pneumatic Hydraulic and Electronic controllers for control of parameters like Displacement/Position Pressure Flow rate Temperature level Speed, etc. Analog and Digital motor control plant and related experiments.

MEP502 Experimental Methods for Engineers, 4 (1-0-6)

Topics for introductory lectures/theory: Introduction to Hypothesis formulation, Hypothesis testing, Analysis of variance, Data analysis and interpretation, Measurement uncertainty, Experiment design; Experiments on calculating cooling load using Air-conditioning and Refrigeration tutors; Quantification of the amount of heat transfer taking place due to natural and forced convection mechanisms; Comparison of radioactive hear transfer between different types of materials and calibration of thermocouples; Fracture Toughness Measurement of Materials (K_{IC} and J_{IC} measurement); Extension-torsion coupling study in composite beams; Uni-axial tensile and stress relaxation behavior of visco-elastic materias; Multi degree freedom system with force vibration; vibration of Continuum system; Measurement of machining forces and tool life during orthogonal cutting, Comparison with analytically predicted forces via Merchant's model; Estimation of mean fusion zone temperature in welding (either SMAW or MIG or TIG); Effects of spray lubrication during high speed machining; Effect of annealing on strain-hardened metals.

MEL602 Finite Element Methods in Engineering, 3 (3-0-0)

Basic concepts: The standard discrete system, Finite elements of an elastic continuum- displacement approach, Generalization of finite element concepts–weighted residual and variational approaches. Element types: triangular, rectangular, quadrilateral, sector, curved, isoparametric elements and numerical integration. Automatic mesh generation schemes. Application to structural mechanics problems: plane stress and plane strains. Axisymmetric stress analysis, introduction to three

dimensional stress analysis. Introduction to use of FEM in steady state field problems-heat conduction fluid flow and non linear material problems, plasticity, creep etc., Computer procedure for Finite element analysis.

MEL603 Machine Vibration Analysis, 3 (3-0-0)

Characterization of engineering vibration problems. Model study through single degree of freedom analysis. Two degrees and multidegree of freedom systems with applications. Continuous medium. Vibration measuring instruments, computational techniques like matrix iterations, transfer matrix method and other methods, Lagrange's mechanics, system stimulation technique.

MEL604 Vibration and Shock Isolation, 2 (3-0-0)

Multidegree of freedom system excited by force and motion with two planes of symmetry. Natural frequencies for T.P.S. problems in isolatior application. Natural frequencies for T.P.S. and O.P.S. inclined isolaters and decoupling of modes. Velocity shock elastic and in elastic impact, effect of snubbing and preloading. Isolation of shock force that causes small and large displacements. Properties of material, design an isolation. Particular application of isolators.

MEL608 Mechatronics, 3 (3-0-0)

Basic solid state components and devices elements of electromechanical energy conversion, starting, inversion and control of electrical drives. Coupling of mechanical loads to DC and AC electrical drives and speed control. Optoelectronic encoding, sensing, signal shaping and processing devices and techniques. Basics of digital signal processing data acquisition. Special simulation techniques for mechatronic systems, special techniques for solving of shift system model with switching and delay components. Elements of telemetry and remote control of mechatronic systems, theory of linear observers, optimal filters and their digital implications. Introduction to design and implementation of digital control strategies for mechanical systems.

MEL614 Nonlinear oscillations, 3 (3-0-0)

Review of linear systems and stability. Nonlinear systems: fixed points and linearization, stable and unstable manifolds, Stability and Lyapunov functions, index theory, Floquet's theory. Elementary bifurcation theory: normal forms of saddle node, transcritical, and pitchfork bifurcations, Hopf bifurcation. Maps: 1-D maps, stability of periodic orbits, symbolic dynamics and conjugacy. Chaos: Lyapunov exponent, roots to chaos.

MEL 616 Fracture and Fatigue, 3 (3-0-0)

Fracture: Energy release rate, crack tip stresses and deformation fields, plastic zone, Elasto-plastic fracture through J-integral and CTOD, Dynamic fracture, Testing for Fracture, Toughness, Fatigue: Endurance limit and S-N diagram, strain-life equation, Crack nucleation and growth, Factors influencing fatigue strength, Influence of stress concentration, Fatigue life prediction, Statistical analysis, Fatigue testing modules.

MEL618 Molecular, Cellular and Tissue Biomechanics, 4 (3-0-2)

Molecular Mechanics: Mechanics at the Nanoscale (Intermolecular forces and their origins, Single molecules, Thermodynamics and statistical mechanics); Formation and Dissolution of Bonds (Mechanochemistry, Motion at the molecular and macromolecular level, Muscle mechanics, Experimental methods at the single molecule level - optical and magnetic traps, force spectroscopy, light scattering.)

Tissue Mechanics: Elastic (time independent); viscoelastic and poroelastic (time-dependent) behavior of tissues; Continuum and microstructural models; Constitutive laws; Electromechanical and physicochemical properties of tissues; Physical regulation of cellular metabolism; Experimental methods - macroscopic rheology.

Cellular Mechanics: Static and dynamic cell processes; Cell adhesion, migration and aggregation; Mechanics of biomembranes; The cytoskeleton and cortex; Microrheological properties and their implications; Mechanotransduction; Experimental methods - passive and active rheology, motility and adhesion assays.

MEL624 Crystal Plasticity, 4 (3-0-2)

Elements of Tensor Analysis; Theory of Strains and Stresses; Basic Equations of Solid Mechanics; Symmetry of Elastic Properties; Failure Theories; Flow Rule; Isotropic and Kinematic Yield Criteria; Finite Element Method; Metallurgical Fundamentals of Plastic Defromation; Crystalline Anisotropy; Constitutive Behavior of Single Crystal;

Homogenization Models for Polycrystals; Numerical Aspects of Crystal Plasticity Finite Element Method Implementations; Microscopic, Mesoscopic and Macroscopic Examples.

MEL626 Theory of Elasticity, 3 (3-0-0)

CreditsGeneralized Coordinates, Analysis of stress and strain, Infinitesimal and finite deformation elasticity, Constitutive equations, Uniqueness and superposition, Boundary value problems in plane stress and plain strain, Stress functions, Bending and Torsion of non circular cross sections, Kelvin problem and 3-D problems, Anisotropic Elasticity.

MEL 509 Convective Heat Transfer, 3 (3-0-0)

Forced Convective Heat Transfer: Introduction to heat transfer by convection, a review of viscous flow, conservation of mass and momentum – the continuity and Navier-Stokes equation, boundary layer equation, laminar boundary layer a flat plate, boundary layer separation, energy equation, derivation of energy equation, energy equation in non dimensional form, deviation of thermal boundary layer equation, heat transfer in a parallel flow over a flat surface, forced convection in internal flows, concept of entrance length and fully developed flow, heat transfer characteristics for internal flow

Natural Convection Heat Transfer: Governing equation and similarity considerations, free convection in laminar flow over a vertical plate, empirical co-relation in external free convection flows, inclined plates, long horizontal cylinder, spheres, free convection in enclosures, and cavities, combined free and forced convection.

Heat Transfer with Phase Change: Heat transfer in boiling, modes of boiling, regimes of pool boiling, pool boiling correlation, critical heat flux in nucleate pool boiling, forced convection boiling, modes of condensation, theory of film condensation, drop wise condensation.

MEL524 Energy Conservation and Waste Heat Recovery, 3 (3-0-0)

Potential for energy conservation, optimal utilization of fuels, methods of conserving energy, total energy approach.

Combined plants and cogeneration: Gas turbine-steam turbine plant, magneto hydro dynamic (MHD)-steam power plant, thermionic-steam power plant, thermoelectric-steam power plant, integrated gasification of combined cycle, cogeneration.

Utilization of industrial waste heat: sources and uses of waste heat, fluidized bed heat recovery systems, using waste heat in HVAC systems, heat pumps, heat recovery from incineration, heat exchangers, waste heat boilers, heat pipes, thermoelectric system to recover waste heat.

Energy storage and usage: using low grade rejected heat, electrical, magnetic, chemical and biological methods, thermo-economic optimization.

MEL521 Computational Fluid Dynamics, 4 (3-0-2)

A brief overview of the basic conservation equations, classification of PDE and pertinent physical behaviour, parabolic, elliptic and hyperbolic equations, role of characteristics. Common methods of discretization. Explicit and implicit schemes, consistency, stability and convergence. Numerical solution of systems of linear algebraic equations and iterative schemes and their convergence. Steady and transient diffusion problems (1-D and 2-D). Convection-diffusion problems: Central difference, upwind, exponential, hybrid and power-law schemes, concept of false diffusion, QUICK scheme. Numerical solution of the Navier-Stokes system for incompressible flows: stream-function vorticity and artificial compressibility methods, requirement of a staggered grid. MAC, SIMPLE, SIMPLEC and SIMPLER algorithms. An introduction to unstructured grid finite volume methods.

MEL 522 Air Conditioning and Ventilation, 3 (3-0-0)

Psychrometry, simple psychometrics processes, use of psychometrics chart. Comfort and industrial air conditioning. Air filtration. Principles of ventilation. Physiological factors. Comfort index. Air conditioning systems: Spray systems, chilled water and DE Coils, absorption and adsorption systems. Humidifiers. Air conveying: fans, ducts and air diffusion equipment. Estimation of air conditioning load, determination of supply state. Design and constructional details of Unitary air conditioning equipment. Noise level and acoustic control. Automatic controls in air conditioning.

MEL 523 Refrigeration systems, 3 (3-0-0)

Reverse Carnot cycle and standard vapour compression refrigeration cycle- analysis, comparison and Ewings construction. Compressor –

reciprocating, centrifugal, rotary, screw type. Volumetric efficiency and performance of single stage refrigeration system, its limitations. Multistage multi evaporator and Cascade systems. Properties of refrigerants: primary, secondary and mixtures, piping design and lubricants. Absorption refrigeration systems: LiBr-water and aqua-ammonia systems, calculations by h-x diagram. Electrolux system. Steam jet refrigeration, vortex tube, thermoelectric refrigeration, Gas Cycle refrigeration. Air liquefaction cycles. Condenser and evaporators, overall heat transfer coefficient, classification, design and performance. Expansion valves; performance and balance point. System balancing of condensing unit and evaporator.

MEL609 Solar Thermal Engineering, 3 (3-0-0)

Fundamentals of Solar Radiation, Atmospheric Absorption, Planck's Law and Wein's displacement Law, Radiative transport in participating media , Sky Radiation, Optical Properties of Layered Media, Flat-Plate Collectors, Concentrating Collectors, Energy Storage, Solar Loading, Solar Water Heating: Active and Passive, Building Heating: Active and Passive, Solar Thermal Power Systems, solar thermal energy utilization.

MEL610 Advanced Conduction & Radiative Heat Transfer, 3 (3-0-0)

Multi-dimension conduction, finite difference method, implicit and explicit schemes, steady-state and transient cases, flow of heat in infinite and semi infinite bodies; flow of heat in sphere, cone, cylinders; phase – change, black- body radiation, Plank's Law and Wein's displacement law, radiative transport equation, participative media, surface radiation.

MEL611 Combustion Engineering, 3 (3-0-0)

Combustion and thermo chemistry, chemical kinetics and reaction mechanisms. Rates of reaction, chain reactions, surface reactions, flame velocity, ignition and quenching, laminar premixed and diffusion flames, turbulent premixed flames, solid combustion, pollution and environment impact.

MEL612 Turbulent Flow, 3 (3-0-0)

Introduction to turbulence, equation of fluid flow, continuity and momentum equations, Reynolds stresses, turbulence modeling, Turbulent boundary layers, wall turbulence and free – turbulence, jets and Wakes, Free stream turbulence, scales of turbulent flow, length and time scales, velocity spectra, dissipation factor, skewness, flatness, turbulence measurement techniques.

MEL619 Engine Management, 4 (3-1-0)

Diesel engine management: cylinder charge control systems; Diesel fuel injection system: parameters, various designs etc.; Fuel supply systems, Governors and control systems: inline, distributor, helix and port controlled distributor injection pumps; Overview of discrete cylinder systems; Unit injector and Unit pump systems; Common rail direct injection systems (CRDI); Fuel Injection nozzles; Emission control; Electronic diesel Control (EDC), Electronic control unit (ECU); Gasoline engine management: Gasoline fuel injection, Fuel supply, Electronic fuel pump; Manifold and direct fuel injection; Ignition systems; Sensors; Electronic control systems.

MEL620 Fluid Flow and Heat Transfer in Biological Systems, 3 (3-0-0)

The role of transport processes in biological systems, Definition of transport processes, Relative importance of transport processes, Transport in cells, Physiological transport systems , Application of transport processes in disease pathology, treatment, and device development, Blood and its flow and rheological properties, Approximate methods for analysis of complex physiological flow, Transport through porous media, Diffusion in biological systems, Charge transport in biological systems, Heat transport in biological systems.

MEL621 Micro and Nanoscale Heat Transfer, 3 (3-0-0)

Statistical Thermodynamics, Quantum Mechanics, Thermal Properties of Molecules, Kinetic Theory, and Micro/Nanofluidics, Thermal Transport in Solid Micro/Nanostructures, Electron and Phonon Scattering, Size Effects, Quantum Conductance, Electronic Band Theory, Tunneling, Nonequilibrium Heat Conduction, Energy Transfer in Nanostructures, and Analysis of Solid State Devices Such As Thermoelectric Refrigeration and Optoelectronics, Nanoscale Thermal Radiation and Radiative Properties of Nanomaterials, Radiation Temperature and Entropy, Surface Electromagnetic Waves, and Near-Field Radiation for Energy Conversion Devices

and Applications in Thermal Management, Microfluidics, and Energy Conversion.

MEL622 Engine Instrumentation and Combustion Diagnostics, 3 (3-0-0)

General Engine Instrumentation; Dynamometers: AC, DC, Eddy Current & Chassis; Crank angle encoders; Pressure and temperature sensors; Measurement of fuel, combustion air and oil consumption; Injection and spark timing control methods; Test cell control and data acquisition, Combustion diagnostics by cylinder pressure measurement: knock, cyclic variations, IMEP, Efficiency, Combustion noise; Fast Response FID; In-Cylinder Flow Field Measurement: LDA, PIV; In-Cylinder soot concentration and particle size measurement; Fuel injection and spray characterization; Gas temperature measurement.

MEL623 Alternative Fuels and Advances in Engines, 3 (3-0-0)

Combustion process in IC engines; Principle quality requirement of automotive fuels; Conventional Fuels for Land Transportation; Liquid alternative Fuels, Advantages, Potential problems associated with utilization, Vegetable oils, Biodiesel, Fischer-Tropsch Diesel, Alcohols, Pyrolysis bio-oil, Effect on Lubricating oils; Gaseous Alternative Fuels, Hydrogen, Compressed Natural Gas, Liquified petroleum Gas, Di-methyl ether; Multi-fuel engines; Modern developments in IC Engines, GDI, Low temperature combustion concepts, HCCI, RCCI, PPC; Sources and Nature of various types of pollutants: Pollution monitoring instruments and techniques, Control measures, Emission legislations.

MEL629 Advanced Fluid Mechanics, 3 (3-0-0)

Fluid kinematics. Governing equations: equation of continuity, momentum equation, energy conservation, entropy; Navier-Stokes equations, Turbulent flow, Reynolds equations of turbulent flow, Turbulence modelling, Boundary layer theory, Hagen - Poiseuille flow.

Exact solutions of Navier-Stokes Equations: Couette flows, Poiseuille flows, Fully developed flows in non-circular cross-sections, Unsteady flows, Creeping flows.

Elements of Stability Theory: Concept of small-disturbance stability, Orr-Sommerfeld equation, Inviscid stability theory, Boundary layer stability, Thermal instability, Transition to turbulence.

Compressible flow: isentropic flows; normal shock wave relations, oblique shock waves, weak and strong shocks, and shock wave structure; compressible flows in ducts with area changes.

Dimensional Analysis: Fundamental dimensions-Physical Quantity and Dimensions-Dimensional Homogeneity- Non Dimensional parameters, p-Theorem dimensional analysis, Choice of variables, Determination of Dimensionless parameters.

MEL520 Advanced Topics in Biomedical Engineering, 4 (3-0-1)

Lectures: Concepts of Biomedical Engineering, Advance topics of Genetic Engineering, Advance topics of Cell Culture Engineering, Biomedical Instrumentations: Anesthesia and Cardiac instruments, Concepts of Biomolecular Engineering, Advance Engineering of Immunity, Advance topics of Cardiovascular Physiology, Advance topics of Renal Physiology, Advance topics of Biomechanics and Orthopedics, Advance topics of Bioimaging, Advance topics of Tissue Engineering, Biomedical Engineering and Cancer, Artificial Organs.

MEL601 Advanced Tribology, 3 (3-0-0)

Introduction, Surfaces: nature, characterization and effects. Friction: mechanisms and types. Wear: nature, mechanism and types. Lubrication: lubrication regimes, hydrodynamic and hydrostatic lubrication, lubricants: characterization, types and effects, lubrication and bearings, properties and testing of lubricants. Mechanics of fluid flow-Reynolds equation and its limitations, idealized bearings: infinitely long plane pivoted shoe and fixed shoe sliders, infinitely long journal bearings, infinitely short (narrow) bearings, lightly loaded infinitely long journal bearing (Petroff's solution), finite bearings, approximate analytical solution, numerical solution and electrical analogy method. Hydrostatic oil bearing: thrust and journal bearings. Squeeze film bearings: gas lubricated bearings, hydrodynamic bearings, hydrostatic bearings, porous bearings, elasto-hydrodynamic lubrication, Friction and wear of metals, polymers and composites, case studies, methods of improving tribological behavior, friction control and wear prevention.

MEL625 Engineering Ethics, 4 (3-1-0)

Evolution of the engineering profession; Basis for universal human values and ethical human conduct; Engineering profession in the light of comprehensive human gaol; Responsibility in engineering; Social and value dimensions of technology; Ethics in science and engineering; Ethical issues in engineering practice; Engineering education and engineering for social justice; Environmental ethics and sustainability; Ethics in innovation; Ethics in Medicine and Business; Research ethics; Engineering for health; Case Studies.

MEL 627 Micromechanics, 3 (3-0-0)

Mathematical Preliminaries on Tensor Algebra and Tensor Calculus, Review of basic concepts in Continuum Mechanics (Kinematics of deformation, deformation rate, stress and strain tensors etc.), Homogenization Methods for Heterogeneous Materials (Specially particle and fiber reinforced composites), Plasticity in Metals, Crystal Plasticity (single and polycrystal plasticity), Fundamentals of Cohesive Surface Modelling and its application in modelling crack propogation, Discrete dislocation Plasticity (Concept of dislocations, stress and displacement field associated with dislocations, Application of discrete dislocation plasticity in solving boundary value problems).

MEL 628 Introduction to Virtual Instrumentation, 4 (2-0-4)

Introduction to virtual Instrument(VI), Lab VIEW Environment, Data Flow Techniques, Advantages of VI Techniques, Basic Editing and Dubbing Technique; Creating a VI :Icon and connector, Sub VI; Loops and Charts, List of Shift Registers,; Arrays and Graphics ;Case structure , Sequence structure, and Graphics ;Case structure , Sequence structure, I/O Operations, Sensors, Transducers and Signal Conditioning,; Common Transducers for Displacement, Temperature, Load, Pressure, flow, etc; Single Ended, Floating and Differential Inputs, grounding, Noise and Filtering, Data Acquisition Basics; AD DAC, DIO, Counters and Timers, Pc Hardware structure, Timing, PCI buses; Exploratory data Analysis Using Lab VIEW.

4.8. Department of Physics

M.Sc.- Core Courses

PHL411 Classical mechanics, 4(3-1-0)

Constrained motion, degree of freedom, virtual work, d'Alembert's principle, Lagrange's equation of motion: simple examples; small oscillations, normal modes and frequencies; Hamilton's principle, derivation of Lagrange's equation of motion from Hamilton's principle; Legendre transformation, Hamilton's equation of motion; Principle of least action; Canonical transformations: examples; integral variant of Poincare; infinitesimal canonical transformation; Lagrange and Poisson brackets; conservation theorem and angular momentum relation in Poisson bracket formalism; Liouville's theorem; Hamilton-Jacobi equation; Hamilton characteristic function, action and angle variables; example of simple harmonic oscillator; Classical chaos: periodic motion and perturbation, attractors, chaotic trajectories, Lyapunov exponents, the logistic equations; Rigid body dynamics: orthogonal transformation and rotation; Euler's theorem and Euler's angles; inertia tensor and principal axis theorem; Euler's equations; Heavy symmetrical top with one-point fixed on the axis; Special theory of relativity: Review (Lorentz transformation, length contraction and time-dilation); Time-like and space-like vectors, 4-vectors, 4-dimensional velocity and acceleration; 4-momentum and 4-force; Covariant equations of motion; Relativistic kinematics (decay and elastic scattering); Lagrangian and Hamiltonian of a relativistic particle; Deformable bodies: strain and stress tensor, energy of elastic deformation; Fluid dynamics: permanency of vortices, Navier-Stokes theorem.

PHL412 Mathematical Physics, 4 (3-1-0)

Brief Introduction to vector calculus, Linear vector space: linear independence, orthogonality, Gram-Schmidt orthogonalization; Linear operators; Algebra of matrices: rank, elementary transformations, solution of linear equations, linear transformation, change of basis, eigen values and eigenvectors, diagonalization. Infinite dimensional function space, Hilbert space, Brief review of complex algebra: analytic function, Cauchy-Riemann equations. Complex calculus: integration in

complex plane, Cauchy's integral formula, Singularity (poles and branch points, Riemann sheets), Residue theorem and its application to definite integrals. Integrals involving branch point singularity, Fourier and Laplace transformations and their inverse; Convolution; Solution of differential equations by transform methods, Brief review of differential equations and their series solutions; brief review of special functions (Bessel, Hermite, Legendre, Laguerre); Green's functions of differential equations; Integral equations (Fredholm and Volterra equations), Introduction to Tensor analysis: covariant and contravariant forms, addition, subtraction, outer and inner products, symmetric and anti-symmetric tensors, raising and lowering of indices, Christoffel symbols, Group theory: Group postulates, order of a group, subgroup, rearrangement theorem; invariant subgroups; generators, isomorphism and homomorphism, cyclic and permutation group; reducible and irreducible representation; character tables; infinite groups: rotation group, SU(2) and SU(3) groups; applications of groups in Physics.

PHL413 Quantum Mechanics I, 4(3-1-0)

Introduction: Origin of quantum theory, de-Broglie hypothesis and wave-particle duality, Wave packet, Gaussian wave packet, Fourier transform, Spreading of Gaussian wave packet, Schrodinger equation, coordinate and momentum representation, One-dimensional problems: potential step, potential barrier, potential well, -function and double- potential, Application: Kronig-Penney model, One dimensional harmonic oscillator, Spherically symmetric potentials: separation of variables in spherical polar coordinate, orbital angular momentum, hydrogen atom, System of identical particles: Indistinguishability, symmetric and antisymmetric wave functions, incorporation of spin, Slater determinants, Pauli exclusion principle, Hilbert space formalism and Dirac notation: Operators and observables, significance of eigenfunctions and eigenvalues, commutation relations, uncertainty principle, harmonic oscillators by operator method, coherent states; Matrix representation of states and operators, continuous basis, Angular momentum: angular momentum algebra, eigenvalues of J2 and Jz, spinors and Pauli matrices, addition of angular momenta, CG coefficient, Symmetry operations and unitary transformations, generators, conservation principles, space and time translations, rotation, space inversion and time reversal, symmetry and degeneracy.

PHL414 Electromagnetic Theory, 4 (3-1-0)

Laplace's equation in 1, 2 and 3 dimensions; Uniqueness theorems; Method of images; Separation of variables; Multipole expansions for scalar and vector potentials. Polarization; Field due to a polarized object; Linear dielectrics; Magnetization; Field due to a magnetized object; Linear and nonlinear media, Boundary conditions. Faraday's law; Maxwell's equations in free space and matter. Charge, energy and momentum conservation; Poynting's theorem; Maxwell's stress tensor. Monochromatic EM waves in vacuum; Reflection and transmission of EM waves across an interface – normal and oblique incidence, Fresnel's equations, Brewster's angles, parallel and perpendicular polarization. EM waves in conductors; Skin depth; Reflection at a conducting surface; Frequency dependence of permittivity; Anomalous dispersion. Wave guides, Coaxial transmission line, Cavity resonators. Scalar and vector potentials; Gauge transformations; Coulomb and Lorenz gauge; Retarded potentials, Jefimenko's equations; Lienard-Wiechert potential; Field due to a moving point charge. Dipole radiation-electric and magnetic; Radiation power; Radiation reaction. Relativistic electrodynamics – Field transformation, EM field tensor, Potentials.

PHL415 Electronics & Lab., 5(2-0-6)

Introduction to semiconductor Physics, load lines, applications of diodes in circuits: dc power supply, voltage multipliers, limiters, clampers and peak-to-peak detectors, special purpose diodes, Bipolar junction transistors, small signal amplifiers, CE, CB and CC configurations,

Input & output impedances and amplification factors, multistage amplifiers, FET and differential amplifiers. Power amplifiers: push-pull amplifiers, ac compliances, load line, OP-Amp: linear and nonlinear amplifiers with Op-Amp, negative feedback amplifiers and its parameters stabilization, Oscillators: Monostable, bistable & astable multivibrators, 555 timer and its applications, Digital techniques and applications (registers, counters,comparators and similar circuits); Data Acquisition System: Brief introduction to digital

electronics, A/D & D/A converters, Microprocessor and microcontroller basics.

PHP420 Physics Lab - I, 4 (0-0-8)

X-ray diffraction, Hall Effect and four probe measurements, Band gap measurement, Electron spin resonance, Magnetism and superconductivity.

PHL421 Quantum Mechanics- II, 4(3-1-0)

Review of Symmetry; Rotation group, homomorphism between SO(3) and SU(2); Explicit matrix representation of generators for j=1/2 and j= 1; Rotation matrices; Irreducible spherical tensor operators, Wigner-Eckert theorem, Time-independent perturbation theory with non-degenerate levels: First and second-order correction to the energy eigenvalues; first-order correction to the eigenvector; Case of degenerate levels; Applications (fine structure, Stark effect, Zeeman effect and hyperfine splitting of levels, relativistic mass correction), Variational method: Application to Helium atom, WKB method, Time-dependent perturbation; Fermi's Golden Rule; Sudden and adiabatic approximation; Application: interaction of an atom with em field (semiclassical and quantum approach), Scattering Theory; Scattering of a particle by a fixed centre of force. Scattering amplitude differential and total cross sections. Method of partial waves. Phase shifts. Optical theorem. Scattering by a hard sphere and potential well. Integral equation for potential scattering. Green's function. Born approximation. Yukawa and Coulomb potential., Relativistic quantum mechanics; Klein-Gordon equation: covariant notation, negative energy and negative probability density, antiparticles; Introduction to Dirac equation: properties of Dirac matrices, non-relativistic limit, Measurement theory of quantum mechanics; EPR paradox, Bell inequality, Entanglement.

PHL422 Statistical Mechanics, 4(3-1-0)

Review of thermodynamics: Laws of thermodynamics, Thermodynamics potential, Maxwell's relations; Objective of statistical mechanics, concept of macrostates, microstates, phase space and ensembles, ergodic hypothesis, postulate of equal a-priori probability and equality of ensemble average and time average. Boltzmann's postulate of entropy. Counting the number of microstates in phase space: connection to thermodynamics, Entropy of ideal gas : Sackur-Tetrode equation and Gibbs' paradox; Canonical and grand-canonical ensemble, formulation of partition functions, Energy fluctuation, application of partition functions: ideal gas, harmonic oscillators, rigid rotors, para-magnetism, negative temperature; Quantum statistics: Density Matrix (properties, pure and mixed states); Quantum Liouville theorem; Density matrices for microcanonical, canonical and grand canonical systems; Simple examples of density matrices – one electron in a magnetic field, particle in a box; Identical particles; Ideal Fermi and Bose gases, their energy distribution BE: Bose-Einstein condensation, superfluidity, Planck's law, phonon gas, Debye theory of specific heat. FD: Fermi energy, ideal electronic gas, Landau levels, Landau diamagnetism, white dwarf and neutron stars; Strongly interacting systems: Ising model (Heisenberg and Ising Hamiltonian), solution of 1D Ising system in matrix methods, Mean-field approximation; Phase transitions and critical phenomena: critical indices, Landau's order parameters; Fluctuations: Thermodynamic fluctuations, Brownian motion, Langevin theory, Fokker-Planck equation, The fluctuation-dissipation theorem.

PHL423 Atomic and Molecular Physics, 4(3-1-0)

Quantum states of an Electron in an Atom: Bohr's Postulates, Bohr's Model for the One Electron Atom, Wilson-Sommerfeld Quantization Rules; Sommerfeld's Extension of Bohr's Model and Quantum Mechanics of Hydrogen Atom, Electron Spin, Pauli's Principles and Hund's rule, L-S & J-J Couplings, Selection Rules, Spectrum of Helium and Alkali Atom, Normal and Anomalous Zeeman effects, Stark Effects, Relativistic corrections for energy levels of hydrogen atom, hyperfine structure and isotopic shift, width of spectrum lines, Molecular Spectra, Electric dipole Transitions and Selection Rules; Electronic Transition in Diatomic Molecules, Rotational and Vibrational Spectra of Diatomic Molecules, X-ray Spectra, Raman Spectra and Franck-Condon Principle, Absorption, Fluorescence, Phosphorescence, Electron spin resonance, Nuclear magnetic resonance and Advances in Molecular Spectroscopy.

PHL424 Nuclear and Particle Physics, 4(3-1-0)

Foundations of nuclear and particle physics: discovery of nucleus, size, shape and charge

distribution, spin and parity. Origin of nuclear energy: mass defect, binding energy, semi-empirical mass formula and liquid drop model. Nuclear forces and two-body problem: nuclear stability and forces between nucleons, form of nucleon-nucleon potential, charge-independence and charge-symmetry of nuclear forces, Deuteron problem: ground and excited states of deuteron, normalization of deuteron wave function – radius of deuteron. Evidence of shell structure: single-particle shell model, its validity and limitations. De-excitation of excited nuclei: elementary ideas of alpha, beta and gamma decays and their selection rules, Nuclear reaction dynamics: classification of nuclear reactions, fusion, fission, (non)compound and direct reactions

The fundamental forces and the carrier particles & their quantum numbers (i.e., charge, spin, parity, isospin, strangeness, etc.), Gell-mann-Nishijima formula, Quark model, Baryons and Mesons. Invariance principles and conservation laws: translation and rotation, parity, charge conjugation, Charge Conservation and Gauge Invariance, Baryon and lepton conservation, CPT Theorem, CP violation and T violation, Isospin symmetry, Relativistic kinematics: Space & time mixing, "usual" relativistic effects, particle-decay, particle collisions & scattering.

PHL425 Condensed Matter Physics, 4(3-1-0)

Bonding in solids - Ionic, covalent, Metallic and vander Waals bonds; Crystalline and amorphous solids; Lattice, basis and crystals; Unit cell; Lattice parameters; Primitive cell; Crystal symmetry: Point and space groups; Miller indices

X-ray diffraction; Classical theory of lattice vibration under harmonic approximation; Vibrations of 1D monatomic and diatomic lattices; Elastic wave quantization; Free electron models; band theory of solids; Band gap; Electrons and Holes; Effective mass; Carrier concentration in intrinsic semiconductor; mobility of charge carriers; Fermi surface and metals Optical, dielectric, and magnetic properties of solid Phenomenological description of superconductor; Effect of magnetic field; AC resistivity; Meissner effect; Energy gap; Isotope effect; Penetration depth; Type-I and Type-II superconductors; Introduction to BCS theory and High Tc superconductors.

PHP510 Physics Lab II, 4(0-0-8)

Fabry-Perot Interferometer, Michelson-Interferometer, Fresnel Biprism, Fiber optics, Malus Law, Diffraction grating, Kerr effect, Absorption spectroscopy, Balmer series and Emission spectra, Zeemen effect, Magneto-optical effects.

PHP511 Modern Optics, 4(3-1-0)

Particle and wave-nature of light, Maxwell's equations, wave equation, coherence of light (spatial and temporal), Superposition of waves, two wave interference, multiple beam interference, Michelson interferometer, Fabry-Perot interferometer, light at planar interface, Fresnel Equations, TE and TM modes, optics of multilayer films, antireflection coatings, diffraction of light, single, and double slit, circular aperture, diffraction grating, polarizations, dichroism, Jones Matrix, different kinds of polarizers, optical activity, optical modulators, optics of liquid crystals, Light in anisotropic media, double refraction, light in conducting medium. Magneto optics and electro optics, Thermal radiation and modes in cavity. The concept of light quanta, Planks theorem. Light pressure, spontaneous and stimulated emission, population inversion, laser threshold , properties of laser radiation, Introduction to non-linear optics, second and third order effects, harmonic generation, kerr effect.

PHL512 Experimental Methods, 4(3-0-2)

Error analysis and data reduction: classification and propagation, probability distributions, graphical handling and curve fitting, Vacuum pumps, Gauges, Cryogenics, Transducers, Sources, Accelerators and Detectors, Signal processing: Signal transmission and impedance matching; noise sources; signal noise optimization; pre-amplifiers, amplifiers and pulse shaping, Measurement of voltage, current, charge, frequency, etc.; overview of digital and analog systems in measurement; data acquisition, X-Ray Diffraction: Basic and X-ray diffraction techniques, XRD of single crystal, polycrystalline and amorphous materials, Transmission Electron Microscopy: Imaging and diffraction, data interpretation, Neutron diffraction, Introduction to the techniques, analysis for magnetic structures of a crystal, Magnetic materials and its properties, Superconducting Quantum Interferometer Device, Vibrating Sample Magnetometer, Physical Properties Measurement System, Four point probe, Van der Pauw methods, Hall effect, Scanning Probe Microscopy: Contact,

non-contact and tapping modes, current sensing AFM, STM and STS, Scanning Electron Microscopy: Imaging and EDX, X-ray Photoelectron Spectroscopy: calibration, elemental analysis, depth measurement, Auger spectroscopy, Ultraviolet photoelectron spectroscopy, Optical sources and tables, beam parameters, Absorption, reflection and transmission measurements, FTIR, Raman and Laser induced breakdown spectroscopy, optical microscopy and imaging, near field microscopy, Optical coherence tomography, Images analysis, Light amplifiers, time resolved spectroscopy.

PHL513 Numerical Methods & Programming, 5(2-0-6)

Basic concepts and ideas in numerical analysis: Introduction to error, accuracy and stability. Data Reliability assessment: parameter sensitivity, experimental perturbations, Interpolation (Lagrange's method, divided difference formula, splines), integration (Simpson's method, Romberg's method, quadrature formula), extrapolation, discretization, convergence,
regression, quadrature, Random numbers, Solution of linear algebraic equations (elimination methods, LU decomposition), Eigenvalue problems, numerical solution of ordinary differential equations: explicit and implicit methods, multistep methods, Runge-Kutta and predictor-corrector methods. Introduction to numerical solutions of partial differential equations; Von Neumann stability analysis; alternating direction implicit methods and nonlinear equations.

PHL551 Nano-optics, 3(3-0-0)

(Review) Maxwell's equations, wave equation in vacuum, crystal structures, Bragg diffraction reciprocal lattice vectors, basic semiconductor physics,.
Introduction to nanophotonics as a new way to manipulate light, semiconductor quantum dots, quantum wells, nano-wires, Meta-materials, Photonic crystals, photonic ban gap, spontaneous emission control, photon density of states, light in disordered nanostructures, surface plasmons, localized surface plasmons, near-field optics, optical micro/nano cavities, nano-lasers, optical circuits.
Overview of different synthesis methods and characterization of nano-optics structures, nanophotonics devices, negative refractive index materials.

PHL552 Physics of Nanomaterials and Nanotechnology, 3(3-0-0)

Physics of 0D, 1D, 2D and 3D confinement; Density of states and Surface plasmons; Excitons in nanomaterials and Coulomb blockade; Size and surface dependence of physical; electronic; optical; magnetic; catalysis and mechanical properties
Nanoparticles growth using homogenous nucleation and heterogeneous nucleation
Fundamental of evaporation-dissolution growth; vapor-liquid solid; vapor-solid and vapor-solid-solid growth mechanisms; control the size of nanowires; template based synthesis; tunable growth of nanowire; nanotubes and nanoflute; Fundamental of thin film growth; Thermodynamics of nucleation and growth; kinetics process in nucleation and growth; growth models and superlattice; Carbon nanomaterials: nanofullerenes; nanotubes; graphene; nanodiamond; coreshell nanostructures; nanoflute
Characterization of nanomaterials and application to Molecular and nanoelectronics; biological application of nanomaterials; band gap engineering; nanomechanics; nanowires based hazardous chemical sensors; 1-D nanomaterials based mass sensors; antenna and laser and solar cells.

PHL553 Surface and Interfacial Forces, 3 (3-0-0)

Forces between atoms and molecules: Introduction, Forces of nature, Thermodynamic and statistical aspects of intermolecular forces, Covalent and coulomb interactions, Polar molecules and polarization, Van der Waals forces, Casimir force, Force measuring techniques, Forces in liquids, Hydrogen bonding, hydrophobic and hydrophilic forces
Forces between particles and surfaces: Concepts in intermolecular and interparticle forces, Differences between Intermolecular, Interparticle and Intersurface forces, VdW forces between particles and surfaces, Electrostatic double layer, Capillary forces,
Hydrodynamic forces, Adhesion and wetting, Friction and lubrication, Self assembly, Applications

PHL554 Nonlinear Optics, 3(3-0-0)

Introduction: Maxwell equations and Propagation of light waves in different media, Introduction to nonlinear optics and Nonlinear Optical Interactions;

Nonlinear Polarization and Nonlinear Susceptibility, Wave Equation for nonlinear Optical Media; Quantum Mechanical Description, Second order nonlinear optical Process: Second Harmonic Generation (SHG), Sum and Difference Frequency Generation, Phase Matching Conditions, Optical Parametric Generation and Amplification, SHG from surfaces and interfaces, Third order nonlinear optical Process: Third Harmonic generation, Four photon Parametric Interactions (four wave Mixing), Self Focusing, Self-Phase-Modulation, Refractive Index in Nonlinear Optics, Optical Phase conjugation, Coherent Anti-Stokes Raman Spectroscopy (CARS), Sum Frequency Generation Vibrational Spectroscopy.

PHL555 Nuclear Reactions & Instability, 3(3-0-0)

Alpha decay: semi classical theory of β-decay, β-particle energies and selection rules, Gamow's theory, Beta decay: energy spectrum allowed and forbidden transitions, decay rates, electron capture, Fermi-curie plot and mass of neutrino, comparative half-life, Gamma decay: energetics, Mossbauer Effect, angular momentum and parity selection rules, internal conversion, Non-conservation of Parity and Wu's experiment, Nuclear reactions: energy spectra, angular distributions, cross-sections, elastic scattering and nuclear size – electron scattering and optical model for nuclear scattering, direct reactions – angular momentum transfer and selectivity, Compound Nucleus Hypothesis – formation and resonances in CN, low energy neutron induced
fission, Introduction to heavy ion reactions: elastic and direct reactions, fusion, deep inelastic reactions and limits to fusion.

PHL556 Particle and Radiation Detectors, 3(3-0-0)

Interactions of heavy ions, gamma-rays and neutrons with matter: Bethe-Bloch formula, energy dependence, Bragg curve, projectile dependence, medium dependence stopping power, photo-electric effect, Compton scattering, pair production, attenuation and neutron moderation, Gas filled detectors: Ionization Chamber, Proportional Counter, GM counter, Semiconductor detectors:surface barrier and HPGe, solid state–segmented detectors, detector performance, energy resolution, peak-to-total ratio, Scintillation detectors: plastic detectors and PMTs, Neutron detectors: slow and fast neutron detectors, Particle identification: E-dE telescopes, time of flight, Idea of particle-gamma and gamma-gamma coincidence measurements.

PHL557 Data Reduction and Measurement Techniques 3(3-0-0)

Presentation of physical quantities: Precision and accuracy, Processing and interpretation of experimental data, Orders of magnitude approximation (Fermi estimates), Graphical handling of data with errors: Normalization, Least squares fitting, Rejection of Data, Weighted average, Fitting functions to data: Linear and nonlinear curve fitting, Chi-square test, general least-squares fit, accuracy of parameters, F-test on significance of the fit, From binomial to normal distributions: binomial, multinomial, Poisson, and normal - Gaussian distributions, Introduction to ROOT and GEANT, Signal processing and control: conditioning and recovery. Impedance matching, amplification, filtering and noise reduction, shielding and grounding, coupling of Analog and digital electronics.

PHL558 Nuclear Scattering and Heavy Ion Reactions, 3(3-0-0)

Introduction:A brief review of different types of nuclear reactions and Q-equation, cross-section, CN hypothesis and Ghosal experiment, Statistical theory of reactions, pre-compound emission and direct reactions: PEE, pair-transfer and multi-nucleon transfer reactions, The nuclear optical model:optical model at low energies, Formal derivation of the optical model potential, Kinematics and theory of stripping and pick-up reactions, Heavy-Ion reactions: Physical description of heavy ion interaction, elementary idea of classical and approximate quantum mechanical theories, classical and semi-classical analysis of heavy ion reaction data, nuclear rainbow scattering, Exotic and super heavy nuclei: complete and incomplete fusion, idea of sub-barrier fusion, high-spin states, the relativistic heavy-ion collisions (introduction), Sub-barrier fusion, Coulomb excitation.

PHL559 Physics of Low Dimensional Systems, 3(3-0-0)

Introduction to layered and low dimensional materials (organic and inorganic), quasi low

dimensional materials, quantum wells, dots, and their synthesis, Quantum mechanical approach to realize the bands of low dimensional materials, and their consequences, Electrical and thermal conduction in low dimensional materials, charge statistics and transport, Coulomb blockade in low dimensional systems and single electron transistors, Tuning of the electrical and other properties by electric field and magnetic field, effect of functionalization on the electrical properties of low dimensional materials, For fabrication of nano-devices from low dimensional materials with electron beam lithography, Application of low dimensional systems in fabrication of transistors, sensors, LEDs, solar cells.

PHL560 Semi Conductor Physics, 3(3-0-0)

Semiconductor crystal growth, doping technique, wafer fabrication, Lithographic techniques for device fabrications using mask and maskless lithographic techniques, Quantum theory of Solids, Formation of energy bands, The k-Space diagram, Electrical conduction in solids, Extension to three dimensions, Density of states function, Charge carriers in semiconductors equilibrium, distribution of electrons and holes, Dopant atoms and energy levels, Statistics of donors and acceptors, Position of Fermi energy level, Non-equilibrium excess carriers in semiconductors, Carrier generation and recombination, Characteristics of excess carriers, Ambipolar transport, Quasi-Fermi energy levels, Excess-carrier lifetime, Basic structure of the pn junction, Zero applied bias, Reverse applied bias, Non-uniformly doped junctions, Bipolar transistor action, Minority carrier distribution, Optical devices, Optical absorption, pn junction solar cell, Photo-detectors.

PHL610 Quantum Optics I: Fundamentals, 3(3-0-0)

Quantization of electromagnetic field, number states, coherent states, squeezed states, variances in electric field, phase properties; Coherence properties of em field: field correlation functions, optical coherence, spatial coherence, photon-photon correlations, bunching and antibunching, higher-order correlations, Hanbury Brown-Twiss experiment, phase dependent correlation functions; Representation of em field: P, Q, and W representation, general theory; Nonclassicality of em field: Mandel's Q-parameter, squeezing parameter, nonclassical statistics, other measures of nonclassicality, mixed non-classical states, quantum state tomography; Two-mode squeezed states: its nonclassicality, phase-space representation, Type I and II parametric down-conversion, second harmonic generation, optical bistability; Optical interferometry with single photons: beam splitter operation with number states, Hong-Ou-Mandel experiment, beam splitter operation with two-mode squeezed states, Mach-Zehnder interferometer with photons and two-mode squeezed states, Balanced homodyne interferometer, sensitivity of an optical interferometer, quantum statistics of the output field; Atomic coherent states, spin-squeezing, Ramsey interferometry.

PHL611 Introduction to Quantum Computation and Communication, 3(3-0-0)

Reviewing Quantum mechanics: Hilbert space and Dirac notation, Linear operators and matrices, Quantum observables as operators, measurement of observables, density operator, The Q-bit: Idea of a qubit, Bloch sphere representation, rotation operations on the Bloch sphere, single qubit measurement, pure and mixed states of a qubit, entanglement of two qubits, EPR paradox and Bell inequality, different physical realization of qubit, Quantum gates and quantum circuit: Reversibility, Single qubit gates, Two-qubit gates, Circuit representation of quantum gates, Toffoli and Fredkin gates, Quantum Algorithms:Basics of classical computation and computational complexity, principle of quantum computation, different quantum algorithms: Deutsch-Jozsa algorithm, Quantum Fourier transform, Shor's factoring algorithm, Grover's search algorithm, phase estimation algorithm, Quantum Communication: Classical cryptography, The no-cloning and no-deleting theorem, Quantum cryptography-BB84 protocol, quantum key distribution, Dense coding, Quantum teleportation, Physical realization:DiVincenzo's criteria, NMR , Ion trap, cavity-QED, linear optics, neutral atoms, quantum dots.

PHL612 Thin Films Science and Technology, 3(3-0-0)

Pre-requisites : Nil

Basic vacuum concept; pumping systems and detection; Materials in Vacuum; Leak

DetectionThermodynamics of nucleation and growth; kinetics process in nucleation and growth; Volmer-Weber, Frank-Van der Merwe and Stranski-Krastanov growth models and textured of thin filmsPhysics and chemistry of evaporation; Basics of Plasma; discharge and arc; reactions in plasma; physics of sputtering; ion beam induced surface modification; DC, RF and reactive sputtering process; magnetron sputtering; plasma etching; hybrid and modified PVD process; confocal and combinatorial sputtering Thermodynamics of CVD process; gas transport; film growth kinetics; thermal CVD, PE-CVD process and MOCVD Classical and quantum theory of electron transport; various conduction mechanism (Thermionic, field enhanced, hoping, polaron conduction); conduction in ionic and insulating thin films; electron transport in semiconductor thin films

Characterization of thin films; Application of thin films in solar cells (active and passive); thin film transistors; heaters; chemical sensors and optical coatings.

PHL614 Laser Physics, 3(3-0-0)

Interaction of light with matter: basics, spontaneous emission, stimulated emission, density of states and relation to decay rates, Einstein coefficients, population inversion, condition for population inversion, laser gain, Two, three and four level gain medium, rate equation, pumping schemes, homogenous and inhomogeneous line broadening, Resonator theory, different kinds of laser cavities, stability of laser resonator, unstable resonators, ring cavity, gain saturation, threshold curve, laser properties and beam parameters.

Laser cavity modes: Fabry Perot cavity modes, longitudinal and transverse modes, mode, Characteristics, spectral and spatial hole burning, CW and pulsed lasers, Mode locking and Q switching, active and passive mode locking, line broadening, single mode and multimode lasers, different kinds of lasers.

Lasing cooling and trapping of atoms, application of lasers in medicine, industry and in communication. Random lasers and lasing without cavity.

PHL615 Introduction to Quantum Information, 3(3-0-0)

Classical information:Information and disorder: relation to statistical mechanics, quantifying information (Shannon's entropy); classical data compression (Shannon's noiseless coding theorem), capacity of noisy channel , Tools of quantum mechanics: Brief review (Hilbert space, eigenvalues, qubit, measurement), density matrix (pure state and mixed state), reduced density operator, partial trace and partial transpose, Schmidt decomposition, Quantum information: Quantum data compression (Schumacher's noiseless channel coding theorem), accessible information and Holevo bound, capacity of a Bosonicchannel;Fidelity, von Neumann entropy, conditional entropy, mutual information, relative entropy and its interpretation, equalities and inequalities related to entropy, entropy increase due to eraser, Landauer eraser, relative entropy and thermodynamics, Entanglement: EPR paradox, non-locality, Bell inequalities (pure and mixed states),separable state, Detection of entanglement: Entanglement witness, Peres-Horodecki criterion, spin-squeezing criterion, Measures of entanglement: Properties of entanglement measures, entanglement of formation, entanglement of distillation, concurrence, negativity, quantum discord, relative entropy and entanglement, Error Correction: Concept of decoherence, Kraus operators; quantum noise, bit flip and phase flip, amplitude and phase damping,; quantum error correction, three-qubit bit-flip and phase-flip code, Shor code, independent error model, Hamming bound, classical linear codes, CSS code, stabilizer code, Relation of classical information and thermodynamics to entanglement.

PHL616 Quantum Optics II: Basic Applications, 3(3-0-0)

Brief review of time-dependent perturbation theory, sudden and adiabatic approximation; Brief review of Maxwell's equations inside dielectric media: absorption, dispersion, Kramers-Kronig relation; Semi-classical treatment of light-matter interaction: Two-level systems, Rabi oscillation, optical Bloch equation, coherence and applicability of rate equations; Absorption and dispersion spectra, optical saturation, resonance fluorescence from a driven two-level system; Coherent Control of absorption: Coherent population trapping, Stimulated Raman adiabatic passage, electromagnetically induced transparency; Coherent control of dispersion: slow

light, storage of optical pulse, superluminal propagation, issue of causality, magneto-optical effects; Quantum treatment of light-matter interaction: Jaynes-Cummings model, collapse and revival, Wigner-Weisskopf formula, stimulated emission, dressed state theory for Mollow spectrum; Mechanical effects of light: radiation forces, cooling and trapping of atoms; Polarization and orbital angular momentum of quantum fields: Stokes parameters, HG and LG modes; Quantum optics in other different systems: cavity QED, ion trap, NMR, superconductors.

PHL617 Ion Beam Fundamentals and Patterning, 3(3-0-0)

Introduction, Interatomic potentials, Binary elastic collisions, Cross sections, Ion stopping, Ion range, Ion distributions, Radiation damage and Spikes, Sputtering

Instabilities during sputtering, Kinetic processes contributing to surface evolution

Factors for patterning – Energy, Angle of incidence, Temperature; Fluence, Crystallinity

Regimes of patterning – Linear, Nonlinear, Theoretical approaches – Scaling concepts, KS equation, Redeposition models, Applications.

PHL618 Linear & Nonlinear Laser Spectroscopy, 3(3-0-0)

Light matter Interaction; UV-Vis absorption Spectroscopy; Phenomena and Characteristic of Fluorescence Emission: Jablonski Diagram, Stokes Shift, Fluorescence Lifetime and Quantum Yields, Detailed theory and applications of Raman and IR Spectroscopy; ATR-FTIR spectroscopy, Concept of Static and Dynamic Light Scattering and applications, Second and Third Order nonlinear Susceptibility, Three and Four Wave Mixing Spectroscopy and it's applications, Laser Induced Transient Grating, Photon Echo spectroscopy and Pump-Probe Transient Absorption spectroscopy, Light scattering spectroscopy, Stimulated Raman Scattering, Stimulated Brillouin Scattering, Stimulated Kerr Scattering, Coherent Anti-Stokes Raman Spectroscopy, Detailed discussion on Second Harmonic and Sum Frequency Generation Scattering Spectroscopy with recent days applications.

PHL619 Particle Physics, 3(3-0-0)

Particle Phenomenology: Elementary particles and interactions – fundamental interactions, deep inelastic scattering and quark jets, Classification of particles: fermions and bosons, leptons and hadrons, particles and resonant states, Quark model:quark flavours, confinement and QCD potential,Isospin, Baryon octets and decuplet,Gell-Mann-Nishijima relation, baryon isospin, colour degree of freedom,Magnetic moments of baryons, Elementary ideas of QED, Standard model:Symmetries, and conservation laws,Group theories, gauge invariance, Lagrangian of the Standard Model, Flavor group, flavor-changing neutral currents, CKM quark mixing matrix, GIM mechanism, Rare processes, Neutrino masses, Seesaw mechanism, QCD confinement and chiral symmetry breaking, instantons, strong CP problem, QCD.

PHL620 Nuclear Models, 3(3-0-0)

Nuclear Models I: Shell structure and magic numbers, Single particle model and its applications, The spin-orbit coupling; spin, magnetic moment and quadrupole moment,Single particle model, seniority, reduced isotopic spin,Ground state spins of odd-odd nuclei (Nordheim's rule), configuration mixing, The individual (independent) particle model: LS and jj coupling schemes, Nuclear Collective Models:Varieties of collective motion, Nuclear rotational motion: rotational energy spectra and the nuclear wave functions for even-even and odd-A nuclei, nuclear moments, Collective oscillations: liquid drop model quadrupole deformation, kinetic energy and potential energy for quadrupole deformation, Deformation in nuclei: The Nilsson model, Coupling between modes of collective excitation: rotation vibration interaction, Rotation-particle coupling, core excitation

PHL621 Superconductivity and magnetism, 3 (3-0-0)

Superconductivity - Different classes, different theories, and their ranges of validity, theory for superconductivity, Explain type-I and type-II superconductivity, Discuss vortices and their properties, Equations for Josephson junctions and its applications. Magnetism: Paramagnetism, magnetically ordered materials: Ferromagnets, Ferrimagnets and Anti Ferromagnets. exchange interactions, phase transitions, magnetic ordering and domains, spin waves (magnons), itinerant

magnetism, Magnetism in insulators, Amorphous materials. Transformer steel. Various forms of magnetic energies: Magnetostatic, Magnetic Anisotropy and Magnetostriction. Direct, Indirect, super and double exchange. Magnetism in thin films, muiltilayers and fine particles, Superparamagnetism, Recent developments: Giant Magneto resistance, Collosal magnetoresistance, Tunnel magnetoressistance. Spin values. Basics of spin polarized transport and spintronics. Ferromagnetic Resonance, Basics of spin-wave theory, Spin wave resonance. Magnetostatic modes.

PHL601 Classical and Mathematical Physics, 3 (3-0-0)

Mathematical Physics: Fourier series; Fourier and Laplace Transforms: Sine and Cosine Transforms, Convolution and Correlations, Application-oriented problems; Linear vector space: properties, Gram-Schmidt orthogonalization; Matrices: inverse, rank, eigenvalues and eigenfunctions, diagonalization; Solution of linear equations: linear transformation, change of basis;Tensors: rank, products, contraction, tensors with special forms, examples in physics; Complex calculus: Integration in complex plane, Cauchy's integral formula, singularities, residue theorem, definite integration; Group Theory: Isomorphism and homomorphism, cyclic and permutation group, reducible and irreducible representation, character tables, finite and infinite groups, crystallographic and molecular symmetries

Classical Mechanics: Lagrange's and Hamilton's equations of motion: scope of the application, introductory problems, Poisson's bracket, Liouville equation; Damped and forced harmonic oscillation, Q-factor; Small oscillations of coupled systems, Normal modes; Classical theory of harmonic crystal: monoatomic and diatomic one-dimensional chain, dispersion relations; Special theory of relativity: Length contraction and time dilation, four-vector notations, Lorentz transformations.

PHL602 Quantum and Statistical Physics, 3 (3-0-0)

Quantum Mechanics: Schrodinger equation in time-independent potential: Particle in a box, Barrier and well (Outline of calculations, emphasis on essential physics), tunnelling and bound state; resonant tunnelling in two quantum wells; Harmonic oscillator: Outline of calculations in wave function and operator approach, Comparison with barrier and well; vibrational modes of a linear chain of coupled harmonic oscillators: phonons; Electron energy levels in periodic potentials: Bloch's theorem; band structures; density of states; concept of holes; Particle in a central potential: Hydrogen atom, Outline of calculations; angular momentum algebra, symmetry; Case studies: rotation of diatomic molecules, charged particle in a magnetic field (Landau levels); Scattering of a particle by a fixed center of force: cross sections, Fermi's Golden Rule, partial waves, phase shift, optical theorem; Born approximation

Statistical Mechanics: microcanonical, canonical, and grand canonical ensembles; examples, partition functions; paramagnetism, negative temperatures; Ideal Bose systems: thermodynamic properties, examples: black-body radiation, liquid Helium II; Ideal Fermi systems: Thermodynamic properties, examples: Pauli paramagnetism, Landau diamagnetism.

PHL603 Physics of Electromagnetic Waves 2,3 (3-0-0)

Classical Electrodynamics: Maxwell's equations: Energy and momentum of electromagnetic field, Radiation pressure, Boundary conditions of electromagnetic field at interfaces, reflection, refraction, and transmission, Brewster's angle; Solution in free space, concept of polarization, Stokes' parameters, Jone's matrix; Solution in a dielectric media: theory of local field and polarization, Clausius-Mossotti relation, atomic polarizability, Kramers-Kroenig relation, Lorentz-Lorentz formula for dispersion, normal and anomalous dispersion, electrical conductivity in a metal, plasma frequency, negative refractive index; Radiation from electric dipole, multipole radiation, Radiation of a uniformly moving charged particle; Relativistic electrodynamics: electromagnetic field tensor, Lorentz force in vacuum, energy-momentum tensor in material media, radiation reaction; mechanical property of electromagnetic field of a charge

Optics: Light propagation inside a metal: reflection and refraction, optical constant of metal; Light propagation inside a crystal: Fresnel's formula, optical properties of uniaxial and biaxial crystals, double refraction, interference; Nonlinear susceptibility, phase matching and second harmonic

generation;
Intermolecular Forces: Forces between atoms and molecules, Forces between particles and surfaces.

PHL604 Physics of Atoms, Molecules And Solids, 3 (3-0-0)

Quantum Mechanics: Quantization of electromagnetic field, emission and absorption of photons by atoms, Einstein's A and B coefficients, Concepts of lasers; Rayleigh, Thomson, and Raman scattering, Resonance Fluorescence, Dispersion relation; Relativistic quantum mechanics: Klein-Gordon equation, Dirac equation, simple solutions, relativistic covariance; negative energy solutions, hole theory; revisit of Hydrogen atom problem; Perturbation theory: time-independent theory up to second order, Zeeman and Stark shifts; time-dependent theory with sinusoidal fields, Rabi oscillation; Addition of angular momentum, electron spin, L-S coupling in atoms, Zeeman effect revisited, electric dipole transition and selection rules

Applications: Molecular spectra: selection rules, rotational and vibrational spectra, Raman and IR spectra; Crystal structure: reciprocal lattice, X-ray diffraction and Bragg's law, Bravais lattice and Brillouin zone; Electron gas in metals: Sommerfeld's theory, Fermi surface, thermodynamic properties; Case of weak periodic potentials: perturbation approach, energy levels near Bragg plane, bands and Brillouin zones, effective mass of electron and holes.

PHL605 Numerical Methods, 3 (3-0-0)

Basic concepts and ideas in numerical analysis: Introduction to error, accuracy and stability. Data Reliability assessment: parameter sensitivity, experimental perturbations, Interpolation (Lagrange's method, divided difference formula, splines), integration (Simpson's method, Romberg's method, quadrature formula), extrapolation, discretization, convergence, regression, quadrature, Random numbers, Solution of linear algebraic equations (elimination methods, LU decomposition), Eigenvalue problems, numerical solution of ordinary differential equations: explicit and implicit methods, multistep methods, Runge-Kutta and predictor-corrector methods. Introduction to numerical solutions of partial differential equations; Von Neumann stability analysis; alternating direction implicit methods and nonlinear equations.

Computer organization and programming: Fundamental computer concepts in hardware, software, Programming in C++ for scientific computations (hands-on with basic programming), Use of graphical software: Basics of curve fitting.Introduction to grid/parallel computing

Fast Fourier Transforms and Convolution, Monte Carlo techniques.

PHL606 Pre-Thesis Literature Survey And Seminar, (2-0-0)

Title, Introduction, Problem definition, Literature Survey, Objectives, Methodology, References, Report Writing, Seminar.

5. Fees

5.1. Mode of Payment

(a) Institute dues

All Institute dues are to be paid through Demand Draft favoring "The Registrar, IIT Ropar" payable at Ropar / through Netbanking.

(b) Mess dues

Mess dues are to be paid by demand draft favoring "The Director, IIT Ropar, Hostel Account" payable at Ropar or State Bank of India Internet Banking as available.

5.2. Deadlines for Payment

(a) Institute dues

(i) All Institute dues to be paid in full before the last date for Late Registration (this is typically one week after the first day of classes)

(ii) Students who do not pay the required amount by this date, or those who make partial payments, shall have their registration cancelled. Registration will be restored on payment of fees and a fine as stipulated in the Institute rules.

(iii) In case of new entrants, the fee has to be paid by demand draft on the day of registration at the time of joining the Institute.

(b) Mess dues

All Mess dues are to be paid on or before the date for Registration Validation, i.e. before the first day of classes

5.3. Refund of Fees

The whole amount of fees/other charges deposited by the students will be refundable after deduction of Rs. 1,000/, if the students do not join the programme after paying the dues and leave the Institute by applying for refund on or before the date of registration. No refund of fees will be permissible to students who have registered for the programme but leave immediately thereafter. In such cases, only caution money will be refunded and that too only at the end of the semester.

5.4. Withdrawal from the Institute

If a student is continuously absent from the Institute for more than four weeks without informing the HOD, Dean (Academics) his/her name will be removed from the Institute rolls.

A student wishing to leave the Institute on his/her own should submit an application duly countersigned by his/her father/guardian. He/she shall also obtain "No Dues Certificate" from the Department, the Deputy librarian, the Warden, the Officer Commanding, NCC, and the Accounts Section, and submit to the Academics Section for settling his/her accounts in the Accounts Section. The student shall remain liable to pay all dues till the date on which his/her name is formally struck off the Institute rolls.

A Post Graduate Student wishing to withdraw from the programme should submit his/her request to the Head of the Deptt./School on the prescribed form, who will forward the same to Associate Dean (Research) with his/her recommendations.

5.5. Transcripts, Degree and other Certificates

Additional transcripts, duplicate degrees/diplomas, etc can be obtained on payment of the following charges:

a)	Degree, in person		: Rs.	1000
b)	Degree, in absentia	(In India)	: Rs.	1000
		(In Abroad)	: Rs.	1500
		Or	:US$	150
c)	Migration Certificate (Only one original)		: Rs.	500
d)	Duplicate Degree/certificate (Only one Original)	(In India)	: Rs.	2500
		(In Abroad)	: US$	250
e)	Transcripts	(In India)	: Rs.	500
	(1 Original + 4 Attested Copies)	(In Abroad)	: US$	50
f)	Duplicate Identity Card		: Rs.	500
g)	Certificate of medium of instruction in English	(In India)	: Rs.	100
	(Only one original)	(In Abroad)	: US$	10
h)	Verification of degree certificate, JEE	(In India)	: Rs.	1000
	Rank, membership of Institute bodies,	(In Abroad)	: US$	100
	etc. (for each individual verification)			
i)	Character Certificate (only one original)	(In India)	:Rs.	100
		(In Abroad)	:US$	10

5.6 Details of Semester Fees for the Academic Year 2016-17.

	ITEM Student's → Programme ↓	M.Tech/ MS-R/MS (Gen)	M.Tech/ MS-R/MS (SC/ST)	M.Sc (Gen)	M.Sc (SC/ST)	PhD
1.	**SEMESTER FEES (To be paid every semester)**	**(INR)**	**(INR)**	**(INR)**	**(INR)**	**(INR)**
1.1	**INSTITUTE FEES**					
	i) Tuition Fee	6785	1785	4235	1735	2500
	ii) Examination Fee	350	350	350	350	300
	iii) Registration/Enrolment Fee	250	250	250	250	250
	iv) Gymkhana Fee	500	500	500	500	500
	v) Medical Fee	50	50	50	50	50
	vi) Laboratory & other facilities	1500	1500	1500	1500	1500
	vii) Library	500	500	500	500	500
	viii) Hostel & Mess Establishment, Amenities charges	1000	1000	1000	1000	1000
	ix) Transfer charges (Campus Bus Services)	0	0	0	0	0
1.2	**HOSTEL FEES +**					
	i) Hostel Seat Rent	3000	3000	3000	3000	1000
	ii) Fan, Electricity and water charges	2300	2300	2300	2300	1000
	TOTAL (Semester Fees to be paid)	**16235**	**11235**	**13685**	**11185**	**8600**
2.	**ONE TIME PAYMENTS (Non -refundable) To be paid at the time of admission**					
	i)Admission Fees	200	200	200	200	150
	ii) Thesis Fees	0	0	0	0	950
	iii) Grade card	200	200	200	200	0
	iv) Provisional certificate	200	200	200	200	100
	v) Student welfare fund	300	300	300	300	200
	vi) Modernization fees	400	400	400	400	500
	vii) Identity card	100	100	100	100	100
	viii) Benevolent fund	100	100	100	100	100
	ix) Alumni fees	1000	1000	1000	1000	1000
	x)Training & Placement	500	500	500	500	0
	Total (one time payment at the time of admission)	**3000**	**3000**	**3000**	**3000**	**3100**
3	**Deposits (Refundable)**					
	i) Institute security deposit	2000	2000	2000	2000	1000
	ii) Library security deposit	2000	2000	2000	2000	1000
4	**OTHER PAYMENTS** Insurance Scheme (To be paid every year in 1st semester)	500	500	500	500	500
	GRAND TOTAL	**23735**	**18735**	**21185**	**18685**	**14200**

The fee payable at IIT Ropar is subject to change as per the Institute rules.

Note: Mess charges will be notified separately.

Tuition Fees for Foreign Nationals:

For SAARC Countries- US$ 2000

For Other Countries- US$ 4000

All other fees is the same as that of the regular students

6. Discipline

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

(b) 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 him/her from the Institute.

(c) 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.

6.1 Punishment to the students who indulge in unfair means during quizzes/mid semester/end-semester examinations .

The following graded punishments will be imposed on those who indulge in Academic Mal-practices —unfair means during Mid-semester/End-semester examinations:

(a) For rude behaviour :

(i) Severe warning shall be issued to a student who is found to display rude behaviour towards fellow students /invigilators.

(ii) The student is liable to be expelled from the examination hall.

(iii) In such cases, the parents of that student would be informed of such indiscipline.

(b) Malpractices and corresponding Punishments:

S.No.	Nature of Malpractice	Recommended Punishment
1	Communicating with neighbours in the examination hall	The erring student(s) shall be awarded `F' grade in the subject concerned
2.	Possessing incriminating* materials inside the examination hall (or) Possessing the answer book of another candidate (or) Passing on answer book to another student (or) Exchange of question papers, with some answers noted down on them (or) Individual referral of material/discussion with other students, during visit outside the examination hall	The Disciplinary Committee shall have the discretion to recommend one of the following punishments: (a) The erring students(s) shall be awarded 'F' grade in the subject concerned. (or) (b) The erring student(s) shall be awarded 'F' grade in the subject concerned and one grade less in all the other subjects in the concerned semester. (or) (c) The concerned student(s) shall be awarded `F' grade in all the subjects in the concerned semester.
3.	Involved in malpractice in the examination for the second time, in a premeditated manner.	The concerned student i) shall be awarded 'F' grade in all subjects, in the concerned semester and ii) shall be debarred from attending classes and taking examinations in the subsequent semester.
4.	Impersonation in the examination	The concerned student i) shall be awarded `F' grade in all subjects, in the concerned semester and ii) shall be debarred from attending classes and taking examinations in the next two subsequent semesters.

(* incriminating materials include written/printed material; unauthorized additional sheets without or with write-ups, bits, scribbles on scales / handkerchief / on the body; abuse of calculator / organizer / cell phone, etc.)

7.

INDIAN INSTITUTE OF TECHNOLOGY ROPAR, PUNJAB

The Honour Code

I, ……..,…… Entry No……..

Do hereby undertake that as a student of IIT Ropar, Punjab:

1. I will not give or receive aid in examination; that I will not give or receive unpermitted aid in classwork, in preparation of reports or in other work that is to be used by the instructor as the basis of grading; and
2. I will do my share and take an active part in seeing to it that others as well as I uphold the spirit and letter of the Honour Code.
3. I realize that some examples of misconduct which are regarded as being in violation of the Honour Code include:
   - Copying from another's examination paper or allowing another to copy from one's own paper;
   - Unpermitted collaboration;
   - Plagiarism;
   - Revising and resubmitting a marked quiz or examination paper for regarding without the instructor's knowledge and concern;
   - Giving or receiving unpermitted aid on take home examination;
   - Representing as one's own work the work of another, including information available on the internet;
   - Giving or receiving aid on academic assignments under circumstances in which a responsible person should have known that such aid was not permitted; and
   - Committing a cyber offence such as breaking passwords and accounts, sharing passwords, electronic copying, planting viruses etc.

I accept that any act of mine that can be considered to be an Honour Code violation will invite disciplinary action.

Date:…….

Student's Signature……...……..

Name:…….…….

Entry No: ……...…....

8. Academic Integrity

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 behavior that will be considered are: I) plagiarism, II) cheating and III) conflict of interest.

1. Cases of ethical plagiarism are the use of material, ideas, figures, code or data without appropriate acknowledgment 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 (8) explain how to carry out proper referencing, as well as examples of plagiarism and how to avoid it.

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

(a) Copying during exams, and copying of homework assignments, term papers or manuscripts.
(b) Allowing or facilitating copying, or writing a report or exam for someone else.
(c) Using unauthorized material, copying, collaborating when not authorized, and purchasing or borrowing papers or material from various sources.
(d) Fabricating (making up) or falsifying (manipulating) data and reporting them in thesis and publications.

3. 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 re-quired, and the changes made should be clearly described.
(c) Ensure robust reproducibility and statistical analysis of experiments and simulations. It is important to be truthful about the data and not to omit some data points to make an impressive figure (commonly known as "cherry picking").
(d) Lab notebooks must be well maintained in bound notebooks with printed page numbers to enable checking later during publications or patent. Date should be indicated on each page.
(e) Write clearly in your own words. It is necessary to resist the temptation to "copy and paste' from the Internet or other sources for class assignments, manuscripts and thesis.
(f) Give due credit to previous reports, methods, computer programs etc. with appropriate citations. Material taken from your own published work should also be cited; as mentioned above, it will be considered self-plagiarism otherwise.

4. At 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 in the section below dealing with resources.

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

(a) Student roles: Before submitting a thesis to the department, the student is responsible for checking the thesis for plagiarism using software that is available on the web. 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 thesis is original work. A web-check does not necessarily rule out plagiarism.

(b) 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 theses, the Institute will pro-vide some commercial software at SERC for plagiarism checking. Faculty members are en-couraged to use this facility for checking reports, theses and manuscripts. Faculty members are also responsible for ensuring personal compliance with the above broad issues relating to academic integrity.

(c) 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 sections. 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 members bring any academic violations to the notice of the Department Chairman. 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.

6. Intellectual Property Rights: The Indian Institute of Technology Ropar will own the Intellectual Property (IP) made or created by any student carrying out research under the supervision of any employee of the Institute, or the IP developed individually by the student in the course of his/her studies at IIT Ropar, or with any use of IIT Ropar facilities. By accepting admission to IIT Ropar, a student agrees to assign to the IIT Ropar all such IP made or created at IIT Ropar, including inventions and copyrightable material; and to execute all papers required to assign, apply for, obtain, maintain, issue and enforce IP and IP rights.

References:

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

9. Scholarships and Fellowships

9.1. Scholarship for PhD Scholars

Period of Assistantship	Qualifying Degree	Fellowship Amount	Hours/week Teaching assistance
First 2 years of registration (JRF)	Post Graduate Degree in Basic Science with NET/GATE Qualification or Graduate degree in Professional Course with NET /GATE Qualification or Graduate degree in Professional Course	Rs. 25000/-p.m + 10% HRA if applicable	8 hrs/week
After 2 years of registration(SRF)	JRF Qualification with two years of Research experience	Rs. 28000/-p.m + 10% HRA if applicable	8 hrs/week

Duration : The fellowship will get expire at the end of 5 years.

9.2. Scholarship for M.Tech./MS-Research Scholars

Qualifying Degree	Fellowship Amount	Hours/week Teaching assistance
B.E./B.Tech./BS/B.Des and GATE/GPAT qualified	Rs. 12,400/-p.m (Both 1st and 2nd year and 5th year of Dual Degree Programmes.	8 hrs/week

The above is subject to change as per MHRD guidelines

- The maximum duration for which Assistantship can be awarded to M.Tech/ MS(R) students is 4 semesters.
- Only full-time non-sponsored students who have qualified GATE are eligible for assistantship.
- In the first instance, the assistantship is awarded only for one semester. Thereafter continuation of the assistantship during each semester is contingent upon satisfactory academic performance and satisfactory performance in the discharge of responsibilities assigned under the assistantship scheme. For this purpose an SGPA of not less than 7.00 (6.75 in the case of SC/ST/PH) at the end of the semester is treated as satisfactory academic performance.
- Candidates qualified for CSIR JRF will not be allowed to avail fellowship for doing M.Tech / M.S- (R) programmes. However, they can avail the CSIR fellowship for doing the Ph.D programme.

9.3 Merit-cum-Means scholarship to M.Sc. students

The M.Sc. students are eligible for for Merit-cum-Means scholarship in the form of tuition fee waiver and monthly pocket allowance on the following terms and conditions.

The students are exempted from paying tuition fee and will further receive a pocket allowance of Rs. 1000/- per month at par with B.Tech. students.

M.Sc. students will be eligible to receive MCM in the first semester based on All India Rank in JAM. The scholarship will be renewed/continued on semester to semester basis until he/she clears all academic requirements of the programme, provided that he/she continues to satisfy the eligibility and continuation criteria. This is continuation of MCM, the performance of the student will be reviewed at the end of each semester.

Criteria for Continuation.

1. CGPA must be 6.0 or more; and
2. Earned credit requirement. (Each department will notify the no. of credits required to be registered by the students and number of credits to be passed)
3. SGPA in the previous semester must be 6.0 or more.
   Only those students are eligible whose parents have a gross yearly income upto Rs. 4.5 lac per annum or as notified by govt. of India from time to time.

9.4. Director's Fellowship

1. Eligibility

Research scholars who have already submitted their thesis from IIT Ropar and who would like to continue research for some more time to conclude some unfinished work.

2. Application Processing

a) The applicant may apply during submission of synopsis not exceeding 5 years of doctoral research.
b) The applicant may apply during submission of synopsis.
c) Application should be addressed to Dean (Research) through PhD supervisor and HoD.
d) The application should be accompanied with a recommendation from the supervisor.

3. Selection

Selection will be done based on the recommendation of the DSC.

4. Duration and joining

a) The duration of the fellowship will be maximum for a period of 6 months.
b) After joining as a pre-doctoral fellow, the student has to give a joining report.

5. Benefits

The pre-doctoral fellows are eligible for the following benefits.

• Fellowship Amount	Rs. 40,000/ - (consolidated) before defense of thesis and Rs. 45,000(consolidated) thereafter.
• Accommodation	Suitable Hostel/Campus accommodation as per IIT norms will be provided if requested and if available
• Medical benefits/Insurance	As applicable to PhD Scholars
• Permission for Conference	Can use funds left from the PhD period
• Leave	As applicable to PhD Scholars (on pro rata basis)
• Contingency	Can be given on a pro rata basis.
• Certificate	The candidate will receive a certificate of appreciation for this fellowship from IIT Ropar.

6. Termination

If the student wishes to leave the programme before the end of the tenure, he/she can do so with prior approval of Dean (Research) giving one month's notice. The fellowship may be terminated by the Institute if the performance / conduct of the student is unsatisfactory after giving one month's notice to the student.

9.5. Institute Post Doctoral Fellowship

1. Eligibility

PhD degree holders are eligible to apply within five years after completion of PhD Candidates completing PhD from IIT Ropar can apply after 3 years of completion of their PhD.

2. Application processing and interview

a. Applications will be invited twice a year.
b. The application received by the respective departments will be shortlisted and the candidates to be called for interview.
c. Interview call letter will be sent to the shortlisted candidates along with proforma for TA claim and No Objection certificate, if employed by the Academic section.
d. Candidates called for interview are eligible for reimbursement for Train Fare (II AC) to and fro by shortest route.
e. The Department have to send the list of shortlisted candidates along with the short listing criterion followed to the PSC.
f. It is informed that the selected candidates who had obtained their PhD from IIT Ropar, the Collaborator faculty member will be other than the candidate's PhD Thesis Supervisor.

3. Selection and offer

a. The short listing criterion will be left to the respective departments to decide.
b. At least 2 letters of recommendation (1 preferably from PhD Thesis supervisor) should be obtained.

4. Duration and joining

a. The duration of the fellowship will be for a period of 3 years. Renewal needs to be done each year based on the progress of the PDF and the recommendation of the Department.
b. After joining as Institute PDF, the PDF has to give joining report.

5. Progress report

a. The candidate should present a yearly progress report to PPAC detailing the research work carried our and research findings supported by reprints/preprints/manuscripts of the papers published/accepted for publication or communicated/research reports for this purpose.
b. The progress report has to be duly endorsed by the HOD in consultation with the dept.

6. Assignment

a. Apart from the research pursued by the post-doctoral fellow services of post-doctoral fellow may be engaged by the department up to 8 hours per week for academics assistance in the departmental work including teaching, handling of tutorials and laboratory work.
b. Apart from quality research work, post-docs will also be encouraged to write funding proposals. They will not be engaged in teaching in general, unless the scholar himself/herself wishes so.
c. The post docs will be attached to the mentor only for administrative purpose. He/she will work 'with' the mentor rather than 'under' the mentor. He/she will have independence to change the course of research.
d. Post docs will be eligible to serve as co-guide for B.Tech./M.Sc. and M.Tech. projects along with at least 1 faculty member from the concerned dept.

7. Benefits

a. The PDFs are eligible for the following benefits:

• Fellowship Amount	Between Rs. 45,000-55,000/- consolidated (depending upon experience and qualification)
• Accommodation	Suitable Hostel/Campus accommodation as per IIT norms will be provided if requested and if available
• Contingency Grant	A contingency grant of Rs. 1,00,000/per annum will be provided to the Post-doctoral fellow for research purpose. Unspent amount can be carried over to the next financial year
• Medical benefits/Insurance	As applicable to PhD Scholars

• Permission for Conference	Either national or international conference can be permitted provided funds available in the contingency grant of the concerned doctoral fellow.
• TA claim for attending interview	Train fare by II AC from place of residence to IIT Roar (by shortest route).
• Leave	With fellowship not exceeding 30 days in a year for each completed year of the fellowship. The leave can be availed on a prorate basis for the duration (on a 6 month's basis) of the fellowship completed.

8. Termination

If the Post-Doctoral Fellow wishes to leave the programme before the end of the tenure, he/she can do so with prior approval of the PPAC giving one month's notice. The fellowship may be terminated by the Institute if the performance / conduct of the fellow is unsatisfactory after giving one month's notice to the Post-Doctoral Fellow.

10. Library Facilities

The Central Library functions as the primary information resource centre and repository of printed and electronic resources for teaching and research activities at the institute. Apart from textbooks and recommended reading materials prescribed for each course offered at the institute, the library houses a growing collection of research monographs, reports, multi-volume reference works, dictionaries, encyclopaedias, handbooks, and so on. In addition, the library also facilitates access to a number of journals through its participation in consortia, such as E-Shodh Sindhu. At present, users can consult more than 13, 000 books (available on shelves) and thousands of electronic journals. Online access is also provided to bibliometric and scientometric databases such as Web of Science, Scopus and MathSciNet.

The library operations are automated using LIBSYS software. The Online Public Access Catalogue (OPAC) enables users to search documents in the possession of the library. Recently library has introduced the Radio Frequency Identification Technology (RFID) which is the state-of-the-art auto identification technology helps in self servicing and enhanced security. A separate e-resources section is provided in the library to browse CDs and DVDs of books; theses and dissertations. Library has developed institutional digital repository (IDR) to archive and provide online access to intellectual output of the institute. These steps will greatly enhance the library's efficiency in making the resources available to the academic community at large and also enable the institute participate in various inter-library initiatives at national and international levels.

11. Medical Facilities

The institute has a Medical Centre adjacent to the hostel complex. A doctor (Homeopathic & Allopathic), Pharmacist & Staff nurse have been appointed to attend to medical emergencies of the campus residents. In addition, the institute relies on a few super-specialty hospitals in the city of Ropar and Chandigarh for providing medical care to its members.

12. Hostels and Dining Facilities

The Institute campus houses four hostels with the latest and modern facilities: Jupiter, Mercury (Wing A & Wing B), Neptune Hostels for boys and Venus Hostel for girls. The hostels are well equipped for comfortable board and lodging of approximately 600 students. All hostels are provided with water coolers with RO systems. Facilities for indoor recreation and games are also available.

The hostel complex also includes four shops that caters to the basic needs of the residents; washing machine facilities are also available for the students in the hostels.

The Institute houses two Messes adjacent to the old and new hostel. Breakfast, lunch, tea / snacks and dinner are served to the students. The Mess Comittee looks after the day to day administration.

13. Student Activities

The Institute has a Society for Publication and Communication Skills Development. In addition, there are Music, Dance, Dramatics and Literary Societies where the students can participate and develop a well-rounded personality.

14. Recreational Facilities

At present, the transit campus has excellent facilities for several sports, including a cricket field, three lawn tennis courts, a football field, a hockey field, a gymnasium, a basket ball court, badminton courts, an athletics track, table tennis room and also facilities for several athletic events. The institute encourages its students to participate in inter-IIT sport events and other competitions. Space for recreational and creative activities is also available.

15. General Facilities

The Institute has a branch of SBI as well as a Post office to cater to the needs of the faculty members, staff and students.

16.Academic Calendar for the 1st Semester of Academic Year 2016 – 17

S. No.	Academic Events	First Semester 2016-17
1	Reporting of new PG students	Jul 19 (Tue)
2	Reporting of new UG students	Jul 22 (Fri)
3	Registration of new PG students	Jul 20 (Wed)
4	Registration of new UG students	Jul 23 (Sat)
5	Orientation of all new students	Jul 23 (Sat) – Jul 25 (Mon) & 30 (Sat)
6	Registration of continuing students	Jul 25 (Mon)
7	Commencement of classes	Jul 26 (Tue)
8	Late registration	Aug 01 (Mon)
9	Last date for course **ADD / DROP** (for UG students only)	Aug 03 (Wed)
10	Last date for adding courses (in lieu of dropped courses) (for UG students only)	Aug 05 (Fri)
11	Last date for course **ADD / DROP** (for PG students only)	Aug 10 (Wed)
12	Last date for adding courses (in lieu of dropped courses) (for PG students only)	Aug 12 (Fri)
13	Last date for getting mid semester course evaluation form filled	Sept 13 (Tue)
14	Last date for departments to float courses for next semester	Sept 16 (Fri)
15	**Mid Semester Examination**	**Sept 19 (Mon) – Sept 24 (Sat)**
16	Midterm evaluation project **for UG (No Classes)**	Sept 26 (Mon)
17	Last date for return of marked answer-scripts	Oct 07 (Fri)
18	Short-attendance warning to students	Oct 10 (Mon)
19	Class committee meeting	Oct 17 (Mon) – Oct 21(Fri)
20	Last date for **Audit** and **Withdrawal**	Oct 20 (Thu)
21	Course registration for next semester	Oct 24 (Mon) – Oct 28 (Fri)
22	Meeting of timetable incharges for courses of next semester	Oct 31 (Mon)
23	Last date for getting course evaluation form filled	Nov 15 (Tue)
24	Last date for submission of preliminary project reports **for UG** students	Nov 17 (Thu)
25	Last day of classes	Nov 17 (Thu)
26	Display of Pre-Major Totals (PMT)	Nov 17 (Thu)
27	Display of list of students with short attendance	Nov 17 (Thu)
28	**End Semester Examination**	**Nov 19 (Sat) – Nov 25 (Fri)**
29	**Project viva-voce for UG**	**Nov 28 (Mon)**
30	Last date for submission of final project reports **for UG** students	Dec 05 (Mon)
31	Viewing of answer-scripts by the student	Dec 05 (Mon)
32	Last date for grades to reach to the Academics Section	Dec 06 (Tue)
33	Display of grades	Dec 07 (Wed)
34	Winter Vacation **(for UG & M.Sc. only)**	Dec 05 (Mon) – Jan 01 (Sun)
35	Last date for progress report submission **(for PhD only)**	Dec 30 (Fri)

Note:

- Aug 17 (Wed) works as per Monday Timetable.
- Sep 13 (Tue) works as per Monday Timetable.
- Sep 29 (Thu) works as per Monday Timetable.
- No classes, quiz, presentation, or any other academic activity can be scheduled on Nov 18, 2016 (Fri).
- In event of changes in date(s) of holiday(s) announced by the Government of India through the media (AIR/TV/Newspaper, etc) then the Institute shall automatically observe the subject holiday(s) accordingly and a Saturday will work as per the timetable followed on the working day in lieu of that day.

Reporting of new PG students	-	December 29, 2016 (Thu)
Registration of new PG students	-	December 30, 2016 (Fri)
Orientation of new PG students	-	January 02, 2017 (Mon)
Registration of continuing students	-	January 02, 2017 (Mon)
Commencement of classes	-	January 03, 2017 (Tue)

Annexure 1

Regulations for preparation of PhD Thesis

1. Thesis should be type-written on both sides of good quarto-size/A-4 size paper in 1.5 space with sufficient margins (left margin 1.5", right margin 0.75") in Times Roman (12 font size) with multi-plastic ring binding.
2. Suitable reproduction of Indian-Ink diagrams should be used. Photographs should be suitably mounted on the same quality paper as the thesis.
3. Reference should be given in a style in the text consistent with a standard journal in the field.
4. Three copies of thesis in multi-plastic spiral binding in Dark Orange color cover and three soft copies (CDs/DVDs) must be submitted for evaluation. In case of student being supervised by more than one supervisor, appropriate number of additional copies must be submitted.
5. The cover should have the following printed on it in block letters:
   (a) The title at the top (b) author's name in the middle (c) Name of Department/Centre and Indian Institute of Technology Ropar at the bottom.
6. After the Viva-Voce Examination, two copies of thesis in hard maroon-color cover must be submitted. The cover should have the material indicated in item 5 above. Besides, the following should be printed on the spine of the thesis:
   (a) The year of publication at the top (b) the author's last name in the middle and (c) Ph.D. at the bottom.
7. The contents of thesis should have the following format:

(i) The hard bound copies of the thesis must contain the following copy right notice in the beginning of the thesis (left side of the inner cover page):--

(ii) Inner cover page (iii) certificate of the Supervisor(s) (iv) Acknowledgements (v) Abstract
(vi) Table of contents (vii) List of figures (viii) Body of the thesis (ix) References
(x) Appendices and (xi) Brief Bio data of the author.

8. The inner cover page should read as follows:

TITLE OF THESIS
By
(NAME OF AUTHOR)
……..Department/School
Submitted
In fulfillment of the requirements of the degree of Doctor of Philosophy
to the

Indian Institute of Technology Ropar
Month & Year