HANDBOOK OF INFORMATION

UNDERGRADUATE PROGRAMME

2015-16

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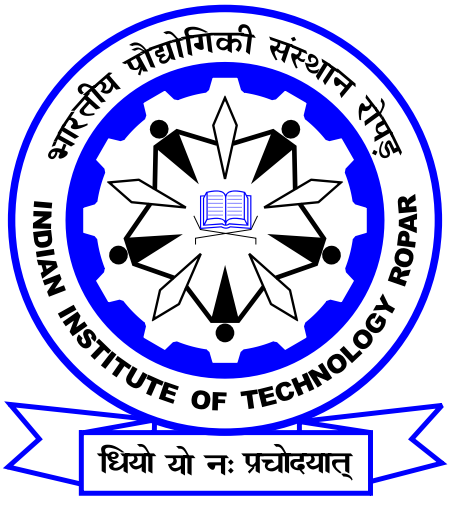

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1. Introduction

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 provide state-of-the-art technical education in a variety of fields, and also to facilitate transmission of knowledge using the latest developments in pedagogy. In its initial years, IIT Ropar was mentored by IIT Delhi, and the first academic session (2008–09) of IIT Ropar was held at the campus of IIT Delhi. The institute started operating from the transit campus, i.e., the premises of the Government Polytechnic College for Girls (Ropar) from 18 August 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. In a few years, the institute will be relocated to its own campus. The new campus is spread over an area of 500 acres, and is situated on the banks of the Satluj river.

1.2. Departments and School

Each course is offered by an academic unit which could either be a department or a school. The various Departments and School 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. Academic Departments and School

Name of Academic Unit (alphabetical order)	Code
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. For all undergraduate programmes, students are admitted after 10+2 schooling. The admission is done through JEE only. The various programmes and their specializations are listed below.

1.3.1. Undergraduate Programmes

Bachelor of Technology (B.Tech.)

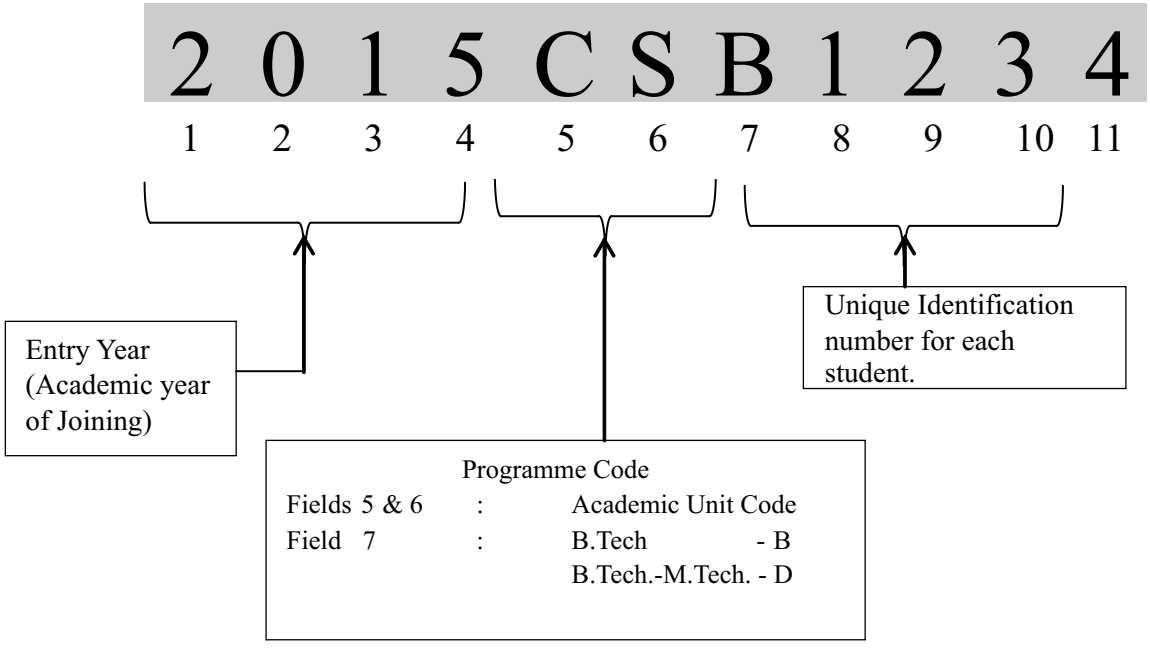
Department	Specialization	Code
Computer Science and Engineering	B.Tech. in Computer Science and Engineering	CS
Electrical Engineering	B.Tech. in Electrical Engineering	EE
Mechanical Engineering	B.Tech. in Mechanical Engineering	ME

Dual Degree programme

Department	Specialization	Code
Mechanical Engineering	B.Tech.-M.Tech.	ME

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.

2. 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 engineer-scientists. The curriculum provides broad-based knowledge and simultaneously builds a temper for life-long learning and exploring. The undergraduate 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 current Academic year begins in July and ends in May of the following year. For the academic year 2015-2016, the 1st semester starts on 21st July 2015. 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.

2.1. Academic Programmes

Currently, the following programmes are being offered:

i. Bachelor of Technology in Computer Science and Engineering
ii. Bachelor of Technology in Electrical Engineering
iii. Bachelor of Technology in Mechanical Engineering
iv. B.Tech.-M.Tech. Dual Degree in Mechanical Engineering

Admission to these programmes is through the JEE and the students are admitted after completing 10+2 schooling.

2.2. Credit System

2.2.1. Credit System

Education at the Institute is organized around the semester-based credit system of study. 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 fulfilment 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.

2.2.2. 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

2.2.3. 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 (A&R), 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 (A&R). 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 a project-type course based on a request by the student. The regulations for UG students are as follows:

UG Students:

The 'X' grade is awarded for incomplete work in Independent Study, Mini Project, or Major Project Part 1 and Part 2, based on the request of the student. On completion of the work,an X grade can be con-verted to a regular grade within the first week of the next semester. Otherwise, the student will be awarded an 'X' grade on a permanent basis and it will appear in his/her grade card. Further, the student will be required to register for the course in the next semester. The credits of the course will be counted towards his/her total load for the semester. In case Major Project part 1 is not completed, the student will not be permitted to register for Major project Part 2 as Major Project Part 1 is a prerequisite for Major Project Part 2. A Student can be awarded an 'X' grade only once in a course, other than the summer semester.

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.

2.2.4. 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 UG 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
CSLXXX	4	C(-)	4	5	20
PHLXXX	4	A	4	10	40
PHPXXX	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. (column 1)	**Course credits** (column 2)	**Grade awarded** (column 3)	**Earned credits** (column 4)	**Grade Points** (column 5)	**Points secured** (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

2.2.5. 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.

(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. A 100 level course has no Prerequisite and is a compulsory non-credit course.

2.3. Registration and Attendance

2.3.1. 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 (A&R). In case of illness or absence during registration, the student should intimate the same to his/her course adviser and Dean (A&R). 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.

2.3.2. 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.

2.3.3. Advice on Courses

At the time of registration, each student must consult his/her student 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.

2.3.4. 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.

2.3.5. Late Registration

Late registration is permitted under the following conditions:

(a) 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

(b) 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 (A&R) for late registration. Dean (A&R) will onsider and may 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.

2.3.6. 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.

2.3.7. 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.

2.3.8. 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.

2.3.9. 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.

2.3.10. 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 (A&R), his/her registration will be terminated and the name will be removed from the Institute rolls.

2.3.11. 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 practicals 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.

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).

Students are required to attend lectures, laboratories, workshops, etc., and not to absent themselves without adequate reasons and prior permission. Applications for leave of absence are to be made in writing to the Head of the Department through the Advisor or Research Supervisor(s). Any type of absence for more than 10 days should be notified to the Academic Section Immediately.

2.4. Rules and Regulations

2.4.1. Absence during the Semester

(a) A student must inform the Dean (A&R) 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 practi-tioner 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 will grant approval depending on the merit of the case and inform the course coordinators and U.G. section. The student should complete all the course requirements within ten days from the last day of the Major Tests 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. 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 (A&R) on recommendations of the concerned Head of the Department and the course coordinators. A request to this effect must be included in the ap-plication 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 (A&R), 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 (A&R), his/her name will be removed from institute rolls.

2.4.2. Programme Change at the end of First Year

a) A student is eligible to apply for change of discipline at the end of first year only, provided he/she satisfies the following criteria:-

   (i) CGPA for GE/OBC category student :- > 7.50 or greater

   (ii) CGPA for SC/ST/PD category student :- > 6.50 or greater

   (iii) Earned credits at the end of first academic session are 40credits or more.

b) Change of the branch will be permitted strictly in the order of merit , in each category as determined by CGPA at the end of the first year, subject to the limitation that the actual number of students in the third

semester in the discipline to which the transfer is to be made should not exceed its sanctioned strength by more than 10% and the strength of the branch from which transfer is being sought does not fall be-low 85% of its sanctioned strength.

c) The condition mentioned in item I-III above will not be insisted upon for a change to a branch in which a vacancy exists with the reference to the sanctioned strength and the concerned student was eligible as per JEE Rank for admission to that branch at the time of entry to IIT Ropar. However, these conditions will continue to apply in the case of students seeking change to a branch to which the concerned student was not eligible for admission at the time of entry to IIT Ropar.

2.4.3. 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.

2.5. Curriculum and Structure of the Bachelor of Technology Programmes

2.5.1. Credit Structure

The total earned credit requirements for the Bachelor of Technology programme is 163. The distribution of 163 credits among the various categories is given below in Table 1.

Table 1: Credit structure of the B. Tech. programme

Category	Credits requirements	Remarks
Science requirement (SR)	28 (minimum)	At most 20 credits can be specified as Core in a programme.
General Engineering Requirement (GR)	16	16 credits as GE core for each Programme.
Programme Core (PC)	47 (maximum)	Compulsory part of the Programme credits cannot exceed 47. This excludes credits of Internship.
Programme Elective (PE)	19 (minimum)	PC + PE credit to be done by a student in a programme must be at least 66 credits.
Humanities and Social Sciences (HS)	20 (minimum)	
Institute Core Project (CP)	3+5=8	The Core Project, 3 + 5 credits over two semesters, in an Institutional requirement.
Core Industry Internship (CT)	3 (Summer followed by colloquium in on semester)	A Summer Industry Internship and a Colloquium for a total of 3 credits is an institutional requirement. Internship will have only Satisfactory/Unsatisfactory/Continuation Grades.
Open Category (OC)	22	
Graduation Requirements (GR)	163	

Every student is also required to complete the three non-credit mandatory course requirements listed below in Table 2.

Table 2: Non-credit mandatory requirements

Category	Credits requirement	Remarks
NCC / NSS / NSO (NN)	Nil	A student is required to complete the requirements for NCC, NSS or NSO for two semesters. Grading will be Satisfactory / Unsatisfactory.
Introduction to the Programme (CSN, EEN, MEN)	Nil	The student is required to complete the requirements for one semester. Grading will be Satisfactory/ Unsatisfactory / Continuation.
Introduction to Humanities & Social Sciences (HUN)	Nil	The student is required to complete the requirements for one semester Grading will be Satisfactory / Unsatisfactory / Continuation

Over and above the mandatory requirements listed in Tables 1 and 2, a student may opt for the elective courses listed in Table 3.

Table 3: Options / Electives over and above the core requirements

Category	Credits requirement	Remarks
Capstone Project (EP)	12(one semester)	A Student may also do a 12 credit Capstone Project, the credits for which will be beyond the minimum graduation requirement.
Industry Internship (ET)	12(one semester)	The semester Industry Intern - ship of 12 credits is optional and beyond the minimum graduation requirement Internship will be assessed with Satisfactory / Unsatisfactory / Continuation grades.

Further regulations are described below.

(a) A student may complete the course requirements in 7 semesters and utilize the 8th semester for the Capstone Project or the Industry Internship over and above the minimum credits requirements. Details are given below.

(b) Registration as full-time student for Eight (8) semesters is mandatory for completing graduation requirements.

(c) NCC, NSS or NSO requirements are over and above the requirements in Table 1.

(d) Every student will have to take at least one course (in any appropriate category) related to Environment.

(e) Students may study one course from the regular listings as an independent learning course, one that is not being taught as a regular course that semester. The teacher will assign reading material and assignments, term papers, etc. and be available for an hour every week for discussions with the student. Tests will be held as usual.

(f) The 12-credit Capstone Project should be conducted to replicate as closely as possible the real-world industry projects whose hallmarks are teamwork (5-10 persons), well-defined deliverable product for the customer, cross-disciplinary nature of work and product, regular work, and professional project management amongst others.

(g) The General Engineering core consists of the following four courses for 16 credits.

Product Design and Realization-I	–	GEL101	1-0-6	4 credits
Materials Science and Engineering	–	GEL102	3-0-2	4 credits
Introduction to Computing	–	GEL103	3-0-2	4 credits
Principles of Electrical Engineering	–	GEL104	3-0-2	4 credits

2.5.2. Minimum CGPA for award of B. Tech. Degree

The minimum CGPA for award of the B. Tech. degree is 5.0

2.5.3. B. Tech. (Honours) Degree

A student who completes the Capstone Project with a minimum grade of 'B' can be awarded the B. Tech. (Honours) degree. A student must declare his/her intention to work for the honours degree by the end of the third semester if he/she is interested in completing the requirements for the degree in eight semesters. If a student has maintained a CGPA of at least 7.5 at the time of declaring the intention for the honours degree and has accumulated on the average 20 credits for each registered semester, permission could be granted for completing the 163 credits for the B. Tech. degree in seven semesters in an accelerated mode by registering for up to 25 credits every semester. Permission for continuation of registration in the accelerated mode is contingent upon the student maintaining a SGPA of at least 7.0 and getting a pass grade in all courses registered in the previous semester. Further, a student who has completed the degree requirement with a CGPA of 7.5 will be given permission for working for the honours degree. Since a Capstone Project is a team effort of an ambitious nature, it will be necessary that at least two semesters prior to the one in which the Capstone Project work is formally executed, the work be identified, team formulated and preparatory work started.

2.5.4. Special Requirements

Communication Skills

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.

2.6. Performance Requirements and Monitoring

2.6.1. 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.

The maximum permissible number of registered semesters for completing all degree requirements for the B. Tech. degree is twelve (12). If a student opts for the slow-paced programme (as defined later), then the maximum permissible number of registered semesters shall be increased by two semesters.

2.6.2. Conditions for Termination of Registration, Probation and Warning

If the performance at the end of first two registered semesters is very poor, then registration will be terminated. If the performance is poor but not very poor, then the student will be given an option to start afresh. Rules for re-start/termination are given below.

a) Student will be given a chance to re-start after the first two registered semesters if his/her total number of earned credits is less than or equal to 20 at the end of the second semester.

b) If a student re-starts after the first two registered semesters, then his/her credits earned and semesters registered will not be carried over. The re-start will be indicated on the transcript. The re-start will be permitted only once. If at the end of two registered semesters after re-start, the earned credits are less than or equal to 20 then the registration will be terminated.

c) Each student is expected to earn at least 10 credits in the first registered semester and 12 credits in each subsequent registered semester with an SGPA greater than or equal to 5.0. If the performance of a student at the end of the any registered semester is below this minimum acceptable level, then he/she will be placed on probation and a warning shall be given to him/her and intimation sent to the parents also.

d) The student placed on probation shall be monitored, including mandatory attendance in classes, special tutorials and mentoring.

e) If the performance of a student on probation does not meet the above criterion (c) in the following registered semester, then the student will be permitted to register only if the department makes a favorable recommendation. The Head of the Department's recommendation shall be prepared after consultation with the student, and will include (i) feasibility of completing the degree requirements, and (ii) identifica-tion or remedial measures for the problems leading to poor performance.

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.

2.6.3. Slow-paced Programme

A student who has earned between 21 and 30 credits at the end of the first two registered semesters will be eligible to opt for the slow-paced programme. A student opting for such a programme shall be permitted two additional registered semesters for completing degree requirements.

In the slow paced programme, the upper limit for credits registered in a semester will be 14. A student in this programme is expected to earn at least 9 credits with minimum SGPA 5.0 in any semester, failing which he/she will be issued a warning and placed on probation.

(a) The student placed on probation shall be regularly monitored. Ensuring mandatory attendance in classes, engaging special tutorials and mentoring will be some of the ways of monitoring.

(b) If the performance of a student on probation does not meet the above criterion in the following registered semester, then the student should be permitted to register only if the department makes a favorable recommendation. The Head of the Department's recommendation shall be prepared after consultation with the student, and should include (i) feasibility of completing the programme, and (ii) identification of remedial measures for the problems leading to poor performance.

Such slow-paced programmes will be defined by the respective department for each student.

2.7. Programme Structure

2.7.1. B.Tech. in Computer Science and Engineering

Core Curricular Structure

Science core

Sr. No.	Course Code	Course Description	Credits	L-T-P
1	MAL111	Mathematical Laboratory	2	(1-0-2)
2	MAL115	Real Analysis	3	(3-0-0)
3	MAL213	Introduction to Probability Theory and Stochastic Processes	3	(3-0-0)
4	CYL101	Structure, Reactivity, and Dynamics	4	(3-1-0)
5	One of	PHL 101/PHL 102/ PHL 103	4	(3-1-0)
6	PHP100	Physics Laboratory	2	(0-0-4)
7	CYP100	Chemistry Laboratory	2	(0-0-4)
Science core credits			**20**	

Programme core

Sr. No.	Course Code	Course Description	Credits	L-T-P
1	CSL105	Discrete Mathematical Structures	4	(3-1-0)
2	CSL201	Data Structures	5	(3-0-4)
3	CSL202	Programming Paradigms and Pragmatics	5	(3-0-4)
4	CSP203	Software Systems Laboratory	2	(0-0-4)
5	CSL211	Computer Architecture	5	(3-1-2)
6	CSL333	Operating Systems	5	(3-0-4)
7	CSL343	Computer Network	4.5	(3-0-3)
8	CSL355	Logic and Computability	4	(3-1-0)
9	CSL356	Analysis and Design of Algorithms	4	(3-1-0)
10	EEL206	Digital Electronics Circuits	4	(3-1-0)
11	EEP206	Digital Electronics Laboratory	1.5	(0-0-3)
Programme core credits			**44**	

Scheduling of Courses (typical)

B.Tech. in Computer Science and Engineering

First Semester	
MAL111	Mathematics Laboratory
MAL115	Real Analysis
CYL101	Structure, Reactivity And Dynamics
CYP100 / PHP100	Chemistry Laboratory / Physics Laboratory
GEL101 / GEL104	Product Design And Realization - I / Principles Of Electrical Engineering
CSN100	Introduction To Computer Science And Engineering
HUL101	Professional Communication
HUN100	Introduction To Humanities And Social Sciences
Total Credits	**18**

Second Semester	
CSL105	Discrete Mathematical Structures
PHL10X Or MAL114	Students Are Advised To Do One Of PHL101 / PHL103 / PHL104 / PHL105 Or MAL114
CYP100 / PHP100	Chemistry Laboratory / Physics Laboratory
GEL103	Introduction To Computing
GEL101 / GEL104	Product Design And Realization - I / Principles of Electrical Engineering
HULXXX	Humanities Course
Total Credits	**21 / 22**
	(Depending on the course chosen from PHL105, MAL114 / PHL101, PHL103, PHL104)

Third Semester	
EEL206	Digital Electronic Circuits
EEP206	Digital Electronics Laboratory
CSL201	Data Structures
CSL 211	Computer Architecture
Total Credits	**15.5**

Fourth Semester	
CSL202	Programming Paradigms And Pragmatics
MAL213	Introduction To Probability Theory And Stochastic Processes
CSP203	Software Systems Laboratory
Total Credits	**10**

Fifth Semester	
CSL333	Operating Systems
CSL356	Analysis And Design Of Algorithms
PHL102	Quantum Physics
Total Credits	**13**

Sixth Semester	
CSL343	Computer Networks
CSL355	Logic And Computability
Total Credits	**8.5**
Summer	
IIP201	Core Industry Internship And Colloquium

Seventh Semester	
CPP301	Core Project - I
IP201	Core Industry Internship And Colloquium
Total Credits	**6**

Eighth Semester	
CPP302	Core Project - II
Total Credits	**5**

2.7.2. B.Tech. in Electrical Engineering

Core Curricular Structure

Science core

Sr. No.	Course Code	Course Description	Credits	L-T-P
1	PHL101	Electromagnetics	4	(3-1-0)
2	MAL111	Mathematical Laboratory	2	(1-0-2)
3	MAL114	Linear Algebra	3	(2-0-2)
4	MAL213	Introduction to Probability Theory and Stochastic Processes	3	(3-0-0)
5	CYL101	Structure, Reactivity, and Dynamics	4	(3-1-0)
6	PHP100	Physics Laboratory	2	(0-0-4)
7	CYP100	Chemistry Laboratory	2	(0-0-4)
Science core credits			**20**	

Programme core

Sr. No.	Course Code	Course Description	Credits	L-T-P
1	EEL201	Signals and Systems	4	(3-1-0)
2	EEL202	Circuit Theory	4	(3-1-0)
3	EEL203	Electro mechanics	4	(3-1-0)
4	EEL204	Analog Electronics	4	(3-1-0)
5	EEL205	Control Engineering	4	(3-1-0)
6	EEL206	Digital Electronic Circuits	4	(3-1-0)
7	EEL207	Engineering Electromagnetics	4	(3-1-0)
8	EEL208	Communication Engineering	4	(3-1-0)
9	EEL209	Power Systems	4	(3-1-0)
10	EEP203	Electro mechanics Laboratory	1.5	(0-0-3)
11	EEP204	Analog Electronics Laboratory	1.5	(0-0-3)
12	EEP206	Digital Electronics Laboratory	1.5	(0-0-3)
13	EEP305	Control Engineering Laboratory	1.5	(0-0-3)
14	EEP307	Engineering Electromagnetics Laboratory	1.5	(0-0-3)
15	EEP308	Communication Engineering Laboratory	1.5	(0-0-3)
16	EEP309	Power Systems Laboratory	1.5	(0-0-3)
Programme core credits			**46.5**	

Scheduling of Courses (typical)

B.Tech. in Electrical Engineering

First Semester	
MAL111	Mathematics Laboratory
PHL101	Electromagnetics
CYL101	Structure, Reactivity And Dynamics
CYP100 / PHP100	Chemistry Laboratory / Physics Laboratory
MAL112	Advanced Calculus
GEL101 / GEL104	Product Design And Realization - I / Principles Of Electrical Engineering
EEN100	Introduction To Electrical Engineering
HUL101	Professional Communication
HUN100	Introduction To Humanities And Social Sciences
Total Credits	**23**

Second Semester	
EEL201	Signals And System
MAL114	Linear Algebra
CYP100 / PHP100	Chemistry Laboratory / Physics Laboratory
GEL103	Introduction To Computing
GEL101 / GEL104	Product Design And Realization - I / Principles Of Electrical Engineering
HULXXX	Humanities Course
Total Credits	**21**

Third Semester	
EEL206	Digital Electronic Circuits
EEP206	Digital Electronics Laboratory
EEL202	Circuit Theory
EEL203	Electromechanics
GEL102	Materials Science & Engineering
Total Credits	**17.5**

Fourth Semester	
EEL204	Analog Electronics
EEP204	Analog Electronics Laboratory
EEL205	Control Engineering
EEL208	Communication Engineering
MAL213	Introduction To Probability Theory And Stochastic Processes
EEP203	Electromechanics Laboratory
Total Credits	**18**

Fifth Semester	
EEL207	Engineering Electromagnetics
EEL209	Power Systems
EEP305	Control Engineering Laboratory
EEP308	Communication Engineering Laboratory
Total Credits	**11**

Sixth Semester	
EEP309	Power Systems Laboratory
EEP307	Engineering Electromagnetics Laboratory
Total Credits	**3**
Summer	
IIP201	Core Industry Internship And Colloquium

Seventh Semester	
CPP301	Core Project-I
IIP201	Core Industry Internship And Colloquium
Total Credits	**6**

Eighth Semester	
CPP302	Core Project – II
Total Credits	**5**

2.7.3. B.Tech. in Mechanical Engineering

Core Curricular Structure

Science core

Sr. No.	Course Code	Course Description	Credits	L-T-P
1	PHL103	Classical Mechanics	4	(3-1-0)
2	MAL111	Mathematics Laboratory	2	(1-0-2)
3	MAL116	Introduction to Ordinary Differential Equations	3	(3-0-0)
4	MAL213	Introduction to Probability Theory and Stochastic Processes	3	(3-0-0)
5	CYL101	Structure, Reactivity and Dynamics	4	(3-1-0)
6	PHP100	Physics Laboratory	2	(0-0-4)
7	CYP100	Chemistry Laboratory	2	(0-0-4)
Science core credits			**20**	

Programme core

Sr. No.	Course Code	Course Description	Credits	L-T-P
1	MEL403	Continuum Mechanics	4	(3-1-0)
2	MEL102	Energy Science and Technology	4	(3-1-0)
3	MEP103	Engineering Communication	2	(0-0-4)
4	MEL201	Fluid Mechanics	4	(3-1-0)
5	MEL202	Manufacturing with Metallic Materials	3	(3-0-0)
6	MEL203	Manufacturing with Non-metallic Materials	3	(3-0-0)
7	MEL204	Machine Element Design	3	(3-0-0)
8	MEP205	Product Design and Realization - Intermediate	2	(0-0-4)
9	MEL301	Heat and Mass Transfer	4	(3-1-0)
10	MEP302	Manufacturing Laboratory	3	(0-0-6)
11	MEL303	Theory of Machines	3	(3-0-0)
12	MEP304	Design Laboratory	2	(0-0-4)
13	MEP305	Control Engineering Laboratory	1.5	(0-0-3)
14	MEP401	Thermo fluids Laboratory	1.5	(0-0-3)
15	MEL402	Manufacturing Systems	3	(3-0-0)
16	EEL205	Control Engineering	4	(3-1-0)
Programme core credits			**47**	

Scheduling of Courses (typical)

B.Tech. in Mechanical Engineering

First Semester	
MAL111	Mathematics Laboratory
CYL101	Structure, Reactivity And Dynamics
MAL112	Advanced Calculus
CYP100 / PHP100	Chemistry Laboratory / Physics Laboratory
MEL101	Engineering Mechanics
GEL101 / GEL104	Product Design And Realization - I / Principles Of Electrical Engineering
MEN100	Introduction To Mechanical Engineering
HUL101	Professional Communication
HUN100	Introduction To Humanities And S ocial Sciences
Total Credits	**23**

Second Semester	
MEL206 / MEL468	Mechanics of Materials
PHL103	Classical Mechanics
MAL116	Introduction To Ordinary Differential Equations
CYP100 / PHP100	Chemistry Laboratory / Physics Laboratory
GEL101 / GEL104	Product Design And Realization - I / Principles Of Electrical Engineering
GEL103	Introduction To Computing
Total Credits	**21**

Third Semester	
MEL102	Energy Science And Technology
MEL303	Theory Of Machines
MEP103	Engineering Communication
GEL102	Materials Science & Engineering
Total Credits	**13**

Fourth Semester	
MEL201	Fluid Mechanics
EEL205	Control Engineering
MEP205	Product Design And Realization - Intermediate
MAL213	Introduction To Probability Theory And Stochastic Processes
Total Credits	**13**

Fifth Semester	
MEL301	Heat And Mass Transfer
MEL202	Manufacturing With Metallic Materials
MEL204	Machine Element Design
PHL102	Quantum Physics
MEP305	Control Engineering Laboratory
Total Credits	**15.5**

Sixth Semester	
MEP401	Thermo-Fluids Laboratory
MEP304	Design Laboratory
MEL203	Manufacturing With Non - Metallic Materials
MEL403	Continuum Mechanics
Total Credits	**10.5**
Summer	
IIP201	Core Industry Internship And Colloquium

Seventh Semester	
CPP301	Core Project - I
IIP201	Core Industry Internship And Colloquium
MEP302	Manufacturing Laboratory
Total Credits	**12**

Eighth Semester	
CPP302	Core Project - II
Total Credits	**5**

2.7.4. Scheduling of Science and General Engineering Courses

Monsoon semester

CYP100	Chemistry Laboratory
GEL101	Product Design and
GEL102	Materials Science and
GEL104	Principles of Electrical
MAL111	Mathematics Laboratory
MAL112	Advanced Calculus
MAL115	Real Analysis
PHP100	Physics Laboratory
PHL101	Electromagnetics
PHL102	Quantum Physics

Winter semester

CYP100	Chemistry Laboratory
GEL101	Product Design and Realization-I
GEL103	Introduction to Computing
GEL104	Principles of Electrical Engineering
MAL114	Linear Algebra
MAL213	Introduction to Probability Theory and Stochastic
PHP100	Physics Laboratory
PHL103	Classical Mechanics

2.8. B.Tech.- M.Tech. Dual Degree in Mechanical Engineering

IIT Ropar is commencing B.Tech.-M.Tech. dual degree programme in Mechanical Engineering from the Academic Year 2015-16. The admission to this programme is through the JEE and the students are admitted after 10+2 schooling. The detail programme structure is as follows:-

2.8.1. Credit Structure of the Programme

Category	Credits requirments
UG Core courses	97
Electives	50
PG Project work	32
PG Level courses	21
Total	**200**

2.8.2. Scheduling of Courses-Semester-Wise.

First Semester	Second Semester	Third Semester	Fourth Semester	Fifth Semester
MAL 111	MEL 101	MEL 102	MEL 201	MEL 301
CYL 101	PHL 103	MEL 204	EEL 205	MEL 202
MAL 112	MAL 116	MEP 103	MEP 205	MEL 303
CYP 100/ PHP 100	CYP 100/ PHP 100	GEL 102	MAL 213	MEP 305
GEL 101/ GEL 104	GEL 101/ GEL 104			
PHL 102	GEL 103			
MEN 100				
HUL 101				
HUN 100				

Sixth Semester	Seventh Semester	Eighth Semester	Ninth Semester	Tenth Semester
MEP 401	IIP 201	PG Core-II	M.Tech. Thesis (16 Credits)	M.Tech. Thesis (16 Credits)
MEP 304	MEP 302	PG Core-III		
MEL 203	MEL 402	PG Soft Core-II		
	PG Core-I	PG Elective-I		
	PG Soft Core-I	PG Elective-II		
		Seminar		

i) Duration of the programme: 5 years
ii) Total No. of credits requirements: 200
iii) M.Tech. Thesis credits: 32
iv) Core Industry Internship credits: 3
v) Humanities and Social Sciences credits = 20 (At the end of the 8th Semester students has to complete 168 credits)
vi) Curriculum listed in 7th and 8th semester are produced in 2.8.3.
vii) Requirement of internship programme – Doing project in the industries etc. **Yes**
viii) Minimum CGPA required for successful completion of the course - **6.0**
ix) Prospective Employers / Takers : All relevant industries / Academic institutes / Research and Developments organizations.

Students of the B.Tech. - M.Tech. (Dual degree) programme spend their first seven semesters doing undergraduate courses together with the students of the B.Tech. programme, while the last three semesters are spent doing postgraduate courses together with the students of the M.Tech. programme. At the end of five years, they graduate, receiving both B.Tech. and M.Tech. degrees together. There is no option of early exit with a B.Tech. degree only unless the student's performance is so poor that he/she is considered incapable of securing the higher degree. Institute reserves the sole right to make the decision in such cases.

2.8.3. Courses for M.Tech. Programme

Sr. No.	Maths	Manufacturing	Design	Thermal
1	MEL632 (Math - 1) Mathematics for Engineers:(3-0-0)3 credits	MEL501 Advanced Composites: (3-0-0)3 Credits	MEL507 Engineering Design Optimization: (3-0-0) 3 Credits	MEL507 Engineering Design Optimization: (3-0-0) 3 Credits
2	MEL633 (Math - 2) Numerical Methods in Mechanical Engineering: (3 -0-0)3credits	MEL502 Advanced Welding Technology: (3-0-0)3 Credits	MEL508 Advanced Mechanics of Solids: (3-0-0) 3 Credits	MEL509 Convective Heat Transfer: (3-0-0) 3 Credits
3		MEL503 Solidification Processing: (3-0-0)3 Credits	MEL510 Rotor Dynamics and Condition Monitoring: (3-0-2) 4 Credits	MEL524 Energy Conservation and Waste Heat Recovery: (3-0-0) 3 credits
4		MEL 504 Advanced Metal Casting Technology: (3-0-0)3 Credits	MEL513 Introduction to Plasticity: (3-0-0) 3 Credits	MEL 521 Computational Fluid Dynamics: (3-0-2) 4 Credits
5		MEL505 Industrial Robotics: (3-0-0) 3 Credits	MEL515 Bone Biology: (3-0-0) 3 Credits	MEL 522 Air Conditioning and Ventilation: (3-0-0) 3 Credits
6		MEL506 Surface Engineering: (3-0-0)3 Credits	MEL516 Orthopedic Biomechanics: (3-0-2) 4 Credits	MEL 523 Refrigeration Systems (3-0-0) 3 Credits

Sr. No.	Maths	Manufacturing	Design	Thermal
7		MEL507 Engineering Design Optimization: (3-0-0) 3 Credits	MEL518 Robot Manipulators: Kinematics, Dynamics and Control: (3-0-2) 4 Credits	MEL609 Solar Thermal Engineering: (3-0-0) 3 Credits
8		MEL 511 Atomistic Simulation and Modeling of Materials: (3-0-0)3 Credits	MEP501 Control Engineering Laboratory: (0-0-4) 2 Credits	MEL610 Advanced Conduction & Radiative Heat Transfer: (3-0-0) 3 Credits
9		MEL512 Nanocomposites-Processing, characterization and Applications: (3-0-0) 3 Credits	MEL602 Finite Element Methods in Engineering: (3-0-0) 3 Credits	MEL611 Combustion Engineering: (3-0-0) 3 Credits
10		MEL514 Metallic Corrosion: (3-0-0) 3 Credits	MEL603 Machine Vibration Analysis: (3-0-0) 3 Credits	MEL612 Turbulent Flow: (3-0-0) 3 Credits
11		MEL517 Sustainable Design and Manufacturing: (2-0-4) 4 Credits	MEL604 Vibration and Shock Isolation: (3-0-0) 3 Credits	MEL 619 Engine Management : (3-1-0) 4 Credits
12		MEL519 Biological Materials:(3-0-2)4 Credits	MEL608 Mechatronics: (3-0-0) 3 Credits	MEL 620 Fluid Flow and Heat Transfer in Biological Systems (3-0-0) 3 Credits
13		MEL605 Friction and Wear in Machinery: (3-0-0) 3 Credits	MEL614 Nonlinear oscillations : (3-0-0) 3 Credits	MEL 621 Micro and Nanoscale Heat Transfer
14		MEL606 Modern Manufacturing Processes: (3-0-0) 3 Credits	MEL616 Fracture and Fatigue: (3-0-0) 3 Credits	MEL 622 Engine Instrumentation and Combustion Diagnostics: (3-0-0) 3 Credits
15		MEL607 Rapid Prototyping: (3-0-0)3 Credits	MEL618 Molecular, Cellular and Tissue Biomechanics: (3-0-2) 4 Credits	MEL 623 Alternative Fuels and Advances in Engines: (3-0-0) 3 Credits
16		MEL613 Science of Machining: (3-0-0) 3Credits	MEL 624 Crystal Plasticity: (3-0-2) 4 Credits	MEL629 Advanced Fluid Mechanics: (3-0-0) 3 Credits
17		MEL615 Advanced Material Characterization Techniques: (2-0-4) 4 Credits	MEL 626 Theory of Elasticity: (3-0-0) 3 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		

2.9. Course Descriptions

2.9.1. General Engineering

GEL101 Product Design and Realization – 1, 4 (1-0-6)

Prerequisite: Nil

Analysis and synthesis of engineered products; Representation of engineering designs-visualization, sketching, communicating engineering ides/designs role of s/w and h/w; engineering drawings involving mechanical, electrical, civil, etc. aspects, packages typically used in industry, component, sub-assembly, assembly and exploded assembly drawing; Product dissection-product analysis, disassembly process planning, tooling and sequence, preparing drawings, parts list, specifications, functional requirements, inspection including fits, tolerances and surface roughness, materials, assembly issues; Assembly-tooling, inspection, checking and inspection, operation. Manufacture of a product-planning and manufacturing as per detailed design given using some bought out items; assembly and operation. Activities will be done in teams of 4-6 students as per professional practices.

GEL102 Materials Science and Engineering, 4 (3-0-2)

Prerequisite: Nil

Structure of materials, -crystal structure, substructure, microstructure, phase diagram and phase transformation; Material properties-mechanical, electrical, physical corrosion, etc. properties; Material treatment-heat, surface, etc; Alloys-metals, effects of different alloying elements, super alloys; Ceramics- classification, characterization, properties; Polymers-classification, properties, processing; Composite materials - structure, properties, classification, processing; Conductors, semi-conductors and magnetic materials- properties, production; Surface engineering and applications - techniques, coatings, processing and heat treatment; Materials classifications-engineering standards, material selection (CES type packages); Special materials; Environmental impact; Reprocessing; Applications.

GEL103 Introduction to Computing, 4 (3-0-2)

Prerequisite: Nil

Connection between mathematics and computation. The main abstractions in computation (processor, storage, communication) and their realization in architecture. Introduction to elementary software artifacts (IDEs, compilers, operating systems, etc.) for creating and executing programs. Elementary and inductive data types and their representation in high-level languages; integers, strings, reals, sequences, etc. Rigorous specification of problems and solutions over these types. Concept of an algorithm; termination and correctness. From algorithms to programs; specification, top-down development and stepwise refinement. Use of a high level programming language for the systematic development of programs. Introduction to the design and implementation of correct, efficient and maintainable programs. Stateful data structures such as arrays. Efficiency issues in programming; time and space measures. Elementary control structures in an imperative model. Assertions, representational invariants and loop invariants. Encapsulation of data. Objects and classes.

GEL104 Principles of Electrical Engineering, 4 (3-0-2)

Prerequisite: Nil

DC circuits, KCL, KVL, Network Theorems, mesh and nodal analysis, step response and transients. RC, RL and RLC circuits. Phasor diagram solution of AC circuits, Power in 1- and 3-phase AC circuits. Diodes: rectifiers, clipping and clamping. Two port networks. Operational Amplifiers: model and applications. Magnetic circuits. Transformers: modeling and analysis. Energy in magnetic field, production of force and EMF. Principles of measurement.

2.9.2. Projects

CPP301 Core Project-1, 3 (0-0-6)

Could be done singly or in a group of two/three students; involves working under a faculty member and carrying out a detailed feasibility study and literature survey for solving the problem specified by the faculty member; preparing a work plan and making presentations to a committee appointed to evaluate the progress.

CPP302 Core Project-2, 5 (0-0-10)

Continuation of Core Project-1; objective is to complete the work as per the prepared work plan; prepare a detailed project report and defend the work done by making presentations and demonstrations to the committee.

CPP303 Capstone Project, 12 (0-0-24)

Involves working in a large group of 6 to 8 students with the objective of building a sophisticated system requiring interdisciplinary inputs; getting permission to register for this project will be on the basis of a project report which will establish the feasibility of achieving the aims from all angles, i.e. time required, skill set of the team, availability of material and finances, and a clear plan of work and individual responsibilities.

2.9.3. Industry Internship

IIP201 Core Industry Internship and Colloquium, 3 credits

Involves working in industry, consultancy organization, or a research centre for a period of at least ten weeks during a summer. On return from training, the work will be evaluated at the institute on the basis of a detailed written report of the work done and presentation to a committee and to students. Daily diary of work done will need to be maintained and award of "satisfactory" grade will require concurrence from the supervisor of the internship. As part of Colloquium, every student would also have to make presentations on assigned topics.

IIP301 Semester Industry Internship, 12 credits

Involves working in industry, consultancy organization or a research centre for a full summer and the following semester. Permission for semester internship will be given on the basis of a proposal wherein the work to be done during internship is detailed and recommended by the supervisor under whom the work will get done. The work will be evaluated at the institute on the basis of a detailed written report of the work done and a presentation to a committee. Daily diary of work done will need to be maintained and award of "satisfactory" grade will require concurrence from the supervisor of the internship. Credits for this internship will not count towards degree requirements.

2.9.4. Chemistry

CYL101 Structure, Reactivity and Dynamics, 4 (3-1-0)

Prerequisite: Nil

Quantum Mechanical principles of structure and bonding in molecules. Reaction rates. Free energy and entropy changes in chemical processes. EMF of galvanic cells, Liquid junction potential. Structure and stereoisomerism. Conformational analysis. Reactivity-acids and bases. Kinetic and thermodynamic criteria of reactions. Electrophilic and nucleophilic substitution reactions. Elimination reactions. Determination of mechanism. Transition metal complexes-crystal field theory, electronic spectra and magnetism. Organometallics-EAN rule, metal carbonyls, metallocenes. Inorganic solid-structure and applications.

CYP100 Chemistry Laboratory, 2 (0-0-4)

Prerequisite: Nil

Integrated course with an emphasis on experiment design. Focus on measurement techniques and the interpretation of results.

CYL200 / CYL451 Synthesis and Catalysis, 4 (3-1-0)

Prerequisite: CYL101

Structure-activity relationships in simple organic molecules. Strategies for C-C bond formation. Pericyclic reactions. Basic heterocyclic and organometallic chemistry. Catalysis- homogeneous, cross-coupling reactions, Catalytic cycles, phase transfer, heterogeneous.

CYL210 / CYL452 Materials Chemistry, 4 (3-1-0)

Prerequisite: CYL101

Synthesis of molecular, non molecular and composite

materials. Characterization techniques. Structure property relationships. Applications-Clean energy, environmental remediation.

CYL220/ CYL453 Polymers and Soft Materials, 4 (3-1-0)

Prerequisite: CYL:101

Polymer classification, Molecular weight, structure and morphology determination. Polymerisation techniques. Kinetics and mechanism of chain growth. Copolymers-engineering the properties of materials.

CYL250 / CYL454 Environmental Science and Engineering, 3 (3-0-0)

Prerequisite: Nil

Water and wastewater analysis : Basic concepts and instrumental methods of analysis ; Determination of major parameter of water such as pH, acidity, alkalinity, hardness, BOD, COD, Solids, anions, cations, volatile acids and trace contaminants. Concepts of water treatment: coagulation, softening, flocculation, sedimentation, filtration, disinfection and adsorption. Atmosphere, Composition & Behavior: Gaseous & particulate constituents of the atmosphere, temperature and pressure profile of atmosphere, Atmospheric Photochemistry: Electromagnetic radiations, kinetics of thermal and photochemical processes, Reactions in the upper atmosphere, photo processes in the troposphere, photochemical smog, photosynthesis, Ozone chemistry. Green Chemistry: Principle and applications, green chemical industrial process, sustainable fuel for automobiles and power generation. Air pollution: Standards, effect of air pollutants, origin and fate of air pollutants, atmospheric dispersion, and air pollution control at stationary and mobile sources, Introduction to Hazardous waste management, Environmental impact statement and global pollution issues. Introduction to Environmental legislation, regulation, ethics and system overview

CYL300 / CYL455 Measuring Molecules, 4 (3-1-0)

Prerequisite: CYL101

Spectrosocopy-Radiation matter interactions: IR, UV, NMR etc. Theoretical basis and data analysis.

CYL240/CYL456 Chemistry of Life-An Introduction, 4 (3-1-0)

Prerequisite: CYL101

Cell: prokaryotic and eukaryotic cell structure, major cell organelles and their function, cell membrane and its function including cell signalling, cell cycle, and programmed cell death

Biomolecules: structure and function of carbohydrates, lipids, nucleic acids, and proteins

Enzymes: classification based on their structure, role as biocatalysts, and enzyme inhibition

Vitamins: types and functions, and their role as coenzymes

Nucleic acids: understanding DNA as a hereditary material, structures of DNA and RNA, concept of gene and genome, basic outline of the central dogma, concepts of replication, transcription, and translation, mutations, viruses, an overview of genetic engineering/biotechnology (recombinant DNA/hybridoma), polymerase chain reaction (PCR), and DNA sequencing

Metabolism: ATP and energy generation, outline of glycolysis, β-oxication, the TCA cyle, de-animation, and the urea cycle.

CYL230 / CYL457 Theoretical Chemistry, 4 (3-1-0)

Prerequisite: CYL 101

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), Hybrid methods, The Mulliken charges, Orbital population, Vibration analysis,Potential energy surfaces and Quantum dynamics,Plane wave formalism.

CYL458 Biomaterials, 4 (3-1-0)

Prerequisite: CYL101; Basic understanding of cells, tissues, and proteins (optional)

•Biomaterials, bulk and surface properties of biomaterials and their influence on tissue interface dynamics, classes of biomaterials used in medicine (metals, ceramics, com-posites, polymers, hydrogels / gels, and bio-logics), biodegradable biomaterials

•Protein adsorption to surfaces, cell and tissue interaction with biomaterials, host re-sponses to biomaterials (inflammation, im-munity, systemic toxicity, hypersensitivity, blood coagulation, and tumoriegenesis), concept of biocompatibility

•Testing biomaterials in vitro and in vivo

•Application of biomaterials in medicine (soft and hard tissue replacement, and drug de-livery)

CYL459 Biomedical Nanotechnology, 3 (3-0-0)

Prerequisite: Basic understanding of organic reaction mechanism, stereochemistry of carbon compounds, biomolecules, cells and tissues.

Biomedical Nanotechnology**:** An introduction to nanotechnology; fabrication and characterization of nanomaterials; quantum dot, carbon-based, magnetic, polymer-based , and bio nanomaterials; advantages of using nanoscale materials; biomedical nanotechnology Biomedical Nanotechnology in Diagnostics: High through put screening (HTPS) and diagnostics; point-of-care (POC) diagnostics; arrays; nanoparticle, quantum-dot, silicon nanowire-based detection systems; DNA biochips; label-free detection

Biomedical Nanotechnology in Therapeutics: Drug delivery; use of quantum dots, carbon nanotubes, and nanoparticles in therapy; polymeric nanoparticles and spheres; polymeric nanoparticles in photodynamic therapy; polymer therapeutics; liposomes; growth of neurons on nanomaterials; nanomaterials for brain protection and repair; nanorobotics for surgery

Biomedical Nanotechnology in Cancer Treatment: Rationale for using nanotechnology in cancer therapy; examples of abraxane and doxil; passive tumor targeting by enhanced permeability and retention effect; active targeting strategies in cancer therapy; multifunctional nanoparticles in cancer therapy; theranostics

Biomedical Nanotechnology in Implants and Prostheses: Implants and prostheses; reconstructive Intervention; biomaterials and biocompatibility; an overview on methods currently used for nanofabrication of implants

Potential risks: Toxicities of nanoparticles and carbon nanotubes; FDA approval, clinical trials, and regulatory pathways for nanoparticle therapeutics.

2.9.5. Computer Science and Engineering

CSL105 Discrete Mathematical Structures, 4 (3-1-0)

Prerequisite: Nil

Fundamental structures using sets. Functions (surjections, injections, inverses, composition); relations (reflexivity, symmetry, transitivity, equivalence relations); sets (union, intersection, complements, Cartesian products, power sets); pigeonhole principle; cardinality and countability. Syntax and semantics of logic: Propositional logic: logical connectives; truth tables; normal forms (conjunctive and disjunctive); validity. First- order logic; limitations of predicate logic, universal and existential quantification; modus pones and modus tollens. Elementary Proof techniques: Notions of implication, converse, inverse, contrapositive, negation and contradiction; the structure of formal proofs; direct proofs; proof by counterexample; proof by contraposition; proof by contradiction; mathematical induction; strong induction; recursive mathematical definitions; well orderings. Basics of counting: Counting arguments; pigeonhole principle; permutations and combinations; inclusion exclusion, recurrence, generating functions. Elementary Graph Theory.

CSL201 Data Structures, 5 (3-0-4)

Prerequisite: GEL103

Revision of notions of time and space complexity, and trade-offs in the design of data structures. Introduction to object-oriented programming through stacks, queues and linked lists. Dictionaries; skip-lists, hashing, analysis of collusion resolution techniques. Trees, traversals, binary search trees, Balanced BSTs, tries, priority queues and binary heaps. Object oriented implementation and building libraries. Applications to discrete event simulation. Sorting: merge, quick, radix, selection and heap sort, Graphs: Breadth first search and connected components. Depth first search in directed and undirected graphs. Union-find data structure and applications. Directed acyclic graphs; topological sort.

CSL202 Programming Paradigms and Pragmatics, 5 (3-0-4)

Prerequisite: CSL201

Notions of syntax and semantics of programming languages; introduction to operational and mathematical semantics of declarative (functional and logic) and imperative languages. Exposure to different programming language paradigms.

Data abstractions and control constructs; block-

structure and scope, principles of abstraction, qualification and correspondence; parameter passing mechanisms; runtime structure and operating environment; practical and implementation issues in run-time systems and environment; abstract machines; features of functional and imperative languages. The untyped and simply-typed Lambda calculus, type systems for programming languages including simple types and polymorphism; objects; classes and inheritance in object-oriented

CSP203 Software Systems Laboratory, 2 (0-0-4)

Prerequisite: CSL201

Programming exercises and projects using software tools. IDEs, spreadsheets, configuration management, make, version control, documentation tools, literate programming (noweb); scientific document type-setting software (LaTeX), XML, scripting languages and tools (Perl, awk, etc.). Botting systems, and installation and compression tools. Archiving and creation of libraries. Security and encryption software. Application software development tools. Simulation tools, Sockets and RPCs, Pthreads. Numerical packages. Using query languages and data bases. Validation, testing and verification tools and techniques.

CSL211 Computer Architecture, 5 (3-1-2)

Prerequisite: GEL103 and GEL104

Subsystems of a computer; Instructions and their formats; Assembly programming; Performance metries; Performance comparison; Information representation; Integer and floating point arithmetic; Processor datapath design; Control unit design; Microprogramming; Performance improvement with pipelining; Memory organization - cache and virtual memory; input/output organization, interrupts and DMA.

CSL301 /CSL451 Introduction to Database Systems, 4 (3-0-2)

Prerequisite: CSL201

The world of Database Systems. The E-R Model, The three database models, Representation and Evaluation of Relationship. The Relational Database Model, Functional Dependencies, Multi-valued and join dependency, Normalization theory, Concurrency Control in Relational Database. Object-oriented Data Models.

CSL302 / CSL452 Artificial Intelligence, 4 (3-0-2)

Prerequisite: CSL201

Problem solving, search techniques, control strategies, game playing (mini-max), reasoning, knowledge representation through predicate logic, rule-based systems, semantic nets, frames, conceptual dependency formalism, Planning. Handling uncertainty: Bayesian Networks, Dempster-Shafer theory, certainty factors, Fuzzy logic, Learning through Neural nets — Back propagation, radial basis functions, Neural computational models - Hopfield Nets, Bolzman machines. PROLOG programming.

CSL303 / CSL453 Logic for Computer Science, 4 (3-0-2)

Prerequisite: CSL105

Review of the principle of mathematical induction; the principal of structural induction; review of Boolean algebras; Syntax of propositional formulas; Truth and the semantics of propositional logic; Notions of satisfiability, validity, inconsistency; Deduction systems for propositional logic; Soundness and Completeness of deduction systems; First order logic (FOL): syntax and semantics; Proof theory for FOL: introduction to model theory; completeness and compactness theorems; First order theories. Introduction to model logics. Programming exercises will include representation and evaluation; conversion to normal-forms; tautology checking; proof normalization; resolution; unification; Skolemization, conversion to Horn-clauses; binary-decision diagrams.

CSL304 /CSL454 Numerical and Scientific Computing, 5 (3-1-2)

Prerequisite:GEL103, MAL114

Introduction to Scientific Computing (floating point arithmetic). Review of matrices and linear systems. Linear Least Squares, Eigenvalue Problems. Review of Singular value decomposition. Direct methods Gauss, Cholesky and Householder's methods, Matrix iterative methods: Jacobi, Gauss-Siedel and relaxation methods, conjugate gradient methods and its pre-conditioning, Computation of Eigenvalues and Eigenvectors: Jacobi, Givens, Householder, QR and inverse methods. Nonlinear Equations. Optimization, interpolation, Numerical integration and Differentation, Initial and Boundary value Problems for Ordinary Differential Equations. Partial Differential Equations, Fast Fourier Transform. Throughout the course implementation of the various

methods and their comparisons with professionally written software such as LINPAC, ITPACK, EISPACK LAPACK, SPARSE PACK will be emphasized with the understanding of various data structures, storage schemes etc. Existence and uniqueness, sensitivity and condition, convergence and error analysis will be part of every topic.

CSL305 / CSL455 Compiler Design, 4 (3-0-2)

Prerequisite:CSL202 and CSL355

Compilers and translators; lexical and syntactic analysis, top-down and bottom up parsing techniques; internal form of source programs; semantic analysis, symbol tables, errior detection and recovery, code generation and optimization. Data flow and control flow analysis. Type checking and static analysis Algorithms and implementation techniques for type-checking, code generation and optimization. Students will design and implement translators, static analysis, type-checking and optimization.

CSL306 / CSL456 Software Engineering, 4 (3-0-2)

Prerequisite:CSL201 and CSL202

Concepts and techniques relevant to production of large software systems: Structured programming, Requirements specification and analysis. Top-down design and development, Information hiding, abstraction, modularity, object-oriented techniques. Separate compilation, configuration management, program libraries Design patterns, UML Documentation, validation, Quality assurance, safety, Testing and test case generation, Software metrics, Cost analysis and estimation, manpower and time management. Organization and management of large software design projects. Constraints and triggers, Disk Storage, Disk and Memory Organization for Relational Operators, Representing Data Elements, Index Structures, Query execution, Query Compilation, Query Optimization, Coping with System Failures, Concurrency Control, Transaction Management, Representation of Date.

CSL307/CSL457 Computer Graphics, 4 (3-0-2)

Prerequisite: CSL201

Graphics pipeline; Graphics hardware: Display devices, input devices; Raster Graphics; line and circle drawing algorithms; Windowing and 2D/3D clipping. Cohen and Sutherland line clipping, Cyrus Beck clipping method; 2D and 3D Geometrical Transformations: scaling, translation, rotation, reflection; Viewing Transformations: parallel and perspective projection; Curves and Surfaces: cubic splines, Bezier curves, B-splines, Parametric surface. Surface of revolution Sweep surfaces, Fractal curves and surfaces; Hidden line / surface removal methods; illuminations model; shading: Gouraud, Phong; Introduction to Ray-tracing; Animation; Programming practices with standard graphics libraries like openGL.

CSL309 / CSL459 Architecture of High Performance Computers, 4 (3-0-2)

Prerequisite:CSL211 ; CSL333

Classification of parallel computing structures, instruction level parallelism - static and dynamic pipelining, improving branch performance, superscalar and VLIW processors; High performance memory system; Shared memory multiprocessors and cache coherence; Multiprocessor interconnection networks; Performance modeling; issues in programming multiprocessors; Data parallel architectures.

CSL333 Operating Systems, 5 (3-0-4)

Prerequisite:CSL201 and CSL211

Overview: functions of Operating Systems, layered architecture basic concepts; interrput architecture system calls and notion of process and threads; synchronization and protection issues; scheduling; memory management including virtual memory and paging techniques; input-output architecture and device management; file systems; distributed file systems. Case studies of Unix, Windows NT. Design and implementation of small operating systems.

CSL343 Computer Networks, 4.5 (3-0-3)

Prerequisite: CSL201

Suggested additional background: Signals and Systems, and Operating Systems

Fundamentals of Digital Communications, including channel capacity, error rates, multiplexing, framing and synchronization. Broadcast network and multi-access protocols, including CSMA/CD. Data link protocols, network protocols including routing and congestion control, IP protocol. Transport protocol including TCP. Network application services and protocols including email, www, DNS. Network security and management.

CSL355 Logic and Computability, 4 (3-1-0)

Prerequisite: CSL105

Myhill-Nerode Theorem, introduction to non-determinism, Context free grammars, Pushdown automata, equivalence and applications. Turing machines, Recursive and Recursively enumerable sets, non-determinism, RAMs and equivalence, Universal Turing Machines, undecidability, Rice's theorems for REsets, Post machines, Basics of Recursive function theory. Equivalence, Church's thesis, computational complexity, space and time complexity of Turing Machines, Relationships, Savage's theorem, Complexity classes, Complete problems, NP- completeness, Cook-Levin theorem.

CSL356 Analysis and Design of Algorithms, 4 (3-1-0)

Prerequisite:CSL105 and CSL201

RAM model and complexity; O(log n) bit model, integer sorting and string sorting. Review of fundamental data structures; Red-black trees, mergeable heaps, interval trees. Fundamental design methodologies and their implementations; Search Techniques, Dynamic Programmings, Greedy algorithms, Divide-and-Conquer, Randomised techniques. Algorithms for set manipulations, their implementations and applications; Union Find Randomized data structures; Skip lists, Universal Hash functions, Graph Algorithms with implementation issues; Depth-First Search and its applications, minimum Spanning Trees and shortest Paths. Convex hulls, sorting, Selection Matrix multiplication, pattern matching, integer and polynomial arithmetic, FFT, introduction to the theory of lower bounds, NP-Completeness and Reductions. Approximation algorithms.

CSL458 Special Topics in Computer Systems, 4 (2-1-2)

Prerequisite: GEL103, CSL201

This course is aimed at providing an introduction to certain special topics in systems is computer science and engineering. One of the goal of this course is to equip a students with necessary knohow of computer systems so that he/she can design and build software applications. Topics covered in this course will include but not limited to the following:

1.Basics of operating systems. It will cover at a high-level the topics like process management, CPU scheduling, file systems, system calls, etc.

2.Basics of computer networks. Topics such as layered architecture of network protocol stack and high-level working of different layers will be discussed.

3.Basics of database systems. Topics such as data modelling, information storage it in relational database systems, concurrency and scalability issues in database systems will be discussed.

4.Basics of computer system security. Topics will include a high-level discussions of security threats, building blocks for securing computer systems and applications.

5.Software development and design isses. Basic design tactics and design patterns.

This course will have sufficient hands-on implementation component in the form of a test project and coding assignments. Students are expected to know how to program in a high-level programming language such as Python or Java etc.

CSL401/CSL460 Advanced Algorithms, 3 (3-0-0)

Prerequisite: CSL356

Advanced data structures: self-adjustment, persistence and multi-dimensional trees. Randomized algorithms; Use of probabilistic inequalities in analysis, Geometric algorithms; Point location, Convex hulls and Voronoi diagrams. Arrangements applications using examples, Graph algorithms; Matching and Flows. Approximation algorithms; Use of Linear programming and primal dual, local search heuristics. Parallel algorithms; Basic techniques for sorting, searching merging, list ranking in PRAMs, and interconnection networks.

CSL402 / CSL461 Digital Image Analysis, 4 (3-0-2)

Prerequisite: CSL201 and EEL201

Digital Image Fundamentals; Image Enhancement in Spatial Domain; Gray Level Transformation, Histogram Processing, Spatial Filters; image Transforms; Fourier Transform and their properties, Fast Fourier Transform, Other Transforms; Image Enhancement in Frequency Domain; Colour Image Processing; Image warping and restoration; Image Compression; Image Segmentation; edge detection, Hough transform, region based segmentation; Morphological operators; Representation and Description; Features based matching and Bayes classification; Introduction to some computer vision techniques; Imaging geometry, shape from shading, optical flow; Laboratory exercise will emphasize development and evaluation of image processing methods.

CSL404 / CSL462 Computer Vision, 4 (3-0-2)

Prerequisite: Nil

Camera models, Calibration, multi-views projective geometry and invariants. Edge/feature extraction, correspondence and tracking, 3D structure/motion estimation. Object recognition, Scene and activity interpretation.

CSL405 / CSL463 Complexity Theory, 3 (3-0-0)

Prerequisite: CSL355 and CSL356

Turing machines and non-determinism, models of computation like RAM and pointer machines. Relations between complexity classes. Time-space tradeoffs for some fundamental problems. Reductions and completeness, Randomized complexity classes, Boolean circuit complexity. Cryptography and one-way functions. Polynomial hierarchy, P-space completeness, Interactive proofs and Hardness of approximation, Parallel complexity classes.

CSL406 / CSL464 Advanced Computer Networks, 3 (3-0-0)

Prerequisite:CSL343

Flow and Congestion Control; Window and Rate Based Schemes, Debit, TCP. ATM, ABR, hop-by-hop schemes, Quality of Service: in ATM, IETF integrated services model, Differentiated Services Model. Flow identification, Packet Classifiers and Filters. Scheduling. Network Management: ASN, SNMP, CMIP. Issues in the management of large networks. Multicast: IGMP, PIM, DVMRP, Mobility: Mobile IP.

CSL465 Machine Learning, 4 (3-0-2)

Prerequisite: CSL201

Course Overview: A detailed investigation of current machine learning theory and methodologies. Hands on experience on some of the basic machine learning algorithms through matlab / R/octave implementations.

Course Content: 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 – maximum 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.

CSL467 Foundations of Cryptology, 4 (3-0-2)

Prerequisite: CSL201

This is first course in cryptology with a thorough mathematical treatment of the concepts. The course assumes that the student is familiar with the basics of computer science and has undergone a first course in programming. Although the required math will be covered in the first few lecture hours, the course assumes that the student has good mathematical aptitude coupled with an ability to read and write proofs with rigour.

Syllabus: Security in computing, classical cryptosystems and its cryptanalysis, number theory prerequisites (congruences, Euler's theorem, quadratic reciprocity), algebra prerequisites (groups, rings, fields, finite fields). DES, AES and other symmetric key cryptosystems, public key cryptosystems, primality testing and factoring techniques, pseudorandom numbers, perfectly-secret encryption, one time pad, limitations of one time pad, shannon's theorem, message authentication codes and collision-resistant hash functions, digital signature schemes, secret sharing schemes, zero knowledge proofs.

CSL 469 Wireless and Mobile systems, 4(3-0-2)

Prerequisite: CSL 201 Data Structures

Fundamental and protocols of cellular systems, Satellite systems, Ad Hoc networks, Sensor networks, Vehicular networks, RFID and wirelessLANs, MANs and PANs 3G and 4G, Femtocell Networks , Cognitive Radios, Directional Smart Antennas.

2.9.6. Electrical Engineering

EEL201 Signals and Systems, 4 (3-1-0)

Prerequisite: Nil

Classification of signals and systems, various system representation techniques, differential, difference and state-space representations, Fourier transforms and series, application to analysis of systems, Laplace transform, its properties, and its application to system analysis, Z-transforms, its properties and applications, Random variables and random process, characterization of random variables and random process, linear systems and random signals.

EEL202 Circuit Theory, 4 (3-1-0)

Prerequisite: Nil

Overview of network analysis techniques, Network theorems, Transient and steady state sinusoidal response. Network graphs and their applications in network analysis. Tellegen theorem, Two-port networks, z, y, h and transmission parameters, combination of two ports, Analysis of common two ports, Resonance, Coupled circuits, Scattering matrix and its application in network analysis. Network functions, parts of network functions, obtaining a network function from a given part. Network transmission criteria; delay and rise time, Elmore's and other definitions of cascading. Elements of network synthesis techniques. Butterworth and Chebyshev Approximation.

EEL203 Electromechanics, 4 (3-1-0)

Prerequisite: Nil

Transformer and its application: the ideal transformer and evolution of the equivalent circuit, regulation and efficiency, three phase transformer connection, the per-unit system and its utility, the autotransformer connection and its analysis, multi-circuit transformers, their equivalent circuit and applications, tap-changers and induction regulators; general features of polyphase AC machine; the polyphase induction machine: the electromagnetic behavior of a squirrel cage rotor, evolution of the equivalent circuit in wound and cage type rotors, skewing and its effects, the effect of deep bar and double cage rotors; the polyphase synchronous machine: emf generation in synchronous generator, armature reaction and its effect on torque production, the difference between saliency and non saliency, the d-q axes representation, reactances in a synchronous machine, power angle characteristics and effect on stability, the synchronous motor and its applications, details of synchronous characteristics with method of speed control and starting methods, variants of the synchronous machine – the reluctance motor and the permanent magnet motor, their characteristics, control, and starting, the hysteresis motor and the difference with other synchronous machines, the PMBLDC motor: operation, application, and characteristics; the single phase motor; the DC machine.

EEL204 Analog Electronics, 4 (3-1-0)

Prerequisite: Nil

Introduction of diodes, diode characteristics, voltage multipier, half wave and full wave rectifiers, peak detector, small signal analysis of diode circuit, Zener regulator, varactor diode, amplifier, cascading of amplifiers, y, z, h and g parameters, two port analysis, frequency limitations, distortion in amplifiers, bipolar junction transistor invertor, transistor biasing, stable biasing schemes, common emitter amplifiers, Introduction to MOSFETs and JFET, characteristics, introduction to operational amplifiers, introduction to feedback theory, positive and negative feedback, inverting and non-inverting amplifiers, differential amplifiers, integrator, differentiator, differential amplifiers, summer, precession rectifiers, A/D, D/A convertors, waveform generators, phase locked loop.

EEL205 Control Engineering, 4 (3-1-0)

Prerequisite: Nil

Introduction to the control systems; mathematical basics for linear control systems; feedback and its features; common components for control engineering; time response analysis in linear analog domain; time response analysis in linear digital domain; stability of linear systems in analog and digital time domain; root-locus concepts in analog and digital domain; frequency response analysis; stability of linear systems in analog and digital frequency domain; controller design in analog and digital domain; details of state variables; lyaunov stability analysis.

EEL206 Digital Electronic Circuits, 4 (3-1-0)

Prerequisite: Nil

Review of Boolean Algebra, Karnaugh Map and Logic Gates; Designing combinational Circuits using gates and/or Multiplexers; Introduction to logic families: TTL, ECL, CMOS; PLAs and FPGAs; Sequential Circuits: Flip Flops, Counters and Registers; Design of Sequential Circuits: STD and applications; Pipelining and Timing issues; Memories.

EEL207 Engineering Electromagnetics, 4 (3-1-0)

Prerequisite: Nil

Review of Maxwell's equations, wave propagations in unbounded medium. Boundary conditions, reflection and refraction of plane waves. Transmission Lines: distributed parameter circuits, traveling and standing waves, impedance matching, Smith chart, analogy with plane waves. Waveguides: parallel-plane guide, TE, TM and TEM waves, rectangular and cylindrical waveguides, resonators. Planar transmission lines: stripline, microstripline, application of numerical techniques. Dielectric guides and optical fibres. Radiation: retarded potentials, Hertzian dipole, short loop, antenna parameters. Radia-wave propagation: ground-wave, sky-wave, space-wave.

EEL208 Communication Engineering, 4 (3-1-0)

Prerequisite: Nil

Review of Fourier Series and Transforms. Hilbert Transforms, Bandpass Signal and System Representaion. Random Processes, Stationarity, Power Spectral Density, Gaussian Process, Noise. Amplitude Modulation, DSBSC, SSB, VSB: Signal Representation, Generation and Demodulation. Frequency Modulation: Signal Representation, Generation and Demodulation. Mixing, Superheterodyne Receiver, Phase Recovery with PLLs. Noise: in AM Receivers using Coherent Detection, in AM Receivers using Envelope Detection, in FM Receivers. Sampling, Pulse-Amplitude Modulation. Quantization, Pulse-Code Modulation. Noise Considerations in PCM, Time Division Multiplexing, Delta Modulation.

EEL209 Power Systems, 4 (3-1-0)

Prerequisite: Nil

Essential fundamentals of power networks: evolution of utility generation, transmission, and distribution- economies of scale, daily load curves, type of generation resources and their allocation, generic operation of generating units, intro to AGC, normal, alert, and emergency modes, the Indian power industry; Importance of reactive power management; HVDC and FACTS, symmetrical components and unbalanced system, per-unit quantities; apparatus in power networks: transformers and tap changers, synchronous generators, transmission lines and cables, HVDC, loads and power quality; analysis and operation; various aspects of power flows, steady state, transient, dynamic, and voltage stability, SMIB and SLIB systems, swing equations, control of large interconnected power networks; protection; breakers and their role in protection, relay coordination and circuit breakers, balanced and unbalanced fault calculations; management of utilities.

EEP203 Electromechanics Laboratory,1.5 (0-0-3)

Prerequisite: Nil

Experiments on transformers, DC and AC machines.

EEP204 Analog Electronics Laboratory,1.5(0-0-3)

Prerequisite: Nil

Experiments based on design and testing of single stage and multistage amplifiers, power amplifiers, and oscillators on bread board.

EEP206 Digital Electronics Laboratory,1.5 (0-0-3)

Prerequisite: Nil

The experiments would be divided into two parts. The objective of the experiments for the first part would be to familiarize the students with basic digital electronic techniques. The second part would be on designing and fabricating a digital module.

EEP305 Control Engineering Laboratory, 1.5 (0-0-3)

Prerequisite: EEL205

First and second order electrical systems, A.C. and D.C. servo motors and experiments related to the course Control Engineering.

EEP307 Engineering Electromagnetics Laboratory, 1.5 (0-0-3)

Prerequisite: EEL207

Laboratory experiments on different transmission lines, antennas, microwave sources and devices.

EEP308 Communication Engineering Laboratory, 1.5 (0-0-3)

Prerequisite: EEL208

Laboratory experiments on analog, pulse and basic digital modulation and demodulation techniques.

EEP309 Power Systems Laboratory, 1.5 (0-0-3)

Prerequisite:EEL209

Experiments related to the course Power Systems.

EEL314/EEL451 Microwave Theory and Techniques. 3 (3-0-0)

Prerequisite: EEL207

Review of EM theory: Maxwell's equations, plane waves in dielectric and conducting media, energy and power, Transmission lines and waveguides: closed and dielectric guides, planar transmission lines and optical fibre. Network analysis: scattering matrix other parameters, signal flow graphs and network representation. Impedance matching and tuning. Analysis of planar transmission lines. Analysis of design of passive components.

EEL315 / EEL452 Antennas and Propagation, 3 (3-0-0)

Prerequisite: EEL207

Antennas: Introduction to various types of antennas. Fundamentals of electromagnetic radiation, radiation from thin wires and small loops. Different types of linear arrays. Pattern multiplication, long wire antennas, aperture antennas. Waveguides.

EEL312/EEL453 Digital Communication, 4(3-0-2)

Prerequisite: EEL208

Matched Filter, Error Rate due to Noise. Intersymbol Interference, Nyquist's Criterion, Duobinary Signaling. Optimum Linear Receiver. Geometric Representation of Signals. Coherent Detection of Geometric Representation of Signals. Coherent Detection of Signals in Noise, Probability of Error. Coherent Digital Modulation Schemes: MPSK, MFSK, MQAM; Error Analysis. Noncoherent FSK, Differential PSK. Comparison of Digital Modulation Schemes, Bandwidth Efficiency. Pseudo-Noise Sequences and Spread Spectrum. Information Theory, Entropy, and Source-Coding.

EEL313 / EEL454 Information Theory and Coding, 3 (3-0-0)

Prerequisite: EEL205

Entropy, relative entropy, and mutual information. Asymptotic equipartition property. Entropy rates of a stochastic process, Markov chains. Data compression: Kraft inequality, Huffman codes. Channel capacity: symmetric channels, Channel coding theorem, Fano's inequality, feedback capacity. Differential entropy. The Gaussian channel: bandlimited channels, channels with coloured Gaussian noise, Gaussian channels with feedback. Rate distortion theory: rate distortion function, strongly typical sequences, computation of channel capacity. Network information theory: Gaussian multiple user channels, the multiple access channel, encoding of correlated sources, the broadcast channel, the relay channel, source coding and rate distrotion with side information, multiterminal networks.

EEL412 / EEL455 Selected Topics in Communication Engineering-I, 3 (3-0-0)

Prerequisite: EEL208

Topics of current interest in communication engineering; details will be provided by the instructor.

EEL311 / EEL456 Digital Signal Processing, 4 (3-0-2)

Prerequisite: EEL201

Review of Signals and Systems, Sampling and data reconstruction processes. 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.

EEL316 / EEL457 Embedded Systems and Applications, 3 (3-0-0)

Prerequisite: EEL206 & EEP206

Digital computing systems organization. Microprocessors and basic embedded systems concepts. Embedded systems design with Motorola microcontrollers. The advantages of RISC based systems. Details of embedded systems concepts.

Component Interfacing : Interrput, DMA, I/O Bus Structure, I/O devices. Software for Embedded Systems : Program Design and Optimisation techniques, O.S for Embedded Systems, Real-time Issues. Designing Embedded Systems .Design Issues, Hardware-Software Co-design, Use of UML.

EEL413 / EEL458 Selected Topics in Computers, 3 (3-0-0)

Prerequisite: GEL103

Topics of current interest related to computers; details will be provided by the instructor.

EEL327 / EEL459 Soft Computing, 3 (3-0-0)

Prerequisite: MAL213

Introduction to Soft Computing: Rationale and Basics of Learning: Neural Networks: Multi-layer Feed-forward Network, Recurrent Networks, Self-organising Networks; Fuzzy Logic: Basics, inferencing scheme, Neuro-Fuzzy systems; Evolutionary Algorithms: GA and Optimisation, Evolutionary Systems, Genetic Programming; Introduction to Rough Sets, Rough-Fuzzy representations, Belief Networks; Principles of SVM; Applications.

EEL419 / EEL460 Engineering optimization techniques and application, 3 (3-0-0)

Optimal problem formulation, Single-variable optimization algorithms: optimality criteria, region-elimination methods, gradient based methods, Multivariable optimization algorithms: optimality criteria, unidirectional search, direct search method, gradient based methods, Constrained optimization : Kuhn-Tucker conditions, sensitivity analysis, penalty function method, linearised search techniques, generalized reduced gradient method, Specialized algorithms: Integer linear programming, simplex method, geometric programming, dynamic programming, Evolutionary optimization techniques: Genetic algorithm, Simulated annealing. Engineering optimization problems: optimal routing in communication networks, optimization of electronic circuits, economic load dispatch, state estimation, electricity trading, etc.

EEL411 / EEL461 Selected Topics in Control Engineering, 3 (3-0-0)

Prerequisite: EEL321

Select topics in control engineering; details will be decided by the instructor.

EEL321 / EEL462 Control Engineering - II, 3 (3-0-0)

Prerequisite: EEL205

Controllability and observability and their involvement in controller design; basic concepts of adaptive control – model reference and self tuning; robustness and controller design in robust domain; H-infinity concepts, fuzzy logic and its application in analog and digital control.

Control examples from chemical processes, robotic and communication.

EEL323/ EEL463 Measurements and Instrumentation, 3 (3-0-0)

Prerequisite: GEL104

Introduction to measurement systems, definition and classification of sensors/transducers and actuators: introduction to electrical, mechanical, magnetic sensors and their applications, measurement of various physical quantities such as displacement, force, pressure, temperature etc., acoustical transducers and their application, radiation detectors, signal conditioning and processing for various sensing mechanisms.

EEL322 / EEL464 Mechatronics, 3 (3-0-0)

Prerequisite: EEL205 and EEL206

Mechatronics: definitions and terminology, its elements such as mechanics, electronics, microelectronics, power electronics and information technology. Mechanical elements with integrated electronics suspension systems, vibration dampers, clutches, bearing mechanical or magnetic, gears etc. Machines with integrated electronics, electric drives, pneumatic and hydraulic drives, water steam or gas turbines, combustion engines, etc. Generators, pumps, compressors, machines tools, robots, printing machines, vehicles: automobiles, ships and aircraft. Precision machines with integrated electronics devices for telecommunication, consumer electronics, data processing devices, sensors, actuators, optical devices and medical devices, Power electronics converters.

EEL324 / EEL465 Physical Electronics, 3 (3-0-0)

Prerequisite: GEL104

Band model of solids, electrons and holes in semiconductors, carrier statistics, current flow in semiconductors, Junction devices, Metal-oxide-semiconductor devices, Schottky and optoelectronic devices.

EEL317 / EEL466 Microelectronic Circuit Design, 3 (3-0-0)

- Field-Effect Transistors- Characte-ristics of the MOS Capacitor, NMOS Transistor, PMOS Transistors, MOS Transistor Fabrication and Layout Design Rules, Capacitances in MOS Transistors.

• MOS Based Logic Design- NOMS Logic Design, Power Dissipation, Dynamic Behavior of MOS Logic Gates., PMOS Logic.

• Complementary MOS (CMOS) Logic Design- CMOS Inverter Technology, Dynamic Behavior and Power Dissipation, CMOS based Logic Gates, Dynamic Domino CMOS Logic.

• Memory and Storage Circuits- Random Access Memory (RAM), Static Memory Cells, Dynamic Memory Cells Sense Amplifiers.

Advance Topics- BICMOS Logic Design, Manufacturing Processes, Modeling and Simulation of Devices and Interconnects, Novel Materials and their Applications.

EEL415 / EEL467 Selected Topics in Electronics, 3 (3-0-0)

Prerequisite: EEL204

Topics of interest in areas of electronics; details will be provided by the instructor.

EEL325 / EEL468 VLSI Technology and Design, 4 (3-0-2)

Prerequisite: EEL206

MOS transistors. CMOS and Pseudo NMOS inverters. Pass transistors. Designing Logic gates in CMOS. CMOS sequential circuits. Timing issues, Basic CMOS technology, Layout design rules and CMOS gate layout, Circuit and Logic simulation. Layout generations- partitioning, placements and routing.

EEL326 / EEL469 Fault Diagnosis of Digital Circuit, 3 (3-0-0)

Prerequisite: EEL206

Concepts of faults and fault models; test generation, test selection, and fault dictionaries. Test generation for fault detection, fault location and fault correction. Some basic reliability-enhancing design techniques for digital circuits and systems.

EEL343 / EEL470 Modeling and Simulation of Electrical Machines, 3 (3-0-0)

Prerequisite: EEL203

Energy state functions, Modelling of electromechanical systems Matrix method and use of generalised circuit theory of machines. Different methods of transformation, phase variable instantaneous symmetrical component techniques, Development of basic performance equation and analysis of different rotating machines such as D. C., synchronous and induction machines, Dynamics and transients in electric machines. Switching transients and surges, Transient and short circuit studies on alternators Run-up reswitching and other transients in induction machines relevant computer techniques for machine analysis. Modelling of special electrical machines.

EEL331 / EEL471 Power Electronics Devices and Circuits, 4 (3-1-0)

Prerequisite: GEL104

The technology of power electronics; types of power electronic switches; driving circuits and protection circuits for power electronic switches; DC to DC convertors; AC to Dc convertors; DC to AC convertors; AC to AC convertors.

EEL341 / EEL472 Power System Optimization, 3 (3-0-0)

Prerequisite: EEL209

Economic load dispatch in thermal and hydro-thermal system; reactive power optimization;optimal power flow. Linear programming and non-linear programming techniques to optimal power flow problems. Security constrained optimization. Unit commitment and maintenance schedule

EEL334 / EEL473 Power System Protection, 3 (3-0-0)

Prerequisite: EEL203

Basic Principles - CTs, PTs. Static relays. Modern circuit breakers, Protection of power transformers, alternators, transmission lines, cables, reactors and capacitors. Protection of motors, rectifiers and thyristors. HVDC protection. Relay Coordination, Numerical relaying algorithms, Travelling wave relays, adaptive relaying.

EEL337 / EEL474 HVDC Transmission, 3 (3-0-0)

Prerequisite: EEL209

Comparison of HVAC and HVDC transmission, HVDC transmission schemes, Component description, converter: principles, characteristics, control circuits, HVDC system control, Protection, Harmonics and filters, AC-DC system interaction, AC-DC load flow.

EEL345 /EEL475 Topics in High Voltage Engineering, 4.5 (3-0-3)

Fundamentals of High Voltage Engineering, DC, AC

and Impulse Generators, Power Equipment and Testing, Measurement of High Voltage, Electric Fields Space Charges, Dielectric Materials, Over voltage in electrical power system, Switching and Lightning, Transmission Lines - waves Electrical breakdown in gases, solids and liquids.

LAB Component: Simulation and experiments on generation of voltages, Simulation of over voltages (using PSpice/MATLABsimulink/PSCAD)

EEL333 / EEL476 Flexible A.C transmission systems, 3 (3-0-0)

Prerequisite: EEL209

The phenomenon of voltage collapse; the basic theory of line compensation. Static excitation systems; static VAR compensators; static phase shifters; thyristor controlled series capacitors. Co-ordination of FACTS devices with HVDC links. The FACTS optimization problem Transient and dynamic stability enhancement using FACTS components. Advanced FACTS devices-the STATCON and the unified power flow controller.

EEL417 / EEL477 Selected Topics in Power Electronics, 3 (3-0-0)

Prerequisite: EEL209

The instructor from among current areas of power systems will decide topics.

EEL418 / EEL478 Selected Topics in Power Systems, 3 (3-0-0)

Prerequisite: EEL209

Topics of interest in power systems; will be decided by the instructor.

EEL414 / EEL479 Selected Topics in Electrical Machines, 3 (3-0-0)

Prerequisite: EEL203

Topics of current interest related to electrical machines; details will be provided by the instructor.

EEL336/EEL480 Switched-Mode Power Conversion, 3 (3-0-0)

Prerequisite: EEL203

The course coordinator will decide details.

EEL481 Physics and Modeling of Sub-Micron Mosfets, 3 (3-0-0)

Prerequisite: GEL104, MAL112

Quantum Theory of Solids; Carrier transport mechanisms; MOS capacitor; Basic physics and modelling of MOSFET; Scaling: Non-uniform vertical doping, non-uniform lateral doping, poly-depletion effect, quantum-mechanical effects; Small dimension effects: channel length modulation, drain induced barrier lowering, narrow-width effect, threshold-voltage lowering; Drain current model: bulk charge, mobility degradation, source-drain resistance, velocity saturation, drain saturation voltage; Bulk-current Modeling: Impact ionization, GIDL/GISL; Gate direct tunnelling current model; Large-signal models: quasi-static and non-quasi-static charge modelling; Small-signal models: low and medium frequency; Small-signal models: high frequency/RF models; Noise Models: flicker and thermal noise; Industry standard compact MOSFET models, BSIM, PSP and EKV; Multi-gate MOSFETs (FinFETs); SOI, High-K, Metal-gate, and Non-classical MOSFETs; Emerging nanotechnology devices.

EEL482 CMOS Radio Frequency Integrated Cir-cuit Design, 3 (3-0-0)

Prerequisite: GEL104, EEL204

Passive RLC Networks, Passive IC components, Distributed systems, Smith chart and S-parameters, Bandwidth estimation techniques, High frequency amplifier design, Voltage reference and biasing, Noise, Low noise amplifiers, Mixers, RF power amplifiers, Phase-locked loops, Oscillators and synthesizers, Phase noise.

EEL483 Stochastic Processes in Electrical En-gineering, 4 (3-0-2)

Prerequisite: Nil

Behaviour of Electric and Thermal Fields in dielectrics of power equipment; Dielectric Parameters; Models for Electrical Insulation Failure: Single and multi-Stress modelling; Stochastic Nature of Power Equipment Failure-Statistical aspects of Electric and Thermal Ageing; Concepts in Life Testing of Insulation: Miner's Theory of Cumulative Damage, Accelerated Stress Testing and Censored Life Testing; Statistical Techniques for Life Data Analysis. Diagnostic Testing of Insulation in HV Power equipment.

EEL484 Image Processing and Pattern Recog-nition, 4 (3-0-2)

Prerequisite: EEL201

Image Preliminaries: Laplace Transform and their properties, Discrete Fourier Transform, Fast Fourier Transform, Definition of Z-Transform and its

properties. Image Enhancement in Spatial and Frequency Domains, Mathematical Morphology, Color Image Processing. 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.

EEL485 Advanced Semiconductor Devices, 3 (3-0-0)

Prerequisite: EEL324/465

Review of Quantum Mechanics, E-k diagrams, effective mass, junction devices (pn, Metal-Semiconductor, Solar Cells, etc.), 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.

EEL486 VLSI Fabrication Technology, 3 (3-0-0)

Prerequisite: Nil

Environment for VLSI Technology: Clean room & safety requirements. Wafer cleaning processes and wet chemical etching techniques. Impurity incorporation: Solid State diffusion modeling and technology, Ion Implantation modeling, technology and damage annealing, characterization of Impurity profiles. Oxidation: Kinetics of Silicon dioxide growth both for thick, thin and ultrathin films. Oxidation technologies in VLSI and ULSI, Characterization of oxide films, High k and low k dielectrics for ULSI. Lithography: Photolithography, E-beam lithography and newer lithography techniques for VLSI/ULSI; Mask generation. Chemical Vapour Deposition techniques: deposition of polysilicon, silicon dioxide, silicon nitride and metal films, Epitaxial growth of silicon, modelling and technology. Metal film deposition: Evaporation and sputtering techniques. Failure mechanisms in metal interconnects, Multi-level metallisation schemes. Plasma and Rapid Thermal Processing: PECVD, Plasma etching and RIE techniques, RTP techniques for annealing, growth and deposition of various films for use in ULSI. Process integration for NMOS, CMOS and Bipolar circuits, Advanced MOS technologies.

EEL487 Analog Integrated Circuit Design, 3 (3-0-0)

Prerequisite: EEL204 Analog Electronics

Introduction, Passives in CMOS technology, M.OS transistor basics, Common source amplifier, MOS single stage amplifiers, Current mirrors, Biasing, Differential amplifiers, OpAmps, Folded Cascode Amplifier, Multi Stage Amplifiers, Frequency Response, Stability of feedback systems, Frequency compensation, Electronic noise.

EEL488 Mixed Signal Integrated Circuit Design, 3 (3-0-0)

Prerequisite: EEL204 Analog Electronics

Analog and discrete-time signal processing, analog integrated continuous-time and discrete-time (switched-capacitor) filters. Basics of Analog to digital converters (ADC). Basics of Digital to Analog converters (DAC). Successive approximation ADCs. Dual slope ADCs (e.g. flash ADC, pipeline ADC and related architectures). High-resolution ADCs (e.g. delta-sigma converters). DACs. Mixed Signal layout. Interconnects. Phase locked loops. Delay Locked Loops.

2.9.7. Humanities & Social Sciences

HUL101 Professional Communication, 3 (2-1-0)

Lectures- What is Communication, Process of Communication, Barriers to Communication, Non-verbal Communication, Oral Presentation (theory), Group Discussion (theory), Reading Comprehension & Vocabulary (theory), Technical Style and Vocabulary (theory), Business Letters & Emails, Report Writing (theory), Interview Skills (theory), American and British English

Tutorials- Case Study, Oral Presentation, GD, Reading Comprehension exercises, vocabulary, business letters and emails, mock interviews, grammar, presentation of reports

HUL201 / HUL451 Introduction to Philosophy, 4 (3-1-0)

This course is meant to introduce students to the range of questions that philosophers seek to address, and also introduce the range of conceptual and logical tools employed in this enterprise. Using materials from both classical and modern authors, the course will attempt to sample issues concerning the notions of knowledge, truth, justification, belief, skepticism, being, substances, qualities, relations, space and time, rightness and wrongness of action, moral judgment and so on.

HUL202 / HUL452 Fundamentals of Linguistics, 4 (3-1-0)

The aim of this course is to introduce the students to the fundamental concepts of different sub areas of linguistics, namely, phonetics, phonology, morphology, syntax, semantics and pragmatics. It also includes some preliminary discussions on corpus linguistics and psycholinguistics. These areas might be the foundation of future studies in speech and natural language processing as well as cognitive science. This course is designed also to help students to understand and use human sounds and grammatical concepts from a linguistic point of view.

HUL203 / HUL453 Pragmatic Communication, 3 (2-1-0)

The communication process, Barriers to communication, Flow of communication in an organization, Oral and non verbal communication, Oral Presentation skills(theory), Intercultural communication- High context and low context cultures, Theories of motivation - content and process theories, Negotiation skills, Sentence construction and paragraph development, email writing, Vocabulary , indianisms and malapropisms.

HUL204 / HUL454 Leadership, Communication and Decision Making in Organizations, 4 (3-1-0)

The course objective is to acquire an understanding of the psychological principles and factors involved in leadership, decision making, and communication in organizations; with the ultimate aim of using this knowledge in the leader/manager roles that IIT graduates are expected to perform. The introductory section is concerned with leadership, the second section deals with communication, and the final section teaches decision making. Understanding the practical applications of the concepts learnt during the course is crucial for success in the course. As part of the course work, students also work individually or in groups to conduct studies on any topic related to the course, using tests, interviews, or questionnaires

HUL205 / HUL455 Language Processing, 4 (3-1-0)

Introduction, Linguistics(basics required for this course: Morphology, Syntax, Semantics), Natural language Processing, Parsing, Corpus, Parts of Speech tagging, Word Sense disambiguation, Morphological Analysis, Anaphora, Machine translation, Computational Grammar, Human Language processing, Human Parser, Introduction to Brain and Language.

HUL206 / HUL456 Introduction to Phonetics and Phonology, 4 (3-1-0)

This course is designed for the UG level students to introduce phonetics and phonology. Learning of these two major areas of linguistics will follow a few sessions of general introduction of linguistics. Phonetics part will mainly concentrate on articulatory phonetics, transcriptions, acoustic phonetics (sound properties) and auditory or perceptual phonetics. Phonology includes phonological features of languages, phonological rules in terms of sound change, syllable structure, Basic concepts of stress and intonation patterns. Students will learn about the basic usage and output of the phonetic tools (e.g., PRAAT) and experiments during the lab sessions.

HUL207 / HUL457 Atomism before Dalton, 4 (3-1-0)

The course is an exercise in the history of science and metaphysics, and the course objective is to trace the

contours of thinking that led to the postulation of atoms and the subsequent developments of the atomic theory up to the modern period. Starting out from problems of plurality and division, formulated by Parmenides and Zeno, and then consider in what sense the thesis of infinite divisibility (propounded by Anaxagoras), and the introduction of ultimate indivisible corporeal constituents and the void (propounded by Leucippus and Democritus), the course will then consider the writings on modern atomism /corpuscular theory such as that of Pierre Gassendi and Boyle. We also address the implications of atomism for epistemology, in particular the relationship between early atomism and skepticism.

HUL211 / HUL458 Object Perception and Memory, 3 (2-1-0)

The course objective is to understand the psychological principles and factors involved in object perception and memory, with the ultimate aim of applying this knowledge to diverse areas such as human-machine interface, designing intelligent systems, improving communication through media, etc.

The introductory section of the course explores the basic idea of an object and the perspectives and methods used to study objects. The second section studies the role of features such as location, shape, color, etc. in object perception and memory, whilst the third and final section is concerned with real world objects and factors affecting their perception and memory. As part of the coursework, each student has to independently design and conduct one experiment with at least two independent variables, involving normal human subject(s).

HUL212 / HUL459 Fiction And Film, 3 (2-1-0)

Contemplating novel and film as popular cultural forms. Studying generic connections between novel and film by identifying and analyzing common language, symbolism and iconography in both the art forms. Discussing the elements of literature internalized by cinema, the development if the cinematic language as visual narration. Literary texts into films: The politics and poetics of adaptation/adoption. Examining adaptation as reinterpretation, the issue of translating timeless literary classics for a topical scenario. In depth study of selected works of literature and their cinematic adaptations. Training students to comprehend the major issues of the literary origin of the film and later to read and analyze the film as a visual text. Studying the process of filmic transposition and comparing and analyzing the two genres. Future of Fiction and Film.

HUL221 / HUL460 Principles of Economics, 3 (2-1-0)

Economics, as the study of choice under scarcity, is important to each of us, whether we study it formally or not. This course is an introduction to micro and macro economics. In this course students will learn how these ways of thinking can help to see the world with fresh insight. Students will see new perspectives on the important public policy issues of our day and also see how they can make better informed choices about our own life. Particularly, students will be introduced to basic economic concepts and its uses in modern day environment. The course is an introduction to the principles of economics. We will start by looking at the basic concepts of economics to understand what economics is and what the importance of economics in present day environment is and how to use relevant concepts in our day-to-day activities.

HUL225 / HUL461 Morphology, 4 (3-1-0)

Morphology as a subsystem of grammar-word structure, lexical morphology, inflectional and derivational morphemes, word formation processes, models of morphological analysis, relations between phonology, morphology and syntax, Problem solving in morphology (analysis), generative morphology.

HUL226 / HUL462 Neurolinguistics, 4 (3-1-0)

Introduction, neurolinguistics, theories about brain and language, Lateralization, Handedness and the Hemispheres, co-evolution of language and the brain, Aphasia and its classification, Linguistic account of Aphasia, Dyslexia and its classification, Models of Brain- Language relationship, Classical Connectionist model, Hierarchical Models, Global Models, Process models, Bihemespheric theories of language, Neurocognitive methods

HUL227/ HUL463 Financial Markets and Institutions, 3 (2-1-0)

Role of Financial Markets and Institutions – Determination and Structure of Interest Rates – Bond Markets – Money Markets – Operation of Commercial Banks – Stock Market:- Derivatives – Regulatory Bodies – Foreign Exchange Market – Mutual Fund Operations – Insurance Market

HUL464 Syntatic Typology, 3 (2-1-0)

Typology and universals, Word order, Agreement System, Grammatical relations, Case-marking Pattern, Relative clause, Complementizer, Anaphora, causative constructions, participial constructions, Animacy, Topic and Focus constructions, India as a linguistic area.

HUL465 Laboratory Phonology, 3 (2-0-2)

Phonological theories – basics of speech acoustics – acoustic analysis – speech perception – experimental design – digital signal processing – speech corpora – corpus analysis. There will be regular laboratory sessions. Additionally, students will develop and execute their own experimental projects during the course.

HUL466 Topics In Econometrics, 3 (2-1-0)

Introduction and Statistical Background; Classical Linear Regression Models: Two Variable Case; Classical Multiple Linear Regression Model; Violations of Classical Assumptions and Remedies; Stationary Time Series Models; Modeling Volatility; Models with Trend; Multiple Equation Models; Panel Data Models.

There will be regular laboratory sessions for statistical data handling and estimations of parameters by statistical / econometrics software's. In addition, students will develop and execute their own experimental projects during the course.

HUL467 Topics in Macroeconomics, 3 (2-1-0)

The Solow Growth Model; Elements of Endogenous Growth Models; Infinite – Horizon and Overlapping Generations Models; Rational Expectations and Economic Policy; The Philips Curve; Lucas Model; Consumption under Uncertainty: The Random-Walk Hypothesis; Stochastic Macroeconomics (Behavior Under Uncertainty).

HUL468 Science and Society, 3 (3-0-0)

The course will address the relationship of science and technology with other social institutions in the society. The contents would be – Sociology of science – this will introduce the importance of studying SCIENCE as a social institutions; Science and the state – will discuss the relationship and implications of state support and S&T, or in other words science policy in different countries; Science and the economy – Science and Innovation and its links with the economy of the country will form the crux of this unit; Science and Religion – Religious beliefs in history have facilitated and hindered the growth of science or the extension of new knowledge. The trade off between faith and fact will be covered.

HUL469 History of Science and Technology, 3 (3-0-0)

The course will address primarily 4 major units on the social history of modern western science – Diffusion of S&T: Following an introduction on defining western science, a discussion on the model given by George Basalla on the stages in the spread of western science will constitute the first unit; Organising of S&T: This will address the rise of universities and Development: The divide across the world with respect to advances in S&T and the centre – pweriphery relationships will be the main focus; Modern Science in India: Starting with Colonial science the organisation of science and institutionalisation in post independent India will be covered.

HUL470 Contemporary India: A Sociological Perspective, 3 (3-0-0)

The course will endeavour to provide a compressed overview of four main units necessary to understand Indian society sociologically. They are as follows:

Social Institutions Family and Kinship; Religion; State and Society; Social Inequality Caste; Class and Gender; Social Change: Modernisation and Role of the State; Voluntary Action and Social Movements; Globalisation and Acculturation; Social Problems: Population and Poverty; Unemployment and Skill Requirement; Social Exclusion and Affirmative Action.

HUL471 Introduction to Canadian Literature, 3 (2-1-0)

The course provides and Introduction to Canadian Literature in English, where the main emphasis will be on poetry and fiction (novels, play as well as short stories) from the twentieth century, although some central texts from the nineteenth century will also be addressed. The main focus of the course will be on 1) main points of development in Canadian literary history, and 2) some central Canadian theme (e.g. "identity").

HUL472 International Economics and Finance, 3 (2-1-0)

Introduction to the International Economy, Institutions of the International Economy, Modern Theories of Trade, International Movements of Capital, the Balance of Trade and other Measures of International Transactions, the Mundell – Fleming Model and Exchange Rate Regimes, Fixed Versus Floating Exchange Rates, Purchasing Power Parity, Current Account Adjustment and Real Exchange Rates, International Finance (Financial Flows, The role of Multinational corporations, Capital and Labour Mobility, Financial Crises and Currency Crises).

HUL 473: An Introduction to Urban Economics, 3(2-1-0)

Why Cities Exist-Role of Scale Economies vs Agglomeration Forces-Role of Transport Costs in the formation of Cities-Urban Spatial Structure-Standard Urban Model-Economic Effects on Housing Price-Land Rent-Population Density-Housing Demand-Traditional vs Hedonic Approaches-tenure choice-Housing Policies-Role of Government Intervention in the Housing Market-Role of Rent Control Laws-Housing Subsidy Program-Role of Pollution in Urban Economies-Socially Optimum Level of Pollution-Economic Theory of Crime-Role of Crime reducing Government Expenditure on the volume of Crime-Urban Quality of Life-Theories-Measurement Issues.

HUL 474: Career Success Principles from the West, 3(3-0-0)

Pre-requisite: Nil

This course teaches IIT students/alumni who are the best and brightest in the field of technology, and helps them develop new strategies and soft skills that provide them fast path to the C-level management or the Boardroom table anywhere in the world, and especially in the West. This course is set up to be a bridge course between the Highly Technical Research and Development World of IIT, and the Business World. The course provides the value systems and emotional drivers that take an intelligent individual to the next level of productivity, and value creation; not just for their organization, but for the society as a whole. Appropriate examples and case studies will be covered to highlight lessons learned and best practices. The students will learn about the 12 key success enablers in the Western business world. Once they understand the necessity of the following 12 success enablers, and acquire the right mindset to attend to them, they can further take additional courses in each of the 12 individual success enablers to deepen their knowledge, understanding, and practice of these enablers.

Key Success Enablers:

1. Value Creation Mindset. 2. Personal Strategy Development and Execution 3. Effective Personal Leadership 4. Networking Success 5. Successful Communication 6. Relationship Nourishment7. Creativity Development 8. Innovative Disruption 9. Collaboration Extension10.Entrepreneurship and Intrapreneurship 11.Personal Marketing and Branding 12.Legacy Driver.

This important bridge course is set up to instill the above Success Enablers into the IIT students, and set them up on the fast path to success and distinction in business and at work.

2.9.8. Mathematics

MAL111 Mathematics Laboratory, 2 (1-0-2)

Prerequisite: Nil

Rank of a matrix, consistent linear system of equations, row reduced echelon matrices, inverse of a matrix, Gauss -Jordan method of finding an inverse of a matrix. Eigenvalues and eigenvectors, diagonalisation of matrics, Caley-Hamilton theorem, Hermitian, Unitary and Normal Matrices, bilinear and quadratic forms; Roots of a polynomial; numerical solution of a system of algebraic equations: Newton-Raphson and iterative methods; interpolation: Lagrange interpolation formula, interpolation formula by use of differences, Numerical differentiation; numerical integration: trapezoidal rule and Simpson's formula; error estimates in numerical differentiation and integration. Computer graphics: plotting of line, triangle and

circle; plotting of cylinder, cube and sphere; projections; rotations.

MAL112 Advanced Calculus, 3 (2-1-0)

Prerequisite: Nil

Calculus of functions of several variables, implicit functions, partial derivatives and total differentials, equality of mixed derivatives of composite functions, Taylor's Theorem, Maxima and Minima, constrained extrema, Lagrange multipliers. Definite integrals, differentiation under integral sign, differentiation of integrals with variable limits, improper integral, Beta and Gamma functions. Multiple integrals: definitions, properties and evaluation of multiple integrals, application of double integrals (in Cartesian and polar coordinates), change of coordinates, Jacobian, line integrals, Green's theorem, proof, first and second forms.Solution of first order differential equations. Existence and uniqueness of solution, Picard's method of successive approximations.

MAL114 Linear Algebra, 3 (2-0-2)

Prerequisite: Nil

Vector spaces, bases and dimensions, linear transformations, matrix of linear transformations, change of bases, inner product space, Graham-Schmidt orthogonalization. Triangular form, matrix norms, conditioning of linear systems, Singular value decomposition. Direct methods: Gauss, cholesky and Householder's methods. Matrix iterative methods: Jacobi, Gauss-Siedel and relaxation methods, conjugate gradient methods and its pre- conditioning.Computation of eigenvalues and eigenvectors: Jacobi, Givens, Householder, QR and inverse methods.

MAL115 Real Analysis, 3 (3-0-0)

Prerequisite: Nil

Product of sets, mappings and their compositions, denumerable sets, upper and lower bounds, supremum and infimum. Metric spaces: Definition and examples, open closed and bounded set; interior boundary, convergence and limit of a sequence. Cauchy sequence, completeness, Bolzano-Weierstrass theorem, continuity, intermediate value theorem, and uniform continuity, connectedness, compactness and separability. Integration: Riemann sums, Riemann integral of a function, integrability of a function on a closed interval, mean value theorem, improper integrals.Fourier Series, Fourier Integrals and Fourier Transforms.

MAL116 Introduction to Ordinary Differential Equations, 3 (3-0-0)

Prerequisite: Nil

Second order differential equations with constant coefficients: homogeneous and non-homogeneous differential equations, method of undetermined coefficients, annihilation method, method of variation of parameters. Wronskian and linear independence of solutions, solution of ODE by Laplace transform. Second order equations with variable coefficients: Euler equation, linearly independent solutions, solution of second order equation with one known solution, application of variations of parameters method to second order equations with variable coefficients, Series solutions, Frobenius method, Legendere and Bessel equations, orthogonal properties of Legendre polynomials. Higher order differential equations. Boundary Value Problems and Strum -Liouville Theory: Two point boundary value problems, Strum-Liouville boundary value problems, non-homogeneous boundary value problems; series of orthogonal functions, mean covergence.

MAL213 Introduction to Probability Theory and Stochastic Processes, 3 (3-0-0)

Prerequisite: Nil

Axioms of probability, conditional probability, probability space, random variables, distribution functions, standard probability distribution functions. Multidimensional random variables, marginal and conditional probability distribution, independence of random variables, bivariate, normal and multinomial distributions. Functions of several random variables, expectations, moments and moment generation functions, correlations, moment inequalities. Conditional expectation and regression, random sums, convergence in probability, weak law of large number and central limit theorem. Markov chains and random processes: Markov and other stochastic processes, stationary distributions and limit theorem, reversibility, branching processes and birth- death processes, Markov chains, Monte Carlo Simulations. Queues: Single-server queues, M/M/1, M/G/1, G/M/1, and G/G/1 queues.

MAL113 / MAL451 Vector Field Theory, 2 (2-0-0)

Prerequisite: Nil

Vector calculus, arc length, directional derivative, differentiation and integration of vector valued functions, derivative of composite functions, vector equations: straight line, plane, space curves. Gradient, curl and divergence. Orthogonal curvilinear coordinates, line, area and volume elements, expressions for gradient, curl and divergence. Line and double integrals, Green's theorem, surface integrals, triple integrals, Stokes and divergence theorems with applications. Conservative vector fields and path independence.

MAL211 / MAL 452 Complex Analysis, 3 (3-0-0)

Prerequisite: Nil

Limit, continuity and differentiability of functions of a complex variable, analytic functions, Cauchy-Riemann equations. Definition of integral, Cauchy integral theorem, integral formula, derivatives of analytic functions, Morera's and Liouvile's theorems, maximum modulus principle. Poles and singularities, Taylor's and Laurent series, isolated singular points, Cauchy residue theorem, evaluation of real integrals. Conformal and bilinear mappings.

MAL214 / MAL453 Introduction to Functional Analysis, 3 (2-1-0)

Prerequisite: Nil

Calculus of variations and applications. Normed linear spaces, Banach spaces, Hahn-Banach Theorem. Open mapping theorem, principle of uniform bounded, Hilbert Spaces. Orthogonal projections, self-adjoint, unitary and normal linear operators. Orthogonal bases, Parseval's relation and Bassel's inequality, Riesz representation theorem and Lax Milgram Theorem.

MAL212 / MAL454 Modern Algebra, 3 (2-1-0)

Prerequisite: Nil

Definition and example of groups, Lagrange theorem, cyclic groups, linear groups, permutation groups. Subgroups, normal subgroups, and factor groups, isomorphism theorems, Sylow theorems, and their applications. Rings and fields.

MAL202 / MAL455 Operations Research, 3 (3-0-0)

Prerequisite: Nil

Introduction to optimization, Formulation of linear Optimization problems, Convex set, Linear Programming model, Graphical method, Simplex method, Finding a feasible basis – Big M and two phase Simplex method, Duality in Linear Program. Primal-dual relationship & economic interpretation of Duality. Dual Simplex Algorithm. Sensitivity analysis. Network analysis: Transportation & Assignment problem, Integer programming problem: Formulation, Branch & Bound and Cutting Plane methods, Dynamic Programming (DP); Non-linear Programming, Lagrange multipliers and Kuhn - Tucker conditions.

MAL215 / MAL456 Fuzzy Logic and Applications, 3 (3-0-0)

Prerequisite: Nil

Introduction: Information and Uncertainty, Classical/ Crisp set theory, Fuzzy set theory, Set theoretic operations: t-norm and t-conorm, Fuzzy relations, Fuzzy Arithmetic: Fuzzy number and fuzzy equations, Fuzzification and defuzzyfication, Propositional and predicate logic, Fuzzy rule base and approximate reasoning, Fuzzy logic, Applications, Switching circuit and Boolean Algebra.

MAL 457 An Introduction To Number Theory, 3(2-1-0)

Prerequisite: MAL-212/454 Modern algebra

Divisibility: Division algorithm, Euclid's algorithm, Fundamental theorem of arithmetic, properties of prime; Arithmetical functions: The greatest integer function, multiplicative functions, Euler's totient function, mobtus function, Riemann zeta-function, average orders ; Congruences: Chinese remainder theorem, Fermat's little theorem and Euler's generalization, Wilson's theorem, Lagranges's Theorem, primitive roots; Quadratic reciprocity law, Jacobi's symbol; Quadratic forms; Representations by binary forms, sums of two squares, sums of four squares; continued fractions; Quadratic fields: Algerbraic number fields, units, primes and factorization, Euclidean fields, Gaussain field; Diophantine equations : The pell equation, The thue equation, The Mordell equation, The Fermat equation, The Catalan equation etc.

MAL 458 Combinatorics, 3(3-0-0)

Prerequisite: Nil

Counting Principles and Generating Functions , The method of generating functions, Recurrence Relations: Linear Recurrence Relation, Binominal coefficients, binominal theorem, Derangements, Involutions , Fibonacci Numbers, Catalan Numbers,

Bell Numbers, Eulerian Numbers, The Pigeonhole Principle, The Principle of inclusion and exclusion Derangements revisited , Counting Surjective maps , Stirling numbers of first kind, Stirling numbers of second kind Posets and Mobius functions, Lattices, The classical mobius function, The Lattice of partitions; The orbit stabilizer formula, Permutation groups, Burnside's Lemma, P'olya's Theory, The cycle index; Block designs: Gaussain Binominal Coefficients, Introduction to design, Steiner triple system, Incidence Matrics , Fisher's inequality, Bruck-Ryser –Chowla Theorem ,Codes and Design , Hamming sphere, Reed-Solomon Codes.

MAL 459 Applied Linear Algebra, 3(3-0-0)

Prerequisite: MAL 114-Linera algebra

Inner Product spaces, Normal, Unitary and self-adjoint operators in finite dimensional spaces, Finite Dimensional spectrum Theorem for normal operators; Quadratic forms, orthogonal reduction, Rang3e-null space decomposition, orthogonal decomposition, singular value, decomposition , orthogonal projection, Least-square method; Positive and Stochastic matrices, applications to Markov chains.

MAL 460 Fixed Point Theory and Applications, 3(2-0-2)

Prerequisite: Basic knowledge in Real Ananlysis

Basic fixed point theorems: Contractions, non-expansive mapping, Banach contraction principle, Eldesten fixed point theorem, Banach –kirk fixed point theorem, Brouwer fixed point theorem, Application to differential equations : Intial value problem, Picardws Existence and uniqueness theorem.

Applicatin to integral equatios: Valterra integral equations and its solution. Application to matrix analysis: System of equatins and their solutions via Ja-cobi method. Applicatin to game theory: N- person cooperative theory, Prisoner's dilemma, existence of Nash equilibrium.

2.9.9. Mechanical Engineering

MEL101 Engineering Mechanics, 4 (3-1-0)

Prerequisite: Nil

General principles; Force vectors; Equivalent force system and equilibrium of a rigid body; Principles of statics; Free body diagram; Structural mechanics; Analysis of trusses and frames; Virtual work; Interfacial friction; Frictional forces in inclined planes, wedges, screw jacks and belt drives; Centre of gravity and centroid; Moment of inertial; Kinematics and Dynamics of particles and rigid bodies including impulse and momentum (linear and angular) and energy formulations; Work and energy; impact.

MEL102 Energy Science and Technology,4 (3-1-0)

Prerequisite: Nil

Energy resources – salient features and utilization. Renewable and non-renewable sources. Environmental and sustainability issues. Basic concepts and definitions – system, boundary, equilibrium, steady state, etc. Work and heat – definition and application. 1st Law – internal energy and enthalpy, applications to non flow/closed and flow/open systems. 2nd Law – corollaries, Clausius inequality, entropy. Introduction to availability, irreversibility and energy. Cannot cycle. Thermodynamic properties of a pure substance – saturated and other states. Basics of gas-vapor mixtures and reacting systems. Vapor power cycles – Rankine cycle and its modifications. Air standard cycles – Otto, Diesel, Brayton cycles. Vapor compression and absorption refrigeration cycles. Introduction to real cycles.

MEP103 Engineering Communication, 2 (0-0-4)

Prerequisite: Nil

Introduction to design process and drawings. Drawing standards and their use in industry. Review of sectioning, drawing standards, dimensioning and notes. Standard representations of fastening and joining. Machine assembly drawings with sectioning, exploded views and bill of materials, parts detailing and assembly. Relationship between from and function – limits, fits and tolerances, dimensional and geometric tolerances, surface finish. Process engineering diagrams for manufacturing and assembly. Schematic and process flow diagrams – standard equipment and symbols. Instrumentation

and control diagrams. Architectural layout drawings, sequence control diagrams, Project management charts. A combination of free hand drawing and use of industry standard software packages will be employed.

MEL201 Fluid Mechanics, 4 (3-1-0)

Prerequisite: Nil

Fluid kinematics: Lagrangian and Eulerian descriptions, pathlines, streaklines and streamlines, acceleration. Integral flow analysis: Reynolds transport theorem, conservation of mass/continuity equation and conservation of linear and angular momentum for a control volume in inertial and accelerating reference frames, energy equation, Bernoulli's equation, engineering applications. Differential analysis of flow: Continuity and Navier- Stokes equations. Dimensional analysis and Similitude theory. Inviscid flows: Irrotational flow, circulation, velocity potential and applications. Viscous flows in pipes and ducts. External viscous flows: concept of boundary layer, momentum integral equation, drag and lift, separation. NPSH concept, similarity rules, applications

MEL202 Manufacturing with Metallic Materials, 3 (3-0-0)

Prerequisite: GEL102

Product realization with metals, Material properties, Microstructure, Correlation between microstructure and properties, interfaces and intermetallics, Property modifications-heat treatment and allied process, Casting techniques and analysis, Forming techniques and analysis, Forging technique and analysis, Machining methods, Conventional and Non-conventional and their analysis, Assembly and fabrication techniques, welding and allied processes, product testing and quality control, Advanced applications in general engineering, aerospace, automobile and biomedical industries.

MEL203 Manufacturing with Non-metallic Materials, 3 (3-0-0)

Prerequisite: GEL102

Product realization with polymers and composites; Type of polymers - Thermoplastics, Thermosets and Elastomers; Correlation between microstructure and property; Property enhancement by blending, alloying, reinforcing; Manufacturing techniques for general polymer based products and its mold / die design fundamentals; extrusion, injection molding, blow molding, rota molding, etc.; FRP composites. Lamina, laminate and lamination theory; Manufacturing of composites; Autoclave molding, Pultrusion, Filament winding, Compression molding; Carbon – Carbon Composites; Applications in automobile, aerospace and general engineering.

MEL204 Theory of Machines, 3 (3-0-0)

Prerequisite: PHL103

Kinematic pairs, diagram and inversion. Mobility and range of movements. Displacement, velocity and acceleration analysis of planar linkages. Dimensional synthesis for motion, function and path generation.
Profile synthesis. Gears. Dynamic force analysis, flywheel, inertia, forces and their balancing for rotating and reciprocating machines.

MEP205 Product Design and Realization - Intermediate, 2 (0-0-4)

Prerequisite: MEP103, GEL101

Fabrication of a finished product through: (a) Identification of engineering solution parameters like materials, manufacturing and configuration variables, (b) Study and improvement of existing designs, (c) Open ended design problems for generating innovative designs/solutions and engineering problem solving, and (d) Product design with other life-cycle considerations in mind such as manufacturing, maintenance and environmental considerations (e) application of core mechanical engineering principles and practices.

MEL206 / MEL468 Mechanics of Materials, 4 (3-1-0)

Prerequisite: Nil

Stress, Strain, Axial deformation of bars: Statically determinate systems. Axial deformation of bars: Statically indeterminate systems, Generalized Hooke's law: Pressure vessls. Torsion. Beam statics. Symmetric beam bending. Unsymmetric (skew) beam bending. Shear stresses in beams. Stress and strain transformation: Mohr's circle. Yield and fracture criteria. Elastic stress analysis. Beam deflections by direct integration. Beam deflections by the moment – area method. Columns. Energy and virtual work. Classical energy methods. Elastic analysis of systems. Plastic limit analysis.

MEL301 Heat and Mass Transfer, 4 (3-1-0)

Prerequisite: MEL201

Modes of heat transfer in various applications. Conduction: Heat diffusion equation, 1-D steady state conduction in extended surfaces, infinite and semi-infinite walls, heat generation, lumped capacitance and simple transient models. Convection: Forced and free convection - mass, momentum and energy conservation equations, non- dimensional numbers, hydrodynamic and thermal boundary layers, basics of heat transfer in external and internal laminar and turbulent flows, and use of co-relations. Boiling and condensation: physical phenomena and co-relations. Mass transfer – Fick's law, similarity with convection and correlations. Radiation: properties, laws,
3-surface network for diffuse-gray surfaces. Heat exchanger fundamentals and design.

MEP302 Manufacturing Laboratory, 3 (0-0-6)

Prerequisite: MEL202, MEL203

Practice on the use of processes to produce high precision and multifunction components with metals and non- metals.

MEL303 Machine Element Design, 3(3-0-0)

Prerequisite: Nil

Engineering design vis-a-vis Solid mechanics, factor of safety, standards and design equations. Application of theories of failure to design. Design procedure and its application to static strength. Design based on static loads: screws including power screws, bolted joints including ecentrically loaded joints, axles and coupling, clutches and brakes. Introduction to design for fatigue strength. Endurance and modifying factors. Surface strength. Review of design procedure of fatigue failure with application to the design of bolts and springs subjected to fatigue loading. Design of shafts, spur, helical, bevel and worm gears, journal and rolling contact bearings, belts and chains.

MEP304 Design Laboratory, 2 (0-0-4)

Prerequisite: MEL204

Laboratory experiments on motion, forces, stresses and durability of mechanical components.

MEP305 Control Engineering Laboratory, 1.5 (0-0-3)

Prerequisite: EEL205

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.

MEP401 Thermo-fluids Laboratory, 1.5 (0-0-3)

Prerequisite: MEL201, MEL301, MEL102

Experiments in fluid mechanics and heat transfer.

MEL402 Manufacturing Systems, 3 (3-0-0)

Prerequisite: IIP201

Generalized model of a production system. Financial evaluation of new product polices. Profit Volume Charts, Risk analysis, Product mix decisions, Location and layout analysis, Product, process and cellular layouts, Demand forecasting, Aggregate production planning, Materials planning, MRP and inventory management, scheduling in job and flow shops.

MEL403 Continuum Mechanics, 4(3-1-0)

Prerequisite: Nil

Continuum Theory, Stress Principles, Kinematics of Deformation and Motion, Fundamental Laws and Equations, Linear Elasticity, Classical Fluids, Nonlinear Elasticity, Linear viscoelasticity.

MEL411/MEL451 Transportation Mechanics, 4 (3-0-2)

Prerequisite: PHL103

Basic features of surface transport on land and water. Mechanics of passenger transport equipment - hand carts, bicycle, tri-cycle, cycle rickshaw, motorized 2-wheelers, automobile, bus, train, trams, cable cars, etc. Freight transport – trucks, tractor trailers, trains, etc. Water transport – manual and motor powered boats, ships, and hoverchart. Earth moving equipment – bulldozers, backhoe, dumper, etc. Topics will include powering device, transmission, drive, train aspects, ride comfort and stability, and safety features, amongst others.

MEL412 / MEL452 Propulsion Technologies, 4 (3-0-2)

Prerequisite: MEL102 and 90 Credits

Prime movers – I.C. engine, gas turbine, steam turbine, electric motor. I.C. engine fundamental covering mechanisms, thermodynamics, controls and operation, and components, their materials and manufacture; applications in land and water propulsion; Jet propulsion - fundamentals, types of engines, their characteristics and applications; construction features and materials; applications in surface (land and water) transport and aircraft propulsion. Rocket propulsion – basics, solid and

liquid propelled engines, construction features, multistage rockets. Energy and environmental impacts.

MEL413 / MEL453 Indoor Environment Control, 4 (3-0-2)

Prerequisite: MEL102, MEL201, MEL301

Air quality and comfort - temperature and humidity, dust and contaminants; standards, ambient air quality, measurement techniques; Space cooling techniques – ceiling fans, evaporative cooling and air-conditioning, fundamentals, systems and components, construction features; vapour compression and vapour absorption systems; cooling load estimations. Space heating techniques - fire place, electric and gas heating, solar heating, load estimations. Clean room - classification and system. Applications for domestic, office, transport, and specialized uses, such as hospitals, factories, assembly areas, etc. Energy and environmental impact.

MEL414 / MEL454 Electric Power Generation, 4 (3-0-2)

Prerequisite: MEL102

Centralized and de-centralized electric system, grid and its management, demand variation and forecasting; thermodynamics, systems, components and construction features of diesel generating sets, coal/oil/gas burning, combined cycle, solar thermal, geothermal, ocean thermal power plants. Nuclear power plants – types, basic nuclear physics and construction features, fuel, moderator and coolant, steam cycle; hydroelectric plants – fundamentals, construction features; Fuel cells; Solar photovoltaic systems; Carbon footprint and future trends.

MEL415 / 455 Biomechanics, 4 (3-0-2)

Prerequisite: PHL103

Basics of kinematics and dynamics; Physiology of various life forms, structural aspects. Locomotion principles. Properties of tissue, analysis of motion and forces. Mechanics of injuries and ageing effects; Design and use of implants their materials of construction features and manufacture.

MEL416 / MEL456 Tribology, 4 (3-0-2)

Prerequisite: MEL303

Tribology basics, surfaces and their characterization and measurement; Apparent and real area of contact; Contact pressure and deformation. Genesis of friction, friction in contacting surfaces, sliding and rolling friction, laws and theory of friction. Stick-slip friction behavior, frictional heating and temperature rise. Wear: types, mechanisms adhesive- abrasive, corrosive, erosion, fatigue, fretting, etc. Wear models, rates their control and damage. Lubrication – types, hydrodynamics lubrication regimes, lubricating oils, their specification, contamination in use; lube oil systems for engineering equipment, such as, hydraulic and steam turbines, IC engines, industrial machinery, brakes and clutches, etc. Micro-and nano-tribology.

MEL417/MEL457 Noise and Vibration, 4 (3-0-2)

Prerequisite: MEL303

Introduction to engineering acoustics. Noise – properties, loudness and weighing networks, octave and FFT analysis, Sound power, intensity; Measurements and diagnostics. Noise control techniques Noise from machines, such as, fans, engines, bearings, turbines, motors, jets, etc. Noise standards. Introduction to vibration engineering, Spatial, modal and response models; Lumped parameter and distributed parameter modeling; free- and forced-vibrations and single & multi-degree of freedom systems. Balancing of rotating and reciprocating machines, vibration-isolators and shock absorber design, construction and properties. Flow induced vibrations. Measurement and instrumentation.

MEL418 / MEL458 Robotics, 4 (3-0-2)

Prerequisite: MEL204

Evolution of automations, manipulators and autonomous systems, components of a manipulator, transformations, D-H parameters, forward and inverse kinematics, velocity control; Jacobian control of systems; singular value decompositions and null spaces; Interpolation in 3-D spaces, dual numbers, quaternions and screws, dynamics of mainpulators. EL and NE formulations, parallel manipulators, basics of vision systems, Robotic Al paradigms and navigation.

MEL419 / MEL459 Mechatronics, 4 (3-0-2)

Prerequisite: EEL205

Introduction to mechatronics systems and components; Basics, interfacing and integration of microprocessors, sensors, actuators, and other

hardware; Interfacing, AD and DA converters, software and hardware tools; component selection including: sensors – encoders and resolvers, actuators – stepper and servo motors, solenoids; transmission elements – ball screws; controllers. Analysis and synthesis of systems for robotics, CNC and industrial applications.

MEL421/MEL460 Medical Devices and Equipment, 4 (3-0-2)

Prerequisite: 90 Credits

Basic anatomy and physiology of human system, such as, circulation, respiration, etc. and organs and associated tissues; Requirement of devices and euipment for various procedures, e.g. surgery, dental procedures, dialysis, etc.; inserts, implants, artificial limbs; etc. – design, manufacturing, installation and use.

MEL422 / MEL461 Composite Materials, 4 (3-0-2)

Prerequisite: MEL203

Types of co.mposites, natural composites; fiber types, forms and properties; lamina and laminate; micro-and macro-mechanical analysis and properties, failure theories; primary and secondary manufacturing – lay-up, filament winding, pultrusion, compression moulding, RTM, RIM, SRIM; Machining, drilling, joining, routing, etc.; Applications – metal matrix composites, ceramic matrix composites, etc. – components and processing techniques.

MEL423 / MEL462 Micro-manufacturing, 4 (3-0-2)

Prerequisite: GEL101 & 90 Credits

Overview of micro-and nano-mechanical systems and their applications; MEMS microfabrication methods, silicon micromachining, laser micromachining, mechanical micromachining; nonmanufacturing methods, CAD and CAM tools for micro-and nano-manufacturing techniques.

MEL424/MEL463 Finite Elements Analysis, 4 (3-1-0)

Prerequisite: Nil

Direct Approach for Discrete System-(e.g. Spring system). One Dimensional Continuum Problem (1D axially loaded bar, 1Dheat conduction),Governing differential equations for such problems, Equivalent functional form, Calculus of variation:- simple variational problems, Euler-Lagrange equations, variable end-point problem, and discussion on boundry conditions (natural and necessary boubdry conditions. Drichlet and Neuman boundry conditions),Minimization of functional as solution of governing equations(Rayleigh Ritz methods), Weak formulations and galerkin methods, Piece-wise polynomials as approximate solutions (Interpolation functions), :Stiffness" matrix, "force" and "Displacement" vectors, Programming and numerical integration (gauss quadrature). Two Dimensional Continuum Problem: 2D contimuum problems (heat and 2D elasticity problems), Calculus of variations for several independent variables, Solutions using Triangular (CST and LST) elements, Isoparametric elements (4-noded). Beam and frame Elements.

MEL425 /MEL464 Engineering Optimization, 4 (3-1-0)

Prerequisite: Nil

Optimization Studies: Problem formulation, Solution Strategies,Performance Criteria, Classification of Optimization Techniques, One-dimensional Optimization: Optimality criteria- necessary and sufficient conditions, Direct search methods, Gradient Methods, Sensitivity Analysis, Multi-dimensional Optimization: Optimality criteria, Gradient-based methods. Conjugate-direction methods, Quasi-Newton methods, Constrained Optimization: Constrained Optimization Criteria, Penalty Methods, Direct search methods, linearization Methods, Quadratic Approximation and Concept of Duality, Linear Programming: Formulation of problems, Analytical and Graphical Solutions, Sensitivity Analysis, Integer Programming, Applications of Unconstrained and Constrained Optimization, Multi-Objective Optimization. Evolutionary optimization(EO): Genetic Algorithms(GA), Multi-Objective Evolutionary Algorithms (MOEA), Global Optimization, Importance of Simulated Annealing.

MEL426 / MEL465 Introduction to Biomedical Engineering, 4 (3-0-2)

Prerequisite: Nil

Lecture: Basic concepts of Biomedical Engineering, Genetic Engineering, Cell Culture Engineering, Cell Communication and Immunology, General Concepts of Bimolecular Engineering, Engineering of Immunity, Cardiovascular Physiology, Renal Physiology, Biomechanics and Orthopedics, Bioimaging, Tissue Engineering, Biomedical Engineering and Cancer, Artificial Organs. Laboratory: Biosignals: instrumentation, signal processing, ECG, nerve and muscle excitation,

control system: Mass transfer; dialysis, respiratory system, digestion; Medical imaging: ionizing radiation, gamma camera, nuclear magnetic resonance, ultrasound, image processing.

MEL466 CFD and Heat Transfer, 4 (3-1-0)

Prerequisite: MEL201, MEL301

Introduction; Partial differential equations (PDEs), Classification of PDEs; Finite difference method (FDM) discretization schemes; Convergence, stability, and consistency criterion of different FDM schemes; FDM schemes for steady and unsteady heat conduction problems and boundary layer problems, Stream function vorticity method, Finite volume method (FVM) for fluid flow and heat transfer problems, Approaches adopted in FDM, finite element method (FEM) and FVM formulations, Concept of mesoscopic approach, Introduction to lattice Boltzmann method for solving transient heat conduction problems.

MEL467 Design Research, 3 (2-0-2)

Prerequisite: GEL101

Introduction to research, product design, design research, types of research, research areas of design, hypothesis, publications; steps of conducting research, Design Research Methodology, tools used in research, research using instruments: Think Aloud Protocol, usability study; research will people: interview (face to face, telephonic, computer assisted), observational study, interventional study, literature research, questionnaire; writing an article; introduction to statistics, experiments and experimental designs, Probability, Distribution, Sampling, Inferential Statistics, Significance testing, Correlation, Multi-level analysis, ANOVA, choosing a significance test, t test, Chi Square, ethical issues in research, technical English, reference styles.

MEL427 / MEL469 Clean and Sustainable Energy Engineering, 4 (3-0-2)

Prerequisite: MEL102, MEL201, MEL301

Overview of various clean and sustainable energy sources – such as Solar thermal, Solar Photo – Voltaic, Wind, Bioenergy, Hydro, Geothermal, Tidal, Wave; Active and passive solar heating; Daylighting; Basic principles of PV in silicon; Combustion/Pyrolysis of biomass; Energy storage; Hydro & tidal turbines; Aerodynamics of wind turbines; Wave energy technology; Economics of clean energy; Environmental impact and safety; Current and future trends.

MEL470 Combustion & Emissions in Reciprocating Engines, 4 (3-0-2)

Prerequisite: MEL102

Introduction of basic engine components; Thermodynamics of combustion; Charge preparation in SI and CI engines; Combustion in SI engines, Flame structure and speed, Spark ignition, Abnormal Combustion, Cyclic variations; Combustion in CI engines; Fuel spray behaviour, Ignition delay, Mixing-Controlled combustion; Emission control technologies, Emission control by design variable, EGR, Exhaust gas after-treatment, SCR, DOC, DPT; Engine fuels quality and emissions; Alternative automotive power plants, Homogeneous and stratified charge engines; Combustion Diagnostics; Emission standards, test procedures and measurement; Engine laboratories.

MEL471 Materials Characterization Techniques, 4 (3-0-2)

Prerequisite: GEL102

XRD: Properties and generation of X-ray, Continuous and characteristics spectra, Bragg's diffraction law, Diffraction methods, Scattering by electron / atom / unit cell, Structure-factor calculation, Determination of crystal structures, Quantitative and qualitative analyses, Residual stress measurement

Electron Microscopic Techniques; (a) TEM – Introduction to electron microscopy and principles, Design of TEM, Models of operation, Specimen preparation techniques, Diffraction pattern analysis, STEM, (b) SEM / EDS – principle and operation Scanning Probe microscopy: AFM and STM Simultaneous Thermal Analysis; TGA/MS and DSC

Vibrational Spectroscopic Techniques: IR, NMR, Raman Mercury Porosimetry and Nitrogen Adsorption methods Bio Materials Characterization: by nanoindentation technique.

MEL472 Automotive Engineering, 4 (3-1-0)

Prerequisite: GEL102, MEL204, MEL303

Prime movers for automotive applications; Powertrain components; Power generation characteristics of internal combustion engines; Engine dynamics; Design and structural analysis of engine components; Vehicle longitudinal dynamics; Clutch fundamentals, Different type of clutches; Vehicle Transmission Systems: Basic Design

Principles, Automatic and manual transmissions, Matching Engine and Transmission, Gear-shifting Mechanisms; Electronic Transmission Control; Driveline Systems and Vehicle Performance, Front, Rear and all-wheel drivelines; Suspension Systems; Steering Systems and Steering Dynamics; Automotive brake systems; Automotive tyres and wheels; Automotive electrical systems: starting, charging, lighting, engine management.

MEL473 Statistical Thermodynamics, 4 (3-1-0)

Prerequisite: PHL102, MAL112

Principles and methods of statistical mechanics: Classical and quantum statistics, grand ensembles, fluctuations, molecular distribution functions, and other topics in equilibrium statistical mechanics. Topics in thermodynamics and statistical mechanics of irreversible processes.

System of interacting particles, Elementary kinetic theory of transport processes, Transport theory using the relaxation time approximation, Near exact formulation of transport theory, Irreversible processes and fluctuations,

Kinetic theory of gases, statistical mechanics of ideal gases, classical mechanics, statistical kinetic theory, non-equilibrium thermodynamics, Correlation functions; linear response theory, theory of Brownian motion, projection operator formalism, hydrodynamic fluctuations.

MEL474 Computer Aided Design and Manufacturing, 4 (2-0-4)

Prerequisite: GEL101, MEP205

Introduction to product design, manufacturing and process planning; introduction to CAD / CAM / CAE / CEM; introduction to geometric modelling; types of mathematical representations of curves, surfaces, and solids; solid modelling, solid representation – Brep and CSG; introduction to CNC machine tools, principle of operation of CNC, construction features including structure, drive system, tool-work movement actuation system, machine control system; manual and automated part programming on Lathe and machining centres using G & M codes; ATCs, modern cutting tool materials and their applications, some advanced manufacturing processes, CMM; RP; introduction to group technology; FMS; introduction to different CAD / CAM / CAE tools.

MEL475 Applied Thermal Engineering, 4 (3-1-0)

Prerequisite: MEL102

Overview of energy conversion technologies, Combustion and applications – IC engines, burners, furnaces and components. Compressible flow fundamentals – Mach number, normal shock, adiabatic 1 – D flow through variable area passages. Turbo-machinery – flow through a stationary and moving passage, velocity triangles, impulse and reaction principles, characteristics and components of axial and centrifugal turbo-machines, Refrigeration and air conditioning – system analysis, components design, psychrometry, and air-conditioning calculations. Steam generation and its use – power plants, co-generation, combined cycles. Steam and gas turbine construction and performance. Equipment studies and performance calculations in the laboratory will concurrently accompany lectures.

MEL476 Applied Fluid Mechanics, 4 (3-1-0)

Prerequisite: Nil

Fluid kinematics: Governing equations; equation of continuity, momentum equation, energy conservation, entropy; Navier-Stokes equations, Turbulent flow, Reynolds equation of turbulent flow, Turbulence modelling, Boundary layer theory, Hagen – Poiseuille flow.

Compressible flow: isentropic flow; normal shock wave relations, oblique shock waves, weak and strong shocks, and shock wave structure; compressible flows in ducts with area changes.

Water Turbines: Impulse turbine-Reaction turbines – Significance of specific speed – Unit quantities, Concept of performance characteristics for water turbines Centrifugal pumps: Pumps in series and parallel, Specific speed, Unit quantities, and characteristics curves, Cavitation in turbines and pumps.Dimensional Analysis: Fundamental dimensions – Physical Quantity and Dimensions – Dimensional Homogeneity – Non Dimensional parameters, ρ-Theorem dimensional analysis, Choice of variables, Determination of Dimensionless parameters.

MEL477 Sustainability Science and Technology, 3 (3-0-0)

Prerequisite: Nil

Introduction to sustainability science; Identification of human needs, Harmony in nature; Ecological systems; Human relationship and interaction with nature; Framework of sustainable society and development; Human role in sustainability;

Sustainable production-work system; Sustainable Health system; Principles of sustainable engineering; Ethics of green / sustainable engineering; Strategies for sustainability, Sustainable energy planning; Sustainable energy technologies; Transportation technologies for sustainability; Restoring and rehabilitating ecosystems; Case studies – holistic technologies and production systems.

MEL479 Complex Fluid Mechanics, 4(3-1-0)

Prerequisite: MEL201, MEL403

Non-Newtonian Fluids: non-Newtonian fluids and commonly used rheological models; the fluid mechanics of such non-Newtonian fluids (flow in pipes and flumes); applied rheology.

Suspension Dynamics. Forces acting on particles in a fluid-particle suspension; Flow regimes; Creeping flow: Fundamentals of Stokes flow, singularity solutions, and the fluid velocity disturbance due to an isolated particle; Inertial flow: fluid-particle and particle-particle interactions; Hydrodynamic interactions between suspended participles; Sedimentation, rheology and self-diffusion of dilute Stokesian suspensions; Dynamics of concentrated suspensions; Continuum description of suspensions using volume and ensemble averaging; Non-linear rheology and segregation; Applications to living cells and other biological systems.

Granular Materials: definition of granular materials, dense flow and rapid flow regimes, various models used to describe granular flow. Rheology and mathematical tools to study the dynamics of granular materials.

MEL480 Engineering Metrology, 4 (2-0-4)

Prerequisite: Nil

Introduction to measurements; basic and auxiliary functional elements of a measurement system; mechanical versus electrical /electronic instruments; errors in measurements; statistical analysis of data; regression analysis, correlation; estimation of uncertainty and presentation of data; primary, secondary and working standards; Limits, fits and tolerances; linear and angular measurements; comparators- their types, relative merits and limitations; gauge design; interferometry; geometric form, straightness, and flatness measurement; alignment and testing methods; measurement of screw threads and gears; measurement of surface roughness and texture; measurement of field quantities such as temperature, pressure and velocity; measurement of thermo-physical properties, radiation properties of surfaces, vibration and noise; tolerance analysis in manufacturing and assembly.

B.Tech.-M.Tech. (Dual Degree)

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.

Specialization : Manufacturing

MEL501 Advanced Composites, 3 (3-0-0)

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 dis-tribution, 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. Oxi-dation 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, 4 (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 treat-ment) 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.

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

Any Twelve 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, Electrofoaming, 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.

Specialization : Design

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 un-constrained minimization techniques. Direct methods; approximation techniques; duality; general design applications.

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)

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 Rela-tions, 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 biomechanics 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)

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.

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, 3 (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 sys-tems: 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 (3-1-0)

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 Deformation; Crystalline Anisotropy; Constitutive Behavior of Single Crystal; Homogenization Models for Polycrystals; Constitutive 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)

Generalized 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.

Specialization : Thermal

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 me-thods, 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.

2.9.10. Physics

PHP100 Physics Laboratory, 2 (0-0-4)

Prerequisite: Nil

List of Experiments: 1. Coupled pendulum, 2. Study of DC power supply, 3. measurements of magnetic field using Helmholtz coil, 4. Measurement of Planck's constant using photoelectric effect and LED, 5. Quantum analog, 6. Measurement of Curie temperature 7. Newton's Ring, 8. Spectrometer experiments with prisms and gratings, 9. Polarimeter, 10. Biprism, 11. Fabry-Perot Interferometer, 12. Diffraction of light from single slit to double-slit.

The experiment 1 belongs to mechanics, experiment 2 belongs to electronics, experiment 3 belongs to electricity and magnetism, experiments 4 and 5 belongs to modern physics, experiment 6 belongs to condensed matter physics, and the rest of the experiments belongs to optics.

PHL101 Electromagnetics, 4 (3-1-0)

Prerequisite: Nil

Gauss' law in vector form and application to electrostatics, Electric polarization, electric permittivity, Displacement vector, Laplace's equation and Poisson's equation and solutions in simple situations; Amperes law, Magnetization, Faraday's law of induction, Equation of continuity; Displacement current, Maxwell's equations; electromagnetic waves in dielectrics; reflection and refraction of electromagnetic waves, polarization, transmission lines and metal waveguides; Special theory or relativity, Michelson Morley experiment, Lorentz transformations, time dilation, length contraction and velocity addition.

PHL102 Quantum Physics, 4 (3-1-0)

Prerequisite: Nil

Particles and Waves in classical mechanics; need for quantum mechanics (Planck's law of blackbody radiation, photoelectric effect, Compton scattering, Raman effect specific heat of solid); atomic stability and Bohr's atomic theory. Double-slit experiment with light; matter wave, de-Briglie hypothesis, Davisson-Germer experiment. Quantum states, Hilbert space, operators, expectation value; Schrodinger equation (time-independent and time-dependent), stationary states; uncertainty principle; postulates of quantum mechanics. Schrodinger equation in 1-dimension: particle in a box, concept of quantum numbers; step potential; potential barrier: scattering and tunneling; potential well: bound states; harmonic oscillator. Continuous symmetry: translational and rational symmetry, generator and angular momentum operators; discrete symmetry: parity, lattice translation symmetry, time-reversal symmetry. Schrodinger equation in higher dimension: charged particle in uniform magnetic field; hydrogen atom, degeneracy. Stern-Gerlach experiment, spin, Zeeman effect. Bra-ket notation. Harmonic oscillator in operator and Bra-ket notation.

PHL103 Classical Mechanics, 4 (3-1-0)

Prerequisite: Nil

Constraints, virtual work and D'Alemberts principle; generalized coordinates, Hamilton's principle, Lagrange's equation; Cyclic coordinates, conservation laws. Central force and effective potential; Kepler's problem. Scattering of particles by a central force. Rutherford's law. Non-inertial frames; centrifugal and coriolis force. Rigid body motion; Euler's theorem; moment of inertia tensor and principal axes; Euler' equations of motion; precession and nutation of a symmetric top; Euler's angles.

Oscillation: damped and forced oscillation, Q-factor; small oscillation, nature of equilibrium and normal modes. Hamilton's equation of motion; principle of least action. Canonical transformations, poisson's brackets, Liouville's theorem. Both the Newtonian and lagrangian approach would be presented, wherever necessary.

PHL104 Optics and Lasers, 4 (3-1-0)

Prerequisite: Nil

Plane waves and spherical waves; Interference: two beam and multiple beam interference; Michelson, Sagnac, Fabry Perot interferometers; Diffraction: Fraunhofer and Fresnel diffraction, Fraunhofer diffraction by rectangular and circular apertures; Resolution of optical instruments; Fourier optics and spatial frequency filtering; Fresnel diffraction: Diffraction of a Gaussian beam; Polarization and polarization components; Basics of lasers, Einstein coefficients, population inversion and optical amplification; Threshold for laser oscillation; Optical resonators, stability condition, transverse and longitudinal modes; Mode selection; Q-switching and mode locking; Properties of laser beams; Types of lasers, Some lasers applications.

PHL201 / PHL451 Thermal and Statistical Physics, 4 (3-1-0)

Prerequisite: PHL102

Elements of Thermodynamics:- Laws of thermodynamics, entropy, thermodynamic potentials and Maxwell relations; Elementary probability theory:- Bionomial, Poissons and Gaussian distributions, introduced via the random walk problem, central limit theorm and its significance; Kinetic theory of gases:- Averages and distributions of molecules in a gas, random walk and Brownian motion, random walk and diffusion; Statistical basis for thermodynamics:- Macrostates and microstates, postulates of statical mechanics; Gibb's Paradox; Elements of ensemble theory:- Partition function, rules of calculation through microcanconical and grandcanonical ensemble, applications to systems of ideal gas molecules, paramagnetic spins, harmonic oscillators, etc.; Quantum statistical mechanics:- Bose-Einsetein, Fermi-Dirac and Maxwell-Boltzmann statistics; their utility in Bose-Einstein condensation, black body radiation, etc.

PHL202 / PHL452 Physics of Materials, 4 (3-1-0)

Prerequisite: "Knowledge of Quantum Mechanics".

Brief review of essential concepts of quantum mechanics, Classical and Quantum distribution functions and their comparison, Free electron theory, Origin of energy bands in solids, Density of states, E-k diagrams, Brillouin zones, Effective mass, Metals, semimetals, semiconductors and insulator and resistivity of metals, Semiconductors: Intrinsic and Extrinsic semiconductors, Fermi level, Temperature and carrier concentration variation of Fermi level, Metal-semiconductor junction, p-n junction, tunnel diode, solar cell and LED, Superconductivity; Zero resistance, critical temperature, current and field, isotope Effect, Type-I and II Superconductors, London penetration depth and coherence length, BCS Theory (qualitative), Josephson Junctions.

PHL453 Fundamentals of Experimental Techniques, 3 (3-0-0)

Prerequisite: Nil

Error analysis and data reduction methods; presentation of physical quantities, classification and propagation of errors, probability distributions, graphical handling and fitting functions. Vacuum, cryogenics; vacuum chamber, types of pumps, gauges, controls and leak detection techniques, basic of cryogenics. Thin film deposition and characterization techniques: basic idea of thin film deposition, structural and compositional analysis (XRD, SPM, SEM, TEM and EDAX), electrical characterizations (Four Probe, Hall Effect)

PHL454 Fundamentals of Nuclear Energy, 3 (3-0-0)

Prerequisite: Nil

Natural and artificial radioactivity, Elementary nuclear processes, Energetics of fission and fusion reactions, Cross-sections and resonances, Fissionable and fertile isotopes, Neutron budgets per fission, Light water, heavy water and graphite reactors, World nuclear energy production and status of India, World reserves of uranium and thorium, Plutonium, reprocessing and proliferation, Half lives of fission decay products and actinides made by neutron capture Nuclear waste management, Three Mile Island and Chernobyl, Molten sodium breeders, Generation-IV reactors, Fast neutron production and fission-fusion hybrids reactors.

PHL456 Mathematical Physics for Engineers, 3 (3-0-0)

Prerequisite: Nil

Ordinary derivatives of vectors, space curves, Partial derivatives of vectors, Differentials of vectors, Concept of gradient, divergence and curl, Ordinary integration of vectors, Line integral, surface integral and volume integrals, Green's theorem, Gauss's divergence theorem, Strokes' theorem and their applications, Differential equations, series method of solutions (Frobenius), Legendre's differential equations, Bessel's differential equations, Hermit's differentia equations, generating function, spherical harmonics, orthogonal properties & recurrence relations, Linear operators and matrices, Eigenvalues and eighenvectors, orthogonal polynomials, elements of complex analysis, Laplace transforms, Fourier analysis.

PHL457 Engineering Photonics, 3 (3-0-0)

Prerequisite: Nil

Introduction to wave optics, wave – particle duality of light, wave equation for light. Light in dielecteic materials, polarization in materials, normal and anomalous dispersion of light, the concept of refractive index. Light reflection / refraction, Snell's law and total internal reflection, Goos-Hanchen shift, Light at a planar interface, and optical coatings.

Introduction to wave guides, step and graded-index waveguide, modes in wave guides, strip and channel waveguides, wave guide couplers and devices including directional couplers and optical switch, electro and acoustro-optic waveguide, phase and amplitude modulators, Introduction to Fiber-optics communications and devices.

Light emission process, spontaneous and stimulated emission. Einstein A and B coefficients, concepts of laser, laser beam parameters and properties, laser threshold and gain of the laser, line broadening and laser line – width. CW and pulsed lasers, mode locking and Q-switching, laser applications, laser cooling and trapping of atoms.

Light transport and emission in nanostructures, concept of photonic band gap, photonic cavities, light localization, nano-waveguides and nano-lasers.

PHL 459 Lasers And Non –linear Optics, 3(3-0-0)

Prerequisite: Nil

Einstein's Quantum Theory of Radiation, Interaction of Radiation with Matter, Theory of some simple Optical Processes, Basic Operational Principles of Lasers, Theory of line broadening mechanism, Second and third order non linear optical processes: Second harmonic generation(SHG), Sum and Difference frequency Generation, Third Harmonic Generation, Phase Matching Conditions, Self Focusing, Self-phase-Modulation.

3. Fees

3.1. Mode of Payment

(a) Institute dues

All Institute dues are to be paid through Demand Draft favouring "The Registrar, IIT Ropar" payable at Ropar.

(b) Mess dues

Mess dues are to be paid by demand draft favouring "The Director, IIT Ropar, Hostel Account" payable at Ropar or State Bank of India Internet Banking as available.

3.2. 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 fees 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

3.3. 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.

3.4. Withdrawal from the Institute

If a student is continuously absent from the Institute for more than four weeks without informing the Dean (A&R), his/her name will be removed from the Institute rolls. Such absence during the first year will render the B.Tech. student ineligible for re-admission.

A B.Tech. 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 "Clearance Certificate" from the Department, the Librarian, the Warden, the Officer Commanding, NCC, and the Accounts Section, and submit to the Academics Section (U.G.) 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.

3.5. 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)	: US$	150
c)	Migration Certificate		: Rs.	500
	(Only one original)			
d)	Duplicate Degree/certificate	(In India)	: Rs.	2500
	(Only one Original)	(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

3.6. Details of Semester Fees for the Academic Year 2015-16.

	ITEM ↓ Student's Programme →	B.Tech.
1.	**SEMESTER FEES (To be paid every semester)**	**(INR)**
1.1	**INSTITUTE FEES**	
	i) Tuition Fee	45000
	ii) Examination Fee	350
	iii) Registration/Enrolment Fee	250
	iv) Gymkhana Fee	500
	v) Medical Fee	50
	vi) Laboratory & other facilities	1500
	vii) Library	500
	viii) Hostel & Mess Establishment, Amenities charges	1000
1.2	**HOSTEL FEES +**	
	i) Hostel Seat Rent	1000
	ii) Fan, Electricity and water charges	1000
	TOTAL (Semester Fees to be paid)	**51150**
2.	**ONE TIME PAYMENTS (Non -refundable)** **To be paid at the time of admission**	
	i) Admission Fees	200
	ii) Grade card	200
	iii) Provisional certificate	200
	iv) Student welfare fund	300
	v) Modernization fees	400
	vi) Identity card	100
	vii) Benevolent fund	100
	viii) Alumni fees	1000
	ix)Training & Placement	500
	Total (one time payment at the time of admission)	**3000**
3	**Deposits (Refundable)**	
	i) Institute security deposit	2000
	ii) Library security deposit	2000
4	**OTHER PAYMENTS** Insurance Scheme (To be paid every year in 1st semester)	500
	GRAND TOTAL	**58650**

The fee payable at IIT Ropar is subject to change as per the Institute rules.

Note: * All SC and ST students will get 100% tuition fee exemption.

Partial Fee waiver of up to 50% can be given to deserving students.

+ 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.

4. Discipline and Attendance

4.1. 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.

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

4.2. 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 Malpractice unfair means during Mid-semester/End-semester examinations:

4(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.

4(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.)

5.

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 glasswork, 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: ……...…....

6. Academic Integrity

1. Cases of ethical lapses emanating from institutions of scientific research are increasingly being reported in the news. In this context, we need to create awareness and come up with a set of clear guidelines to maintain academic integrity. A flourishing academic environment entails individual and community responsibility for doing so. The three broad categories of improper academic behavior that will be considered are: I) plagiarism, II) cheating and III) conflict of interest.
2. 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.

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

(a) Copying during exams, and copying of homework assignments, term papers or manuscripts.
(b) Allowing or facilitating copying, or writing a report or exam for someone else.
(c) Using unauthorized material, copying, collaborating when not authorized, and purchasing or borrowing papers or material from various sources.
(d) Fabricating (making up) or falsifying (manipulating) data and reporting them in thesis and publications.

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

(a) Use proper methodology for experiments and computational work. Accurately describe and compile data.
(b) Carefully record and save primary and secondary data such as original pictures, instrument data readouts, laboratory notebooks, and computer folders. There should be minimal digital manipulation of images/photos; the original version should be saved for later scrutiny, if required, and the changes made should be clearly described.
(c) Ensure robust reproducibility and statistical analysis of experiments and simulations. It is important to be truthful about the data and not to omit some data points to make an impressive figure (commonly known as "cherry picking").
(d) Lab notebooks must be well maintained in bound notebooks with printed page numbers to enable checking later during publications or patent. Date should be indicated on each page.
(e) Write clearly in your own words. It is necessary to resist the temptation to "copy and paste" from the Internet or other sources for class assignments, manuscripts and thesis.
(f) Give due credit to previous reports, methods, computer programs etc. with appropriate citations. Material taken from your own published work should also be cited; as mentioned above, it will be considered self-plagiarism otherwise.

5. 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.

6. 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 provide some commercial software at SERC for plagiarism checking. Faculty members are encouraged 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.

7. 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 copyright able material; and to execute all papers required to assign, apply for, obtain, maintain, issue and enforce IP and IP rights.

8. References:

i. National Academy of Sciences article "On being a scientist," http://www.nap.edu/openbook.phpρrecord_id=4917&page=RI
ii. http://www.admin.cam.ac.uk/univ/plagiarism/
iii. http://www.aresearchguide.com/6plagiar.html
iv. https://www.indiana.edu/~tedfrick/plagiarism
v. http://www.files.chem.vt.edu/chem-ed/ethics/index.html
vi. http://www.ncusd203.org/central/html/where/plagiarism_stoppers.html
vii. http://sja.ucdavis.edu/files/plagiarism.pdf
viii. http://web.mit.edu/academicintegrity/
ix. http://www.northwestern.edu/provost/students/integrity/
x. http://www.ais.up.ac.za/plagiarism/websources.htm#info
xi. http://ori.dhhs.gov/
xii. http://www.scientificvalues.org/ceses.html

7.Scholarships and Fellowships

7.1. Scholarship for B.Tech. Students

7.1.1. Institute Merit-cum-Means (MCM) Scholarships

The Institute offers Merit-cum-Means scholarships to under-graduate students in engineering and technology. These are permissible to about 25% of the students. The present value of Merit-cum-Means scholarship is Rs. 1000 per month for general category students and the recipient is exempted from paying tuition fee. 4-year B.Tech. students are eligible to receive Merit-cum-Means scholarship at the time of joining the Institute. The criterion of merit for the first year is All India Rank (AIR) in the JEE. The scholarships are renewed on a yearly basis until he/she clears all academic requirements of the programme, provided that he/she continues to satisfy the eligibility and continuation criteria.

For continuation of MCM, the performance of the students will be reviewed at the end of each semester. The first such review will be held at the end of the second semester.

Continuation of MCM Scholarship: For the general category students, the requirements of merit for the continuation of Institute **Merit-cum-Means Scholarship** are:

(i) CGPA must be 6.0 more; and
(ii) Earned credits should not less than 20 times the number of semesters registered for;
(iii) SGPA in the previous semester must be 6.0 or more.

On the criterion of means, only those students are presently eligible whose parents have a gross yearly income up to Rs. 4.5 lac per annum. This criterion is applicable for all categories of students including SC/ST students. The terms and conditions of the award of the scholarship are laid down in the rules and regulations thereof in force and are subject to change from time to time.

7.1.2. Institute Merit Prizes and Certificates

The Institute offers merit prizes and certificates to the top 7% of the students of each 4-year B.Tech. Programme for the 1st and 2nd semester. The value of merit prize is Rs. 2500.

7.1.3. Institute Free Studentship

The Institute offers free studentship to 10% of the students on the basis of means alone. The recipient is exempted from paying tuition fee. Students who are not eligible for the award of MCM Scholarship on the basis of their parent's income will not be considered eligible for the award of Free Studentship Scholarship. For continuation of Free studentship, the scholar must have to maintain the following criteria:

(i) CGPA must be 6.0 more; and
(ii) Earned credits should not less than 20 times the number of semesters registered for;
(iii) SGPA in the previous semester must be 6.0 or more.

On the criterion of means, only those students are presently eligible whose parents have a gross yearly income up to Rs. 4.5 lac per annum. This criterion is applicable for all categories of students including SC/ST students. The terms and conditions of the award of the scholarship are laid down in the rules and regulations thereof in force and are subject to change from time to time.

7.1.4. Scholarship provision for Students of SC/ST Category

(a)Tuition fee exemption is admissible to all SC/ST students irrespective of their parents/guardians income.

(b)The Institute offers a scholarship of Rs. 300/- per month and exemption from paying room rent of the hostel, only to those SC/ST students whose parent'/guardians' income does not exceed the limit prescribed by the Government of India from time to time for the award of Merit-cum-Means scholarship. The students can opt for free mess facilities (basic menu) and Rs. 250/- per month as pocket allowance in lieu of the amount of the scholarship.

(c)All the eligible SC/ST students while on training or doing courses during semester breaks or required to stay in the Institute during the semester breaks or exempted to take meals from the hostel due to medical reasons etc. may be given a payment of Rs. 70/- as pocket allowance (per month) and a per diem allowance in lieu of free mess facilities on the basis of prevalent average rate of mess charges as applicable from time to time.
(d)Where an SC/ST candidate fails in the examination for the first time, the award may be renewed subject to a maximum limit of 5 years.

7.1.5. Post-Matric Scholarship

The SC/ST can opt for Post Matric Scholarship offered by the State Government. For further details, Students can visit respective State Government website.

7.2. Central Sector Scholarship for SC/ST students

The student can opt for CSS awarded by Government of India. Students are required to apply for this scholarship to Academic Section, IIT Ropar.

7.3. Other Scholarship

In addition to above mentioned scholarships there are few other scholarships awarded by NGO's and some external agencies.

7.4. Scholarship for B.Tech.-M.Tech. dual degree

Students belong to B.Tech.-M.Tech. dual degree programme who have good academic performance are given a scholarship in the final year, which is at par with that given to students of M.Tech. programmes.

NOTE:

For all the scholarships only affidavit on a judicial stamp paper of Rs 20/- duly signed by Magistrate / S.D.O/B.D.O / Tehsildar / Revenue Officer of his Jurisdiction as per requisite proforma in support of income proof OR Income Tax Return will be acceptable.

8. Library Facilities

The central library of IIT Ropar is functioning as the primary information resource and repository for all the teaching and research activities at the institute.

Apart from textbooks and recommended reading material prescribed for each course offered at the institute, the library houses a growing collection of research monographs, reports, multi volume reference books, dictionaries, encyclopedias handbooks and so on.

In addition, the library also facilitates access to a number of journals through its participation in consortia such as INDEST-AICTE. At present, users can consult more than 11,800 books (available on shelves) and hundreds of journals (though electronic subscription). The library staff members are currently working towards automation of user services using LIBSYS 7 *(Web centric Library Management System) and other aspects of info management and settling up a digital library and e-resource center.

9. Medical Facilities

The institute has a Medical Center adjacent to the hostel complex. A doctor (Homeopathic, Ayurvedic & 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.

10. 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.

11. 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.

12. 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.

13. 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.

14. Details of Medals

NAME OF THE MEDAL	CRITERIA FOR AWARD
President's Gold Medal	To a candidate who obtains the highest CGPA among all students obtaining a B.Tech. degree in that year from the 4-year B.Tech. programme. In case there is a tie, the medal is awarded to the student with the largest earned credits.
Director's Gold medal	To a candidate who is adjudged as the best all-rounder from amongst the graduating students of the 4-year B.Tech. programme.
Institute Gold Medal	To a candidate securing a CGPA of 10, other than the one who has been awarded the President's Gold medal.
Institute Silver Medal (for each programme)	To a candidate (one in each programme) who obtains the highest CGPA among and undergraduate graduating class of the Institute in his/her programme. No silver medal will be awarded in the discipline from which a student gets the President's Gold Medal & Institute Gold Medal. A minimum CGPA of 8.5 is required for the Institute Silver Medal; in case no graduating student satisfies this criterion, the student with the highest CGPA is given a certificate.

15.Academic Calendar for the 1st Semester of Academic Year 2015 – 16

S.No.	Academic Events	First Semester 2015-16
1	Reporting of new UG students	Jul 21 (Tue)
2	Registration of new UG students	Jul 22 (Wed)
3	Orientation of new UG students	Jul 23(Thu)-Jul 27(Mon)
4	Registration of continuing student (and new PG students)	Jul 27 (Mon)
5	Commencement of classes	Jul 28 (Tue)
6	Late registration	Aug 03 (Mon)
7	Last date for course **ADD / DROP**	Aug 05 (Wed)
8	Last date for adding courses (in lieu of dropped courses)	Aug 07 (Fri)
9	Last date for getting mid semester course evaluation form filled	Sept 08 (Tue)
10	Last date for departments to float courses for next semester	Sept 11 (Fri)
11	**Mid Semester Examination**	**Sept 14 (Mon) – Sept 21 (Mon)**
12	Midterm evaluation project **for UG (No Classes)**	Sept 22 (Tue)
13	Last date for return of marked answer-scripts	Oct 06 (Tue)
14	Short-attendance warning to students by departments	Oct 08 (Thu)
15	Zeitgeist (No Classes)	Oct 09 (Fri)-Oct 11(Sun)
16	Class committee meeting	Oct 12(Mon)-Oct 16(Fri)
17	Last date for **Audit** and **Withdrawal**	Oct 15(Thu)
18	Course registration for next semester	Oct 26 (Mon) – Oct 30 (Fri)
19	Meeting of timetable incharges for courses of next semester	Nov 02 (Mon)
20	Last date for getting course evaluation form filled	Nov 12 (Thu)
21	Last date for submission of preliminary project reports **for UG** students	Nov 18(Wed)
22	Last day of classes	Nov 18(Wed)
23	Display of Pre-Major Totals (PMT)	Nov 18(Wed)
24	Display of list of students with short attendance	Nov 13 (Fri)
25	**Major Examination**	**Nov 20 (Fri) – Nov 27 (Fri)**
26	**Project viva-voce for UG**	**Nov 30 (Mon)**
27	Last date for submission of final project reports **for UG** students	Dec 07 (Mon)
28	Viewing of answer-scripts by the student	Dec 07 (Mon)
29	Last date for grades to reach to the Academics Section	Dec 08(Tue)
30	Display of grades	Dec 09 (Wed)
31	Winter Vacation **(for UG & M.Sc. only)**	Dec 07(Mon)– Jan 03 (Sun)
32	Last date for progress report submission **(for PhD only)**	Dec 28 (Mon)

Note:

- Sep 23 (Wed) works as per Friday Timetable.
- Sep 29 (Tue) works as per Friday Timetable.
- No classes, quiz, presentation, or any other academic activity can be scheduled on Nov 19, 2015 (Thu). • 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.

Registration for 2nd Semester 2015-16 – Jan 04, 2016 (Mon)
Commencement of classes – Jan 05, 2016 (Tue)

CONTACT INFORMATION

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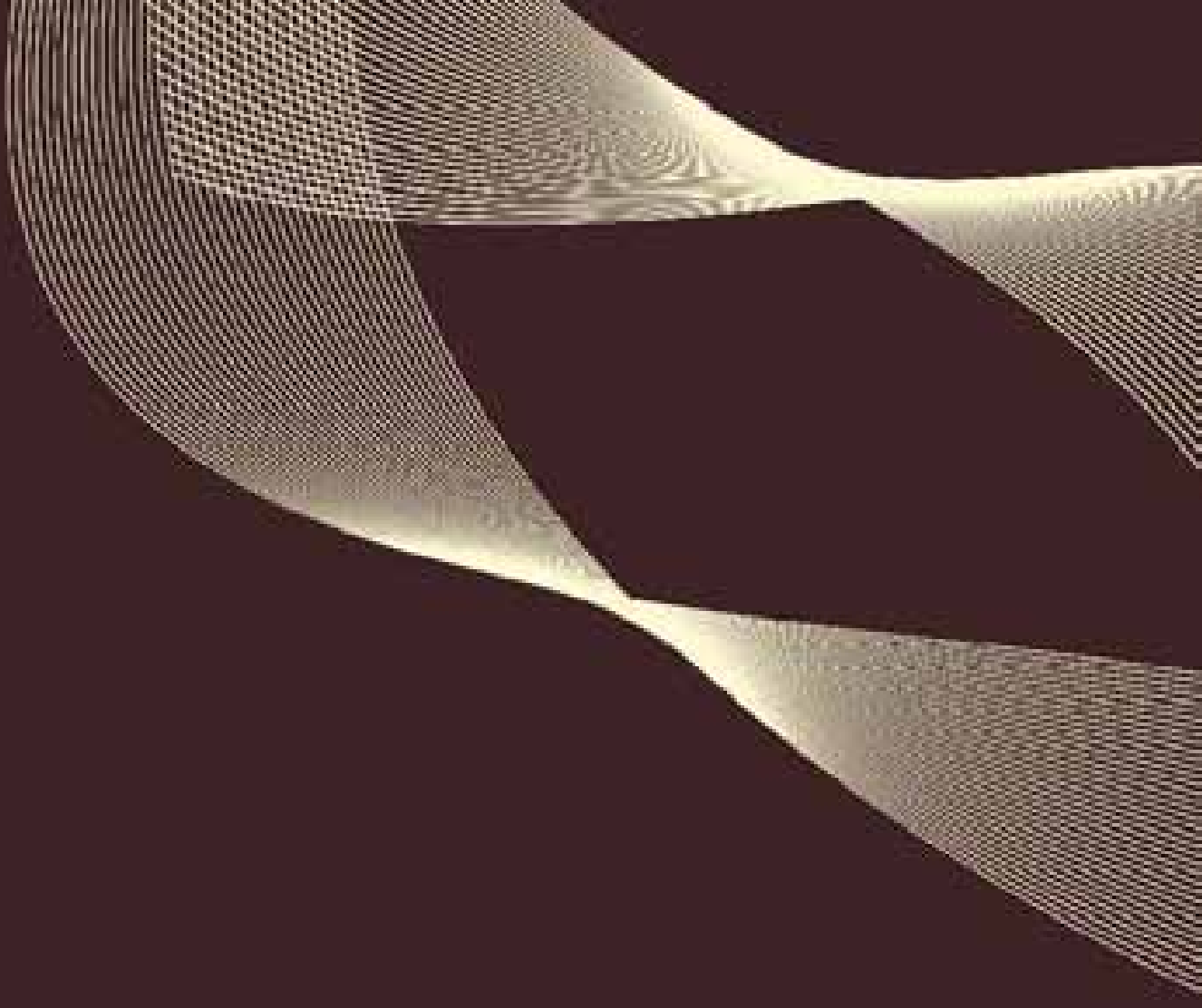

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