INDIAN INSTITUTE
OF TECHNOLOGY DELHI
HAUZ KHAS, NEW DELHI

COURSES OF STUDY

2006-2007

UNDER-GRADUATE PROGRAMMES

IIT DELHI

Vision

To contribute to india and the world through excellence in scientific and technical education and research; to serve a as valuable resource for industry and society; and to remain a source of pride for all indians.

Mission

To generate new knowledge by engaging in cutting-edge research and to promote academic growth by offering state-of-the-art undergraduate, postgraduate and doctoral programmes.

To identify, based on an informed perception of indian, regional and global needs, areas of specialization upon which the institute can concentrate.

To undertake collaborative projects which offer opportunities for long-term interaction with academia and industry.

To develop human potential to its fullest extent so that intellectually capable and imaginatively gifted leaders can emerge in a range of professions.

Values

- Academic integrity and accountability
- Respect and tolerance for the view of every individual
- Attention to issues of national relevance as well as of global concern.
- Breadth of understanding, including knowledge of the human sciences.
- Appreciation of intellectual excellence and creativity.
- A unfettered spirit of exploration, rationality and enterprises.

Courses of Study
2006-2007

Programmes
Bachelor of Technology
5-year Dual Degree
5-year Integrated Master of Technology

Indian Institute of Technology Delhi
Hauz Khas, New Delhi

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1. INTRODUCTION

I.I.T. Delhi provides science-based engineering education with a view to produce quality engineer-scientists. The curriculum provides broad based knowledge and simultaneously builds a temper for the life long process of learning and exploring. A student needs to do compulsory foundation courses in the areas of basic sciences, humanities and social sciences and engineering sciences apart from departmental requirements. Departmental courses (core and electives) constitute 50% of the total curriculum. Further, students do open category electives to develop broad inter-disciplinary knowledge base or to specialize significantly in an area outside his parent discipline.

Medium of Instruction in the Institute is English.

1.1 Programmes

The information given in this bulletin is for the following programmes:

Bachelor of Technology: (B.Tech.) - Four year programmes

- Chemical Engineering
- Civil Engineering
- Computer Science and Engineering
- Electrical Engineering
- Electrical Engineering (Power)
- Engineering Physics
- Mechanical Engineering
- Production and Industrial Engineering
- Textile Technology

Dual-Degree: (B.Tech. and M.Tech.) - Five year programmes

- Bachelor of Technology (B. Tech.) in Biochemical Engineering and Biotechnology, and Master of Technology (M. Tech.) in Biochemical Engineering and Biotechnology
- Bachelor of Technology (B. Tech.) in Chemical Engineering, and Master of Technology (M. Tech.) in Computer Applications in Chemical Engineering
- Bachelor of Technology (B. Tech.) in Chemical Engineering, and Master of Technology (M. Tech.) in Process Engineering and Design
- Bachelor of Technology (B. Tech.) in Computer Science and Engineering, and Master of Technology (M. Tech.) in Computer Science and Engineering
- Bachelor of Technology (B. Tech.) in Electrical Engineering, and Master of Technology (M. Tech.) in Information and Communication Technology

Integrated Master of Technology: (Integrated M.Tech.) - Five year programme

- Master of Technology in Mathematics and Computing.

1.2 Accreditation

The Institute is accredited by the following professional institutions in India and abroad for the purpose of exemption from their examinations: 1.Institution of Engineers (India), 2. Ministry of Transport and Shipping, Government of India, Directorate General of Shipping, Bombay; 3. Institution of Electronics and Telecommunication Engineers (India); 4. Institution of Electrical Engineers, London; 5. Textile Institute, U.K.

The degrees are also accredited by the Association of Indian Universities and the Association of Commonwealth Universities.

1.3 Programme Structure

I.I.T, Delhi follows credit system in its academic programmes. Each course is associated with a fixed credit. All programmes are defined by its total credit requirement and a pattern of credit distribution over courses of different categories. Total credit requirement for different programmes are as follows:

(i)	B.Tech.	:	180 credits
(ii)	Dual Degree and Integrated M.Tech.	:	216-218 credits.

(a) <u>B.Tech. programmes</u>

For B.Tech. programmes and undergraduate part of the dual degree programmes, the total credits are distributed over two categories: undergraduate core (UC) and undergraduate elective (UE).

The Undergraduate core (UC) has following components:

(i) *Basic Sciences* (BS) which include Mathematics, Physics and Chemistry courses.
(ii) *Engineering Arts and Sciences* (EAS) which include fundamental engineering courses.
(iii) *Departmental Core* (DC) which include courses of relevant discipline.

Undergraduate electives (UE) courses belong to basically three categories:

(i) *Departmental Electives (DE)*: Electives related to the parent discipline.
(ii) *Humanities and Social Sciences, and Management (HM)*: Electives to provide a wide exposure to different areas of Humanities, Social Sciences and Management.
(iii) *Open Category (OC)*: Electives to provide an opportunity to the student to develop broad inter-disciplinary knowledge base or to specialize significantly in an area outside the parent discipline.

(b) Dual degree programmes

In case of Dual degree programmes, credits of the M.Tech. part are divided into two categories:

(i) *Programme Core* (PC): Core courses related to the M.Tech. specialization.
(ii) *Programme Electives* (PE): Elective courses related to the M.Tech. specialization.

(c) Integrated M.Tech. programme

Total credit for the integrated M.Tech. programme is divided into two categories:

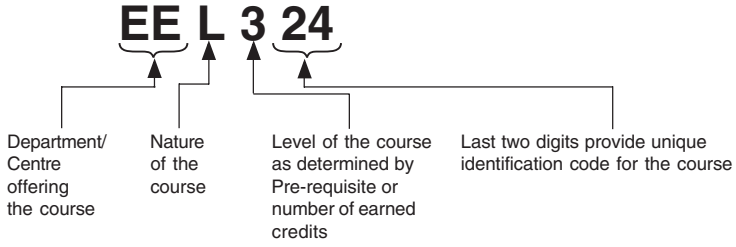
(i) *Integrated Core* (IC)
(ii) *Integrated Electives* (IE)

Integrated Core and Integrated Electives have components similar to those of the undergraduate core and undergraduate electives, respectively.

Details of the credit system and requirements of each programme are provided in Section 2.

1.4 Course Numbering Scheme

Course numbers are denoted by six alpha-numerals:



1.4.1 Department/Centre Codes

The code of the Department or Centre or School offering the courses are as under:

Code	Name of Department or Centre
AM	Department of Applied Mechanics
AS	Centre for Atmospheric Sciences
BE	Department of Biochemical Engineering and Biotechnology
BM	Centre for Biomedical Engineering
CH	Department of Chemical Engineering
CY	Department of Chemistry
CE	Department of Civil Engineering
CS	Department of Computer Science and Engineering
EE	Department of Electrical Engineering
EP	Department of Physics (Engineering Physics Courses)
ES	Centre for Energy Studies
HU	Department of Humanities and Social Sciences
IT	Industrial Tribology, Machine Dynamics and Maintenance Engineering Centre
SM	Department of Management Studies
MA	Department of Mathematics
ME	Department of Mechanical Engineering
PH	Department of Physics
PS	Centre for Polymer Science and Technology
RD	Centre for Rural Development and Technology
TT	Department of Textile Technology

1.4.2 Codes for the nature of the course

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

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.)

D Project based courses leading to dissertation (e.g. Major, Minor, Mini Projects)

T Training

C Colloquium

R Professional Practice

N Introduction to the Programme or to Humanities and Social Sciences, etc.

S Independent Study

V Special Topics Lecture Courses (1 or 2 credits)

1.4.3 Level of the Course

The first digit of the numeric part of the course code indicates level of the course as determined by pre-requisite course and/or number of earned credits. In general,

100 – 400 level courses : Core and Electives for B.Tech. programmes

700 & 800 level courses : Core and Electives for M.Tech programmes

700 level courses can be electives for B.Tech. programmes also.

1.4.4 Numbering Scheme for Courses of Special Nature

Here 'xx' is the deparment code and 'y' is the digit from the programme code.

Introduction to the Programme	**xxN1y0**
Independent Study	**xxS3y0**
Professional Practices	**xxR3y0**
Practical Training	**xxT4y0**
Colloquium	**xxC4y0**
Mini Project	**xxD1y0**
B.Tech. Major Project Part 1	**xxD4y1**
B.Tech. Major Project Part 2	**xxD4y2**
Minor Project (Dual Degree)	**xxD7y0**
M.Tech. Major Project Part 1	**xxD8y1**
M.Tech. Major Project Part 1 (alternative)	**xxD8y3**
M.Tech. Major Project Part 2	**xxD8y2**
M.Tech. Major Project Part 2 (alternative)	**xxD8y4**

1.5 Course Content Description

Course content description consists of following components: (i) Course Number, (ii) Title of the Course; (iii) Credit and L-T-P; (iv) Pre-requisites; (v) Overlapping/Equivalent Courses; and (vi) Description of the Content. Content description for all courses are given in Section 5. An example is given below:

HUL215 Econometric Methods

4 credits (3-1-0)

Pre-requisites: HUN100

Definition, scope and methodology of econometric research. Estimation and testing of hypotheses. Simple linear regression. OLS and its properties. Gauss-Markov theorem. Statistical tests of significance. Multiple regressions. Statistical tests. Heteroskedasticity. Autocorrelation. Multicollinearity. Distributed lagged models. Pooling of time series and cross-section data. Simultaneous equation systems. Identification problem. Estimation methods. ILS, 2SLS. Qualitative and limited dependent variables. Maximum likelihood methods. Forecasting.

A student will be eligible to register for a course provided he/she satisfies pre-requisites for the course. A student can register for at most one course in a set of overlapping/equivalent courses. Departments may use these overlapping/ equivalent courses for meeting degree/pre-requisite requirements in special circumstances.

1.6 Entry Number of Students

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

	2	0	0	3	A	B	C	6	7	8	9
Field no.	11	10	9	8	7	6	5	4	3	2	1
	Entry year				Programme Code			4-digit number			

Interpretations:

Fields 8 → 11 Entry year

Fields 5 → 7 Programme code
Fields 7 & 6 = Department, Center or School code
Field 5 = 0 – 9 for entry through JEE
(4-yr. B.Tech., dual degree, 5-yr. Integrated M.Tech.)

Fields 1 → 4 Unique identification number for each student

1.7 List of Programme Codes

Programme Name	Current Code	Past Code
Bachelor of Technology in Biochemical Engineering and Biotechnology, and Master of Technology in Biochemical Engineering and Biotechnology	**B B 5**	B B
Bachelor of Technology in Chemical Engineering	**C H 1**	C H
Bachelor of Technology in Chemical Engineering and Master of Technology in Computer Applications in Chemical Engineering	**C H 5**	C C
Bachelor of Technology in Chemical Engineering and Master of Technology in Process Engineering and Design	**C H 6**	C P
Bachelor of Technology in Computer Science and Engineering	**C S 1**	C S
Bachelor of Technology in Computer Science and Engineering, and Master of Technology in Computer Science and Engineering	**C S 5**	C O
Bachelor of Technology in Civil Engineering	**C E 1**	C E
Bachelor of Technology in Electrical Engineering	**E E 1**	E E
Bachelor of Technology in Electrical Engineering (Power)	**E E 2**	E P
Bachelor of Technology in Electrical Engineering, and Master of Technology in Information and Communication Technology	**E E 5**	EI
Master of Technology in Mathematics and Computing	**M T 5**	M T
Bachelor of Technology in Mechanical Engineering	**M E 1**	M E
Bachelor of Technology in Production and Industrial Engineering	**M E 2**	P E
Bachelor of Technology in Engineering Physics	**P H 1**	P H
Bachelor of Technology in Textile Engineering	**T T 1**	T T

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 will be in use.

2. CREDIT SYSTEM

2.1 Credits Assignment

Each course, except a few special courses, has a certain number of credits assigned to it depending upon its lecture, tutorial and laboratory contact hours in a week.
Lectures/Tutorials: One lecture/tutorial hour per week per semester is assigned one credit.
Practical : One laboratory hour per week per semester is assigned half credit.
A few courses are without credit and are referred to as noncredit (NC) courses.

Illustration: EEL101 Fundamentals of Electrical Engineering; 4 credits (3-0-2)

4 credit course = (**3** h Lectures **+ 0** h Tutorial + **2** h Practical) **per week**

2.2 Earning Credits

A letter grade, corresponding to specified number of grade points, is awarded in each course for which a student is 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. A student has the option of auditing some courses. Grades obtained in these audit courses are not counted for computation of grade point average. However, a pass grade is essential for earning credits from an audit course. A minimum number of credits should be acquired in order to qualify for a degree and continuation on semester or session basis.

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, subject to fulfilling minimum requirement for continuation.

2.3 Pre-requisites

Each course, other than 100 level courses, has another course or a fixed number of credits or both, specified as it's pre-requisite. A student who has not obtained a pass grade, viz., A, A(-), B, B(-), C, C(-), D, NP, in the pre-requisite or has not earned requisite number of credits will not be eligible to do that course. Examples:

AML310 Computational Mechanics
Pre-requisite: AML140/AML150/AML160/AML170/AML180/CHL231/CHL204 and E.C. 60

A student who has obtained a pass grade in any one of the courses AML140, AML150, AML160, AML170, AML180, CHL231, or CHL204, *and* has earned 60 credits will be eligible to register for this course.

BEL702 Bioprocess Plant Design
Pre-requisite: AML110 & MEL110 & CHL205 & CHL204 & BEL401 and 90 E.C.

A student who has obtained a pass grade in all these courses AML110, MEL110, CHL205, CHL204, and BEL401, *and* has earned 90 credits will be eligible to register for this course.

Pre-requisite earned credits for some courses of special nature are:

Independent Study	80
Mini Project	80
Minor Project (Dual Degree)	120
B.Tech. Major Project Part 1	120
M.Tech. Major Project Part 1 (Dual Degree /Integrated M.Tech.)	165

2.4 Overlapping/Equivalent Courses

Wherever applicable, for a given course overlapping and equivalent courses have been identified. A student is not permitted to earn credits by registering for more than one course in a set of overlapping/equivalent courses. Departments may use these overlapping/equivalent courses for meeting degree/pre-requisite requirements in special circumstances. Example:

EEL301 Control Engineering - I
Overlapped course: MEL312, CHL261

A student who has earned a pass grade in EEL301 will not be eligible to register for and earn credits, under any category, for either MEL312 or CHL261.

2.5 Course Coordinator

A member of the faculty called the course coordinator, coordinates each course. He/she has the full responsibility for coordinating the course, coordinating the work of other members of the faculty involved in that course, holding the

tests and awarding the grades. In case of any difficulty with a course, the student is expected to approach the respective course coordinator for advice and clarification.

2.6 Grading System

2.6.1 Grade Points

The grades and their equivalent numerical points are listed below:

Grade	*Points*	*Description of performance*
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
I	-	Incomplete
NP	-	Audit Pass
NF	-	Audit Fail
W	-	Withdrawal
X	-	Continued
S	-	Satisfactory completion
Z	-	Course continuation

2.6.2 Description of Grades

A Grade

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

C Grade

The 'C' grade stands for average performance. This is the minimum grade required to pass in the Major Project Part 1 and Part 2 of M.Tech. (Dual degree) and Integrated M.Tech.

D Grade

The 'D' grade stands for marginal performance; i.e. it is the minimum passing grade in any course. The minimum marks for 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 i.e. failing a course. 'F' grade is also awarded in case of poor attendance (see Attendance Rules). A student has to repeat all core courses in which she/he obtains either 'E' or 'F' grades, until a passing grade is obtained. For the other (elective) courses in which 'E' or 'F' grades have 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. 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.

I Grade

An 'I' grade denotes incomplete performance in any L (lecture), P (practical), V (Special Module) category courses. It may be awarded to a student if he/she has not fulfilled all the requirements of the course due to extra-ordinary circumstances. 'I' grade does not appear permanently in the grade card. Upon completion of all course requirements, the 'I' grade is converted to a regular grade (A to F, NP or NF).

Please see other requirements in *Regulations and Procedures*, Chapter 3.

NP and **NF** Grades

These grades are awarded in a course that the student opts to audit. Audit applications are allowed during the first four weeks of a semester. The audit pass (NP) Grade is awarded if the student's attendance is above 75% in the class and he/she has obtained at least 'D' grade unless course coordinator has specified a higher criterion at the beginning of the semester. If either of these requirements is not fulfilled, the audit fail (NF) grade is awarded. The grades obtained in an audit course are not considered in the calculation of SGPA or CGPA.

W Grade

A '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 first Minor Tests.

X Grade

The 'X' grade is awarded for incomplete work in Independent Study, Mini Project, Minor Project, Major Project – Part 1 and Part 2 (B.Tech, M.Tech.-dual degree, integrated M.Tech.) based on the application of the student. On completion of the work, X grade can be converted to a regular grade within the first week of the next semester. Otherwise, the student will be awarded '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 total load for the semester. In case of Major Project Part 1, the student will not be permitted to register for Major Project Part 2 simultaneously as Major Part 1 is a pre-requisite for Major Project Part 2. A student can be awarded 'X' grade only once in a course.

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 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 for 2003 and post-2003 entry students are:

(i) Introduction to the Programme
(ii) Practical Training
(iii) NCC/NSO/NSS
(iv) Introduction to Humanities and Social Sciences
(v) Professional Practices.

2.7 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 SGPA is calculated on the basis of grades obtained in all courses, except audit courses and courses in which S/Z grade is awarded, registered for in the particular semester:

$$\text{SGPA} = \frac{\sum_{\text{Semester}} (\text{Course credits x Grade point}) \text{ for all courses except audit \& S/Z grade courses}}{\sum_{\text{Semester}} (\text{Course credits}) \text{except audit \& S/Z grade courses}}$$

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

$$\text{CGPA} = \frac{\sum_{\text{All semesters}} (\text{Course credits x Grade point}) \text{ for all courses with pass grade except audit \& S/Z grade courses}}{\sum_{\text{All semesters}} (\text{Course credits}) \text{except audit \& S/Z grade courses}}$$

An example of these calculations is given below:

I Semester

Course No.	Course Credits	Grade Awarded	Earned Credits	Grade Points	Points Secured
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
MALXXX	5	C	5	6	30
CSLXXX	4	C(-)	4	5	20
PHPXXX	4	A	4	10	40
PHLXXX	1.5	B	1.5	8	12
MELXXX	4	E	0	2	08
AMLXXX	4	B(-)	4	7	28

Credits registered in the semester (total of column 2) = 22.5
Earned Credits in the semester (total of column 4 = total of column 2 excluding E and F grades) = 22.5 - 4 = 18.5
Points secured in this semester (total of column 6) = 138

$$SGPA = \frac{\text{Points secured in this semester}}{\text{Credits registered excluding audit \& S/Z grade courses}} = \frac{138}{22.5} = 6.133$$

$$CGPA = \frac{\text{Cumulative points secured in all passed courses}}{\text{Cumulative earned credits, excluding audit and S/Z gade courses}} = \frac{130}{18.5} = 7.027$$

II Semester

Course No.	Course Credits	Grade Awarded	Earned Credits	Grade Points	Points Secured
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
MALXXX	5	D	5	4	20
EELXXX	5	F	0	0	00
CYLXXX	4	B(-)	4	7	28
CYPXXX	1.5	C	1.5	6	09
MELXXX	4	A(-)	4	9	36
AMLXXX	5	W	0	N.A.	00
HULXXX	2	NP	2	N.A.	00

Credits registered in the semester (total of column 2 excluding W grades courses) = 21.5
Earned Credits in the semester (total of column 4 = total of column 2 excluding E and F grades) = 16.5
Cumulative Earned Credits (earned credits in previous semesters and current semester) = 35.0
Points Secured in this semester (total of column 6) = 93
Cumulative points secured (total of points secured in previous semesters and current semester) = 223

$$SGPA = \frac{\text{Points secured in this semester}}{\text{Credits registered excluding audit \& S/Z grade courses}} = \frac{93}{19.5} = 4.769$$

$$CGPA = \frac{\text{Cumulative points secured in all passed courses}}{\text{Cumulative earned credits, excluding audit and S/Z gade courses}} = \frac{130+93}{18.5+14.5} = 6.757$$

2.8 Degree Requirements

2.8.1 Earned Credits

The degree requirements for the various programmes listed earlier are as follows:

(a) Completion of 180 earned credits for 4-year B. Tech. Programmes.

(b) Completion of 216 earned credits for 5-year Integrated M.Tech. programme in Mathematics & Computing.

(c) For the 5-year Dual-Degree programmes, completion of 168-170 earned credits for the B. Tech. Degree and 48-50 earned credits for the M. Tech. Degree.

These credits are needed to be earned under different categories as specified in Section 4 for individual programmes.

2.8.2 Cumulative Grade Point Average (CGPA) Requirement

A student must obtain a minimum Cumulative Grade Point Average (CGPA) of 4.5 to be eligible for award of the B.Tech. degree and the 5-year Integrated M.Tech. degree. The minimum CGPA requirement for M.Tech. part of dual degree programme is 6.0.

All exceptions to the above conditions will be dealt with as per following regulations:

(a) If a student completes required credits for B.Tech./Integrated M. Tech. with CGPA less than 4.5, then the student will be permitted to do additional elective courses under any category to improve the CGPA within the maximum time limit for completion of B.Tech./ M.Tech. degree i.e. 6 years or 7 years, respectively, as the case may be. In case a CGPA of 4.5 or more is achieved within the stipulated period, a B.Tech./ Integrated M.Tech. Degree will be awarded and in case the same is not achieved no degree will be awarded.

(b) If a student completes requisite credits for Dual Degree Programme:

(i) <u>with B. Tech. CGPA less than 4.5 but M.Tech. CGPA more than 6.0</u>
The student will be permitted to do additional elective courses (under any category) to improve the CGPA for completion of B. Tech. part within the maximum time limit of 7 years. In case a CGPA of 4.5 or more is achieved for B.Tech., the student will be eligible for award of the Dual Degrees (B.Tech. & M. Tech.) and in case the same is not achieved no degree will be awarded.

(ii) <u>with B. Tech. CGPA more than 4.5 but M. Tech. CGPA less than 6.0</u>
The student will be eligible for grant of only B.Tech. degree provided a written request is made to the Dean, UGS. Alternatively, the student may opt to do additional elective courses (PE category only) to improve the CGPA within the maximum time limit of 7 years. If no programme elective (PE) courses are available, other relevant 700 and 800 level courses as certified by the department can be done for the purpose of improving

the CGPA. In case CGPA of 6.0 or more is achieved for the M. Tech. part, the student will be eligible for award of the dual degrees (B. Tech. & M. Tech.). However, in case the same is not achieved at the end of stipulated period, the student will be eligible for the award of only B. Tech. degree, provided a written request for the same is made to the Dean UGS.

(iii) with B. Tech. CGPA less than 4.5 and M. Tech. CGPA less than 6.0

The student will be permitted to do additional elective courses (under any category) to improve the CGPA for completion of B. Tech./M. Tech. degrees (PE category only) within the maximum time limit of 7 years. (If no programme elective courses are available, relevant 700 and 800 level courses as certified by the department can be done for the purpose of improving the CGPA of the M.Tech. part). In case a CGPA of 4.5 or more for B. Tech. and 6.0 or more for M. Tech. is achieved, the student will be eligible for award of the Dual Degrees (B. Tech. & M. Tech.). However, in case a CGPA 4.5 or more for B. Tech. is achieved but the CGPA 6.0 or more for M. Tech. is not achieved at the end of stipulated period, the student will be eligible for award of only B. Tech. degree provided a written request for the same is made to the Dean UGS.

(c) No self-study course will be permitted for the purpose of improvement of CGPA for M. Tech. or B. Tech. part.

2.8.3 Practical Training

A student of the 4-year B.Tech., 5-year Dual-degree and 5-year Integrated M.Tech. programmes must complete the prescribed number of days of practical training to the satisfaction of the concerned department. This training will be normally arranged in the summer vacation following the 6th semester. Practical training duration is a minimum of 50 working days. Practical training should be carried out preferably in industry on R&D institutions in India. Practical training in academic institutions is discouraged. Details are given in section 3.11(f).

2.8.4 NCC/NSS/NSO

All students are required to enroll for either one of NCC, NSS or NSO in their first year. This requirement should be completed in one year. If, however, a student is not able to complete this requirement in the first year, he/she must complete it by the end of the 2nd year (4th semester). See also 3.11 (a).

2.8.5 Break-up of Earned Credits

Minimum Earned Credit requirements for the B.Tech., 5-year Dual Degree and 5-year Integrated M.Tech. programmes along with detailed break-up of the credits in various categories are given below.

	Category	**Symbol**	**Programme**		
			4-year B.Tech.	**Dual degree**	**Integrated M.Tech.**
1	**UG Core**	**UC**	**111**	**99-111**	**132 (IC)**
1.1	Departmental core	DC	60 (min.)	48-50 (min.)	90
1.2	Basic Sciences	BS	20 (min.)	20 (min.)	20 (min.)
1.3	Engineering Arts and Sciences	EAS	20 (min.)	20 (min.)	20 (min.)
1.4	Humanities and Social Sciences	HU	1	1	1
2	**UG Elective**	**UE**	**70**	**70**	**84 (IE)**
2.1	Departmental electives	DE	20 (min.)	20 (min.)	40
2.2	Humanities and Social Sciences	HM	14	14	14
2.3	Open category	OC	25 (min.)	25 (min.)	30
3	**Departmental requirement**	**DC + DE**	**90**	**78-80**	**130**
4	**TOTAL REQUIREMENT**	**UR**	**180**	**168-170**	**216**
5	**PG REQUIREMENT**	**PR**		**48-50**	
5.1	**Programme core**	PC		32	
5.2	**Programme elective**	PE		16-18	
7	**TOTAL PG REQUIREMENT**	**PR**		48-50	
8	**TOTAL REQUIREMENT**	**UR+PR**		**216-218**	

Maximum of 6 credits under open category can be taken from the departmental U.G. or P.G. courses, and other programme-relevant courses as identified by the department.

Exact requirements for each programme are detailed in Section 4.

2.9 Audit Courses

Audit facility is open to all students who have completed 100 earned credits. A student will be permitted to do any number of audit courses over and above the graduation requirements. *The audit rules are*:

(a) 4-year Programme: A maximum of 8 credits from the elective courses in any category *out of 180 credits* required for B.Tech. degree may be completed on audit basis.

(b) Dual-degree Programme: A maximum of 8 credits from the elective courses in any category may be completed on audit basis from the UG part of the programme.

(c) Integrated M.Tech. Programme: A maximum of 8 credits from the elective courses in any category may be completed on audit basis.

3. REGULATIONS AND PROCEDURES

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. Each student is required to complete the registration form on the computer by indicating the slot-wise choice of courses. Web based registration facility is available only on the intranet of I.I.T. Delhi. His/Her choice must be approved by his/her adviser. The student must also take steps to pay his/her dues before the beginning of the next semester by making use of internet banking facility of SBI through the intranet of I.I.T, Delhi. 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 Dean, UGS. In case of illness or absence during registration, the student should intimate the same to his/her course adviser and Dean, UGS. A student must meet his/her advisor within the first week of the new semester for confirmation of his/her registration. A students registration record will be available on-line for reference.

3.2 Advice on Courses

At the time of registration, each student must consult his/her student adviser to finalize the academic programme, keeping in view minimum/maximum numbers of total and lecture credits, past performance, backlog of courses, SGPA/CGPA, pre-requisite, work load and student's interests. Special provisions exist for academically weak students.

3.3 Lower and Upper Limits for Credits Registered

A student must register for a minimum of 15 credits and a maximum of 26 credits in a semester. The minimum and maximum lecture credits that a student can register for in a semester are 9 and 18, respectively. For the dual-degree and Integrated M.Tech. programmes, the above limits apply up to the 8th semester. In the 9^{th} and 10^{th} semesters, these students will normally register for a minimum of 12 credits and a maximum of 22 credits per semester.

Under exceptional circumstances a student can register for a maximum of 28 credits including not more than 6 (six) 'L' (Lecture) courses. However, this will be permitted at most twice during the programme in semesters other than 1^{st} and 2^{nd} and those in which the student is registered for Major Project Part 1 or 2.

These conditions will not be applicable for those students whose load is restricted by the criteria defined in section 3.8.

3.4 Minimum Student Registration in a Course

An undergraduate course (100, 200, 300, 400 level course) will run if minimum of 12 students register for the course. Under special circumstances, a departmental elective course may be allowed to run with minimum registration of 8 students, with prior permission of Chairman, Senate. A 700 or 800 level course can run with minimum of 6 students.

3.5 Late Registration

Late registration is permitted under the following conditions:

(a) A student, who was not in the 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 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 (UGS) for late registration. Dean (UGS) will consider and may approve late registration in genuine cases on payment of an extra fee of Rs. 250/-. Late registration is permitted until one week after the start of the semester.

3.6 Addition, Deletion, Audit and Withdrawal from Courses

(a) Add/Drop: A student has the option to add or drop courses for which he/she has registered. 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 first minor test.

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

Appropriate web-based applications are to be used at the academic web site from I.I.T.Delhi intranet for availing the above options.

3.7 Attendance Requirements

3.7.1 Attendance Rule

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.**

A student with less than 75 % attendance in a course during the semester, in lectures, tutorials and practicals taken together (as applicable), will be awarded an 'F' grade in that course irrespective of his/her performance in the tests. **The course coordinator will award 'F' grade to the student who is deficient in attendance** taking into account the consolidated attendance record for the whole semester.

For the purpose of attendance calculation, every scheduled 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 practicals together, as applicable).

3.7.2 Absence during the semester

(a) A student must inform the Dean, UGS 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 a minor test due to illness should approach the course coordinator for a make-up test immediately on return to class. The request should be supported with a medical certificate from institute's medical officer. A certificate from a registered medical practitioner will also be acceptable for a student normally residing off-campus provided registration number of the medical practitioner appears explicitly on the certificate.

(d) In case a student cannot appear in a minor test on the same day in which he/she has appeared in a test, a medical certificate only from the institute's medical officer will be acceptable.

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

(f) In special situations arising due to the student's inability to be present at the institute during the stipulated period, in (e) 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 Dean, UGS on recommendations of the concerned Head of the department, course coordinators and concerned warden. A request to this effect must be included in the application for I-grade.

(g) In case 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. Dean (UGS), depending on the merit of the case, will approve such applications. Partial withdrawal from courses registered in a semester is not allowed.

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

3.8 Academic Performance Monitoring and Load Restriction

The Standing Review Committee of the Senate (SRC) monitors the academic performance of students at the end of each semester.

3.8.1 Identification of Students for Load Restriction

At the end of each semester, students will be identified by the following criteria for restricted load:

(a) If Cumulative Earned Credits falls below 16 times the number of regular semesters spent by the student at IIT Delhi; or

(b) If CGPA (B.Tech. CGPA for dual-degree students) falls to 4.75 or less and SGPA is less than 6.

A student thus identified will not be permitted to register for more than 20 credits in a semester. In rare cases, Dean, UGS can permit relaxation of this limit.

3.8.2 Identification of Students for Monitoring

At the end of each semester, students will be identified by the following criteria for monitoring of their academic performance and appropriate advice:

(a) SGPA of a student falling 2 points below that of the previous semester; or

(b) M. Tech. CGPA for dual degree students falling below 6.25; or

(c) Students whose load has been restricted.

3.9 Termination of Registration due to Unsatisfactory Academic Performance

The SRC while reviewing the academic performance of weak students would also recommend termination of registration if a student fails to satisfy the minimum academic criteria laid down for continuation as a student at the end of each semester.

1st year students: A student in general category must complete at least 20 credits at the end of the 2nd semester of his/her stay in the Institute, failing which his/her registration would be terminated and no appeal would be allowed. A student in SC/ST/PH category must complete at least 16 credits at the end of the 2nd semester of his/her stay in the Institute failing which his/her registration would be terminated and no appeal would be allowed.

2nd year students: A student in general category must complete at least 50 credits at the end of 4th semester of his/her stay in the Institute, failing which his/her registration would be terminated and no appeal would be allowed. A student in SC/ST/PH category must complete at least 46 credits at the end of 4th semester of his/her stay in the Institute failing which his/her registration would be terminated and no appeal would be allowed.

3rd year onwards: A student's registration may be terminated at the end of 3rd year, 4th year or 5th year if he/she fails to earn at least 84, 120 or 156 credits, respectively. The student may appeal against termination within the first week of the next semester.

In case a student has withdrawn for one or more semesters, the earned credit requirements would be reduced by 10 credits for each semester of withdrawal in the 1st year, and by 16 credits for each semester of withdrawal in the 2nd

year onwards. However, if at any stage, the number of credits required is more than 26**N* where *N* is the number of semesters left, the registration would be terminated without giving any opportunity to appeal.
A summary of the above criterion is presented in the following table:

Year	Semester	For General Category Students		For SC/ST/PH Category Students	
		With appeal allowed	With no appeal	With appeal allowed	With no appeal
1	I	-	-	-	-
	II	-	20	-	16
2	I	-	-	-	-
	II	-	50	-	46
3	I	-	-	-	-
	II	84	-	84	-
4	I	-	-	-	-
	II	120	76 □	120	76 □
5	I	-	102	-	102
	II	156	128 □	156	128 □
6	I	-	154	-	154
	II	180	180 □	180	180 □

NOTE: □ implies that credits are checked after the summer semester of that year.

3.10 Preparatory English Course

Students who are declared deficient in English will be prescribed a preparatory English course (HUL101) in the first semester. It will be a regular course and credits earned by successful completion of this course will be counted towards Open Category requirement. The student is required to get valid pass grade in this course in order to be eligible for graduation.

3.11 Courses of Special Nature

Courses of special nature are: National Cadet Corps (N.C.C.), National Sports Organization (N.S.O.) and National Service Scheme (N.S.S); Introduction to the Programme, Introduction to Humanities and Social Sciences; Independent Study, Mini Project. Practical Training; Colloquium; and Major Project. Salient features of these courses are given below.

(a) N.C.C., N.S.O. and N.S.S.

Satisfactory completion of one of these courses is a non-credit (NC) mandatory requirement and every student is required to complete this course in the first year by participating in the prescribed requirements. Additional information about these activities is given in the *Prospectus* (see Chapter 7). At the time of joining the Institute, all students have to opt for one of these three activities. Based on facilities available, a student will be enrolled in one of these and he/she will be registered in the corresponding course: NCN100 for N.C.C., NSN100 for N.S.S., and NPN100 for N.S.O. An 'S' grade in these courses will be awarded on successful completion of 50 hours of prescribed activities in a semester. The hours completed during one semester will NOT be carried over to the next semester. Every student is required to obtain an 'S' grade in NCN100/NSN100/NPN100 in two semesters. This requirement should preferably be completed in the first year, but not later than the end of his/her second year (4th semester). If a student does not complete these requirements within the first two years of his/her stay at the Institute, he/she will not be allowed to register for any course except NCN100/NSN100/NPN100.

(b) Introduction to the Programme

A student is introduced to his/her engineering discipline through this course in the first semester itself. This course is a 2 credit compulsory course. A student is required to complete this course in the first year by attending at least 75 % of the classes for getting 'S' grade. In case, a student is not able to complete it in the first year, he/she must do so by the end of the second year, otherwise he/she will not be allowed to register in the 3rd year, as is the case for NCC/NSS/NSO courses.

(c) Introduction to Humanities and Social Sciences

A student is exposed to various facets of humanities and social sciences through this course. This is a compulsory

1 credit course that is normally done in first year. In case, a student is not able to complete it in the first year, he/she must do so by the end of the second year, otherwise he/she will not be allowed to register in the 3rd year, as is the case for NCC/NSS/NSO courses.

(d) Independent Study

'Independent Study' is an elective course that some departments may offer from fourth semester onwards. It is a 3-credit course covering:

(i) In-depth study and critical review of a specified topic;
(ii) Specialized laboratory work/experimental project/feasibility study;
(iii) Work on a research project;
(iv) Software development on a specified topic.

An individual student and teacher should decide upon the topic and submit an initial write-up to get the approval of *the Course Coordinator* before the end of the semester when the course is registered for (i.e. in the semester prior to doing the course). The duration of the course will be the entire semester. A written report should be submitted by the student on completion of the course. The student's performance will be evaluated by a departmental committee via a mid-term and final evaluation. A student has to earn 80 credits and obtain at least 7.5 CGPA to become eligible to do Independent Study.

(e) Mini Project

An elective course under this title may be floated by departments from fifth semester onwards. Mini project will be a regular course to conduct a design and fabrication type project. The student and teacher would decide upon the topic, prepare a plan of work and get the approval of the *Course Coordinator* before the end of the semester when the course is registered for. The duration of the course will be the entire semester. A project report would be submitted by the student on completion of the course. The student's performance will be evaluated by a departmental committee via a mid-term and a final evaluation. Mini-project can be done jointly by 2 students, each having earned 80 credits with a CGPA of at least 6.5. A dual degree student can do either Mini Project or Minor Project.

(f) Practical Training

Practical Training is a non-credit departmental core course (NC) to be done typically in the summer semester following sixth semester. A student who has earned at least 90 credits at the end of 5 semesters is eligible to undergo practical training in the summer following sixth semester for 50 working days, preferably in an industry or R&D institution in India. Practical training in academic institutions is discouraged.

It is the joint responsibility of the departments and the T&P unit to arrange for training for all their students. In the beginning of each academic session, T&P unit will prepare programme wise lists of potential training organizations in consultation with the respective departments. These organizations will be approached by the T&P unit with a request to provide training seats. Consolidated lists of training offers will be made available to the students through departments in the beginning of second semester of the session. If a student is interested in making his/her own arrangement for the training seat, he/she will need to have the training organization approved and route the application through the departmental training incharge and T&P unit. All such applications must be completed before the end of first semester.

The department will appoint a training supervisor for each student. The supervisor is expected to keep contact with the assigned students through e-mail and /or telephone. The students will be required to get their training plan reviewed by their supervisor within the first week and report their progress on weekly basis. Supervisor, if desires, may visit the organization. Visits within the country will be supported by the institute.

A student will be registered for practical training course in the summer semester in which the training is being done. The Department will scrutinize the training report and the training certificate and will award 'S' grade within the next semester, if the training is satisfactory. In case the training is considered to be unsatisfactory, a 'Z' grade will be awarded and the student may have to undergo fresh practical training for a part or full duration. Practical Training and submission of summer training report is a mandatory requirement for graduation.

(g) Colloquium

Colloquium is a 3-credit course and includes assessment of practical training. A student will be eligible to do Colloquium if he/she had registered for Practical Training earlier. Typically, a student will register for Colloquium in the regular semester following the summer semester in which he/she has done the practical training.

(h) Major Project

The Major Project is a core course spread over at least two regular semesters and comprises of Part 1 and Part 2. The allocation of major projects, faculty guides and tentative plan of work are to be done typically before the last day

of classes of the 6th semester (for 4 year programmes) and 8th semester (for dual-degree and integrated M.Tech. programmes). Part 2 is normally expected to be a continuation of Part 1, except under those exceptional circumstances in which the supervisor (guide) is changed at the end of Part 1. A mid-term assessment and an end semester assessment will be carried out for each part. Part 1 and Part 2 will be graded separately. **C grade is considered as the minimum pass grade in each part of the M.Tech. Major Project in Dual Degree and Integrated M.Tech. programmes.**

A student must have obtained a pass grade in Project Part 1 in order to be eligible for registering for Project Part 2.

Major project for the dual degree and Integrated M. Tech. programmes will be spanned over one summer semester and two regular semesters. Typically a student will register for the Part 1 of major project (xxD8y1 - 6 credits) in the summer semester following eighth semester. He/she will be automatically awarded an X-grade in the summer semester unless he/she is awarded an F grade. If a student is awarded X grade, he/she will be automatically registered for M.Tech. Project Part 1 (xxD8y1) in the following regular semester. Mid-term evaluation of the M.Tech. Project Part 1 will be held within first two weeks of the corresponding semester. At the end of the regular semester, the student will be awarded a proper grade in M.Tech. Project Part 1 (xxD8y1). If he/she obtains a valid pass grade in this course, he/she can register for M.Tech. Project Part 2 (xxD8y2-14 credits) in the following regular semester. His/her M.Tech. Project Part 2 will be evaluated at the end of the corresponding semester as per the stipulated deadline (normally before 31st May).

In case a student does not obtain an X-grade in M.Tech. Project Part 1 in the summer semester, he/she will require permission from the Head of the Department to register for M.Tech. Project Part 1 in a regular semester. In this situation, he/she will register for M.Tech. Project Part 1 with reduced credits, viz. 4 credits (xxD8y3). After completing this course with a valid pass grade he/she will be required to register for M.Tech. Project Part 2 with 16 credits (xxD8y4). In this case the project will either start in the regular semester and extend into the following summer semester or start in the summer semester and extend into the following regular semester. M.Tech. Project Part 2 will be evaluated taking into account the work done in both the semesters. Extension from one semester to the other will be permitted automatically by awarding X-grade to the student. An F grade instead of X will bar a student from continuing the M.Tech. Project Part 2 in the following semester. The student will need to do fresh registration for M.Tech. Project Part 2.

(xxD8ym – is the course number for M.Tech. Major Project as explained in section 1.4.4)

3.12 Minor Area

3.12.1 A set of pre-defined courses of total 20 credits in a focus area comprises a Minor Area. A student can use Open Category (OC) credits to complete the specific requirements.

3.12.2 Any student is eligible to take the Minor Area at the end of the 3rd semester and may register for Minor Area courses from 4th semester onwards.

3.12.3 Registration for a Minor Area is not mandatory. If a student succeeds in completing the requirements during his/her stay in the institute, then the Minor Area will be mentioned on the degree certificate.

3.12.4 A student registered in any programme of a specific department will not be eligible to take the minor area(s) offered by the same department; additional conditions and details of individual minor areas are given in Section 5.

3.12.5 If any course of a minor area overlaps with any core course (DC or PC category courses) or elective course (DE or PE category courses) of the student's programme, then credits from this course will not count towards the minor area credit requirements, though this course may contribute towards satisfying the core (or elective) requirement of the minor area. In such a case, the requirement of 20 credits must be completed by taking other courses of the minor area.

For example, a student of BB5 programme intending to complete the minor area *Computational Mechanics* (that has CHL204, or any of its alternates, and AML310 as core courses) will take CHL204 as a DC category course and complete the minor area requirements by completing AML310 (core course of the minor area) and 16 credits (4 courses in this case) from the listed minor area elective courses, viz. AML410 AML430, AML440, AML705, and AML710.

3.12.6 For purposes of completing minor area requirements, the listed minor area course may be substituted by an equivalent course so identified in the course descriptions.

3.13 Self-study Course

A self-study course will be from the regular UG courses listed in the *Programme Bulletin*. The main features of a self-study course are as follows:

(a) A student may be given a self-study course of weightage not exceeding 5 credits in the final semester if he/she is short by a maximum of 5 earned credits required for graduation provided that the course is not running

in that semester as a regular course. Students in the Dual-degree and Integrated M.Tech. programmes are allowed to avail of this provision during their last semester. However, they would be permitted to take only a UG course as a possible self-study course. A student can make use of this provision only once during the programme.

(b) A student may also be permitted to do a U.G. (UC/IC) core course not exceeding 5 credits in self-study mode at most once during the program, provided he/she has failed in it earlier and the course is not being offered as a regular course during that semester.

(c) Students should apply for a self-study course with appropriate recommendation of the Course Coordinator and the Head of the Department of the student's programme. The final sanction of a self-study course to a student is made by the Dean, UGS.

(d) Grant of a course to be taken as a self-study course cannot be claimed by any student as a matter of right.

(e) Normally, no formal lectures will be held for a self-study course but laboratory, design and computation exercises will be conducted if they form an integral part of the course.

(f) The Course Coordinator will hold minor and major tests besides other tests/quizzes for giving his/her assessment at the end of the semester. In summer semester, there will be at least one mid semester test and a major test.

(g) The self-study course will run during the total duration of the semester (including summer semester).

(h) The grades after due moderation by the Moderation Committee will be sent by the Department to Officer In-charge (UGS) at the end of the semester along with grades of all other courses.

(i) Colloquium will not be offered as a self-study course.

3.14 Summer Semester

In the summer semester, registration for 'L' (lecture) and 'P' (practical) category courses will be strictly limited to the students who have obtained an E grade in the subject earlier or whose load has been restricted by SRC. In a summer semester, a student cannot earn more than 12 credits (in all the categories) except when he/she is registered for M.Tech. Project Part 2 with maximum of 16 credits.

A summer course will run only if there is a minimum registration of 5 students.

3.15 Assistantship for Dual-degree and Integrated M.Tech. Programmes

The students of dual-degree programmes and 5 year integrated M.Tech programmes will be considered for award of institute research/teaching assistantship if they have earned 165 credits. Only those students who have qualified GATE / have CGPA more than 8.0 will be eligible for this assistantship. The assistantship will be provided for a maximum period of 14 months beginning from the summer semester following 8^{th} semester, provided the student is registered for M.Tech major project part-I in that semester. The student will be required to provide 8 hours of assistance per week besides his normal academic work. For continuation of assistantship a student will need to secure SGPA of 7.0. A student will be eligible to receive assistantship from sources other than institute fund or MHRD if he/she has a CGPA of 7.0 and has earned 165 credits.

A student receiving assistantship will be eligible for total of 30 days leave during the 14-month period. He/she will not be entitled to mid-semester breaks, winter and summer vacations.

3.16 Change of Programme

The following regulations apply for change of programme.

(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 general category student :$\geq$ 7.50
(ii) CGPA for SC/ST/PH category student : $\geq$ 6.50
(iii) Earned credits at the end of first academic session : $\geq$ 40

(b) Change of the discipline will be permitted strictly in the order of merit as determined by their CGPA at the end of 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 the sanctioned strength and the strength of the discipline from which transfer is being sought does not fall below 90% of existing strength.

(c) For a student with CGPA 9.0 or more, even if a vacancy does not exist, he/she will be permitted to change provided the strength in the discipline to which the change is being sought does not exceed by 5% of the approved strength.

(d) A student with CGPA 9.0 or more will be permitted to change discipline even if strength of discipline from which change is being sought falls below 90% of the existing strength.

(e) Stipulation of minimum credits and CGPA requirements will not be insisted upon for change of discipline to a branch in which a vacancy exists and the concerned student was eligible for admission to that discipline at the time of entry to IIT Delhi. However, requirements of credits and CGPA will continue to apply in case of both general and SC/ST category students seeking change to a discipline to which the concerned student was not eligible for admission at the time of entry to IIT Delhi.

3.17 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 described in the *Prospectus*.

4. PROGRAMME STRUCTURES

Programme Code: CH1 / (CH)

Bachelor of Technology in Chemical Engineering

Department of Chemical Engineering

The overall credits structure

Undergraduate Core (UC)		Undergraduate Elective (UE)	
Category	**Credits**	**Category**	**Credits**
DC	70	DE	20
BS	20	HM	14
EAS	20	OC	35
HU	1		
TOTAL	*111*	*TOTAL*	*69*

Total credits = 180

Basic Sciences (BS) Core

CYL110	Physical Chemistry: Concepts and Applications	3-1-0	**4**
CYL120	Inorganic and Organic Chemistry: Concepts and Applications	3-1-0	**4**
CYP100	Chemistry Laboratory	0-0-4	**2**
MAL110	Mathematics - I	3-1-0	**4**
MAL120	Mathematics - II	3-1-0	**4**
PHP100	Physics Laboratory	0-0-4	**2**
	TOTAL BS Core	**12-4-8**	**20**

Engineering Arts and Sciences (EAS) Core

AML120	Materials Science	3-0-2	**4**
CSL101	Introduction to Computers and Programming OR	3-0-2	**4**
CSL102	Introduction to Computer Science	3-0-2	**4**
EEL102	Principles of Electrical Engineering	3-0-2	**4**
MEL110	Graphic Science	2-0-4	**4**
MEL120	Manufacturing Practices	2-0-4	**4**
	TOTAL EAS Core	**13-0-14**	**20**

Humanities and Social Sciences (HU) Core

HUN100	Introduction to Humanities and Social Sciences	1-0-0	**1**

Departmental Core (DC)

CHC410	Colloquium (CH)	0-3-0	**3**
CHD411	Major Project Part 1 (CH)	0-0-8	**4**
CHD412	Major Project Part 2 (CH)	0-0-12	**6**
CHL110	Transport Phenomena	3-1-0	**4**
CHL111	Material and Energy Balance	2-2-0	**4**
CHL112	Chemical Process Technology	3-1-0	**4**
CHL121	Chemical Engineering Thermodynamics	3-1-0	**4**
CHL122	Chemical Reaction Engineering – I	3-1-0	**4**
CHL221	Chemical Reaction Engineering – II	3-1-0	**4**
CHL231	Fluid Mechanics for Chemical Engineers	3-1-0	**4**
CHL251	Heat and Mass Transfer	3-1-0	**4**
CHL261	Instrumentation and Process Control	3-1-0	**4**
CHL331	Fluid-particle Mechanics	3-1-0	**4**
CHL351	Mass Transfer Operations	3-1-0	**4**
CHL471	Process Equipment Design and Economics	3-0-3	**4.5**
CHN110	Introduction to Chemical Engineering	0-0-4	**2**
CHP301	Fluid Mechanics and Heat Transfer Laboratory	0-0-3	**1.5**
CHP302	Mass Transfer and Fluid Particle Mechanics Laboratory	0-0-3	**1.5**
CHP303	Chemical Reaction Engineering and Process Control Laboratory	0-0-3	**1.5**
CHP311	Design and Laboratory Practices	0-0-4	**2**
CHT410	Practical Training (CH)	—	**NC**
	TOTAL DC	**35-15-40**	**70**

Departmental Electives (DE)

CHD310	Mini Project (CH)	0-0-6	**3**
CHL133	Powder Processing and Technology	3-1-0	**4**
CHL260	Applications of Programming in Chemical Engineering	3-0-2	**4**
CHL275	Safety and Hazards in the Process Industries	3-1-0	**4**
CHL277	Materials of Construction	3-0-0	**3**
CHL291	Introduction to Biochemical Engineering	3-1-0	**4**
CHL296	Nano Engineering of Soft Materials	3-0-0	**3**
CHL332	Fluidization Engineering	3-1-0	**4**
CHL353	Modern Separation Processes	3-1-0	**4**
CHL390	Process Utilities and Pipeline Design	3-0-2	**4**
CHL392	Polymer Science and Engineering	3-1-0	**4**
CHL705	Electrokinetic Transport Phenomena	3-0-2	**4**
CHL707	Adsorption Separation Processes	3-0-0	**3**
CHL710	Process Dynamics and Control	3-1-2	**5**
CHL724	Environmental Engineering and Waste Management	3-1-0	**4**
CHL727	Heterogeneous Catalysis and Catalytic Reactors	3-0-2	**4**
CHL743	Petrochemical Technology	3-0-0	**3**
CHL751	Multi-component Mass Transfer	3-0-0	**3**
CHL766	Interfacial Engineering	3-0-0	**3**
CHL768	Fundamentals of Computational Fluid Dynamics	2-0-2	**3**
CHL773	Planning of Experiments and Analysis of Engineering Data	3-0-2	**4**
CHL774	Process Optimization	3-0-2	**4**
CHL793	Membrane Science and Engineering	3-0-0	**3**
CHL794	Petroleum Refinery Engineering	3-0-2	**4**
CHR310	Professional Practices (CH)	0-1-2	**2**
CHS310	Independent Study (CH)	0-3-0	**3**

B.Tech. in Chemical Engineering (CH) **CH1**

Sem.										Lect Courses	L	T	P	Weekly contact	Credits
I	CHN110 Intr to Chem Engg (0 - 0 - 4) 2	CSL101/102 Int Comp Prg/Sc (3 - 0 - 2) 4	MEL110 Graphic Science (2 - 0 - 4) 4	MAL110 Mathematics - I (3 - 1 - 0) 4	CYL110 Physical Chem. (3 - 1 - 0) 4	CYP100 Chemistry Lab (0 - 0 - 4) 2				*4*	11	2	14	27	**20**
II	CHL110 Transp Phen (3 - 1 - 0) 4	EEL102 Prin Elec Engg (3 - 0 - 2) 4	MEL120 Mfg Practices (2 - 0 - 4) 4	MAL120 Mathematics - II (3 - 1 - 0) 4	CYL120 Inorg & Org Chem. (3 - 1 - 0) 4	PHP100 Physics Lab (0 - 0 - 4) 2			HUN100 Intro Hu & So Sc (1 - 0 - 0) 1	*5*	15	3	10	28	**23**
III	CHL111 Matl Energy Bal. (2 - 2 - 0) 4	CHL121 Ch Engg Thermo (3 - 1 - 0) 4	CHL231 Fl Mech Ch Engr (3 - 1 - 0) 4	CHL251 Heat Mass Transf (3 - 1 - 0) 4	AML120 Materials Science (3 - 0 - 2) 4				*HUL2xx* Hu. & So. Sc. #1 (3 - 1 - 0) 4	*6*	17	6	2	25	**24**
IV	CHL112 Chem Proc Techn (3 - 1 - 0) 4	CHL122 Ch React Engg-I (3 - 1 - 0) 4	CHP311 Des Lab Practices (0 - 0 - 4) 2	CHL351 Mass Transf Oprns (3 - 1 - 0) 4	CHP301 F M & H T Lab (0 - 0 - 3) 1.5			*OC-1* (3 - 1 - 0) 4	*HUL2xx* Hu. & So. Sc. #2 (3 - 1 - 0) 4	*5*	15	5	7	27	**23.5**
V	CHL221 Ch React Engg-II (3 - 1 - 0) 4	CHL261 Instr Proc Control (3 - 1 - 0) 4	CHL331 Fluid-particle Mech. (3 - 1 - 0) 4	CHP302 M T & F P M Lab (0 - 0 - 3) 1.5			*OC-2* (3 - 1 - 0) 4	*OC-3* (3 - 1 - 0) 4	*HUL2xx* Hu. & So. Sc. #3 (2 - 1 - 0) 3	*6*	17	6	3	26	**24.5**
VI	CHL471 Proc Eq Des Eco (3 - 0 - 3) 4.5	CHP303 Ch RE & PC Lab (0 - 0 - 3) 1.5		**DE-1** (3 - 1 - 0) 4	**DE-2** (3 - 1 - 0) 4		*OC-4* (3 - 1 - 0) 4	*OC-5* (3 - 1 - 0) 4		*5*	15	4	6	25	**22**
summer	CHT410 Practical Training (CH)									*NC*					
VII	CHC410 Colloquium (CH) (0 - 3 - 0) 3	CHD411 Maj Proj P-1 (CH) (0 - 0 - 8) 4		**DE-3** (3 - 1 - 0) 4	**DE-4** (3 - 1 - 0) 4		*OC-6* (3 - 0 - 0) 3	*OC-7* (3 - 1 - 0) 4	*HUL2xx* Hu. & So. Sc. #4 (2 - 1 - 0) 3	*5*	14	7	8	29	**25**
VIII		CHD412 Maj Proj P-2 (CH) (0 - 0 - 12) 6		**DE-5** (3 - 1 - 0) 4			*OC-8* (3 - 1 - 0) 4	*OC-9* (3 - 1 - 0) 4		*3*	9	3	12	24	**18**

Reqd. DE=20, plan DE = 5@4 = 20 cr. from 5 courses.

Reqd. OC=35, plan OC = 8@4 + 1@3 = 35 cr. from 9 courses.

HU = 2@4 + 2@3 + 1@1= 15 cr. from 4 courses & 1 Intro.

DC = 70, EAS = 20, BS = 20

TOTAL = 180.0

Programme Code: CE1 / (CE)

Bachelor of Technology in Civil Engineering

Department of Civil Engineering

The overall credits structure

Undergraduate Core (UC)		Undergraduate Elective (UE)	
Category	**Credits**	**Category**	**Credits**
DC	69	DE	21
BS	20	HM	14
EAS	21	OC	34
HU	1		
TOTAL	*111*	*TOTAL*	*69*

Total credits = 180

Basic Sciences (BS) Core

CYL110	Physical Chemistry: Concepts and Applications	3-1-0	**4**
CYP100	Chemistry Laboratory	0-0-4	**2**
MAL110	Mathematics - I	3-1-0	**4**
MAL120	Mathematics - II	3-1-0	**4**
PHL110	Fields and Waves	3-1-0	**4**
PHP100	Physics Laboratory	0-0-4	**2**
	TOTAL BS Core	**12-4-8**	**20**

Engineering Arts and Sciences (EAS) Core

AML110	Engineering Mechanics	3-0-2	**4**
AML120	Materials Science	3-0-2	**4**
AML150	Mechanics of Solids and Fluids	3-1-2	**5**
CSL101	Introduction to Computers and Programming	3-0-2	**4**
	OR		
CSL102	Introduction to Computer Science	3-0-2	**4**
MEL110	Graphic Science	2-0-4	**4**
	TOTAL EAS Core	**14-1-12**	**21**

Humanities and Social Sciences (HU) Core

HUN100	Introduction to Humanities and Social Sciences	1-0-0	**1**

Departmental Core (DC)

CEC410	Colloquium (CE)	0-3-0	**3**
CED411	Major Project Part 1 (CE)	0-0-6	**3**
CED412	Major Project Part 2 (CE)	0-0-14	**7**
CEL212	Environmental Engineering	3-0-2	**4**
CEL222	Engineering Geology and Soil Mechanics	3-1-3	**5.5**
CEL231	Structural Analysis – I	3-1-2	**5**
CEL232	Concrete Material and Design	3-1-4	**6**
CEL241	Transportation Engineering – I	3-0-2	**4**
CEL251	Hydrology and Hydraulics	3-1-4	**6**
CEL271	Elements of Surveying	2-0-2	**3**
CEL321	Geotechnical Engineering	3-1-3	**5.5**
CEL331	Structural Analysis – II	3-1-2	**5**
CEL332	Design of Steel Structures	3-1-2	**5**
CEL351	Design of Hydraulic Structures	2-0-2	**3**
CEN110	Introduction to Civil Engineering	0-0-4	**2**
CEP200	Design Concepts in Civil Engineering	0-0-4	**2**
CET410	Practical Training (CE)	—	**NC**
	TOTAL DC	**31-10-56**	**69**

Departmental Electives (DE)

CED310	Mini Project (CE)	0-0-6	**3**
CEL311	Advanced Water and Wastewater Engineering	3-0-2	**4**
CEL341	Transportation Engineering – II	3-1-0	**4**
CEL362	Construction Management	3-1-0	**4**
CEL411	Industrial Waste Management	3-0-0	**3**
CEL412	Environmental Assessment Methodologies	3-0-0	**3**
CEL421	Ground Improvement	3-0-2	**4**
CEL422	Rock Engineering	3-0-0	**3**
CEL423	Designs of Foundation, Earth and Earth Retaining Structures	3-1-0	**4**
CEL431	Advanced Structural Analysis	2-0-2	**3**
CEL432	Design of Prestressed Concrete and Industrial Structures	3-0-2	**4**
CEL433	Advanced Structural Design	3-0-2	**4**
CEL442	Traffic and Transportation Planning	2-1-0	**3**
CEL443	Transportation Safety and Environment	3-0-0	**3**
CEL451	Water Power Engineering	3-0-2	**4**
CEL453	Water Resources Management	3-1-0	**4**
CEL459	River Mechanics	2-0-2	**3**
CEL464	Construction Contract and Economics	2-1-0	**3**
CEL466	Construction Equipment and Methods	2-1-0	**3**
CEP452	Computational Aspects in Water Resources	1-0-4	**3**

B.Tech. in Civil Engineering (CE) **CE1**

Sem.										Lect Courses	L	T	P	Weekly contact	Credits
I	CEN110 Intro to Civil Engg (0 - 0 - 4) 2	AML110 Engg Mechanics (3 - 0 - 2) 4	AML120 Materials Science (3 - 0 - 2) 4	MAL110 Mathematics - I (3 - 1 - 0) 4	PHL110 Fields & Waves (3 - 1 - 0) 4	PHP100 Physics Lab (0 - 0 - 4) 2			HUN100 Intro Hu & So Sc (1 - 0 - 0) 1	*4*	13	2	12	27	**21**
II	AML150 Mech Fluid Solid (3 - 1 - 2) 5	CSL101/102 Int Comp Prg/Sc (3 - 0 - 2) 4	MEL110 Graphic Science (2 - 0 - 4) 4	MAL120 Mathematics - II (3 - 1 - 0) 4	CYL110 Physical Chem. (3 - 1 - 0) 4	CYP100 Chemistry Lab (0 - 0 - 4) 2				*5*	14	3	12	29	**23**
III	CEL231 Struc. Analysis - I (3 - 1 - 2) 5	CEL241 Transp. Engg. - I (3 - 0 - 2) 4	CEL251 Hydrol. Hydraul. (3 - 1 - 4) 6	CEL271 Ele. Surveying (2 - 0 - 2) 3				*OC-1* (3 - 0 - 0) 3	*HUL2xx* Hu. & So. Sc. #1 (3 - 1 - 0) 4	*6*	17	3	10	30	**25**
IV	CEL212 Environ. Engg. (3 - 0 - 2) 4	CEL222 Eng Geo So Mech (3 - 1 - 3) 5.5	CEL232 Conc Matl & Des. (3 - 1 - 4) 6	CEL351 Des Hydraulic Str. (2 - 0 - 2) 3	CEP200 Des Concept CE (0 - 0 - 4) 2				*HUL2xx* Hu. & So. Sc. #2 (2 - 1 - 0) 3	*5*	13	3	15	31	**23.5**
V	CEL321 Geotech. Engg. (3 - 1 - 3) 5.5	CEL331 Struc. Analysis - II (3 - 1 - 2) 5					*OC-2* (3 - 1 - 0) 4	*OC-3* (3 - 1 - 0) 4	*HUL2xx* Hu. & So. Sc. #3 (3 - 1 - 0) 4	*5*	15	5	5	25	**22.5**
VI	CEL332 Design Steel Str. (3 - 1 - 2) 5			**DE-1** (3 - 1 - 0) 4		*OC-4* (3 - 1 - 0) 4	*OC-5* (3 - 0 - 2) 4	*OC-6* (3 - 0 - 2) 4	*HUL2xx* Hu. & So. Sc. #4 (2 - 1 - 0) 3	*6*	17	4	6	27	**24**
summer	CET410 Practical Training (CE)									*NC*					
VII	CEC410 Colloquium (CE) (0 - 3 - 0) 3	CED411 Maj Proj Pt 1 (CE) (0 - 0 - 6) 3	**DE-2** (3 - 0 - 0) 3	**DE-3** (3 - 1 - 0) 4	**DE-4** (3 - 0 - 0) 3		*OC-7* (3 - 1 - 0) 4	*OC-8* (3 - 0 - 0) 3		*5*	15	5	6	26	**23**
VIII		CED412 Maj Proj Pt 2 (CE) (0 - 0 - 14) 7		**DE-5** (3 - 1 - 0) 4	**DE-6** (3 - 0 - 0) 3		*OC-9* (3 - 0 - 2) 4			*3*	9	1	16	26	**18**

Reqd. DE=21, plan DE = 3@4 + 3@3 = 21 cr. from 6 courses. HU = 2@4 + 2@3 + 1@1= 15 cr. from 4 courses & 1 Intro. **TOTAL = 180.0**

Reqd. OC=34, plan OC = 7@4 + 2@3 = 34 cr. from 9 courses. **DC = 69, EAS = 21, BS = 20**

Programme Code: CS1 / (CS)

Bachelor of Technology in Computer Science and Engineering

Department of Computer Science and Engineering

The overall credits structure

Undergraduate Core (UC)		Undergraduate Elective (UE)	
Category	**Credits**	**Category**	**Credits**
DC	66	DE	24
BS	24	HM	14
EAS	20	OC	31
HU	1		
TOTAL	*111*	*TOTAL*	*69*

Total credits = 180

Basic Sciences (BS) Core

CYL110	Physical Chemistry: Concepts and Applications	3-1-0	**4**
CYP100	Chemistry Laboratory	0-0-4	**2**
MAL111	Introduction to Analysis and Differential Equations	3-1-0	**4**
MAL124	Introduction to Algebra and Matrix Analysis	3-1-0	**4**
PHL110	Fields and Waves	3-1-0	**4**
PHL120	Physics of Materials	3-1-0	**4**
PHP100	Physics Laboratory	0-0-4	**2**
	TOTAL BS Core	**15-5-8**	**24**

Engineering Arts and Sciences (EAS) Core

AML110	Engineering Mechanics	3-0-2	**4**
CSL101	Introduction to Computers and Programming	3-0-2	**4**
	OR		
CSL102	Introduction to Computer Science	3-0-2	**4**
EEL101	Fundamentals of Electrical Engineering	3-0-2	**4**
MEL110	Graphic Science	2-0-4	**4**
MEL120	Manufacturing Practices	2-0-4	**4**
	TOTAL EAS Core	**13-0-14**	**20**

Humanities and Social Sciences (HU) Core

HUN100	Introduction to Humanities and Social Sciences	1-0-0	**1**

Departmental Core (DC)

CSC410	Colloquium (CS)	0-3-0	**3**
CSD411	Major Project Part 1 (CS)	0-0-8	**4**
CSD412	Major Project Part 2 (CS)	0-0-16	**8**
CSL105	Discrete Mathematical Structures	3-1-0	**4**
CSL201	Data Structures	3-0-4	**5**
CSL211	Computer Architecture	3-1-2	**5**
CSL302	Programming Languages	3-0-4	**5**
CSL356	Analysis and Design of Algorithms	3-1-0	**4**
CSL373	Operating Systems	3-0-4	**5**
CSL374	Computer Networks	3-0-3	**4.5**
CSN110	Introduction to Computer Science and Engineering	0-0-4	**2**
CSP301	Design Practices in Computer Science	0-1-4	**3**
CST410	Practical Training (CS)	—	**NC**
EEL201	Digital Electronic Circuits	3-1-0	**4**
EEL205	Signals and Systems	3-1-0	**4**
EEP201	Electronics Laboratory - I	0-0-3	**1.5**
MAL250	Introduction to Probability Theory and Stochastic Processes	3-1-0	**4**
	TOTAL DC	**30-10-52**	**66**

Departmental Electives (DE)

CSD310	Mini Project (CS)	0-0-6	**3**
CSL303	Logic for Computer Science	3-0-2	**4**
CSL316	Digital Hardware Design	3-0-4	**5**
CSL332	Introduction to Database Systems	3-0-3	**4.5**
CSL333	Artificial Intelligence	3-0-2	**4**
CSL361	Numerical and Scientific Computing	3-1-2	**5**
CSL362	Simulation and Modelling	3-0-2	**4**
CSL705	Theory of Computation	3-1-0	**4**
CSL719	Synthesis of Digital Systems	3-0-2	**4**
CSL728	Compiler Design	3-0-3	**4.5**
CSL740	Software Engineering	3-0-2	**4**
CSL750	Foundations of Automatic Verification	3-0-2	**4**
CSL771	Database Implementations	3-0-2	**4**
CSL781	Computer Graphics	3-0-3	**4.5**
CSL783	Digital Image Analysis	3-0-3	**4.5**
CSP315	Embedded System Design Laboratory	0-1-6	**4**
CSR310	Professional Practices (CS)	0-1-2	**2**
CSS310	Independent Study (CS)	0-3-0	**3**

B.Tech. in Computer Science and Engineering (CS) **CS1**

Sem.										Lect Courses	L	T	P	Weekly contact	Credits
I	CSN110 Intr Comp Sc Engg (0 - 0 - 4) 2	CSL101/102 Int Comp Prg/Sc (3 - 0 - 2) 4	MEL110 Graphic Science (2 - 0 - 4) 4	MAL111 Analysis Diff Eqns (3 - 1 - 0) 4	PHL110 Fields & Waves (3 - 1 - 0) 4	PHP100 Physics Lab (0 - 0 - 4) 2			HUN100 Intro Hu & So Sc (1 - 0 - 0) 1	*4*	12	2	14	28	**21**
II	CSL201 Data Structures (3 - 0 - 4) 5	EEL101 Fund Elec Engg (3 - 0 - 2) 4	MEL120 Mfg Practices (2 - 0 - 4) 4	MAL124 Alg Matrix Analys (3 - 1 - 0) 4	CYL110 Physical Chem. (3 - 1 - 0) 4	CYP100 Chemistry Lab (0 - 0 - 4) 2				*5*	14	2	14	30	**23**
III	CSL105 Discrete Math Stru (3 - 1 - 0) 4	CSL211 Computer Arch (3 - 1 - 2) 5	CSP301 Des Pract in CS (0 - 1 - 4) 3	EEL201 Digital Electronics (3 - 1 - 0) 4	EEP201 Electronics Lab - I (0 - 0 - 3) 1.5	AML110 Engg Mechanics (3 - 0 - 2) 4			*HUL2xx* Hu. & So. Sc. #1 (3 - 1 - 0) 4	*5*	15	5	11	31	**25.5**
IV	CSL302 Programing Lang. (3 - 0 - 4) 5	MAL250 Prob Stoch Proc. (3 - 1 - 0) 4	PHL120 Phy Materials (3 - 1 - 0) 4		**DE-1** (3 - 0 - 4) 5				*HUL2xx* Hu. & So. Sc. #2 (3 - 1 - 0) 4	*5*	15	3	8	26	**22**
V	CSL356 Analy Des Algor (3 - 1 - 0) 4	EEL205 Signals Systems (3 - 1 - 0) 4			**DE-2** OR Mini Project (3 - 0 - 0) 3		*OC-1* (3 - 0 - 0) 3	*OC-2* (3 - 0 - 2) 4	*HUL2xx* Hu. & So. Sc. #3 (2 - 1 - 0) 3	*6*	17	3	2	22	**21**
VI	CSL373 Operating Systems (3 - 0 - 4) 5			**DE-3** (3 - 0 - 4) 5	**DE-4** OR Indep. Study (3 - 0 - 0) 3		*OC-3* (3 - 0 - 2) 4	*OC-4* (3 - 0 - 2) 4	*HUL2xx* Hu. & So. Sc. #4 (2 - 1 - 0) 3	*6*	17	1	12	30	**24**
summer	CST410 Practical Training (CS)									*NC*					
VII	CSC410 Colloquium (CS) (0 - 3 - 0) 3	CSD411 Maj Proj Pt 1 (CS) (0 - 0 - 8) 4	CSL374 Compu Networks (3 - 0 - 3) 4.5		**DE-5** (3 - 0 - 2) 4		*OC-5* (3 - 0 - 2) 4	*OC-6* (3 - 0 - 2) 4		*4*	12	3	17	32	**23.5**
VIII		CSD412 Maj Proj Pt 2 (CS) (0 - 0 - 16) 8			**DE-6** (3 - 0 - 2) 4		*OC-7* (3 - 0 - 2) 4	*OC-8* (3 - 0 - 2) 4		*3*	9	0	22	31	**20**

Reqd. DE=24, plan DE = 6@4 average = 24 cr. from 6 courses.

Reqd. OC=31, plan OC = 7@4 + 1@3 = 31 cr. from 8 courses.

HU = 2@4 + 2@3 + 1@1= 15 cr. from 4 courses & 1 Intro.

DC = 70, EAS = 20, BS = 20

TOTAL = 180.0

Programme Code: EE1 / (EE)

Bachelor of Technology in Electrical Engineering

Department of Electrical Engineering

The overall credits structure

Undergraduate Core (UC)		Undergraduate Elective (UE)	
Category	**Credits**	**Category**	**Credits**
DC	69	DE	21
BS	20	HM	14
EAS	21	OC	34
HU	1		
TOTAL	*111*	*TOTAL*	*69*

Total credits = 180

Basic Sciences (BS) Core

CYP100	Chemistry Laboratory	0-0-4	**2**
MAL111	Introduction to Analysis and Differential Equations	3-1-0	**4**
MAL124	Introduction to Algebra and Matrix Analysis	3-1-0	**4**
MAL250	Introduction to Probability Theory and Stochastic Processes	3-1-0	**4**
PHL110	Fields and Waves	3-1-0	**4**
PHP100	Physics Laboratory	0-0-4	**2**
	TOTAL BS Core	**12-4-8**	**20**

Engineering Arts and Sciences (EAS) Core

AML110	Engineering Mechanics	3-0-2	**4**
CSL101	Introduction to Computers and Programming	3-0-2	**4**
	OR		
CSL102	Introduction to Computer Science	3-0-2	**4**
CSL201	Data Structures	3-0-4	**5**
EEL101	Fundamentals of Electrical Engineering	3-0-2	**4**
MEL120	Manufacturing Practices	2-0-4	**4**
	TOTAL EAS Core	**14-0-14**	**21**

Humanities and Social Sciences (HU) Core

HUN100	Introduction to Humanities and Social Sciences	1-0-0	**1**

Departmental Core (DC)

EEC410	Colloquium (EE)	0-3-0	**3**
EED411	Major Project Part 1 (EE)	0-0-6	**3**
EED412	Major Project Part 2 (EE)	0-0-14	**7**
EEL201	Digital Electronic Circuits	3-1-0	**4**
EEL202	Circuit Theory	3-1-0	**4**
EEL203	Electromechanics	3-1-0	**4**
EEL204	Analog Electronics Circuits	3-1-0	**4**
EEL205	Signals and Systems	3-1-0	**4**
EEL207	Engineering Electromagnetics	3-1-0	**4**
EEL301	Control Engineering - I	3-1-0	**4**
EEL303	Power Engineering - I	3-1-0	**4**
EEL306	Communication Engineering	3-1-0	**4**
EEL308	Computer Architecture	3-1-0	**4**
EEN110	Introduction to Electrical Engineering	0-0-4	**2**
EEP201	Electronics Laboratory - I	0-0-3	**1.5**
EEP203	Electromechanics Laboratory	0-0-3	**1.5**
EEP204	Electronics Laboratory - II	0-0-3	**1.5**
EEP211	Design (EE)	0-0-4	**2**
EEP301	Control Engineering Laboratory	0-0-3	**1.5**
EEP303	Power Engineering Laboratory	0-0-3	**1.5**
EEP306	Communication Engineering Laboratory	0-0-3	**1.5**
EEP307	Electromagnetics Laboratory	0-0-3	**1.5**
EEP308	Computer Technology Laboratory	0-0-3	**1.5**
EET410	Practical Training (EE)	—	**NC**
	TOTAL DC	**30-13-52**	**69**

Departmental Electives (DE)

EED310	Mini Project (EE)	0-0-6	**3**
EEL212	Measurements and Instrumentation	3-0-0	**3**
EEL218	Physical Electronics	3-0-0	**3**
EEL311	Graph Theory and its Application to Electrical Engineering	3-0-0	**3**
EEL314	Medical Electronics	3-0-0	**3**
EEL315	Analog Integrated Circuits	3-0-0	**3**
EEL316	Digital Communications	3-0-2	**4**
EEL319	Digital Signal Processing	3-0-2	**4**
EEL322	Integrated Circuits Technology	3-0-0	**3**
EEL324	Digital Hardware Design	3-0-0	**3**
EEL325	Control Engineering - II	3-0-0	**3**
EEL326	Micromotors and their Applications	3-0-0	**3**
EEL327	Fault Diagnosis of Digital Circuits	3-0-0	**3**
EEL329	VLSI Technology and Design	3-0-2	**4**
EEL330	Selected Topics in Communication Engineering - I	3-0-0	**3**
EEL331	Electromagnetics and Advanced Electromechanics	3-0-0	**3**
EEL338	Antennas and Propagation	3-0-0	**3**
EEL340	Selected Topics in Power and Machines	3-0-0	**3**
EEL342	DSP based Control of Electric Drive	3-0-0	**3**
EEL346	Electrical Machines and Industrial Drives	3-0-0	**3**
EEL358	Operating Systems	3-0-0	**3**
EEL360	Selected Topics in Control Engineering - I	3-0-0	**3**
EEL365	Intelligent Control	3-0-0	**3**
EEL370	Selected Topics in Computers - I	3-0-0	**3**
EEL375	Embedded Systems	3-0-4	**5**
EEL380	Selected Topics in Electronics - I	3-0-0	**3**
EEL390	Selected Topics in Information and Communication Technology – I	3-0-0	**3**
EEL404	Flexible AC Transmission System	3-0-0	**3**
EEL420	Selected Topics in Electronics - II	3-0-0	**3**
EEL422	Computers in Biomedicine	3-0-0	**3**
EEL430	Selected Topics in Communication Engineering - II	3-0-0	**3**
EEL432	Satellite Communication	3-0-0	**3**
EEL433	Communication Engineering - II	3-0-0	**3**
EEL435	Optical Communication	3-0-0	**3**
EEL441	Industrial Electronics	3-0-2	**4**
EEL451	Power Systems Protection	3-0-0	**3**
EEL452	HVDC Transmission	3-0-0	**3**
EEL453	Power System Dynamics and Control	3-0-0	**3**
EEL455	Power System Planning	3-0-0	**3**
EEL456	Power Engineering - II	3-0-2	**4**
EEL460	Selected Topics in Control Engineering - II	3-0-0	**3**
EEL462	Identification and Adaptive Control	3-0-0	**3**
EEL470	Selected Topics in Computers - II	3-0-0	**3**
EEL472	Parallel and Distributed Processing	3-0-0	**3**
EEL473	Computer Communication	3-0-0	**3**
EEL482	Mechatronics	3-0-0	**3**
EEL704	Robotics and Automation	3-0-0	**3**
EEL706	Soft Computing	3-0-0	**3**
EEL710	Coding Theory	3-0-0	**3**
EEL713	Microwave Theory and Circuits	3-0-0	**3**
EEL715	Image Processing	3-0-2	**4**
EEL716	Telecommunication Switching and Transmission	3-0-0	**3**
EEL749	Special Electromechanical Systems	3-0-0	**3**
EEL754	Computer Graphics	3-0-2	**4**
EEL758	Intelligent and Knowledge Based Systems	3-0-0	**3**
EEL772	Optimal Control Theory	3-0-0	**3**
EEL781	Neural Networks	3-0-0	**3**
EEL790	Selected Topics in Information and Communication Technology - II	3-0-0	**3**
EEP321	Measurements and Instrumentation Laboratory	0-0-3	**1.5**
EEP443	FEM Analysis of Machines Laboratory	0-0-3	**1.5**
EEP446	Electrical Machines and Industrial Drives Laboratory	0-0-3	**1.5**
EEP467	Computer Control Laboratory	0-0-3	**1.5**
EEP719	Communication Engineering Laboratory - II	0-0-3	**1.5**
EES310	Independent Study (EE)	0-3-0	**3**
EEV401	Special Module in Communication Engineering	1-0-0	**1**
EEV402	Special Module in Power Systems, Machines and Power Electronics	1-0-0	**1**
EEV404	Special Module in Control Engineering	1-0-0	**1**
EEV405	Special Module in Electronics	1-0-0	**1**
EEV704	Special Module in Computers	1-0-0	**1**
MAL341	File Structures and Information Systems Design	3-0-2	**4**
MAL342	Analysis and Design of Algorithms	3-1-0	**4**
MAL373	Wavelets and Applications	3-1-0	**4**
MAL382	Theory of Automata	3-1-0	**4**
MAL710	Database Management Systems	3-0-2	**4**
MAL717	Fuzzy Sets and Applications	3-1-0	**4**
MAL745	Software Engineering	3-0-2	**4**
MAL786	Cryptology	3-1-0	**4**

Elective Streams (DE-A,-B,-C)	**Course Advise**		
Information & Commnication Technology	EEL358	EEL316	EEL319
Integrated Electronics and Circuits	EEL219	EEL329	EEL319
Control and Automation Engineering	EEL325	EEL704	EEL375
Power, Machines and Power Electronics	EEL331	EEL441	EEL456

The student has to opt for one elective stream and must take all courses of that stream.

B.Tech. in Electrical Engineering

(EE) **EE1**

Sem.										Lect Courses	L	T	P	Weekly contact	Credits
I	EEN110 Intro to Elec Engg (0 - 0 - 4) 2	EEL101 Fund Elec Engg (3 - 0 - 2) 4	MEL120 Mfg Practices (2 - 0 - 4) 4	MAL111 Analysis Diff Eqns (3 - 1 - 0) 4	PHL110 Fields & Waves (3 - 1 - 0) 4	PHP100 Physics Lab (0 - 0 - 4) 2			HUN100 Intro Hu & So Sc (1 - 0 - 0) 1	*4*	12	2	14	28	**21**
II	EEL205 Signals Systems (3 - 1 - 0) 4	EEL203 Electromechanics (3 - 1 - 0) 4	AML110 Engg Mechanics (3 - 0 - 2) 4	MAL124 Alg Matrix Analy (3 - 1 - 0) 4	CSL101/102 Int Comp Prg/Sc (3 - 0 - 2) 4	CYP100 Chemistry Lab (0 - 0 - 4) 2				*5*	15	3	8	26	**22**
III	EEL201 Digital Electronics (3 - 1 - 0) 4	EEP201 Electronics Lab - I (0 - 0 - 3) 1.5	EEL202 Circuit Theory (3 - 1 - 0) 4	EEP203 Electromech Lab (0 - 0 - 3) 1.5	CSL201 Data Structures (3 - 0 - 4) 5	MAL250 Prob Stoch Proc. (3 - 1 - 0) 4			*HUL2xx* Hu. & So. Sc. #1 (3 - 1 - 0) 4	*5*	15	4	10	29	**24**
IV	EEL301 Control Engg - I (3 - 1 - 0) 4	EEL204 Analog Elec Cir (3 - 1 - 0) 4	EEP204 Electronics Lab - II (0 - 0 - 3) 1.5	EEL306 Communic Engg (3 - 1 - 0) 4	EEL308 Computer Arch (3 - 1 - 0) 4	EEP308 Comp Tech Lab (0 - 0 - 3) 1.5	EEP211 Des Practice (EE) (0 - 0 - 4) 2		*HUL2xx* Hu. & So. Sc. #2 (3 - 0 - 0) 3	*5*	15	4	10	29	**24**
V	EEL207 Engg Electromag (3 - 1 - 0) 4	EEL303 Power Engg - I (3 - 1 - 0) 4	EEP301 Control Engg Lab (0 - 0 - 3) 1.5	EEP306 Comm Engg Lab (0 - 0 - 3) 1.5	**DE-A** (3 - 0 - 0) 3	**DE-1** (3 - 0 - 0) 3		*OC-1* (3 - 1 - 0) 4	*HUL2xx* Hu. & So. Sc. #3 (2 - 1 - 0) 3	*6*	17	4	6	27	**24**
VI	EEP303 Power Engg Lab (0 - 0 - 3) 1.5	EEP307 Electromag Lab (0 - 0 - 3) 1.5		**DE-2** (3 - 0 - 0) 3	**DE-B** (3 - 0 - 2) 4	**DE-3** (3 - 0 - 0) 3	*OC-2* (3 - 1 - 0) 4	*OC-3* (3 - 0 - 2) 4	*HUL2xx* Hu. & So. Sc. #4 (3 - 1 - 0) 4	*6*	18	2	10	30	**25**
summer	EET410 Practical Training (EE)									*NC*					
VII	EEC410 Colloquium (EE) (0 - 3 - 0) 3	EED411 Maj Proj Pt 1 (EE) (0 - 0 - 6) 3			**DE-C** (3 - 0 - 2) 4	*OC-4* (3 - 1 - 0) 4	*OC-5* (3 - 1 - 0) 4	*OC-6* (3 - 0 - 0) 3	*OC-7* (3 - 0 - 0) 3	*5*	15	5	8	28	**24**
VIII		EED412 Maj Proj Pt 2 (EE) (0 - 0 - 14) 7			**DE-4** EEV (1 - 0 - 0) 1		*OC-8* (3 - 1 - 0) 4	*OC-9* (3 - 1 - 0) 4		*2*	7	2	14	23	**16**

Reqd. DE=21, plan DE = 11 stream + 3@3 +1@1 = 21 cr. from 6 + 1V courses.

Reqd. OC=34, plan OC = 7@4 + 2@3 = 34 cr. from 9 courses.

HU = 2@4 + 2@3 + 1@1= 15 cr. from 4 courses & 1 Intro.

DC = 69, EAS = 21, BS = 20

TOTAL = 180.0

Programme Code: EE2 / (EP)

Bachelor of Technology** in **Electrical Engineering (Power)

Department of Electrical Engineering

The overall credits structure

Undergraduate Core (UC)		Undergraduate Elective (UE)	
Category	**Credits**	**Category**	**Credits**
DC	69	DE	21
BS	20	HM	14
EAS	21	OC	34
HU	1		
TOTAL	*111*	*TOTAL*	*69*

Total credits = 180

Basic Sciences (BS) Core

CYP100	Chemistry Laboratory	0-0-4	**2**
MAL111	Introduction to Analysis and Differential Equations	3-1-0	**4**
MAL124	Introduction to Algebra and Matrix Analysis	3-1-0	**4**
MAL230	Numerical Methods and Computation	3-1-0	**4**
PHL110	Fields and Waves	3-1-0	**4**
PHP100	Physics Laboratory	0-0-4	**2**
	TOTAL BS Core	**12-4-8**	**20**

Engineering Arts and Sciences (EAS) Core

AML110	Engineering Mechanics	3-0-2	**4**
CSL101	Introduction to Computers and Programming OR	3-0-2	**4**
CSL102	Introduction to Computer Science	3-0-2	**4**
CSL201	Data Structures	3-0-4	**5**
EEL101	Fundamentals of Electrical Engineering	3-0-2	**4**
MEL120	Manufacturing Practices	2-0-4	**4**
	TOTAL EAS Core	**14-0-14**	**21**

Humanities and Social Sciences (HU) Core

HUN100	Introduction to Humanities and Social Sciences	1-0-0	**1**

Departmental Core (DC)

EEC420	Colloquium (EP)	0-3-0	**3**
EED421	Major Project Part 1 (EP)	0-0-6	**3**
EED422	Major Project Part 2 (EP)	0-0-14	**7**
EEL201	Digital Electronic Circuits	3-1-0	**4**
EEL202	Circuit Theory	3-1-0	**4**
EEL203	Electromechanics	3-1-0	**4**
EEL204	Analog Electronics Circuits	3-1-0	**4**
EEL205	Signals and Systems	3-1-0	**4**
EEL209	Power Electronics Devices and Circuits	3-1-0	**4**
EEL301	Control Engineering - I	3-1-0	**4**
EEL303	Power Engineering - I	3-1-0	**4**
EEL305	Electric Drives	3-1-0	**4**
EEL308	Computer Architecture	3-1-0	**4**
EEN120	Introduction to Electrical Engineering (Power)	0-0-4	**2**
EEP201	Electronics Laboratory - I	0-0-3	**1.5**
EEP203	Electromechanics Laboratory	0-0-3	**1.5**
EEP204	Electronics Laboratory - II	0-0-3	**1.5**
EEP209	Power Electronics Laboratory	0-0-3	**1.5**
EEP221	Design (EP)	0-0-4	**2**
EEP301	Control Engineering Laboratory	0-0-3	**1.5**
EEP303	Power Engineering Laboratory	0-0-3	**1.5**
EEP305	Drives Laboratory	0-0-3	**1.5**
EEP308	Computer Technology Laboratory	0-0-3	**1.5**
EET420	Practical Training (EP)	—	**NC**
	TOTAL DC	**30-13-52**	**69**

Departmental Electives (DE)

EED320	Mini Project (EP)	0-0-6	**3**
EEL306	Communication Engineering	3-1-0	**4**
EEL319	Digital Signal Processing	3-0-2	**4**
EEL322	Integrated Circuits Technology	3-0-0	**3**
EEL325	Control Engineering - II	3-0-0	**3**
EEL326	Micromotors and their Applications	3-0-0	**3**
EEL331	Electromagnetics and Advanced Electromechanics	3-0-0	**3**
EEL339	Power Conditioning	3-0-0	**3**
EEL340	Selected Topics in Power and Machines	3-0-0	**3**
EEL341	Selected Topics in Power Electronics and Drives - I	3-0-0	**3**
EEL342	DSP based Control of Electric Drive	3-0-0	**3**
EEL344	Electric Transportation	3-0-0	**3**
EEL346	Electrical Machines and Industrial Drives	3-0-0	**3**
EEL349	Advanced Electrical Machines	3-0-0	**3**
EEL359	Electric Machine Design and CAD of Electric Machines	3-0-0	**3**
EEL360	Selected Topics in Control Engineering - I	3-0-0	**3**
EEL361	Selected Topics in Power Systems - I	3-0-0	**3**
EEL365	Intelligent Control	3-0-0	**3**
EEL375	Embedded Systems	3-0-4	**5**
EEL380	Selected Topics in Electronics - I	3-0-0	**3**
EEL388	Stepper Motors	3-0-0	**3**
EEL389	Computer Aided Testing of Electric Machines	2-0-2	**3**
EEL394	Permanent Magnet Motors	3-0-0	**3**
EEL398	Machines and Drives Dynamics	3-0-0	**3**
EEL404	Flexible AC Transmission System	3-0-0	**3**
EEL405	Power Engineering Instrumentation	3-0-0	**3**
EEL407	Distribution System Planning and Automation	3-0-0	**3**
EEL421	Selected Topics in Power Electronics and Drives - II	3-0-0	**3**
EEL423	Demand Side Management	3-0-0	**3**
EEL424	Nuclear Power Generation	3-0-0	**3**
EEL428	Substation Design	3-0-0	**3**
EEL437	Selected Topics in Power Systems - II	3-0-0	**3**
EEL440	Selected Topics in Power, Machines and Power Electronics	3-0-0	**3**
EEL450	Switchgear and Transients	3-0-0	**3**
EEL451	Power Systems Protection	3-0-0	**3**
EEL452	HVDC Transmission	3-0-0	**3**
EEL453	Power System Dynamics and Control	3-0-0	**3**
EEL455	Power System Planning	3-0-0	**3**
EEL456	Power Engineering - II	3-0-2	**4**
EEL458	Power Systems Optimization	3-0-0	**3**
EEL460	Selected Topics in Control Engineering - II	3-0-0	**3**
EEL462	Identification and Adaptive Control	3-0-0	**3**
EEL481	Testing and Commissioning of Electrical Equipment	3-0-0	**3**
EEL482	Mechatronics	3-0-0	**3**
EEL483	Hydro Power Generation	3-0-0	**3**
EEL486	Illumination and Heating	3-0-0	**3**
EEL487	Intelligent Algorithms for Power Systems	3-0-0	**3**
EEL499	Selected Topics in Electrical Machines	3-0-0	**3**
EEL741	Modelling and Analysis of Electrical Machines	3-0-0	**3**
EEL746	Power Quality	3-0-0	**3**
EEL749	Special Electromechanical Systems	3-0-0	**3**
EEL772	Optimal Control Theory	3-0-0	**3**
EEP443	FEM Analysis of Machines Laboratory	0-0-3	**1.5**
EEP446	Electrical Machines and Industrial Drives Laboratory	0-0-3	**1.5**
EEP452	Machine Modelling and Simulation Laboratory	0-0-3	**1.5**
EEP483	Neural Computing Applications to Power Systems Laboratory	0-0-3	**1.5**
EEP487	Power Quality Laboratory	0-0-3	**1.5**
EEP488	Power Electronics and Simulation Laboratory	0-0-3	**1.5**
EEP493	CAD of Electric Machines Laboratory	0-0-3	**1.5**
EEP495	Distribution System Design Laboratory	0-0-3	**1.5**
EEP496	Power System Dynamics and Control Laboratory	0-0-3	**1.5**
EES320	Independent Study (EP)	0-3-0	**3**
EEV403	Special Module in Electrical Machines	1-0-0	**1**
EEV404	Special Module in Control Engineering	1-0-0	**1**
EEV405	Special Module in Electronics	1-0-0	**1**
EEV406	Special Module in Power Electronics and Drives	1-0-0	**1**
EEV407	Special Module in Power Systems	1-0-0	**1**
EEV704	Special Module in Computers	1-0-0	**1**

B.Tech. in Electrical Engineering (Power) (EP) **EE2**

Sem.										Lect Courses	L	T	P	Weekly contact	Credits
I	EEN120 Intro Elec Engg (P) (0 - 0 - 4) 2	EEL101 Fund Elec Engg (3 - 0 - 2) 4	MEL120 Mfg Practices (2 - 0 - 4) 4	MAL111 Analysis Diff Eqns (3 - 1 - 0) 4	PHL110 Fields & Waves (3 - 1 - 0) 4	PHP100 Physics Lab (0 - 0 - 4) 2			HUN100 Intro Hu & So Sc (1 - 0 - 0) 1	*4*	12	2	14	28	**21**
II	EEL205 Signals Systems (3 - 1 - 0) 4	EEL203 Electromechanics (3 - 1 - 0) 4	AML110 Engg Mechanics (3 - 0 - 2) 4	MAL124 Alg & Matrix Ana (3 - 1 - 0) 4	CSL101/102 Int Comp Prg/Sc (3 - 0 - 2) 4	CYP100 Chemistry Lab (0 - 0 - 4) 2				*5*	15	3	8	26	**22**
III	EEL201 Digital Electronics (3 - 1 - 0) 4	EEP201 Electronics Lab - I (0 - 0 - 3) 1.5	EEL202 Circuit Theory (3 - 1 - 0) 4	EEP203 Electromech Lab (0 - 0 - 3) 1.5	CSL201 Data Structures (3 - 0 - 4) 5	MAL230 Num Meth Compu (3 - 1 - 0) 4			*HUL2xx* Hu. & So. Sc. #1 (3 - 1 - 0) 4	*5*	15	4	10	29	**24**
IV	EEL301 Control Engg - I (3 - 1 - 0) 4	EEL204 Analog Elec Cir (3 - 1 - 0) 4	EEP204 Electronics Lab - II (0 - 0 - 3) 1.5	EEL209 P Elec Dev Circ (3 - 1 - 0) 4	EEL308 Computer Arch (3 - 1 - 0) 4	EEP308 Comp Tech Lab (0 - 0 - 3) 1.5	EEP221 Des Practice (EP) (0 - 0 - 4) 2		*HUL2xx* Hu. & So. Sc. #2 (3 - 0 - 0) 3	*5*	15	4	10	29	**24**
V	EEL305 Electric Drives (3 - 1 - 0) 4	EEL303 Power Engg - I (3 - 1 - 0) 4	EEP301 Control Engg Lab (0 - 0 - 3) 1.5	EEP209 Power Electr Lab (0 - 0 - 3) 1.5	**DE-A** (3 - 0 - 0) 3	**DE-1** (3 - 0 - 0) 3		*OC-1* (3 - 1 - 0) 4	*HUL2xx* Hu. & So. Sc. #3 (2 - 1 - 0) 3	*6*	17	4	6	27	**24**
VI	EEP303 Power Engg Lab (0 - 0 - 3) 1.5	EEP305 Drives Lab (0 - 0 - 3) 1.5		**DE-2** (3 - 0 - 0) 3	**DE-B** (3 - 0 - 2) 4	**DE-3** (3 - 0 - 0) 3	*OC-2* (3 - 1 - 0) 4	*OC-3* (3 - 0 - 2) 4	*HUL2xx* Hu. & So. Sc. #4 (3 - 1 - 0) 4	*6*	18	2	10	30	**25**
summer				EET420 Practical Training (EP)						*NC*					
VII	EEC420 Colloquium (EP) (0 - 3 - 0) 3	EED421 Maj Proj Pt 1 (EP) (0 - 0 - 6) 3			**DE-C** (3 - 0 - 2) 4	*OC-4* (3 - 1 - 0) 4	*OC-5* (3 - 1 - 0) 4	*OC-6* (3 - 0 - 0) 3	*OC-7* (3 - 0 - 0) 3	*5*	15	5	8	28	**24**
VIII		EED422 Maj Proj Pt 2 (EP) (0 - 0 - 14) 7		**DE-4** EEV (1 - 0 - 0) 1			*OC-8* (3 - 1 - 0) 4	*OC-9* (3 - 1 - 0) 4		*2*	7	2	14	23	**16**

Reqd. DE=21, plan DE = 11 stream + 3@3 +1@1 = 21 cr. from 6 + 1V courses.

Reqd. OC=34, plan OC = 7@4 + 2@3 = 34 cr. from 9 courses.

HU = 2@4 + 2@3 + 1@1= 15 cr. from 4 courses & 1 Intro.

DC = 69, EAS = 21, BS = 20

TOTAL = 180.0

Programme Code: PH1 / (PH)

Bachelor of Technology in *Engineering Physics*

Department of Physics

The overall credits structure

Undergraduate Core (UC)		Undergraduate Elective (UE)	
Category	**Credits**	**Category**	**Credits**
DC	70	DE	20
BS	20	HM	14
EAS	20	OC	35
HU	1		
TOTAL	*111*	*TOTAL*	*69*

Total credits = 180

Basic Sciences (BS) Core

CYL110	Physical Chemistry: Concepts and Applications	3-1-0	**4**
CYP100	Chemistry Laboratory	0-0-4	**2**
MAL110	Mathematics - I	3-1-0	**4**
MAL120	Mathematics - II	3-1-0	**4**
PHL120	Physics of Materials	3-1-0	**4**
PHP100	Physics Laboratory	0-0-4	**2**
	TOTAL BS Core	**12-4-8**	**20**

Engineering Arts and Sciences (EAS) Core

CHL110	Transport Phenomena	3-1-0	**4**
CSL101	Introduction to Computers and Programming	3-0-2	**4**
	OR		
CSL102	Introduction to Computer Science	3-0-2	**4**
EEL101	Fundamentals of Electrical Engineering	3-0-2	**4**
MEL110	Graphic Science	2-0-4	**4**
MEL120	Manufacturing Practices	2-0-4	**4**
	TOTAL EAS Core	**13-1-12**	**20**

Humanities and Social Sciences (HU) Core

HUN100	Introduction to Humanities and Social Sciences	1-0-0	**1**

Departmental Core (DC)

EPC410	Colloquium (PH)	0-3-0	**3**
EPD411	Major Project Part 1 (PH)	0-0-6	**3**
EPD412	Major Project Part 2 (PH)	0-0-14	**7**
EPL101	Classical Mechanics and Relativity	3-1-0	**4**
EPL103	Mathematical Physics	3-1-0	**4**
EPL105	Optics	3-1-0	**4**
EPL107	Electromagnetics	3-1-0	**4**
EPL202	Quantum Mechanics and its Applications	3-1-0	**4**
EPL204	Thermal and Statistical Physics	3-1-0	**4**
EPL206	Solid State Physics	3-1-0	**4**
EPL208	Principles of Electrodynamics and Plasmas	3-1-0	**4**
EPL211	Principles of Material Synthesis	3-1-0	**4**
EPL213	Fundamentals of Semiconductors	3-1-0	**4**
EPN110	Introduction to Engineering Physics	0-0-4	**2**
EPP109	Physics Laboratory - I	0-0-6	**3**
EPP110	Physical System Design	0-0-4	**2**
EPP215	Physics Laboratory - II	0-0-6	**3**
EPP216	Physics Laboratory - III	0-0-6	**3**
EPP301	Design Laboratory	0-0-8	**4**
EPT410	Practical Training (PH)	—	**NC**
	TOTAL DC	**30-13-54**	**70**

Departmental Electives (DE)

EPD310	Mini Project (PH)	0-0-6	**3**
EPL331	Vacuum Technology and Surface Physics	3-0-0	**3**
EPL332	Nuclear Science and Engineering	3-0-0	**3**
EPL333	Computational Physics	3-0-2	**4**
EPL334	Lasers	3-0-0	**3**
EPL335	Low Dimensional Physics	3-1-0	**4**
EPL336	Semiconductor Optoelectronics	3-1-0	**4**
EPL337	Materials Science and Engineering	3-1-0	**4**
EPL338	Non-linear Phenomena in Physics and Engineering	3-1-0	**4**
EPL439	Microelectronic Devices	3-0-0	**3**
EPL440	Quantum Electronics	3-0-0	**3**
EPL441	Applications of Lasers in Technology	3-0-0	**3**
EPL442	Fiber and Integrated Optics	3-0-0	**3**
EPL443	Holography and Optical Information Processing	3-0-0	**3**
EPL444	Functional Nanostructures	3-0-0	**3**
EPL445	Engineering Optics	3-0-0	**3**
EPL446	Spintronics and Data Storage	3-0-0	**3**
EPR310	Professional Practices (PH)	0-1-2	**2**
EPS310	Independent Study (PH)	0-3-0	**3**
EPV430	Special Topics in Nano-Technology	1-0-0	**1**
EPV431	Special Topics in Photonics and Optoelectronics	1-0-0	**1**
EPV432	Special Topics in Emerging Processes	1-0-0	**1**
EPV433	Special Topics in Emerging Materials	1-0-0	**1**
EPV434	Special Topics in Emerging Devices	1-0-0	**1**
EPV450	Selected Topics in Nano-Technology	2-0-0	**2**
EPV451	Selected Topics in Photonics and Optoelectronics	2-0-0	**2**
EPV452	Selected Topics in Emerging Processes	2-0-0	**2**
EPV453	Selected Topics in Emerging Materials	2-0-0	**2**
EPV454	Selected Topics in Emerging Devices	2-0-0	**2**

B.Tech. in Engineering Physics

(PH) **PH1**

Sem.										Lect Courses	L	T	P	Weekly contact	Credits
I	EPN110 Intro to Engg Phys (0 - 0 - 4) 2	CSL101/102 Int Comp Prg/Sc (3 - 0 - 2) 4	MEL120 Mfg Practices (2 - 0 - 4) 4	MAL110 Mathematics - I (3 - 1 - 0) 4	CYL110 Physical Chem (3 - 1 - 0) 4	CYP100 Chemistry Lab (0 - 0 - 4) 2				*4*	11	2	14	27	**20**
II	CHL110 Transp Phen (3 - 1 - 0) 4	EEL101 Fund Elec Engg (3 - 0 - 2) 4	MEL110 Graphic Science (2 - 0 - 4) 4	MAL120 Mathematics - II (3 - 1 - 0) 4	PHL120 Phy Materials (3 - 1 - 0) 4	PHP100 Physics Lab (0 - 0 - 4) 2			HUN100 Intro Hu & So Sc (1 - 0 - 0) 1	*5*	15	3	10	28	**23**
III	EPL101 Class Mech Relat. (3 - 1 - 0) 4	EPL103 Math Physics (3 - 1 - 0) 4	EPL105 Optics (3 - 1 - 0) 4	EPL107 Electromagnetics (3 - 1 - 0) 4	EPP109 Physics Lab - I (0 - 0 - 6) 3				*HUL2xx* Hu. & So. Sc. #1 (3 - 1 - 0) 4	*5*	15	5	6	26	**23**
IV	EPL202 Quant Mech Appl. (3 - 1 - 0) 4	EPL204 Ther Stat Physics (3 - 1 - 0) 4	EPL206 Solid State Phys (3 - 1 - 0) 4	EPP110 Physical Sys Des (0 - 0 - 4) 2	EPL208 Pr Elec-dyn Plas (3 - 1 - 0) 4			*OC-1* (3 - 1 - 0) 4	*HUL2xx* Hu. & So. Sc. #2 (2 - 1 - 0) 3	*6*	17	6	4	27	**25**
V	EPL211 Prin Material Syn. (3 - 1 - 0) 4	EPL213 Fund Semicond. (3 - 1 - 0) 4	EPP215 Physics Lab - II (0 - 0 - 6) 3			*OC-2* (3 - 1 - 0) 4	*OC-3* (3 - 1 - 0) 4	*OC-4* (3 - 1 - 0) 4	*HUL2xx* Hu. & So. Sc. #3 (2 - 1 - 0) 3	*6*	17	6	6	29	**26**
VI	EPP216 Physics Lab - III (0 - 0 - 6) 3			**DE-1** (3 - 1 - 0) 4	**DE-2** (3 - 1 - 0) 4		*OC-5* (3 - 1 - 0) 4	*OC-6* (3 - 0 - 0) 3	*HUL2xx* Hu. & So. Sc. #4 (3 - 1 - 0) 4	*5*	15	4	6	25	**22**
summer	EPT410 Practical Training (PH)									*NC*					
VII	EPC410 Colloquium (0 - 3 - 0) 3	EPD411 Maj Proj Pt 1 (PH) (0 - 0 - 6) 3	EPP301 Design Laboratory (0 - 0 - 8) 4	**DE-3** (3 - 0 - 0) 3	**DE-4** (3 - 0 - 0) 3	*OC-7* (3 - 0 - 0) 3	*OC-8* (3 - 0 - 0) 3	*OC-9* (3 - 0 - 0) 3		*5*	15	3	14	32	**25**
VIII		EPD412 Maj Proj Pt 2 (PH) (0 - 0 - 14) 7		**DE-5** (3 - 0 - 0) 3	**DE-6** (3 - 0 - 0) 3		*OC-10* (3 - 0 - 0) 3			*3*	9	0	14	23	**16**

Reqd. DE=20, plan DE = 2@4 + 4@3 = 20 cr. from 6 courses.

Reqd. OC=35, plan OC = 5@4 + 5@3 = 35 cr. from 10 courses.

HU = 2@4 + 2@3 + 1@1= 15 cr. from 4 courses & 1 Intro.

DC = 70, EAS = 20, BS = 20

TOTAL = 180.0

Programme Code: ME1 / (ME)

Bachelor of Technology in *Mechanical Engineering*

Department of Mechanical Engineering

The overall credits structure

Undergraduate Core (UC)		Undergraduate Elective (UE)	
Category	**Credits**	**Category**	**Credits**
DC	66	DE	24
BS	20	HM	14
EAS	24	OC	31
HU	1		
TOTAL	*111*	*TOTAL*	*69*

Total credits = 180

Basic Sciences (BS) Core

CYL120	Inorganic and Organic Chemistry: Concepts and Applications	3-1-0	**4**
CYP100	Chemistry Laboratory	0-0-4	**2**
MAL110	Mathematics - I	3-1-0	**4**
MAL120	Mathematics - II	3-1-0	**4**
PHL120	Physics of Materials	3-1-0	**4**
PHP100	Physics Laboratory	0-0-4	**2**
	TOTAL BS Core	**12-4-8**	**20**

Engineering Arts and Sciences (EAS) Core

AML110	Engineering Mechanics	3-0-2	**4**
AML140	Mechanics of Solids	3-1-0	**4**
CSL101	Introduction to Computers and Programming	3-0-2	**4**
	OR		
CSL102	Introduction to Computer Science	3-0-2	**4**
EEL102	Principles of Electrical Engineering	3-0-2	**4**
MEL110	Graphic Science	2-0-4	**4**
MEL120	Manufacturing Practices	2-0-4	**4**
	TOTAL EAS Core	**16-1-14**	**24**

Humanities and Social Sciences (HU) Core

HUN100	Introduction to Humanities and Social Sciences	1-0-0	**1**

Departmental Core (DC)

AML160	Mechanics of Fluids	3-1-0	**4**
AMP262	Fluids and Solids Laboratory	0-0-3	**1.5**
MEC410	Colloquium (ME)	0-3-0	**3**
MED411	Major Project Part 1 (ME)	0-0-6	**3**
MED412	Major Project Part 2 (ME)	0-0-14	**7**
MEL140	Engineering Thermodynamics	3-1-0	**4**
MEL211	Kinematics and Dynamics of Machines	3-0-2	**4**
MEL232	Casting, Welding and Forming	3-0-2	**4**
MEL233	Machining, Machine-tools and Metrology	3-0-2	**4**
MEL241	Energy Conversion	3-0-2	**4**
MEL242	Heat and Mass Transfer	3-1-0	**4**
MEL311	Machine Element Design	3-1-2	**5**
MEL312	Control Theory and Applications	3-1-2	**5**
MEL421	Production Management	3-0-2	**4**
MEN110	Introduction to Mechanical Engineering	0-0-4	**2**
MEP201	Mechanical Engineering Drawing	1-0-4	**3**
MEP202	Design Innovation and Manufacturing	0-0-4	**2**
MEP311	Mechanisms Laboratory	0-0-2	**1**
MEP341	Thermal Engineering Laboratory	0-0-3	**1.5**
MET410	Practical Training (ME)	—	**NC**
	TOTAL DC	**31-8-54**	**66**

Departmental Electives (DE)

MED310	Mini Project (ME)	0-0-8	**4**
MEL310	Concurrent Engineering	3-1-0	**4**
MEL314	Noise Engineering	3-0-2	**4**
MEL316	Mechanical Vibrations	3-0-2	**4**
MEL321	Ergonomics	3-0-2	**4**
MEL332	Design and Manufacturing of Composites	3-0-2	**4**
MEL333	Metrology	3-0-2	**4**
MEL334	Low Cost Automation	3-0-2	**4**
MEL341	Gas Dynamics and Propulsion	3-0-2	**4**
MEL342	Power Plant Technologies	3-0-2	**4**
MEL343	Fuels, Combustion and Pollution	3-0-2	**4**
MEL344	Refrigeration and Air-Conditioning	3-0-2	**4**
MEL345	Internal Combustion Engines	3-0-2	**4**
MEL346	Turbo-machinery	3-0-2	**4**
MEL410	Creativity in Engineering	3-1-0	**4**
MEL411	Mechatronics	3-0-2	**4**
MEL412	Advanced Mechanical Design	3-0-2	**4**
MEL413	Design of Mechanisms	3-1-0	**4**
MEL414	Computer Aided Mechanical Design	3-0-2	**4**
MEL415	Vibrations Engineering Design	3-0-2	**4**
MEL416	Robotics Engineering	3-1-0	**4**
MEL417	Lubrication	3-0-2	**4**
MEL420	Total Quality Management	3-0-2	**4**
MEL422	Project Management	3-0-2	**4**
MEL425	Flexible Manufacturing Systems	3-0-2	**4**
MEL431	CNC Machines and Programming	3-0-2	**4**
MEL432	Microprocessor Applications in Manufacturing	3-0-2	**4**
MEL433	Micro- and Nano- Manufacturing	3-0-2	**4**
MEL434	Design for Manufacturing and Assembly	3-0-2	**4**
MEL435	Geometric Modelling for Manufacturing	3-0-2	**4**
MEL436	Injection Moulding and Mould Design	2-0-4	**4**
MEL441	Modelling and Experiments in Heat Transfer	2-0-4	**4**
MEL442	Thermal Analysis of Bio-systems	3-0-2	**4**

B.Tech. in Mechanical Engineering

(ME) **ME1**

Sem.										Lect Courses	L	T	P	Weekly contact	Credits
I	MEN110 Intro to Mech Engg (0 - 0 - 4) 2	AML110 Engg Mechanics (3 - 0 - 2) 4	MEL110 Graphic Science (2 - 0 - 4) 4	MAL110 Mathematics - I (3 - 1 - 0) 4	CYL120 Inorg & Org Chem (3 - 1 - 0) 4	CYP100 Chemistry Lab (0 - 0 - 4) 2				*4*	11	2	14	27	**20**
II	MEL140 Engg Thermodyn (3 - 1 - 0) 4	CSL101/102 Int Comp Prg/Sc (3 - 0 - 2) 4	MEL120 Mfg Practices (2 - 0 - 4) 4	MAL120 Mathematics - II (3 - 1 - 0) 4	PHL120 Phy Materials (3 - 1 - 0) 4	PHP100 Physics Lab (0 - 0 - 4) 2			HUN100 Intro Hu & So Sc (1 - 0 - 0) 1	*5*	15	3	10	28	**23**
III	AML160 Mechanics Fluids (3 - 1 - 0) 4	MEL211 Kin. & Dynamics (3 - 0 - 2) 4	MEP201 Mech Engg Drwg. (1 - 0 - 4) 3	AML140 Mechanics Solids (3 - 1 - 0) 4	EEL102 Prin Elec Engg (3 - 0 - 2) 4				*HUL2xx* Hu. & So. Sc. #1 (3 - 1 - 0) 4	*5*	16	3	8	27	**23**
IV	MEL241 Energy Convn. (3 - 0 - 2) 4	MEP311 Mechanism Lab (0 - 0 - 2) 1	MEP202 Des Inno & Mfg (0 - 0 - 4) 2	AMP262 Fluid Solid Lab (0 - 0 - 3) 1.5	MEL232 Cast Weld Form (3 - 0 - 2) 4		*OC-1* (3 - 0 - 0) 3	*OC-2* (3 - 0 - 2) 4	*HUL2xx* Hu. & So. Sc. #2 (3 - 1 - 0) 4	*5*	15	1	15	31	**23.5**
V	MEL242 Heat Mass Trnsf. (3 - 1 - 0) 4	MEL311 M/C Ele Design (3 - 1 - 2) 5	MEL233 M/cing, M/C tools (3 - 0 - 2) 4				*OC-3* (3 - 0 - 0) 3	*OC-4* (3 - 0 - 2) 4	*HUL2xx* Hu. & So. Sc. #3 (2 - 1 - 0) 3	*6*	17	3	6	26	**23**
VI	MEP341 Ther. Engg. Lab (0 - 0 - 3) 1.5	MEL312 Control Th & Appl (3 - 1 - 2) 5			**DE-1** (3 - 0 - 2) 4	*OC-5* (3 - 0 - 0) 3	*OC-6* (3 - 0 - 0) 3	*OC-7* (3 - 0 - 2) 4	*HUL2xx* Hu. & So. Sc. #4 (2 - 1 - 0) 3	*6*	17	2	9	28	**23.5**
summer	MET410 Practical Training (ME)									*NC*					
VII	MEC410 Colloquium (ME) (0 - 3 - 0) 3	MED411 Maj Proj Pt 1 (ME) (0 - 0 - 6) 3	MEL421 Production Mgmt (3 - 0 - 2) 4	**DE-2** (3 - 0 - 2) 4	**DE-3** (3 - 0 - 2) 4	**DE-4** (3 - 0 - 2) 4	*OC-8* (3 - 0 - 0) 3			*5*	15	3	14	32	**25**
VIII		MED412 Maj Proj Pt 2 (ME) (0 - 0 - 14) 7		**DE-5** (3 - 0 - 2) 4	**DE-6** (3 - 0 - 2) 4		*OC-9* (3 - 0 - 2) 4			*3*	9	0	20	29	**19**

Reqd. DE=24, plan DE = 6@4 = 24 cr. from 6 courses.

Reqd. OC=31, plan OC = 4@4 + 5@3 = 31 cr. from 9 courses.

HU = 2@4 + 2@3 + 1@1= 15 cr. from 4 courses & 1 Intro.

DC = 66, EAS = 24, BS = 20

TOTAL = 180.0

Programme Code: ME2 / (PE)

Bachelor of Technology in *Production and Industrial Engineering*

Department of Mechanical Engineering

The overall credits structure

Undergraduate Core (UC)		Undergraduate Elective (UE)	
Category	**Credits**	**Category**	**Credits**
DC	66	DE	24
BS	20	HM	14
EAS	24	OC	31
HU	1		
TOTAL	*111*	*TOTAL*	*69*

Total credits = 180

Basic Sciences (BS) Core

CYL120	Inorganic and Organic Chemistry: Concepts and Applications	3-1-0	**4**
CYP100	Chemistry Laboratory	0-0-4	**2**
MAL110	Mathematics - I	3-1-0	**4**
MAL120	Mathematics - II	3-1-0	**4**
PHL120	Physics of Materials	3-1-0	**4**
PHP100	Physics Laboratory	0-0-4	**2**
	TOTAL BS Core	**12-4-8**	**20**

Engineering Arts and Sciences (EAS) Core

AML110	Engineering Mechanics	3-0-2	**4**
AML120	Materials Science	3-0-2	**4**
CSL101	Introduction to Computers and Programming	3-0-2	**4**
	OR		
CSL102	Introduction to Computer Science	3-0-2	**4**
EEL102	Principles of Electrical Engineering	3-0-2	**4**
MEL110	Graphic Science	2-0-4	**4**
MEL120	Manufacturing Practices	2-0-4	**4**
	TOTAL EAS Core	**16-0-16**	**24**

Humanities and Social Sciences (HU) Core

HUN100	Introduction to Humanities and Social Sciences	1-0-0	**1**

Departmental Core (DC)

AML150	Mechanics of Solids and Fluids	3-1-2	**5**
MEC420	Colloquium (PE)	0-3-0	**3**
MED421	Major Project Part 1 (PE)	0-0-6	**3**
MED422	Major Project Part 2 (PE)	0-0-14	**7**
MEL211	Kinematics and Dynamics of Machines	3-0-2	**4**
MEL221	Industrial Engineering and Operations Research	3-0-2	**4**
MEL231	Casting and Welding	3-0-2	**4**
MEL234	Metal Forming and Machining	3-1-2	**5**
MEL235	Metrology and Quality Assurance	3-0-2	**4**
MEL311	Machine Element Design	3-1-2	**5**
MEL322	Operations Planning and Control	3-0-2	**4**
MEL331	Machine-tools and CNC Manufacturing	3-0-2	**4**
MEL423	Computers in Manufacturing Enterprises	3-0-2	**4**
MEN120	Introduction to Production and Industrial Engineering	0-0-4	**2**
MEP201	Mechanical Engineering Drawing	1-0-4	**3**
MEP202	Design Innovation and Manufacturing	0-0-4	**2**
MEP331	Process Engineering and Tool Design Project	1-0-4	**3**
MET420	Practical Training (PE)	—	**NC**
	TOTAL DC	**32-6-56**	**66**

Departmental Electives (DE)

MED320	Mini Project (PE)	0-0-8	**4**
MEL310	Concurrent Engineering	3-1-0	**4**
MEL312	Control Theory and Applications	3-1-2	**5**
MEL323	Investment Planning	3-0-2	**4**
MEL324	Value Engineering	3-0-2	**4**
MEL332	Design and Manufacturing of Composites	3-0-2	**4**
MEL334	Low Cost Automation	3-0-2	**4**
MEL335	Advances in Metal Forming	3-1-0	**4**
MEL336	Advances in Welding	3-0-2	**4**
MEL410	Creativity in Engineering	3-1-0	**4**
MEL411	Mechatronics	3-0-2	**4**
MEL414	Computer Aided Mechanical Design	3-0-2	**4**
MEL415	Vibrations Engineering Design	3-0-2	**4**
MEL416	Robotics Engineering	3-1-0	**4**
MEL420	Total Quality Management	3-0-2	**4**
MEL422	Project Management	3-0-2	**4**
MEL424	Knowledge Management for Competitiveness	3-0-2	**4**
MEL425	Flexible Manufacturing Systems	3-0-2	**4**
MEL426	Materials Management	3-0-2	**4**
MEL427	Manufacturing Economics and Analysis	3-0-2	**4**
MEL431	CNC Machines and Programming	3-0-2	**4**
MEL432	Microprocessor Applications in Manufacturing	3-0-2	**4**
MEL433	Micro- and Nano- Manufacturing	3-0-2	**4**
MEL434	Design for Manufacturing and Assembly	3-0-2	**4**
MEL435	Geometric Modelling for Manufacturing	3-0-2	**4**
MEL436	Injection Moulding and Mould Design	2-0-4	**4**

B.Tech. in Production and Industrial Engineering

(PE) **ME2**

Sem.										Lect Courses	L	T	P	Weekly contact	Credits
I	MEN120 Intor to P&I Engg (0 - 0 - 4) 2	AML110 Engg Mechanics (3 - 0 - 2) 4	MEL110 Graphic Science (2 - 0 - 4) 4	MAL110 Mathematics - I (3 - 1 - 0) 4	CYL120 Inorg & Org Chem (3 - 1 - 0) 4	CYP100 Chemistry Lab (0 - 0 - 4) 2				*4*	11	2	14	27	**20**
II	AML120 Materials Science (3 - 0 - 2) 4	CSL101/102 Int Comp Prg/Sc (3 - 0 - 2) 4	MEL120 Mfg Practices (2 - 0 - 4) 4	MAL120 Mathematics - II (3 - 1 - 0) 4	PHL120 Phy Materials (3 - 1 - 0) 4	PHP100 Physics Lab (0 - 0 - 4) 2			HUN100 Intro Hu & So Sc (1 - 0 - 0) 1	*5*	15	2	12	29	**23**
III	MEL231 Casting & Welding (3 - 0 - 2) 4	MEL211 Kin. & Dynamics (3 - 0 - 2) 4	MEP201 Mech Engg Drwg. (1 - 0 - 4) 3	AML150 Mech Fluid Solid (3 - 1 - 2) 5	EEL102 Prin Elec Engg (3 - 0 - 2) 4				*HUL2xx* Hu. & So. Sc. #1 (3 - 1 - 0) 4	*5*	16	2	12	30	**24**
IV	MEL234 Met Form&M/c-ing (3 - 1 - 2) 5	MEL235 Metrology & QA (3 - 0 - 2) 4	MEP212 Des Inno & Mfg (0 - 0 - 4) 2				*OC-1* (3 - 0 - 0) 3	*OC-2* (3 - 0 - 2) 4	*HUL2xx* Hu. & So. Sc. #2 (3 - 1 - 0) 4	*5*	15	2	10	27	**22**
V	MEL331 M/c-tools & CNC (3 - 0 - 2) 4	MEL311 M/c Ele Design (3 - 1 - 2) 5	MEL221 Indstr Engg & OR (3 - 0 - 2) 4				*OC-3* (3 - 0 - 0) 3	*OC-4* (3 - 0 - 2) 4	*HUL2xx* Hu. & So. Sc. #3 (2 - 1 - 0) 3	*6*	17	2	8	27	**23**
VI	MEP331 PE & TD Project (1 - 0 - 4) 3	MEL322 Oprn Plng Contrl (3 - 0 - 2) 4			**DE-1** (3 - 0 - 2) 4	*OC-5* (3 - 0 - 0) 3	*OC-6* (3 - 0 - 0) 3	*OC-7* (3 - 0 - 2) 4	*HUL2xx* Hu. & So. Sc. #4 (2 - 1 - 0) 3	*6*	18	1	10	29	**24**
summer	MET420 Practical Training (PE)									*NC*					
VII	MEC420 Colloquium (PE) (0 - 3 - 0) 3	MED421 Maj Proj Pt 1 (PE) (0 - 0 - 6) 3	MEL423 Comp Mfg Entrp (3 - 0 - 2) 4	**DE-2** (3 - 0 - 2) 4	**DE-3** (3 - 0 - 2) 4	**DE-4** (3 - 0 - 2) 4	*OC-8* (3 - 0 - 0) 3			*5*	15	3	14	32	**25**
VIII		MED422 Maj Proj Pt 2 (PE) (0 - 0 - 14) 7		**DE-5** (3 - 0 - 2) 4	**DE-6** (3 - 0 - 2) 4		*OC-9* (3 - 0 - 2) 4			*3*	9	0	20	29	**19**

Reqd. DE=24, plan DE = 6@4 = 24cr. from 6 courses.

Reqd. OC=31, plan OC = 4@4 + 5@3 = 31 cr. from 9 courses.

HU = 2@4 + 2@3 + 1@1= 15 cr. from 4 courses & 1 Intro.

DC = 66, EAS = 24, BS = 20

TOTAL = 180.0

Programme Code: TT1 / (TT)

Bachelor of Technology in Textile Technology

Department of Textile Technology

The overall credits structure

Undergraduate Core (UC)		Undergraduate Elective (UE)	
Category	**Credits**	**Category**	**Credits**
DC	70	DE	20
BS	20	HM	14
EAS	20	OC	35
HU	1		
TOTAL	*111*	*TOTAL*	*69*

Total credits = 180

Basic Sciences (BS) Core

CYL120	Inorganic and Organic Chemistry: Concepts and Applications	3-1-0	**4**
CYP100	Chemistry Laboratory	0-0-4	**2**
MAL110	Mathematics - I	3-1-0	**4**
MAL140	Probability and Statistics	3-1-0	**4**
PHL110	Fields and Waves	3-1-0	**4**
PHP100	Physics Laboratory	0-0-4	**2**
	TOTAL BS Core	**12-4-8**	**20**

Engineering Arts and Sciences (EAS) Core

AML120	Materials Science	3-0-2	**4**
CSL101	Introduction to Computers and Programming	3-0-2	**4**
	OR		
CSL102	Introduction to Computer Science	3-0-2	**4**
EEL102	Principles of Electrical Engineering	3-0-2	**4**
MEL110	Graphic Science	2-0-4	**4**
MEL120	Manufacturing Practices	2-0-4	**4**
	TOTAL EAS Core	**13-0-14**	**20**

Humanities and Social Sciences (HU) Core

HUN100	Introduction to Humanities and Social Sciences	1-0-0	**1**

Departmental Core (DC)

CYL230	Polymer Chemistry	2-1-0	**3**
TTC410	Colloquium (TT)	0-3-0	**3**
TTD411	Major Project Part 1 (TT)	0-0-6	**3**
TTD412	Major Project Part 2 (TT)	0-0-14	**7**
TTL211	Structure and Physical Properties of Fibres	3-0-0	**3**
TTL212	Manufactured Fibre Technology	3-1-0	**4**
TTL221	Yarn Manufacture - I	3-1-0	**4**
TTL222	Yarn Manufacture - II	3-1-0	**4**
TTL231	Fabric Manufacture - I	3-1-0	**4**
TTL232	Fabric Manufacture - II	3-1-0	**4**
TTL241	Technology of Textile Preparation and Finishing	3-0-0	**3**
TTL242	Technology of Textile Colouration	3-1-0	**4**
TTL361	Textile Testing	3-0-0	**3**
TTL362	Theory of Textile Structures	3-2-0	**5**
TTN110	Introduction to Textile Technology	0-0-4	**2**
TTP200	Design of Textile Products and Processes	0-0-4	**2**
TTP211	Introduction to Fibres	1-0-2	**2**
TTP212	Manufactured Fibre Technology Laboratory	0-0-2	**1**
TTP221	Yarn Manufacture Laboratory - I	0-0-2	**1**
TTP222	Yarn Manufacture Laboratory - II	0-0-2	**1**
TTP231	Fabric Manufacture Laboratory - I	0-0-2	**1**
TTP232	Fabric Manufacture Laboratory - II	0-0-4	**2**
TTP241	Technology of Textile Preparation and Finishing Laboratory	0-0-3	**1.5**
TTP242	Technology of Textile Colouration Laboratory	0-0-3	**1.5**
TTP361	Textile Testing Laboratory	0-0-2	**1**
TTT410	Practical Training (TT)	—	**NC**
	TOTAL DC	**33-12-50**	**70**

Departmental Electives (DE)

BEL110	Molecular Cell Biology	3-0-0	**3**
CHL110	Transport Phenomena	3-1-0	**4**
TTD310	Mini Project (TT)	0-0-6	**3**
TTL311	High Performance and Specialty Fibres	3-0-0	**3**
TTL321	Mechanics of Spinning Machinery	2-1-0	**3**
TTL322	Mechanics of Spinning Processes	3-0-0	**3**
TTL323	Process Control in Spinning	3-0-0	**3**
TTL324	Spinning of Man-made Fibres and Blends	3-0-0	**3**
TTL331	Fabric Structure and Analysis	2-0-2	**3**
TTL332	Computer Aided Fabric Manufacturing	2-0-2	**3**
TTL333	Process Control in Weaving	3-0-0	**3**
TTL341	Polymers and Surfactants for Textiles	3-0-0	**3**
TTL351	Apparel Technology	2-0-2	**3**
TTL352	Clothing Science	3-0-0	**3**
TTL363	Technical Textiles	3-1-0	**4**
TTL364	Intelligent and Functional Textile	2-0-0	**2**
TTL365	Costing and its Application in Textiles	3-1-0	**4**
TTL724	Textured Yarn Technology	3-0-0	**3**
TTL744	Environment Management in Textile and Allied Industries	3-0-0	**3**
TTL762	Management of Textile Production	3-0-0	**3**
TTL773	Design of Experiments and Statistical Techniques	3-0-0	**3**
TTP312	Simulation of Fibre Production Processes	1-0-4	**3**
TTR310	Professional Practices (TT)	0-1-2	**2**
TTS310	Independent Study (TT)	0-3-0	**3**
TTV301	Special Module in Yarn Manufacture	1-0-0	**1**
TTV302	Special Module in Fabric Manufacture	1-0-0	**1**
TTV303	Special Module in Textile Chemical Processing	1-0-0	**1**
TTV304	Special Module in Fibre Science	1-0-0	**1**
TTV305	Special Module in Textile Technology	1-0-0	**1**

B.Tech. in Textile Technology

(TT) **TT1**

Sem.										Lect Courses	L	T	P	Weekly contact	Credits
I	TTN110 Intro to Tex Tech (0 - 0 - 4) 2	CS101/102 Int Comp Prg/Sc (3 - 0 - 2) 4	MEL120 Mfg Practices (2 - 0 - 4) 4	MAL110 Mathematics - I (3 - 1 - 0) 4	CYL120 Inorg & Org Chem (3 - 1 - 0) 4	CYP100 Chemistry Lab (0 - 0 - 4) 2				*4*	11	2	14	27	**20**
II	AML120 Materials Science (3 - 0 - 2) 4	EEL102 Prin Elec Engg (3 - 0 - 2) 4	MEL110 Graphic Science (2 - 0 - 4) 4	MAL140 Prob. & Stat. (3 - 1 - 0) 4	PHL110 Fields & Waves (3 - 1 - 0) 4	PHP100 Physics Lab (0 - 0 - 4) 2			HUN100 Intro Hu & So Sc (1 - 0 - 0) 1	*5*	15	2	12	29	**23**
III	TTL211 Str Phy Prop Fibre (3 - 0 - 0) 3	TTP211 Intro to Fibers (1 - 0 - 2) 2	TTL221 Yarn Manf. - I (3 - 1 - 0) 4	TTP221 Yarn Manf Lab - I (0 - 0 - 2) 1	TTL231 Fabric Manf.- I (3 - 1 - 0) 4	TTP231 Fabric Manf. Lab-I (0 - 0 - 2) 1	TTL241 Tech Tex P&F (3 - 0 - 0) 3	TTP241 Tech T P&F Lab-I (0 - 0 - 3) 1.5	CYL230 Polym Chemistry (2 - 1 - 0) 3	*5*	15	3	9	27	**22.5**
IV	TTL212 Mfd. Fibre Tech. (3 - 1 - 0) 4	TTP212 Mfd Fibre Tech Lab (0 - 0 - 2) 1	TTL222 Yarn Manf. - II (3 - 1 - 0) 4	TTP222 Yarn Manf Lab - II (0 - 0 - 2) 1	TTL232 Fabric Manf.- II (3 - 1 - 0) 4	TTP232 Fabric Manf. Lab-II (0 - 0 - 4) 2	TTL242 Tech Tex Col (3 - 1 - 0) 4	TTP242 Tech Tex Col Lab (0 - 0 - 3) 1.5	*HUL2xx* Hu. & So. Sc. #1 (3 - 1 - 0) 4	*5*	15	5	11	31	**25.5**
V	TTL361 Tex. Testing (3 - 0 - 0) 3	TTP361 Tex. Testing Lab (0 - 0 - 2) 1	TTL362 Theo Tex Struct. (3 - 2 - 0) 5	TTP200 Des Tex Prd Proc (0 - 0 - 4) 2	**DE-1** (3 - 0 - 0) 3		*OC-1* (3 - 1 - 0) 4	*OC-2* (3 - 0 - 0) 3	*HUL2xx* Hu. & So. Sc. #2 (3 - 0 - 0) 3	*6*	18	3	6	27	**24**
VI	**DE-2** TTD310/TTS310 (0 - 0 - 6) 3			**DE-3** (3 - 0 - 0) 3	**DE-4** (3 - 1 - 0) 4	*OC-3* (3 - 1 - 0) 4	*OC-4* (3 - 1 - 0) 4	*OC-5* (3 - 1 - 0) 4	*HUL2xx* Hu. & So. Sc. #3 (2 - 1 - 0) 3	*6*	17	5	6	28	**25**
summer	TTT410 Practical Training (TT)									*NC*					
VII	TTC410 Colloquium (TT) (0 - 3 - 0) 3	TTD411 Maj Proj Pt 1 (TT) (0 - 0 - 6) 3			**DE-5** (3 - 0 - 2) 4	**DE-6** (3 - 0 - 0) 3	*OC-6* (3 - 0 - 0) 3	*OC-7* (3 - 1 - 0) 4	*HUL2xx* Hu. & So. Sc. #4 (3 - 1 - 0) 4	*5*	15	5	8	28	**24**
VIII		TTD412 Maj Proj Pt 2 (TT) (0 - 0 - 14) 7			**DE-7** TTV (1 - 0 - 0) 1		*OC-8* (3 - 1 - 0) 4	*OC-9* (3 - 1 - 0) 4		*2*	7	2	14	23	**16**

Reqd. DE=20, plan DE = 1@4 + 5@3 + 1@1 = 20 cr. from 6+1V courses.

Reqd. OC=35, plan OC = 8@4 + 1@3 = 35 cr. from 9 courses.

HU = 2@4 + 2@3 + 1@1= 15 cr. from 4 courses & 1 Intro.

DC = 70, EAS = 20, BS = 20

TOTAL = 180.0

Programme Code: BB5 / (BB)

Bachelor of Technology in *Biochemical Engineering and Biotechnology,* and *Master of Technology* in *Biochemical Engineering and Biotechnology*

Department of Biochemical Engineering and Biotechnology

The overall credits structure

Undergraduate Core (UC)		Undergraduate Elective (UE)	
Category	**Credits**	**Category**	**Credits**
DC	60	DE	20
BS	20	HM	14
EAS	20	OC	35
HU	1		
TOTAL	*101*	*TOTAL*	*69*

Program Core (PC)		Program Elective (PE)	
Category	**Credits**	**Category**	**Credits**
PC	32	PE	16

Total credits = 218

Basic Sciences (BS) Core

CYL120	Inorganic and Organic Chemistry: Concepts and Applications	3-1-0	**4**
CYP100	Chemistry Laboratory	0-0-4	**2**
MAL110	Mathematics - I	3-1-0	**4**
MAL120	Mathematics - II	3-1-0	**4**
PHL110	Fields and Waves	3-1-0	**4**
PHP100	Physics Laboratory	0-0-4	**2**
	TOTAL BS Core	**12-4-8**	**20**

Engineering Arts and Sciences (EAS) Core

AML110	Engineering Mechanics	3-0-2	**4**
CHL110	Transport Phenomena	3-1-0	**4**
CSL101	Introduction to Computers and Programming	3-0-2	**4**
	OR		
CSL102	Introduction to Computer Science	3-0-2	**4**
MEL110	Graphic Science	2-0-4	**4**
MEL120	Manufacturing Practices	2-0-4	**4**
	TOTAL EAS Core	**13-1-12**	**20**

Humanities and Social Sciences (HU) Core

HUN100	Introduction to Humanities and Social Sciences	1-0-0	**1**

Departmental Core (DC)

BEC450	Colloquium (BB)	0-3-0	**3**
BEL101	Biochemistry	3-1-3	**5.5**
BEL102	Bioprocess Calculations	3-1-0	**4**
BEL103	General Microbiology	3-0-3	**4.5**
BEL204	Molecular Biology and Genetics	3-0-3	**4.5**
BEL301	Bioprocess Engineering	3-0-0	**3**
BEL302	Fluid Solid Systems	3-0-0	**3**
BEL401	Bioprocess Technology	2-0-0	**2**
BEL403	Enzyme Engineering and Technology	3-0-2	**4**
BEN150	Introduction to Biochemical Engineering and Biotechnology	0-0-4	**2**
BEP303	Design of Bioprocesses	0-1-3	**2.5**
BET450	Practical Training (BB)	—	**NC**
CHL101	Introduction to Chemical Engineering Thermodynamics	2-1-0	**3**
CHL103	Chemical Reactor Analysis and Design	3-1-0	**4**
CHL202	Process Systems Analysis and Control	3-1-0	**4**
CHL203	Transport Processes - I	3-1-0	**4**
CHL204	Transport Processes - II	3-1-0	**4**
CHP304	Chemical Engineering Laboratory - I	0-0-3	**1.5**
CHP305	Chemical Engineering Laboratory - II	0-0-3	**1.5**
	TOTAL DC	**37-11-24**	**60**

Departmental Electives (DE)

BED350	Mini Project (BB)	0-0-6	**3**
BEL311	Physical and Chemical Properties of Biomolecules	2-1-0	**3**
BEL312	Carbohydrates and Lipids in Biotechnology	2-1-0	**3**
BEL411	Food Science and Engineering	3-0-0	**3**
BEL412	Immunology	3-0-2	**4**
BEL413	Modelling and Simulation of Bioprocesses	3-0-2	**4**
BEL414	Thermodynamics of Biological Systems	3-0-0	**3**
BEL415	Advanced Bioprocess Control	3-0-0	**3**
BEL416	Membrane Applications in Bioprocessing	3-0-0	**3**
BEL417	Biophysics	3-0-0	**3**
BEL418	Bioinformatics	2-0-2	**3**
BEL419	Enzyme Catalyzed Organic Synthesis	2-0-2	**3**
BEL420	Analytical Methods in Biotechnology	2-0-2	**3**
BEL421	Metabolic Regulation and Engineering	3-0-0	**3**
BEL422	Solid State Cultivation	3-0-0	**3**
BER350	Professional Practices (BB)	0-1-2	**2**
BES350	Independent Study (BB)	0-3-0	**3**
BEV330	Special Module in Biochemical Engineering and Biotechnology	1-0-0	**1**
CHL277	Materials of Construction	3-0-0	**3**
CHL332	Fluidization Engineering	3-1-0	**4**
CHL392	Polymer Science and Engineering	3-1-0	**4**

Program Core (PC)

BEC750	Seminar (BB)	1-0-0	**NC**
BED851	Major Project Part 1 (BB)	0-0-12	**6**
BED852	Major Project Part 2 (BB)	0-0-28	**14**
BED853	Major Project Part 1 (BB)	0-0-8	**4**
BED854	Major Project Part 2 (BB)	0-0-32	**16***
BEL701	Biotechnology Resource Planning and IPR Issues	2-0-0	**2***
BEL702	Bioprocess Plant Design	3-0-4	**5**
BEL703	Downstream Processing in Biotechnology	3-0-4	**5**
	TOTAL PC	**9-0-48**	**32**

* BED853 and BED854 together are alternatives to BED851 and BED852.

Program Electives (PE)

BEL711	Recombinant DNA Technology	2-0-4	**4**
BEL712	Plant Cell Technology	2-0-2	**3**
BEL713	Microbial Engineering	3-0-0	**3**
BEL714	Protein Science and Engineering	3-0-0	**3**
BEL715	Biological Waste Treatment	3-0-2	**4**
BEL716	High Resolution Methods in Biotechnology	2-0-2	**3**
BEL717	Animal Cell Technology	3-0-2	**4**
BEL718	Combinatorial Biotechnology	3-0-0	**3**
BEL719	Current Topics in Biochemical Engineering and Biotechnology	3-0-0	**3**
BEL720	Biotechnology in Food Processing	3-0-0	**3**
BEL721	Bionanotechnology	3-0-0	**3**
BEL722	Genomics and Proteomics	3-0-0	**3**
BEL723	Data Analysis for DNA Microarrays	3-0-2	**4**
BEL724	Advanced Biochemistry	3-0-0	**3**

B.Tech. + M.Tech. in Biochemical Engineering and Biotechnology

(BB) **BB5**

Sem.										Lect cour	L	T	P	Week cont.	Cr.
I	BEN150 Intr Bioch Biotech (0 - 0 - 4) 2	MEL120 Mfg Practices (2 - 0 - 4) 4	AML110 Engg Mechanics (3 - 0 - 2) 4	MAL110 Mathematics - I (3 - 1 - 0) 4	CYL120 In & Or Chem (3 - 1 - 0) 4	CYP100 Chemistry Lab (0 - 0 - 4) 2			HUN100 Intro Hu & So Sc (1 - 0 - 0) 1	*4*	12	2	14	28	**21**
II	CHL110 Transp. Phen. (3 - 1 - 0) 4	CSL101/102 Int Comp Prg/Sc (3 - 0 - 2) 4	MEL110 Graphic Science (2 - 0 - 4) 4	MAL120 Mathematics - II (3 - 1 - 0) 4	PHL110 Fields & Waves (3 - 1 - 0) 4	PHP100 Physics Lab (0 - 0 - 4) 2				*5*	14	3	10	27	**22**
III	CHL101 Intr Ch E Thermo (2 - 1 - 0) 3	CHL203 Transp Process- I (3 - 1 - 0) 4	BEL101 Biochemistry (3 - 1 - 3) 5.5	BEL103 Genrl Microbiology (3 - 0 - 3) 4.5					*HUL2xx* Hu. & So. Sc. #1 (3 - 1 - 0) 4	*5*	14	4	6	24	**21**
IV	CHL204 Transp Process -II (3 - 1 - 0) 4	BEL102 Bioprocess Calc (3 - 1 - 0) 4	BEL302 Fluid Solid Syst (3 - 0 - 0) 3	BEL204 Mol Bio Genetics (3 - 0 - 3) 4.5				*OC-1* (3 - 1 - 0) 4	*HUL2xx* Hu. & So. Sc. #2 (3 - 1 - 0) 4	*6*	18	4	3	25	**23.5**
V	CHL103 Ch React Ana Des (3 - 1 - 0) 4	CHP304 Ch Engg Lab - I (0 - 0 - 3) 1.5	BEL301 Bioprocess Engg (3 - 0 - 0) 3	BEP303 Design Bioproc (0 - 1 - 3) 2.5	**DE-1a** Prof Prac BER350 (0 - 0.5 - 1) 1		*OC-2* (3 - 1 - 0) 4	*OC-3* (3 - 1 - 0) 4	*HUL2xx* Hu. & So. Sc. #3 (2 - 1 - 0) 3	*5*	14	5.5	7	26.5	**23**
VI	CHL202 Proc Sys An Cntrl (3 - 1 - 0) 4	CHP305 Ch Engg Lab - II (0 - 0 - 3) 1.5	BEL401 Bioproc Technol (2 - 0 - 0) 2		**DE-1b** Prof Prac BER350 (0 - 0.5 - 1) 1	**DE-2** (3 - 0 - 0) 3	**DE-3** (3 - 0 - 0) 3	*OC-4* (3 - 1 - 0) 4	*HUL2xx* Hu. & So. Sc. #4 (2 - 1 - 0) 3	*6*	16	3.5	4	24	**21.5**
summer	BET450 Practical Training (BB)									*NC*					
VII	BEC450 Colloquium (BB) (0 - 3 - 0) 3	BEL403 Enzy Engg Tech (3 - 0 - 2) 4		**DE-4** (3 - 0 - 0) 3	**DE-5** (3 - 0 - 0) 3	**DE-6** BED/BES (0 - 0 - 6) 3	*OC-5* (3 - 1 - 0) 4	*OC-6* (3 - 0 - 0) 3	*OC-7* (3 - 0 - 0) 3	*6*	18	4	8	30	**26**
VIII	BEL702 Bioproc Plant Des (3 - 0 - 4) 5	BEL703 D/str Proc Biotech (3 - 0 - 4) 5		**PE-1** (3 - 0 - 0) 3	**PE-2** (3 - 0 - 0) 3	**DE-7** (3 - 0 - 0) 3		*OC-8* (3 - 1 - 2) 5		*6*	18	1	10	29	**24**
summer	BED851 Major Project Part 1 (BB)														
IX	BEL701 Biotech Res Plng (2 - 0 - 0) 2	BED851 Maj Proj P-1 (BB) (0 - 0 - 12) 6		**PE-3** (3 - 0 - 0) 3	**PE-4** (2 - 0 - 4) 4	**PE-5** (3 - 0 - 0) 3		*OC-9* (3 - 1 - 0) 4		*5*	13	1	16	30	**22**
X	BEC750 Seminar (BB) (1 - 0 - 0) NC	BED852 Maj Proj P-2 (BB) (0 - 0 - 28) 14								*0*	1	0	28	29	**14**
summer	BED852 Major Project Part 2 (BB)														

Reqd. DE=20, plan DE = 6@3 + 1@2 = 20 cr. from 7 courses. Reqd. PE=16, plan PE = 1@4 + 4@3 = 16 cr. from 5 courses. **TOTAL = 218.0**

Reqd. OC=35, plan OC = 7@4 + 1@3 + 1@5 = 35cr. from 9 courses. HU = 2@4 + 2@3 + 1@1= 15 cr. from 4 courses & 1 Intro. **DC = 60, EAS = 20, BS = 20. PC = 32, PE = 16**

Programme Code: CH5 / (CC)

Bachelor of Technology in Chemical Engineering, and
Master of Technology in Computer Applications in Chemical Engineering

Department of Chemical Engineering

The overall credits structure

Undergraduate Core (UC)		Undergraduate Elective (UE)	
Category	**Credits**	**Category**	**Credits**
DC	60	DE	20
BS	20	HM	14
EAS	20	OC	35
HU	1		
TOTAL	*101*	*TOTAL*	*69*

Program Core (PC)		Program Elective (PE)	
Category	**Credits**	**Category**	**Credits**
PC	32	PE	16

Total credits = 218

Basic Sciences (BS) Core

CYL110	Physical Chemistry: Concepts and Applications	3-1-0	**4**
CYL120	Inorganic and Organic Chemistry: Concepts and Applications	3-1-0	**4**
CYP100	Chemistry Laboratory	0-0-4	**2**
MAL110	Mathematics - I	3-1-0	**4**
MAL120	Mathematics - II	3-1-0	**4**
PHP100	Physics Laboratory	0-0-4	**2**
	TOTAL BS Core	**12-4-8**	**20**

Engineering Arts and Sciences (EAS) Core

AML120	Materials Science	3-0-2	**4**
CSL101	Introduction to Computers and Programming	3-0-2	**4**
	OR		
CSL102	Introduction to Computer Science	3-0-2	**4**
EEL102	Principles of Electrical Engineering	3-0-2	**4**
MEL110	Graphic Science	2-0-4	**4**
MEL120	Manufacturing Practices	2-0-4	**4**
	TOTAL EAS Core	**13-0-14**	**20**

Humanities and Social Sciences (HU) Core

HUN100	Introduction to Humanities and Social Sciences	1-0-0	**1**

Departmental Core (DC)

CHC410	Colloquium (CH)	0-3-0	**3**
CHL110	Transport Phenomena	3-1-0	**4**
CHL111	Material and Energy Balance	2-2-0	**4**
CHL112	Chemical Process Technology	3-1-0	**4**
CHL121	Chemical Engineering Thermodynamics	3-1-0	**4**
CHL122	Chemical Reaction Engineering – I	3-1-0	**4**
CHL221	Chemical Reaction Engineering – II	3-1-0	**4**
CHL231	Fluid Mechanics for Chemical Engineers	3-1-0	**4**
CHL251	Heat and Mass Transfer	3-1-0	**4**
CHL261	Instrumentation and Process Control	3-1-0	**4**
CHL331	Fluid-particle Mechanics	3-1-0	**4**
CHL351	Mass Transfer Operations	3-1-0	**4**
CHL471	Process Equipment Design and Economics	3-0-3	**4.5**
CHN110	Introduction to Chemical Engineering	0-0-4	**2**
CHP301	Fluid Mechanics and Heat Transfer Laboratory	0-0-3	**1.5**
CHP302	Mass Transfer and Fluid Particle Mechanics Laboratory	0-0-3	**1.5**
CHP303	Chemical Reaction Engineering and Process Control Laboratory	0-0-3	**1.5**
CHP311	Design and Laboratory Practices	0-0-4	**2**
CHT410	Practical Training (CH)	—	**NC**
	TOTAL DC	**35-15-20**	**60**

Departmental Electives (DE)

CHD310	Mini Project (CH)	0-0-6	**3**
CHL133	Powder Processing and Technology	3-1-0	**4**
CHL260	Applications of Programming in Chemical Engineering	3-0-2	**4**
CHL275	Safety and Hazards in the Process Industries	3-1-0	**4**
CHL277	Materials of Construction	3-0-0	**3**
CHL291	Introduction to Biochemical Engineering	3-1-0	**4**
CHL296	Nano Engineering of Soft Materials	3-0-0	**3**
CHL332	Fluidization Engineering	3-1-0	**4**
CHL353	Modern Separation Processes	3-1-0	**4**
CHL390	Process Utilities and Pipeline Design	3-0-2	**4**
CHL392	Polymer Science and Engineering	3-1-0	**4**
CHL705	Electrokinetic Transport Phenomena	3-0-2	**4**
CHL707	Adsorption Separation Processes	3-0-0	**3**
CHL710	Process Dynamics and Control	3-1-2	**5**
CHL724	Environmental Engineering and Waste Management	3-1-0	**4**
CHL727	Heterogeneous Catalysis and Catalytic Reactors	3-0-2	**4**
CHL743	Petrochemical Technology	3-0-0	**3**
CHL751	Multi-component Mass Transfer	3-0-0	**3**
CHL766	Interfacial Engineering	3-0-0	**3**
CHL768	Fundamentals of Computational Fluid Dynamics	2-0-2	**3**
CHL773	Planning of Experiments and Analysis of Engineering Data	3-0-2	**4**
CHL774	Process Optimization	3-0-2	**4**
CHL793	Membrane Science and Engineering	3-0-0	**3**
CHL794	Petroleum Refinery Engineering	3-0-2	**4**
CHR310	Professional Practices (CH)	0-1-2	**2**
CHS310	Independent Study (CH)	0-3-0	**3**

Program Core (PC)

CHC750	Seminar (CC)	0-0-2	**1**
CHD851	Major Project Part 1 (CC)	0-0-12	**6**
CHD852	Major Project Part 2 (CC)	0-0-28	**14**
CHD853	Major Project Part 1 (CC)	0-0-8	**4***
CHD854	Major Project Part 2 (CC)	0-0-32	**16***
CHL711	Numerical Methods in Chemical Engineering	3-0-2	**4**
CHL712	Computer Aided Design in Chemical Engineering	2-0-2	**3**
CHL762	Modelling, Simulation and Control	3-0-2	**4**
	TOTAL PC	**8-0-48**	**32**

* CHD853 and CHD854 together are alternatives to CHD851 and CHD852.

Program Electives (PE)

CHL710	Process Dynamics and Control	3-1-2	**5**
CHL763	Computer Process Control	3-0-0	**3**
CHL768	Fundamentals of Computational Fluid Dynamics	2-0-2	**3**
CHL774	Process Optimization	3-0-2	**4**
CHL807	Population Balance Modelling	3-0-0	**3**
CHL830	Advanced Computational Techniques in Chemical Engineering	2-0-2	**3**
CHL864	Applications of AI and ANN in Chemical Engineering	3-0-2	**4**
CHL869	Applications of Computational Fluid Dynamics	2-0-2	**3**
CHP754	Applications of Simulation Software	1-0-2	**2**
EEL758	Intelligent and Knowledge Based Systems	3-0-0	**3**

B.Tech. in Chemical Engg. + M.Tech. in Computer Applictions in Chemical Engg. (CC) CH5

Sem.										Lect cour	L	T	P	Week cont.	Cr.
I	CHN110 Intr to Chem Engg (0 - 0 - 4) 2	CSL101/102 Int Comp Prg/Sc (3 - 0 - 2) 4	MEL110 Graphic Science (2 - 0 - 4) 4	MAL110 Mathematics - I (3 - 1 - 0) 4	CYL110 Physical Chem. (3 - 1 - 0) 4	CYP100 Chemistry Lab (0 - 0 - 4) 2			0	*4*	11	2	14	27	**20**
II	CHL110 Transp Phen (3 - 1 - 0) 4	EEL102 Prin Elec Engg (3 - 0 - 2) 4	MEL120 Mfg Practices (2 - 0 - 4) 4	MAL120 Mathematics - II (3 - 1 - 0) 4	CYL120 Inorg & Org Chem. (3 - 1 - 0) 4	PHP100 Physics Lab (0 - 0 - 4) 2			HUN100 Intro Hu & So Sc (1 - 0 - 0) 1	*5*	15	3	10	28	**23**
III	CHL111 Matl Energy Bal. (2 - 2 - 0) 4	CHL121 Ch Engg Thermo (3 - 1 - 0) 4	CHL231 Fl Mech Ch Engr (3 - 1 - 0) 4	CHL251 Heat Mass Transf (3 - 1 - 0) 4	AML120 Materials Science (3 - 0 - 2) 4				*HUL2xx* Hu. & So. Sc. #1 (3 - 1 - 0) 4	*6*	17	6	2	25	**24**
IV	CHL112 Chem Proc Techn (3 - 1 - 0) 4	CHL122 Ch React Engg-I (3 - 1 - 0) 4	CHP311 Des Lab Practices (0 - 0 - 4) 2	CHL351 Mass Transf Oprns (3 - 1 - 0) 4	CHP301 F M & H T Lab (0 - 0 - 3) 1.5			*OC-1* (3 - 1 - 0) 4	*HUL2xx* Hu. & So. Sc. #2 (3 - 1 - 0) 4	*5*	15	5	7	27	**23.5**
V	CHL221 Ch React Engg-II (3 - 1 - 0) 4	CHL261 Instr Proc Control (3 - 1 - 0) 4	CHL331 Fluid-particle Mech. (3 - 1 - 0) 4	CHP302 M T & F P M Lab (0 - 0 - 3) 1.5			*OC-2* (3 - 1 - 0) 4	*OC-3* (3 - 1 - 0) 4	*HUL2xx* Hu. & So. Sc. #3 (2 - 1 - 0) 3	*6*	17	6.0	3	26.0	**24.5**
VI	CHL471 Proc Eq Des Eco (3 - 0 - 3) 4.5	CHP303 Ch RE & PC Lab (0 - 0 - 3) 1.5		**DE-1** (3 - 1 - 0) 4	**DE-2** (3 - 1 - 0) 4		*OC-4* (3 - 1 - 0) 4	*OC-5* (3 - 1 - 0) 4		*5*	15	4	6	25	**22**
summer	CHT410 Practical Training (CH)									*NC*					
VII	CHC410 Colloquium (CH) (0 - 3 - 0) 3	CHL711 Num Meth Ch Eng (3 - 0 - 2) 4		**DE-3** (3 - 1 - 0) 4	**DE-4** (3 - 1 - 0) 4		*OC-6* (3 - 0 - 0) 3	*OC-7* (3 - 1 - 0) 4	*HUL2xx* Hu. & So. Sc. #4 (2 - 1 - 0) 3	*6*	17	7	2	26	**25**
VIII	CHL712 CAD Chem Engg (2 - 0 - 2) 3	CHL762 Modlg Sim Control (3 - 0 - 2) 4	CHC750 Seminar (CC) (0 - 0 - 2) 1		**DE-5** (3 - 1 - 0) 4		*OC-8* (3 - 1 - 0) 4	*OC-9* (3 - 1 - 0) 4		*5*	14	3	6	23	**20**
summer	CHD851 Major Project Part 1 (CC)														
IX		CHD851 Maj Proj P-1 (CC) (0 - 0 - 12) 6	**PE-1** (3 - 1 - 0) 4	**PE-2** (3 - 1 - 0) 4	**PE-3** (3 - 1 - 0) 4	**PE-4** (3 - 1 - 0) 4				*4*	12	4	12	28	**22**
X		CHD852 Maj Proj P-2 (CC) (0 - 0 - 28) 14								*0*	0	0	28	28	**14**
summer	CHD852 Major Project Part 2 (CC)														

Reqd. DE=20, plan DE = 5@4 = 20 cr. from 5 courses. Reqd. PE=16, plan PE = 4@4 = 16 cr. from 4 courses. **TOTAL = 218.0**

Reqd. OC=35, plan OC = 8@4 + 1@3 = 35 cr. from 9 courses. HU = 2@4 + 2@3 + 1@1= 15 cr. from 4 courses & 1 Intro. **DC = 60, EAS = 20, BS = 20. PC = 32, PE = 16**

Programme Code: CH6 / (CP)

***Bachelor of Technology** in **Chemical Engineering,** and*
Master of Technology** in **Process Engineering and Design
Department of Chemical Engineering

The overall credits structure

Undergraduate Core (UC)		Undergraduate Elective (UE)	
Category	**Credits**	**Category**	**Credits**
DC	60	DE	20
BS	20	HM	14
EAS	20	OC	35
HU	1		
TOTAL	*101*	*TOTAL*	*69*

Program Core (PC)		Program Elective (PE)	
Category	**Credits**	**Category**	**Credits**
PC	32	PE	16

Total credits = 218

Basic Sciences (BS) Core

CYL110	Physical Chemistry: Concepts and Applications	3-1-0	**4**
CYL120	Inorganic and Organic Chemistry: Concepts and Applications	3-1-0	**4**
CYP100	Chemistry Laboratory	0-0-4	**2**
MAL110	Mathematics - I	3-1-0	**4**
MAL120	Mathematics - II	3-1-0	**4**
PHP100	Physics Laboratory	0-0-4	**2**
	TOTAL BS Core	**12-4-8**	**20**

Engineering Arts and Sciences (EAS) Core

AML120	Materials Science	3-0-2	**4**
CSL101	Introduction to Computers and Programming	3-0-2	**4**
	OR		
CSL102	Introduction to Computer Science	3-0-2	**4**
EEL102	Principles of Electrical Engineering	3-0-2	**4**
MEL110	Graphic Science	2-0-4	**4**
MEL120	Manufacturing Practices	2-0-4	**4**
	TOTAL EAS Core	**13-0-14**	**20**

Humanities and Social Sciences (HU) Core

HUN100	Introduction to Humanities and Social Sciences	1-0-0	**1**

Departmental Core (DC)

CHC410	Colloquium (CH)	0-3-0	**3**
CHL110	Transport Phenomena	3-1-0	**4**
CHL111	Material and Energy Balance	2-2-0	**4**
CHL112	Chemical Process Technology	3-1-0	**4**
CHL121	Chemical Engineering Thermodynamics	3-1-0	**4**
CHL122	Chemical Reaction Engineering – I	3-1-0	**4**
CHL221	Chemical Reaction Engineering – II	3-1-0	**4**
CHL231	Fluid Mechanics for Chemical Engineers	3-1-0	**4**
CHL251	Heat and Mass Transfer	3-1-0	**4**
CHL261	Instrumentation and Process Control	3-1-0	**4**
CHL331	Fluid-particle Mechanics	3-1-0	**4**
CHL351	Mass Transfer Operations	3-1-0	**4**
CHL471	Process Equipment Design and Economics	3-0-3	**4.5**
CHN110	Introduction to Chemical Engineering	0-0-4	**2**
CHP301	Fluid Mechanics and Heat Transfer Laboratory	0-0-3	**1.5**
CHP302	Mass Transfer and Fluid Particle Mechanics Laboratory	0-0-3	**1.5**
CHP303	Chemical Reaction Engineering and Process Control Laboratory	0-0-3	**1.5**
CHP311	Design and Laboratory Practices	0-0-4	**2**
CHT410	Practical Training (CH)	—	**NC**
	TOTAL DC	**35-15-20**	**60**

Departmental Electives (DE)

CHD310	Mini Project (CH)	0-0-6	**3**
CHL133	Powder Processing and Technology	3-1-0	**4**
CHL260	Applications of Programming in Chemical Engineering	3-0-2	**4**
CHL275	Safety and Hazards in the Process Industries	3-1-0	**4**
CHL277	Materials of Construction	3-0-0	**3**
CHL291	Introduction to Biochemical Engineering	3-1-0	**4**
CHL296	Nano Engineering of Soft Materials	3-0-0	**3**
CHL332	Fluidization Engineering	3-1-0	**4**
CHL353	Modern Separation Processes	3-1-0	**4**
CHL390	Process Utilities and Pipeline Design	3-0-2	**4**
CHL392	Polymer Science and Engineering	3-1-0	**4**
CHL705	Electrokinetic Transport Phenomena	3-0-2	**4**
CHL707	Adsorption Separation Processes	3-0-0	**3**
CHL710	Process Dynamics and Control	3-1-2	**5**
CHL724	Environmental Engineering and Waste Management	3-1-0	**4**
CHL727	Heterogeneous Catalysis and Catalytic Reactors	3-0-2	**4**
CHL743	Petrochemical Technology	3-0-0	**3**
CHL751	Multi-component Mass Transfer	3-0-0	**3**
CHL766	Interfacial Engineering	3-0-0	**3**
CHL768	Fundamentals of Computational Fluid Dynamics	2-0-2	**3**
CHL773	Planning of Experiments and Analysis of Engineering Data	3-0-2	**4**
CHL774	Process Optimization	3-0-2	**4**
CHL793	Membrane Science and Engineering	3-0-0	**3**
CHL794	Petroleum Refinery Engineering	3-0-2	**4**
CHR310	Professional Practices (CH)	0-1-2	**2**
CHS310	Independent Study (CH)	0-3-0	**3**

Program Core (PC)

CHC760	Seminar (CP)	0-0-2	**1**
CHD861	Major Project Part 1 (CP)	0-0-12	**6**
CHD862	Major Project Part 2 (CP)	0-0-28	**14**
CHD863	Major Project Part 1 (CP)	0-0-8	**4***
CHD864	Major Project Part 2 (CP)	0-0-32	**16***
CHL701	Process Engineering	3-0-2	**4**
CHL702	Plant Design	3-0-2	**4**
CHL761	Chemical Engineering Mathematics	3-0-0	**3**
	TOTAL PC	**9-0-46**	**32**

***** CHD863 and CHD864 together are alternatives to CHD861 and CHD862.

Program Electives (PE)

CHL710	Process Dynamics and Control	3-1-2	**5**
CHL714	Advanced Heat Transfer	3-0-0	**3**
CHL717	Mechanical Design of Process Equipment	3-0-2	**4**
CHL723	Chemical Reaction and Reactor Engineering	3-0-0	**3**
CHL724	Environmental Engineering and Waste Management	3-1-0	**4**
CHL735	Design of Separation Processes	3-0-2	**4**
CHL751	Multi-component Mass Transfer	3-0-0	**3**
CHL794	Petroleum Refinery Engineering	3-0-2	**4**
CHL813	Thermodynamics and Process Design	2-0-2	**3**
CHP711	Process Development Laboratory	0-0-6	**3**

B.Tech. in Chemical Engg. + M.Tech. in Process Engineering & Design

(CP) **CH6**

Sem.										Lect cour	L	T	P	Week cont.	Cr.
I	CHN110 Intr to Chem Engg (0 - 0 - 4) 2	CSL101/102 Int Comp Prg/Sc (3 - 0 - 2) 4	MEL110 Graphic Science (2 - 0 - 4) 4	MAL110 Mathematics - I (3 - 1 - 0) 4	CYL110 Physical Chem. (3 - 1 - 0) 4	CYP100 Chemistry Lab (0 - 0 - 4) 2				*4*	11	2	14	27	**20**
II	CHL110 Transp Phen (3 - 1 - 0) 4	EEL102 Prin Elec Engg (3 - 0 - 2) 4	MEL120 Mfg Practices (2 - 0 - 4) 4	MAL120 Mathematics - II (3 - 1 - 0) 4	CYL120 Inorg & Org Chem. (3 - 1 - 0) 4	PHP100 Physics Lab (0 - 0 - 4) 2			HUN100 Intro Hu & So Sc (1 - 0 - 0) 1	*5*	15	3	10	28	**23**
III	CHL111 Matl Energy Bal. (2 - 2 - 0) 4	CHL121 Ch Engg Thermo (3 - 1 - 0) 4	CHL231 Fl Mech Ch Engr (3 - 1 - 0) 4	CHL251 Heat Mass Transf (3 - 1 - 0) 4	AML120 Materials Science (3 - 0 - 2) 4				*HUL2xx* Hu. & So. Sc. #1 (3 - 1 - 0) 4	*6*	17	6	2	25	**24**
IV	CHL112 Chem Proc Techn (3 - 1 - 0) 4	CHL122 Ch React Engg-I (3 - 1 - 0) 4	CHP311 Des Lab Practices (0 - 0 - 4) 2	CHL351 Mass Transf Oprns (3 - 1 - 0) 4	CHP301 F M & H T Lab (0 - 0 - 3) 1.5			*OC-1* (3 - 1 - 0) 4	*HUL2xx* Hu. & So. Sc. #2 (3 - 1 - 0) 4	*5*	15	5	7	27	**23.5**
V	CHL221 Ch React Engg-II (3 - 1 - 0) 4	CHL261 Instr Proc Control (3 - 1 - 0) 4	CHL331 Fluid-particle Mech. (3 - 1 - 0) 4	CHP302 M T & F P M Lab (0 - 0 - 3) 1.5			*OC-2* (3 - 1 - 0) 4	*OC-3* (3 - 1 - 0) 4	*HUL2xx* Hu. & So. Sc. #3 (2 - 1 - 0) 3	*6*	17	6.0	3	26.0	**24.5**
VI	CHL471 Proc Eq Des Eco (3 - 0 - 3) 4.5	CHP303 Ch RE & PC Lab (0 - 0 - 3) 1.5		**DE-1** (3 - 1 - 0) 4	**DE-2** (3 - 1 - 0) 4		*OC-4* (3 - 1 - 0) 4	*OC-5* (3 - 1 - 0) 4		*5*	15	4	6	25	**22**
summer	CHT410 Practical Training (CH)									*NC*					
VII	CHC410 Colloquium (CH) (0 - 3 - 0) 3	CHL701 Process Engg (3 - 0 - 2) 4	CHL761 Ch Engg Maths (3 - 0 - 0) 3		**DE-3** (3 - 1 - 0) 4		*OC-6* (3 - 0 - 0) 3	*OC-7* (3 - 1 - 0) 4	*HUL2xx* Hu. & So. Sc. #4 (2 - 1 - 0) 3	*6*	17	6	2	25	**24**
VIII	CHL702 Plant Design (3 - 0 - 2) 4	CHC760 Seminar (CP) (0 - 0 - 2) 1			**DE-4** (3 - 1 - 0) 4	**DE-5** (3 - 1 - 0) 4	*OC-8* (3 - 1 - 0) 4	*OC-9* (3 - 1 - 0) 4		*5*	15	4	4	23	**21**
summer	CHD861 Major Project Part 1 (CP)														
IX		CHD861 Maj Proj P-1 (CP) (0 - 0 - 12) 6	**PE-1** (3 - 1 - 0) 4	**PE-2** (3 - 1 - 0) 4	**PE-3** (3 - 1 - 0) 4	**PE-4** (3 - 1 - 0) 4				*4*	12	4	12	28	**22**
X		CHD862 Maj Proj P-2 (CP) (0 - 0 - 28) 14								*0*	0	0	28	28	**14**
summer	CHD862 Major Project Part 2 (CP)														

Reqd. DE=20, plan DE = 5@4 = 20 cr. from 5 courses. Reqd. PE=16, plan PE = 4@4 = 16 cr. from 4 courses. **TOTAL = 218.0**

Reqd. OC=35, plan OC = 8@4 + 1@3 = 35 cr. from 9 courses. HU = 2@4 + 2@3 + 1@1= 15 cr. from 4 courses & 1 Intro. **DC = 60, EAS = 20, BS = 20. PC = 32, PE = 16**

Programme Code: CS5 / (CO)

Bachelor of Technology in *Computer Science and Engineering,* and *Master of Technology* in *Computer Science and Engineering*

Department of Computer Science and Engineering

The overall credits structure

Undergraduate Core (UC)		Undergraduate Elective (UE)	
Category	**Credits**	**Category**	**Credits**
DC	54	DE	24
BS	24	HM	14
EAS	20	OC	31
HU	1		
TOTAL	*99*	*TOTAL*	*69*

Program Core (PC)		Program Elective (PE)	
Category	**Credits**	**Category**	**Credits**
PC	32	PE	16

Total credits = 218

Basic Sciences (BS) Core

CYL110	Physical Chemistry: Concepts and Applications	3-1-0	**4**
CYP100	Chemistry Laboratory	0-0-4	**2**
MAL111	Introduction to Analysis and Differential Equations	3-1-0	**4**
MAL124	Introduction to Algebra and Matrix Analysis	3-1-0	**4**
PHL110	Fields and Waves	3-1-0	**4**
PHL120	Physics of Materials	3-1-0	**4**
PHP100	Physics Laboratory	0-0-4	**2**
	TOTAL BS Core	**15-5-8**	**24**

Engineering Arts and Sciences (EAS) Core

AML110	Engineering Mechanics	3-0-2	**4**
CSL101	Introduction to Computers and Programming	3-0-2	**4**
	OR		
CSL102	Introduction to Computer Science	3-0-2	**4**
EEL101	Fundamentals of Electrical Engineering	3-0-2	**4**
MEL110	Graphic Science	2-0-4	**4**
MEL120	Manufacturing Practices	2-0-4	**4**
	TOTAL EAS Core	**13-0-14**	**20**

Humanities and Social Sciences (HU) Core

HUN100	Introduction to Humanities and Social Sciences	1-0-0	**1**

Departmental Core (DC)

CSC410	Colloquium (CS)	0-3-0	**3**
CSL105	Discrete Mathematical Structures	3-1-0	**4**
CSL201	Data Structures	3-0-4	**5**
CSL211	Computer Architecture	3-1-2	**5**
CSL302	Programming Languages	3-0-4	**5**
CSL356	Analysis and Design of Algorithms	3-1-0	**4**
CSL373	Operating Systems	3-0-4	**5**
CSL374	Computer Networks	3-0-3	**4.5**
CSN110	Introduction to Computer Science and Engineering	0-0-4	**2**
CSP301	Design Practices in Computer Science	0-1-4	**3**
CST410	Practical Training (CS)	—	**NC**
EEL201	Digital Electronic Circuits	3-1-0	**4**
EEL205	Signals and Systems	3-1-0	**4**
EEP201	Electronics Laboratory - I	0-0-3	**1.5**
MAL250	Introduction to Probability Theory and Stochastic Processes	3-1-0	**4**
	TOTAL DC	**30-10-28**	**54**

Departmental Electives (DE)

CSL303	Logic for Computer Science	3-0-2	**4**
CSL316	Digital Hardware Design	3-0-4	**5**
CSL332	Introduction to Database Systems	3-0-3	**4.5**
CSL333	Artificial Intelligence	3-0-2	**4**
CSL361	Numerical and Scientific Computing	3-1-2	**5**
CSL362	Simulation and Modelling	3-0-2	**4**
CSL705	Theory of Computation	3-1-0	**4**
CSL719	Synthesis of Digital Systems	3-0-2	**4**
CSL728	Compiler Design	3-0-3	**4.5**
CSL740	Software Engineering	3-0-2	**4**
CSL750	Foundations of Automatic Verification	3-0-2	**4**
CSL771	Database Implementations	3-0-2	**4**
CSL781	Computer Graphics	3-0-3	**4.5**
CSL783	Digital Image Analysis	3-0-3	**4.5**
CSP315	Embedded System Design Laboratory	0-1-6	**4**
CSR310	Professional Practices (CS)	0-1-2	**2**
CSS310	Independent Study (CS)	0-3-0	**3**

Program Core (PC)

CSD750	Minor Project (CO)	0-1-6	**4**
CSD851	Major Project Part 1 (CO)	0-0-12	**6**
CSD852	Major Project Part 2 (CO)	0-0-28	**14**
CSD853	Major Project Part 1 (CO)	0-0-8	**4***
CSD854	Major Project Part 2 (CO)	0-0-32	**16***
CSL718	Architecture of High Performance Computers	3-0-2	**4**
CSL758	Advanced Algorithms	3-1-0	**4**
	TOTAL PC	**6-2-48**	**32**

***** CSD853 and CSD854 together are alternatives to CSD851 and CSD852.

Program Electives (PE)

CSL719	Synthesis of Digital Systems	3-0-2	**4**
CSL728	Compiler Design	3-0-3	**4.5**
CSL740	Software Engineering	3-0-2	**4**
CSL750	Foundations of Automatic Verification	3-0-2	**4**
CSL771	Database Implementations	3-0-2	**4**
CSL781	Computer Graphics	3-0-3	**4.5**
CSL783	Digital Image Analysis	3-0-3	**4.5**
CSL812	System Level Design and Modelling	3-0-0	**3**
CSL821	Reconfigurable Computing	3-0-0	**3**
CSL830	Distributed Computing	3-0-0	**3**
CSL831	Semantics of Programming Languages	3-0-0	**3**
CSL832	Proofs and Types	3-0-0	**3**
CSL840	Computer Vision	3-0-2	**4**
CSL847	Distributed Algorithms	3-0-0	**3**
CSL851	Algorithmic Graph Theory	3-0-0	**3**
CSL852	Computational Geometry	3-0-0	**3**
CSL853	Complexity Theory	3-0-0	**3**
CSL854	Approximation Algorithms	3-0-0	**3**
CSL855	Models of Computation	3-0-0	**3**
CSL856	Mathematical Programming	3-0-0	**3**
CSL858	Advanced Computer Networks	3-0-2	**4**
CSL859	Advanced Computer Graphics	3-0-2	**4**
CSL860	Special Topics in Parallel Computation	3-0-0	**3**
CSL861	Special Topics in Hardware Systems	3-0-0	**3**
CSL862	Special Topics in Software Systems	3-0-0	**3**
CSL863	Special Topics in Theoretical Computer Science	3-0-0	**3**
CSL864	Special Topics in Artificial Intelligence	3-0-0	**3**
CSL865	Special Topics in Computer Applications	3-0-0	**3**
CSL866	Special Topics in Algorithms	3-0-0	**3**
CSL867	Special Topics in High Speed Networks	3-0-0	**3**
CSL868	Special Topics in Database Systems	3-0-0	**3**
CSL869	Special Topics in Concurrency	3-0-0	**3**
CSV880	Special Module in Parallel Computation	1-0-0	**1**
CSV881	Special Module in Hardware Systems	1-0-0	**1**
CSV882	Special Module in Software Systems	1-0-0	**1**
CSV883	Special Module in Theoretical Computer Science	1-0-0	**1**
CSV884	Special Module in Artificial Intelligence	1-0-0	**1**
CSV885	Special Module in Computer Applications	1-0-0	**1**
CSV886	Special Module in Algorithms	1-0-0	**1**
CSV887	Special Module in High Speed Networks	1-0-0	**1**
CSV888	Special Module in Database Systems	1-0-0	**1**
CSV889	Special Module in Concurrency	1-0-0	**1**

B.Tech. + M.Tech. in Computer Science and Engineering

(CO) **CS5**

Sem.										Lect cour	L	T	P	Week cont.	Cr.
I	CSN110 Intr Comp Sc Engg (0 - 0 - 4) 2	CSL101/102 Int Comp Prg/Sc (3 - 0 - 2) 4	MEL110 Graphic Science (2 - 0 - 4) 4	MAL111 Analysis Diff Eqns (3 - 1 - 0) 4	PHL110 Fields & Waves (3 - 1 - 0) 4	PHP100 Physics Lab (0 - 0 - 4) 2			HUN100 Intro Hu & So Sc (1 - 0 - 0) 1	*4*	12	2	14	28	**21**
II	CSL201 Data Structures (3 - 0 - 4) 5	EEL101 Fund Elec Engg (3 - 0 - 2) 4	MEL120 Mfg Practices (2 - 0 - 4) 4	MAL124 Alg Matrix Analys (3 - 1 - 0) 4	CYL110 Physical Chem. (3 - 1 - 0) 4	CYP100 Chemistry Lab (0 - 0 - 4) 2				*5*	14	2	14	30	**23**
III	CSL105 Discrete Math Stru (3 - 1 - 0) 4	CSL211 Computer Arch (3 - 1 - 2) 5	CSP301 Des Pract in CS (0 - 1 - 4) 3	EEL201 Digital Electronics (3 - 1 - 0) 4	EEP201 Electronics Lab - I (0 - 0 - 3) 1.5	AML110 Engg Mechanics (3 - 0 - 2) 4			*HUL2xx* Hu. & So. Sc. #1 (3 - 1 - 0) 4	*5*	15	5	11	31	**25.5**
IV	CSL302 Programing Lang. (3 - 0 - 4) 5	MAL250 Prob Stoch Proc. (3 - 1 - 0) 4	PHL120 Phy Materials (3 - 1 - 0) 4		**DE-1** (3 - 0 - 4) 5				*HUL2xx* Hu. & So. Sc. #2 (3 - 1 - 0) 4	*5*	15	3	8	26	**22**
V	CSL356 Analy Des Algor (3 - 1 - 0) 4	EEL205 Signals Systems (3 - 1 - 0) 4			**DE-2** (3 - 0 - 0) 3		*OC-1* (3 - 0 - 0) 3	*OC-2* (3 - 0 - 2) 4	*HUL2xx* Hu. & So. Sc. #3 (2 - 1 - 0) 3	*6*	17	3	2	22.0	**21**
VI	CSL373 Operating Systems (3 - 0 - 4) 5			**DE-3** (3 - 0 - 4) 5	**DE-4** OR Indep. Study (3 - 0 - 0) 3		*OC-3* (3 - 0 - 2) 4	*OC-4* (3 - 0 - 2) 4	*HUL2xx* Hu. & So. Sc. #4 (2 - 1 - 0) 3	*6*	17	1	12	30	**24**
summer	CST410 Practical Training (CS)									*NC*					
VII	CSC410 Colloquium (CS) (0 - 3 - 0) 3		CSL374 Compu Networks (3 - 0 - 3) 4.5	**PE-1** (3 - 0 - 0) 3	**DE-5** (3 - 0 - 2) 4		*OC-5* (3 - 0 - 2) 4	*OC-6* (3 - 0 - 2) 4		*5*	15	3	9	27	**22.5**
VIII	CSL718 Arch Hi Perf Com (3 - 0 - 2) 4	CSD750 Minor Project (CO) (0 - 1 - 6) 4	CSL758 Advanced Algori (3 - 1 - 0) 4		**DE-6** (3 - 0 - 2) 4		*OC-7* (3 - 0 - 2) 4	*OC-8* (3 - 0 - 2) 4		*5*	15	2	14	31	**24**
summer	CSD851 Major Project Part 1 (CO)														
IX		CSD851 Maj Proj P-1 (CO) (0 - 0 - 12) 6	**PE-2** (3 - 0 - 0) 3	**PE-3** (3 - 0 - 0) 3	**PE-4** (3 - 0 - 0) 3	**PE-5** (3 - 0 - 0) 3	**PE-6** (3 - 0 - 0) 3			*5*	15	0	12	27	**21**
X		CSD852 Maj Proj P-2 (CO) (0 - 0 - 28) 14								*0*	0	0	28	28	**14**
summer	CSD852 Major Project Part 2 (CO)														

Reqd. DE=24, plan DE = 6@4 average = 24 cr. from 6 courses. Reqd. PE=16, plan PE = 6@3 = 18 cr. from 6 courses. **TOTAL = 218.0**

Reqd. OC=31, plan OC = 7@4 + 1@3 = 31 cr. from 8 courses. HU = 2@4 + 2@3 + 1@1= 15 cr. from 4 courses & 1 Intro. **DC = 66, EAS = 20, BS = 24. PC = 32, PE = 16**

Programme Code: EE5 / (EI)

Bachelor of Technology in Electrical Engineering, and
Master of Technology in Information and Communication Technology

Department of Electrical Engineering

The overall credits structure

Undergraduate Core (UC)		Undergraduate Elective (UE)	
Category	**Credits**	**Category**	**Credits**
DC	59	DE	21
BS	20	HM	14
EAS	21	OC	34
HU	1		
TOTAL	*101*	*TOTAL*	*69*

Program Core (PC)		Program Elective (PE)	
Category	**Credits**	**Category**	**Credits**
PC	32	PE	16

Total credits = 218

Basic Sciences (BS) Core

CYP100	Chemistry Laboratory	0-0-4	**2**
MAL111	Introduction to Analysis and Differential Equations	3-1-0	**4**
MAL124	Introduction to Algebra and Matrix Analysis	3-1-0	**4**
MAL250	Introduction to Probability Theory and Stochastic Processes	3-1-0	**4**
PHL110	Fields and Waves	3-1-0	**4**
PHP100	Physics Laboratory	0-0-4	**2**
	TOTAL BS Core	**12-4-8**	**20**

Engineering Arts and Sciences (EAS) Core

AML110	Engineering Mechanics	3-0-2	**4**
CSL101	Introduction to Computers and Programming	3-0-2	**4**
	OR		
CSL102	Introduction to Computer Science	3-0-2	**4**
CSL201	Data Structures	3-0-4	**5**
EEL101	Fundamentals of Electrical Engineering	3-0-2	**4**
MEL120	Manufacturing Practices	2-0-4	**4**
	TOTAL EAS Core	**14-0-14**	**21**

Humanities and Social Sciences (HU) Core

HUN100	Introduction to Humanities and Social Sciences	1-0-0	**1**

Departmental Core (DC)

EEC410	Colloquium (EE)	0-3-0	**3**
EEL201	Digital Electronic Circuits	3-1-0	**4**
EEL202	Circuit Theory	3-1-0	**4**
EEL203	Electromechanics	3-1-0	**4**
EEL204	Analog Electronics Circuits	3-1-0	**4**
EEL205	Signals and Systems	3-1-0	**4**
EEL207	Engineering Electromagnetics	3-1-0	**4**
EEL301	Control Engineering - I	3-1-0	**4**
EEL303	Power Engineering - I	3-1-0	**4**
EEL306	Communication Engineering	3-1-0	**4**
EEL308	Computer Architecture	3-1-0	**4**
EEN110	Introduction to Electrical Engineering	0-0-4	**2**
EEP201	Electronics Laboratory - I	0-0-3	**1.5**
EEP203	Electromechanics Laboratory	0-0-3	**1.5**
EEP204	Electronics Laboratory - II	0-0-3	**1.5**
EEP211	Design (EE)	0-0-4	**2**
EEP301	Control Engineering Laboratory	0-0-3	**1.5**
EEP303	Power Engineering Laboratory	0-0-3	**1.5**
EEP306	Communication Engineering Laboratory	0-0-3	**1.5**
EEP307	Electromagnetics Laboratory	0-0-3	**1.5**
EEP308	Computer Technology Laboratory	0-0-3	**1.5**
EET410	Practical Training (EE)	—	**NC**
	TOTAL DC	**30-13-32**	**59**

Departmental Electives (DE)

The list of Departmental Elective courses for this dual degree program is identical to the list of Departmental Elective courses for the *4-year Bachelor of Technology in Electrical Engineering* program. Please refer to the list given on page no. 26.
Also see EE1 Programme for Elective streams DE-A, -B, -C.

Program Core (PC)

EED851	Major Project Part 1 (EI)	0-0-12	**6**
EED852	Major Project Part 2 (EI)	0-0-28	**14**
EED853	Major Project Part 1 (EI)	0-0-8	**4***
EED854	Major Project Part 2 (EI)	0-0-32	**16***
EEL703	Computer Networks	3-0-0	**3**
EEL707	Multimedia Systems	3-0-2	**4**
EEL711	Signal Theory	3-0-0	**3**
EEP702	Software Laboratory	0-0-4	**2**
	TOTAL PC	**9-0-46**	**32**

* EED853 and EED854 together are alternatives to EED851 and EED852.

Program Electives (PE)

CSL858	Advanced Computer Networks	3-0-2	**4**
CSL859	Advanced Computer Graphics	3-0-2	**4**
CSL867	Special Topics in High Speed Networks	3-0-0	**3**
EED750	Minor Project (EI)	0-0-6	**3**
EEL702	Computer System Software	3-0-2	**4**
EEL704	Robotics and Automation	3-0-0	**3**
EEL706	Soft Computing	3-0-0	**3**
EEL708	Information Retrieval	3-0-0	**3**
EEL709	Pattern Recognition	3-0-0	**3**
EEL710	Coding Theory	3-0-0	**3**
EEL714	Information Theory	3-0-0	**3**
EEL715	Image Processing	3-0-2	**4**
EEL718	Statistical Signal Processing	3-0-0	**3**
EEL754	Computer Graphics	3-0-2	**4**
EEL758	Intelligent and Knowledge Based Systems	3-0-0	**3**
EEL768	Detection and Estimation Theory	3-0-0	**3**
EEL781	Neural Networks	3-0-0	**3**
EEL804	Scientific Visualization	3-0-0	**3**
EEL806	Computer Vision	3-0-0	**3**
EEL818	Access Networks	3-0-0	**3**
EEL851	Special Topics in Computers - I	3-0-0	**3**
EEL852	Special Topics in Computers - II	3-0-0	**3**
EEL853	Agent Technology	3-0-0	**3**
EEL854	Protocol Engineering	3-0-2	**4**
EEL855	Internet Technologies	3-0-2	**4**
EEL857	Network Security	3-0-2	**4**
EEL858	Mobile Computing	3-0-0	**3**
EEL859	Network Management	3-0-2	**4**
EEL861	Selected Topics in Communication Engineering - I	3-0-0	**3**
EEL862	Selected Topics in Communication Engineering - II	3-0-0	**3**
EEL863	Selected Topics in Communication Engineering - III	3-0-0	**3**
EEV704	Special Module in Computers	1-0-0	**1**

B.Tech. in Electrical Engg. + M.Tech. in Information and Communication Technology (EI) **EE5**

Sem.										Lect cour	L	T	P	Week cont.	Cr.
I	EEN110 Intro to Elec Engg (0 - 0 - 4) 2	EEL101 Fund Elec Engg (3 - 0 - 2) 4	MEL120 Mfg Practices (2 - 0 - 4) 4	MAL111 Analysis Diff Eqns (3 - 1 - 0) 4	PHL110 Fields & Waves (3 - 1 - 0) 4	PHP100 Physics Lab (0 - 0 - 4) 2			HUN100 Intro Hu & So Sc (1 - 0 - 0) 1	*4*	12	2	14	28	**21**
II	EEL205 Signals Systems (3 - 1 - 0) 4	EEL203 Electromechanics (3 - 1 - 0) 4	AML110 Engg Mechanics (3 - 0 - 2) 4	MAL124 Alg Matrix Analy (3 - 1 - 0) 4	CSL101/102 Int Comp Prg/Sc (3 - 0 - 2) 4	CYP100 Chemistry Lab (0 - 0 - 4) 2				*5*	15	3	8	26	**22**
III	EEL201 Digital Electronics (3 - 1 - 0) 4	EEP201 Electronics Lab - I (0 - 0 - 3) 1.5	EEL202 Circuit Theory (3 - 1 - 0) 4	EEP203 Electromech Lab (0 - 0 - 3) 1.5	CSL201 Data Structures (3 - 0 - 4) 5	MAL250 Prob Stoch Proc. (3 - 1 - 0) 4			*HUL2xx* Hu. & So. Sc. #1 (3 - 1 - 0) 4	*5*	15	4	10	29	**24**
IV	EEL301 Control Engg - I (3 - 1 - 0) 4	EEL204 Analog Elec Cir (3 - 1 - 0) 4	EEP204 Electronics Lab - II (0 - 0 - 3) 1.5	EEL306 Communic Engg (3 - 1 - 0) 4	EEL308 Computer Arch (3 - 1 - 0) 4	EEP308 Comp Tech Lab (0 - 0 - 3) 1.5	EEP211 Des Practice (EE) (0 - 0 - 4) 2		*HUL2xx* Hu. & So. Sc. #2 (3 - 0 - 0) 3	*5*	15	4	10	29	**24**
V	EEL207 Engg Electromag (3 - 1 - 0) 4	EEL303 Power Engg - I (3 - 1 - 0) 4	EEP301 Control Engg Lab (0 - 0 - 3) 1.5	EEP306 Comm Engg Lab (0 - 0 - 3) 1.5	**DE-A** (3 - 0 - 0) 3	**DE-1** (3 - 0 - 0) 3		*OC-1* (3 - 1 - 0) 4	*HUL2xx* Hu. & So. Sc. #3 (2 - 1 - 0) 3	*6*	17	4.0	6	27.0	**24**
VI	EEP303 Power Engg Lab (0 - 0 - 3) 1.5	EEP307 Electromag Lab (0 - 0 - 3) 1.5		**DE-2** (3 - 0 - 0) 3	**DE-B** (3 - 0 - 2) 4	**DE-3** (3 - 0 - 0) 3	*OC-2* (3 - 1 - 0) 4	*OC-3* (3 - 0 - 2) 4	*HUL2xx* Hu. & So. Sc. #4 (3 - 1 - 0) 4	*6*	18	2	10	30	**25**
summer	EET410 Practical Training (EE)									*NC*					
VII	EEC410 Colloquium (EE) (0 - 3 - 0) 3	EEL711 Signal Theory (3 - 0 - 0) 3			**DE-C** (3 - 0 - 2) 4	*OC-4* (3 - 1 - 0) 4	*OC-5* (3 - 1 - 0) 4	*OC-6* (3 - 0 - 0) 3		*5*	15	5	2	22	**21**
VIII	EEL703 Compu Networks (3 - 0 - 0) 3	EEL707 Multimedia Sys (3 - 0 - 2) 4	EEP702 Software Lab (0 - 0 - 4) 2	**PE-1** (3 - 0 - 0) 3	**PE-2** (3 - 0 - 0) 3	**DE-4** EEV (1 - 0 - 0) 1		*OC-7* (3 - 1 - 0) 4		*5*	16	1	6	23	**20**
summer	EED851 Major Project Part 1 (EI)														
IX		EED851 Maj Proj P-1 (EI) (0 - 0 - 12) 6		**PE-3** (3 - 0 - 0) 3	**PE-4** (3 - 0 - 0) 3	**PE-5** (3 - 0 - 2) 4	*OC-8* (3 - 1 - 0) 4	*OC-9* (3 - 0 - 0) 3		*5*	15	1	14	30	**23**
X		EED852 Maj Proj P-2 (EI) (0 - 0 - 28) 14								*0*	0	0	28	28	**14**
summer	EED852 Major Project Part 2 (EI)														

Reqd. DE=21, plan DE = 11 stream + 3@3 +1@1 = 21 cr. from 6 + 1V courses. Reqd. PE=16, plan PE = 4@3 + 1@4 = 16 cr. from 5 courses. **TOTAL = 218.0**

Reqd. OC=34, plan OC = 7@4 + 2@3 = 34 cr. from 9 courses. HU = 2@4 + 2@3 + 1@1= 15 cr. from 4 courses & 1 Intro. **DC = 59, EAS = 21, BS = 20. PC = 32, PE = 16**

Programme Code: MT5 / (MT)

Master of Technology in Mathematics and Computing

Department of Mathematics

The overall credits structure

Integrated Core (IC)		Integrated Elective (IE)	
Category	**Credits**	**Category**	**Credits**
DC	90	DE	40
BS	20	HM	14
EAS	21	OC	30
HU	1		
TOTAL	*132*	*TOTAL*	*84*

Total credits = 216

Basic Sciences (BS) Core

CYL110	Physical Chemistry: Concepts and Applications	3-1-0	**4**
CYP100	Chemistry Laboratory	0-0-4	**2**
MAL115	Multivariable Calculus and Matrix Theory	3-1-0	**4**
MAL122	Real and Complex Analysis	3-1-0	**4**
PHL120	Physics of Materials	3-1-0	**4**
PHP100	Physics Laboratory	0-0-4	**2**
	TOTAL BS Core	**12-4-8**	**20**

Engineering Arts and Sciences (EAS) Core

AML110	Engineering Mechanics	3-0-2	**4**
CSL101	Introduction to Computers and Programming OR	3-0-2	**4**
CSL102	Introduction to Computer Science	3-0-2	**4**
CSL201	Data Structures	3-0-4	**5**
EEL101	Fundamentals of Electrical Engineering	3-0-2	**4**
MEL110	Graphic Science	2-0-4	**4**
	TOTAL EAS Core	**14-0-14**	**21**

Humanities and Social Sciences (HU) Core

HUN100	Introduction to Humanities and Social Sciences	1-0-0	**1**

Integrated Core (IC)

EEL201	Digital Electronic Circuits	3-1-0	**4**
EEL308	Computer Architecture	3-1-0	**4**
EEP201	Electronics Laboratory - I	0-0-3	**1.5**
EEP308	Computer Technology Laboratory	0-0-3	**1.5**
MAC450	Colloquium (MT)	0-3-0	**3**
MAD851	Major Project Part 1 (MT)	0-0-12	**6**
MAD852	Major Project Part 2 (MT)	0-0-28	**14**
MAD853	Major Project Part 1 (MT)	0-0-8	**4***
MAD854	Major Project Part 2 (MT)	0-0-32	**16***
MAL180	Discrete Mathematical Structures	3-1-0	**4**
MAL230	Numerical Methods and Computation	3-1-0	**4**
MAL245	Topology and Functional Analysis	3-1-0	**4**
MAL250	Introduction to Probability Theory and Stochastic Processes	3-1-0	**4**
MAL255	Linear Algebra	3-1-0	**4**
MAL335	Differential Equations: Theory and Numerical Methods	3-1-0	**4**
MAL342	Analysis and Design of Algorithms	3-1-0	**4**
MAL358	Operating Systems	3-0-2	**4**
MAL390	Statistical Methods and Algorithms	3-1-0	**4**
MAL710	Database Management Systems	3-0-2	**4**
MAL715	Digital Image Processing	3-0-2	**4**
MAL745	Software Engineering	3-0-2	**4**
MAL754	Principles of Computer Graphics	3-0-2	**4**
MAN150	Introduction to Mathematics and Computing	0-0-4	**2**
MAP290	System Design Laboratory	0-0-4	**2**
MAT450	Practical Training (MT)	—	**NC**
	TOTAL IC	**45-13-64**	**90**

* MAD853 and MAD854 together are alternatives to MAD851 and MAD852.

Integrated Electives (IE)

AML710	Computer Aided Design and Design Methods	3-0-2	**4**
ASL410	Numerical Simulation of Atmospheric and Oceanic Phenomenon	3-0-2	**4**
BEL413	Modelling and Simulation of Bioprocesses	3-0-2	**4**
CSL374	Computer Networks	3-0-3	**4.5**
CSL728	Compiler Design	3-0-3	**4.5**
CYL410	Computational Methods and Analysis	3-0-0	**3**
EEL375	Embedded Systems	3-0-4	**5**
EEL422	Computers in Biomedicine	3-0-0	**3**
EEL703	Computer Networks	3-0-0	**3**
EEL704	Robotics and Automation	3-0-0	**3**
EEL706	Soft Computing	3-0-0	**3**
EEL707	Multimedia Systems	3-0-2	**4**
EEL708	Information Retrieval	3-0-0	**3**
EEL709	Pattern Recognition	3-0-0	**3**
EEL758	Intelligent and Knowledge Based Systems	3-0-0	**3**
EEL804	Scientific Visualization	3-0-0	**3**
EEL806	Computer Vision	3-0-0	**3**
MAD350	Mini Project (MT)	0-0-6	**3**
MAL145	Number Theory	3-1-0	**4**
MAL146	Combinatorics	3-1-0	**4**
MAL210	Optimization Methods and Applications	3-1-0	**4**
MAL256	Modern Algebra	3-1-0	**4**
MAL260	Boundary Value Problems	3-1-0	**4**
MAL311	Parallel Algorithms	3-0-2	**4**
MAL341	File Structures and Information Systems Design	3-0-2	**4**
MAL353	Algebraic Methods in Computer Science	3-1-0	**4**
MAL355	Partial Differential Equations: Theory and Computation	3-1-0	**4**
MAL365	Mathematical Programming Techniques	3-1-0	**4**
MAL373	Wavelets and Applications	3-1-0	**4**
MAL375	Programming Languages	3-0-2	**4**
MAL376	Graph Algorithms	3-1-0	**4**
MAL380	Numerical Linear Algebra	3-1-0	**4**
MAL381	Finite Element Theory and Applications	3-0-2	**4**
MAL382	Theory of Automata	3-1-0	**4**
MAL465	Parallel Computing	3-1-0	**4**
MAL466	Multivariate Statistical Methods	3-1-0	**4**
MAL468	Graph Theory	3-1-0	**4**
MAL717	Fuzzy Sets and Applications	3-1-0	**4**
MAL720	Neurocomputing and Applications	3-0-0	**3**
MAL736	Information Integrity	3-1-0	**4**
MAL755	Algebraic Geometry	3-1-0	**4**
MAL760	Advanced Algorithms	3-0-2	**4**
MAL780	Special Topics in Computer Applications	3-0-2	**4**
MAL782	Data Mining and Knowledge Discovery	3-0-2	**4**
MAL785	Natural Language Processing	3-0-2	**4**
MAL786	Cryptology	3-1-0	**4**
MAL790	Special Topics in Computer Science	3-0-2	**4**
MEL420	Total Quality Management	3-0-2	**4**
SML410	Computational Techniques for Management Applications	3-0-2	**4**

Integrated M.Tech. in Mathematics and Computing

(MT) **MT5**

Sem.										Lect cour	L	T	P	Week cont.	Cr.
I	MAN150 Intr Math & Comp (0 - 0 - 4) 2	MEL101 Graphic Science (2 - 0 - 4) 4	CSL101/102 Intro Comp Prog (3 - 0 - 2) 4	MAL115 Multivar Calculus (3 - 1 - 0) 4	CYL110 Physical Chem. (3 - 1 - 0) 4	CYP100 Chemistry Lab (0 - 0 - 4) 2				*4*	11	2	14	27	**20**
II	AML110 Engg Mechanics (3 - 0 - 2) 4	CSL201 Data Structures (3 - 0 - 4) 5	EEL101 Fund Elec Engg (3 - 0 - 2) 4	MAL122 Real & Complex (3 - 1 - 0) 4	PHL120 Physics Materials (3 - 1 - 0) 4	PHP100 Physics Lab (0 - 0 - 4) 2			HUN100 Intro Hu & So Sc (1 - 0 - 0) 1	*5*	16	2	12	30	**24**
III	MAL180 Discr Math Struct (3 - 1 - 0) 4	MAL255 Linear Algebra (3 - 1 - 0) 4	EEL201 Signals Systems (3 - 1 - 0) 4	EEP201 Electronics Lab - I (0 - 0 - 3) 1.5				*OC-1* (3 - 1 - 0) 4	*HUL2xx* Hu. & So. Sc. #1 (3 - 1 - 0) 4	*5*	15	5	3	23	**21.5**
IV	MAL230 Num Meth Comp (3 - 1 - 0) 4	MAL342 Analy Des Algor (3 - 1 - 0) 4	MAL250 Int Pro Th Sto Pro (3 - 1 - 0) 4	EEL308 Computer Arch (3 - 1 - 0) 4	EEP308 Comp Tech Lab (0 - 0 - 3) 1.5			*OC-2* (3 - 0 - 0) 3	*HUL2xx* Hu. & So. Sc. #2 (3 - 1 - 0) 4	*6*	18	5	3	26	**24.5**
V	MAP290 Sys Design Lab (0 - 0 - 4) 2	MAL358 Operating Systems (3 - 0 - 2) 4	MAL754 Prin Comp Graph (3 - 0 - 2) 4		**DE-1** (3 - 0 - 2) 4	**DE-2** (3 - 0 - 2) 4		*OC-3* (3 - 1 - 0) 4		*5*	15	1.0	12	28.0	**22**
VI	MAL335 Diff Eqns Th N M (3 - 1 - 0) 4	MAL745 Software Engg (3 - 0 - 2) 4	MAL710 D B M S (3 - 0 - 2) 4	MAL715 Digital Image Proc (3 - 0 - 2) 4		**DE-3** (3 - 1 - 0) 4			*HUL2xx* Hu. & So. Sc. #3 (3 - 0 - 0) 3	*6*	18	2	6	26	**23**
summer	MAT410 Practical Training (MT)									*NC*					
VII	MAC410 Colloquium (MT) (0 - 3 - 0) 3	MAL245 Topo Func Analys (3 - 1 - 0) 4		**DE-4** (3 - 1 - 0) 4	**DE-5** (3 - 0 - 0) 3	**DE-6** (3 - 1 - 0) 4		*OC-4* (3 - 1 - 0) 4	*HUL2xx* Hu. & So. Sc. #4 (3 - 0 - 0) 3	*6*	18	7	0	25	**25**
VIII	MAL390 Stat Meth Algo (3 - 1 - 0) 4			**DE-7** (3 - 1 - 0) 4	**DE-8** (3 - 0 - 0) 3	**DE-9** (3 - 1 - 0) 4	*OC-5* (3 - 1 - 0) 4	*OC-6* (3 - 1 - 0) 4		*6*	18	5	0	23	**23**
summer	MAD851 Major Project Part 1 (MT)														
IX		MAD851 Maj Proj P-1 (MT) (0 - 0 - 12) 6		**DE-10** (3 - 0 - 0) 3	**DE-11** (3 - 0 - 0) 3		*OC-7* (3 - 1 - 0) 4	*OC-8* (3 - 0 - 0) 3		*4*	12	1	12	25	**19**
X		MAD852 Maj Proj P-2 (MT) (0 - 0 - 28) 14								*0*	0	0	28	28	**14**
summer	MAD852 Major Project Part 2 (MT)														

Reqd. DE=40, plan DE = 7@4 + 4@3 = 40 cr. from 11 courses. **TOTAL = 216.0**

Reqd. OC=30, plan OC = 6@4 + 2@3 = 30 cr. from 8 courses. HU = 2@4 + 2@3 + 1@1= 15 cr. from 4 courses & 1 Intro. **IC = 90, EAS = 21, BS = 20**

5. MINOR AREA STRUCTURES

Minor Area in Biochemical Engineeirng and Biotechnology
Department of Biochemical Engineering and Biotechnology

Eligibility/Restrictions
As per section 3.12.4

Core courses

BEL110	Molecular Cell Biology	3-0-0	3
CHL291	Introduction to Biochemical Engineering	3-1-0	4

Elective courses

BEL401	Bioprocess Technology	2-0-0	2
BEL413	Modelling and Simulation of Bioprocesses	3-0-2	4
BEL416	Membrane Applications in Bioprocessing	3-0-0	3
BEL418	Bioinformatics	2-0-2	3
BEL422	Solid State Cultivation	3-0-0	3
BEL701	Biotechnology Resource Planning and IPR Issues	2-0-0	2
BEL713	Microbial Engineering	3-0-0	3
BEL714	Protein Science and Engineering	3-0-0	3
BEL715	Biological Waste Treatment	3-0-2	4
BEL720	Biotechnology in Food Processing	3-0-0	3
BEL721	Bionanotechnology	3-0-0	3

Minor Area in Business Management
Department of Management Studies

Eligibility/Restrictions
As per section 3.12.4

Core courses

SML391	Organization and Human Resource Management	3-1-0	4
SML494	Management Accounting and Financial Management	3-1-0	4

Elective courses

SML710	Creative Problem Solving	2-0-2	3
SML713	Information Systems Management	2-0-2	3
SML720	Business Environment and Corporate Strategy	2-0-2	3
SML740	Quantitative Methods in Management	2-0-2	3
SML745	Operations Management	2-0-2	3
SML760	Marketing Management	2-0-2	3
SML780	Managerial Economics	2-0-2	3
SML887	Business Law	2-0-2	3

Minor Area in Computational Mechanics
Department of Applied Mechanics

Eligibility/Restrictions
As per section 3.12.4

Core courses
Any one of the following

AML140	Mechanics of Solids	3-1-0	4
AML150	Mechanics of Solids and Fluids	3-1-2	5
AML160	Mehcanics of Fluids	3-1-0	4
AML170	Fluid Mehcanics	3-1-2	5
AML180	Solid Mechanics	3-1-2	5
CHL204	Transport Processes-II	3-1-0	4
CHL231	Fluid Mechanics for Chemical Engineers	3-1-0	4
And			
AML310	Computational Mechanics	3-0-2	4

Elective courses

AML410	Computational Methods in Fluid Dynamics	3-0-2	4
AML430	Advanced Computational Methods	3-1-0	4
AML440	Parallel Processing in Computational Mechanics	3-0-2	4
AML705	Finite Element Methods	3-0-2	4
AML710	Computer Aided Design and Design Methods	3-0-2	4

Minor Area in Computer Science and Engineering
Department of Computer Science and Engineering

Eligibility/Restrictions

As per section 3.12.4.Also, this minor area is not available to students of the following programmes: (i) B. Tech. in Electrical Engineering (EE1), (ii) Dual degree B.Tech. in Electrical Engineering + M.Tech. in (Information and Communication Technology) (EE5), and (iii) Integrated M.Tech. in Mathematics and Computing (MT5).

Core courses

CSL201	Data Structures	3-0-2	4
CSL211	Computer Architecture	3-1-2	5

Elective courses

CSL302	Programming Languages	3-0-4	5
CSL332	Introduction to Database Systems	3-0-3	4.5
CSL356	Analysis and Design of Algorithms	3-1-0	4
CSL373	Operating Systems	3-0-4	5
CSL374	Computer Networks	3-0-3	4.5
CSL433	Artificial Intelligence	3-0-2	4

Minor Area in Energy Technology
Department of Mechanical Engineering

Eligibility/Restrictions

As per section 3.12.4

Core courses

MEL140	Engineering Thermodynamics	3-1-0	4
MEL241	Energy Conversion	3-0-2	4

Elective courses

MEL242	Heat and Mass Transfer	3-1-0	4
MEL341	Gas Dynamics and Propulsion	3-0-2	4
MEL342	Power Plant Technologies	3-0-2	4
MEL343	Fuels, Combustion and Pollution	3-0-2	4
MEL345	I.C. Engines	3-0-2	4
MEL346	Turbo-machinery	3-0-2	4
MEP341	Thermal Engineering Laboratory	0-0-3	1.5

Minor Area in Nano Science and Engineering
Department of Physics

Eligibility/Restrictions

As per section 3.12.4

Core courses

PHL120	Physics of Materials	3-1-0	4
EPL206	Solid State Physics	3-1-0	4

Elective courses

BEL721	Bionanotechnology	3-0-0	3
CHL296	Nano Engineering of Soft Materials	3-0-0	3
EPL211	Principles of Material Synthesis	3-1-0	4
EPL335	Low Dimensional Physics	3-1-0	4
EPL444	Functional Nanostructures	3-0-0	3
EPL446	Applied Electrodynamics and Radiation	3-0-0	3
EPV430	Special Topics in Nano-Technology	1-0-0	1
EPV450	Selected Topics in Nano-Technology	2-0-0	2
PHL727	Quantum Heterostructures	3-0-0	3

Minor Area in Photonics
Department of Physics

Eligibility/Restrictions
As per section 3.12.4

Core courses

PHL110	Fields and Waves	3-1-0	4
EPL105	Optics	3-1-0	4

Elective courses

EPL334	Lasers	3-0-0	3
EPL336	Semiconductor Optoelectronics	3-1-0	4
EPL440	Quantum Electronics	3-0-0	3
EPL442	Fiber and Integrated Optics	3-0-0	3
EPL443	Holography and Optical Information Processing	3-0-0	3
EPL445	Engineering Optics	3-0-0	3
EPV431	Special Topics in Photonics and Opto-electronics	1-0-0	1
EPV451	Selected Topics in Photonics and Opto-electronics	2-0-0	2

Minor Area in Process Engineering
Department of Chemical Engineering

Eligibility/Restrictions

As per section 3.12.4 Also, this minor area is not available to students of Dual degree B.Tech. and M.Tech in Biochemical Engineering and Biotechnology (BB5).

Core courses

CHL110	Transport Phenomena	3-1-0	4
CHL111	Material and Energy Balance	2-2-0	4

Elective courses

CHL112	Chemical Process Technology	3-1-0	4
CHL231	Fluid Mechanics for Chemical Engineers	3-1-0	4
CHL251	Heat and Mass Transfer	3-1-0	4
CHL122	Chemical Reaction Engineering-I	3-1-0	4
CHL261	Instrumentation and Process Control	3-1-0	4
CHL331	Fluid-particle Mechanics	3-1-0	4
CHL275	Safety and Hazards in the Process Industries	3-1-0	4

Minor Area in Systems Dynamics and Control
Department of Mechanical Engineering

Eligibility/Restrictions
As per section 3.12.4

Core courses

MEL211	Kinematics and Dynamics of Machines	3-0-2	4

Elective courses

MEL312	Control Theory and Applications	3-1-2	5
MEL316	Mechanical Vibrations	3-0-2	4
MEL411	Mechatronics	3-0-2	4
MEL415	Vibrations Engineering Design	3-0-2	4
MEL416	Robotics Engineering	3-1-0	4

6. COURSE DESCRIPTIONS

Department of Applied Mechanics

AMD310 Mini Project (AM)
3 credits (0-0-6)
Pre-requisites: EC 80

A project will be specified by the concerned teacher and it is expected that under his/her guidance the students will carry out all the activities related to the project.

AML110 Engineering Mechanics
4 credits (3-0-2)

Laws of mechanics, equivalent force systems and equations of equilibrium, Internal forces in structures and beams, friction and its applications, Kinematics of point mass and rigid body, Center of mass, System of particles, Inertia tensor, Dynamics of rigid bodies, Euler's equations of motion, Impulse-momentum, Work-energy methods with applications, Principle of virtual work and stability.

AML120 Materials Science
4 credits (3-0-2)

Structures of materials – crystal structure, substructure, microstructure, etc. Phase diagram and phase transformation. Diffusion phenomenon. Mechanical behavior – strength, hardness, deformation, creep, fatigue, etc. Mechanisms of strengthening and toughening of materials. Metallic alloys, Ceramics, Polymeric and Composite materials. Conductors, semiconductors and magnetic materials.

AML130 Experimental Methods and Analysis
5 credits (3-1-2)

(a) Experimental Analysis: measurements and errors, internal and external estimates of errors, statistical analysis, accuracy and precision, best estimate, accuracy of the mean, significant digits, methods of least squares, curve fitting, linear regression, comparison and combination of measurements, extensions least square method. Theory of errors, Gaussian distribution, confidence limits, significance test, and goodness of fit.

(b) Instrumentation: Principle of measurements, Basic elements of measurement device, various types of measurement systems, standards and calibration, Dynamic characteristics of first and second order instruments, Transducers.

(c) Experimental Devices: displacement measurement dial gauge, optical method pneumatic transducer, variable resistance, inductance and capacitance transducer, Seismic devices for motion measurement. Principle of planimeter, Strain and stress measurements, Force and torque measurements, various types of load cells and their applications.

AML140 Mechanics of Solids
4 credits (3-1-0)
Overlaps with: AML150, AML180

Introduction, Definition of stress, Equations of equilibrium, Principal stress, Maximum shear stress, Plane stress, Concept of strain, Strain displacement relations, Principal strains, Plane strain, Constitutive relations, Uniaxial tension test, Idealized stress-strain diagram, Isotropic linear elastic, viscoelastic and plastic materials, Uniaxial deformations, Thermal stresses, Torsion of shafts, Bending and shear of beams, Energy methods, Fracture, Deflection, Stability.

AML150 Mechanics of Solids and Fluids
5 credits (3-1-2)
Overlaps with: AML140, AML160, AML170, AML180, CHL231, CHL204, AMP262

Introduction, fundamental concepts, mathematical preliminaries.

Analysis of strain deformation, strain displacement relations, Normal and shear strains, Transformation, Principal strains and Maximum shear strains, Volumetric strain, Compatibility equations, Plane strain, Stain rosettes, Velocity field and strain rates.

Constitutive relations; Hookean elastic solids, Yield criteria and plasticity, Viscoelasticity, Non-viscous fluid, Newtonian fluid.

Solid mechanics applications – Axisymmetric thin shells, Uniaxial deformation. Torsion, bending, buckling, etc.

Fluid mechanics applications – Fluid statics, fluid motion; Material and spatial description. Integral and differential flow analysis, ideal fluid flow, simple viscous flow, Dimensional analysis.

AML160 Mechanics of Fluids
4 credits (3-1-0)
Overlaps with: AML150, AML170, CHL231, CHL204

Introduction. Definitions. Fluid properties: classification of fluids and flow regimes. Fluid statics: Stationary fluids and liquids subjected to constant linear acceleration and to constant rotation. 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. Fluid machinery: Introduction and classification of machines, types of hydraulic turbines and pumps and their performance characteristics, turbomachinery analysis and velocity triangles, cavitation, NPSH concept, similarity rules, applications.

AML170 Fluid Mechanics
5 credits (3-1-2)
Overlaps with: AML150, AML160, CHL231, CHL204, AMP262

Introduction, fluid properties, classification, fluid statics, rigid body motions, kinematics of fluid motions, Reynolds transport theorem, mass, momentum and energy laws with applications, governing equations for Newtonian fluids, exact solutions, laminar and turbulent pipe flow. Introduction to boundary layer theory, Dimensional analysis and modelling, open channel flow.

AML180 Solid Mechanics
5 credits (3-1-2)
Overlaps with: AML140,AML150, AMP262

Introduction, Definition of stress, Equations of equilibrium, Principal stress, Maximum shear stress, Plane stress, Concept of strain, Strain displacement relations, Principal strains, Plane strain, Constitutive relations, Uniaxial tension test, Idealized stress-strain diagram, Isotropic linear elastic, viscoelastic and plastic materials, Uniaxial deformations, Thermal stresses, Torsion of shafts, Bending and shear of beams, Energy methods, Fracture, Deflection, Stability.

AML190 Design Engineering
5 credits (3-1-2)

INTRODUCTION TO DESIGN: History of Design, Industrial Design, Engineering Design, Craft Design. DESIGN PROCESS: Recognition of need, Conceptualization and Creativity, Feasibility Assessment, Preliminary Design, Detailed Design, Prototype Testing. IMPORTANT DESIGN CONSIDERATIONS: Design Materials, Manufacturing Processes, Human Factors, Applied Ergonomics, Reliability, Safety and Environmental Protection, Optimization, Engineering Economics, Engineering Ethics. ADVANCED TECHNOLOGY FOR DESIGN: Concurrent/Simultaneous Design, CAD and CAM, Rapid Prototyping, CIM.

AML300 Constitutive Modelling and Application of New Materials
3 credits (3-0-0)
Pre-requisites: AML140 / AML150 / AML180 and EC 60

Overview of new developments in materials. Composites, fiber and matrix. Mechanical property of lamina. Failure of lamina. Micro-mechanics. Laminates and their applications. Visco elasticity – spring/ dashpot models. 3-D constitutive relation. Creep, age / strain hard. Applications to beams and torsion. Fracture mechanics. Introduction to 1-D FEM and simple applications.

AML310 Computational Mechanics
4 credits (3-0-2)
Pre-requisites: AML140 / AML150 / AML160 / AML170 / AML180 / CHL231 / CHL204 and EC 60

Concept of a continuum. Introduction to stress, strain and rate-of-strain tensors. Principal stresses and strains. Equations of equilibrium/motion in solid and fluid mechanics constitutive equations. Role of computational methods in Mechanics. Error analysis. Determination of constitutive curves interpolation techniques. Application of numerical integration and differentiation to axial loading of bars and beams; integration of the boundary layer equations. Integration of ODEs. Application to axial and transverse loading of beams. Application to I-D fluid flow. Boundary value and initial value problems. Simultaneous linear and non-linear equations. How they arise in Mechanics. Direct and indirect methods of solution. PDEs classification. Applications to transientbeam bending, axial stretching, boundary-layer equations. Emphasis will be on finite difference type methods.

AML340 Chaos in Engineering Systems
3 credits (3-0-0)
Pre-requisites: AML110 and EC 60

Introduction to chaos. Various examples of chaos in engineering systems, electrical systems (Van Der Pol oscillator); electrical systems (Van Der Pol oscillator); Fluid mechanical systems (Lorenzequations, Aeroelastic flutter), Vibration (Duffing sequation), Chemical reactions (Belousov-Zhabotinski reaction) etc. Basic concepts in the mathematical treatment of non linear systems. Note: The emphasis in this course will be on developing a physical understanding of chaotic systems. The laboratory sessions will be partly experimental demonstrations and partly computer simulations (performed by the students).

AML350 Corrosion and Prevention
3 credits (3-0-0)
Pre-requisites: EC 60

Aqueous corrosion, theory and mechanism, corrosion kinetics, corrosion behaviour of specific metals and alloys, effects of stress, strain temperature and environment, corrosion fatigue, stress corrosion cracking, corrosion testing methods, Prevention of corrosion in practice (cathodic and anodic protection, corrosion inhibitors, protective coating etc., case studies.

AML360 Engineering Fluid Flows
4 credits (3-1-0)
Pre-requisites: AML150 / AML160 / AML170 / CHL231 / CHL204 and EC 60
Overlaps with: AML711 / AML713 / AML715

Fundamentals. Governing equations: Equation of motion; Stress at a point; Relative motion near a point; Constitutive laws for Newtonian fluid; Navier-Stokes equations; Boundary conditions; Energy equation. Exact Solutions: Solutions involving one and two variables; Conversion of PDEs to ODEs. Non-dimensionalization: Non-dimensionalization of the N.S. equations; Order of magnitude analysis; Thin layer approximation. Low Reynolds number flows: Stokes and Oseen approximations; Hydrodynamic lubrication. Inviscid Flows: Vorticity equation; Irrotational flows. Flow at High Reynolds number: Prandtl's boundary layer equations; Blasius solution; Falkner-Skan solution; Momentum Integral equation; Jets and Wakes. Hydrodynamic Stability: Experimental results; Fundamentals of stability theory; Orr-Sommerfield equation. Turbulence: Fundamentals; Reynolds averaging; Closure problem; Turbulence Models. CFD: Finite difference and finite volume methods.

AML370 Pipeline Engineering
3 credits (3-0-0)
Pre-requisites: AML150 / AML160 / AML170 / CHL231 / CHL204 and EC 60
Overlaps with: CHL390

Flow through pipes, Designing of pipelines for non Newtonias and Newtonian Liquids, Laminar and Turbulent Flows, Friction Factor, Time independent and Visco Elastic Fluid Flow through pipelines, Multiphase pipelines, slumy pipeline transportation. Flow of gas-solid and liquid-liquid mixture, Hydro and pneumo capsule pipelines, corrosion-errors in pipelines and its control, Transient flow in pipelines and pipeline networks.

AML380 Biomechanics
4 credits (3-0-2)
Pre-requisites: AML110 and EC 60

Revision of mechanics. Kinematics and dynamics. Introduction to physiology of various life forms. Structural aspects. Locomotion principles. Properties of tissue. Analysis of motion and forces. Mehanics of injuries. Ageing effects. Design and use of implants. Materials of construction and maufacture of orthopaedic inserts.

AML410 Computational Methods in Fluid Dynamics
4 credits (3-0-2)
Pre-requisites: AML310

Conservation laws, boundary layer theory and similarity solutions, finite difference and finite volume methods, primitive and secondary variable formulations, explicit, implicit and semi-implicit methods, panel methods for inviscid flows, turbulence modelling, application to laminar and turbulent flows, introduction to finite element methods, grid generation.

AML430 Advanced Computational Methods
4 credits (3-1-0)
Pre-requisites: AML310
Overlaps with: AML806

Advanced topics in Computational Solid/Fluid mechanics to suit specific student needs and topics chosen from the following: (i) finite element analysis of plates and shells,

(ii) finite elements in fluids, (iii) reduced integration patch test, (iv) dynamic FE analysis, (v) geometrically nonlinear problems. (vi) material nonlinearity. (vii) automated mesh generation. (viii) pre and post processing. (ix) solid fluid interaction problems. (x) efficient solution technique-PCG, domain decomposition. (xi) point source method. (xii) boundary element method. (xiii) aero elastic flutter. (xiv) other special topics.

AML440 Parallel Processing in Computational Mechanics

4 credits (3-0-2)
Pre-requisites: AML310

Advanced topics in computational solid/fluid mechanics to suit specific student needs and topics chosen from the following: Finite element analysis of plates and shells, Finite elements in fluids, Reduced integration patch test, Dynamic FE analysis, Geometrically nonlinear problems, Material nonlinearity, Automated mesh generation, Pre and Post processing, Solid fluid interaction problems, Efficient solution technique-PCG, domain decomposition, Point source method, Boundary element method, Aero elastic flutter, Other Special Topics.

AML705 Finite Element Methods

4 credits (3-0-2)
Pre-requisites: AML140 / AML150 / AML160 / AML170 / AML180 / CHL231 / CHL204
Overlaps with: MAL381

Introduction to Finite Element Principles. Derivation of the discretized equations using variational principle. Galerkin and other approaches-solution of 1-D problems, Assemby, Imposition of boundary conditions, Solution of large systems. St. Venant's torsion problem, Classical solution. Finite Element solution. Analogy to other field problems. Two-dimensional elasticity problems. Classical solution using Airy's stress function. Finite Element formulation-problems involving initial stress and initial strain. Axisymmetric problems-classical solution. Finite Element solution of free vibration problems. Principles of transient dynamic analysis. Laboratory work for the solution of solid mechanics problems using FE packages.

AML710 Computer Aided Design and Design Methods

4 credits (3-0-2)
Pre-requisites: EC 60
Overlaps with: MEL414

Design methodology including Needs analysis. Problem formulation, Synthesis of alternatives, Product visualization, Modelling analysis and optimization, detailed design, prototype-construction and testing, design development Introduction to computer graphics-mathematical approach to transformation and projections. Representation of curves and surfaces. Hidden surface removal algorithms-rendering-introduction to Solid modelling principles – B rep modelers – CSG modelers. Representation of Boolean operations on primitives. Computer-aided drafting. Practical work with drafting systems, solid modelers and development of graphics packages.

AMP262 Fluids and Solids Laboratory

1.5 credits (0-0-3)
Pre-requisites: AML140 & AML160
Overlaps with: AML150 / AML170 / AML180

Experiments will build-up on knowledge of Mechanics of Solids and Mechanics of Fluids. Applications of uncertainty analyses. A professional report is to be prepared for each experiment. Students work in a group of two.

Department of Biochemical Engineering & Biotechnology

BEC450 Colloquium (BB)
3 credits (0-3-0)
Pre-requisites: registered for BET450

Each student is to make a minimum of three presentations of about 30 minutes duration. Topics for these presentations could be drawn from the practical training experience or other scientific documents/publications.

BEC750 Seminar (BB)
1 credit (1-0-0)
Pre-requisites: EC 165

Literature study on a selected topic. Report writing. Seminar presentations.

BED350 Mini Project (BB)
3 credits (0-0-6)
Pre-requisites: EC 80

No fixed course content. Study to concentrate on a selected topic under the supervision of a faculty member of the department.

BED851 Major Project Part 1 (BB)
6 credits (0-0-12)
Pre-requisites: EC 165
Overlaps with: BED853

Initial phase of the major project chosen by the student under a pre-designated supervisor. Projects are to be individual and should be an in-depth intensive effort.

BED852 Major Project Part 2 (BB)
14 credits (0-0-28)
Pre-requisites: BED851
Overlaps with: BED854

Continuation and completion of the work started as of Major Project Part 1.

BED853 Major Project Part 1 (BB)
4 credits (0-0-8)
Pre-requisites: EC 165
Overlaps with: BED851

Initial phase of the major project chosen by the student under a pre-designated supervisor. Projects are to be individual and should be an in-depth intensive effort.

BED854 Major Project Part 2 (BB)
16 credits (0-0-32)
Pre-requisites: BED853
Overlaps with: BED852

Continuation and completion of the work started as of Major Project Part 1.

BEL101 Biochemistry
5.5 credits (3-1-3)

Course contents (about 100 words): Introduction-aims and scope; Non-covalent interactions in biological systems, Carbohydrates-structure and function; Proteins-structure and function; Nucleic acids-structure and function; Protein purification techniques; Introduction to enzymes; Vitamins and coenzymes; Lipids and biological membranes; Transport across cell membrane; Design of metabolism; Metabolic pathways for breakdown of carbohydrates-glycolysis, pentose phosphate pathway, citric acid cycle, electron transport chain, Photo-phosphorylation; Oxidation of fatty acids; Gluconeogenesis and control of glycogen metabolism, Signal transduction.

Laboratory : Estimation of proteins and nucleic acids; Extraction of lipids; Separation of lipids using thin layer chromatography, Gel filtration and ion exchange chromatography; Gel electrophoresis, Determination of enzymatic activities and determination of K_m, V_{max}; Identification of intermediates of EMP pathway.

BEL102 Bioprocess Calculations
4 credits (3-1-0)
Overlaps with: CHL231, CHL251

Units and dimensions, Fundamentals of material balance, Balance on unit processes and reactive systems, Behaviour of ideal and real gases, vapour pressure, humidity and saturation. Energy balance, Heat capacity of gases, liquid and solids, Latent heat, Heat of reaction, formation and combustion, Solution and dilution, Energy balance of reactive and non-reactive processes. Stoichiometric relations and yield concepts, Maintenance coefficient, Mass balance based on available electron concept. Unsteady state material and energy balance in bioprocess.

BEL103 General Microbiology
4.5 credits (3-0-3)

Lectures: Introduction-aims and scope. Role of microbes in agriculture, public health, medicine and industry. Organization of prokaryotic and eukaryotic cells: Structure and function of cell organelles and surface structure and cellular reserve materials; Distinguishing features of various groups of microorganisms: actinomycetes, bacteria, molds, yeasts and algae and their broad classification. Characteristics of selected groups of microorganisms including microorganisms of extreme environment. Microbial nutrition and growth-principles of nutrition, growth measurement techniques, effect of environmental and culture parameters on growth, assimilation of nitrogen and sulphur. Isolation and preservation of cultures. Energy transduction in microbial systems: fermentation, aerobic and anaerobic respiration. Phototrophic microorganisms, Phosphoketolase, Entner-Doudoroff and glyoxalate pathways. Control of microbial growth – effect of heat, disinfectants and therapeutic agents. Microbial pathogenicity, Bioassays.

Laboratory: Preparation and sterilization of media, examination of possible sources of contamination; microscopic examination of different groups of microorganisms; aseptic technique; simple and differential staining; isolation of a pure culture - use of enrichment media; growth and enumeration of microorganisms; effect of physical and chemical environment on growth; selected biochemical tests; isolation of auxotropic mutants; microbiological assay of antibiotics.

BEL110 Molecular Cell Biology
3 credits (3-0-0)
Overlaps with: BEL101, BEL103

Biology-technology interface; Cell structure and function; Noncovalent interactions in living cells; Molecules in cell; Enzymes: Structure, Catalysis, Industrial applications; Membrane transport; Bioenergetics; Introduction to metabolism; Information storage and processing in cells; Cell signaling; Nerve cells and electrical properties; Techniques in cell and molecular biology; Cell evolution: biochemical capacities.

BEL204 Molecular Biology and Genetics
4.5 credits (3-0-3)
Pre-requisites: BEL101 & BEL103

Historical development and essentials of Mendelian genetics. Chromosomal theory of inheritance. Evolution and development of molecular biology. DNA model and classes. Organization of eukaryotic chromosome – the chromatin structure. Genetic Information and its perpetuation – DNA

replication and repair. Transcription, translation. Molecular biology of bacteriophage lamda. Gene exchange in bacteria. Gene regulation in prokaryotes. The operon model – lac, ara, trp operons and gene regulation.

Laboratory : Isolation of DNA, Denaturation of DNA, isolation of chromatin, lambda DNA, transformation, conjugation. Gene induction.

BEL301 Bioprocess Engineering
3 credits (3-0-0)
Pre-requisites: BEL101 & BEL103 and EC 60
Overlaps with: CHL291

Microbial growth, substrate utilisation and product formation kinetics; simple structured models; air sterilization; media sterilization; batch, fed-batch and continuous processes; aeration and agitation; rheology of fermentation fluids; scale-up concepts; design of fermentation media; aseptic transfer; various types of microbial and enzyme reactors; instrumentation in bioreactors.

BEL302 Fluid Solid Systems
3 credits (3-0-0)
Pre-requisites: CHL203
Overlaps with: CHL331

Size reduction; crushing and grinding; equipment for size reduction; screening; design procedure;Flow of fluids past a stationary particle for low, medium and high Reynolds numbers; sedimentation and sedimentation theory; thickeners and classifiers; flow through packed beds; flow distribution, packings and pressure drop calculations; fluidization; filtration theory and its application in plate and frame and rotary vacuum filters; solid-liquid separation using centrifugation; 'S' concept in centrifugation for scale-up; different types of centrifuges and their design; application for biological suspensions.

BEL311 Physical and Chemical Properties of Biomolecules
3 credits (2-1-0)
Pre-requisites: BEL101 and EC 60

Introduction: characteristic features of biological systems, structure-functions relationships in biomolecules; Characterization of macromolecules: molecular shape and size; molecular weight; Transport properties of solution-Applications in deducing conformation of biomolecules: viscosity, Diffusion, Ultra centrifugation, electrophoresis; Optical properties of biomacromolecules; Spectroscopic methods: IR, NMR, optical rotary and circular dichroism.

BEL312 Carbohydrates and Lipids in Biotechnology
3 credits (2-1-0)
Pre-requisites: BEL101 and EC 60

Introduction, Molecular Structure of polysaccharides; Enzymes degrading polysaccharides; Physical properties of polysaccharides; Production of microbial polysaccharides; Food usage of exopolysaccharides; Industrial Usage of exopolysaccharides; Medical applications of exopolysaccharides. Molecular structure of lipids; Physical properties of lipids; oleaginous microorganisms and their principal lipids; Production of microbial lipids; Modification of lipids for commercial application; Extracellular microbial lipids and biosurfactants; Micelles and Reverse micelles in biology, Liposomes in drug delivery.

BEL401 Bioprocess Technology
2 credits (2-0-0)
Pre-requisites: BEL301

Bioprocessing vs. chemical processing. Substrates for bioconversion processes. Inoculum development. Process technology for production of primary metabolites, such as baker's yeast, ethanol, citric acid, amino acids, polysaccharides and plastics. Microbial production of industrial enzymes- glucose isomerase, cellulase, amylase, protease etc.. Production of secondary metabolites- penicillins and cephalosporins.

BEL403 Enzyme Engineering and Technology
4 credits (3-0-2)
Pre-requisites: BEL401

Introduction and Scope; Chemical and Functional nature of enzymes; Application of enzymes in process industries and health care; Microbial production and purification of industrial enzymes, Kinetics of enzyme catalyzed reactions; Immobilization of enzymes; Stabilization of enzymes.

Bioreactors for soluble and immobilized enzymes, Mass transfer and catalysis in immobilized enzyme reactors; Case studies of some industrial enzymatic processes.

Enzyme based biosensors; Enzyme catalyzed processes with cofactor regeneration; Enzymatic reactions in micro-aqueous medium and non-conventional media.

Laboratory: assay of enzyme activity and specific activity; Kinetic analysis of an enzyme catalyzed reaction; Immobilization of enzymes by adsorption and covalent binding; Salt precipitation of an enzyme; Immobilization of microbial cells by entrapment; Effect of water activity and solvent on the lipase catalyzed esterification reaction.

BEL411 Food Science and Engineering
3 credits (3-0-0)
Pre-requisites: BEL301

Chemical constituents of foods, their properties and functions; Characteristic features of natural and processed foods; Chemical/biochemical reactions in storage/handling of foods; Units operations in food processing – size reduction, evaporation, filtration etc.; Methods for food preservation; Rheology of food products; Flavour, aroma and other additives in processed foods; Case studies of a few specific food processing sectors, cereals, protein foods, meat, fish and poultry, vegetable and fruit, milk products; legislation, safety and quality control.

BEL412 Immunology
4 credits (3-0-2)
Pre-requisites: BEL204 and EC 90

Immune system. Molecules of immune system – immunoglobulins, MHCs, Cytokines, T cell receptors. Generation of antibody and T cell receptor diversity. Complement system. Humoral and Cell mediated immunity. Immune regulation. Vaccines. Hybridoma. Immunodeficiencies and AIDS. Transplantation immunity and cancer.

BEL413 Modelling and Simulation of Bioprocesses
4 credits (3-0-2)
Pre-requisites: BEL301

Types of kinetic models, Data smoothing and analysis, Mathematical representation of Bioprocesses, Parameter estimation, Numerical Integration techniques, Parameter Sensitivity analysis, Statistical validity, Discrimination between two models.

Physiological state markers and its use in the formulation of a structured model, Development of compartment and metabolic pathway models (Software Probe) for intracellular state estimation.

Dynamic Simulation of batch, fed-batch steady and transient culture metabolism, Numerical Optimization of Bioprocesses using Mathematical models.

BEL414 Thermodynamics of Biological Systems
3 credits (3-0-0)
Pre-requisites: CHL101 and EC 90

Biological systems as open, non-equilibrium systems, failure of classical thermodynamics in describing biological processes, concepts of thermodynamic flux and force, concept of entropy production, constitutive equations, Onsager reciprocal relations, Prigogine's principle, coupling in biological processes, thermodynamics of coupled biochemical reactions, thermodynamic analysis of oxidative phosphorylation, Nath's principle for coupling in bioenergetic processes, active transport, stability of non-equilibrium states.

BEL415 Advanced Bioprocess Control
3 credits (3-0-0)
Pre-requisites: CHL202 and EC 90

The course begins with a detailed analysis of the stability of bioreactors and gradually brings in the general concept of Lyapunov stability. The contrast between classical control and modern control is illustrated through state space techniques and concepts of reachability (Controllability) and reconstructability (Observability). Then several techniques of differential are brought and the power of the method demonstrated through various techniques such as the input-output linearization. In the final phase of the course several case studies are undertaken and future trends in the field of research presented.

BEL416 Membrane Applications in Bioprocessing
3 credits (3-0-0)
Pre-requisites: BEL301

Introduction; Organic/inorganic membranes and its manufacture; transport theories for MF/UF/NF membranes; Laboratory/ commercial modules of membranes: Applications of membranes: Milk/ cheese processing, Fruit/ sugarcane juice processing, Pharmaceuticals/ Therapeutic drugs processing and membrane-coupled separation of biomolecules; Membrane based bioreactor for cell/enzyme recycle; Mammalian/ plant cell culture; Case studies.

BEL417 Biophysics
3 credits (3-0-0)
Pre-requisites: PHL110 and EC 90

Spectroscopic methods in biophysics, conformational changes in biological processes, biological energy conservation and transduction, photosynthesis, transport across biomembranes, the biophysics of motility, the biophysics of the nerve impulse.

BEL418 Bioinformatics
3 credits (2-0-2)
Pre-requisites: CSL110 / CSL120 and EC 90

Introduction to Bioinformatics and its Application, Molecular Biology for bioinformatics (Central Dogma), Biological data bases (primary, secondary hybrid etc), and its Annotation, Protein and Nucleotide (DNA) sequencing techniques, Pairwise and multiple sequence alignment algorithm, Phylogentic Analysis, Hidden Markov Model (HMM) and its Application, Microbial Genomics, Metabolic Flux Analysis.

BEL419 Enzyme Catalyzed Organic Synthesis
3 credits (2-0-2)
Pre-requisites: BEL101 and EC 90

Enzyme as biocatalysts, Enzyme catalyzed reactions in organic solvents, Structure of enzyme in organic solvents, pH memory and molecular imprinting, Biocatalyst design and challenges, cofactor recycling, enzyme stability and stabilization. Biocatalytic applications in organic synthesis-hydrolytic reactions, oxidation reduction reactions, formation of C-C bond, addition and elimination reactions, glycosyl transfer reactions, isomerization, halogenation/ dehalogenation reactions.

Laboratory: Use of lipases to demonstrate esterification and interesterification reactions. Effect of solvents on lipase catalyzed reactions, Use of proteases for synthetic reactions. Cofactor recycling. Immobilized biocatalysts for bioconversion.

BEL420 Analytical Methods in Biotechnology
3 credits (2-0-2)
Pre-requisites: BEL101 and EC 90

Nature and properties of biochemical metabolites, Radioactivity and use of isotopes in biological systems, Autoradiography, Principles and applications of chromatography, Hydrodynamic methods : Sedimentation and ultracentrifugation, Spectrophotometry, Fluorescence methods, Circular dichroism, Mass spectrometry, Gas chromatography.

BEL421 Metabolic Regulation and Engineering
3 credits (3-0-0)
Pre-requisites: BEL204 & BEL301

Regulatory mechanisms for control of enzyme synthesis – an overview. Control of enzyme activity-proteolysis, covalent modification and ligand binding. Metabolic control theory and metabolic flux analysis, and their applications. Metabolic regulation of a few major metabolic pathways especially those relevant to bioprocess industries. Metabolic pathway synthesis. Application of gene cloning in redirecting cellular metabolism for over-production of a few industrial products. Strategies to overcome regulatory mechanisms for hyper production of primary and secondary metabolites such as enzymes, amino acids, alcohols, anti-oxidants, organic acids and antibiotics.

BEL422 Solid State Cultivation
3 credits (3-0-0)
Pre-requisites: BEL301

Definition, Microbial basis of processes, Substrate for processes, Quantification of biomass, Environmental parameters, Growth patterns, Growth kinetics and the modelling of growth in SSC, General principles of reactor design and operation for SSC, Overall process concepts in fungal biomass production, product leaching and downstream processing.

BEL701 Biotechnology Resource Planning and IPR Issues
2 credits (2-0-0)
Pre-requisites: BEL401 & BEL403

Economic, social and product benefits of modern biotechnology; Resource base for process biotechnology; Typical stages in commercialization of process/ product; Commercial and financial aspects of bioprocessing ; Financial appraisal of bioprocessing projects .

TRIPS agreement; IPR issues in relation to biotech products/ processes; Architecture of Patent application.

Alternative models of technology transfer and licensing; Good manufacturing practices; Funding mechanisms of commercial projects.

Biosafety Principles - environment and health risk assessment; biosafety regulatory guidelines and controlling agencies, Environmental law for hazardous microorganisms

and GMOs; Biotechnology Related Issues of Public Concern - Bioethics.

BEL702 Bioprocess Plant Design
5 credits (3-0-4)
Pre-requisites: AML110 & MEL110 & CHL205 & CHL204 & BEL401 and EC 90

Introduction; General design information; Mass and energy balance; Flow sheeting; Piping and instrumentation; Materials of construction for bioprocess plants; Mechanical design of process equipment; Vessels for biotechnology applications; Design of fermenters; Design considerations for maintaining sterility of process streams and processing equipment; Selection and specification of equipment for handling fluids and solids; Selection, specification and design of heat and mass transfer equipment used in bioprocess industries; Design of facilities for cleaning of process equipment used in biochemical industries; Utilities for biotechnology production plants; Process economics; Bioprocess validation; Safety considerations; Case studies.

Laboratory: Design of the complete process plant for an identified product or service. Each student to choose a separate product/industry.

BEL703 Downstream Processing in Biotechnology
5 credits (3-0-4)
Pre-requisites: BEL301 & BEL401

Characteristics of bio product, flocculation and conditioning of fermented medium, Revision of mechanical separation (filtration, Centrifugation etc.), cell disruption, Protein precipitation and its separation, Extraction, Adsorption-Desorption processes, Chromatographic methods based on size, charge, shape, biological affinity etc., Membrane separations- ultrafiltration and electrodialysis, Electrophoresis, Crystallization, Drying, Case studies.

Laboratory: Conventional filtration, centrifugation in batch and continuous centrifuge, Cell disruption, Protein precipitation and its recovery, Ion-exchange chromatography, Membrane based filtration- ultrafiltration in cross flow modules and microfiltration, Adsorption processes in batch and continuous mode.

BEL711 Recombinant DNA Technology
4 credits (2-0-4)
Pre-requisites: BEL204

Restriction and modification phenomena, Other enzymes used in rDNA research, Plasmid, λ phage, M13 biology, Vectors – plasmid, phage, phagemid, Cosmid, Expression vectors, Construction of libraries, DNA Sequencing, PCR, Genome mapping, Stability of recombinant cells in the production of biochemicals.

BEL712 Plant Cell Technology
3 credits (2-0-2)
Pre-requisites: BEL301

Lectures: Special features and organization of plant cells. Totipotency, regeneration of plants. Plant products of industrial importance. Biochemistry of major metabolic pathways and products. Autotrophic and heterotrophic growth. Plant growth regulators and elicitors; Cell suspension culture development: methodology, kinetics of growth and production formation, nutrient optimisation. Production of secondary metabolites by suspension cultures with a few case studies. Biological and technological barriers- hydrodynamic shear and its quantification, mixing and impeller design aspects. Plant cell reactors: comparison of reactor performances. Immobilized plant cell and cell-retention reactors. Hairy root cultures and their cultivation.

Laboratory : Development of callus and suspension cultures of plant cells; shear sensitivity; growth and product formation kinetics in suspension cultures; production of secondary metabolites in bioreactors using suspension cultures / immobilized cells; development of hairy root cultures.

BEL713 Microbial Engineering
3 credits (3-0-0)
Pre-requisites: BEL403

Non-ideality and RTD in bioreactors; stability analysis; analysis of multiple interacting microbial populations; stability of recombinant cells; physiology of immobilised cells; special reactors for animal and plant cells; integrated systems of bioreaction and bioseparation; biosensors.

BEL714 Protein Science and Engineering
3 credits (3-0-0)
Pre-requisites: BEL204

Introduction-Definition, Aims; Basic structural principles of proteins-amino acids, Motifs of protein structure and their packing: alpha domain, alpha/Beta domain, Antiparallel β structures; Protein folding and assembly – protein folding pathways in prokaryotes and eucaryotes; Folding of BPTI, Recovery of active proteins from inclusion bodies; Structure prediction-structural classes, secondary and tertiary protein structure prediction; Sequence homology searches, Strategies for protein engineering – random, site-directed, case studies; X-ray and NMR analysis of proteins-basic principles; Drug-protein interactions and design, Rational protein design.

BEL715 Biological Waste Treatment
4 credits (3-0-2)
Pre-requisites: BEL301

Qualitative and quantitative characterization of wastes; Waste disposal norms and regulations; Indian regulations; Principles of biological treatment; Aerobic and anaerobic biological wastewater treatment systems; Suspended and attached cell biological wastewater treatment systems; Biological nutrient removal; Treatment plant design calculations; Treatment and disposal of sludges; biological means for stabilization and disposal of solid wastes; Treatment of hazardous and toxic wastes; Degradation of xenobiotic compounds; bioremediation.

Laboratory: Characterization of wastes; Design calculations for various types of wastes using various types of biological processes.

BEL716 High Resolution Methods in Biotechnology
3 credits (2-0-2)
Pre-requisites: BEL301

Need for high resolution separation for biologicals; Difficulties with traditional methodologies; Affinity precipitation and partitioning; MF/UF/NF for high resolution separation; chromatography techniques; Affinity chromatography and electrophoresis, Separation by gene amplification (PCR), Molecular imprinting.

BEL717 Animal Cell Technology
4 credits (3-0-2)
Pre-requisites: BEL301

Characteristic of animal cell, metabolism, regulation and nutritional requirements; Kinetics of cell growth and product

formation and effect of shear force; Product and substrate transport; Perfusion bioreactors, hollow fiber bioreactor, operational strategies and integrated approach; Micro and macro carrier culture; Hybridoma technology; Genetic engineering in animal cell culture; Scale-up and large scale operation; Case studies.

Laboratory: Cell culture in static phase (T-flask), quantification of cell growth, monolayer culture, determination of critical shear stress, micro carrier and perfusion culture, product formation.

BEL718 Combinatorial Biotechnology
3 credits (3-0-0)
Pre-requisites: BEL204

Introduction, solid phase synthesis, solution phase synthesis. Strategies for library construction. Solid phase synthesis of peptides and oligonucleotides. Strategies for identification of potent molecules. Indexed combinatorial library. Combinatorial libraries of various biomolecules. Instrumentation and analytical methods.

BEL719 Current Topics in Biochemical Engineering and Biotechnology
3 credits (3-0-0)
Pre-requisites: BEL403

Topics of current interest in various areas of Biochemical Engineering and Biotechnology will be covered. The faculty offering the course will specify the contents at the time of offering.

BEL720 Biotechnology in Food Processing
3 credits (3-0-0)
Pre-requisites: BEL301

Microbial role in food process operations and production; new protein foods-SCP, mushroom, food yeasts, algal proteins; fermentation as a method of preparing and preserving foods. Food additives like colouring, flavours and vitamins. Organisms and their use in pickling, producing colours and flavours, alcoholic beverages and other products. Mechanism of enzyme functions and reactions in process techniques-starch and sugar conversion processes, baking by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill-proofing cheese making by proteases and various other enzyme catalytic actions in food processing. Process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products, Genetically Modified Food.

BEL721 Bionanotechnology
3 credits (3-0-0)
Pre-requisites: BEL101 and EC 60

Introduction; Scanning probe microscopy (SPM), Self-assembly of biomolecules in nanotechnology; Tailoring nanometer scale objects to mimic and interact with natural materials; Biological nanostructures and biomimetic machinery; Molecular motors: natural molecular motors like kinesin, dynein, flagella, RNA and DNA helicases, topoisomerases; Ion channels as molecular switches; patch clamp technique; Photoreceptors as single photon optical detector; Manipulating redox systems application in nanotechnology; Microfabricated devices in biotechnology e.g. micro reactors; Protein array technology; Exploiting enzymes in bionanotechnology; Nanoscale devices for biosensors, Biodegradable nanoparticles for drug and gene delivery to cells and tissues.

BEL722 Genomics and Proteomics
3 credits (3-0-0)
Pre-requisites: BEL204

Genomics and proteomics- introduction, DNA sequencing, DNA fingerprinting, ESTs and SNPs, Application in pharmagenomics, Structural and functional genomics, DNA microarrays and expression profiling, protein isolation and purification, protein expression – methodologies, proteome analysis – various techniques, 2D gel elctrophoresis, FPLC, MALDI-TOF etc., Protein structure determination.

BEL723 Data Analysis for DNA Microarrays
4 credits (3-0-2)
Pre-requisites: BEL204

Microarray technology, Basic digital imaging and image processing, Probabilities, common distributions, Bayes' theorem, Analyzing microarray data with classical hypothesis testing, Analysis of variance, Experimental Design, Analysis and visualization tools: Box plots, Scatter plots, Histograms, Cluster Analysis: one-way, two-way, Graphic, Methods for selection of differentially regulated genes, Hypothesis- driven experiments using focused microarrays, Biological interpretation, Commercial software available.

BEL724 Advanced Biochemistry
3 credits (3-0-0)
Pre-requisites: BEL204

Overview of carbohydrate and fatty acid metabolism and linkage to Bioenergetics, Biosynthesis of Amino acids, Protein Synthesis and Targeting, Protein Degradation and turnover, Enzymatic reaction mechanism and role of transition metal ions, Allosteric transitions and cellular controls, Signal Transduction, Peptide synthesis and peptide sequencing, Protein folding and stabilization, Molecular chaperones and neurodegenerative disorders, and Biosynthesis of Lipids and nucleotides.

BEN150 Introduction to Biochemical Engineering and Biotechnology
2 credits (0-0-4)

Demonstration, audio-visual presentations, and/or hands-on experiments about micro-organisms and their applications; heredity and genetics; bioinformatics; infrastructural and analytical tools required for biotechnology operations and engineering aspects of biochemical and biotechnology products.

BEP303 Design of Bioprocesses
2.5 credits (0-1-3)
Pre-requisites: BEL101 & BEL103 and EC 60

Design and execution of simple laboratory scale experiments on the following topics: Estimation of cell mass; different phases of microbial growth; Mass and energy balance in a typical bioconversion process; Concept of limiting nutrient and its effect on cell growth; growth inhibition kinetics; product formation kinetics in a fermentation process; aerobic and anaerobic bioconversion process; power consumption in a fermentation process and its correlation with rheology of the fermentation fluid; different agitator types; mixing time in a bioreactor; quantification of KLa in a fermentation process; Heat balance across a batch sterilization process; Assembly and characterization of pH/DO electrodes.

BER350 Professional Practices (BB)
2 credits (0-1-2)
Pre-requisites: EC 60

No fixed course content. Activities to include visits to industry, interactive meetings with personnel from industry and R&D organizations.

BES350 Independent Study (BB)
3 credits (0-3-0)
Pre-requisites: EC 80

No fixed course content. Study to concentrate on a selected topic under the supervision of a faculty member of the department.

BET450 Practical Training (BB)
Non credit
Pre-requisites: EC 90 at the end of 5th sem.

Observation of processes, operating procedures, construction techniques, management procedures, amongst others, and executing a project related to the industry.

BEV330 Special Module in Biochemical Engineering and Biotechnology
1 credit (1-0-0)
Pre-requisites: EC 60

Special module that focusses on state of the art and research problems of importance in biochemical engineering and biotechnology.

Department of Chemical Engineering

CHC410 Colloquium (CH)
3 credits (0-3-0)
Pre-requisites: registered for CHT410 and EC 90
One hour lecture by each student on his practical training. Circulation of a ten page notes on his lecture. Some special assignment on his training.

CHC750 Seminar (CC)
1 credit (0-0-2)
Pre-requisites: EC 165
Literature study on a selected topic. Report writing. Seminar presentations.

CHC760 Seminar (CP)
1 credit (0-0-2)
Pre-requisites: EC 165
Literature study on a selected topic. Report writing. Seminar presentations.

CHD310 Mini Project (CH)
3 credits (0-0-6)
Pre-requisites: EC 60
Design/fabrication work under the guidance of a faculty member. Prior to registration, a detailed plan of work should be submitted by the student to the Head of Department for approval.

CHD411 Major Project Part 1 (CH)
4 credits (0-0-8)
Pre-requisites: EC 120
Formulation of the problem; Literature search; Design of the experimental setup and study of experimental techniques in the case of experimental projects; Formulation of design equations, development of solution techniques and familiarization with relevant software in the case of design or theoretical projects.

CHD412 Major Project Part 2 (CH)
6 credits (0-0-12)
Pre-requisites: CHD411
Theoretical or design projects: To arrive at a complete design of a chemical plant in particular give complete design detail of major process equipment or to develop computer simulation models for industrial processes at macro or micro level.

Experimental Projects: Collect and interact data and model the experimental system.

CHD851 Major Project Part 1 (CC)
6 credits (0-0-12)
Pre-requisites: EC 165
Overlaps with: CHD853
Formulation of the problem; Literature search; Design of the experimental setup and study of experimental techniques in the case of experimental projects; Formulation of design equations in development of solution techniques and familiarization with relevant software in the case of design or theoretical projects.

CHD852 Major Project Part 2 (CC)
14 credits (0-0-28)
Pre-requisites: CHD851
Overlaps with: CHD854
Theoretical or design projects: To arrive at a complete design of a chemical plant in particular give complete design detail of major process equipment or to develop computer simulation models for industrial processes at macro or micro level.

Experimental Projects: Collect and data and model the experimental work.

CHD853 Major Project Part 1 (CC)
4 credits (0-0-8)
Pre-requisites: EC 165
Overlaps with: CHD851
Formulation of the problem Literature search; Design of the experimental setup and study of experimental techniques in the case of experimental projects; Formulation of design equations in development of solution techniques and familiarization with relevant software in the case of design or theoretical projects.

CHD854 Major Project Part 2 (CC)
16 credits (0-0-32)
Pre-requisites: CHD853
Overlaps with: CHD852
Theoretical or design projects: To arrive at a complete design of a chemical plant in particular give complete design detail of major process equipment or to develop computer simulation models for industrial processes at macro or micro level.

Experimental Projects: Collect and data and model the experimental work.

CHD861 Major Project Part 1 (CP)
6 credits (0-0-12)
Pre-requisites: EC 165
Overlaps with: CHD863
Formulation of the problem; Literature search; Design of the experimental setup and study of experimental techniques in the case of experimental projects; Formulation of design equations in development of solution techniques and familiarization with relevant software in the case of design or theoretical projects.

CHD862 Major Project Part 2 (CP)
14 credits (0-0-28)
Pre-requisites: CHD861
Overlaps with: CHD864
Theoretical or design projects: To arrive at a complete design of a chemical plant in particular give complete design detail of major process equipment or to develop computer simulation models for industrial processes at macro or micro level.

Experimental Projects: Collect and data and model the experimental work.

CHD863 Major Project Part 1 (CP)
4 credits (0-0-8)
Pre-requisites: EC 165
Overlaps with: CHD861
Formulation of the problem; Literature search; Design of the experimental setup and study of experimental techniques in the case of experimental projects; Formulation of design equations in development of solution techniques and familiarization with relevant software in the case of design or theoretical projects.

CHD864 Major Project Part 2 (CP)
16 credits (0-0-32)
Pre-requisites: CHD863
Overlaps with: CHD862
Theoretical or design projects: To arrive at a complete design of a chemical plant in particular give complete design detail of major process equipment or to develop computer simulation

models for industrial processes at macro or micro level.

Experimental Projects: Collect and data and model the experimental work.

CHL101 Introduction to Chemical Engineering Thermodynamics

3 credits (2-1-0)
Overlaps with: CHL121

Simplified mechanical structure of solids, liquids and gases; Origin of‘ intermolecular forces and non-ideal behaviour of gases; Cp, Cv and equations of state; Generalized properties; First law and energy balances as applied to thermochemistry and fluid flow. Work in compression and expansion of fluid flow; Second law, concept of irreversibility; Introduction to phase and chemical equilibria; partial molar properties.

CHL103 Chemical Reactor Analysis and Design

4 credits (3-1-0)
Overlaps with: CHL122

Basic introduction to reaction engineering; Introduction to rate equations, stoichiometry and rate laws for biochemical reactions; Design of batch, plug flow, well mixed and semi-batch biochemical reactors; Introduction to pseudo steady state hypothesis and transition state theory; Michaelis – Menten equation and identification of its parameters; Multiple enzyme and substrate systems; Design equations for bio-reactors; Inhibitors and Propagators for biochemical reactions; Residence time Distribution; Diffusion with chemical reaction in catalyst particles, effectiveness factors; Scale up of bioreactors; Treatment of unsteady state and non-isothermal conditions for catalysed/uncatalysed biochemical reactions.

CHL110 Transport Phenomena

4 credits (3-1-0)

Definition of transport properties, their measurement and estimation. Shell balance approach for developing equations for momentum, heat and mass transport. Solution of problems involving transport in one dimension. Introduction to turbulent flows and expressions for turbulent fluxes. Concept of transfer coefficients. Similarity of momentum, heat and mass transport and various analogies. Application of these concepts to various disciplines in engineering and science.

CHL111 Material and Energy Balance

4 credits (2-2-0)

Mathematical and engineering calculations, Dimensional groups and constants, , Behaviour of ideal gases, gaseous mixtures, Vapour pressure, Clausius Clapeyron equation, Cox chart, During’s plot, Raoult’s law, Humidity and saturation, humid heat, humid volume, dew point, humidity chart and its use, Crystallisation, dissolution, Material balance; solving material balance problems with and without simultaneous equations; recycle, bypass and purge calculations, Aid of computer in solving material balance problems, Energy balance: heat capacity, calculation of enthalpy changes; energy balances with chemical reaction, Heat of vaporization, heat of formation, laws of thermochemistry, heat of combination, heat of reaction, Solution of sets of equations, Case studies.

CHL112 Chemical Process Technology

4 credits (3-1-0)

The course covers the concept of combination of unit processes and unit operations along with the basic raw materials. Synthesis of steady state flow sheets for the chemical plant. Processing of water for various end uses. Industrial gases and different techniques for air separation systems. Manufacture of Fertilizers including sulfuric acid; ammonia and its allied products like, Urea, Nitric acid and other products. Food processing and agro based products like paper, sugar, oils and soap etc. including the manufacture of ethyl alcohol. Electrochemicals and chloralkali industries. Safety and Hazard in chemical process plant design and environmental constraints. Concept of green technologies.

CHL121 Chemical Engineering Thermodynamics

4 credits (3-1-0)
Overlaps with: CHL101

Basic concepts – force, energy, heat, work etc.; closed and open systems; First law for closed and open (flow) systems; Heat effects; Second law and entropy; Second law for flow systems and lost work. Thermodynamic relations – fundamental property relations and Mazwell’s relations; PVT behaviour of pure substances; Equations of state generalized correlations, acentric factor; Calculation of thermodynamic properties using these; Heat engine, Carnot and other cycles; Refrigeration cycles; General Vapor Liquid Equilibrium (VLE) behaviour, equilibrium criterion and Raoult’s law; Partial molar quantities, excess properties, chemical potential, fugacity and activity coefficients; VLE calculations – Bubble point, Dew point and Flash calculations. Chemical reaction equilibrium and equilibrium constants; single and multi-reaction equilibria.

CHL122 Chemical Reaction Engineering – I

4 credits (3-1-0)
Overlaps with: CHL103

Introduction to reaction engineering; Concepts of rate equations, stoichiometry and rate laws; Material balance for CSTR and PFR, their use for kinetic interpretation and design; Comparison of batch reactor, CSTR and PFR; Evaluation of performance properties of the reactors; Analysis of rate data for batch/continuous flow reactors and development of rate equation; Introduction to the concept of yield and selectivity for multiple reactions; Unsteady state reactor design; Concepts of adiabatic and non-isothermal operations (energy balance).

CHL133 Powder Processing and Technology

4 credits (3-1-0)

Powder characterization for size, size distribution, surface area and flowability. Size distribution and material handling equipment performance, powder strength and flowability. Shape characterization. Instruments for measurement of powder characteristics. Powder storage in silos. Flow properties of powders. Air induced segregation, segregation during heap formation and flow through chutes. Measurement of flow factor and silo design. Analysis methods for flow through chutes, cyclones, etc. Retrofitting. Comminution. Grinding process and circuit analysis. Gas solid separation and equipment like cyclone collectors and bag house scrubbers. Application of cyclone in waste heat recovery. Energy saving through pollution control.

CHL202 Process Systems Analysis and Control

4 credits (3-1-0)
Pre-requisites: MAL110
Overlaps with: CHL261

Revision of Laplace transform; Dynamic behaviour of first order and second order systems: response of first order systems, response of first order systems in series, second order systems and transportation lag, block diagrams and transfer functions; Feedback Control: P, PI, PID controllers, transient response of control systems: Stability: general concepts, Routh stability criterion, direct substitution method; Frequency response: Bode diagrams, Nyquist diagrams, control system design by frequency response, tuning and troubleshooting; feedforward control, ratio control, cascade control; Introduction to modern control theory.

CHL203 Transport Processes - I
4 credits (3-1-0)
Pre-requisites: CHL110
Overlaps with: CHL231, AML160, AML150, AML170

Revision of momentum transfer principles; flow of incompressible fluids in conduits; fittings and valves; network of pipelines; economic pipe diameter; flow through open channels; compressible fluid flow; transportation and metering of fluids; pumps, fans, blowers and compressors; flow measuring devices; agitation and mixing of fluids; Revision of heat transfer principles; boiling and condensation; heat exchangers; overall heat transfer coefficients; LMTD; analysis of heat exchangers; jacketed vessels; heat exchanger coils; condensors and evaporators; multiple effect evaporation; surface area determination.

CHL204 Transport Processes - II
4 credits (3-1-0)
Pre-requisites: CHL110
Overlaps with: CHL251

Empirical correlations based on analogy between momentum, heat and mass transfer; Mass balance in co-current and counter-current continuous contact equipment; operating line concept; ideal stage and stage efficiency; design of continuous contact equipment; HTU and NTU concept; batch and continuous distillation; absorption; adsorption: applications to chromatography; extraction and leaching operations; equipments and equilibrium diagrams; design procedures and calculations; humidification operations; design of cooling towers; drying of solids; design of batch and continuous dryers.

CHL221 Chemical Reaction Engineering – II
4 credits (3-1-0)
Pre-requisites: CHL122

Introduction to Catalysis, classification, preparations, properties; Physical and chemical adsorption, Different types of adsorption isotherms; Kinetics of solid catalyzed gas phase reaction; Laboratory reactors for catalytic gas-solid reactions; Diffusion and chemical reaction in catalysts; Effects of external mass transfer and heat transfer; Effectiveness factors; Fixed bed catalytic reactors; Fixed bed reactor models; Pseudo- Homogeneous and 2-dimensional models concept of heterogeneous models Non-catalytic gas-solid reactions different models reactors; Gas-liquid reaction; Film and penetration theories; Enhancement factor in G-L reactions; Reactor systems for G-L reactions. Laboratory/ design activities could also be included.

CHL231 Fluid Mechanics for Chemical Engineers
4 credits (3-1-0)
Pre-requisites: CHL110
Overlaps with: AML160, AML150, AML170, CHL203

Properties of fluids, classification of fluids, forces on fluids, normal forces and shear stresses on fluids, pressure-depth relation for fluids, forces on submerged bodies, rigid body motion, pressure and velocity measurement, kinematics of flow, mass energy and momentum balances (macroscopic), Fluid friction in pipes, flow in chemical engineering equipment, differential equations of fluid mechanics, solution of viscous flow problems, Laplace's equation for irrotational flow, stream function, potential flow, description of fluid fields, boundary layer, other unidirectional flow, turbulent flow .

CHL251 Heat and Mass Transfer
4 credits (3-1-0)
Pre-requisites: CHL110
Overlaps with: CHL204

Diffusion in gases, liquids, and solids. Steady and unsteady Mass/Heat conduction in solids Mass transfer operations. Heat exchange equipment Mass balance in simple situations with and without chemical reaction. Theories of mass transfer. Individual and overall mass and heat transfer coefficients. Simultaneous heat and mass transfer. Mass, heat, and momemtum transfer analogies. Convective mass transfer. Convection – diffusion problems. Mole and energy balance in co-current and countercurrent continuous contact equipments. Empirical correlations for mass/heat transfer coefficients in various situations. Dimensionless numbers and their significance. Concept of operating line. Multistage countercurrent operations. Concept of ideal stage. Stage efficiencies. Design of continuous contact equipments. HTU and NTU concepts. Gas absorption. Heat effects. Design of a packed-bed gas absorber.

Laboratory/design activities could also be included.

CHL260 Applications of Programming in Chemical Engineering
4 credits (3-0-2)
Pre-requisites: CSL110/CSL120

Solving of linear, non-linear algebraic equations, interpolating polynomials, different ion, integration, ordinary differentiation equations and their applications to Chemical Engineering Design problems. Application of Matlab, various toolboxes, features of symbolic math toolbox.

Use of MATLAB functions for performing integration and differentiation and solving algebraic equations, ordinary and partial differential equations with initial and boundary conditions.

Introduction to ANSI C, character set, keywords, constants, data types, variables, expressions, simple input/output programs, pointers, conversion characters, escape sequence, relational and logical expression and control statements, bit manipulations, introduction to functions with examples, classes of variables, arrays and pointers, Preprocessor and recursive functions, structures, union, field type definition, input/output files.

CHL261 Instrumentation and Process Control
4 credits (3-1-0)
Pre-requisites: MAL110
Overlaps with: MEL312, EEL301, CHL202

Introduction to instrumentation and process control. Measuring instruments for: Temperature, pressure, level, flow, composition, pH. Basic concepts of feedback control: Control loop and its elements. Dynamic behaviour of first, second and higher order physical systems. Linearization of non-linear systems. Controller hardware, sensors, transmitters and control valves. Stability of control loop using Routh's test. Introduction to root locus method. Frequency response analysis: Bode stability criteria. Introduction to advanced control systems: feed forward, cascade, ratio control. Design of single loop feedback control systems and tuning of feedback controllers. Control schemes with applications to distillation systems, chemical reactors, heat exchangers, boilers etc. State space representation of physical system. Transfer function matrix and multivariable control.

CHL275 Safety and Hazards in the Process Industries
4 credits (3-1-0)
Pre-requisites: CHL112

Identification, classification and assessment of various types of hazards, Hazards due to fire, explosion, toxicity and radiation, Protective and preventive measures in hazards

control, Industrial hygiene, Reliability and risk analysis, HAZOP and HAZAN, Consequence analysis (vapour cloud modelling), Event probability and failure frequency analysis, Safety Training, Emergency planning and disaster management, Case studies.

CHL277 Materials of Construction
3 credits (3-0-0)
Pre-requisites: CHL112

Types and mechanism of corrosion, factors influencing corrosion, combating corrosion, corrosion testing methods, Metallic materials, Non-metals, High and low temperature materials, Selection of materials of construction for handling different chemicals, Industrial applications and case studies.

CHL291 Introduction to Biochemical Engineering
4 credits (3-1-0)
Pre-requisites: CHL112
Overlaps with: BEL301

Basics of microbiology and biochemistry. Mass and energy balance in microbial processes. Microbial growth, substrate utilization and product formation kinetics. Medium and air sterilization. Enzyme kinetics and immobilized enzyme systems. Design of batch, continuous and fed-batch bioreactors. Mass Transfer in biological reactors. Scale-up principles, Instrumentation and control of bioprocesses, Bioseparation.

CHL296 Nano Engineering of Soft Materials
3 credits (3-0-0)
Pre-requisites: CHL110

The course can be subdivided in three subheadings viz., Soft materials, Intermolecular forces, Surface Instabilities in soft materials

Soft materials: soft materials and their properties, ways to control and measure the properties of soft materials.

Intermolecular forces: van der Waals, Acid-Base, Double layer and other forces, their decay behavior and measurement

Surface instabilities: Conditions for onset of surface instability; Morphological changes during evolution of instability. Ways to tune this evolution to result in desired morphology.

CHL331 Fluid-particle Mechanics
4 credits (3-1-0)
Pre-requisites: CHL231
Overlaps with: CHL204

Size and size distribution: size distribution equations and their uses. Shape characterization, fractals and fourier analysis. Method of measurements, image processing. Instrumental method for measurement of powder size and distribution, microscope, sieve analysis. Settling of single particle and multiple particles, application for size analysis of particles and design of settling tank. Pressure, vacuum and ultra filtrations. Flow through packed and fluidized beds. Application of Kozney Carman equation for development of surface area meter and evaluate bag filter performance. Powder storage in Silos. Flow properties of powders. Jensen equation Funnel and mass flow. Retrofitting with inserts and bin serts. Comminution. The selection of Comminution equipment. Grinding circuit analysis. Various methods of production of particles, nano particles and their importance. Gas solid separation: Settling chambers, cyclone collectors. bag house scrubbers, Electrostatic separators, scrubbers and other filtration techniques. Laboratory design activities could be also included.

CHL332 Fluidization Engineering
4 credits (3-1-0)
Pre-requisites: CHL231

Fluidization, Classification of particles, regimes of fluidization, minimum fluidization velocity, Particulate and aggregative fluidization, bubbling fluidization, bubbling bed models for catalytic reactions, turbulent and fast fluidization, dilute and dens phase transport, cyclones, stand pipes, circulating fluidized beds, spouted beds, three phase fluidization, performance modelling of multiphase systems.

Laboratory/design acivities could also be included.

CHL351 Mass Transfer Operations
4 credits (3-1-0)
Pre-requisites: CHL251
Overlaps with: CHL203

Distillation: Raoult's law, ideal solutions, x-y and H-x-y diagrams, flash vaporization and condensation, Differential distillation, steam distillation, Binary distillation: McCabe-Thicle and Ponchon-Savarit Method, Total reflux, minimum and optimum reflux ratios, Design of distillation column with open steam, multiple feeds, side streams and partial condensers, Approximate and plate to plate calculations for multicomponent distillation, Liquid-liquid extraction, Extraction equipment Design, Equilibrium diagram, Choice of solvent, Single stage and multistage counter current extraction with/without reflux, Continuous contact extractors, Leaching equipment and equilibrium, Single stage and multistage cross current and counter-current leaching, Adsorption: adsorption equilibria, adsorption column sizing.

CHL353 Modern Separation Processes
4 credits (3-1-0)
Pre-requisites: CHL251

Membrane separation processes, Pressure swing adsorption, Foam separation, Chromatographic techniques: Column chromatography, Gas-liquid chromatography, Ion-exchange chromatography, Separation by thermal diffusion, Electrophoresis, Crystallization. Laboratory/design activities could also be included.

CHL390 Process Utilities and Pipeline Design
4 credits (3-0-2)
Pre-requisites: CHL231&CHL251

Steam systems: sizing and pressure drop, water hammer, steam trap, flash tank design, lagging, scale formation. Water treatment. Air systems: vessels, air cleaning and dehumidification, air filters, compressors, blowers and piping. Refrigeration and air conditioning basics. Instrumentation and feed back control systems. Energy auditing for steam and air systems. Solar energy applications for utilities.

CHL392 Polymer Science and Engineering
4 credits (3-1-0)
Pre-requisites: CHL221
Overlaps with: CYL230

Classification of polymers. Thermosets and thermoplastics. Physical states and transition. Glass transition and its measurements. Crystallization and measurement of crystallinity. Polymer synthesis step growth polymerization with examples: chain growth including free radical, anionic and cationic polymerization with examples: chain growth including free radical, anionic and cationic polymerization. Polymer kinetics, molecular weight and its distribution. Copolymers and copolymerization. Polymerization systems including bulk, solution, suspension and emulsion. Rubber elasticity. Flow of polymers. Techniques for processing of polymers.

Properties of commodity and engineering polymers. End application. Polymer based industries.

CHL471 Process Equipment Design and Economics
4.5 credits (3-0-3)
Pre-requisites: CHL351

Heat Exchange Equipment: rating of an existing unit and design of a new system of shell and tube heat exchangers; design of multiple-effect evaporator.

Mass Exchange Equipment: design of a sieve-tray tower for distillation; design of a packed tower for gas absorption.

Plant Economics: estimation of various costs to install and run a plant; interest costs and present/future worth of cash flows; straight-line and combination methods for depreciation; discounted cost flow/net present worth methods for profitability analysis.

CHL701 Process Engineering
4 credits (3-0-2)
Pre-requisites: CHL112 & CHL351

Process Synthesis; Hierarchical conceptual design of process; Batch vs. continuous; input-output structure of flowsheet; choice of reactor; choice of separation system; Distillation column sequencing; Heat exchanger network design; Pinch technology; Utility selection; Steam and cooling water circuits.

Process economics: Cost estimation; annuities; perpetuities and present value; Tax and depreciation; Profitability measures; comparison of equipments and projects; NPV and DCFROR, Risk management.

Introductory Optimization: Linear programming and its use in process industry; transportation problems; integer programming (branch and bound method); use of commercial softwares LINDO, CPLEX.

Second Law Analysis: Estimate of inefficiency in equipment/ process by finding lost work' modification of operating conditions/process to improve efficiency.

CHL702 Plant Design
4 credits (3-0-2)
Pre-requisites: CHL471

Plant layout, Flow sheeting, Auxiliaries, Cost estimation, Materials handling, offsite facilities, Selection and detailed design of equipments e.g Pumps, Blowers and compressors, Mixers, Conveyors etc.; Selection of valves, Pressure reducing valves and fittings; Water treatment, Storage; Steam: Steam handling ,Steam Trap, Ejectors etc.; Pipe Size and pressure drop calculation for single and two phase flow, multiple pipe line networking.

CHL705 Electrokinetic Transport Phenomena
4 credits (3-0-2)
Pre-requisites: CHL331

Definition of colloidal state and implications, intermolecular and surface forces, electrostatics, transport equations in electrolytic solution, electrokinetic phenomena, electrophoresis, sedimentation potential, coagulation of particles, Particle deposition and aggregation.

CHL707 Adsorption Separation Processes
3 credits (3-0-0)
Pre-requisites: CHL351

Microporous adsorbents, Physical adsorption and characterization of porous adsorbents, Adsorption equilibria, Diffusion in porous media, kinetics of adsorption in batch systems, Column processes, Chromatographic separation processes, Pressure swing adsorption, Structure and properties of ion exchange resins, Ion-exchange equilibrium, Ion-exchange kinetics, Ion-exchange columns, Behaviour of ion-exchanges in non-aqueous and mixed solvents.

CHL710 Process Dynamics and Control
5 credits (3-1-2)
Pre-requisites: CHL261

Advanced control schemes such as split range control, selective control, inferential control, model based control, control of inverse response systems, dead time compensation. Z-transform and sampled data control systems. State space approach to control system design, controllability and observability. Control of complete chemical plants.

CHL711 Numerical Methods in Chemical Engineering
4 credits (3-0-2)
Pre-requisites: (CSL101/CSL102) & MAL110 and EC 90

Efficient and recent numerical techniques applied to problems of chemical engineering interests. Solution of linear and non-linear simultaneous algebraic equations, Interpolation, extrapolation and finite difference, Numerical integration and differentiation, coupled ordinary differential and partial differential equations, curve fitting, spline, regression analyses, molecular simulation.

CHL712 Computer Aided Design in Chemical Engineering
3 credits (2-0-2)
Pre-requisites: CHL351

Software development for design of various chemical equipments. Design of minimum energy heat exchanger network, sequencing and energy integration in distillation column simulation of process flow sheets using software package, Aspen Plus.

CHL714 Advanced Heat Transfer
3 credits (3-0-0)
Pre-requisites: CHL251 & MAL260

Unsteady state conduction; numerical and analytical solution. Radiation leading to furnace design. Special topics in heat transfer: heat transfer in fixed beds, fluidised beds, magneto fluid dynamic systems. Transpiration cooling in non-Newtonian fluids. Heat pipes, solar collectors.

CHL717 Mechanical Design of Process Equipment
4 credits (3-0-2)
Pre-requisites: CHL471

Specification and design of simple structural members; Design of spherical/ cylindrical shells and heads/ closures for cylindrical shells under internal and external pressure; Design of a self- supporting tall vertical cylindrical vessel under wind/ seismic loading; Design of RCC foundation for a tall vessel; Compensation for openings in cylindrical shells; Design of special flanges; Design of storage tanks for liquids.

Laboratory/ design activities could also be included.

CHL723 Chemical Reaction and Reactor Engineering
3 credits (3-0-0)
Pre-requisites: CHL351 & CHL221

Theory of mass transfer with chemical reaction. Regimes of absorption for a (1,1) order irreversible reaction and their identification. Enhancement factor, Extension to (m,n) order

case. Design of ideal gas-liquid reactors. Enhancement factor for reversible and other complex reaction schemes. Heat effects in gas-absorption. Absorption accompanied by gas-desorption. Prediction of gas-liquid reactor parameters. Introduction to liquid-liquid and gas-liquid-solid reactor design.

CHL724 Environmental Engineering and Waste Management
4 credits (3-1-0)
Pre-requisites: CHL291

The course covers the concept of ecological balance and the contribution of industrial and human activities in the changes in environmental quality. The ecological cycles. Concept of pollutants and regulatory measures for the maintenance of air and water quality. The course also covers the air pollution its source and dependence on the atmospheric factors like wind velocity, temperature gradient etc., concept of atmospheric stability and its relationship with dispersion of pollutants. Models for the prediction of air quality. Health effects of various pollutants. Control of emission of pollutants including the design of particulate matter separation by multicyclone systems, ESP, bag filters, scrubber and cleaning of gaseous components by wet scrubber, adsorption by activated carbon etc.

Water pollution its cause and effects. Pollutants and its dispersion in water bodies to predict water quality through modelling. Concept of inorganic and organic wastes and definition of BODs and COD.

CHL727 Heterogeneous Catalysis and Catalytic Reactors
4 credits (3-0-2)
Pre-requisites: CHL221

concepts in heterogeneous catalysis, catalyst preparation and characterization, poisoning and regeneration. Industrially important catalysts and processes such as oxidation, processing of petroleum and hydrocarbons, synthesis gas and related processes, commercial reactors (adiabatic, fluidized bed, trickle-bed, slurry, etc.). Heat and mass transfer and its role in heterogeneous catalysis. Calculations of effective diffusivity and thermal conductivity of porous catalysts. Reactor modelling . Emphasizes the chemistry and engineering aspects of catalytic processes along with problems arising in industry. Catalyst deactivation kinetics and modelling.

CHL735 Design of Separation Processes
4 credits (3-0-2)
Pre-requisites: CHL351

Over-view of multi-component distillation: short comings and challenges, new technologies – adsorption, membrane, crystallization. Separation processes based on micro-emulsion, micro-gas bubble, electrical charges. Design of such processes with special emphases on separation technology in petroleum refinery and petro-chemicals.

CHL743 Petrochemical Technology
3 credits (3-0-0)
Pre-requisites: CHL221

Introduction : Composition of petroleum, laboratory tests, refinery products, characterization of crude oil. Indian Petrochemical Industries ; A review. Feed stocks for petrochemical Industries and their sources. A brief introduction to Catalytic cracking ,Catalytic reforming, Delayed coking Hydrogenation and Hydro cracking, Isomerization, Alkylation and Polymerization. Purification of gases. Separation of aromatics by various Techniques. Petrochemicals from Methane. Petrochemicals from Ethane – Ethylene – Acetylene. Petrochemicals from C3, C4 and higher Hydrocarbons. Synthetic Gas Chemicals. Polymers from Olefins. Petroleum Aromatics. Synthetic Fibers, Rubber, Plastics and Synthetic Detergents. Energy conservation in petrochemical Industries. Pollution control in Petrochemical Industries. New Trends in petrochemical Industry.

CHL751 Multi-component Mass Transfer
3 credits (3-0-0)
Pre-requisites: CHL351

Diffusion: Maxwell-Stefan's, Fick's and Irreversible Thermodynamics approaches to multicomponent diffusion. Estimation of multicomponent Diffusion Coefficients. Effect of nonideality of fluids, Linearized theory for multicomponent diffusion problems. Interphase mass transfer: mass transfer coefficients, bootstrap matrix, Film Theory, Surface renewal models, mass transfer in turbulent flows.

Laboratory/design activities could also be included.

CHL761 Chemical Engineering Mathematics
3 credits (3-0-0)
Pre-requisites: MAL110 and EC 90
(laboratory/design activities could also be included)

Data Analysis: Classification, estimation and propagation of errors, Presentation of data, Statistical methods, sample and population distributions, testing of hypothesis, analysis of variance.

Solution of equations: Vector spaces, basis, matrices and differential operators. Eigen values, vectors and functions. Solvability conditions for linear equations, Sturm-Louiville Theory, Separation of variables and Fourier transform, Frobenius method for ordinary differential equations, Greens Function and its application.

CHL762 Modelling, Simulation and Control
4 credits (3-0-2)
Pre-requisites: CHL351&CHL221&CHL261

Development of conservation and constitutive equations for a variety of chemical engineering unit operations and processes under steady state and unsteady state conditions, their analysis and solution. Concept of lumped and distributed parameter models. Introduction to steady state and dynamic simulation software. Study of plant wide control schemes.

CHL763 Computer Process Control
3 credits (3-0-0)
Pre-requisites: MEL432/EEL308/CSL211

16 bit microprocessor architecture, overview of IBM PC to Pentium Computer, Computer- Process Interface equipment, DDC, Distributed Process Control, Supervisory Control, PLC, Fuzzy Logic and Neural Networks, Applications in Control of Chemical Processes.

CHL766 Interfacial Engineering
3 credits (3-0-0)
Pre-requisites: CHL351&CHL110&CHL121

Concept and definition of interface. Physical surfaces. Surface chemistry and physics of colloids, thin films, dispersions, emulsions, foams, polyaphrons. Interfacial processes such as crystallization, epitaxy, froth flotation, adsorption, adsorptive bubble separation, catalysis, reaction-injection moulding, microencapsulation. Industrial aspects of interfacial engineering.

CHL768 Fundamentals of Computational Fluid Dynamics
3 credits (2-0-2)
Pre-requisites: CHL331
Overlaps with: AML811

Review of basic fluid mechanics and the governing

(Navier-Stokes) equations; Techniques for solution of PDEs – finite difference method, finite element method and finite volume method; Finite volume (FV) method in one-dimension; Differencing schemes; Steady and unsteady calculations; Boundary conditions; FV discretization in two and three dimensions; SIMPLE algorithm and flow field calculations; variants of SIMPLE. Turbulence and turbulence modelling; illustrative flow computations; Commercial softwares FLUENT and CFX – grid generation, flow prediction and post-processing.

CHL773 Planning of Experiments and Analysis of Engineering Data

4 credits (3-0-2)

Pre-requisites: CHL331

Graphical methods and plots. Three variable empirical equations. Multivariable empirical equation. Dimensionless numbers. Nomography. Logarithmic charts. Emperical equations for data fitting. Testing of hyposthesis, mean and variances. Planning of experiments as per factorial design to estimated significant variables. Fractional factorial design to use significant variables to estimates the relationship between the significant variables and independent variable. Response surface analysis by reducing the equations developed to canonic equations. Estimations of parameters in equations of second order with interaction factor. Case studies on application to research and industrial data analysis.

CHL774 Process Optimization

4 credits (3-0-2)

Pre-requisites: CHL221& CHL471

Formulation of an optimization problem, Convexity Analysis, Linear Programming, Nonlinear Programming, Optimality Conditions, Dynamic Optimization, Dynamic Programming, Introduction to Mixed Integer Programming. Laboratory/design activities could also be included.

CHL793 Membrane Science and Engineering

3 credits (3-0-0)

Pre-requisites: CHL110 & CHL351

Introduction to membrane separation processes, their classification, and applications. General transport theories including theory of irreversible thermodynamics for multicomponent systems.

Membrane preparation techniques. Design and analysis and industrial application of various membrane processes such as reverse osmosis, ultrafiltration electrodialysis, dialysis, liquid membrane separation, gas permeation and pervaporation.

CHL794 Petroleum Refinery Engineering

4 credits (3-0-2)

Pre-requisites: CHL351

Introduction : Composition of petroleum, laboratory tests, refinery products, characterization of crude oil. Design of crude oil distillation column. Catalytic cracking. Catalytic reforming. Delayed coking. Furnace design. Hydrogenation and Hydrocracking. Isomerization, Alkylation and Polymerization. Lube oil manufacturig. Energy conservation in petroleum refineries. New Trends in petroleum refinery operations. Pyrolysis of Naphtha and light hydrocarbons: modelling (time permitting).

CHL807 Population Balance Modelling

3 credits (3-0-0)

Pre-requisites: CHL761

Particle size distribution, Crystal size distribution, Comminution processes and other particulate processes, Representation of distribution, Properties of distributions, Particle phase space, Population fluxes distributions, Particle phase space, Population fluxes-convections, Birth and death, Particle number continuity equation, Population balance over a macroscopic external coordinate region, Moment transformation of population balance over a macroscopic external coordinate region, Macro-moment equations, Recovery of particle size distribution function, Steady state MSMPR crystalliser, Significance of distribution representation, Exponential distribution, Mass Balance, Dynamic population balance, CSD transients, Transient moment equations, Transient size distribution by method of characteristics, Stability of CSD, Crystallisation kinetics, Nucleation, Crystal growth, Comminuton Processes, Microbial population, Residence-time distribution, Dispersed-phase mixing.

CHL813 Thermodynamics and Process Design

3 credits (2-0-2)

Pre-requisites: CHL701

Thermophysical properties of pure fluids, Equilibrium properties such as vapour pressure, latent heats, critical constants and PVT behaviour, Transport properties such as viscosity, thermal conductivity and diffusivity, estimation and correlation methods, Properties of multicomponent systems, V-L-E using equations of state and group contribution methods, L-L-E correlation and prediction, Homogeneous and heterogeneous chemical equilibria with competing chemical reactions.

CHL830 Advanced Computational Techniques in Chemical Engineering

3 credits (2-0-2)

Pre-requisites: CHL711

Introduction, Review of fundamental conservation equations for momentum, heat and mass transport. Formulation of problems in steady state. Weighted residual methods: orthogonal collocation, Galerkin finite element, Fourier collocation. Application to reaction-diffusion in porous catalysts pellets. The non-isothermal situation. Calculation of effectiveness factor. Application in micro-fluid mechanics-particle capture efficiency in suspension flows. Moving boundary problems. Transient problems leading to PDEs. Examples in heat and mass transfer and their numerical solution. The MonteCarlo method and its diverse applications. Computational laboratory exercises.

CHL864 Applications of AI and ANN in Chemical Engineering

4 credits (3-0-2)

Pre-requisites: EEL758

AI and Chemical Engineering, Expert System and Chemical Engineering-CONPHYDE and OPS5, KBS for Process Synthesis and Design, Design problem solving (Exsep), Product design methodologies – polymeric composites, molecules, developing design support environment, Process plant diagnosis and safety analysis (Falcon), Expert system tools and shells for Chemical Engineering – critical evaluation of KBES tools such as KEE, ART, INSIGHT2 +, NEXPERT, etc. from the perspective of Chemical Engineers.

CHL869 Applications of Computational Fluid Dynamics

3 credits (2-0-2)

Pre-requisites: CHL768

Brief review of CFD for single phase flows; Solution of scalar equations – heat and mass transfer; Application to heat exchanger and stirred tank flows; CFD for multiphase systems

– Lagrange-Euler and Euler – Euler approaches; Multiphase models – granular kinetic theory; Reaction modeling; Volume of Fluid (VOF) method for two-phase flow with interfaces; Current status of multiphase flow simulation in various chemical process equipment—bubble column, phase separator, packed bed, fluidized bed, polymerization reactor, cyclones etc.

CHN110 Introduction to Chemical Engineering
2 credits (0-0-4)
Presentations, discussions, demonstrations, literature survey and industrial visit related to different aspects of chemical engineering and its applications in energy, security, food, textiles, habitat, health and hygiene, body care and cosmetics, information and entertainment technology and environmental care.

CHP301 Fluid Mechanics and Heat Transfer Laboratory
1.5 credits (0-0-3)
Pre-requisites: CHL231
Overlaps with: CHP304
Selected experiments in fluid mechanics (e.g. Flow Visualisation, Flow through a converging-diverging duct, Free jets through nozzles and orifices, Flow over a notch or weir, Fully developed flow through pipes, Performance characteristics of a centrifugal pump) and heat transfer (e.g. Shell and tube heat exchanger, Double pipe heat exchanger, Thermal conductivity of metal bar, Heat transfer through forced convection and natural convection).

CHP302 Mass Transfer and Fluid Particle Mechanics Laboratory
1.5 credits (0-0-3)
Pre-requisites: CHL251
Overlaps with: CHP304, CHP305
Selected experiments in (a) mass transfer - batch distillation, diffusion effects, batch drier, absorber, cooling tower performance; and (b) particle mechanics - fluidization, packed bed, particle drag, mill operations, cyclone performance, grinding operations.

CHP303 Chemical Reaction Engineering and Process Control Laboratory
1.5 credits (0-0-3)
Pre-requisites: CHL122 & CHL261
Overlaps with: CHP305
Practicals in reaction engineering and process control and instrumentation.

CHP304 Chemical Engineering Laboratory - I
1.5 credits (0-0-3)
Pre-requisites: CHL203
Overlaps with: CHP301, CHP302
Experiments in fluid mechanics, fluid-particle mechanics and heat transfer.

CHP305 Chemical Engineering Laboratory - II
1.5 credits (0-0-3)
Pre-requisites: CHL103 & CHL204
Overlaps with: CHP302, CHP303
Experiments in mass transfer, thermodynamics and reaction engineering.

CHP311 Design and Laboratory Practices
2 credits (0-0-4)
Pre-requisites: CHL231 & CHL251
Preparation of fabrication drawings and testing of fabricated laboratory equipment. Piping connections. Study and use of various valves and fittings.

CHP711 Process Development Laboratory
3 credits (0-0-6)
Pre-requisites: CHL221 & CHL352
Selection of a problem. Definition of the problem. Literature Search. Design of an experimental program. Fabrication of necessary equipment. Operation of the equipment. Interpretation of data, report writing and oral defence. Measurements, and interpretation of data.

CHP754 Applications of Simulation Software
2 credits (1-0-2)
Pre-requisites: CHL351 & CHL121 & CHL111
Introduction to simulation software packages - PROII, Aspen Plus, HEXTRAN, Data reconciliation. Techniques of solving recycle flow problems. Techniques Dynamic simulation. Practice sessions with 'Simsci' and Aspen Plus software for steady state simulation of chemical plants.

CHR310 Professional Practices (CH)
2 credits (0-1-2)
Pre-requisites: EC 60
Lectures on recent developments in chemical engineering by faculty and executives from industry. Visits to industry to observe and study various chemical operations.

CHS310 Independent Study (CH)
3 credits (0-3-0)
Pre-requisites: EC 60
Research oriented activities or study of subjects outside regular course offerings under the guidance of a faculty member. Prior to the registration, a detailed plan of work should be submitted by the student to the Head of Department for approval.

CHT410 Practical Training (CH)
Non credit
Pre-requisites: EC 90 at the end of 5th sem.
Observation of operating chemical plants. Noting down operating procedures, construction details, management procedures. Doing a Project related to the selected industry.

Department of Chemistry

CYL110 Physical Chemistry: Concepts and Applications

4 credits (3-1-0)

(i) Chemical thermodynamics – Free energy and entropy changes in chemical processes, Phase rule and phase equilibria, Equilibrium electrochemistry. (ii) Quantum mechanical principles of structure and bonding in molecules and thermodynamic connection. (iii) Chemical dynamics – Reaction rates, Homogeneous and heterogeneous catalysis.

CYL120 Inorganic and Organic Chemistry: Concepts and Applications

4 credits (3-1-0)

Inorganic Chemistry:

(i) Transition metal complexes: Crystal field theory, basic concepts, crystal field effects in linear (ML2), tetrahedral, square planar (ML4) and octahedral geometry (ML6), pairing energies, weak field and strong field case, crystal field stabilization energy, factors affecting magnitude of 10Dq, high and low spin complexes, evidences for crystal field stabilization, tetragonal distortions from octahedral geometry, electronic spectra and magnetism.

(ii) Organometallics: EAN rule, metal carbonyls – synthesis, bonding and structure, metallocenes – synthesis and properties, Homogeneous and heterogeneous catalysis.

(iii) Bioinorganic chemistry: Metalloporphyrins, metalloproteins, hemoglobin and myoglobin – structure and function.

(iv) Inorganic solids: Structures and applications. Layered solids, Zeolites, magnetic and electronic properties of inorganic solids.

Organic Chemistry:

(i) Structure and Stereoisomerism: Conjugation and aromaticity, stereoisomerism, structural representation of stereoisomers, IUPAC conventions for optical and geometrical isomers. Conformations and conformational analysis - linear and cyclic compounds. Resolution of racemates - chemical and enzymatic methods.

(ii) Reactivity of molecules: Acids and bases. Factors influencing their relative strengths. Free energy criteria for reactivity. Kinetic and thermodynamic criteria for chemical reactions. Hammond's postulate and reaction coordinate - potential energy profiles. Kinetic vs. thermodynamic control of reactions. Determination of reaction mechanisms.

(iii) Applications: Formation, stability and aplication of reactive intermediates. Use of reactive intermediates in the design of synthesis of simple organic compounds.

CYL210 Applied Chemistry: Chemistry at Interfaces

6 credits (3-1-3)

Pre-requisites: CYP100 & CYL120

Unit processes in organic synthesis. Laboratory vs. industrial synthesis. Role of medium in directing synthetic outcomes, organised media. Natural and synthetic constrained systems (inorganic and organic) for control of reactivity in organic reactions. Phase transfer catalysis, polymer and other supported reagents for control of reactions. Green chemistry. Heterogeneous and homogeneous catalysis, surface chemistry, kinetics of catalysed reactions. Industrial catalysts.

CYL230 Polymer Chemistry

3 credits (2-1-0)

Pre-requisites: CYL120

Classification of polymers, Molecular weights, Chemical structure and morphology, Kinetics and mechanism of chain growth and step growth polymerisation. Fibre forming polymers. Epoxy and Phenolic Resins. Copolymerization, techniques of polymerization. Stereoregular polymerization.

CYL250 Special Topics in Organic Chemistry

4 credits (3-1-0)

Pre-requisites: CYL120

Structure - activity relationships in simple organic molecules. Strategies for carbon-carbon bond formation. Dienes, Polyenes and Pericyclic reactivity. Free radical reactions. Heterocyclic chemistry, Organometallic chemistry, Natural Product chemistry: Carbohydrates, Nucleic Acids, Lipids, Aminoacids and Proteins.

CYL330 Chemistry of High Temperature Materials

4 credits (3-1-0)

Pre-requisites: CYL120 and EC 60

Synthesis of molecular, non-molecular and composite materials. Physico-chemical characterization of materials; structure-property relationship among materials; Application in refractory catalysis, sensors, semiconductors and superconductors.

CYL340 Supramolecular Chemistry

4 credits (3-1-0)

Pre-requisites: CYL120 and EC 60

Chemistry beyond the molecule. Supramolecular, chemical and biochemical recognition, biomodels, molecular organization and aggregation, organized media and its use in developing new technologies. Host guest chemistry with cations and anions, clatherates, liquid crystals, use of weak interaction-weak bonds for obtaining new materials and molecular catalysis, membrane mimetic chemistry and technologies, purpose linked molecular design and devices.

CYL410 Computational Methods and Analysis

3 credits (3-0-0)

Pre-requisites: CYL110 and EC 90

Structure, dynamics and equilibrium; Monte Carlo method, Brownian dynamics and molecular dynamics. Simple and associated liquids, aqueous solutions, colloids and simple polymers. Electronic Structure Calculations; Matrix methods for many particle Schrodinger equation, combining molecular dynamics methods with electronic structure calculations and quantum Monte Carlo etc. The systems to be considered as molecules, metals and semiconductors. Special methods for macromolecular systems; Energy minimization in multi-dimensions, visualization (exploration of steric and electrostatic complementarities) on systems such as biomolecules (protein and nucleic acids), Complex polymers. Zeolities. Implementation of all the above methods on computers.

CYP100 Chemistry Laboratory

2 credits (0-0-4)

An integrated laboratory course consisting of 12-14 experiments from physical, inorganic and organic chemistry. The course exposes the student to inorganic and organic synthesis as well as basic quantitative and qualitative analysis and is designed to illustrate the underlying principles of chemical and electro-analytical techniques, dynamics and chemical transformations. The following topics will be involved: Titrimetry, Surface tension and viscosity, Potentiometry, Conductometry, Preparations of metal complexes, Kinetic experiments, Thermo-chemical measurements, Quantitative estimation of organic compounds.

Department of Civil Engineering

CEC410 Colloquium (CE)
3 credits (0-3-0)
Pre-requisites: registered for CET410

Presentation by each student on his/her practical training and other topics specified by the course coordinator.

CED310 Mini Project (CE)
3 credits (0-0-6)
Pre-requisites: EC 80

Design/fabrication/implementation work under the guidance of a faculty member. Prior to registration, a detailed plan of work should be submitted by the student to the Head of the Department for approval.

CED411 Major Project Part 1 (CE)
3 credits (0-0-6)
Pre-requisites: EC 120

To set the objectives, deliverables, work plan, logistics planning and milestones with discernible outputs and then to demonstrate the feasibility through some initial work.

CED412 Major Project Part 2 (CE)
7 credits (0-0-14)
Pre-requisites: CED411

Preferably continuation of the topic of CED411.

CEL100 Earth and Earth Processes
3 credits (3-0-0)

Environmental crisis, Earth as a closed system, Limitations of earth resources. Earth resources: Geologic Cycle, Minerals, Rocks, Soils, Water, Wind and Ice. Hazardous processes and mitigation: River flooding and fluvial processes, Volcanic activity, Earthquakes and related phenomena including seismic microzonation, Mass movements and land slides, Marine activity and coastal erosion. Soil resources: Problematic soils, Regional distribution, Erosion, Contamination of soils and ground water and remediation, Land reclamation. Rock-masses and stability: In-situ stresses, Discontinuities, Weathering, Tunnel collapses and Rock bursts. Mining and impact: Blasting, Subsidence, Mine fills and wastes. Waste disposal: Nuclear waste repositories. Land evaluation.

CEL110 Basic Concepts in Sustainable Development
4 credits (3-1-0)

Introduction; Basic characteristics of pollution and receiving environment; Concepts in sustainability; Contaminants and fate of contaminants; Noise Pollution, Sustainability and Bioenvironment, ISO 14000 Series.

CEL120 Pollution Prevention and Control
3 credits (3-0-0)

Legislative Framework for Environmental Management; Introduction to pollution: Sources, types, characteristics and impacts. Prevention versus control of pollution: Environmentally sound technology management; Tools for clean production: reuse, recycle, recovery, source reduction, raw material substitution, toxic use reduction and process modifications. Voluntary environmental programs: life cycle analysis; environmental cost accounting; use of a business-friendly, prevention-based approach; and the measurement of environmental performance, EIA.

Urbanization and Sustainability, Environmental consequences of personal choices and examples of social marketing of more environmentally responsible consumption; Public Participation: Structure, Processes and Trends; Conflict Resolution.

CEL212 Environmental Engineering
4 credits (3-0-2)
Pre-requisites: CEN110

Water supply: Sources, Water demand and forecasting. Quality of water, water borne diseases, standards, water quality index. Unit Processes: Systems and unit processes of water purification. Water distribution networks. Wastewater Engineering: Systems of sanitation, wastewater flows, Collection and conveyance of wastewater, layout systems. Characteristics and microbiology of wastewater. BOD kinetics. Disposal of treated wastewater on land and in water. Unit processes for wastewater treatment.

Sludge management, introduction to solids and hazardous waste management, air and noise pollution and control.

CEL222 Engineering Geology and Soil Mechanics
5.5 credits (3-1-3)
Pre-requisites: AML110 & CEN110

Engineering Geology: Introduction; Dynamic Earth; Materials of Earth; Silicate Structures and Symmetry Elements; Formations of Rocks; Characterisation; Weathering Processes; Geological Work – Landforms; Formation of Soils; Geological Time Scale; Structural Features; Tectonics; Stress Distribution; Earthquakes; Geological Maps and Air Photos; Ground Water. Soil Mechanics: Origin and Classification of Soils; Phase Relationships; Effective Stress Principle; Effective Stress Under Hydrostatic and 1D flow; Permeability; Compressibility; Consolidation; Terzaghi's 1D Consolidation Theory; Shear Strength; Drainage Conditions; Pore Water Pressure; Mohr's Circle; Failure Envelope and Strength Parameters; Factors Affecting Shear Strength.

Laboratory: Geological Mapping – contouring, topo sheets, outcrops, apparent and true dips, three point problems, depth, thickness, joints, faults; Megascopic and Microscopic identification of Minerals and Rocks. Visual Soil Classification; Water Content; Atterberg Limits; Grain Size Analysis; Specific Gravity; Permeability; Introduction to consolidation and strength apparatus.

Guided tour through representative geological formations and structures.

CEL231 Structural Analysis – I
5 credits (3-1-2)
Pre-requisites: AML110

Introduction to structures, loading and modelling. Internal forces in statically determinate structures – plane and space trusses, beams, frames, arches and cables. Deflection of statically determinate structures – moment area method, conjugate beam method, virtual work method. Static and Kinematic indeterminacy of structures. Force method of analysis of indeterminate structures including temperature changes and lack of fit. Analysis of rolling loads. Influence lines for statically determinate and indeterminate structures.

CEL232 Concrete Material and Design
6 credits (3-1-4)
Pre-requisites: AML110 / AML120

Chemistry: properties and types of cement:; Properties of aggregates and fresh concrete; Concrete Mix Design; Properties of hardened concrete; Reinforcing steel. Design Philosophy: Working stress and limit state design concepts; Design of R.C. beam Sections in flexure, shear, torsion and bond; Design for serviceability; Design of R.C. beams; Design of one way and two way R.C. Slabs; Design of R.C. short and long columns; Design of R.C. footings.

CEL241 Transportation Engineering – I
4 credits (3-0-2)
Pre-requisites: CEN110

Transportation Systems and their classification and description. Role of Roads, Road Transport and Planning in India. Road User and the Vehicle. Geometric Design: Horizontal Alignment, Vertical Alignment, Cross-section Elements. Highway Project Preparation: Surveys and Investigations. Pavements: Types of Pavements, Flexible and Rigid pavement Analysis and Design, Overlay Design. Road Construction Materials. Highway Maintenance. Traffic Engineering: Traffic Characteristics, Fundamental relationships, theories of traffic flow, shock waves, intersection design and traffic signs and signals - design, Highway Capacity.

CEL251 Hydrology and Hydraulics
6 credits (3-1-4)
Pre-requisites: CEN110 & AML110

Open Channel Flow: Channel Characteristics and parameters, Uniform flow, Critical flow, Specific Energy concepts, Gradually Varied Flows, Rapidly Varied flow with special reference to hydraulic jump.

Boundary Layer Theory:Navier Stokes Equation, Boundary Layer Equation in 2-dimensions, Boundary layer characteristics, Integral Momentum equation, onset of turbulence, properties of turbulent flow, skin friction, drag, lift and circulation. Pipe Flow: Laminar and Turbulent flow in Smooth and Rough pipes, pipe network analysis, Losses in pipes.

Hydrologic Cycle, Processes and Applied Methodologies: Rainfall, Evapotranspiration, Infiltration, Streamflow; Unit Hydrographs, Flood Routing and Frequency Analysis; Occurrence of Groundwater and Groundwater Flow.

CEL271 Elements of Surveying
3 credits (2-0-2)
Pre-requisites: CEN110

Introduction to Surveying, Instruments of Leveling, Theodolites and Plane-tables. Measurement of Distances, directions and elevations by different methods. Traversing. Vertical control, Precise leveling, Trigonometric leveling. Mapping of details and contouring. Measurement of areas, volumes. Application of above measurements in quantity computations. Errors of measurements and their adjustments. Curve setting: simple circular curves, compound and reverse curves. Introduction to GPS, Differential GPS.

CEL311 Advanced Water and Wastewater Engineering
4 credits (3-0-2)
Pre-requisites: CEL212

Water purification: Theory, operation and design: Settling tanks, tube settlers, Coagulation and flocculation - Orthokinetic and Perikinetic, Slow and rapid sand filters. Methods, Theory and application of disinfection: chlorine, ozone, UV, Solar etc. Adsorption kinetics in water treatment. Design of water treatment plants.

Wastewater characteristics, Wastewater Treatment: Theory, operation and design of aerobic (activated sludge and its variations, trickling filter, RBC and Oxidation ponds and ditches), anaerobic (anaerobic digestion, UASBR, anaerobic filter, lagoons); Secondary settling tanks. Tertiary wastewater treatment: Removal of N, P, K and other trace elements. Sludge treatment and disposal. Design of wastewater treatment plants. Advanced wastewater treatment systems: Root zone technology, wetlands, Duckweeds, Membrane processes (RO, Ultra and Nano filtration, Ion Exchange). Centralized vs decentralized systems, low cost water and wastewater systems. Disposal of treated wastewater: Inland surface water, land for irrigation, marine coastal areas.

CEL321 Geotechnical Engineering
5.5 credits (3-1-3)
Pre-requisites: CEL222

Soils of India; Engineering properties of Natural and Compacted Soils; Flow Through Soils – Laplace equation, flownets, seepage; Site Investigations; Foundations – types, selection, design considerations, bearing capacity and settlement of shallow foundations; deep foundations; Slope Stability Analysis; Earth Dams – types and design aspects; Earth Pressures and Retaining Structures; Engineering Properties of Rocks; Rock as Construction Material; Geological Site Criteria for Tunnels and Underground Structures, Dams, Rock Slopes and Landslides.Laboratory: Compaction, consolidation, sample preparation, vane shear test, direct shear test, unconfined compression test, unconsolidated undrained test, consolidated drained test, consolidated undrained test with pore water pressure measurement, direct shear test, drilling and sampling, field density, engineering properties of rocks, refraction and resistivity methods.

CEL326 Geo-environmental Engineering
3 credits (3-0-0)
Pre-requisites: EC 60

Sources of subsurface contamination and their effects; types of waste; integrated management of waste; transportation and disposal of solid waste on land; types of soils, permeability of soils, flow through soils, soil-waste interaction; ground water contamination.

Waste containment principles; environmental control through liners, covers, leachate management and gas management; waste disposal in municipal solid waste landfills and in hazardous waste landfills.

Waste disposal of coal-ash and mine tailings in ponds and mounds, of very hazardous waste in rocks; detection and monitoring of subsurface contamination; contaminated site characterization; control and remedial measures for contaminated sites; pollution control regulations.

CEL331 Structural Analysis – II
5 credits (3-1-2)
Pre-requisites: CEL231

Development of Slope-Deflection Equations of Equilibrium: Applications to Beams, frames undergoing user support settlement; Development of Moment Distribution Method; Distribution Factors; Application to Beams and Frames without side sway; Application to Frames with side sway; Beams and Frames with uneven loading; Support Settlement; Cases of Symmetry and anti symmetry; Strain energy method of analysis; Introduction to nature methods of analysis; Flexibility Method; Stiffness method; Direct Stiffness Methods for computer Application; Introduction to computer Software for Analysis.

CEL332 Design of Steel Structures
5 credits (3-1-2)
Pre-requisites: CEL231

Introduction to stability and buckling concepts; Structural steel and properties; Riveted, bolted and welded connections; Working stress and plastic design Methods; Design of tension, compression and flexural members (including built-up members); Column bases; Roof trusses.

CEL338 Infrastructure Planning and Management
3 credits (3-0-0)
Pre-requisites: EC 60

Overview of the course, Infrastructure's impact on development of a country, Status of various sectors in Indian Infrastructure, Infrastructure Financing, Private Sector participation in infrastructure models, Basics of infrastructure planning, Problems in Infrastructure Development and Management.

CEL339 Concrete Technology and Materials
3 credits (3-0-0)
Pre-requisites: EC 60

Cement Hydration: Cement Types, Paste Micro-structure; Workability; Durability; Factors affecting strength of concrete, Quality control; Concrete mix design; Types of concrete; Concrete production; Tests of concrete in structures; Failure criteria; Fracture mechanics; Hardening plasticity and fatigue; Creep and shrinkage; Fresh concrete modelling; Moisture/Ionic diffusion in concrete.

CEL341 Transportation Engineering – II
4 credits (3-1-0)
Pre-requisites: CEL241 and EC 60

Design of transportation facilities. (i) Rail Transport: location and route layout, section signals and intersections, earth work and pavement (track, stops, terminals, yard, parking etc.). (ii) Airports: Layout plan, terminal area, interconnection with other modes of transport, runways, circulation patterns, traffic controllers. (iii) Ports and other transport technology: planning principles, operational requirements, Meglev, Hydrofoil, pipeline, etc. (iv) Transport Structure: FOBs, underground and multistoreyed parking, ramps, escalators, elevators, etc.

CEL351 Design of Hydraulic Structures
3 credits (2-0-2)
Pre-requisites: CEL251

Input studies, canal layout, regime canal design, design concepts for irrigation structures on permeable foundations, energy dissipation devices, design of diversion works, gravity dam, cross drainage works, canal falls.

CEL362 Construction Management
4 credits (3-1-0)
Pre-requisites: EC 60

Overview of the course, Linear programming, Problems in construction, Formulation, Graphical solution, Simplex method, Dual problem, sensitivity analysis and their application to Civil engineering, Transportation Assignment problems and their applications, Building Specifications, estimation and rate analysis. Project planning and network analysis, Time and cost control, Resource scheduling.

CEL411 Industrial Waste Management
3 credits (3-0-0)
Pre-requisites: EC 90

Nature and characteristics of industrial wastes; Control and removal of specific pollutants in industrial wastewaters, i.e., oil and grease, cyanide, fluoride, toxic organics, heavy metals. Recent trends in industrial waste management.

Prevention versus control of industrial pollution; Linkage between technology and pollution prevention; Tools for clean production, reuse, recycle, recovery, source reduction, raw material substitution, toxic use reduction and process modifications.

Point, and area source: dispersion modelling of industrial air pollutants. Source reduction and control of industrial air pollution; Minimization of industrial solid and hazardous waste.

Waste management case studies from various industries.

CEL412 Environmental Assessment Methodologies
3 credits (3-0-0)
Pre-requisites: EC 90

Environmental issues related to developmental activities: Nature and characteristics of environmental impacts of urban and industrial developments. Linkages between technology, environmental quality, economic gain, and societal goals. Environmental indices and indicators for describing affected environment. Methodologies and environmental systems modelling tools for prediction and assessment of impacts on environmental quality (surface water, ground water, air, soil). Monitoring and control of undesirable environmental implications. Environmental cost benefit analysis. Decision methods for evaluation of environmentally sound alternatives.

Environmental health and safety: Basic concepts of environmental risk and definitions; Hazard identification procedures; Consequence analysis and modelling (discharge models, dispersion models, fire and explosion models, effect models etc.).

Emerging tools for environmental management: Environmental Management Systems, Environmentally sound technology transfer, emission trading, international resource sharing issues, climate change, international environmental treaties and protocols. Case studies.

CEL421 Ground Improvement
4 credits (3-0-2)
Pre-requisites: CEL321

Compaction methods used in the laboratory and the field; shallow stabilization with cement, lime, flyash and other chemical admixtures; deep stabilization using vibroflotation, compaction piles, dynamic compaction, blasting, sand drains, stone columns, lime and cement columns.

Grouting by permeation, displacement and jet methods; functions and applications of geosynthetics – geotextiles, geogrids, geomembranes; soil reinforcement using strips, bars and geosynthetics; soil nailing and ground anchors; dewatering techniques.

Earthmoving machines and earthwork principles; piling and diaphram wall construction; tunneling methods in soils; hydraulic barriers and containment systems for waste disposal in soils; control and remediation of soil contamination.

Laboratory : Lab compaction methods – light, heavy, kneading, vibratory- for soils and soils with admixtures; plasticity and undrained strength behaviour of compacted and stabilized clays; drained strength behaviour of compacted / stabilized sands.

CEL422 Rock Engineering
3 credits (3-0-0)
Pre-requisites: CEL321
Overlaps with: CEL651

Geological classification, rock and rock mass classification, strength and deformation behaviour of rocks, pore pressures, failure criteria, laboratory and field testing, measurement of in-situ stresses and strains, stability of rock slopes and foundations, design of underground structures, improvement of in situ properties of rock masses.

CEL423 Designs of Foundation, Earth and Earth Retaining Structures
4 credits (3-1-0)
Pre-requisites: CEL321
Overlaps with: CEL610, CEL704, CEL708

Shallow Foundations: Bearing Capacity: Bearing failure, Terminology; Empirical methods, Generalized bearing capacity

theory, Layered soil, Foundations on or near slopes, Limit state design principles.

Deep Foundations: Pile Foundations: Types and their selection, Ultimate load of individual piles in compressive, uplift, and lateral loading, Pile load tests, Downdrag, Pile groups. Caissons.

Machine Foundations: Principles of vibrations, Types of machine foundations, Design criteria, Design of block foundations.

Earth Dams: Components, Factors influencing design, Design of components.

Earth Retaining Structures: Types, Earth pressure, Design of rigid, flexible and reinforced soil retaining walls, and braced excavations.

CEL431 Advanced Structural Analysis
3 credits (2-0-2)
Pre-requisites: CEL331

Introduction to FEM for structural analysis with review of energy methods –2D plane stress and plane strain elements, beam element, 2D bending element, example problems, elements of structural dynamics- free and forced vibration of SDOF system, treatment of impact and arbitrary loading, frequency and time domain analysis; free vibration mode ships and frequencies of MDOF systems; normal mode theory for forced vibration analysis of MDOF system; example problems. Elements of plastic analysis; upper and lower bound theorems; method of collapse mechanism; application to beams and multistory frames; example problems.

CEL432 Design of Prestressed Concrete and Industrial Structures
4 credits (3-0-2)
Pre-requisites: CEL232 & CEL331

Prestressed Concrete Structures – Fundamentals of prestressing, Prestressing technology, Analysis of prestressed members, Prestress losses, Design for Flexure, Design for shear and torsion, Design of anchorage Zones in post-tensioned members. Industrial Structures- Analysis and design of Cylindrical shell structures, Folded plates, Chimneys, Silos, Bunkers.

CEL433 Advanced Structural Design
4 credits (3-0-2)
Pre-requisites: CEL232 & CEL332

Design of Reinforced Cement concrete (RCC) Structures – Building frames, Liquid retaining structures, Earth retaining walls, Flat slabs, Staircases.Design of Steel Structures – Plate girders, gantry girders and steel bridge components.

CEL442 Traffic and Transportation Planning
3 credits (2-1-0)
Pre-requisites: CEL241 and EC 90

Transportation Engineering System, Random utility theory, Supply and demand, Flow estimation and modelling, Planning and engineering evaluation, Transportation engineering management, Traffic flow theory and management, Air and water navigational control, Rehabilitation and satellite area accessibility, Network and graph theory application.

CEL443 Transportation Safety and Environment
3 credits (3-0-0)
Pre-requisites: EC 90

Multidisciplinary approach to planning for traffic safety and injury control; precrash, crash and post crash models; roles of vehicle, roadway, traffic, driver, and environment, crash and injury causations; Mixed traffic flow; Transport related pollution; Technology Vision-2020; Urban and non-urban traffic noise sources, Noise level factors, Noise pollution; Energy related aspects of different transport technologies. Road transport related air pollution, Sources of air pollution, effects of weather conditions; Vehicular emission parameters, pollution standards, measurement and analysis of vehicular emission; Mitigative measures; EIA requirements of Highway projects, procedure; MOEF/World Bank/RC/UK guidelines; EIA practices in India.

CEL450 Introduction to Remote Sensing
3 credits (2-0-2)
Pre-requisites: EC 90

What is Remote Sensing? Historical development of remote sensing, Remote sensing components, Data collection and transmission, Sensors and satellite imageries, Electromagnetic energy and spectrum, Wavebands, Interactions of electromagnetic energy with atmosphere and earth's surface, radiometric quantities, Photogrammetry and aerial photography, Vertical and tilted photographs, Photographic materials, Photo-processes, Stereoscopic viewing, Fly view, Aerial mosaics, Various satellite systems and monitoring programs, Data Products, Satellite data, Data formats, Data acquisition for natural resources management and weather forecast, Random errors and least square adjustment, Coordinate transformation, Photographic interpretation, Image processing, Potential applications of remote sensing in diverse areas and decision making, Integrated use of remote sensing and GIS, Case studies.

CEL451 Water Power Engineering
4 credits (3-0-2)
Pre-requisites: CEL251 and EC 90

Basic principle of hydropower generation, Hydropower Project Planning, Site selection, Hydropower development schemes, Reservoir storage, Assessment of power potential, Hydrologic analysis: Flow duration and power duration curves, Dependable flow, Design flood, Reservoir operation; Hydraulic design of various components of hydropower plants: intakes, hydraulic turbines, centrifugal and axial flow pumps, conduits and water conveyance..

Penstocks; Performance characteristics of turbines, Specific and unit quantities, Electrical load on hydro-turbines, Power house dimension and planning, Water hammer and surge analysis, Surge tanks, Small hydro power development, tidal plants, Current scenarios in hydropower development, Project feasibility, Impact of hydropower development on water resources systems, environment, socioeconomic conditions and national economy.

CEL453 Water Resources Management
4 credits (3-1-0)
Pre-requisites: CEL251 and EC 90

Scope of Water Resources Management, Global Trends in Water Utilization, Crop Water Requirements and Irrigation Planning, Modern Irrigation methods such as Sprinkler and Drip Irrigation, Soil Salinity and Water Logging Hazard Mitigation, Drainage Design, Hydropower Systems Management, Economic Analysis of water Resources Projects, Flood Control studies.

CEL455 Introduction to Geographic Information Systems
3 credits (2-0-2)
Pre-requisites: EC 90
Overlaps with: CEL747

What is GIS. Geographic concepts for GIS. Spatial

relationships, topology, spatial patterns, spatial interpolation. Data storage, data structure, non-spatial database models. Populating GIS, digitizing data exchange, data conversion. Spatial data models, Raster and Vector data structures and algorithms. Digital Elevation Models (DEM) and their application. Triangulated Irregular Network (TIN) model. GIS application areas, Spatial analysis, quantifying relationships, spatial statistics, spatial search. Decision making in GIS context.

CEL459 River Mechanics

3 credits (2-0-2)

Pre-requisites: CEL251 and EC 90

Introduction, river morpohology, drainage patterns, stream order. Properties of mixture of sediment and water, Incipient motion and quantitative approach to incipient motion, channel degradation and armoring. Bed forms and resistance to flow, various approaches for bed load transport, suspended load profile and suspended load equations, total load transport including total load transport equations. Comparison and evaluation of sediment transport equations. Stable channel design with critical tractive force theory.

CEL464 Construction Contract and Economics

3 credits (2-1-0)

Pre-requisites: EC 90

Overview of the course, Engineering economics of the projects, Time value of money, comparison of alternatives, Depreciation and depletion, Quantity surveying, Direct and indirect costs, Professional agreements; Contracts and specification; Disputes, Arbitration and other methods of dispute resolution. Bidding and bidding models.

CEL466 Construction Equipment and Methods

3 credits (2-1-0)

Pre-requisites: EC 90

Overview of the course; Basic principles of construction, selection and economy; General construction equipment – excavation, earthmoving, drilling, blasting, dewatering, shoring, strutting, disposal and underpinning, well sinking and pile driving, heavy lifting; Operations and maintenance of equipment, Productivity estimates, Cycle time, Planning and scheduling of equipment by networks, Formworks and scaffolding, Concrete construction practices. Prefabrication and modular coordination; Steel construction, special constructions such dams, bridges, high rise buildings, offshore platforms.

CEN110 Introduction to Civil Engineering

2 credits (0-0-4)

Introductory lectures, demonstrations, field visits on activities of department and the Civil Engineering Profession.

CEP200 Design Concepts in Civil Engineering

2 credits (0-0-4)

Pre-requisites: CEN110

Design concepts in Structural Engineering, Design concepts in Water Resources Engineering, Design Concepts in Transportation Engineering, Design Concepts in Environmental Engineering, Design concepts in Geotechnical Engineering.

CEP452 Computational Aspects in Water Resources

3 credits (1-0-4)

Pre-requisites: CEL251 and EC 90

Numerical Interpolation and Integration and application of water resource problems. Numerical solution of differential equations in water resources, such as, groundwater flow, pipe flows, open channel flows.

CET410 Practical Training (CE)

Non credit

Pre-requisites: EC 90 at the end of 5th sem.

Practical Training of 50 working days in an Indian industry or R&D organization.

Department of Computer Science and Engineering

CSC410 Colloquium (CS)
3 credits (0-3-0)
Pre-requisites: Registered for CST410

The students will deliver talks on their experience during the 50 working days of practical training, and topics of current interest in the computer science and engineering field. These would include technology, research as well standards issues.

CSD310 Mini Project (CS)
3 credits (0-0-6)
Pre-requisites: EC 80

Design/fabrication/implementation work under the guidance of a faculty member. Prior to registration, a detailed plan of work should be submitted by the student to the Head of the Department for approval.

CSD411 Major Project Part 1 (CS)
4 credits (0-0-8)
Pre-requisites: EC 120

This project spans also the course CSD412. Hence it is expected that the problem specification and the milestones to be achieved in solving the problem are clearly specified.

CSD412 Major Project Part 2 (CS)
8 credits (0-0-16)
Pre-requisites: CSD411

The student(s) who work on a project are expected to work towards the goals and milestones set in CSD411. At the end there would be a demonstration of the solution and possible future work on the same problem. A dissertation outlining the entire problem, including a survey of literature and the various results obtained along with their solutions is expected to be produced.

CSD750 Minor Project (CO)
4 credits (0-1-6)
Pre-requisites: EC 120

A semester-long project usually involving design and implementation under the guidance of any faculty member approved by the department, is undertaken by one or two students.

CSD851 Major Project Part 1 (CO)
6 credits (0-0-12)
Pre-requisites: EC 165
Overlaps with: CSD853

This project spans also the course CSD852. Hence it is expected that the problem specification and the milestones to be achieved in solving the problem are clearly specified.

CSD852 Major Project Part 2 (CO)
14 credits (0-0-28)
Pre-requisites: CSD851
Overlaps with: CSD854

The student(s) who work on a project are expected to work towards the goals and milestones set in CSD851. At the end there would be a demonstration of the solution and possible future work on the same problem. A dissertation outlining the entire problem, including a survey of literature and the various results obtained along with their solutions is expected to be produced by each student.

CSD853 Major Project Part 1 (CO)
4 credits (0-0-8)
Pre-requisites: EC 165
Overlaps with: CSD851

This project spans also the course CSD854. Hence it is expected that the problem specification and the milestones to be achieved in solving the problem are clearly specified.

CSD854 Major Project Part 2 (CO)
16 credits (0-0-32)
Pre-requisites: CSD853
Overlaps with: CSD852

The student(s) who work on a project are expected to work towards the goals and milestones set in CSD853. At the end there would be a demonstration of the solution and possible future work on the same problem. A dissertation outlining the entire problem, including a survey of literature and the various results obtained along with their solutions is expected to be produced by each student.

CSL101 Introduction to Computers and Programming
4 credits (3-0-2)
Overlaps with: CSL102

Concept of an algorithm: termination and correctness. Algorithms to programs: specification, top-down development and stepwise refinement. Use of high level programming language for the systematic development of programs. Introduction to the design and implementation of correct, efficient and maintainable programs. Introduction to computer architecture: memory, ALU, CPU, I/O devices. Introduction to system software; operating systems, compilers and multi-user environments.

CSL102 Introduction to Computer Science
4 credits (3-0-2)
Overlaps with: CSL101

Design of algorithms; iterative versus recursive style; problem solving using a functional style; correctness issues in programming; efficiency issues in programming; time and space measures; Imperative style of programming; Assertions and loop invariants; programming in an imperative language using advanced features: procedures, functions, list handling using references; file handling; objects and classes.

CSL105 Discrete Mathematical Structures
4 credits (3-1-0)
Overlaps with: MAL180

Fundamental structures: Functions (surjections, injections, inverses, composition); relations (reflexivity, symmetry, transitivity, equivalence relations); sets (Venn diagrams, complements, Cartesian products, power sets); pigeonhole principle; cardinality and countability. Basic logic: Propositional logic; logical connectives; truth tables; normal forms (conjunctive and disjunctive); validity; predicate logic; limitations of predicate logic; universal and existential quantification; modus ponens and modus tollens. 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 relations, generating functions.

CSL201 Data Structures
5 credits (3-0-4)
Pre-requisites: CSL101 / CSL102

Introduction to object-oriented programming through stacks, queues and linked lists. Dictionaries: skip-lists, hashing, analysis of collision resolution techniques. Trees, traversals, binary search trees, Balanced BST, 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 .

CSL211 Computer Architecture

5 credits (3-1-2)
Pre-requisites: (CSL101/CSL102) & (EEL201&EEP201) (Concurrent registration in EEL201&EEP201 is acceptable)
Overlaps with: EEL308, EEP308

Subsystems of a computer; Instructions and their formats; Assembly programming; Performance metrics; 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.

CSL302 Programming Languages

5 credits (3-0-4)
Pre-requisites: CSL201
Overlaps with: MAL375

Notions of syntax and semantics of programming languages; introduction to operational/natural semantics of functional and imperative languages. 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 languages.

CSL303 Logic for Computer Science

4 credits (3-0-2)
Pre-requisites: CSL201

Review of the principle of mathematical induction; the principle 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; Completeness of a deduction system; First order logic; Proof theory for FOL; introduction to model theory; Completeness and compactness theorems; First order theories. 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.

CSL316 Digital Hardware Design

5 credits (3-0-4)
Pre-requisites: CSL211 & EEL201 & EEP201
Overlaps with: EEL324

Combinational circuit design using MSI/LSI and programmable logic modules; Iterative and tree networks; Sequential circuit design and implementation; Algorithmic state machine design; Asynchronous and pulse mode circuit design; Hardware description language and synthesis; Microprogrammed control design; Testing of digital systems; Introduction to hardware-software codesign.

CSL332 Introduction to Database Systems

4.5 credits (3-0-3)
Pre-requisites: CSL201
Overlaps with: MAL710

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 Databases, Object Oriented Data Models.

CSL333 Artificial Intelligence

4 credits (3-0-2)
Pre-requisites: CSL201
Overlaps with: EEL758

Problem solving, search techniques, control strategies, game playing (minimax), 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, Boltzman machines. PROLOG programming.

CSL356 Analysis and Design of Algorithms

4 credits (3-1-0)
Pre-requisites: CSL201 & CSL105
Overlaps with: MAL342

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 Programming, Greedy algorithms, Divide and Conquer, Randomized 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.

CSL361 Numerical and Scientific Computing

5 credits (3-1-2)
Pre-requisites: CSL101 / CSL102 and EC 60
Overlaps with: MAL230, EPL333

Introduction to Scientific Computing, Review of matrices and linear systems, Linear Least Squares, Eigenvalue Problems, Nonlinear Equations. Optimization, Interpolation, Numerical Integration and Differentiation, 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 LINPACK, 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.

CSL362 Simulation and Modelling

4 credits (3-0-2)
Pre-requisites: CSL201 & MAL250

Fundamentals of modelling; Classification of simulation models; The simulation process: System investigation; model formulation, validation and translation; Time flow mechanisms; Design of computer simulation experiments; Simulation of complex discrete-event systems with applications in industrial and service organizations. Tactical planning and management aspects; Random variable generation and analysis.

CSL373 Operating Systems
5 credits (3-0-4)
Pre-requisites: CSL201 & CSL211 & CSL302
Overlaps with: CSL633, EEL358, MAL358

Overview: functions of Operating Systems, layered architecture; basic concept; interrupt architecture, system calls and notion of a 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.

CSL374 Computer Networks
4.5 credits (3-0-3)
Pre-requisites: EEL205 & CSL211 & CSL201
Overlaps with: EEL703

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.

CSL705 Theory of Computation
4 credits (3-1-0)
Pre-requisites: CSL105 & EC 90

Regular Languages, Finite Automata, equivalence, minimization, 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 RE sets 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.

CSL718 Architecture of High Performance Computers
4 credits (3-0-2)
Pre-requisites: CSL373

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 modelling; Issues in programming multiprocessors; Data parallel architectures.

CSL719 Synthesis of Digital Systems
4 credits (3-0-2)
Pre-requisites: CSL316

After a basic overview of the VLSI design flow, hardware modelling principles and hardware description using the VHDL language are covered. This is followed by a study of the major steps involved in behavioural synthesis: scheduling, allocation, and binding. This is followed by register-transfer level synthesis, which includes retiming and Finite State Machine encoding. Logic synthesis, consisting of combinational logic optimisation and technology mapping, is covered next. Popular chip architectures - standard cells and FPGA are introduced. The course concludes with a brief overview of layout synthesis topics: placement and routing.

CSL728 Compiler Design
4.5 credits (3-0-3)
Pre-requisites: CSL302 & CSL705
Overlaps with: EEL702

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

CSL740 Software Engineering
4 credits (3-0-2)
Pre-requisites: CSL201 & CSL302
Overlaps with: MAL745

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.

CSL750 Foundations of Automatic Verification
4 credits (3-0-2)
Pre-requisites: CSL302 & CSL705

A selection from the following topics, and experiments with the mentioned tools:

Review of first-order logic, syntax and semantics. Resolution theorem proving. Binary Decision Diagrams (BDDs) and their use in representing systems. (Programming exercises coding and using logic programming frameworks). Transition systems, automata and transducers. Buechi and other automata on infinite words; Linear Time Temporal Logic (LTL), and specifying properties of systems in LTL; the relationship between temporal logic and automata on infinite words, LTL Model checking (exercises using Spin or similar tools); Computational Tree Logic (CTL and CTL*); CTL model checking (exercises); Process calculi such as CSP and CCS. Notions of program equivalence — traces, bisimulation and other notions. Hennessy-Milner Logic (HML) and Mu calculus (exercises using tools such as CWB — Concurrency Work Bench). Symbolic model checking, exercises using tools such as SMV. Sat-based model checking and Davis-Putnam procedure; (exercises using tools such as nuSMV). Possible additional topics include: equational logic frameworks, real-time frameworks, reactive frameworks, pi-calculus (exercises using tools such as the Mobility Workbench), Tree automata and Weak Second-order Logic with k successors (WSkS), (exercises using Mona or similar tools).

CSL758 Advanced Algorithms
4 credits (3-1-0)
Pre-requisites: CSL356/CSL630
Overlaps with: MAL760

Topics from some or all of the following areas:

Advanced data structures: self-adjustment, persistence and multidimensional 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.

CSL771 Database Implementations
4 credits (3-0-2)
Pre-requisites: CSL332 & CSL201
Overlaps with: CSL630

Relational Algebra, Database Language SQL and System Aspects of SQL, 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 Data.

CSL781 Computer Graphics
4.5 credits (3-0-3)
Pre-requisites: CSL201 and EC 90
Overlaps with: MAL754, EEL754

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 surfaces, 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.

CSL783 Digital Image Analysis
4.5 credits (3-0-3)
Pre-requisites: EEL205 & CSL201 and EC 90
Overlaps with: MAL715, EEL715

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; Color 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 exercises will emphasize development and evaluation of image processing methods.

CSL812 System Level Design and Modelling
3 credits (3-0-0)
Pre-requisites: CSL719

Embedded systems and system-level design, models of computation, specification languages, hardware/software co-design, system partitioning, application specific processors and memory, low power design.

CSL821 Reconfigurable Computing
3 credits (3-0-0)
Pre-requisites: CSL316 and EC 120

FPGA architectures, CAD for FPGAs: overview, LUT mapping, timing analysis, placement and routing, Reconfigurable devices - from fine-grained to coarse-grained devices, Reconfiguration modes and multi-context devices, Dynamic reconfiguration, Compilation from high level languages, System level design for reconfigurable systems: heuristic temporal partitioning and ILP-based temporal partitioning, Behavioral synthesis, Reconfigurable example systems' tool chains.

CSL830 Distributed Computing
3 credits (3-0-0)
Pre-requisites: CSL303 & CSL373 & CSL705

Models of Distributed Computing; Basic Issues: Causality, Exclusion, Fairness, Independence, Consistency; Specification of Distributed Systems: Transition systems, petri nets, process algebra properties: Safety, Liveness, stability.

CSL831 Semantics of Programming Languages
3 credits (3-0-0)
Pre-requisites: CSL302 & CSL303 and EC 120

Study of operational, axiomatic and denotational semantics of procedural languages; semantics issues in the design of functional and logic programming languages, study of abstract data types.

CSL832 Proofs and Types
3 credits (3-0-0)
Pre-requisites: CSL302 & CSL303 and EC 120

Syntax and semantic foundations: Ranked algebras, homomorphisms, initial algebras, congruences. First-order logic review: Soundness, completeness, compactness. Herbrand models and Herbrand's theorem, Horn-clauses and resolution. Natural deduction and the Sequent calculus. Normalization and cut elimination. Lambda-calculus and Combinatory Logic: syntax and operational semantics (beta-eta equivalence), confluence and Church-Rosser property. Introduction to Type theory: The simply-typed lambda-calculus, Intuitionistic type theory. Curry-Howard correspondence. Polymorphism, algorithms for polymorphic type inference, Girard and Reynolds' System F. Applications: type-systems for programming languages; modules and functors; theorem proving, executable specifications.

CSL840 Computer Vision
4 credits (3-0-2)
Pre-requisites: EC 120
Overlaps with: EEL806

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.

CSL847 Distributed Algorithms
3 credits (3-0-0)
Pre-requisites: CSL356 & CSL373 and EC 120

Models of synchronous and asynchronous distributed computing systems: synchronous networks, asynchronous shared memory, asynchronous networks etc.; basic algorithms for synchronous and asynchronous networks: leader election, breadth first search, shortest path, minimum spanning tree etc.; advanced synchronous algorithms: distributed consensus with failures, commit protocols; asynchronous shared memory algorithms: mutual exclusion and consensus; relationship between shared memory and network models; asynchronous networks with failures.

CSL851 Algorithmic Graph Theory
3 credits (3-0-0)
Pre-requisites: CSL356 and EC 120
Overlaps with: MAL376

Intoroduction to graphs. Max-flow Min-cut theorem. Algorithms for computing maximum s-t flows in graphs. Algorithms for computing the minimum cut in a graph. Edge and vertex connectivity of graphs and Menger's theorem. Maximum matching, Hall's theorem, algorithms for computing maximum matching in weighted and unweighted graphs. Arborescences and algorithm for computing minimum arboresence. Edmonds theorem for disjoint arborescences. Planar graphs and algorithms for checking for planarity. Edge and vertex colouring of graphs. Independent sets and perfect graphs. Extremal graph theory.

CSL852 Computational Geometry
3 credits (3-0-0)
Pre-requisites: CSL705 & CSL 356

Visibility problems and triangulation. Line sweep and angle sweep: segment intersection, area, perimeter, diameter, width. Planar Point location: Kirkpatrick's hierarchy, Persistent data structure, Multidimensional data structures: Segment trees, range trees, orthogonal range searching, Convex hulls and Voronoi diagrams: 2d, 3d hulls, 2d Voronoi diagrams, dynamic maintenance, Duality between hulls and Voronoi diagrams, Duality between lines and points, higher order Voronoi diagrams Arrangements : Construction and bounds, k-sets, Zone theorem Algebraic lower bounds: Linear Decision model Ben-Or's theorem Randomized algorithms: Random sampling, Incremental construction, Backward analysis Optimization : Monge matrices, Fixed dimensional linear programming, Prune and Search Parametric search: kth intersection, k-th nearest neighbour. Recent topics : Instructor's choice.

CSL853 Complexity Theory
3 credits (3-0-0)
Pre-requisites: CSL705 & 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.

CSL854 Approximation Algorithms
3 credits (3-0-0)
Pre-requisites: CSL356 and EC 120

NP-hardness and approximation algorithms. Different kinds of approximability. Linear programming and Duality. Randomized Rounding. Covering and packing problems. Facility location, machine scheduling and bin packing. Primal dual approximation algorithms in graph connectivity and Network design. Multi-commodity flows and cuts. Graph embeddings and their application to sparsest cuts, separators and bandwidth minimization. Feedback arc sets and Linear ordering problems. Shop scheduling: Open, flow and job shop. Semi definite programming and applications to max-cut, graph colouring. Concept of best possible approximation algorithms, Hardness of approximations.

CSL855 Models of Computation
3 credits (3-0-0)
Pre-requisites: EC 120

Computing and the notion of an effective procedure. RAM model. Primitive and partial recursive functions. Lambda calculus and combinatory logic. Logic — completeness and incompleteness. Decidability and Church-Turing hypothesis. Limitations of the standard model. Coding and Information theory. Thermodynamics of computation. Quantum computation and quantum algorithms. Physical aspects of computation.

CSL856 Mathematical Programming
3 credits (3-0-0)
Pre-requisites: EC 120
Overlaps with: MAL365

Linear Algebra and Complexity. Theory of Lattices and Linear Diophantine Equations. Algorithms for Linear Diophantine Equations. Diophantine Approximation and Basis Reduction. Fundamental Concepts and Results on Polyhedra, Linear Inequalities, and Linear Programming.The Structure of Polyhedra. Polarity, and Blocking and Anti-Blocking Polyhedra. Sizes and the Theoretical Complexity of Linear Inequalities and Linear Programming.The Simplex Method, Primal-Dual, Elimination, and Relaxation Methods. The Ellipsoid Method for Polyhedra More Generally. Karmarkar's method for linear programming. Introduction to Integer Linear Programming. Estimates in Integer Linear Programming. The Complexity of Integer Linear Programming. Totally Unimodular Matrices: Fundamental Properties and Examples. Integral Polyhedra and Total Dual Integrality. Cutting Planes. Further Methods in Integer Linear Programming.

CSL858 Advanced Computer Networks
4 credits (3-0-2)
Pre-requisites: CSL374
Overlaps with: CSL672

Flow and Congestion Control: Window and Rate Based Schemes, Decbit, 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.

CSL859 Advanced Computer Graphics
4 credits (3-0-2)
Pre-requisites: CSL781

Rendering: Ray tracing, Radiosity methods, Global illumination models, Shadow generation, Mapping, Anti-aliasing, Volume rendering, Geometrical Modelling: Parametric surfaces, Implicit surfaces, Meshes, Animation: spline driven, quarternions, articulated structures (forward and inverse kinematics), deformation — purely geometric, physically-based, Other advanced topics selected from research papers.

CSL860 Special Topics in Parallel Computation
3 credits (3-0-0)
Pre-requisites: CSL201 and EC 120

The course will focus on research issues in areas like parallel computation models, parallel algorithms, Parallel Computer architectures and interconnection networks, Shared memory parallel architectures and programming with OpenMP and Ptheards, Distributed memory message-passing parallel architectures and programming, portable parallel message-passing programming using MPI. This will also include design and implementation of parallel

numerical and non-numerical algorithms for scientific and engineering, and commercial applications. Performance evaluation and benchmarking high-performance computers.

CSL861 Special Topics in Hardware Systems
3 credits (3-0-0)
Pre-requisites: EC 120

Under this topic one of the following areas will be covered: Fault Detection and Diagnosability. Special Architectures. Design Automation Issues. Computer Arithmetic, VLSI.

CSL862 Special Topics in Software Systems
3 credits (3-0-0)
Pre-requisites: EC 120

Special topic that focuses on state of the art and research problems of importance in this area.

CSL863 Special Topics in Theoretical Computer Science
3 credits (3-0-0)
Pre-requisites: EC 120

Under this topic one of the following areas will be covered: Design and Analysis of Sequential and Parallel Algorithms. Complexity issues, Trends in Computer Science Logic, Quantum Computing and Bioinformatics, Theory of computability. Formal Languages. Semantics and Verification issues.

CSL864 Special Topics in Artificial Intelligence
3 credits (3-0-0)
Pre-requisites: CSL433

Under this topic one of the following areas will be covered: Issues in Expert Systems. Theorem Proving. Natural Language Processing. AI in Speech and Computer Vision. Higher Order Logic Programming, Machine Learning, Advanced Neural Networks.

CSL865 Special Topics in Computer Applications
3 credits (3-0-0)
Pre-requisites: EC 120

Special topic that focuses on special topics and research problems of importance in this area.

CSL866 Special Topics in Algorithms
3 credits (3-0-0)
Pre-requisites: CSL356 & CSL705

The course will focus on specialized topics in areas like Computational Topology, Manufacturing processes, Quantum Computing, Computational Biology, Randomized algorithms and other research intensive topics.

CSL867 Special Topics in High Speed Networks
3 credits (3-0-0)
Pre-requisites: EC 120

Research level issues and problems of current interest in the area.

CSL868 Special Topics in Database Systems
3 credits (3-0-0)
Pre-requisites: EC 120

The contents would include specific advanced topics in Database Management Systems in which research is currently going on in the department. These would be announced every time the course is offered.

CSL869 Special Topics in Concurrency
3 credits (3-0-0)
Pre-requisites: EC 120

The course will focus on research issues in concurrent, distributed and mobile computations. Some of the following topics will be covered: Models of Concurrent, Distributed and Mobile computation. Process calculi, Event Structures, Petri Nets an labeled transition systems. Implementations of concurrent and mobile, distributed programming languages. Logics and specification models for concurrent and mobile systems. Verification techniques and algorithms for model checking. Type systems for concurrent/mobile programming languages. Applications of the above models and techniques.

CSN110 Introduction to Computer Science and Engineering
2 credits (0-0-4)

Overview of the Department's academic/research programmes; state of the computer industry in India and abroad.

CSP301 Design Practices in Computer Science
3 credits (0-1-4)
Pre-requisites: CSL201

Basic design methodology – introduction to the steps involved, Familiarization with software practices, tools and techniques, Software project involving conceptualization, design, analysis, implementation and testing using the tools and techniques learnt.

CSP315 Embedded System Design Laboratory
4 credits (0-1-6)
Pre-requisites: CSL211

This course is a project oriented course where a group of students (normally 3 to 5) would be required to work on an innovative embedded system design project. Though the emphasis would be on implementation, they would be required to go through all aspects of system design including drawing up proper specifications as well as evaluation of alternatives. The tutorial hour would be utilized both for preliminary introduction to embedded components by the instructor(s) as well as regular presentation by each group for sharing with other groups.

CSR310 Professional Practices (CS)
2 credits (0-1-2)
Pre-requisites: EC 60

The course would consist of talks by working professionals from industry, government and research organizations. It may also include site visits to various organizations.

CSS310 Independent Study (CS)
3 credits (0-3-0)
Pre-requisites: EC 60

Research oriented activities or study of subjects outside regular course offerings under the guidance of a faculty member. Prior to registration, a detailed plan of work should be submitted by the student to the Head of the Department for approval.

CST410 Practical Training (CS)
Non credit
Pre-requisites: EC 90 at the end of 5th sem.

Expose the students to the actual Industrial environment. Fifty (50) working days or 400 hours of practical training in an industry/research laboratory.

CSV880 Special Module in Parallel Computation
1 credit (1-0-0)
Pre-requisites: EC 120
Special module that focuses on special topics and research problems of importance in this area.

CSV881 Special Module in Hardware Systems
1 credit (1-0-0)
Pre-requisites: EC 120
Special module that focuses on special topics and research problems of importance in this area.

CSV882 Special Module in Software Systems
1 credit (1-0-0)
Pre-requisites: EC 120
Special module that focuses on special topics and research problems of importance in this area.

CSV883 Special Module in Theoretical Computer Science
1 credit (1-0-0)
Pre-requisites: EC 120
Special module that focuses on special topics and research problems of importance in this area.

CSV884 Special Module in Artificial Intelligence
1 credit (1-0-0)
Pre-requisites: EC 120
Special module that focuses on special topics and research problems of importance in this area.

CSV885 Special Module in Computer Applications
1 credit (1-0-0)
Pre-requisites: EC 120
Special module that focuses on special topics and research problems of importance in this area.

CSV886 Special Module in Algorithms
1 credit (1-0-0)
Pre-requisites: EC 120
Special module that focuses on special topics and research problems of importance in this area.

CSV887 Special Module in High Speed Networks
1 credit (1-0-0)
Pre-requisites: EC 120
Special module that focuses on special topics and research problems of importance in this area.

CSV888 Special Module in Database Systems
1 credit (1-0-0)
Pre-requisites: EC 120
Special module that focuses on special topics and research problems of importance in this area.

CSV889 Special Module in Concurrency
1 credit (1-0-0)
Pre-requisites: EC 120
Special module that focuses on special topics and research problems of importance in this area.

Department of Electrical Engineering

EEC410 Colloquium (EE)
3 credits (0-3-0)
Pre-requisites: registered for EET410
Students will deliver talks about their experience during practical training, and on topics of current interest.

EEC420 Colloquium (EP)
3 credits (0-3-0)
Pre-requisites: registered for EET420
Students will deliver talks about their experience during practical training, and on topics of current interest.

EED310 Mini Project (EE)
3 credits (0-0-6)
Pre-requisites: EC 80
Project activity of one semester duration emphasizing design activity in any area of electrical engineering, under the guidance of a faculty member. Prior to registration for the course, a proposal will have to be prepared and approval obtained from the department.

EED320 Mini Project (EP)
3 credits (0-0-6)
Pre-requisites: EC 80
Project activity of one semester duration emphasizing design activity in electrical power engineering, under the guidance of a faculty member. Prior to registration for the course, a proposal will have to be prepared and approved obtained from the department.

EED411 Major Project Part 1 (EE)
3 credits (0-0-6)
Pre-requisites: EC 120
Formation of project team (up to two students and two faculty guides); formulation of work plan; completion of targeted work for the semester; and presentation of progress for award of grade. Topic could be from any area of electrical engineering. Completion of about a third of the total work for assessment and grading.

EED412 Major Project Part 2 (EE)
7 credits (0-0-14)
Pre-requisites: EED411
Continuation of planned tasks started in Project Part 1 to completion, thesis writing and presentation of complete work for award of grade. Completion of the planned work for assessment and grading.

EED421 Major Project Part 1 (EP)
3 credits (0-0-6)
Pre-requisites: EC 120
Formation of project team (up to two students and two faculty guides); formulation of work plan; completion of targeted work for the semester; and presentation of progress for award of grade. Topic should be in the area of electrical power. Completion of about a third of the total work for assessment and grading.

EED422 Major Project Part 2 (EP)
7 credits (0-0-14)
Pre-requisites: EED421
Continuation of planned tasks started in Project Part 1 to completion, thesis writing and presentation of complete workfor award of grade. Completion of the planned work for assessment and grading.

EED750 Minor Project (EI)
3 credits (0-0-6)
Pre-requisites: EC 120
A semester-long project usually involving design and implementation under the guidance of a faculty member.

EED851 Major Project Part 1 (EI)
6 credits (0-0-12)
Pre-requisites: EC 165
This project spans also the course EED852. Topics should be from topics related to information and communication technology. The problem specification and the milestones to be achieved in solving the problem are to be clearly specified. Progress up to the end of the semester is to be presented for assessment and grade.

EED852 Major Project Part 2 (EI)
14 credits (0-0-28)
Pre-requisites: EED851
Continuation and completion of the work started in Project Part 1. Presentation at the end of the semester for award of grade.

EED853 Major Project Part 1 (EI)
4 credits (0-0-8)
Pre-requisites: EC 165
This course forms the first part of the two semester long major project. Work includes significant research and development in the area of information technology/ communication technology under the guidance of faculty. Tasks include problem definition, preparation of work plan, literature review and initiation of work.

EED854 Major Project Part 2 (EI)
16 credits (0-0-32)
Pre-requisites: EED853
This course is the second part of the two semester long major project. Work includes significant research and development in the area of information technology/ communication technology under the guidance of faculty. Tasks include completion of planned work, report writing and presentation.

EEL101 Fundamentals of Electrical Engineering
4 credits (3-0-2)
Overlaps with: EEL102
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. Two port networks. Operational amplifiers: model and applications. Magnetic circuits. Transformers: modelling and analysis. Energy in magnetic field, production of force and EMF. Electro-mechanical energy conversion. Principles of measurement. Electrical and electronic materials. Laboratory experiments will be based on these topics.

EEL102 Principles of Electrical Engineering
4 credits (3-0-2)
Overlaps with: EEL101
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. Operational amplifiers and their applications. Magnetic circuits. Transformers. Energy in magnetic field,

production of force and EMF. Electro-mechanical energy conversion. Principles of rotating machines. Electrical and electronic materials. Laboratory experiments will be based on these topics.

EEL201 Digital Electronic Circuits
4 credits (3-1-0)
Pre-requisites: EEL101 / EEL102

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.

EEL202 Circuit Theory
4 credits (3-1-0)
Pre-requisites: EEL101 / EEL102

Overview of network analysis techniques, Network theorems, Transient and steady state sinusoidal response. Network graphs and their applications in network analysis. Tellengen's 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 sythesis techniques. Butterworth and Chebyshev Approximation.

EEL203 Electromechanics
4 credits (3-1-0)
Pre-requisites: EEL101 / EEL102

Review of 1-phase, 3- phase circuits and magnetic circuits, transformers- 1-phase and 3-phase, special multiphase transformers and their applications, Electro mechanical Energy conversion principles and rotating machines, DC machines-construction, characteristics, commutation, armature reaction, speed control of DC motors and applications in drives; Synchronous machine-construction, characteristics, regulation, V-curves, parallel operation; Induction machines-3-phase and 1- phase- construction, characteristics, starting, braking and speed control, Induction generators and applications- Fractional kW motors, special machines- PM machines, SRM, stepper motors and their applications.

EEL204 Analog Electronics Circuits
4 credits (3-1-0)
Pre-requisites: EEL101 / EEL102

Review of working of BJT, JFET and MOSFET and their small signal equivalent Circuit; Biasing of BJT, JFET and MOSFET circuits; Analysis and Design of various single stage amplifier configurations; Multi Stage Amplifiers; Differential Amplifier and Operational Amplifier; Feedback Amplifiers; Tuned Amplifiers; Oscillators.

EEL205 Signals and Systems
4 credits (3-1-0)
Pre-requisites: EEL101 / EEL102 / MAL110 / MAL111 / MAL115

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.

EEL207 Engineering Electromagnetics
4 credits (3-1-0)
Pre-requisites: PHL110

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.Radio-wave propagation: ground-wave, sky-wave, space-wave.

EEL209 Power Electronics Devices and Circuits
4 credits (3-1-0)
Pre-requisites: EEL101 / EEL102

Basic features of semiconductor junctions, the BJT operations at high currents, switching features of the BJT and MOS transistors. The thyristor operation, distributed gates. IGBT operation, principles and ratings. Boost and buck converters using BJT and IGBT circuits-problems, design and operation. Snubber designs and protection. Firing circuits. Thyristor and BJT based converters-design, phase control, effects on power factor and harmonics, firing circuits and their designs. Inverter circuits operation. Designs using BJT's and MOS devices. Base and gate drive circuits, snubbers, operational problems. The basic concept of PWM control and advantages against phase control. AC voltage controllers, choppers and cycloconverters.

EEL212 Measurements and Instrumentation
3 credits (3-0-0)
Pre-requisites: EEL101 / EEL102

Principles of Measurement, bridge measurements, oscilloscope, measurements of analog waveforms, Q-meter, Spectrum Analysis, Special transducers, A/D and D/A, Telemetering, Data recording and display, Computer-aided Measurement systems.

EEL218 Physical Electronics
3 credits (3-0-0)
Pre-requisites: EEL101 / EEL102
Overlaps with: EPL213, EPL439

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.

EEL301 Control Engineering - I
4 credits (3-1-0)
Pre-requisites: EEL205
Overlaps with: MEL312, CHL261

Introduction to the control problem, Industrial control examples, Transfer function models of suitable mechanical, electrical, thermal and pneumatic systems. Systems with dead time, Control hardware and their models: Potentiometers, synchros, LVDT, DC and AC servo motors, tachogenerators, electro-hydraulic valves, pneumatic actuators. Closed loop control systems, Block diagram and signal flow analysis, Basic Characteristics of feedback control systems : stability, steady-state accuracy, transient accuracy, disturbance rejection,

insensitivity and robustness.Basic modes of feedback control :Proportional Integral, Derivative. Concept of stability and Routh stability criterion.Time response of 2nd order system, steady state error and error constants, Performance specifications in the time domain. Root locus method of design. Lead and lag compensation. Nyquist stability criterion. Frequency response analysis: Nyquist plots, constant M circles, constant N-circles, Bode plots, Nichols Charts Performance specifications in frequency domain, Frequency-domain methods of design. Lead and lag.

EEL303 Power Engineering - I
4 credits (3-1-0)
Pre-requisites: EEL203

Energy resources, power generation: Thermal, hydro and nuclear power plants. Transmission lines, line parameters, corona, interference of power lines with communication circuits, line insulators. Cables, per unit system, symmetrical components, fault analysis, switching surges. Integrated operation of power systems, basic concepts of load flow, economic operation, stability, protection, HVDC transmission. Load management and tariffs.

EEL305 Electric Drives
4 credits (3-1-0)
Pre-requisites: EEL203

Requirements, components and benchmarks of electric drives. Review of induction motor theory, distinction between wound rotor and cage rotor, cases of multiple cages, energy efficient motors, synchronous motor theory-equivalent circuit, extensions as reluctance motors, and permanent magnet motors. Stepper motor features and operation. Speed control of induction motor-basic issues, the ac power controller, and slip energy recovery schemes. VSI and CSI fed induction motors. Speed control of synchronous motors and associated machines. Organisation of micro-controllers, key issues like actuation and signal sensing, interrupt handling, timing, and priority of tasks in a microcomputer controlled drives.

EEL306 Communication Engineering
4 credits (3-1-0)
Pre-requisites: EEL205

Review of Fourier Series and Transforms. Hilbert Transforms, Bandpass Signal and System Representation. 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.

EEL308 Computer Architecture
4 credits (3-1-0)
Pre-requisites: EEL201
Overlaps with: CSL211

Organization of a Computer: von Neumann and Harvard architecture; Instruction Set Architecture: RISC and CISC processors; Computer Arithmetic: fixed point and floating point arithmetic; Design of ALU: hardware algorithms for addition, multiplication and division of fixed point and floating point numbers; Processor design: Data Path and Control Design, Microprogramming, Exception Processing, Pipelining; Memory Organisation: memory hierarchy, cache organization, virtual memory; System Design: bus structure, bus transactions; Input-output Systems: programmed I/O, DMA and interrupt driven I/O. Illustrations with examples of CISC processors from Intel and RISC processors like MIPS and ARM.

EEL311 Graph Theory and its Application to Electrical Engineering
3 credits (3-0-0)
Pre-requisites: CSL201
Overlaps with: MAL376, MAL468

Basic of graph theory: trees, f-circuits, f-cutsets, connected and seperable graphs etc. Matrices of a graph and relations between them. Generation of network functions of one and two-port networks using spanning tree and directed tree algorithms. Graph searches like BFS and DFS. Path problems like shortest paths, all paths between a pair of nodes etc. Generation of directed graphs and their use in the determination of transfer functions of networks. Applications of graph algorithms in routing, assignment and other problems in VLSI design.

EEL314 Medical Electronics
3 credits (3-0-0)
Pre-requisites: EEL204

Basic principles of biomedical, instrumentation and techniques. Problems of interfacing biomedical, electrical and electronic equipments with living systems, measuring instruments for bio-signals e.g. ECG, EMG, EEG and evoked responses. Biomedical transducers for pressure, flow and temperature. Biomagnetic measurement and imaging. Cardiac output measurement techniques. Dignostic and therapeutic instruments. Prosthetic devices like pacemaker, hearing-aid and myoelectric arm. Functional electrical stimulation and algorithms for extremity control. Biotelemetry of biological signals, biosensors. Neonatal monitoring. Special aspects such as safety of medical electronic equipment. Telemedicine, biotechnology and nanotechnology.

EEL315 Analog Integrated Circuits
3 credits (3-0-0)
Pre-requisites: EEL 204 & EEL 202

Review of basic amplifiers. Current Mirrors, Reference Current and Voltage Sources. CMOS Operational Amplifier: Structure, Analysis and Design, Frequency Response and Compensation Techniques. Switched Capacitor Circuits: Principles of operation, Filter and non filter applications. Sample and Hold Circuits, Comparators. ADC: Characterization, Types of ADC and their relative merits and demerits, Design issues. DAC: Characterization, Types of DAC and their relative merits and demerits, Design issues.

EEL316 Digital Communications
4 credits (3-0-2)
Pre-requisites: EEL306

Matched Filter, Error Rate due to Noise. Intersymbol Interference, Nyquist's Criterion, Duobinary Signaling. Optimum Linear Receiver. 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.

EEL319 Digital Signal Processing
4 credits (3-0-2)
Pre-requisites: EEL205

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.

EEL322 Integrated Circuits Technology
3 credits (3-0-0)
Pre-requisites: EEL204

Fabrication of active and passive devices and integrated circuits. Basic technological steps – pattern definition, impurity introduction, layer deposition, etching. Simplified process sequences for bipolar, NMOS and CMOS.

EEL324 Digital Hardware Design
3 credits (3-0-0)
Pre-requisites: EEL201
Overlaps with: CSL316

Review of combinational and sequential logic; Finite state machines and optimization of finite state machines; Hardware Description Languages (HDL), HDL based design; Introduction to data path and control path synthesis; Asynchronous state machine based design; Considerations of technology; testability and fault-tolerance in design.

EEL325 Control Engineering - II
3 credits (3-0-0)
Pre-requisites: EEL301

Introduction to digital control systems,Principles of signal conversion, sampling and reconstruction. Principle of discretization. Impulse and step invariance. Finite difference approximation. Bilinear transformation, Mathematical models discrete time signals and systems. Transfer function and system response. Stability on the z-domain. Closed loop digital control systems. System with dead time. Commonly used digital devices. Examples of industrial control systems. Transform design of digital controllers. Root locus methods and frequency domain method.State variable representation of continious and discrete time systems. Conversions state variable models to transfer function models. Conversion of transfer function to canonical models. Eigen values and eigen vectors. Solution of state equations. Controllability and observability properties. Pole placement design using state feedback. Dead beat control.

EEL326 Micromotors and their Applications
3 credits (3-0-0)
Pre-requisites: EEL203

Micromotors: dc micromotors: PCB motors, voice coilmotors, ultrasonic wave motors, coreless motors, PM motors, disc motors, servo motors, brushless motors, step motors, ac servo motors, synchronous motors, induction motors, universal motors axial field motors. Applications to information technology equipments, Computers FDD, HDD, printers and plotters, instruments, Consumers products such as cameras, camcorders, timers, clock, VCR, VCP Wipers, fax machines, casette recorders, copiers etc.

EEL327 Fault Diagnosis of Digital Circuits
3 credits (3-0-0)
Pre-requisites: EEL201

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.

EEL329 VLSI Technology and Design
4 credits (3-0-2)
Pre-requisites: EEL201
Overlaps with: EEL734

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.

EEL330 Selected Topics in Communication Engineering - I
3 credits (3-0-0)
Pre-requisites: EEL306

Topics of recent interest in the area of Commnication Engineering.

EEL331 Electromagnetics and Advanced Electromechanics
3 credits (3-0-0)
Pre-requisites: EEL203

Review of electromagnetic field concepts, Maxwell's equations for quasi-stationary fields. Boundary values problems in electrostatics: Laplace and Poisson's equations. Solutions in rectangular, spherical and cylindrical coordinates: method of Images: field plotting. Conformal transformation techniques, numerical methods: finite difference methods, finite element based software. Magnetostatic fields - vector potential: Boundary value problems. Current sheet and flux sheets. Relation between field theory and circuit theory for electric machines. Advanced topics in electromechanics, dynamic modelling of D.C., synchronous and induction machines, d-q transformations. Transient/dynamic analysis of machines using classical and numerical methods. Short circuit studies in synchronous machines. Effects of saliency, automatic voltage regulators. Unbalanced operation of Induction motors. Speed control of induction motors.Variable reluctance, permanent magnet and stepper motors.

EEL338 Antennas and Propagation
3 credits (3-0-0)
Pre-requisites: 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.

EEL339 Power Conditioning
3 credits (3-0-0)
Pre-requisites: EEL209

Concepts of nonlinear loads and electric power conditioning unity power factor rectifier STATCON, (Static condenser) SMPS: analysis, design and control. UPS on-line and off-line, power supplies in telecommunication systems. High frequency induction heating, dielectric heating Power supplies in automobiles. Passive filters, active filters for harmonic and reactive power compensation in two wire, three wire and four wire ac systems. Harmonic standards, power quality, surge suppressors, compensation of arc furnace and traction loads. Microwave ovens, light and temperature controllers. Power supplies for appliances such as camera, X-ray equipment. Case studies on microcomputer and DSP control in active filters and power supplies.

EEL340 Selected Topics in Power and Machines
3 credits (3-0-0)
Pre-requisites: EEL203

Topics of interest in the relevant areas.

EEL341 Selected Topics in Power Electronics and Drives - I
3 credits (3-0-0)
Pre-requisites: EEL203 & EEL209

Topics of special interest in power electronics and drives.

EEL342 DSP based Control of Electric Drive
3 credits (3-0-0)
Pre-requisites: EEL203

Features of a DSP in comparison to those of ordinary processors, computational advantage handicaps regarding analog and digital interface. Communication advantages. Harmonic analysis in real time using a DSP specific assembly language features for a DSP. On chip RAM and external RAM I/O interface. PWM and firing pulse generation through a typical DSP, look-up tables and real-time computation. Interfacing and actuation circuits for DSP based controllers. Realization of computationally intensive algorithms like variable structure, adaptive and neural network schemes for drive systems.

EEL344 Electric Transportation
3 credits (3-0-0)
Pre-requisites: EEL203

Battery powered vehicles: electric cars, pallet truck, fork lift trucks, electric bus, solar powered electric vehicles and boats etc. drives used in electric vehicles, d.c. drives,vector controlled ac motor drives, PMBL motor drives, switched reluctance motor drives, Electric traction, trains, trams and trolleys, nature of tractive loads, supply systems, power factor and harmonics, traction motors and drives, Diesel electric traction, a.c. induction motor drives, marine propulsion systems and aircraft system.

EEL346 Electrical Machines and Industrial Drives
3 credits (3-0-0)
Pre-requisites: EEL203

Engineering aspects of electric rotating machines, industrial practices of manufacture and design. Convertor fed operation of d.c. motors, electronically commutated and permanent magnet motors. Electrical Engineering Applications in electric traction, steel milldrives, process industries, audio equipment, automobiles, computers and robotics. Computer aided modelling and analysis of d.c. drives. Modelling of synchronous machines. Saliency effects, steady-state and transient. Brushless synchronous generators using electronic circuits, induction motor operation and control. Variable frequency inverter fed motors for drive applications. Power electronics control of a.c. motors with application to variable speed drives. Energy conservation in motors. Microprocessor and microcontroller applications for a.c. drives. Single phase induction motor and applications in domestic appliances, electronic instrumentation, etc. Stepper motor and control applications in robotics, CNC, computer peripherals, permanent magnet motors, switched reluctance motors, linear motors and their applications. Special generators for renewable energy systems such as wind, biogas, small hydro, solar etc.

EEL349 Advanced Electrical Machines
3 credits (3-0-0)
Pre-requisites: EEL203

Details of PWM inverter fed ac drives with different forms of feedback control, bang-band and sliding mode structures, realisation on microcomputer based systems. Vector control of ac motor; flux estimators and their shortcomings, hardware realisation, start up control of induction motors with PWM and flux vector structures. Present day shortcomings of inverter fed induction motor drives-bearing erosion, shaft fracture and efficiency problems involvement of soft switching inverters and impact on ac drive performance SR motors and PM motors drive control. Design of power electronic modules and microprocessor controllers.

EEL358 Operating Systems
3 credits (3-0-0)
Pre-requisites: EEL308
Overlaps with: CSL373, MAL358

Introduction to OS; Process and Thread management; Scheduling; Concurrent threads and processes: mutual exclusion, synchronization, inter-process communication; Memory management: Cache and Virtual Memory management; Resource management: deadlock and its prevention; File management; I/O management; Introduction to real time systems; Elements of distributed operating systems.

EEL359 Electric Machine Design and CAD of Electric Machines
3 credits (3-0-0)
Pre-requisites: EEL203 & EEP203

Basic design methodology and engineering considerations. Properties of electric magnetic and insulating materials. Choice of materials, frames etc. Computerisation of design procedures, Optimization techniques and their application to design problems. Design of large and FHP motors. Database and knowledge based expert systems. Development of PC based software, Exercise on design using standard software.

EEL360 Selected Topics in Control Engineering - I
3 credits (3-0-0)
Pre-requisites: EEL301

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

EEL361 Selected Topics in Power Systems - I
3 credits (3-0-0)
Pre-requisites: EEL303

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

EEL365 Intelligent Control
3 credits (3-0-0)
Pre-requisites: EEL301

Conventional control review, Feedback linearization, Robust and adaptive control, Fuzzy system: Introduction to fuzzy logic, Examples, fuzzy logic based identification and control, adaptive fuzzy control, Neural networks: Basics, Neural network based identification and control of nonlinear systems, examples. Various other soft computing techniques for control applications. Introduction to reinforcement learning.

EEL370 Selected Topics in Computers - I
3 credits (3-0-0)
Pre-requisites: CSL201

Topics of current interest in computers; details will be decided by the instructor.

EEL375 Embedded Systems
5 credits (3-0-4)
Pre-requisites: EEL308
Overlaps with: CSP413, MEL432

Overview of Embedded Systems; Embedded System Architecture: processor examples - ARM, PIC, etc.; features of digital signal processor; SOC, memory sub-system, bus structure (PC-104, I2C etc.), interfacing protocols (USB, IrDA etc), testing and debugging, power management; Embedded System Software: Program Optimization, Concurrent Programming, Real-time Scheduling and I/O management; Networked Embedded Systems: special networking protocols (CAN, Bluetooth); Applications.

EEL380 Selected Topics in Electronics - I
3 credits (3-0-0)
Pre-requisites: EEL202 and EC 60
Topics of interest in areas of electronics; details will be provided by the instructor.

EEL388 Stepper Motors
3 credits (3-0-0)
Pre-requisites: EEL203
Discretisation of angular position by stepper structures, stepping angle and frequency of excitation. VR and PM rotor structures and their torque production, torque angle characteristics. The hybrid structure and torque production by permanent magnet and excitation fluxes. Power electronic converters for stepper motors, control by load angle. Hardware and software based control. Trajectory and motion definition in angle and angular speed. Transfer function of stepper motors, and control of damping by one-step and one-and-a-half step excitation.

EEL389 Computer Aided Testing of Electric Machines
3 credits (2-0-2)
Pre-requisites: EEL203
Data acquisition system, sensors, transducers such as speed torque, temperature, noise, voltage, current, power, power factor, harmonics, crest factor etc. Digital signal processing and instrumentation. Recorders, computer interface. Case Studies of Computer Aided testing of different electric machines.

EEL390 Selected Topics in Information and Communication Technology – I
3 credits (3-0-0)
Pre-requisites: CSL201 & EEL205 and EC 60
Topics in the emerging areas of information and communication technology and the interface between the two.

EEL394 Permanent Magnet Motors
3 credits (3-0-0)
Pre-requisites: EEL203
Permanent magnet materials and circuits; Characteristics, parameters, properties, classification and calculations, Permanent magnet motors, D.C. brushed motors, design analysis and control and applications, PM synchronous motors, rotor construction such as surface mounted PM, buried PM, inset type PM and interior type PM rotor and cageless rotor motors, line start and inverter fed control and applications. PM brushless dc motor, theory, operation, control and applications, axial field disc construction, PM step motors, hybrid step motors, sensorless control, reduction of torque pulsations; Case studies such electric vehicles, marine propulsion, spindle drives, commercial and industrial drives, PV fed water pumping.

EEL398 Machines and Drives Dynamics
3 credits (3-0-0)
Pre-requisites: EEL203
General volt-ampere and torque equations under stationary and rotating reference frames. Instantaneous symmetrical components and generalised operational equivalent circuits. Space vector concepts. Modelling of D.C. machines: analysis under motoring and generating. Simulation for transient and dynamic conditions. Modelling of synchronous machines: d-q transformations fixed to field structure-steady state and dynamic equations. Phasor diagram for cylindrical rotor and salient pole machines-electromagnetic and reluctance torque. Response under short circuit conditions Modelling of induction machines: Equations under stationary and rotating reference frames, Derivation of equivalent circuits. Correlation of inductances. Run up transients, Dynamics under load change, speed reversal and braking. Unbalanced and asymmetrical operation.Modelling and analysis of permanent magnet, switched reluctance and stepper motors. Development of Computer Software using latest simulation tools to predict the behavior of different machines.

EEL404 Flexible AC Transmission System
3 credits (3-0-0)
Pre-requisites: EEL303
Concepts of reactive power support and voltage stability. Compensation at a bus and over a line. The synchronous condenser, static var compensation, static phase shifter, thyristor controlled switched capacitor, STATCON's and DVR's, unified power flow controller, interphase power controller. Reactive power balance over a network and optimisation.

EEL405 Power Engineering Instrumentation
3 credits (3-0-0)
Pre-requisites: EEL303
The concepts of accuracy and precision, Log errors and sources of measurement errors. Non idealities involved in Power instrumentation Instrument transformers, structures of PT's and CT's ratio and phase errors. Current probes and their efficiency. DC current measurements by Hall devices, saturable reactor set, UPS. Electromechanical meters for dc and ac measurements-moving coil and moving magnet structures. Analog circuits for power instrumentation, voltage followers, buffers, differential amplifiers, specific analog circuits for peak detection, rms detection, and average computation, common mode operation and noise analysis of OPAMP based circuits. Filter designs and concepts of operating bandwidth. Digital instrumentation in power application, A/D and D/A circuits and their operation, errors Basic concepts of digital filtering storage and related circuit design. Microprocessors in power instrumentation, configuration and software flowcharts for basic power measurement involving filtering, arithmetic operations and storage.

EEL407 Distribution System Planning and Automation
3 credits (3-0-0)
Pre-requisites: EEL303
Configuration of distribution systems load characteristics, distribution transformers, distribution substation design, feeder design, voltage regulation, protection in distribution systems, SCADA, distribution automation.

EEL420 Selected Topics in Electronics - II
3 credits (3-0-0)
Pre-requisites: EEL202 and EC90
Topics in electronics; details will be decided by the instructor.

EEL421 Selected Topics in Power Electronics and Drives - II
3 credits (3-0-0)
Pre-requisites: EEL203 & EEL209 and EC90
Topics of current interest in power electronics and drives; details will be provided by the instructor.

EEL422 Computers in Biomedicine
3 credits (3-0-0)
Pre-requisites: CSL201 and EC 90
Introduction to computer simulation in biological sciences. Simulation of normal and pathological states. Artificial intelligence and expert systems for medical applications, Algorithms for automated analysis of bioelectrical signals such as ECG and EEG. Pattern identification and tissue and cell typing. Fractal and chaotic dynamics in biological

systems, 3D Medical Imaging, Telemedicine and Virtual reality, Computers in medical therapeutics; Drug Delivery System, Smart sensors and actuators, Bio-informatics.

EEL423 Demand Side Management
3 credits (3-0-0)
Pre-requisites: EEL303

The concepts of demand-side management (DSM) for electric utilities, DSM alternative and goals. End use equipment and control, utility equipment control, energy storage, dispersed generation, customer DSM promotions, performance improvement equipment and system benefit/cost analysis of DSM alternatives; issue in forecasting DSM program impacts. Implementation of DSM programme; pricing and incentives.

EEL424 Nuclear Power Generation
3 credits (3-0-0)
Pre-requisites: EEL303

Basics of nuclear fission, and characteristics of heavy isotopes. The concepts of beta-decay line, and suitability of nuclear fuels. Fission by fast and slow neutrons, criticality, and moderation. Types and basic structures of common reactor designs-BWR, HWR and PHWR, power output, size and radiation considerations, operation and control by solid and liquid moderators, neutron density and reactivity control. Point from differential equations for common nuclear reactors core models, moderator dynamics, and thermal circuits. Reactor - poisoning by Xenon and strontium, control of performance to avoid poisoning. Special features of alternators and boilers in nuclear plants. Control and safety standards of nuclear units.

EEL428 Substation Design
3 credits (3-0-0)
Pre-requisites: EEL303

Types of substations layout and bus bar arrangements Grounding; design and Practices, substation auxiliaries, Cable routing, data acquisition, substation Control, load shedding, implementation.

EEL430 Selected Topics in Communication Engineering - II
3 credits (3-0-0)
Pre-requisites: EEL306 and EC 90

Selected topics in communication engineering; details will be decided by the instructor.

EEL432 Satellite Communication
3 credits (3-0-0)
Pre-requisites: EEL306

Satellite systems basics, satellite channel, earth station and satellite equipment, different modulation and access techniques, examples of different satellite systems.

EEL433 Communication Engineering - II
3 credits (3-0-0)
Pre-requisites: EEL316

Communication Channels and Their Characteristics. Probability and Random Variables, Transformations of Random Variables. Stochastic Processes, WSS Processes, Power Spectral Density, Characterization of Noise, White Noise, Gaussian Noise. Representation of Bandpass Signals and Systems, Signal Space Representation. Optimum Receivers for the AWGN Channel. Performance of Optimum Receivers for Digital Modulation Schemes: Binary, M-ary Orthogonal, M-ary Biorthogonal, Simplex, MPAM, MPSK, DPSK, MQAM, MFSK. Channel Capacity and Random Selection of Codes. Block and Convolutional Channel Codes. Spread Spectrum Communications.

EEL435 Optical Communication
3 credits (3-0-0)
Pre-requisites: EEL306
Overlaps with: EEL712

Introduction to optical communication, review of optical sources, fiber and detector, optical signaling schemes viz., IM, PL, PCM, PCM/PL, digital PPM, PFM, PAM. Various receiver configurations - direct detection, homodyne and heterodyne receivers, Noise sources in optical communication - modal noise, speckle noise, shot noise, phase noise, thermal noise, Integrated and transimpedance amplifiers, optical line coding, performance evaluation of optical receivers for various modulation and demodulation schemes and their comparative study. Diversity receivers-phase and polarization diversities. Optical fiber link design, fiber optics networks, introduction to optical space communication.

EEL437 Selected Topics in Power Systems - II
3 credits (3-0-0)
Pre-requisites: EEL303 and EC 90

Topics will be decided by the instructor from among current areas of power systems.

EEL440 Selected Topics in Power, Machines and Power Electronics - II
3 credits (3-0-0)
Pre-requisites: EEL303, EEL209 and EC 90

Topics in power, machines and power electronics; details will be decided by the instructor.

EEL441 Industrial Electronics
4 credits (3-0-2)
Pre-requisites: EEL101 / EEL102 and EC 90

Power electronic components- thyristors, triacs, GTOs, MOSFETs and other bipolar devices and their switching properties. Introduction to thyristorised phase controlled rectifiers and dual converters. AC controllers and timers, dimmers, heating. SMPS and UPS systems. Introduction to AC controllers, inverters, choppers, cycloconverters. Introduction to converter fed AC and DC drives-their performance. Other applications of power electronics.

EEL450 Switchgear and Transients
3 credits (3-0-0)
Pre-requisites: EEL303

Switchgear; fault clearing processes and arcing phenomena, thermodynamic aspects of arc interruption, electrical aspects of arc interruption; recovery and restriking voltage. Types of circuit breakers; testing of circuit breakers.

EEL451 Power Systems Protection
3 credits (3-0-0)
Pre-requisites: EEL303

Basic concepts of power system protection, types of relays, protection of generators, transformers, bus bars and transmission lines, distance and carrier current protection. Computer relaying. Induction motor protection. Theory of arc interruption, types of circuit breakers (air, air blast, oil, vacuum and SF6), circuit breaker rating and testing of circuit breakers.

EEL452 HVDC Transmission
3 credits (3-0-0)
Pre-requisites: EEL303

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.

EEL453 Power System Dynamics and Control
3 credits (3-0-0)
Pre-requisites: EEL303

Introduction to power system stability problems, Models of: synchronous machines, excitation systems, prime mover and governor, loads, Transient stability analysis, Dynamic stability analysis, Dynamic Equivalents, Stabilizers, Levels of power system control, AGC, SCADA and Computer control.

EEL455 Power System Planning
3 credits (3-0-0)
Pre-requisites: EEL303

Load forecasting, generation system reliability, transmission system reliability and distribution system reliability. Generation system expansion planning, Transmission system expansion planning and distribution system expansion planning, Reactive power planning, Integrated power system planning.

EEL456 Power Engineering - II
4 credits (3-0-2)
Pre-requisites: EEL303

Integrated operation of power systems, advanced load flow modelling, advanced fault analysis, stability analysis, security analysis, optimal power flow, power system control.

EEL458 Power Systems Optimization
3 credits (3-0-0)
Pre-requisites: EEL303

Characteristics of generation units, economic dispatch of thermal plants, unit commitment hydro thermal coordination maintenance scheduling, emission minimization, optimal power flow, security constrained optimization.

EEL460 Selected Topics in Control Engineering-II
3 credits (3-0-0)
Pre-requisites: EEL301 and EC 90

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

EEL462 Identification and Adaptive Control
3 credits (3-0-0)
Pre-requisites: EEL301

Review of stochastic process. Models and model classification.The identification problem, some fields of applications. Classical methods of identification of impulse response and transfer function models, model learning technique, linear least square estimator, Properties of ISE, generalized and weighted least square, Instrumental variable method. On line identification using recursive least squares, minimum variance algorithm, stochastic approximation and maximum likelihood method. Simultaneous state and parameter estimation extended kalman filter, two stage identification methods. Nonlinear identification, Model reference adaptive control.

EEL470 Selected Topics in Computers - II
3 credits (3-0-0)
Pre-requisites: CSL201 and EC 90

Topics of current interest in the area of Computer Technology; details will be provided by the instructor.

EEL472 Parallel and Distributed Processing
3 credits (3-0-0)
Pre-requisites: EEL308
Overlaps with: CSL830, CSL847, MAL311, MAL465

Motivation for parallel and distributed processing. Classification of Parallel Architectures-SIMD/MIMD,control/ data flow,distributed/shared memory architectures, Mapping algorithms onto regular arrays-data dependencies, linear, rectangular mesh and hexagonal arrays and algorithms for these architectures.SIMD algorithms-design considerations, masking,vector instructions and data structures.Memory allocation techniques.Interconnecting networks.Sorting and data broadcasting. Algorithms for shuffle/exchange networks.MIMD algorithms (shared memory) - synchronization,mutual exclusion, hot spots. Distributed Programming :message passing , RPC and rendezvous , paradigms for process interaction, implementations.

EEL473 Computer Communication
3 credits (3-0-0)
Pre-requisites: EEL306
Overlaps with: CSL 374

Introduction; Mathematical theory of Networks : birth-death proceses, M/M/m, M/G/1, simulation techniques for LANs; Local Area Networks, Metropolitan Area Networks, Access Techniques, Wide Area Network, Routing algorithms. Case studies in network design.

EEL481 Testing and Commissioning of Electrical Equipment
3 credits (3-0-0)
Pre-requisites: EEL303

Testing of Transformers, dc machines, Induction machines synchronous machines and other Electric apparatus. Study of testing standard (BIS and EMC) etc. on electrical equipment Type tests and routine tests. Tests before commissioning and after commissioning of electrical equipments. Various testing standards.

EEL482 Mechatronics
3 credits (3-0-0)
Pre-requisites: EEL201 & EEL203 & EEL301
Overlaps with: MEL411, MEL432

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.

EEL483 Hydro Power Generation
3 credits (3-0-0)
Pre-requisites: EEL303

Types of Hydro plants subsystems of hydro plant, turbines, hydro alternates hydro plant. Auxiliaries, control of hydro power, micro hydel systems, special problems in hydro plants.

EEL486 Illumination and Heating
3 credits (3-0-0)
Pre-requisites: EEL101 / EEL102 and EC 90

Laws of illumination; Types of lamps and fixtures; Energy conservation measures; Electric heating; Electric welding.

EEL487 Intelligent Algorithms for Power Systems
3 credits (3-0-0)
Pre-requisites: EEL303

Introduction of Artificial Neural Networks (ANN), Multilayer feed forward networks, back propagation training algorithm, Radial basis function and recurrent networks. ANN based algorithms for: load flow analysis, economic load dispatch, load forecasting, transient stability, and power system stabilizers. Introduction to genetic algorithms.

EEL499 Selected Topics in Electrical Machines
3 credits (3-0-0)
Pre-requisites: EEL203 and EC 90
Topics of curent interest related to electrical machines; details will be provided by the instructor.

EEL702 Computer System Software
4 credits (3-0-2)
Pre-requisites: CSL201 & EEL308
Overlaps with: CSL728
Introduction to Object Oriented Programming and Object Oriented Design. Use of UML in Software design. System software design issues. Language Translators, Assemblers, Linkers and Loaders. Run-time environment management.

EEL703 Computer Networks
3 credits (3-0-0)
Pre-requisites: EEL306
Overlaps with: CSL374, CSL858
Introduction to Computer Networks, the Internet and World Wide Web; Application Layer and network applications; Transport Layer: TCP, UDP and ATM; Network Layer and Routing; Data Link Layer and Local Area Networks; Physical Layer and communication media; Network management.

EEL704 Robotics and Automation
3 credits (3-0-0)
Pre-requisites: EEL301
Basic component of Robotic systems. Kinematics of manipulators, Selection of Coordinate frames, Transformations. Solution of kinematics and manipulator dynamics. Newton-Euler dynamic formulations. Path planning. Position, velocity and force control, Computed Torque control. Linear and Nonlinear controller design of robot. Introduction to robot vision. Application of computer controlled robot in manufacturing and programmable automation.

EEL706 Soft Computing
3 credits (3-0-0)
Pre-requisites: MAL220 / MAL250
Overlaps with: MAL717, MAL720, EEL781
Introduction to Soft Computing: Rationale and Basics of Learning: Neural Networks: Multi-layer Feed-forward Networks, 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.

EEL707 Multimedia Systems
4 credits (3-0-2)
Pre-requisites: EEL205 & EEL358
Multimedia Data Types: Image, audio, video, animation; Compression Technology, System Design: Architecture and Operating Systems, Multimedia Delivery, Content management and retrieval.

EEL708 Information Retrieval
3 credits (3-0-0)
Pre-requisites: CSL201
Introduction – What is IR; Applications and significance; retrieval evaluation; Query Modelling and Query Languages; Indexing and Searching Text; Multimedia IR; Models, indexing, searching; User Interfaces and Visualisation; Distributed IR; Web Search Engines; Digital Libraries.

EEL709 Pattern Recognition
3 credits (3-0-0)
Pre-requisites: MAL250
Introduction – What is Pattern Recognition? Applications and Relation with other fields like Data Mining, Information Retrieval, etc.; Linear Discriminant Functions and its Applications; Bayesian Decision Theory; Maximum-Likelihood and Bayesian Parameter Estimation; Component Analysis, Expectation Maximisation, Hidden Markov Model; Non-parametric Techniques; Nearest Neighbour, K-NN; Non-metric Methods; Decision Trees, ID3, Grammar based Methods; Neural Network Based Approaches; Introduction to Fuzzy Logic Based Techniques; Support Vector Machine; Applications.

EEL710 Coding Theory
3 credits (3-0-0)
Pre-requisites: EEL306
Measure of information; Source coding; Communication channel models; Channel Capacity and coding; Block codes; Cyclic codes; BCH codes; Reed Solomon codes; Convolutional codes; Trellis coded modulation; Introduction to cryptography.

EEL711 Signal Theory
3 credits (3-0-0)
Pre-requisites: EEL306
Deterministic and random signals; Discrete random variables (Bernoulli, binomial, Poisson, geometric, negative binomial, etc.) and their properties like PDF, CDF, MGF; Continuous random variables: Gaussian, multivariate Gaussian; whitening of the Gaussian random vector; complex Gaussian random vector, circularity; Rayleigh and Rician; exponential; chi-squared; gamma; Signal spaces: convergence and continuity; linear spaces, inner product spaces; basis, Gram-Schmidt orthogonalization; Stochastic convergence, law of large numbers, central limit theorem. Random processes: stationarity; mean, correlation, and covariance functions, WSS random process; autocorrelation and cross-correlation functions; transmission of a random process through a linear filter; power spectral density; white random process; Gaussian process; Poisson process.

EEL713 Microwave Theory and Circuits
3 credits (3-0-0)
Pre-requisites: 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 parametrs, signal flow graphs and network representation.Impedance matching and tuning.Analysis of planar transmission lines.Analysis of design of passive components.

EEL714 Information Theory
3 credits (3-0-0)
Pre-requisites: 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 braodcast channel, the relay channel, source coding and rate distortion with side information, multiterminal networks.

EEL715 Image Processing
4 credits (3-0-2)
Pre-requisites: EEL205 and EC 90
Overlaps with: MAL715, CSL783

Introduction to 2-D Signals and Systems. Image Digitization. Image Transforms. Image Data Compression: Transform Domain Coding , Predictive Coding, JPEG. Image Enhancement: Image Restoration: Inverse Filtering, Algebraic Approach to Restoration, Wiener (LMS) approach, Constrained Least Squares Restoration, Interactive and other methods for restoration. Image Reconstruction: The Filtered Back-Projection Algorithm, Algebraic Renconstruction Method. Image Segmentation: Detection of Discontinuities, Edge Linking and Boundary Detection, Thresholding, Region-Oriented Segmentation. Selected Topics of Current Interest (for example multi-resolution analysis, morphological processing etc.).

EEL716 Telecommunication Switching and Transmission
3 credits (3-0-0)
Pre-requisites: EEL306

Basic line circuits, long haul circuits, signaling, switching exchanges, analysis of telecom switching networks, teletraffic engineering, management protocols, multi-service telecom protocols and networks.

EEL718 Statistical Signal Processing
3 credits (3-0-0)
Pre-requisites: MAL250 & EEL205

To provide an introduction to fundamentals of statistical characterization and analysis of signals, ideas of estimation, optimal linear filtering, geometric ideas, autocorrelation matrices and their properties, eigen-analysis, linear prediction, KL-expansion, factorization of autocorrelation matrices, Kalman filtering, least-squares filtering, adaptive filtering theory, LMS, RLS, and other algorithms, Singular Value Decomposition SVD, fundamentals of array signal processing.

EEL741 Modelling and Analysis of Electrical Machines
3 credits (3-0-0)
Pre-requisites: 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.

EEL746 Power Quality
3 credits (3-0-0)
Pre-requisites: EEL303

Overview and definition of power quality (PQ) Sources of pollution, international power quality standards, and regulations, Power quality problems: rapid voltage fluctuations voltage unbalance, voltage dips and voltage swells, short duration outages, Power system harmonics: harmonic analysis, harmonic sources- the static converters, transformer magnetization and non-linearities, rotating machines, arc furnaces, fluorescent lighting. Harmonic effects-within the power system, interference with communication Harmonic measurements. Harmonic elimination-harmonic filters.

EEL749 Special Electromechanical Systems
3 credits (3-0-0)
Pre-requisites: EEL331

Introduction to Special Electrical Machines and Magnetic Devices, Permanent Magnet Machines, Permanent Magnet Brushless DC Machines, Stepper Motors, Hysteresis Motors, Switched Reluctance Motors, Hybrid Motors, Linear Machines, Magnetic Devices, Applications in Robotics, Industry Automation, Electric Vehicles, Aerospace and Defense Systems, etc, Super conducting Machines and Other Advanced machines, Case Studies, Computer Aided Simulation and Design of Special Electrical Machines.

EEL754 Computer Graphics
4 credits (3-0-2)
Pre-requisites: CSL201
Overlaps with: MAL754, CSL781

Elements of a Graphics System; Computer Graphics Hardware; Geometric primitive generation algorithms; Modelling and Viewing transformations; Curve and surface generation : Hermite, Bezier, B-splines; Solid-modelling techniques; Colour Spaces; Rendering : hidden surface removal, ray tracing, texture mapping, radiosity; Image based rendering.

EEL758 Intelligent and Knowledge Based Systems
3 credits (3-0-0)
Pre-requisites: CSL201
Overlaps with: CSL333

Problem solving: State space representation, problem reduction, constraint satisfaction networks. Heuristics. Knowledge Representation, Predicate calculus, resolution-refutation, Prolog. Rule based systems: forward and backward chaining. Handling of uncertainty: probabilistic techniques, fuzzy logic. Reasoning with incomplete information :non monotonic reasoning. Elements of temporal logic. Structured Knowledge Representation schemes: Semantic Networks, Frames, Inheritence and default reasoning. Description Logic. Expert Systems: Architecture of the expert systems. Expert system shells. Knowledge acquisition. Consistency of the knowledge base. Planning. Case studies. Distributed AI and agent based systems.

EEL768 Detection and Estimation Theory
3 credits (3-0-0)
Pre-requisites: EEL306

Detection theory: hypothesis testing, Bayes, minimax, and Neyman-Pearson criteria, signaling in additive Gaussian noise, receiver operating characteristic. M-ary hypothesis testing, MAP and ML decision rules. Estimation of random parameters, MMS and MAP estimates. Estimation of nonrandom parameters, Cramer-Rao inequality, consistent estimate. Bounds on estimation errors, composite hypotheses. Elements of sequential and non-parametric detection. Wiener-Hopf and Kalman filtering.

EEL772 Optimal Control Theory
3 credits (3-0-0)
Pre-requisites: EEL325

Maximization of functionals of a single and several functions using calculus of variations, Constrained extremals, Necessary conditions for optimal control, Linear regulator problems, Pontryagin's minimum principles and state inequality constraints Minimum time problems, Minimum control effort problems, Singular intervals in optimal control problems, The principle of optimality, Application of the principle of optimality to decision making, Dynamic

programming applied to routing problems, Computational steps for solving optimal control problems using dynamic programming, Discrete linear regulator problem, Hamilton - Jacobi -Bellman Equation, Numerical Techniques to determine optimal trajectories, Optimal control of distributed parameter systems.

EEL781 Neural Networks
3 credits (3-0-0)
Pre-requisites: EEL205
Overlaps with: MAL720

Introduction to Biological Neural Networks; Basic anatomy and physiology of a nerve cell; mathematical models of a biological neuron; networks of neurons; a simple model of a neuron and its application to a classification problem; linear separability and linear dichotomies; nonlinearly separable problems; learning with layered networks; backpropagation; recurrent neural networks; the Hopfield network; application to optimization tasks; unsupervised learning – both co-operative and competitive; Oja and Sanger's rules; Principal Component Analysis; Kohonen's Self Organizing Feature Map; applications of unsupervised learning; Reinforcement Learning; Support Vector Machines; Hardware Realization of Neural Systems; Current Trends and Future Directions.

EEL790 Selected Topics in Information and Communication Technology - II
3 credits (3-0-0)
Pre-requisites: CSL201 & EEL205 and EC 90

Topics of interest and recent developments in information and communication technology.

EEL804 Scientific Visualization
3 credits (3-0-0)
Pre-requisites: EEL754/EEL707

Role of visualization in scientific research. History. Computational cycle. Visual metaphors. Visualization pipeline. Data: Acquisition from numerical simulations and measurements. Selection techniques for data preparation. Volume visualization I: marching cubes; ray casting, multimodal rendering. Applications in biology and molecular visualization. Volume visualization II: splatting, Fourier and wavelet volume rendering. Applications in medical imaging. Vector field visualization: experimental methods, surface particles, flow field topology, probing. Applications in flow visualization. Information Visualization. Applications in bioinformatics.

EEL806 Computer Vision
3 credits (3-0-0)
Pre-requisites: EEL205 and EC 120

What is Vision ; Overview of Applications; Camera : Physics of Image Formation, Projective Model of Camera, Camera Calibration; Multiple-view Geometry and Reconstruction; Shape from X (defocus, shading, texture); Motion Analysis and Tracking; Object Recognition and Image Understanding.

EEL818 Access Networks
3 credits (3-0-0)
Pre-requisites: EEL306 and EC 120

The access loop, wired and wireless access, radio access, optical access networks, PONs, access standards, V5.x standards,service provisioning and inter-networking.

EEL851 Special Topics in Computers - I
3 credits (3-0-0)
Pre-requisites: CSL201 and EC 120

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

EEL852 Special Topics in Computers - II
3 credits (3-0-0)
Pre-requisites: CSL201 and EC 120

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

EEL853 Agent Technology
3 credits (3-0-0)
Pre-requisites: CSL201 and EC 120

Introduction: What are agents? Motivating Applications. Agent Architecture. Multi-agent Systems and Agent Societies. Distributed Problem Solving and Planning. Search Algorithms. Distributed Rational Decision Making. Probabilistic Reasoning. Implementing Agent Systems. Development Environments. Programming issues. Mobility and Security. Applications. Information Retrieval, e-Commerce, Industrial Control, Telecommunication System.

EEL854 Protocol Engineering
4 credits (3-0-2)
Pre-requisites: EEL703

Principles, stages, specification formalisms (UML, SDL, ASN.1) of telecom protocol design, protocol software development process, computer aided protocol engineering, verification and testing of protocols, object oriented techniques in protocol development.

EEL855 Internet Technologies
4 credits (3-0-2)
Pre-requisites: EEL703

Introduction to the Internet, comparison of Internet architectures, QoS issues, network applications, encryption, e-commerce, Web enabled systems, virtual reality, multimedia over the Internet.

EEL857 Network Security
4 credits (3-0-2)
Pre-requisites: EEL703

Practical topics in network security, mechanisms for secure networks, policy, intrusion detection, cryptographic protocols, inter-networking security mechanisms, private and public key encryption, IPSEC-Internet Protocol security architecture.

EEL858 Mobile Computing
3 credits (3-0-0)
Pre-requisites: EEL703

Overview of mobile computing, introduction to SS7 and GSM, Wireless Networking Protocol: mobile IP, Adhoc Networks, Adhoc Routing, Wireless Protocols- Wireless TCP, Data Broadcasting, Mobile data management, Location Dependency/Awareness, Disconnected or Weak-connected operations, Adaptations, Mobile Applications and services, User Interface Issues, Security Issues.

EEL859 Network Management
4 credits (3-0-2)
Pre-requisites: EEL703

Network planning, network initialization and configuration management, fault management, usage accounting, and security. The course will also include discussion of some current network and management products. It will also cover the development of network management systems and discuss the role played by network management protocols and products.

EEL861 Selected Topics in Communication Engineering - I
3 credits (3-0-0)
Pre-requisites: EEL306 and EC 120

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

EEL862 Selected Topics in Communication Engineering - II
3 credits (3-0-0)
Pre-requisites: EEL306 and EC 120
Topics of current interest in communication engineering; details will be provided by the instructor.

EEL863 Selected Topics in Communication Engineering - III
3 credits (3-0-0)
Pre-requisites: EEL306 and EC 120
Topics of current interest in communication engineering; details will be provided by the instructor.

EEN110 Introduction to Electrical Engineering
2 credits (0-0-4)
Discussion with faculty about different aspects of Electrical Engineering; practical sessions on Electrical Components, Circuit drawing, PCB design, Winding of transformer, assembly of a motor, disassembly of a computer, assembly of electronic circuits like audio amplifier, radio receiver/transmitter, etc.

EEN120 Introduction to Electrical Engineering (Power)
2 credits (0-0-4)
Discussions with faculty about different aspects of Electrical Power Engineering, practical sessions on electrical components, circuit drawing, PCB design, winding of a transformer, assembly of a motor, etc.

EEP201 Electronics Laboratory - I
1.5 credits (0-0-3)
Pre-requisites: EEL101 / EEL102
The laboratory is divided into two parts. In the first part, the student is required to perform some set experiments to familiarize himself/ herself with basic digital electronic techniques. In the second half of the semester, the student is required to design and fabricate a digital module. A formal presentation of the design is required at the end of the semester.

EEP203 Electromechanics Laboratory
1.5 credits (0-0-3)
Pre-requisites: EEL203
Experiments on Transformers, DC and AC machines.

EEP204 Electronics Laboratory - II
1.5 credits (0-0-3)
Pre-requisites: EEL101 / EEL102
To design and test single stage and multi stage amplifiers, power amplifiers and oscillators on bread board. The students will be given the specification and the design to be verified before wiring up the circuit. The students are encouraged to trouble shoot with hints from the instructor and TAs.

EEP209 Power Electronics Laboratory
1.5 credits (0-0-3)
Pre-requisites: EEL209
Experiments on measurement of turn on and off characteristics of various devices on storage CRO computation of losses. Assembly and testing of converters and inverters on resistive and inductive loads. Fabrication and testing of firing circuits, base and gate drives. Study of turn on and turn off characteristics of junction and MOS devices Performance of low rating boostand buck converters Design and Testing of firing circuits for: (a)Thyristorised boost/buck converters.(b) BJT/IGBT based boost/buck converters Phase controlled operation of a six pulse thyristorised converter, and harmonics analysis of performance. Performance study of a commercial, low rating, BJT PWM inverter, and harmonics analysis of performance.

EEP211 Design (EE)
2 credits (0-0-4)
Pre-requisites: EEL101 / EEL102
Design activities related to various aspects and applications of electrical engineering.

EEP221 Design (EP)
2 credits (0-0-4)
Pre-requisites: EEL101 / EEL102
Design activities related to various aspects and applications of electrical power engineering.

EEP301 Control Engineering Laboratory
1.5 credits (0-0-3)
Pre-requisites: EEL301
First and Second Order Electrical Systems, A.C and D.C Servo Motors, Synchro Characteristics, D.C Integral Servo Systems, Characteristics of Hydraulic Servo, Amplifier and Servo motor, Pneumatic Process Controller, Process Control Simulator, Microprocessor based speed control of stepper motor.

EEP303 Power Engineering Laboratory
1.5 credits (0-0-3)
Pre-requisites: EEL303
Experiments related to EEL303 Power Engineering - I.

EEP305 Drives Laboratory
1.5 credits (0-0-3)
Pre-requisites: EEL305
Experiments related to course EEL305 Electric Drives.

EEP306 Communication Engineering Laboratory
1.5 credits (0-0-3)
Pre-requisites: EEL306
Laboratory experiments on analog, pulse, and basic digital modulation and demodulation techniques.

EEP307 Electromagnetics Laboratory
1.5 credits (0-0-3)
Pre-requisites: EEL207
Laboratory experiments on different transmission lines, antennas, microwave sources and passive devices.

EEP308 Computer Technology Laboratory
1.5 credits (0-0-3)
Pre-requisites: EEL201 & EEP201
Overlaps with: CSL211
Laboratory Experiments will be on: (a) Use of ALU; (b) Design and implementation of special purpose hardware for application specific computation, like HCF; (c) Design and implementation of interfacing hardware, eg. Serial I/O; (d) Assembly Language programming and interfacing experiment with microprocessor/microcontroller kit; (e) Use of Hardware Description Language like VHDL; (f) Controller synthesis on FPGA.

EEP321 Measurements and Instrumentation Laboratory
1.5 credits (0-0-3)
Pre-requisites: EEL212
The laboratory is divided into two parts. In the first part, the student is required to perform some set experiments to familiarize himself with basic electronic techniques. In the second half of the semester, the student is required to design and produce a demonstrable instrument, together with its operating and maintenance manual.

EEP443 FEM Analysis of Machines Laboratory
1.5 credits (0-0-3)
Pre-requisites: EEL203 and EC 90

Review of EM Theory. Basics of finite element analysis. Mesh formulations. Computer platforms and software. Typical case studies of solving electromagnetic, mechanical and thermal problems. Applications in Electromagnets, transformers, relays dc machines, synchronous machines, induction machines, permanent magnet machines, I-Phase machines, reluctance machines. Project exercises on the use of standard software.

EEP446 Electrical Machines and Industrial Drives Laboratory
1.5 credits (0-0-3)
Pre-requisites: EEL203 and EC 90

Experiments related to the course EEL446.

EEP452 Machine Modelling and Simulation Laboratory
1.5 credits (0-0-3)
Pre-requisites: EEL203 and EC 90

Experiments related to modelling and analysis of electrical machines.

EEP467 Computer Control Laboratory
1.5 credits (0-0-3)
Pre-requisites: EEL301

Familiarisation with programmable logic controllers, Testing and debugging of PLC programming, Microcontroller based interfacing, Computer control of inverted pendulum, Exposure of software for mathematical modelling and analysis.

EEP483 Neural Computing Applications to Power Systems Laboratory
1.5 credits (0-0-3)
Pre-requisites: EEL303

Experimental work to complement EEL487 Intelligent Algorithms for Power Systems.

EEP487 Power Quality Laboratory
1.5 credits (0-0-3)
Pre-requisites: EEL303

Experiments on power quality.

EEP488 Power Electronics and Simulation Laboratory
1.5 credits (0-0-3)
Pre-requisites: EEL209 and EC 90

Performance study with parameter testing for various power electronic converter and inverter circuits using simulation packages like PSPICE, PSIM, SIMULINK/MATLAB and advanced SIMULATORS.

EEP493 CAD of Electric Machines Laboratory
1.5 credits (0-0-3)
Pre-requisites: EEL203 and EC 90

Experiments related to EEL359 Electric Machine Design and CAD of Electric Machines.

EEP495 Distribution System Design Laboratory
1.5 credits (0-0-3)
Pre-requisites: EEL303

Distribution substation design; distribution feeder design; protection. Co-ordination of distribution system, load flow, load shedding strategies.

EEP496 Power System Dynamics and Control Laboratory
1.5 credits (0-0-3)
Pre-requisites: EEL303

Swing equation solution of SMIB system. Transient stability simulation of SMIB with excitation. Transient stability simulation of multimachine system. Small signal stability analysis. Power system control.

EEP719 Communication Engineering Laboratory - II
1.5 credits (0-0-3)
Pre-requisites: EEL713

Experiments on microwave measurement techniques, antennas and design of microwave circuits.

EEP752 Software Laboratory
2 credits (0-0-4)
Pre-requisites: CSL201

Exercises on system and application software development. Emphasis on issues involved in object oriented design and development (UML tools), Compiler design and middleware based distributed applications development.

EES310 Independent Study (EE)
3 credits (0-3-0)
Pre-requisites: EC 80

Study of subjects in electrical engineering outside course offerings or research-oriented activities under the guidance of a faculty member. A proposal detailing the envisaged activities will have to be submitted to the dapartment for approval and prior permission obtained to register for the course.

EES320 Independent Study (EP)
3 credits (0-3-0)
Pre-requisites: EC 80

Study of subjects in electrical power engineering outside course offerings or research-oriented activities under the guidance of a faculty member. A proposal detailing the envisaged activities will have to be submitted to the dapartment for approval and prior permission obtained to register for the course.

EET410 Practical Training (EE)
Non credit
Pre-requisites: EC 90 at the end of 5th sem.

Fifty (50) working days or 400 hours of practical training in an industry.

EET420 Practical Training (EP)
Non credit
Pre-requisites: EC 90 at the end of 5th sem.

Fifty (50) working days or 400 hours of practical training in an industry.

EEV401 Special Module in Communication Engineering
1 credit (1-0-0)
Pre-requisites: EEL306 and EC 90

Details will be decided by the course coordinator.

EEV402 Special Module in Power Systems, Machines and Power Electronics
1 credit (1-0-0)
Pre-requisites: EEL203 & EEL303 & EEL209 and EC 90

Details will be decided by the course coordinator.

EEV403 Special Module in Electrical Machines
1 credit (1-0-0)
Pre-requisites: EEL203 and EC 90
Details will be decided by the course coordinator.

EEV404 Special Module in Control Engineering
1 credit (1-0-0)
Pre-requisites: EEL301 and EC 90
Details will be decided by the course coordinator.

EEV405 Special Module in Electronics
1 credit (1-0-0)
Pre-requisites: EEL202 and EC 90
Details will be decided by the course coordinator.

EEV406 Special Module in Power Electronics and Drives
1 credit (1-0-0)
Pre-requisites: EEL209 and EC 90
Details will be decided by the course coordinator.

EEV407 Special Module in Power Systems
1 credit (1-0-0)
Pre-requisites: EEL303 and EC 90
Details will be decided by the course coordinator.

EEV704 Special Module in Computers
1 credit (1-0-0)
Pre-requisites: CSL201 and EC 90
Details will be decided by the course coordinator.

Department of Humanities and Social Sciences

HUL101 English in Practice
3 credits (2-0-2)

Verb structures and patterns, avoiding common errors, vocabulary building, spelling patterns, developing writing skills (composition, letter writing) etc. developing listening skills.

HUL211 Introduction to Economics
4 credits (3-1-0)
Pre-requisites: HUN100

Current economic problems. Alternative economic systems. An overview of the economy. The market mechanism. National product and income. Consumption, savings and investment. Determination of national income. Aggregate demand and supply. Fiscal policy. The nature of money and monetary policy. Inflation and unemployment. Basic concepts of price theory. Determination of price by supply and demand. Elasticity of demand and supply. Theory of production. Theory of costs. Pricing in competitive and monopoly markets. The gains from international trade. Theory of exchange rates. Balance of payments. Economic growth, and development. Inequality and poverty.

HUL212 Microeconomics
4 credits (3-1-0)
Pre-requisites: HUN100

Micro versus macroeconomics. Theory of consumer behavior and demand. Consumer preferences. Indifference curve. Consumer equilibrium. Demand function. Income and substitution effects. The Slutsky equation. Market demand. Elasticities. Average and marginal revenue. Revealed preference theory of firm. Production functions. Law of variable proportions. Laws of return to scale. Isoquants. Input substitution. Equilibrium of the firm. Expansion path. Cost function. Theory of costs. Short Run and Long run costs. Shape of LAC. Economies and diseconomies of scale. Market equilibrium under perfect competition. equilibrium under alternative forms of market. Monopoly: pure and discriminating. Monopolistic competition. Oligopoly.

HUL213 Macroeconomics
4 credits (3-1-0)
Pre-requisites: HUN100

Major economic problems. National income accounting. Expenditure and income approaches to GNP. Measuring inflation and unemployment. Determination of the equilibrium level of income. Consumption function. Investment demand. Aggregate demand and equilibrium output. The multiplier process. Government sector. Fiscal policy. Tax receipts and Transfer payments. Foreign spending. Money, interest and income. Functions of money. Definition of money. Reserve Bank of India and Commercial Banks. Creation of money. The instruments of monetary control. The demand for money. Investment expenditure and rate of interest. The IS curve. Money market and the LM curve. Liquidity trap. The IS-LM model. Derivation of the aggregate demand curve. Monetary and fiscal polices. Keynesian versus monetarist views. The aggregate supply function: Keynesian and classical. Inflation and unemployment. Stagflation. The Phillips curve. The long-run Phillips curve. Inflation expectations. The rational expectations.

HUL214 International Economics
4 credits (3-1-0)
Pre-requisites: HUN100

Trade determination theories. Absolute and comparative advantage. Hackscher-Ohlin theorem and factor price equalizations theorem. New theories of trade. Economic growth and trade. Effects and sources of growth. Rybczynski theorem. Technical progress. Gains from trade and trade policy. Tariffs and quotas. Metzier paradox. Stopler-Samuelson theorem. ERP. Domestic distortions. Infant industry argument. Foreign direct investments. Multinational corporation. International monetary economics. Balance of payments. Exchange rates-fixed versus flexible. Devaluation. Elasticities approach. Absorption approach. Monetary approach. Internal and external balance.

HUL215 Econometric Methods
4 credits (3-1-0)
Pre-requisites: HUN100

Definition, scope and methodology of econometric research. Estimation and testing of hypotheses. Simple linear regression. OLS and its properties. Gauss-Markov theorem. Statistical tests of significance. Multiple regressions. Statistical tests. Heteroskedasticity. Autocorrelation. Multicollinearity. Distributed lagged models. Pooling of time series and cross-section data. Simultaneous equation systems. Identification problem. Estimation methods. ILS, 2SLS. Qualitative and limited dependent variables. Maximum likelihood methods. Forecasting.

HUL216 Indian Economic Problems and Policies
3 credits (2-1-0)
Pre-requisites: HUN100

Performance of the Indian Economy since 1951. Agricultural growth in India. Inter-regional variation in growth of output and productivity. Institutional changes. Technological changes. Farm price policy. Food situation. Recent trends in industrial growth. Industrial and licensing policy. Growth of private sector. Problems of public sector units. Industrial sickness. Policy changes for industrial growth. Economic reforms and liberalization. Population growth. Unemployment and underemployment in India. Main trends in imports and exports. Balance of payments position in recent years. Foreign capital. Indian planning: strategy and objectives. India's five-year plans. Regional planning. Saving and capital formation. Poverty in India. Income inequalities in India. Environmental problems.

HUL231 An Introduction to Literature
4 credits (3-1-0)
Pre-requisites: HUN100

What is literature? This is the central question that the course will address through representational readings from different genres. The focus will be less on any given genre and more on how it becomes possible for the student to reconstruct something called 'literature' through the variety of genres to which he or she is exposed. The course does not presuppose any knowledge of literature though students will be expected to have a strong command of the English language. The actual texts chosen to illustrate the different forms of literature will not be restricted to any particular culture but will be open ended to include any text that will help the class to answer the question of what constitutes the essence of literary representation.

HUL232 Modern Indian Fiction in Translation
4 credits (3-1-0)
Pre-requisites: HUN100

To study the need, the scope and the processes of literary translation, with particular reference to the multilingual nature of Indian society and the predicaments of the bilingual writers in India. Students will be encouraged to work with at least

some texts of their own choice and to present their work in an acceptable format. A preliminary list of the possible texts will be circulated. This list will be open-ended as it will grow and evolve according to the preferences and the inclinations of the people who are actually doing the course.

HUL233 American Literature

4 credits (3-1-0)
Pre-requisites: HUN100

This course aims to acquaint students with a broad spectrum of issues in the culture of the United States that are reflected in its literature. It will include texts written by both white and coloured peoples of the United States including slavery and immigration narratives. Selections of texts include those pertaining to the culture of New England Puritanism, The American Renaissance, Modernism, Postmodernism, etc. It will also look at the relationship between the categories of race, class and gender as critical tools and examine how these tools force us to revaluate the relationship between culture and literature. It will also address the perennial question of the American Dream and the representation questions that this notion gave rise to.

HUL234 Language and Communication

4 credits (3-1-0)
Pre-requisites: HUN100

This course builds the skill sets needed to understand the basics of both language and communication. It is also interested in exploring the relationship between the two categories (language and communication) in order to work out how they relate to each other. It will include introductory concepts in semantics, semiotics, syntax, lexicography, and discourse analysis. It will also include an analysis of philosophical problems of reference, representation, rhetoric, sense, speech acts, and textuality. Students will have to submit a term paper and make an oral presentation on any aspect of language and/or communication that they wish to explore at length. Workshops are also included to help students internalize the concepts of communication to which they have been introduced.

HUL235 Technical Communication

4 credits (3-1-0)
Pre-requisites: HUN100

This course is designed to sensitize students of technology to the importance of communication. The topics covered include the basic principles and models of communication, stylistic considerations in technical writing, types and formats of technical documents, the process of writing technical reports, graphical representation of technical data, technical presentations including the use of media to support technical presentations and collaborative writing. Students will be expected to prepare a technical report and make a short oral presentation.

HUL236 An Introduction to Drama

4 credits (3-1-0)
Pre-requisites: HUN100

This course will introduce students to problems of both dramatic and theatrical representation. It will include readings from both ancient and modern drama and engage with some of the leading theorists of drama from Aristotle to Brecht. Students will be exposed to the generic differences between the different forms of drama like tragedy, comedy, melodrama, farce, etc. Students will be encouraged to stage scenes from well-known plays as a part of their assessment.

HUL237 Contemporary Fiction

3 credits (2-1-0)
Pre-requisites: HUN100

This course aims to acquaint students with fiction written after the modernist era. Much of this fiction is an attempt to shake off the excessive sense of despair that characterized the modernists. It is also preoccupied with the aftermath of World War II, the cold war, the great ideological debates between capitalism and communism, and the return to realist modes of narration despite the persistence of modernist aesthetics. Representative texts will be examined at length to understand and work through the issues listed above.

HUL238 Modern Fiction

4 credits (3-1-0)
Pre-requisites: HUN100

This course is quite demanding in that it expects students to have not only an excellent command of the English language but a preoccupation with the nature of language per se. Since the very essence of modernist aesthetics is based upon a preoccupation with the combinatorial possibilities of language as opposed to referential or instrumental forms of linguistic expression, only students with an excessive capacity for both existential and linguistic self-reflexivity will enjoy the study of modern fiction. Amongst the writers who will be read include Hardy, Joyce, Lawrence and Nabokov though others may also be included if time permits.

HUL239 Indian Writing in English

4 credits (3-1-0)
Pre-requisites: HUN100

The problem of identity as it emerges in Indian English literature during the nation's struggle for freedom and thereafter. The breakdown of the joint family in the wake of independence and its far-reaching consequences. The age-old conflict between arranged marriages/marital bliss and romantic love as a major preoccupation of the Indian writer. The problem of guilt in man torn between a sense of duty toward family and his need to break away from it for self - fulfillment. The impact of the West on Indian society and mind, and its various manifestations in Indian fiction in English as it exists now in courses of study.

HUL240 Indian English Poetry

4 credits (3-1-0)
Pre-requisites: HUN100

The aim of this course will be to read the poems of Indian English Writers (pre and post Independence), with specific reference to the articulation of their identity. Some of the perspectives from which the poems will be discussed include the notion of home (childhood, family and ancestors); land (history, geography, community and contemporary politics); language (the dialogue between the different languages in the creative repertoire of the poets); and culture (ritual, traditions, legends and myths). The course will also look at the differences between the resident and expatriate poets vis-a-vis the conflicts and resolutions as expressed in their poems. An attempt will be made to make this list as culturally and linguistically representative as possible. Students will be expected to choose one poet and make a presentation and write an assignment.

HUL241 Workshop in Creative Writing

4 credits (3-1-0)
Pre-requisites: HUN100

Introduces the concept of creative writing through an analysis of the techniques of writing and stylistics along with explorations in the problem of literary creativity. It also introduces contemporary writing that is relevant to the areas being discussed in the workshop. Students are invited to write in a genre of their choice. Selected readings in the theory and practice of creative writing will be used to brainstorm on what is involved in acquiring a style of writing.

HUL251 Introduction to Logic
4 credits (3-1-0)
Pre-requisites: HUN100

Informal logic: The student is acquainted with the fundamentals of informal logic needed in verbal analysis. Fallacious reasoning and its forms are analyzed and the student comes to recognize the many informal fallacies that are due to the equivocation of language or to a lack of relevance between premises and the conclusion of an argument. Logical systems: Students conceptualize the difference between inductive and deductive argument forms and systems and perform inductive and deductive inferences. They study the formal rules and principles demonstrated in the deductive system of Aristotelian logic. Symbolic logic: The ability to translate ordinary language into symbolic form is acquired and the student constructs arguments in symbolic expression. Philosophy of logic and the role of logic in science: The procedure of scientific explanation is investigated and its methodologies examined.

HUL252 Introduction to Classical Indian Philosophy
4 credits (3-1-0)
Pre-requisites: HUN100

There is no one system, which can be called Indian philosophy. Diversity and healthy dialogue between even antagonistic systems characterizes the classical philosophical scene in India. The course will begin by exploring the worldview implicit in the Vedas, the Upanishads, and the orthodox systems and then move on to the rejection of this entire system in Buddhism and materialism. Instead of presenting the course material in a historical fashion, the focus will be on analyzing the fundamental questions of classical Indian philosophy.

HUL253 Moral Literacy and Moral Choices
4 credits (3-1-0)
Pre-requisites: HUN100

This is primarily a course in applied ethics. It will focus primarily on questions like: What is the meaning of right action? Can ethical assertions be true or false? Is morality relative to society? Or can we say that acts have universal moral content? The course discussions will help to demonstrate that morality is not always self-evident and that rational morality must come in place of taboo based moralities.

HUL254 Art and Technology
4 credits (3-1-0)
Pre-requisites: HUN100

The course will study the nature of the art object comprising both the cognitive and the aesthetic. It will attempt to work out a relation between truth, morality and beauty and differentiate between the beautiful and the sublime. It will also focus on the element of creativity in art, science and technology by examining the differences between the genius and the expert. It will examine the aesthetics of engineering design and the effect of mechanical and electronic reproduction on the nature of the work of art. Finally, it will consider the relationship between media entertainment and information technology by differentiating between media as message and mass deception. Critical strategies to understand the role of power and ideology in information societies will be examined.

HUL255 History of Natural Science: Copernicus to Einstein
4 credits (3-1-0)
Pre-requisites: HUN100

This course will discuss the history of science in the period from the sixteenth century to the twentieth century. The primary focus will be on astronomy, physics, chemistry, and cosmology. Among the issues that are relevant include the non-scientific or metaphysical basis in the construction and maintenance of any scientific paradigm. There will also be discussions on changes in scientific methodology over this period. The major goals of this course are to get a good understanding of some of the topics in the history of science, and to improve our skills in reading, thinking, speaking and writing critically about topics in the history of science.

HUL256 Critical Thinking
3 credits (2-1-0)
Pre-requisites: HUN100

The course will discuss the fundamental questions involved in the study of logic, metaphysics, ethics, and the philosophy of language. It comprises a study of the different theories of truth, the problem of God's existence, the debate between determinism and free will and the differences between theories of sense and reference.

HUL257 Introduction to Philosophy of Science
4 credits (3-1-0)
Pre-requisites: HUN100

The logical nature and reconstruction of scientific explanation and the laws of nature. The nature of scientific evidence. The differences between verification and falsification as forms of scientific validation. The influence of society on the nature of scientific work.

HUL261 Psychological Basis of Behavior
4 credits (3-1-0)
Pre-requisites: HUN100

Psychology as a science and its methods, fields of psychology. Principles of learning. Remembering and forgetting. Thinking: the thinking process, concepts, problem solving, decision-making, creative thinking. Motivation and conflict. The nature of motivation, various types of motives, frustration and conflict. Perception: attention process, form perception, constancy of perception, depth perception, movement perception, the plasticity of perception, factors affecting perception. Personality. Various approaches to personality.

HUL262 Environmental Psychology
4 credits (3-1-0)
Pre-requisites: HUN100

The nature and history of environmental psychology. Environmental perception. Environmental cognition. Environmental attitudes. Performance in learning. Work environments. Coping with environmental stress. Coping with crowding. Privacy and territoriality. Personal space affiliation and support in the urban/rural environment. Environment and behavior: a unifying framework.

HUL263 Organizational Psychology
4 credits (3-1-0)
Pre-requisites: HUN100

Introduction to organizational psychology, its field, methods of study, organizational psychology as an applied behavioral science. Group behavior and individual adjustment. Levels of communication. Types of organizations. Theories of leadership. Motivation and productivity. Tests for selection. Training for employee's growth and development. Effective organizations.

HUL264 Managerial Behavior: Psycho-social Dimensions
4 credits (3-1-0)
Pre-requisites: HUN100

The psychosocial dimensions of work in organizations: introduction and background. Major approaches to

organization analysis, an organizational behavior approach. The early practice of management. Theories of organization. Organizational processes and functions. The structural variables, context and environment of work organization, socio-cultural environment, its impact on organizations. Social dimensions of organizational behavior: formal/informal organizations. Group dynamics and teams. Motivational processes and theories. Communicational technology and interpersonal processes. Leadership processes and Styles. Decision-making. Behaviour implications of decision-making. Behavior oriented decision-making techniques. Creativity and group decision making.

HUL265 Personality and Society
3 credits (2-1-0)
Pre-requisites: HUN100

Coping with stress management. Approaches to the study of personality. Freud's psychoanalytic theory. Jung's analytic theory. Adler's individual psychology, Roger's person centered approach, Lewin's field theory, and Skinner's operant reinforcement theory. Models of healthy personality, the notion of the mature person, the self-actualizing person, etc. Yoga and personality. The problem and value of psychological growth. Psychotherapeutic techniques and Eastern psychology.

HUL266 Industrial Safety: Psychological Dimensions
4 credits (3-1-0)
Pre-requisites: HUN100

Theories/models of accident causation, psychological factors related to cause and effect of accident. Human errors, human factors in the workplace. Safety and health at work. Managing and motivating safety behavior and performance, prevention and control of industrial hazards. Maintaining industrial hygiene. Occupational health management. Employee participation. Training and development of employees. Technology and development. Social responsibilities of administrators, system designers, managers. Issues related to waste management and accidents.

HUL267 Positive Psychology
4 credits (3-1-0)
Pre-requisites: HUN100

Positive Introductory and historical overview, Positive Prevention and Positive therapy; Identifying strengths: Positive directions in diagnosis and intervention; Emotion focused approaches: Subjective well-being, the concept of flow, Self-esteem, positive affectivity, Emotional intelligence and emotional creativity; Cognitive-focused approaches: The role of personal control in adaptive functioning, Well-being, optimism and wisdom; Self-based approaches: authenticity, uniqueness seeking; Interpersonal approaches: empathy, altruism, moral motivation and forgiveness; Biological approaches: Role of neuro-psychology and biopsychology in positive psychology; Specific coping approaches: Meditation, Yoga and spirituality; Special population and setting: Positive psychology for Adolescents and other age groups. Positive psychology in a multicultural context and setting; The future of the field.

HUL271 Sociology: The Science of Praxis
4 credits (3-1-0)
Pre-requisites: HUN100

The rational organization of knowledge and the emergence of sociology as a scientific discipline. Industrial society in Western Europe. Industrialism and its scientific programme. Key thinkers and key perspectives. Science, reform and revolutionary social change. The critics of modernity. Implications of these thinkers for social science and society today.

HUL272 Introduction to the Sociology of India
4 credits (3-1-0)
Pre-requisites: HUN100

This course focuses on understanding the various constructions of Indian society from colonial to contemporary times. The structural and cultural dimensions of Indian society are explored through the study of village, region nation and civilization. Castes and tribes, kinship and family systems, the diversity of religious traditions and organizational forms are explored together with contemporary issues of secularism communalism, religious conversions and caste-based affirmative action. Institutions such as 'purdah' and 'dowry' allow the understanding of the social construction of gender in Indian society.

HUL273 Science, Technology and Society
4 credits (3-1-0)
Pre-requisites: HUN100

The socio-cultural context of the rise of modern science and technology. The West European case since Copernicus (1473-1543). Transfer of science and technology in the colonial and post-colonial period of Asia and other developing countries. Science and technology for world transformation. From dependency to creative autonomy issues of scientific culture and technological civilization. science and technology in modern India. The colonial experiences. Post-Independence development. Criteria for choice of development alternatives for India.

HUL274 Re-thinking the Indian Tradition
4 credits (3-1-0)
Pre-requisites: HUN100

The examination of sources, the structure, the texts and exemplars of the Indian tradition provide the theoretical framework for the discussion of contemporary political and social issues. These are economic development and social justice religion and the nation, communalism and secularism, caste class and gender equity and so on. The political misuse of tradition in programs of reform and revival both in the past and in modern times will be highlighted to underline the need for rethinking tradition in an academically serious manner.

HUL275 Environment, Development and Society
4 credits (3-1-0)
Pre-requisites: HUN100

Comparative perspective on the nature-culture-technology relationship as embodied in human habitats. Nature as sustenance and as 'symbol'; religion, folklore, and ecology. Indigenous systems of natural resource management, the role of development and technological innovation as sources of change, conflicts over the use of natural resources, ethnicity, class and gender. State of environmental resources - land, water, forests, air. Development projects and their environmental implications - Narmada Dam, Green Revolution, Social Forestry, Biotechnology issues feature among the case studies. Environmental protest movements, major environmental accords (North-South perspectives). Engineering and environmental ethics.

HUL276 Sociology of Knowledge
4 credits (3-1-0)
Pre-requisites: HUN100

The de-mystification of science as a privileged form of

knowledge since Copernicus. Re-examining the laboratory, the factory and the nation-state, structures linked to the West-European model of science. Examining systems deemed ethno-science or folk-lore, to set up a dialogue with institutionalized science. Comparing science with religion as forms of knowledge having competing power over human belief and action. Examining Traditional Knowledge (TK) systems and their relevance for global economy.

HUL281 Mind, Machines and Language
4 credits (3-1-0)
Pre-requisites: HUN100

What is the role of language in the cognitive sciences? What are the implications of conceiving the mind as a machine (computer)? Can theories about language acquisition help us to understand the ways in which humans perceive the world? Finally, how are the three categories (mind, machine and language) related to each other? These are a few of the fundamental questions that will be posed in this course. It will benefit any student who wishes to think systematically the cognitive structures that he or she inhabits but otherwise takes for granted.

HUL282 System and Structure: An Introduction to Communication Theory
4 credits (3-1-0)
Pre-requisites: HUN100

This course is an introduction to theories of communication for which there is not sufficient time in the other communication courses, which are mainly applied in their orientation. This is an interdisciplinary course. It will examine how the notion of communication is used in different disciplines in the humanities and the social sciences. It will intersect with problems of organizational structure, linguistic structure, interpersonal structure and the problem of what is involved in changing a structure. This course will include no components of remedial English, business correspondence or skill building activities. Only those really interested in theoretical questions should enroll.

HUL283 Industrial Organizations
4 credits (3-1-0)
Pre-requisites: HUN100

Individuals, organization and their interaction. The development of individual organization relationships: Choice. Adaptation development processes. Influence on work behavior: structural factors. Structure and context in organizational design. Design of work. Influence on work behavior: organizational practices and social processes. Evaluating and rewarding work effectiveness. Social influences on members and work effectiveness. Improving organizational effectiveness: methods and goals of organizational change. Organizational renewal process.

HUL284 Participative Management
4 credits (3-1-0)
Pre-requisites: HUN100

Participative management: historical development, philosophy, theoretical framework. Psychosocial factors in participative management as an industrial relations system. Technology for participative management systems. Participative management in India: its successes and failures. Implementation strategy in the Indian context. Participative management and job design. Participative management as a strategy for quality of work life.

HUL285 Social Responsibilities of Scientists and Technologists
4 credits (3-1-0)
Pre-requisites: HUN100

The concept of social responsibilities and its relevance. The development of the field. The systems approach and multidisciplinary nature of the issue systems, methodology and planning for social responsibilities. The social sub-system and science and technology. The human sub-system and science and technology. Other methodological aspects. Ethics issues in science and technology.

HUL286 Social Science Approaches to Development
3 credits (2-1-0)
Pre-requisites: HUN100

Historical genesis and theories of development and underdevelopment. Comparative paths of development. Soviet Union, Japan, China. India's path of planning and socialism: development experience in the post independence period. Explanations of the poor achievements of India's economy in meeting basic needs for several decades after independence. Social indicators of development, problems of poverty and inequality. Economic reforms and liberalization. Panchayati Raj and decentralization. Role of religion, caste and family in development. Interrogation of the accepted paradigm of development from the point of view of gender, environment and poverty issues. Appropriate technology and development.

HUL287 Industry and Work Culture under Globalization
4 credits (3-1-0)
Pre-requisites: HUN100

The course will focus on the sociological dimensions of industry under globalization. Changing nature of industrial organization (changes in production processes-horizontal and vertical integration), emergence of new industries, changing rhythms and forms of work, the work culture and the decline of organized industry; the growing importance of the informal sector and the implication of these changes for family and society will be discussed. The transnational nature of much of contemporary industry-new phenomena such as out sourcing, call centers etc, Industry and global governance (WTO) the new international division of labor. Education and industry linkages, rise of the consumer society and its sociological implications for industry.

HUL288 Science and Humanism: Towards a Unified World View
4 credits (3-1-0)
Pre-requisites: HUN100

Introduction and orientation to the development of science up to the 19th century and the concomitant worldview. Traditional conflict between science and religion - its causes and consequences. Role of science as a promoter of human values. Humanism and its true basis. New paradigm emerging from the 20th century Developments in science and the implications of the complementarity of science and humanism- the need for inner development. Education, development, and planning with the new unified worldview.

HUL289 Macro Perspective on Science, Technology and Human Development
4 credits (3-1-0)
Pre-requisites: HUN100

The dynamics of scientific discovery, technological innovation and its application to the human scene. Case histories of some recent developments in physical and biological sciences and their impact on communications, health care, education and defence, interlinking issues such as protection of the environment and avoidance of potential catastrophes arising out of side effects, techniques of conflict

analysis and resolutions of Indian thinkers to the development and application of these techniques, the respective roles of the individual and the social organizations in anticipating and solving problems as well as in optimizing the application of science and technology towards human development.

HUL290 Technology and Culture

4 credits (3-1-0)
Pre-requisites: HUN100

To examine the relationship between technology and culture through a consideration of modern/current developments in various specific areas: e.g. Biotechnology and Medicine, IT, AI & Robotics, Fashion Technology, Magic Technology, Communications, Defense and Space Research.

To focus on the roles played by the IITs themselves in creating 'knowledge societies' - that is, in influencing, formulating and envisioning the links between technological 'solutions' and socio-cultural 'problems' especially in the Indian context. Here we will discuss, for example: Patent Laws, Gender Issues, Environmental Ethics, Design(er) and Person(al) Technological Aesthetics, Technologies for the Disabled, Educational Technologies.

HUN100 Introduction to Humanities and Social Sciences

1 credit (1-0-0)

This introductory course will expose students to the basic concepts, debates, issues, ideas, and the problems of methodology in the different disciplines of Humanities and Social Sciences like Economics, English, Philosophy, Psychology, and Sociology.

HUP102 Psychology Laboratory

1 credit (0-0-2)

To familiarize students with psychological concepts through practical training in a laboratory through experiments pertaining to cognitive psychology, environmental psychology and physiological psychology.

Department of Management Studies

SML100 Introduction to Entrepreneurial Ventures
4 credits (3-1-0)

Nature, Need, Scope and Characteristics of Entrepreneurship. Indian Economic and Industrial Heritage and Entrepreneurial Development. Current economic and Industrial environment with special reference to Entrepreneurial Ventures.

Choice of Technology.

The need, scope and approaches for Project Formulation, Biography of Indian Entrepreneurs.

Elements of Production Process. Production Planning. Leadership. Group Dynamics. Time Management. Elements of Technical Entrepreneurship. Understanding Human Behavior.

Achievement Motivation. Creativity- coping with uncertainties. Attitude towards Wealth and Work. Small-Medium-Large scale enterprise linkage.

SML101 Management Concepts and Techniques - An Introduction
4 credits (3-1-0)

Introduction to Management Theory; the system approach to management. Systems methodology. Management style. Managers and their external environment. Introduction to planning: Nature and scope of planning, Type of planning, Long and short-term plans. Decision-making. Systems approach to decision-making.

Organizing: Basic departmentation. Line and staff authority relationships. Functions of leadership, Nature of leadership, Control: The system and process of control, Control techniques, Control of overall perfomance.

Introduction to functional areas of management: Operation Management, Financial Management, Marketing Management, Human Resources Management and Organization Management.

SML301 Entrepreneurial Operations
4 credits (3-1-0)
Pre- requisites : EC 60

Entrepreneurship in India; The Operating cycle; Market Segmentation; Market Research; Test Marketing; Essentials of Costing & Pricing; Working Capital Management; Break even Analysis; Product Development; Production Planning and Control; Materials Management; Selection and Recruitment Group Dynamics; Delegation; Industrial Policy; Project Identification; Techno Economic Feasibility Report.

SML302 Entrepreneurship Management
4 credits (3-1-0)
Pre-requisites : EC 60

Self employment need and mode. Structural base of Indian economic life. Industrial sector in the national developmental life. Indices of technical entrepreneurship. Opportunity identification and opportunity generation for technical entrepreneurship. Problem solving, decision-making, conflict and change in a new industrial enterprise. Systems consideration in an entrepreneurial venture. Management reporting and information systems of a new business enterprise. Preparing for an entrepreneurial career. Issues in resource management. Managing innovations.

SML303 Cost Analysis and Control
4 credits (3-1-0)
Pre- requisites: EC 60

Meaning, nature and managerial need of cost analysis. Cost concepts and cost classification relating to income determination, profit planning, control and decision-making.

Elements of costs-material, labour and overheads. Allocation, absorption and apportionment of overheads; methods of allocation of overheads.

Cost accounting systems-process and job (contract, unit and operating). Costing for joint products and by-products. Full costing system. Variable costing, differential costing and decision-making. Budget and budgetary control; preparation of operating budgets, fixed and flexible budgets, cash budget. Cost-volume-profit relationship and profit planning. Standard costing and variance analysis.

SML304 Introduction to Marketing Management
4 credits (3-1-0)
Pre- requisites: EC 60

Marketing Orientation; Consumer Behaviour; Segmentation; Forecasting product life cycle; Product decision; Pricing decision; Promotion; Distribution; Sales management; Marketing Information Systems; Market Planning and Control; Market Research; Cases and Exercises.

SML305 Organization of Engineering Systems and Human Resources Management
4 credits (3-1-0)
Pre- requisites: EC 60

Understanding organization. Concerns of organizing engineering business and systems: Structure, processes, design issues in running engineering organization, operating organization. Cybernetics, and socio-technical systems, issues of efficiency and excellence: Man-machine relationship, concerns of recruitment, selection, skill formation and redeployment, developing teams and leadership. Understanding motivation and human resources planning. Indian Industrial law; Managing industrial relations.

SML306 Manufacturing Systems Management
4 credits (3-1-0)
Pre- requisites: EC 60
Overlaps with : MEL421, MEL322

Essentials of Manufacturing Management, Manufacturing Systems Classification, Operations Capacity Planning; Facilities Design-Location, Layout & materials handling; Assembly line Balancing; Organizing Conversion System; Productivity Improvement Techniques; Scheduling Production & Service. Systems, Production Planning & Inventory Control, Material Requirements Planning; Quality Management; Advanced Manufacturing System-Introduction to FMS, JIT; CIM, WCM; Maintenance Management, Applications of Operations Research Techniques to Manufacturing Systems Management. Case Studies.

SML307 Information Systems for Managerial Decision-making
4 credits (3-1-0)
Pre- requisites : EC 60

Role of Information in Managerial decision-making; Information Needs for various Levels of Managerial Decision makers; Computer Based Information Systems-Office Automation Systems; Transaction Processing Systems; Functional Information Systems, Information Systems Planning,

Design & Implementation; Structured Systems Analysis & Design; Object oriented Design; Evaluation of an Information Systems; Introduction to Decision Support Systems; User Involvement & End User Computing. Case Studies.

SML401 Managerial Accounting and Financial Management

4 credits (3-1-0)
Pre- requisites : EC 90
Overlaps with: SML303

Accounting principles underlying preparation of financial statements, Managerial uses of financial data. Ratio analysis and interpretation of financial statements. Cost Concepts. Cost volume-profit relationship and profit planning. Break even analysis. Incremental analysis and managerial decisions. Budgetary control system and preparation of various types of budgets. Time value of money. Cost of capital and capital budgeting. Determinants of working capital and its measurements. Cash management. Receivables management.

Introduction to International Finance; Risk Management in International Operations.

SML402 Industrial Marketing Management

4 credits (3-1-0)
Pre- requisites : EC 90

Fundamentals of Industrial Marketing: Industrial Buyer Behaviour Models: Decision-making Units; Technology and Marketing; System Selling; Role of Service; Intangibles in Industrial Marketing, Derived Demand Methodologies; Globalization; Contract Review; Selling; Strategies for Diversification; Market Planning and Direct Restructuring; Marketing Strategy; Case Studies.

Department of Mathematics

MAC450 Colloquium (MT)
3 credits (0-3-0)
Pre-requisites: registered for MAT450
Students will present seminars on topics of their interest including one on the training taken in the previous summer.

MAD35O Mini Project (MT)
3 credits (0-0-6)
Pre-requisites: EC 80
Design/fabrication/implementation work under the guidance of a faculty member. Prior to registration, a detailed plan of work should be submitted by the student to the Head of the Department for approval.

MAD851 Major Project Part 1 (MT)
6 credits (0-0-12)
Pre-requisites: EC 165
A student will take up project under the guidance of a faculty member in an area of the student's choice. Projects are to be executed individually.

MAD852 Major Project Part 2 (MT)
14 credits (0-0-28)
Pre-requisites: MAD851
Students will continue with the projects taken up in the first part, MAD851, under the guidance of the same faculty member.

MAD853 Major Project Part 1 (MT)
4 credits (0-0-8)
Pre-requisites: EC 165
A student will take up project under the guidance of a faculty member in an area of the student's choice. Projects are to be executed individually.

MAD854 Major Project Part 2 (MT)
16 credits (0-0-32)
Pre-requisites: MAD853
Students will continue with the projects taken up in the first part, MAD853, under the guidance of the same faculty member.

MAL110 Mathematics - I
4 credits (3-1-0)
Overlaps with: MAL111, MAL115
Taylor's theorem and infinite series. Fundamental theorem of integral calculus. Applications of definite integral to area, arc length, surface area and volume. Differential calculus of functions of several variables with applications; Maxima and minima; Ordinary differential equations of first and higher order; Series solution for Legendre and Bessel equations. Laplace transform.

Rank and inverse of a matrix, consistency of linear system of equations; Eigen values, Eigen vectors and their applications to system of ordinary differential equations; Cayley-Hamilton theorem; Diagonalization of matrices.

MAL111 Introduction to Analysis and Differential Equations
4 credits (3-1-0)
Overlaps with: MAL110, MAL115
Product of sets; mappings and their compositions; denumerable sets' upper and lower bounds, supremum, infimum.

Metric spaces: Definition and examples, open and closed subsets; neighborhoods, interior, boundary, closure, diameter of a subset, boundedness, separability. Convergence and limit of a sequence, Cauchy sequence, complete spaces. Continuous functions, bounded functions, intermediate-value theorem. Compactness in metric spaces.

Differential, differentiability, Leibniz rule, Taylor theorem, indeterminate forms, Extrema of functions. Riemann integral: Properties, Fundamental theorem of integral calculus. Applications to arc length, volume and surface area; Improper integrals. Limit and continuity of functions of several variables. Partial derivative and total differential. Composite functions; equality of mixed derivatives; Taylor's theorem; extrema and saddle points; implicit functions, Jacobian.

Solution of $dy/dx = f(x, y)$; linear differential operator L, higher order ordinary differential equation with constant coefficients: Wronskian, solution space; Euler's equation; boundary value problem; initial value problem – existence and uniqueness theorem.

MAL115 Multivariable Calculus and Matrix Theory
4 credits (3-1-0)
Overlaps with: MAL110, MAL111
The Riemann integral definition and properties. The fundamental theorem of integral calculus, applications and improper integrals; Gamma function. Existence properties, Sequence and series of functions, Power series, Properties of functions represented by power series, Fourier series.

Scalar and vector valued functions of several variables: limits, continuity, partial derivatives, differentiability, Jacobian, Implicit differentiation, gradient and directional derivative, Taylor's theorem in one and several variables, maxima and minima, constrained extrema and Lagrange multipliers.

Multiple integrals: definitions, properties, evaluation and applications of double integrals (in Cartesian and polar coordinates) and triple integrals (Cartesian, cylindrical and spherical coordinates), line integrals, Green's theorem; Proof, first and second forms, Applications, Surface integrals, Gauss theorem; proof and extensions; Volume integrals, Stokes' theorem; Proof and applications.

Row reduced Echelon matrices, rank of a matrix, systems of linear algebraic equations, Eigen values and Eigen vectors. Diagonalization of matrices, Hermetian, Unitary and Normal matrices, Bilinear and Quadratic forms.

MAL120 Mathematics - II
4 credits (3-1-0)
Overlaps with: MAL122, MAL124
Vector Field Theory: Vector calculus, arc length, directional derivative, gradient, curl, divergence, line and double integral, Green's theorem, surface integral, triple integral, Gauss and Stokes' theorems with applications.

Complex analysis: Limit and derivative of a function, analytic function, Cauchy-Riemann equations, elementary functions, line integral, Cauchy's integral theorem, Cauchy's integral formula, derivatives of analytic function, convergence of sequence and series, power series, Taylor series, Laurent series, zeros and singularities, residues and residue theorem, evaluation of real integrals, Conformal mapping, Linear fractional transformations, mapping by elementary functions.

Fourier series, Fourier integrals and Fourier transforms.

MAL122 Real and Complex Analysis
4 credits (3-1-0)
Overlaps with: MAL120, MAL124
Metric spaces: Definition and examples, open, closed and

bounded sets; closure, interior and boundary, convergence and completeness; Bolzano-Weierstass theorem, completeness of R, Continuity and uniform continuity, connectedness, compactness and separability.

Limits, continuity and differentiability of functions of a single complex variable, analytic functions, the Cauchy-Riemann equations. Definition of integral, Proofs of Cauchy's integral theorem, Integral formula and derivatives of analytic functions, Morera's and Liouville's theorems, Maximum modulus principle, Taylor's and Laurent series. Isolated singular points. Cauchy residue theorem: proof and evaluation of real integrals. Conformal and bilinear mappings.

MAL124 Introduction to Algebra and Matrix Analysis
4 credits (3-1-0)
Overlaps with: MAL120, MAL122

Group theory: Groups, subgroups, Normal subgroups, Factor subgroups, Lagrange theorem, Homomorphism and Isomorphism theorems, Permutation groups, Matrix groups, Abelian groups.

Rings and Fields, Ideals, Homomorphism, Euclidean domains, Finite and Infinite fields, Polynomial rings Matrix rings.

Linear Algebra and Matrix Theory: Vector spaces, subspaces, direct sums, bases and dimension, Linear transformation, Matrix of the linear transformation, Change of basis, Eigen values and Eigen vectors, The Characteristic and Minimal polynomials, Diagonalization.

Finite dimensional inner product spaces, Graham Schmidt orthogonalization process, Linear functionals, Adjoints of linear operators. Self-adjoint and normal linear operators. Normal linear spaces, Examples of Banach and Hilbert spaces.

MAL140 Probability and Statistics
4 credits (3-1-0)
Overlaps with: MAL220, MAL250

Probability, Conditional probability, random variables, expected value, Specific discrete and continuous distributions, e.g. binomial, Poisson, geometric, Pascal, hypergeometric, Uniform, exponential and normal, Poisson process, Multidimensional random variables, Multinomial and bivariate normal distributions, moment generating function, Law of large numbers and central limit theorem, Sampling distributions, Point and interval estimation, Testing of hypothesis, Goodness of fit and contingency tables. Linear regression.

MAL145 Number Theory
4 credits (3-1-0)

Congruences, Arithmetical functions, Theory of partitions, Diophantine approximations, Binary quadratic forms, diophantine equations, Distributions of primes.

MAL146 Combinatorics
4 credits (3-1-0)
Overlaps with: MAL147

Dilworth's theorem and external set theory, partitions, latin squares, Hadamard matrices and Reed-Muller codes, (0,1) matrices and min-max theorems, codes and designs, projective and combinatorial geometries, Polya's theory of counting.

MAL147 Combinatorial Mathematics
4 credits (3-1-0)
Overlaps with: MAL146

Elementary counting; Recursions and generating functions; Principle of Inclusion and Exclusion; Inversion formula; Cayley's Tree theorem; Colourings of graphs; Ramsey's theorem; Basics of Ramsey numbers; Turan's theorem and external graph theory; system of distinct representatives and Hall's marriage theorem; Harems and tournaments.

MAL180 Discrete Mathematical Structures
4 credits (3-1-0)
Overlaps with: CSL105

Propositional Logic: Language of Propositional logic, truth table, natural deduction, Predicate logic: language of predicate logic, Logical inference with Quantifiers. Proof Techniques; Combinatorics: Counting techniques: recurrence relation and its application to analysis of algorithm; Basic Discrete Probability, probabilistic counting. Graph theory: Graph as a discrete structure, Modelling applications using Graphs, Hamiltonian graphs, Planar graphs, Graph colouring, Network flows, Matching. Algebra: Groups and Examples, Cosets and Normal subgroups, Lagrange theorem, cyclic groups, permutation groups, Finite Abelan groups, Homomorphisms, Matrix groups. Rings, Ideals, Firleds, Finite fields, Polynomial rings, Unique Factorization. Introduction to lattices and Boolean algebra.

MAL210 Optimization Methods and Applications
4 credits (3-1-0)
Pre-requisites: MAL110/ MAL111/ MAL115

Linear programming problem, SIMPLEX algorithm, duality, transportation and assignment problems. Integer linear programming problem, branch and bound and cutting plane methods. Karmarkar's algorithm for linear programming. Non-linear programming problem, Karush-Kuhn-Tucker conditions and duality in non-linear programming, Wolf's method for quadratic programming. Applications of linear, integer and quadratic programming to various areas of science and engineering. Fuzzy linear programming.

MAL220 Basic Probability and Statistical Inference
4 credits (3-1-0)
Pre-requisites: MAL110/ MAL111/ MAL120
Overlaps with: MAL140/MAL250

Probability space, Conditional probability, Random variable, distribution function, pmf and pdf, Standard probability distributions, multidimensional random variables, marginal and conditional probability distribution, independence of random variables, bivariate normal and multinomial distributions, functions of one and more random variables, Expectation, moments, and moment generating functions, correlation, moment inequalities, Markov and Chebychev inequality, conditional expectation and regression, random sums, convergence in probability, Weak Law of Large Numbers, Central Limit Theorem, Sampling Distributions, unbiased and consistent estimators, moment and maximum likelihood estimators, interval estimation, simple and composite statistical hypotheses, power of statistical test, standard statistical tests for population means, variances and proportions, Tests of goodness of fit and linearity of regression.

MAL230 Numerical Methods and Computation
4 credits (3-1-0)
Pre-requisites: MAL110/ MAL111/ MAL115

Errors in computation, instability. Nonlinear equation in one variable: direct and iterative methods, order of convergence. Iterative methods for systems of nonlinear equations. Linear systems of equations direct and iterative methods, rate of convergence of iterative methods, ill-conditionedness of systems and condition numbers. Interpolation: Lagrange, Newton divided difference formula, equispaced Newton's interpolations, errors in interpolation. Approximation: least square and uniform approximations. Differentiation: differentiation using interpolation formulas.

Integration using interpolation: Newton-Cotes formulas, Gauss quadrature rules. Ordinary differential equations: Taylor, Euler and Runge-Kutta formulas. Computer implementation of the methods.

MAL240 Algebra
4 credits (3-1-0)
Pre-requisites: MAL110/ MAL111/ MAL115/ MAL124

Definition and examples of group, rings and fields; Subgroups. Normal subgroups and factor groups, Isomorphism theorems. Sylow theorems of finite groups and applications, Fundamental theorem for finitely generated Abelian groups. Nilpotent and solvable groups.

Commutative rings, Prime ideals, Maximal ideals, Polynomial rings in several variables. Algebraic field extensions, Splitting fields, Finite separable and normal extensions, Fundamental theorem of Galois theory.

MAL245 Topology and Functional Analysis
4 credits (3-1-0)
Pre-requisites: MAL122

Basic concepts of toplogical spaces, continuous functions and homeomorphisms. Hausdorff, Tychonoff and normal spaces. Compactness and connectedness. Normed linear spaces and Banach spaces. Hahn-Banach Theorem, Open mapping theorem and Closed graph theorem. Principle of uniform boundedness. Hilbert Spaces, orthogonal complements and direct sums, othonormal sets. Reisz representation theorem, self adjoint, unitary and normal linear operators.

MAL250 Introduction to Probability Theory and Stochastic Processes
4 credits (3-1-0)
Pre-requisites: MAL110/ MAL111/ MAL115/ MAL120/ MAL122/ MAL124
Overlaps with: MAL140/MAL220

Axioms of probability, Probability space, conditional probability, independence, Baye's rule, Repeated trials, Bernoulli trials, Random variables: discrete r.v., probability mass functions, c.d.f., common distributions, continuous r.v., probability density and distributions of r.v., joint distributions, order statistics, expectation; moments, transforms, conditional expectations, stochastic processes, Markov chains and Markov processes (birth, death, etc.), Queuing models.

MAL255 Linear Algebra
4 credits (3-1-0)
Pre-requisites: MAL110/ MAL111/ MAL115
Overlaps with: EPL333

Finite dimensional vector spaces over arbitrary fields. Linear independence, basis, dimension. Direct sum of subspaces. Linear transformations and their matrices. The minimal and the characteristic polynomials. Eigen values, eigen vectors and digonalization of linear transformations. The primary decomposition theorem. Rational and Jordan forms. Inner product spaces. Hermitian, unitary and normal linear operators. Spectral theorem and polar decomposition. Bilinear and quadratic forms. Digonalization of symmetric bilinear forms.

MAL256 Modern Algebra
4 credits (3-1-0)
Pre-requisites: MAL110/ MAL115/ MAL111
Overlaps with: MAL124

Monoids, Groups and Group actions. Lagrange's theorem, Cyclic groups. Linear Groups. Permutation groups. Isomorphism theorems. Automorphisms. Direct products. Fundamental Theorem for Finitely Generated Abelian Groups. Sylow Theorems and their applications. Free groups. Rings and Fields. Principal ideal domains, Euclidean domains, Unique factorization domains. Polynomial rings, Modules over commutative rings. Field extensions. Splitting fields. Roots of unity and Cyclotomic field extensions.

Normal and separable field extensions. Galois theory. Basic concepts of categories and functors.

MAL260 Boundary Value Problems
4 credits (3-1-0)
Pre-requisites: (MAL110/ MAL111/ MAL115) & (MAL120/ MAL122/ MAL124)

Boundary Value Problems, existence and uniqueness of solution, shooting method, finite difference method, orthogonal set of functions, regular and singular Strum Liouville problems, Eigen function expansions, Green's functions, equivalent integral equations and numerical methods for their solution, analytic and numerical solution of BVPs in PDEs, Ritz Galerkin and Collocation Methods.

MAL311 Parallel Algorithms
4 credits (3-0-2)
Pre-requisites: MAL230

Parallel architecture: shared/local memory systems, pipelining, hypercubes, mesh toroidal, etc. Degree of parallelism, speed up (Sp) and efficiency (Ep) of a parallel algorithm. Parallel algorithms: Searching and sorting, prime finding algorithm, matrix vector and matrix – matrix multiplication for dense, band and triangular matrices. Parallel algorithms for direct methods for dense, band and triangular matrices. Choleski method solving recurrence relations. Parallel interactive methods for finite difference equations of elliptic boundary value problems: point-Jacobi, line Jacobi, block-Jacobi methods, 2-colour and multicolour Gauss-Seidel, SOR, SSOR methods. Domain decomposition method in one and two dimensions. Parallel preconditioned conjugate gradient methods. Quadrant interlocking factorization.

MAL335 Differential Equations: Theory and Numerical Methods
4 credits (3-1-0)
Pre-requisites: (MAL115/ MAL110/ MAL111) & (MAL120/ MAL122 & MAL230)
Overlaps with: EPL333

IVPs for scalar and system of ODEs, existence and uniqueness, method of solving higher order ode's with constant coefficients, Laplace transform and applications to IVPs, regular singular points , Frobenius method, regular and singular Strum Liouville problems. Numerical methods for solving IVPs: Difference equations, Routh-Hurwitz criterion, Test Equation. Single step methods: Taylor series method, explicit Runge-Kutta methods, convergence, order, relative and absolute stability. Multistep methods: Development of linear multistep method using interpolation and undetermined parameter approach, convergence, order, relative and absolute stability, Predictor Corrector methods.

MAL341 File Structures and Information Systems Design
4 credits (3-0-2)
Pre-requisites: CSL201

Secondary storage media, blocking, buffering, External sorting techniques, Concept of a file, primary key and secondary key, sequential, Indexed and relative file organizations. Updation of indexed sequential and random access files, Creation and Updation of relative files, dynamic hashing techniques, list structure, multiring and inverted files, grid files, etc. Introduction to concurrent operations on the structures.

MAL342 Analysis and Design of Algorithms
4 credits (3-1-0)
Pre-requisites: CSL201
Overlaps with: CSL356

Algorithm Fundamentals: space and time complexities, asymptotic notations, randomized algorithms; Basic Algorithms for Different Data Structures: linear, non-linear, priority queues, graphs and their analysis; Divide and Conquer Algorithms - Master theorem; Sorting Algorithms -lower bound, sorting in linear time; Greedy Methods - knapsack, minimum cost spanning trees, single source shortest paths, Huffman coding; Dynamic Programming - matrix multiplication, Travelling salesman, 0/1 knapsack; Search Techniques - depth-first, breadth first, heuristic search algorithms, backtracking and bounding; NP- completeness.

MAL353 Algebraic Methods in Computer Science
4 credits (3-1-0)
Pre-requisites: MAL124 / MAL180

Universal Algebra: Basic constructions, equationally defined classes of algebras, implicationally defined classes of algebras. Algebraic specifications of abstract data types, algebraic semantics of recursive programme schemes, applications of universal algebra to structural aspects such as syntax and semantics, data abstraction, etc. Group theoretical methods in computer science in general and in image processing, image understanding and computer vision in particular. Representation Theory of the classical groups SO(2), SO(3), and SU(2), and applications. Algebraic and projective invariants in computer vision.

MAL355 Partial Differential Equations: Theory and Computation
4 credits (3-1-0)
Pre-requisites: (MAL115/ MAL120 /MAL111) & (MAL230)

Theory : First order equations, Cauchy Kowalewski theorem.

Classification of second order equations. Characteristics, uniqueness theorems for hyperbolic equations with initial and boundary conditions, elliptic equations, Dirichlet and Neumann problems, Maximum and minimum theorem, Poisson's integral, Green's and Neumann's functions. heat equations.

Computation: Parabolic and hyperbolic equations, finite difference methods. Iterative methods, split operator methods, Convergence, stability and consistency of difference methods. Elliptic equations, Self adjoint elliptic equations and elliptic equations with mixed partial derivatives.

MAL358 Operating Systems
4 credits (3-0-2)
Pre-requisites: EEL308
Overlaps with: MAL708/EEL358/CSL373

Operating System components, process creation, management and scheduling in a multiprogramming, multiprocessing, and multitasking system; inter-process communication mechanisms, virtual storage; interactive and batch processing; file management facilities; distributed operating system design issues; load distribution in distributed operating systems; network file system management.

MAL365 Mathematical Programming Techniques
4 credits (3-1-0)
Pre-requisites: EC 60
Overlaps with: CSL856

Upper bound techniques, Fractional programming, convex programming, networks, Multi criteria decision making, Goal programming, Search and gradient methods, Complexity, Karmarkar's algorithm for linear programming, Game theory.

MAL373 Wavelet and Applications
4 credits (3-1-0)
Pre-requisites: EC 60

Fourier transform of square integrable functions, Riesz Fischer theorem, Integral wavelet transform, orthogonal bases of wavelets, multi resolution analysis, compactly supported wavelets, cardinal spline wavelets, fast wavelet transform, numerical algorithms, recent developments and applications.

MAL375 Programming Languages
4 credits (3-0-2)
Pre-requisites: CSL201
Overlaps with: CSL302

Language Definition and Processing - syntax, semantics, translation issues; Data abstraction - encapsulation, storage management, inheritance; Control constructs - sequence control, subprogram control, parameter passing, runtime structures and operating environments; Issues of Language Design - Chomsky hierarchy, features of imperative and functional languages, features of object -based languages; untyped and simply-typed Lambda calculus, Study of a functional language; Meta languages and SML, Logic Programming languages and Prolog.

MAL376 Graph Algorithms
4 credits (3-1-0)
Pre-requisites: CSL201
Overlaps with: CSL851, MAL468

Introduction to Graphs: Definition and basic concepts, Efficient representations of Graphs; Graph Searching: DFS and BFS; Application of Graph Searching: finding connected components, bi-connected components, testing for bipartite graphs, finding cycle in graph; Trees: Different MST algorithms, enumeration of all spanning trees of a graph;

Paths and Distance in Graphs: Single source shortest path problem, All pairs shortest path problem, center and median of a graph, activity digraph and critical path; Hamiltonian Graphs: sufficient conditions for Hamiltonian graphs, traveling Salesman problem; Eulerian Graphs: characterization of Eulerian graphs, construction of Eulerian tour, The Chinese Postman problem; Planar Graphs: properties of planar graphs, a planarity testing algorithms; Graph Coloring: vertex coloring, chromatic polynomials, edge colouring, planar graph coloring; Matching: maximum matching in bipartite graphs, maximum matching in general graphs; Networks: The Max-flow min-cut theorem, max-flow algorithm; NP-Complete Graph problems; Approximation algorithms for some NP-Hard graph problems; Algorithms for some NP-Hard graph problems on special graph classes.

MAL380 Numerical Linear Algebra
4 credits (3-1-0)
Pre-requisites: MAL230 & MAL255

Triangular form, Matrix norms, Conditioning of linear system, Singular value Decomposition, Direct Methods (Gauss, Cholesky, Householder), Iteartive methods (Jacobi,Gauss-seidel, relaxation) methods for solving linear systems. Linear least square problem. Computation of Eigen values and Eigen vectors (Jacobi, Givens, Householder, QR, Inverse methods), Conjugate gradient method and its pre-conditioning.

MAL381 Finite Element Theory and Applications
4 credits (3-0-2)
Pre-requisites: MAL245

Variational Formulation of elliptic boundary value problems; Lax Milgram.

Lemma; existence and uniqueness of solutions; equivalence of Galerkin and Ritz variational formulations;

Triangulations of ordinary domains - rectangles, polygons, circles, ellipses, etc. Finite element problems; conforming and non-conforming methods; Ce'a's Lemma, Interpolation on simplexes in Rn, different Lagrange and Hermite finite elements; Affine, isoparametric,sub-parametric, super parametric finite elements; Triangulation using isoparametric mapping; approximation of boundary; Numerical integration, construction of element stiffness matrices and assembly into global stiffness matrix, Skyline method of solution of finite element equations; Solution of model problems and computer implementation procedures; Asymptotic error estimate results; Eigenvalue problems of Laplace operator.

MAL382 Theory of Automata
4 credits (3-1-0)
Pre-requisites: CSL201
Overlaps with: CSL 705

Finite State Automata and regular languages. Structure of Recognizable sets. Sequential and linear sequential machines. Infinite Digital Computation. Pushdown automata: Context free languages. Linear bounded automata: Context sensitive languages. Turing machines: Recursive languages.

MAL390 Statistical Methods and Algorithms
4 credits (3-1-0)
Pre-requisites: MAL250

Mathematical methods and algorithms predominantly applied to statistical data drawn in social sciences with a desire to design of experiments.

MAL465 Parallel Computing
4 credits (3-1-0)
Pre-requisites: MAL342

Introduction to Parallel Computing: Need, Scope, issues and motivation; Models of Parallel Computation: Taxonomy of Parallel Architectures- SIMD, MIMD; PRAM model of computation; Interconnection Networks: Tree, Hypercube, Mesh, etc., dynamic Interconnection Network; Routing and communication mechanisms for static interconnection networks; elementary Parallel algorithms: Parallel reduction, Parallel prefix sums, List ranking, preorder Tree traversal, Merging. Basic Communication Operations: point to point message transfer, broadcasting, all to all broadcasting, one to all and all to all personalized communication. Parallel programming Paradigm: Explicit versus implicit, shared address space versus Message Passing, data parallelism versus Control Parallelism; Introduction to Message passing Interface (MPI); Parallel Programming Using MPI; Performance and Scalability of Parallel Systems, Basic design techniques; Parallel Algorithms for matrix computation, sorting, graph algorithms, Mapping and scheduling.

MAL466 Multivariate Statistical Methods
4 credits (3-1-0)
Pre-requisites: MAL390

Multivariate Normal Distribution and sampling from it, Hotelling's T2 and Mahalanobis D2 statistics, Multivariate analysis of variance, Multivariate regression model, Discriminant function and classification problems, Canonical correlation, Analysis of covariance structures, Principal Component Analysis, Factor analysis, cluster analysis, pattern recognition.

MAL468 Graph Theory
4 credits (3-1-0)
Pre-requisites: EC 90
Overlaps with: EEL311, MAL376, CSL851

Introduction to Graphs: Definition and basic concepts; Trees: characterizations of trees, minimum spanning tree; Paths and Distance in Graphs: distance in graphs, center and median of a graph, activity digraph and critical path; Hamiltonian Graphs: sufficient conditions for Hamiltonian graphs, traveling Salesman problem; Eulerian Graphs: characterization of Eulerian graphs, The Chinese Postman problem; Planar Graphs: properties of planar graphs, a planarity testing algorithms, dual graph, genus of a graph; Graph Colouring: vertex colouring, chromatic polynomials, edge colouring, planar graph coloring; Matching and Factorizations: maximum matching in bipartite graphs, maximum matching in general graphs, Hall's marriage theorem, factorization; Networks: The Max-flow min-cut theorem, max-flow algorithm, connectivity and edge connectivity, Menger's theorem; Graph representations; Graph searching: BFS, DFS. Basic Graph Algorithms: MST, shortest paths, biconnectivity, strong connectivity, etc.

MAL710 Database Management Systems
4 credits (3-0-2)
Pre-requisites: CSL201
Overlaps with: CSL332/CSL771

Introduction to database concepts: data independence, consistency, security and integrity; Relational Algebra and Relational Calculus; Query languages; Database design: Functional dependencies, Normal forms, Decomposition of Relations; Indexing, Physical design, Transactions and concurrency control: Schedules and serializability, concurrency control techniques, locking mechanisms; Recovery and security: Types of failures and recovery manager, Transaction logging and checkpointing; Concepts of Object oriented data bases; Introduction to Distributed databases.

MAL715 Digital Image Processing
4 credits (3-0-2)
Pre-requisites: CSL201
Overlaps with: EEL715/CSL783/PHL756

Digital image fundamentals - representation, monochrome, and colour models, image sampling and quantization, Image transforms, Image representation by stochastic models, Image enhancement techniques, Image restoration, Image Analysis - edge detection, segmentation, Scene representation and description, Object recognition and image interpretation. Image compression.

MAL717 Fuzzy Sets and Applications
4 credits (3-1-0)
Pre-requisites: EC 90

Fuzzy sets as model for non-deterministic reasoning, logic and mathematical formalisms, fuzzy theory and algebraic theories, applications to: automata theory, decision theory, logic, dynamical systems, theory of computation, optimization.

MAL720 Neurocomputing and Applications
3 credits (3-0-0)
Pre-requisites: EC 90
Overlaps with: EEL781

Biological and Artificial Neuron, Perceptron model, Adaline model, Different types of Activation functions, Learning Techniques: Supervised and Unsupervised, Multilayered feedforward networks, Back-propagation algorithm and its improvements, Applications of Back-propagation algorithm to Statistical Pattern Recognition, classification and regression problems, Advantages of Neural Networks over statistical classification techniques, Recurrent networks, Radial Basis Function Networks as an interpolation model, Time delay neural networks for forecasting problems, Probabilistic Neural Networks, Kohonen's self-organizing maps with quadratic functions and its applications to medical imaging, Adaptive Resonance Theory model, Applications

of Art model for knowledge acquisition, Extensive sessions in MATLAB for solving problems.

MAL736 Information Integrity
4 credits (3-1-0)
Pre-requisites: EC 90

Information Integrity, concepts and definitions; direct integrity and its mechanism; modelling information error; system's view of Information Integrity; open system view of business enterprise system; business process IS view as integral to close loop information and control system and as information origination process; information envelope, uncertainties therein, error Implications and loss of Information Integrity; inadequacy of existing integrity mechanisms; criticality of Information Integrity for efficient and economic processing of information in IS view; Usefulness- Usability - Integrity paradigm; cost benefit analysis of Information Integrity; mathematical equations for information value and for improvement of Information Integrity; design basis for Information Integrity analyzer and controller.

MAL745 Software Engineering
4 credits (3-0-2)
Pre-requisites: CSL201
Overlaps with: CSL740

An introduction to software life cycle models; analysis, design, coding and testing methods, software size estimation; cost and schedule estimation; project management; risk management; formal technical reviews; configuration management and change control; and software reliability estimation. Emphasis on large development projects.

MAL754 Principles of Computer Graphics
4 credits (3-0-2)
Pre-requisites: CSL201
Overlaps with: EEL754/CSL781

Overview of Graphics Systems, Output primitives and their attributes, Geometric primitives in 2D, 2D transformations, 2D viewing, Clipping, Geometric primitives in 3D, 3D Object representations, 3D transformations, 3D viewing, GUI primitives, Computational geometry topics – Binary space partitioning trees, Triangulation, Polygon partitioning, Visible surface detection, Surface rendering, Illumination models, Basics of computer animation.

MAL755 Algebraic Geometry
4 credits (3-1-0)
Pre-requisites: MAL124 / MAL255

Polynomials in one and several variables with coefficients in an arbitrary field. Affine space and affine varities. Parametrizations of affine varities. The Hilbert basis theorem and Groebner bases. The geometry of cubic curves. The theory of plane curves. Sphere with handles. Functions and differentials on a curve, surfaces and hyper surfaces. Resolution of singularities of algebraic surfaces. Hilbert's nullstallensatz. Radical ideals and the ideal varities correspondence. Zariski topology. Irreducible varities and prime ideals. Decomposition of a variety into irreducibles. Symmetric polynomials and introduction to invariant theory. Projective algebraic geometry. Projective spaces and projective varities. Homogeneous coordinates. Projective planes. Intersections of projective curves. Projective invariants.

MAL760 Advanced Algorithms
4 credits (3-0-2)
Pre-requisites: MAL342
Overlaps with: CSL758

Algorithm with advanced data structures: R-B tree, B-tree, Splay Tree, disjoint set forest, Binomial heap, Fibonacci heap, interval tree. Randomized algorithms: Search trees, sorting, skip lists. Advanced graph algorithm: Graph matching algorithms, Network flows, Random graphs. String/vector matching algorithm: Rabin Karp algorithm, string matching with FSA, KMP – algorithm, Boyce+Moore, Dynamic programming algorithms. NP completeness: Basic concepts, NP completeness and reducibility, Cook's theorem, Examples of NP – complete problems. Approximation Algorithms: Vertex-colour problems, set-covering problem, subset-sum problem.

MAL780 Special Topics in Computer Applications
4 credits (3-0-2)
Pre-requisites: EC 90

Topic and course contents will be announced before registration by the concerned faculty.

MAL782 Data Mining and Knowledge Discovery
4 credits (3-0-2)
Pre-requisites: MAL342 & MAL372

Introduction to Data Mining, Data Cleaning and transformation, Data Warehousing architecture, Front end data warehousing operations, data cubes and other visualizations, data synchronization with operational databases, Classificatory knowledge Extraction and prediction, Decision Trees, Association Rule Mining, Error analysis, LIFT charts and ROC curves, Bagging and Boosting, Clustering, Sequence analysis, Design of parallel and distributed data mining systems, mining complex data. Laboratory assignments: Implementation of the above concepts.

MAL785 Natural Language Processing
4 credits (3-0-2)
Pre-requisites: MAL342 & MAL375 & MAL390

Lingustics Essentials: Parts of Speech and Morphology, Inflectional vs. Derivational Morphology, Phrase Structure Grammar (dependency, ambiguity), Syntax and Syntactic Theory, Semantics, Language variations, Pragmatics - language as a means of communication.

Study of Words: Frequency, Hypothesis testing, Collocation, n-gram models, Word-sense Disambiguation - supervised, unsupervised, dictionary-based.

Lexical Acquisition: Verb Categorization, Semantic Similarity.

Grammar: Markov Models, Parts-of-speech Tagging , Transformation-based learning of taggers, Tagging accuracy, Context free Grammars, Parsing and probabilistic parsing, study of divergence.

Applications: Statistical Alignment techniques (length based, word-based, cognate-based), Machine Translation and its various approaches, Information retrieval (vector-based model, term distribution model), Text Categorization.

MAL786 Cryptology
4 credits (3-1-0)
Pre-requisites: EC 90

Private Key Cryptosystems: classical techniques, modern techniques, algorithms like DES, IDEA, RC5, Blowfish, etc., confidentiality using Conventional Encryption; Public Key Encryption and Hash Functions: principles of public key cryptosystems, Diffie-Hellman key exchange, RSA, introduction to elliptic curve cryptography; Introduction to Number Theory: modular arithmetic, Fermat's and Euler's theorem, primality testing, Chinese remainder theorem, discrete logarithms; Basics of Finite fields; Message Authentication and Hash function: MD5, SHa-1, HMAC etc.; Digital Signature and authentication protocols: Digital

signature, DSS, Authentication protocols; Differential and Linear cryptanalysis; existing cryptosystems and their security. Cryptanalysis of existing systems. Zero-knowledge protocols, One-way functions. Advanced protocols for different applications, e.g. e-cheque, e-cash etc. Network and System level security issues.

MAL790 Special Topics in Computer Science
4 credits (3-0-2)
Pre-requisites: EC 90

The course contents will be announced by concerned faculty member before registration.

MAN150 Introduction to Mathematics and Computing
2 credits (0-0-4)

Lecture-demonstrations to introduce the art of reasoning in the discrete world and illustrate the complexities of mathematical software development; hands-on experience with various mathematical and statistical software; interactive sessions with professionals from industry and R&D institutions.

MAP290 System Design Laboratory
2 credits (0-0-4)
Pre-requisites: CSL101/CSL102

Laboratory assignments on various topics covered in MA754 and MA715.

MAT450 Practical Training (MT)
Non credit
Pre-requisites: EC 90 at the end of 5th sem.

Students will work for fifty working days to complete training in a research/industrial organization.

Department of Mechanical Engineering

MEC410 Colloquium (ME)
3 credits (0-3-0)
Pre-requisites: Registered for MET410

Introduction to planning, preparing and making presentations – preparation of slides, time management, communication aspects, etc. Making a presentation on practical training with response sheet for testing audience. Reading an assigned project report, making a presentation with audience response sheet and a critique on writing style, completeness and editorial get-up. Performing patent searches on an allotted product and making a presentation using diagrams/figures only. Preparing posters on practical training and presenting these at a poster session.

MEC420 Colloquium (PE)
3 credits (0-3-0)
Pre-requisites: Registered for MET420

Introduction to planning, preparing and making presentations – preparation of slides, time management, communication aspects, etc. Making a presentation on practical training with response sheet for testing audience. Reading an assigned project report, making a presentation with audience response sheet and a critique on writing style, completeness and editorial get-up. Performing patent searches on a production or industrial engineering process/ product and making a presentation. Preparing posters on practical training and presenting these at a poster session.

MED310 Mini Project (ME)
4 credits (0-0-8)
Pre-requisites: EC 80

Team formation. Formulating work plan, learning objectives and deliverables. Need identification, assessment of alternative approaches, defining design and performance specifications. Defining testing and/or validation procedure(s). Detailed work including preparation of engineering drawings, fabrication and procuring parts. Assembly and testing. Performing experiments. Model development, writing code, its validation, and user's and programmers manuals. Display of outcome at an Open House. Documentation and coding of entire work and knowledge gained.

MED320 Mini Project (PE)
4 credits (0-0-8)
Pre-requisites: EC 80

Team formation. Formulating and executing the work plan on a topic related to production engineering or industrial engineering. Nature of work could be either hardware based , theoretical or computer simulation type. Display of outcome at an Open House and making a presentation. Documentation and coding of entire work and knowledge gained.

MED411 Major Project Part 1 (ME)
3 credits (0-0-6)
Pre-requisites: EC 120

Team formation for designing, manufacturing and operating a selected product, formulating project management procedures. Need identification, assessment of alternative designs, selection of design for development, defining design and performance specifications, and testing procedure. Detailed mechanical, thermal and manufacturing-related design of systems, assemblies, sub-assemblies and components culminating in engineering drawings and material specifications; preparing bill of materials and identification of standard components and bought-out parts.

MED412 Major Project Part 2 (ME)
7 credits (0-0-14)
Pre-requisites: MED411

The same student team continues working as per work plan of Part-1. MED411, and facilitators. Using engineering drawings, the process sheets are developed based on available materials, machine tools and other fabrication facilities. Materials and standard components are procured and manufacturing is carried out. After inspection, parts are accepted. Assembly procedure is finalized and the machine is assembled. Acceptance tests are carried out vis-à-vis specifications from Part-1. Functioning product is displayed at an Open House. Professional quality documentation of all designs, data, drawings, and results, change history, overall assessment, etc. is mandatory, along with a final presentation.

MED421 Major Project Part 1 (PE)
3 credits (0-0-6)
Pre-requisites: EC 120

Team formation and problem identification. Preparing work plan for Parts 1 and 2, and project management procedure. Identification of milestones, deliverables and final outcome. Literature review, revision of basic courses. Formulating a detailed problem statement, knowledge base and completing about 30% of the total work.

MED422 Major Project Part 2 (PE)
7 credits (0-0-14)
Pre-requisites: MED421

The same student team continues working as per the work plan developed in Part-1, MED421, with same guide. Work is continued until all stated objectives and deliverables are met. The project outcome is displayed at an Open House. Professional quality documentation of the entire project is mandatory.

MEL110 Graphic Science
4 credits (2-0-4)

Orthographic, Axonometric, Isometric, Oblique, Perspective projections. Lettering, instruments and line work, free hand sketching, plane geometric constructions, auxiliary planes. Intersection and development of surfaces, planes and solids with their spatial relationships. Transition pieces, rules and conventions for sectioning and dimensioning. Introduction to computer aided drawing. Examples of graphic communication.

MEL120 Manufacturing Practices
4 credits (2-0-4)

The objective of the course is to expose students to basics of manufacturing as it plays a direct role in improvement of quality of human life and creating wealth for the nation. The second objective of the course is to expose students to hands-on practice with common manufacturing processes. It will cover: (i) importance of manufacturing, (ii) relation between materials and manufacturing, (iii) an overview of manufacturing processes, (iv) product manufacturing, (v) importance of product assembly and inspection, (vi) an overview of manufacturing planning, and (vii) manufacturing automation and computer aided manufacturing for industry.

MEL140 Engineering Thermodynamics
4 credits (3-1-0)

Introduction to applications. Basic concepts and definitions – system, boundary, equilibrium, steady state and others. Thermodynamic properties of a pure substance – saturated and other states. Work and heat – definition and applications. 1st Law – internal energy and enthalpy, applications to non-

flow/closed and flow/open systems (SSSF and USUF), reacting systems and gas-vapor mixtures. 2nd Law – corollaries, Clausius inequality, entropy. Introduction to availability, irreversibility and exergy. Carnot cycle. 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. Material deformation, electro-magnetics and other applications.

MEL211 Kinematics and Dynamics of Machines
4 credits (3-0-2)
Pre-requisites: AML110 & MEL110

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. Cam profile synthesis. Gears dynamic force analysis, flywheel, inertia forces and their balancing for rotating and reciprocating machines. Hydrodynamic and boundary lubrication in journal and thrust bearings.

MEL221 Industrial Engineering and Operations Research
4 credits (3-0-2)
Pre-requisites: MAL120

Introduction to Industrial Engineering, Evolution of key Concepts, Work study, Productivity, Partial and Total Productivity, Strategies to improve productivity, Management, Functions of management, Management Information System, Decision Making, Prescriptive and Descriptive models, Type of Production systems and Layouts, Allocation Problems, Design of Assembly Line System, etc., Introduction to Operations Research, Role of modelling, Nature of Problems, Graphical method, Simplex method, various cases of LP problems, Duality, Sensitivity, Special topics etc.

MEL231 Casting and Welding
4 credits (3-0-2)
Pre-requisites: MEL120
Overlaps with: MEL232

This course exposes the student to foundry and welding technologies. The course covers introduction, applications, basic physics involved in various processes, latest trends, basic extractive and engineering physical metallurgy etc. Familiarization and identification of various raw material, equipment and power sources, melting of metals, properties of sand, castings based on various processes. Welding practice, behaviour of covered electrodes, welding in different positions, Basic exercises in SAW, GMAW, GTAW and underwater welding.

MEL232 Casting, Welding and Forming
4 credits (3-0-2)
Pre-requisites: MEL120
Overlaps with: MEL231

Study of metal casting processes; Study of welding and other joining processes; Study of metal forming processes; Processing of plastics; Process planning and process analysis casting, welding and forming processes; Economic and quality issues in casting, welding and forming processes.

MEL233 Machining, Machine Tools and Metrology
4 credits (3-0-2)
Pre-requisites: MEL120
Overlaps with: MEL234

Introduction to machine tools and machining operations. Mechanics of metal machining. Cutting forces, friction, cutting fluids and surface finish, lubrication, temperatures and heat transfer and its measurement, tool life and tool wear aspects. Theoretical models of shear angle solution, Basic concepts of cost and economics of metal cutting operations, Tool nomenclature, chip control and design for machining. Electrical discharge Machining, Electrochemical Machining, Ultrasonic machining, Abrasive Jet Machining, Laser Beam Machining, Water Jet and Electron Beam machining. Construction of Machine tools, alignment, metrology and inspection.

MEL234 Metal Forming and Machining
5 credits (3-1-2)
Pre-requisites: MEL120
Overlaps with: MEL233

Mechanical behaviour of metals in elastic and plastic deformation, stress-strain relationships, Yield criteria, Application to tensile testing, Concept of flow stress by true stress-strain curves, Fundamentals of metalworking, Strain rate and temperature in metal working, Hot deformation, Cold working and annealing, Analysis of bulk forming processes like forging, rolling, extrusion, wire drawing by slab method, Technology and practice of these processes, Sheet metal forming processes, High Energy rate forming processes, Fundamentals of metal cutting and common machining operations, Mechanics of metal cutting, Heat generation in metal cutting, Tool wear and tool life, Nomenclature of cutting tools and cutting tool materials, Cutting fluids, Abrasive machining, Surface finish, Economics of machining, Non-conventional machining processes.

Laboratory activities on study of bulk and sheet forming processes, dies and presses for forming, conventional and unconventional machining processes.

MEL235 Metrology and Quality Assurance
4 credits (3-0-2)
Pre-requisites: MEL120

Introduction to Metrology and its relevance, standardization, dimensional measurement, limits, fits and tolerances, limit gauging, linear and angular measurements and their applications, surface roughness-quantification and measurement, alignment testing of machine tools, feature inspection and online inspection. Introduction to quality assurance and quality control,Various elements in Quality Assurance program, On-line and Off-line quality control, Statistical concepts in quality, Central limit theorem, Quality Characteristics, QC Tools, Chance and assignable causes of quality variation, Process control charts for variables, Control chart parameters, Target process setting/ Centering, Control limits and specification limits. Process capability studies, Remedial / Corrective actions, Special purpose control charts, Reject limits, Variables inspection and attributes Inspection, Control charts for attributes, Defects classification, Sensitivity of control charts. Sampling inspection for product acceptance, single, double, multiple and sequential sampling schemes; OC, AOQ, ASN and ATI curves; Design of sampling plans, Standard sampling systems; Economics of product inspection, quality costs, ISO 9000 quality system; Problems and illustrations in quality assurance.

MEL241 Energy Conversion
4 credits (3-0-2)
Pre-requisites: MEL140

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.

MEL242 Heat and Mass Transfer
4 credits (3-1-0)
Pre-requisites: AML160

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.

MEL310 Concurrent Engineering
4 credits (3-1-0)
Pre-requisites: EC 60

Concurrent Engineering- meaning and need. Review of Engineering Problem Solving methods. Description of methods of Analysis, Decision Making, Creativity and Information processing and their role in engineering. Discussion of Emerging engineering strategies of Total Design, Design for Manufacturing and Assembly, Quality Function Deployment, and Constraint networks.

Integrating concurrent approaches with those of conventional. Implementation of concurrent engineering in industrial environment especially those of IT and high speed computation.

MEL311 Machine Element Design
5 credits (3-1-2)
Pre-requisites: MEL211 & AML140 & & MEP201 & MEP202

Mechanical Engineering Design vis-à-vis Solid Mechanics, factor of safety, standards and design equations. Selection of materials and processes. Standard numbering system including BIS designations of materials. Application of theories of failure to design. Design procedure and its application to static strength. Design of elements subjected to simple loading: screws including power screws, bolted joints including eccentrically 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. Introduction to CAD. Design exercises of systems like those of mechanical drives which may also involve the assistance of a computer.

MEL312 Control Theory and Applications
5 credits (3-1-2)
Pre-requisites: MAL110 & AML110 & (EEL101 / EEL102) and EC 60
Overlaps with: EEL301/CHL261/MEL334

Introduction to automatic controls. Modelling of flow, heat transfer and electrical, pneumatic and vibration systems. Block diagram and transfer function.Modelling of continuous systems. Extraction of reduced order models. Transient and frequency response evaluation using Laplace transform. Characteristics of hydraulic controller, pneumatic, electronic controller, electro-hydraulic and electro-pneumatic controllers. PID control. Stability. Gain and phase margins.Control system design using root and compensation. Application to Machine tool, Boiler, Engine Governing, Aerospace, Active vibration control, etc. Auto-tuning. Sequence control, Logic diagram. Introduction to digital control, Implementation using computer. Introduction to control of MIMO systems. State Space modelling.

Practicals include studies on hydraulic, pneumatics, electronic controller. Control of various parameters such as speed, temperature, level, pressure, etc. Tutorials for control problems in these areas using MATLAB.

MEL314 Noise Engineering
4 credits (3-0-2)
Pre-requisites: MAL110 / MAL120 and EC 60
Overlaps with: ITL760

Fundamentals of vibrations, vibrations of strings and bars, Vibrations of membranes and plates. Acoustic wave equation, Acoustic energy and sound intensity. Propagation of sound, Concept of Acoustic impedance.Sound power transmission, Transmission Loss. Human Response and ratings, Various Measures of Sound. Weighting filters, Loudness, Indices of Loudness. Acoustic radiation from spherical source and piston source. Acoustic sensors. Measuring Techniques and Instruments, Octave Filtering, Sound Intensity Measurement, Intensity Mapping. Different types of measurement environment and uses. Response of beam subjected to an accoustic plane wave. Transmission loss of panels. Sound absorption coefficient. Noise control measures in building. Reverberation time and auditorium design. Industrial Noise control, Noise in Machinery, Traffic Noise, Vehicle Noise. Design of silencers and mufflers. Active noise control.Duct noise control and cabin noise control. Practicals on noise measurements in different situations.

MEL316 Mechanical Vibrations
4 credits (3-0-2)
Pre-requisites: MEL211

Vibration of single degree of freedom (SDF) system. Modelling of stiffness and damping (both Viscous and Coulomb). Estimation of damping by decay plots and half power method. Impulse, transient and forced vibration response of SDF system. Theory and practice of vibration isolation. Vibration measuring instrurments. Two degree freedom system. Application to undamped and damped absorbers. Multi-degree freedom systems. Modal analysis. Rayleigh's and Dunkerley's method. Holzer's and Myklestad-Prohl transfer matrix methods.Continuous systems governed by wave equation and Euler Bernoulli equation. Free and forced vibrations including modal analysis. Finite element based dynamic analysis of simple systems. Introduction to modal testing and system identification problems. Industrial applications - rotors and other systems, balancing, vibration standards, vibration monitoring.

MEL321 Ergonomics
4 credits (3-0-2)
Pre-requisites: MEL221

Introduction to Ergonomics: Definition and importance of ergonomics, History of Ergonomics; Introduction to Human-machine systems ;Human-machine systems – Interfaces; Ergonomics at the Workplace: Anthropometrics principles;

Work-related Musculoskeletal Disorders; Workplace Design; Environmental Factors at Work; visual environment; thermal environment; auditory environment; Vibration; Ergonomic Workplace Analysis: Introduction to workplace analysis; Ergonomics workplace analysis; Ergonomic awareness checklist; Legal and safety issues, Various case studies.

MEL322 Operations Planning and Control
4 credits (3-0-2)
Pre-requisites: MEL221

Production systems and performance measures. Life Cycle of a production system. Major managerial decisions in the life of a production system, Product design and process selection. Location and Layout of production systems, Product,Process and Cellular layouts, Demand Forecasting, Aggregate production planning, Inventory and MRP, Scheduling decisions and emerging trends.

MEL323 Investment Planning
4 credits (3-0-2)
Pre-requisites: MEL221

Basic framework of a firm. Investment options. Various instruments. Portfolio concept. The Basic Theory of Interest, Impact of Inflation. Opportunity Cost of Capital. Deterministic Cash Flows, Project Net present Value, Other Project Evaluation Criteria. Single Period Random Cash Flows, Mean-Variance Portfolio Theory, Portfolio Analysis and Management, Mathematical Programming approach, Single Index Models, Capital Asset Pricing Model. Options and Futures. Black Scholes Equation. Risk evaluation. Case studies from various sectors.

MEL324 Value Engineering
4 credits (3-0-2)
Pre-requisites: MEL221

Introduction to Value Engineering (V.E.) and Value Analysis, Life Cycle of a Product, Methodology of V.E., Quantitative definition of Value, Use Value and Prestige Value, Estimation of product quality/performance, Types of Functions, Relationship between Use Functions and Esteem Functions in product design, Functional Cost and Functional Worth, Effect of value improvement on profitability, Aims of VE systematic Approach.

Introduction to V.E. Job plan / Functional Approach to Value Improvement, Various phases and techniques of the job plan, Factors governing project selection, Life Cycle Costing for managing the Total Value, Concepts in LCC, Present Value concept, Annuity concept, Net Present Value, Pay Back period, Internal rate of return on investment (IRR), Examples and illustrations.

Creative thinking and creative judgement, False material, labor and overhead saving, System Reliability, Reliability elements in series and parallel, Decision matrix, Estimation of weights and efficiencies, Sensitivity analysis, Utility functions, Fast diagramming, Critical path of functions, DARSIRI method of value analysis, Purchase price analysis.

MEL331 Machine Tools and CNC Manufacturing
4 credits (3-0-2)
Pre-requisites: MEL234

This course exposes the student to conventional machine tools and classification, machining operations, work and tool holding devices, drive systems, structures and guideways, mechanisms, NC systems, controls, programming, industrial robots and applications, measurement techniques on machine tools.

Familiarization and identification of various machine tools, study of structural features of machine tools, study of various mechanisms and their assembly, study of machine tool to identify the existing limitations and to suggest changes.

MEL332 Design and Manufacturing of Composites
4 credits (3-0-2)
Pre-requisites: MEL120 & AML140 and EC 60

FRP Composites, fiber types, fiber forms and properties, matrices type and properties, lamina, laminate, orthotropy, anisotropy, composites – macro and micro-mechanical analysis and properties, Failure theories - Tsai-Hill, Tsai-Wu, Primary and Secondary Manufacturing - Lay-up, Autoclave Molding Filament Winding, Pultrusion, Compression Molding, RTM, RIM, SRIM, Machining, drilling, routing etc., design, structural and testing, applications. Metal Matrix Composites and Ceramic Matrix composites - Manufacturing routes and applications.

MEL333 Metrology
4 credits (3-0-2)
Pre-requisites: MEL233

Introduction to Metrology and its relevance, standardization, dimensional measurement, limits, fits and tolerances, limit gauging, linear and angular measurements and their applications, surface roughness-quantification and measurement, alignment testing of machine tools, feature inspection and Computer Aided inspection.

MEL334 Low Cost Automation
4 credits (3-0-2)
Pre-requisites: MEL233 / MEL234
Overlaps with: MEL312/EEL301/CHL261

Introduction, Types of systems - mechanical, electrical, electronics, fluidics; Hydraulics Systems and components; Pneumatic Systems Control; Sequence operation of more than two cylinders and motors; Applications of relays/ switches; Measuring systems, Transducers; Feed back control systems; Programmable controllers; Small components feeders; Automatic orientation and assembly; Design of components for assembly. Cost considerations and case studies. Laboratory work will be hands-on design and operation of automatic systems.

MEL335 Advances in Metal Forming
4 credits (3-1-0)
Pre-requisites: MEL234

Elements of theory of plasticity, Formulation of plastic deformation problems and different methods of solution, Application of theory of plasticity for solving metal forming problems, Numerical methods in metal forming, Friction and lubrication in cold and hot working, Technological advances in metal forming processes- forging, rolling, extrusion, wire drawing and sheet metal forming. Computer aided die design for forging, extrusion and wire drawing, Automation in metal forming processes, Advances in sheet metal forming, Concept of Formability and its evaluation, Hydro-forming of sheets and tubes.

MEL336 Advances in Welding
4 credits (3-0-2)
Pre-requisites: MEL231

This course introduces the concept of welding technology involving metallurgy, designing, automation, welding of high speciality alloys and materials and inspection procedures. Familiarization and identification of various processes, equipment, power sources, consumables, correlations between various responses and welding parameters and under water welding.

MEL341 Gas Dynamics and Propulsion
4 credits (3-0-2)
Pre-requisites: MEL241

Revision of fundamentals. Thermodynamics of compressible flow – wave motion in compressible medium, Mach number and cone, properties. Steady one-dimensional compressible flow through variable area ducts. Converging and converging-diverging nozzles and diffusers. Effects of heating and friction in duct flow, Rayleigh and Fanno lines. Flows with normal shocks. Oblique shocks and reflection. Expansion waves. Prandtl-Meyer flow. Flow over bodies. Measurements and applications. Jet propulsion – types of engines, propulsion fundamentals. Compressor, combustor and turbines construction and performance. Rocket propulsion – basics, solid and liquid propelled engines, parametric studies, construction features, single and multi-stage rockets. Thrust chamber and nozzle models. Studies of in-use engines. Environmental aspects.

MEL342 Power Plant Technologies
4 credits (3-0-2)
Pre-requisites: MEL241 & AML160

Introduction to power systems and technologies. Demand variation and forecasting. Grid features. Siting and costing. Diesel generators: systems, equipment and layout. Fossil-fuelled steam power plants: Boiler and accessories, turbine and accessories, feed cycle equipment, generator. Combined cycle power plants: gas turbine, heat recovery boiler. Nuclear power: nuclear reactions, fuel, moderator and coolant, Neutron life cycle. Light water, Heavy water, Gas-cooled and fast reactors. Hydroelectric plants: Features and siting, Pelton, Francis, Kaplan and propeller turbines construction, mini- and micro-turbines. Renewable energy: solar, geothermal, wind, biomass, ocean, fuel cells, unique features of decentralized systems. Co-generation systems. Environmental issues, sustainability and future scenarios.

MEL343 Fuels, Combustion and Pollution
4 credits (3-0-2)
Pre-requisites: MEL241

Introduction. Fuels: gaseous, liquid and solid. Sources, method of procurement, transportation and end uses. National and international perspectives - economic and social aspects, and policies. Physical and chemical characterizations. Chemical thermodynamics and kinetics. Conservation equations for multi-component systems. Premixed systems: detonation and deflagration. Laminar flame problems and effects of different variables. Measurement of flame velocity. Flammability limits. Ignition and quenching. Turbulent premixed flames. Non-premixed systems: laminar diffusion flame jet, droplet burning. Combustion of solids: drying, devolatilization and char combustion. Coal combustion. Pollution: Main pollutants and their environmental impact. NOx, CO and SOx formation chemistry. Particulate pollutants. Emissions from engines, power plants and industrial applications. Low NOx burners and furnace design.

MEL344 Refrigeration and Air-Conditioning
4 credits (3-0-2)
Pre-requisites: MEL140 and EC 60

Revision of fundamentals. Applications. Environmental issues. Vapor compression system: Ideal and real cycle analyses, design and optimization. Refrigerants: designation, properties, environmental considerations. Advanced vapor compression cycles, part-load operation. Gas cycle refrigeration. Components: condensers, evaporators, compressors and expansion devices – construction, operation and performance. Vapor absorption cycles: operation, system design, components. Psychrometry: definitions, heating, cooling, humidification and dehumidification processes, evaporative cooling systems. Environmental comfort specifications and standards. Cooling load estimation and use of standards. Airconditioning systems and apparatus, air flow ducts, air quality. Control and optimization of HVAC systems.

MEL345 Internal Combustion Engines
4 credits (3-0-2)
Pre-requisites: MEL140 and EC 60

Thermodynamics of fuel-air cycles, real cycles; Unburned and burned gas mixture charts; Ignition, normal and abnormal combustion in SI and CI engines; Conventional and alternative fuels for engines; Conventional and electronic fuel management systems for SI and CI engines; Design of combustion chamber for SI and CI engines; Engine emissions; Lubrication; Cooling; Supercharging and Turbocharging; Modern developments in IC engines.

MEL346 Turbo-machinery
4 credits (3-0-2)
Pre-requisites: MEL140 & AML160 and EC 60

Revision of fundamentals. Types of turbomachines and their applications. Dimensional analysis and performance parameters. Cascade theory: types of cascades, flow and geometric parameters, boundary layer development. Wind tunnels: types, designs, construction features and instrumentation. Axial flow turbines, axial flow compressors, propellers, centrifugal fans, blowers and compressors – fluid flow, types of blading, velocity triangles, diffusers and nozzles, pressure change, multi-staging, stall, enthalpy-entropy diagram, efficiency, acoustics, applications. Wind turbines – types, analysis, site, atmospheric aspects. Solar plant turbines: principles, construction features and performance. Future trends.

MEL410 Creativity in Engineering
4 credits (3-1-0)
Pre-requisites: EC 90

Nature of engineering problems and solutions. Optimal engineering solutions via analysis, decision Making, creativity and information technology. Study of search for existing solutions, modification of existing solutions and innovative or inventive solutions in history of technology. Discussion of creative practices like automated solution searches, check listing, brainstorming, analogy, empathy, inversion, morphological synthesis, inventors' methods, stretching of constraint networks and problem identification. Automation strategies of creativity like those of genetic algorithms, computer aided idea searches.

MEL411 Mechatronics
4 credits (3-0-2)
Pre-requisites: MEL312 & (EEL101 / EEL102)
Overlaps with: MEL433/MEL749/EEL482

Introduction to mechatronic systems and components. Principle of basic electronics. Microprocessors and their applications, integrated circuits, sensors, actuators, and other electrical/electronic hardware in mechatronic systems. Principles of electronic/system communication. Interfacing, DA and AD converters, software and hardware principles and tools to build mechatronic systems. Selection of mechatronic systems, namely, sensors like encoders and resolvers. Stepper and servomotors; Solenoid like actuators; Transmission elements like Ball screw; and Controllers. Analysis and synthesis of mechatronic systems with applications to robotics, CNC systems, and others.

MEL412 Advanced Mechanical Design
4 credits (3-0-2)
Pre-requisites: MEL311
Concepts of fatigue and creep design. Production considerations in design. Advanced concepts for design of spur, bevel, worm and other types of gear drives, bearings, rotating discs, pressure vessels, etc. Optimization in design and computer aided design methods.

MEL413 Design of Mechanisms
4 credits (3-1-0)
Pre-requisites: MEL211 and EC 90
Study of existing mechanisms used in industry, machine tools, vehicles, high speed machinery. Classification of mechanisms. Structural analysis and synthesis for conceptual design. Theory of path curvature and finitely movements. Kinematic and dynamic design. Spatial Mechanisms. Errors in mechanisms and machines. Coding, evaluation and dimensional synthesis of mechanisms.

MEL414 Computer Aided Mechanical Design
4 credits (3-0-2)
Pre-requisites: MEL311
Overlaps with: AML710
Introduction and overview. Need and scope of Computer Aided Machine Design. Role of Geometric Modelling and Finite Element Method (FEM). Introduction to computer graphics technology and overview of hardware available for use in CAD, Geometric transformations and Projections. Windowing and view-porting. Geometric modeling; Modelling of curves, cubics, splines, beziers and b-splines, Modelling of surfaces, Modeling of solids – b-rep, CSG, octree, feature based modeling, Introduction to the Finite Element Method, principle of potential energy, 1D elements, Derivation of Stiffness and Mass matrices for a bar, a beam and a shaft, Comparison with Analytical results, Solution of static problems and case studies in stress analysis of mechanical components, FEA using 2D and 3D elements. Automatic meshing techniques, Interfacing with CAD software, Case studies using FEM for Design of simple element geometries. Introduction to Dynamic analysis, Non-linear problems and FEA for plastic materials.

MEL415 Vibrations Engineering Design
4 credits (3-0-2)
Pre-requisites: MEL312
Overview. Need of vibration engineering design for mechanical equipment. Theoretical and Experimental routes to dynamic design., Modelling and simulation to predict vibration behavior of mechanical systems and products. Techniques for vibration control including designing for reduced excitation, choice of materials and configurations, isolation, passive and active techniques etc. Finite Element model updating. Vibration engineering design

Using techniques of modal testing, Finite element model updating, system identification and structural dynamic modification. Integration of dynamic design in mechanical engineering design. Some case studies of actual systems like machine tools, pumps, compressors, turbines, transportation systems. etc.

MEL416 Robotics Engineering
4 credits (3-1-0)
Pre-requisites: MEL311 & (EEL101 / EEL102) and EC 90
Evolution of automatons, manipulators and autonomous systems. Forward and Inverse Kinematics. Velocity control, Jacobian control of abundant systems, singular value decompositions and null spaces. Interpolation in 3-D spaces, dual numbers, quaternions and screws. Dynamics of manipulators, EL and NE formulations. Parallel Manipulators. Basics of vision systems. Robotic AI Paradigms and Navigation.

MEL417 Lubrication
4 credits (3-0-2)
Pre-requisites: MEL311
Importance of lubrication, mechanisms and regimes of lubrication. Viscosity and its measurement. Bearing varieties and selection. Hydrodynamic lubrication-Journal and Thrust Bearings. Lubricants. Bearing materials. Rolling Bearings.

MEL420 Total Quality Management
4 credits (3-0-2)
Pre-requisites: Completion of Practical Training in any program (xxT4y0)
Evolution of quality paradigms, Customer-orientation, Quality philosophies, TQM in manufacturing and services. Tools and improvement cycle (PDCA). Life cycle approach to quality costs-Prevention; Appraisal and Failure costs.

Organizational, Communicational and Team requirements. Attitude, value system and behavioral patterns. Use of teams in process management. Group dynamics, Quality circles, high performance and self-directed teams, Empowerment. Seven QC tools and their applications, Quality Function Deployment. Statistical process Control,Process capability, Total Productive Maintenance, Importance of Standardization (National and international) Quality Systems, Quality Manuals, Quality Information Systems and documentation. Auditing. Basics of ISO-9000 and ISO 14000:Relevance and misconceptions, Six-sigma philosophy Quality strategy and policy. Motivation and leadership theories. Continuous vs. breakthrough improvements. Management of change. Quality award models and role of self-assessment. Benchmarking. Impact on society-Environment implications. Implementation barriers to TQM practices.

MEL421 Production Management
4 credits (3-0-2)
Pre-requisites: MET410
The 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.

MEL422 Project Management
4 credits (3-0-2)
Pre-requisites: MET410 / MET420
The nature of projects, the project as a non-repetitive unit production system, the project as an agent of change. Project Identification considering objectives and SWOT analysis, Screening of Project Ideas, Technical, Market, Financial, Socio-economic and Ecological Appraisal of a project. Work break down structure and network development. Basic Scheduling, Critical Path and four kinds of floats. Scheduling under probabilistic durations, Time Cost tradeoffs, Project Monitoring with PERT/Cost, Organizational aspects, Computer packages and Project Completion.

MEL423 Computers in Manufacturing Enterprises
4 credits (3-0-2)
Pre-requisites: MET420
Evolving Manufacturing Environment, Role of IT, Manufacturing Enterprise System Concepts, Application of

Computers in Manufacturing Enterprise Systems, Automation Strategies, Hard Automation, Programmable Automation, Flexible Automation, Flexible Manufacturing Systems, Computer Integrated Manufacturing Systems (CIMS), Enterprise Resource Planning (ERP), Supply Chains, Extended Enterprises, e-manufacturing, e-Business, Concurrent Engineering (CE), Group Technology, Artificial Intelligence in Manufacturing, Expert System Applications, Computer Simulation, Modelling, Towards Agile Manufacturing Enterprises etc.

MEL424 Knowledge Management for Competitiveness

4 credits (3-0-2)

Pre-requisites: MET420 & MED421

Knowledge Management (KM) Introduction, Definitions, Industrial Relevance, Evolving Industrial Competition (Multi-Attributed Competition), Complex and Dynamic Systems, Growing Need for Knowledge and its Effective Management, Role of IT, KM and CRM, KM Technical Concepts: (Data .vs. Information vs. Knowledge), The Knowledge Edge, Knowledge Engineering, KM Framework (Process Steps), Aligning KM with Manufacturing Strategy, Business Strategy etc.),Design and Deployment of KM in Industrial Enterprises (KM Team, KM System Analysis, Developing Effective Systems, Knowledge Audit), IT based Tools (Role of Simulation, Intelligent Systems) KM Challenges and Opportunities, Managing Innovations, Performance Measurement, KM and Competitiveness Link, Applications, Cases, Presentations. Group Exercises.

MEL425 Flexible Manufacturing Systems

4 credits (3-0-2)

Pre-requisites: MET410 / MET420

Flexible Manufacturing Systems: Introduction, Definitions, Industrial Relevance, Need for FMS, Problems of conventional batch manufacturing systems, Role of Information Technology, Overview of Multi model and mixed model flexible lines, Understanding Flexibility, Types of Flexibility in FMS, Flexible and Dynamic Manufacturing Systems, IT facilitated flexibility, integration and automation, Role of Integrated and automated material handling systems, Typical FMS operation, IT based Tools: Computer simulation and AI for FMS, Group technology, Decision Support Systems, Design, Planning, Scheduling and Control Issues in FMS, Real time control strategies, Various FMS configurations, Computer configurations, FMS as mini-CIM, Benefits and Justification for FMS, Future challenges and research issues etc.

MEL426 Materials Management

4 credits (3-0-2)

Pre-requisites: MET420 & MEL221

Introduction, Relevance of Materials Management, Need for Integrated approach, Deterministic models: EOQ, EPQ, Discount, backlogging, multi-item models etc., sensitivity analysis, basic systems of inventory management , inventory costing. Aggregate inventory models, Stochastic inventory models, service level, single period model, etc., Role of uncertainty, Selective Inventory control. Material planning, forecasting, Warehousing, Storage etc., documentation for purchasing etc. MRP- concepts, logic, computerized models, implementation issues, case studies. JIT-Philosophy, logic, applications, implementation. Vendor selection, and evaluation, Vendor relations, consolidation of vendor base, single sourcing. Information systems for Materials, Documentation , e-procurement and internet based purchasing, e-commerce and materials management. Organizational issues, and evaluation of materials function.

MEL427 Manufacturing Economics and Analysis

4 credits (3-0-2)

Pre-requisites: MET420 & MEL221

Basics of Engineering economic analysis, concepts of varous types of costs, Decision making: Investment in a new machine, Replacement of the existing machine, Make-or-buy, break-even point, Decision about the product mix, Justifying the investment in advanced manufacturing technology, Various economic measure: NPW, IRR, Pay-back period etc.

Concept and various methods of depreciation, tax considerations, Stochasticity analysis.

Multi-attribute decision-making framework, concept of utility. The traditional accounting system (standard costing) and contemporary costing systems such as Activity Based Costing (ABC), Target Costing, and Information system required for analysis.

MEL431 CNC Machines and Programming

4 credits (3-0-2)

Pre-requisites: MEL331 / MEL233

An overview of CNC machines - need, benefits and limitations, classification of CNC machines, Constructional features of CNC machines, CNC part programming - Preparatory and Miscellaneous codes, transformations, subroutines, canned cycles for CNC lathe and milling, CNC program verification tools, CNC program generation from CAD, CNC controller and motion control in CNC system, Applications of CNC and recent advances in CNC machines.

MEL432 Microprocessor Applications in Manufacturing

4 credits (3-0-2)

Pre-requisites: (MET410 / MET420) & (EEL101 / EEL102)

Overlaps with: MEL411/EEL375/CSP413

Review of manufacturing and need and integration of microprocessor applications. Digital electronics review: number system, gates, flip-flops, counters, registers, tri-state concept, TTL and CMOS circuits, memories, op-amps, comparators, etc.

Microprocessors: Microprocessor architecture and computer systems, timing diagrams and machine cycles, interrupts, instruction set, memory and I/O interfacting, programming techniques, PPI, Timer/Counters, Serial Interfacing and communications, Interfacing to keyboards and displays, Standard busses.Microcontrollers and their applications. 8051 architecture and instruction set.

Microprocessor based measurement and control: D/A and A/D conversion, data acquisition systems, optical interrupters and couplers, incremental encoders, interfacing of motors and transducers, open loop and closed loop systems, PID control, motion control and robotics.

Case studies of applications in process and discrete manufacturing.

MEL433 Micro- and Nano-Manufacturing

4 credits (3-0-2)

Pre-requisites: MEL120 and EC 90

An overview of micro and nano mechanical systems and their applications in Mechanical Engineering, MEMS Microfabrication methods, Silicon Micromachining methods, Laser Micromachining methods, Mechanical Micromachining techniques, Nanomanufacturing methods, CAD/CAM Tools for Micro- and Nanomanufacturing processes.

MEL434 Design for Manufacturing and Assembly
4 credits (3-0-2)
Pre-requisites: MEL331 / MEL233 and EC 90

An overview of three stages of product design, generating and evaluating conceptual alternatives from manufacturability point of view, selection of materials and processes, Evaluating part configurations for manufacturability, Evaluating parametric designs for manufacturability, DFM analysis for various manufacturing processes, Product design for manual assembly, product design for high-speed automatic assembly and product design for robot assembly.

MEL435 Geometric Modelling for Manufacturing
4 credits (3-0-2)
Pre-requisites: MEP201 and EC 90

Geometric representation of curves, surfaces and solids, Machining of free-form surfaces from geometric models, geometric modelling for die/mold design, geometric model driven process simulation and process planning, use of geometric models in inspection of curved geometries and reverse engineering, realization of free-form solids by layered manufacturing, computational geometry for manufacturing and inspection.

MEL436 Injection Molding and Mould Design
4 credits (2-0-4)
Pre-requisites: MEL311

Nature of engineering plastics, visco-elasticity, design methods and grade selection

Principles of Injection Molding, Injection molding machine and types, capacity and clamping tonnage, mold size, plasticating extruder concepts, molding properties and control parameters, molding cycle.

Injection Molds for thermoplastics, cavity and core- integer and insert type, product consideration, material consideration, shrinkage, flow length, mold temperature, molding stresses, parting line, feeding system design - sprue, runner, gate, weld line strength, ejection system design, mold cooling systems, runnerless molding, gas assisted and thermosets molding.

Exercises on CAD/ CAM of molds, mold flow analysis, molding of articles, process control and defect identification.

MEL441 Modelling and Experiments in Heat Transfer
4 credits (2-0-4)
Pre-requisites: MEP341 & MEL242

Introduction Geometrical and physical models of heat transfer applications, comparison with experimental data, assumptions and their implications. Property data and its modelling. Mathematical models: algebraic, ordinary and partial differential equations, boundary and initial conditions, solution methodologies. Results: representation and interpretation, uncertainty and error bands. Heat transfer experiments: design, uncertainty analysis, selection of geometrical and physical parameters, engineering drawings, fabrication and instrumentation, rig calibration. Temperature, pressure and flow rate measurements. Systemic errors in temperature measurement: thermocouple and thermowell conduction, radiation and other phenomena. Data acquisition systems: basics and applications. Project-type work involving modelling, and designing and performing experiments related to heat transfer applications.

MEL442 Thermal Analysis of Bio-systems
4 credits (3-0-2)
Pre-requisites: MEL242 and EC 90

Introduction. Bio-fluid dynamics: Blood system network and physiology, blood rheology, Vessel structure and mechanical properties. Heart and pumping process. Blood flow in body tissues. Engineering applications – dialysis, heart-lung machines. Lung and airways system network and physiology. Air and particle flow in airway passages, Alveolar dynamics. Eye, ear and nose system. Fluid mechanics of flight and swimming. Heat transfer: Body temperature and moisture regulation, heat balance and control system, applications to abnormal conditions. Bioheat equation, temperature distribution in tissue, applications to abnormal situations. Heat transfer in animals, fish, birds and insects. Thermodynamics of muscle. Micro-scale heat transfer and bio-systems. Properties of tissue. Laws, codes and regulations. Applications, plants, food processing, eco-systems.

MEN110 Introduction to Mechanical Engineering
2 credits (0-0-4)

Exposure to a wide range of applications of mechanical engineering through a variety of activities, including hands-on assembly and disassembly of machines, such as, bicycle, sewing machine, pumps, engines, air-conditioners, machine-tools, amongst others; observational study of complex systems via cut sections, visits, videos and computer simulations; design of simple machines/systems including specifications formulation; visits to industries, and discussions with senior students and alumni.

MEN120 Introduction to Production and Industrial Engineering
2 credits (0-0-4)

Exposure to a wide range of production engineering and industrial engineering applications through hands-on experience in assembly-disassembly of machines and machine-tools, use of machines to produce simple parts; simulation (physical and/or computer) of manufacturing and assembly processes; applications of industrial engineering, such as, quality control and production management, amongst others. Several visits to factories will be included as also video and computer simulations on manufacturing processes and systems, and discussions with industry representatives.

MEP201 Mechanical Engineering Drawing
3 credits (1-0-4)
Pre-requisites: MEL110

Introduction to design process and drawings. Review of sectioning, drawing standards, dimensioning and notes. Fasteners – screws, bolts and nuts, riveted joints, pins, locking devices, welded joints, pipe joints, unions and valves. Assembly drawings with sectioning and bill of materials. Cotter and Knuckle Joints. Assemblies involving machine elements like shafts, couplings, bearing, pulleys, gears, belts, brackets. Tool drawings including jigs and fixtures. Engine mechanisms-assembly and disassembly. Detailed part drawings from assembly drawings. Production drawings - limits, fits and tolerances, dimensional and geometric tolerances, surface finish symbols. Layout drawings. Schematics, process and instrumentation diagrams, piping drawings. Structural drawings - examples for reading and interpretation. Computer aided design and use of software packages for engineering drawings.

MEP202 Design Innovation and Manufacturing
2 credits (0-0-4)
Pre-requisites: MEL110 & MEL120

Practical exercises involving: (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.

MEP311 Mechanisms Laboratory
1 credit (0-0-2)
Pre-requisites: MEL211

A set of 10 experiments based on Reuleaux basic mechanical devices, Grashoff mechanisms, Linkages, gear and gear trains, gear tooth profile, cams, belts, brakes, clutches, bearings and lubrication, friction, Coriolis acceleration, gyroscopic couple, balancing of rotating and reciprocating masses, free and forced vibrations, transmission system of automobile vehicles, etc.

MEP331 Process Engineering and Tool Design Project
3 credits (1-0-4)
Pre-requisites: MEL231 & MEL234 & MEL235

Introduction to process planning, part print analysis, make-or-buy decision, product drawing analysis, establishing the sequence of processes, economic processing considerations, machine selection, payback comparison, tooling costs, process documentation, routing, operation sheets, tolerance charting, computing dimensions and tolerances and computer aided process planning.

MEP341 Thermal Engineering Laboratory
1.5 credits (0-0-3)
Pre-requisites: MEL242 & MEL241

Experiments related to courses MEL242 Energy Conversion and MEL243 Heat and Mass Transfer courses. Application of uncertainty analyses. Experiments will be conducted in a group of two students. A professional report is to be prepared for each experiment.

MET410 Practical Training (ME)
Non credit
Pre-requisites: EC 90 at the end of 5th sem.

Prior to training, students and faculty identify industries where training that will meet the course objectives, in particular, linkages to the core mechanical engineering curriculum. An evaluation and monitoring plan is drawn up. Students spend at least 50 working days in the industry and submit regular progress reports to training coordinator. Training activities comprise study and participation in various aspects of a manufacturing enterprise and impacts on humans/society and environment. Before returning, each student submits a comprehensive training report, report(s) on projects, posters, presentation, response sheet and self-assessment. Training in academic institutions, software industry, laboratories, and organizations with narrow specialization is not permitted.

MET420 Practical Training (PE)
Non credit
Pre-requisites: EC 90 at the end of 5th sem.

In the year prior to training, students and faculty identify industries where training will meet the course objectives, in particular, linkages to the core production and industrial engineering curriculum. An evaluation and monitoring plan is drawn up. Student spends at least 50 working days in the industry and submits regular progress reports to program's training coordinator. Before returning, each student submits a comprehensive training report, report(s) on projects executed, posters, presentation, an audience response sheet and self-assessment of training. The work will focus on production and/or industrial engineering.

Department of Physics

EPC410 Colloquium (PH)
3 credits (0-3-0)
Pre-requisites: registered for EPT410
This course will cover the presentations of the work carried out by students during the Practical Training and will be attended by all students.

EPD310 Mini Project (PH)
3 credits (0-0-6)
Pre-requisites: EC 80
The project details to be worked out by the faculty giving the project keeping in view the learning needs of the student.

EPD411 Major Project Part 1 (PH)
3 credits (0-0-6)
Pre-requisites: EC 120
To set the objectives, deliverables, work plan, logistics planning and milestones with discernible outputs and then to demonstrate the feasibility through some initial work.

EPD412 Major Project Part 2 (PH)
7 credits (0-0-14)
Pre-requisites: EPD411
Working out the detailed work plan and implementation of the project.

EPL101 Classical Mechanics and Relativity
4 credits (3-1-0)
Degrees of freedom, Generalized co-ordinates; D'Alemberts Principle; Hamilton's Principle, Lagrange equations, generalized monenta, cyclic coordinates and conservation laws, Applications; Motion in a noninertial frame, Coriolis force; Motion in a central force field; Kepler's problem and its solutions; Scattering of particles and the Rutherford Law; Rigid bodies, Independent coordinates and their orthogonal transformations, Cayley Kein parameters, Euler's theorem, Moment of inertia tensor. Principal axis transformation, Force free motion of a rotating body and methods of solving the Euler equations; Motion of tops, precession and nutation; Hamilton's equations, Legendre transformations, cyclic coordinates, Canonical transformations, Poisson brackets and Liouville's Theorem; Hamilton Jacobi Theory; Dynamical systems: Basic theory, phase slow, eqilibrium and stability, fixed points, nonlinearity and bifurcation, strange attractor and chaos; Lorentz Transformations, Tensor analysis, Time dilation, Length contraction and velocity addition, Invariants and conserved quantities, Newton's equations of motion in relativistic form.

EPL103 Mathematical Physics
4 credits (3-1-0)
Sturm-Liouville Equation, Hermite and Laguerre Polynomials, Laplace, Poisson, Heat diffusion and wave equations; Integral equations; Fredholm and Volterra equations; Green's functions, applications of Green's function in Quantum Mechanics and Solid State Physics; WKB, Perturbation and Variational methods; Cartesian tensors with applications in Physics; Matrices.

EPL105 Optics
4 credits (3-1-0)
Overlaps with: PHL795
Wave propagation, 1-D and 3D dimensional wave equations, Sinusoidal waves, Phase and Group velocities; Superposition of waves, Interference by division of wavefront, Concept of spatial and temporal coherence; Interference by division of amplitude: Anti-reflecting films; Colour of thin films; Newton's rings; Michelson interferometer. Multiple Beam interferometery: Fabry Perot interferometer, Resolution and Free spectral range; Interference filters; Fraunhofer diffraction: diffraction by a single slit, double slit, circular aperture; Resolving power of microscopes and telescopes; Diffraction grating, Resolving power and Dispersive power; Fresnel diffraction: diffraction of a Gaussian beam, Polarization: Concept of linear, circular and elliptical polarizations; Brewster's law and Malus's law; Double refraction by crystals; Interference of polarized light, half wave and quarter wave plates; Analysis of polarized light; Fermat's Principle, Ray equation and its solutions. Ray paths in inhomogeneous media. Applications in fiber optics, mirage formation; Introduction to lasers; interaction of radiation with matter, Einstein coefficients, line shape function, condition for amplification, optical resonators, threshold for laser oscillation.

EPL107 Electromagnetics
4 credits (3-1-0)
Revision of vector algebra and coordinate systems. Electrostatics; Electrostatic field in matter: Electric field and potential due to a dipole, Dielectrics; displacement; electrostatic energy in dielectrics; Magnetostatics: Magnetic field due to a moving charge, motion of charged particles in electric and magnetic fields; divergence and curl of a magnetic field; Magnetic field in matter and magnetic circuits; Electromagnetic Induction: Faraday's law, Lenz's law, energy in magnetic field Maxwell's equations and electromagnetic waves: Displacement currents, generalisation of Ampere's law, Maxwell's equations, EM wave equation, plane waves; Energy flow in EM waves.

EPL202 Quantum Mechanics and its Applications
4 credits (3-1-0)
Pre-requisites: PHL110 / PHL120 / EPL101
Formalism of quantum mechanics, Operators, Schrodinger and Heisenberg pictures; Stationary Schroedinger Equation, Harmonic oscillator, H-atom, Bound states, scattering states; Quantum Mechanical theory of Angular Momentum, Spin, Addition of Angular Momenta and Clebsch-Gordon Coefficients; Time-independent Perturbation Theory and application to bound states, Perturbation of an oscillator, Degenerate case, Zeeman effect without spin, First-order and second order Stark effect; Hartree-Fock, Variational and WKB methods; Time-dependent Perturbation Theory, Interaction Picture, First-order and Harmonic Perturbations, Transition probability, Sudden and Adiabatic Perturbations. Semiclassical Theory of radiation, Einstein Coefficients, Principles of Laser radiation; Quantum Mechanical Scattering Theory, Scattering Amplitude, Differential and Total Cross-sections, Born Approximation, Unitary and sum rules; Density matri and its properties, applications. Many particle wave functions. Identical Particles, Symmetric and anti-symmetric wave functions, and the Pauli Principle.

EPL204 Thermal and Statistical Physics
4 credits (3-1-0)
Pre-requisites: PHL110 / PHL120 / EPL103
First and second laws of thermodynamics, micro and macro-states, entropy and disorder, the Carnot cycle; Some practical cycles; Entropy in quantum theory: the density of states, general definition of temperature; The canonical probability distribution, spin paramagnetism, the partition function technique, photons and phonons, computation of the density of modes, radiation pressure, radiative flux, entropy and

evolution. Sound waves and phonons; The chemical potential; adsorption; the quantum ideal gas, occupation numbers and their estimation; fermions and bosons at low temperatures, white dwarf stars, Bose-Einstein condensation and liquid He; The free energies: Helmhotz, Gibbs; chemical equilibrium, phase equilibrium, adiabatic cooling; superfluidity, Gibbs' phase rules, vander Waals equation of state, The Maxwillian gas equipartition theorem; Third law of thermodynamics, negative absolute temperature.

EPL206 Solid State Physics
4 credits (3-1-0)
Pre-requisites: PHL110 / PHL120 / EPL101

Crystal structure, Quasi crystals, Diffraction by a discrete lattice; X-ray, electron and neutron diffraction; Defects; Lattice vibration: concept of Debye and Einstein temperatures; thermal conductivity.

Dielectric properties of insulators: Types of polarisations, local field and Clausius-Mossotti equation, dielectric constants and dielectric loss, dielectric strength and insulation breakdown, capacitor dielectric materials, piezo, ferro and pyro electricity. Quartz oscillators and filters, piezo-spark generators, uni- and multi-axial ferroelectrics, pyroelectric detectors and devices.

Magnetic properties: Unpaired d-electrons in solids, classification of magnetic materials: dia, para, ferro, antiferromagnetism; magnetic domains, soft and hard magnetic materials; ferrites

Superconductors, Meissner effect, flux quantisation, field penetration and high frequency effects, coherence, energy gap, Josephson junctions, SQUID, soft and hard superconductors, superconducting magnets, HTSC.

EPL208 Principles of Electrodynamics and Plasmas
4 credits (3-1-0)
Pre-requisites: PHL110 / PHL120 / EPL107

Basic laws of electrodynamics; Wave propagation in dielectrics, semiconductors and conductors: attenuation, dispersion, phase and group velocities; Wave propagation in plasma: Basics of plasma, methods of plasma production, electron motion in E and B fields, plasma wave, ion acoustic wave, electromagnetic waves, ionospheric propagation; Surface wave propagation, medium frequency communication; Waveguides: rectangular and cylindrical, Resonators; Antenna: dipole antenna, antenna pattern, antenna array, radar; Instabilities: two stream instability Cerenkov free electron laser; Relativistic covariance of Maxwell's equations, Lienhard-Wichart Potentials, radiation from accelerated charges.

EPL211 Principles of Material Synthesis
4 credits (3-1-0)
Pre-requisites: PHL110 / PHL120
Overlaps with: PHL702

Thin films in solid state devices; Vacuum evaporation-Hertz-Knudsen equation, film thickness uniformity; Glow discharge and plasmas, DC, RF and microwave excitation; Sputtering processes- Sputtering of alloys; Reactive sputtering, Plasma chemistry, plasma etching mechanisms; CVD Deposition-Thermodynamics of CVD, gas transport, growth kinetics; Nucleation and Growth:models for 3D and 2D nucleation, grain structure and microstructure and its dependence on deposition parameters; Epitaxy: lattice misfit and imperfections; epitaxy of compound semiconductor, theories of epitaxy, Role of interfacial layer, Artificial semiconductors, Band-gap engineering; Stresses in thin films-internal stresses, Adhesion; Diffusion, Interdiffusion and Reactions in Thin Films: Electro-migration, metal-semiconductor reactions, silicides, Diffusion barriers, Oxidation-basic models, impurity redistribution during epitaxial growth and oxidation; Ion implantation: profiles of implanted ions, Annealing mechanisms and their role in epitaxy and ion-implantation, Rapid thermal annealing; laser modification effects.

EPL213 Fundamentals of Semiconductors
4 credits (3-1-0)
Pre-requisites: PHL110 / PHL120
Overlaps with: EEL218

Motion of electron in periodic potential: Effective mass and Brillouin zone, Kronig Penneg Model, Nearly free electron model, Energy band gap in semiconductors, Holes, Methods of calculating band structure; Density of States in intrinsic carrier concentration, Donors and acceptors, carrier-drift diffusion, band structure; Phonons and scattering mechanisms: Electron-Phonon, electron-electron interactions, Ionized Impurity scattering; Generation and Recombination Processes: Basic mechanisms- Thermal and Shockley-Read, Hall, Impact-ionization and its transition rate; Optical Absorption in Semiconductors: Optical constants, Kramer-Kronig relations, free carrier absorption, plasma and cyclotron resonance, fundamental absorption, direct and indirect transitions, exciton, impurity and lattice absorption; Photo-conductivity: traps, photoconductive gain, photovoltaic effect, photo magnetic effect, emission of radiation from semiconductors; Junctions: Homojunctions, heterojunctions, metal- semiconductor and MIS junctions in equilibrium; junctions under non-equilibrium, current flow.

EPL331 Vacuum Technology and Surface Physics
3 credits (3-0-0)
Pre-requisites: EC 60

Vacuum: its need in research and industry. Principles of low, high and ultra-high vacuum: production and measurement. Design aspects of vacuum systems for different applications, materials for vacuum systems.

Surface Properties: Structural-surface structure and reconstruction, Electronic-contact potential and work function, surface states and band bending, plasmas and surface optics; Atomic motion-surface diffusion, surface melting and chemisorption

Surface Analytical Techniques: Electron spectroscopic techniques (AES, XPS): Principles and applications in materials/devices; Imaging of atoms and nano-clusters using tunneling and ultra-low forces (STM and AFM); Surface structure by LEED.

EPL332 Nuclear Science and Engineering
3 credits (3-0-0)
Pre-requisites: EC 60

Basics of Nuclear Physics, Nuclear particle detectors, activation analysis, Carbon dating, fission and fusion, principle/design/types of nuclear reactors, effect of nuclear radiation on materials, radiation protection and environment, nuclear tracer techniques in industry, nuclear radiography, thickness, density and other gauges, applications of radioisotopes in agriculture and medical areas

Fusion Energy: Nuclear kinetics; reaction analysis, Coulomb scattering; field effect trajectories; magnetic field configurations; particle transport; energy viability; burn cycles.

EPL333 Computational Physics
4 credits (3-0-2)
Pre-requisites: EC 60
Overlaps with: MAL235

Introduction to Numerical Methods: Locating Roots of

Equations, Interpolation and Numerical Differentiation, Numerical Integration, Systems of Linear Equations, Ordinary Differential Equations, Smoothing of data – Method of Least Squares, Fourier Transform Techniques; Simulation Techniques: Random Number Generation and Monte Carlo Methods, The Metropolis algorithm, Variational Methods and Optimization Techniques; Applications of Computer Simulations in Physics: Random Walk and its Applications to Polymers, Percolation and Fractal Phenomena, Aggregation Diffusion Models for growth, Chaos and Non-Linear Systems, Ising Model Simulations of Magnetic Solids and Phase Transitions, Simulations of simple Neural Network Models, Ray tracing algorithms in graded refractive index media.

EPL334 Lasers
3 credits (3-0-0)
Pre-requisites: EC 60
Overlaps with: PHL795

The Einstein coefficients, Spontaneous and stimulated emission, Optical amplification and population inversion; Lineshape functions: Homogeneous and inhomogeneous broadening, Natural, Doppler and Collision broadening; Laser Rate Equations: Two level, Three level and Four level laser systems, Gain saturation; Optical amplifiers: Rare earth doped fiber amplifiers; Optical Resonators: Fabry Perot cavity, Spherical mirror resonators, Stable and unstable resonators, Longitudinal and Transverse modes of the cavity, Threshold condition for laser oscillation, Optimum output coupling; Q-switching and mode locking in lasers, Single longitudinal and single transverse mode oscillation; Laser systems: Ruby, Nd:Yag, Nd: Glass lasers; Tunable lasers: Ti-Sapphire laser; He-Ne, Argon ion, Carbon dioxide and Excimer lasers; Fiber lasers; Semiconductor lasers: Fundamentals, Operation Characteristics, Quantum well lasers, Distributed Bragg reflector (DBR) and Distributed feedback (DFB) lasers; Laser safety.

EPL335 Low Dimensional Physics
4 credits (3-1-0)
Pre-requisites: EC 60
Overlaps with: PHL726

Concept of dimensionality of solids, 3D to 0D; Energy band structure in low dimensions, motion of electron in bands, Density of states, Quantum wells and low dimensional systems, Tunneling transport in low dimensional solids, Behaviour of low dimension solids under electric and magnetic fields, Quantum mechanical treatment of low dimensional solids, Photon and phonon transport, optical absorption, interband absorption, optical properties, inter sub-band transitions, Two dimensional electron gas.

EPL336 Semiconductor Optoelectronics
4 credits (3-1-0)
Pre-requisites: EC 60
Overlaps with: PHL793

Review of Semiconductor Device Physics: Fermi level and quasi Fermi levels. p-n junctions, Schottky junction and ohmic contact. Semiconductor optoelectronic materials, band gap modification, quantum well structures; Semiconductor Photon Sources: Interaction of photons with electrons and holes in a semiconductor, Rates of emission and absorption. Electroluminescence; the LED-materials, structure and device characteristics; Semiconductor Laser: basic structure, theory and device characteristics, DFB, DBR, Quantum well and VCSE Lasers, Laser diode arrays; Semiconductor Photodetectors: Types of photodetectors: photoconductors and photodiodes, PIN diodes and APDs. Noise in photodetection. Detector characteristics and device performance, phototransistors, solar cells and CCDs; Photovoltaic Cells: Single junctions under illumination, photon and carrier loss mechanism, graded and tandem junction devices; Optoelectronic integrated circuits (OEICs) .

EPL337 Materials Science and Engineering
4 credits (3-1-0)
Pre-requisites: EC 60
Overlaps with: PHL703

Elementary materials science concepts; Diffusion processes and their industrial applications; Phase diagrams: Gibbs phase rule, zone refining and pure Si crystals, First and Second order phase transitions; martensitic transformation and spinodal decomposition; Electrical and thermal behaviour; solid solutions and Nordheim's rule,Skin effect, thin metal films and integrated circuit inter-connections; thermoelectricity, seebeck, Thomson and Peltier effects, thermoelectric heating and refrigeration, thermoelectric generators, the figure of merit; Elastic behaviour of solids, Anelasticity, thermoelasticity, viscoelastic deformation, Corrosion and Degradation of Materials: Electrochemical considerations, corrosion environments, corrosion prevention, Materials Selection and Design Considerations; Economic, Environmental and Societal issues in Materials Science and Engineering.

EPL338 Non-linear Phenomena in Physics and Engineering
4 credits (3-1-0)
Pre-requisites: EC 60

The dynamical system and its mathematical model, classification of dynamical systems; Oscillatory system and its properties, illustrative examples; Linear Oscillators, damped and driven oscillators, phase portraits, examples of applications in physics and engineering; Nonlinear oscillators, fixed points, stability Bifurcation theory, applications to electrical circuits, chemical reaction dynamics, duffing oscillator, transmission lines; Period doubling bifurcations, strange attractor, chaos, applications to Lorentz model and Van der Pol oscillator; Linear waves, weakly nonlinear and dispersive waves, solitons, Kdv, NLS, Sine-Gordon systems, examples of applications in physics and engineering; Nonlinear optical phenomena: second harmonic generation, parametric processes, optical solitons, soliton-based all optical communication systems; Nonlinear phenomena in condensed matter physics: Phase transitions, quasi-crystals, symmetry-breaking,.

EPL439 Microelectronic Devices
3 credits (3-0-0)
Pre-requisites: EC 90
Overlaps with: EEL218

Basic Semiconductor: energy bands, donors and acceptors, carrier concentration, carrier transport, generation-recombination, high field effects, basic equations for device operation; p-n junctions: electrostatics, space charge, abrupt and linearly graded, current-voltage and capacitance-voltage characteristics, junction breakdown, transient behaviour hetero-junctions; Bipolar Transistor: transistor action, current gain, static characteristics, frequency response, transient behaviour, junction breakdown, modelling-Ebers-Moll/ Gummel-Poon, thyristor; Metal-Semiconductor contact: Schottky effect, metal-semiconductor contacts, current-voltage characteristics, ohmic contacts; Field Effect Transistor: Junction field effect, MESFET, metal-insulator-semiconductor (MIS), MOS diode, MOSFET, characteristics, threshold voltage, frequency response, device scaling, modelling, charge couple devices (CCD).

Integrated Circuits: standard-bipolar/MOS/CMOS

technology, circuit realization, semiconductor memories, RAM, ROM and PROMs, static and dynamic memories, design aspects, VLSI and ULSI.

EPL440 Quantum Electronics
3 credits (3-0-0)
Pre-requisites: EC 90
Overlaps with: PHL792

Propagation of light waves through bulk media, Review of electromagnetic waves, plane waves, Poynting vector, polarization, diffraction; propagation through anisotropic media, Nonlinear optical effects, Nonlinear polarization; Second order effects: Second harmonic generation, Sum and difference frequency generation, Parametric amplification, parametric fluorescence and oscillation, Periodically poled materials and their applications in nonlinear devices; Third order effects: Self Phase modulation, Temporal and spatial solitons, Cross Phase modulation, Four wave mixing, Phase conjugation; Quantization of the electromagnetic field; Coherent states and their properties; Squeezed states of light and their properties; Application of optical parametric processes to generate squeezed states of light; Optical resonance and two-level atoms, atom cooling and trapping; Ultra-intense laser matter interactions.

EPL441 Applications of Lasers in Technology
3 credits (3-0-0)
Pre-requisites: EC 90
Overlaps with: PHL752

Brief review of laser principles and operative mechanisms. Laser systems in Industrial research and development. CO2, YAG, Excimer and Ruby lasers in material processing, Laser beam hardening; Lasers in material processing, thermal and non-thermal laser induced processes, laser applications in metal welding, cutting, drilling and nano-particle generation; Laser ablation and thin film deposition; Laser processing of semiconductors; Rapid thermal annealing and alloying; Production of nano-structured Si and compound semiconductors and their characterisation by laser Raman and photoluminesence spectroscopy; recent development in laser source technology; use of lasers in data storage, communication, information technology and medical instrumentation.

EPL442 Fiber and Integrated Optics
3 credits (3-0-0)
Pre-requisites: EC 90
Overlaps with: PHL790, PHL791

Propagation in planar optical waveguides-concepts of modes, prism film coupling, Effective index theory for 2-D waveguides, Coupled mode theory for directional couplers and periodic waveguides, I.O. devices, propagation in step and graded index fibers-pulse dispersion, Single-mode fibers and characteristics, Fiber technology and fiber characterisation, Optical communication system designs and recent trends, Non-linear fiber optics, Solitons, optical fiber sensors.

EPL443 Holography and Optical Information Processing
3 credits (3-0-0)
Pre-requisites: EC 90
Overlaps with: PHL756,PHL758,IDL734

Signals and systems, Fourier transform (FT), sampling theorem; Review of diffraction theory: Fresnel-Kirchhoff formulation and angular spectrum method, FT properties of lenses and image formation by a lens; Frequency response of a diffraction-limited system under coherent and incoherent illumination. Basics of holography, in-line and off-axis holography, plane and volume holograms, diffraction efficiency; Recording medium for holograms; Applications of holography: display, microscopy; memories, interferometry, NDT of engineering objects, etc.; Holo-optical elements. Analog optical information processing: Abbe-Porter experiment, phase contrast microscopy and other simple applications; Coherent image processing: vanderLugt filter; joint-transform correlator; pattern recognition, image restoration; Data processing from synthetic aperture radar (SAR), acousto-optic signal processing, discrete analog processors.

EPL444 Functional Nanostructures
3 credits (3-0-0)
Pre-requisites: EC 90
Overlaps with: PHL726

Basics of low dimensional (0D, 1D, 2D) structures, Quantum dots wires and wells, Nanoparticles-free and dispersed, Nanocrystalline and nanostructured films, Self organized structures; Nanostructures for optical and electronic applications, Quantum dot diodes, lasers and detectors, Single electron devices and logic applications, Optical computing and Information processing; Carbon based nanostructures, Electrical, mechanical and chemical properties of carbon nanotubes, Sensors and drug delivery vehicles, Data processing; Bulk nanostructured material and Photonic crystals; Nanostructures for Magnetic applications, Giant and Colossal Magnetoresistance. Nanostructured ferromagnetism, Random Accsses Memories; Nanostructures for catalysis and hydrogen storage, Nanoclays, colloids and hydrogen storage nano materials. Organic and Biological nanostructures. Nanomachines and supra molecular devices.

EPL445 Engineering Optics
3 credits (3-0-0)
Pre-requisites: EC 90
Overlaps with: PHL751, IDL731

Lens systems and basic concepts in their design; Optical components: Mirrors, prisms, gratings and filters; Sources, detectors and their characteristics; Optical systems:Telescopes, microscopes, projection systems, photographic systems, interferometers and spectrometers; Concepts in design of optical systems; Applications in industry, defense, space and medicine; LCD, CCD, compact disc, scanner, laser printer, photocopy, laser shows, satellite cameras, IR imagers.

EPL446 Spintronics and Data Storage
3 credits (3-0-0)
Pre-requisites: EC 90

Basic magnetism, Spin polarization, Magneto and magneto-optical transport, Magnetic storage devices and other means of data storage, Ferromagnetic semiconductors and their use in recording media, Basics of GMR in materials and its applications in read heads, Spin valve and spin-tunnel devices in data storage, Magnetic RAMs, Superparamagnetic limit, Magnetic nanostructures for very large density recording, Future directions in data storage.

EPN110 Introduction to Engineering Physics
2 credits (0-0-4)

Demonstration and interactive sessions with faculty in the areas of optics, photonics and photonic information processing; materials design and nano-technology; computational physics and device simulation; lasers, fiber optics and communication technology; plasma processing and technology; microelectronics. Visit to major facilities like TEM, SEM, XRD, AFM and R&D institutions and/or industry.

EPP109 Physics Laboratory - I
3 credits (0-0-6)
The experiments planned will be such to (i) bring clarity of understanding of the concepts and mechanisms, (ii) provide measuring capability and feel of the functional behavior, and (iii) expose to the practical aspects in the areas of Modern Physics, Optics, Electromagnetics and Lasers.

EPP110 Physical System Design
2 credits (0-0-4)
Disassembling/reassembling of various physical systems and self-learning through this hands-on-experience; design of systems/set-ups for measurement of physical quantities; design of demonstration systems for some functions; etc. will be included in this course.

EPP215 Physics Laboratory - II
3 credits (0-0-6)
Pre-requisites: EPP109
Concepts and mechanisms, (ii) provide measuring capability and feel of the functional behavior, and (iii) expose to the practical aspects in the areas of Thermal and Statistical Physics, Solid State Physics, Superconductors, Vacuum Technology and Materials Science.

EPP216 Physics Laboratory - III
3 credits (0-0-6)
Pre-requisites: EPP110
The experiments planned will be such to (i) bring clarity of understanding of the concepts and mechanisms, (ii) provide measuring capability and feel of the functional behavior, and (iii) expose to the practical aspects in the areas of Thin Films, Semiconductors, Solid State Electronics, Plasma, Optoelectronics and Fiber Optics.

EPP301 Design Laboratory
4 credits (0-0-8)
Pre-requisites: EPP110 and EC 60
The course intends to go beyond the experience of the previous course and includes design of integrated physical systems involving various components on the lines of a mini project. About four such objectives to be attempted from different major areas.

EPR310 Professional Practices (PH)
2 credits (0-1-2)
Pre-requisites: EC 60
Spread over 5th and 6th semesters organization of Industrial tours/visits with on site demonstrations cum lectures (long duration tours during winter break between the two semesters), Lectures and discussion sessions by eminent personalities from Industry and R&D organizations.

EPS310 Independent Study (PH)
3 credits (0-3-0)
Pre-requisites: EC 80
The course details to be worked out by the faculty giving the course keeping in view the learning needs of the student.

EPT410 Practical Training (PH)
Non credit
Pre-requisites: EC 90 at the end of 5th sem.
Practical Training of 50 working days in an Indian industry or R&D organization.

EPV430 Special Topics in Nano-Technology
1 credit (1-0-0)
Pre-requisites: EC 90
Topics from the emerging areas of nano technology development will form the basis and the specialized/visiting faculty offering the course will provide the detailed course contents.

EPV431 Special Topics in Photonics and Optoelectronics
1 credit (1-0-0)
Pre-requisites: EC 90
Topics from the emerging area of photonics and opto-electronics development will form the basis and the specialized/visiting faculty offering the course will provide the detailed course contents.

EPV432 Special Topics in Emerging Processes
1 credit (1-0-0)
Pre-requisites: EC 90
Topics from the emerging area of process and technique development will form the basis and the specialized/visiting faculty offering the course will provide the detailed course contents.

EPV433 Special Topics in Emerging Materials
1 credit (1-0-0)
Pre-requisites: EC 90
Topics from the emerging area of materials development will form the basis and the specialized/visiting faculty offering the course will provide the detailed course contents.

EPV434 Special Topics in Emerging Devices
1 credit (1-0-0)
Pre-requisites: EC 90
Topics from the emerging areas of device development will form the basis and the specialized/visiting faculty offering the course will provide the detailed course contents.

EPV450 Selected Topics in Nano-Technology
2 credits (2-0-0)
Pre-requisites: EC 90
Topics from the emerging areas of nano technology development will form the basis and the specialized/visiting faculty offering the course will provide the detailed course contents.

EPV451 Selected Topics in Photonics and Optoelectronics
2 credits (2-0-0)
Pre-requisites: EC 90
Topics from the emerging areas of photonics and opto-electronics development will form the basis and the specialized/visiting faculty offering the course will provide the detailed course contents.

EPV452 Selected Topics in Emerging Processes
2 credits (2-0-0)
Pre-requisites: EC 90
Topics from the emerging areas of processes and techniques development will form the basis and the specialized/visiting faculty offering the course will provide the detailed course contents.

EPV453 Selected Topics in Emerging Materials
2 credits (2-0-0)
Pre-requisites: EC 90
Topics from the emerging areas of materials development will form the basis and the specialized/visiting faculty offering the course will provide the detailed course contents.

EPV454 Selected Topics in Emerging Devices
2 credits (2-0-0)
Pre-requisites: EC 90
Topics from the emerging areas of device development will form the basis and the specialized/visiting faculty offering the course will provide the detailed course contents.

PHL110 Fields and Waves

4 credits (3-1-0)

Gauss law and its applications in electrostatics in vector form, electric polarization, permittivity, energy density in an electric field, Ampere's law, charged particle motion in E and B fields, magnetization, Faraday's law of electromagnetic induction; Equation of continuity, generalized Ampere's law, Maxwell's equations, wave equation, plane wave solutions, electromagnetic wave propagation in dielectrics and conductors, reflection/refraction, polarization, interference, Fraunhoffer diffraction; Origin of quantum hypothesis, de Broglie's hypothesis of matter waves, Uncertainty principle, Wave function and wave mechanics, Schroedinger equation, QM operators, Expectation value, one-dimensional solutions: zero potential, step potential, potential barrier and potential well.

PHL120 Physics of Materials

4 credits (3-1-0)

Nature of waves and particles, Wave-packets and uncertainty, Wave particle duality, Wave mechanics and its mathematical tools, Classical and quantum statistics, Statistics of discrete energy levels, Black body spectral density, Bose condensation; Free electrons, density of states, Kronig-Penny model, Effective mass, Band structure, Electrons in various types of solids, Particle in quantum well, Harmonic oscillator and Hydrogen atom problems, Application to semiconductor doping, Non-periodic materials; Tunneling of particles and examples, Tunneling through multiple barriers and semiconductor junctions; Interaction among quantum wells: materials under electric and magnetic fields, magnetic resonance effects; Nanostructures – Concepts of electrons in low dimensional confinement, Quantum wells and Super-lattices leading to new device concepts; Lasers – Einstein coefficients, Population inversion, Light amplification, Optical resonators, Characteristics of lasers; Superconductors – Vortex, Flux quantization, SQUID, Levitation and its applications.

PHP100 Physics Laboratory

2 credits (0-0-4)

Typical experiments on elastic constants, mechanically coupled oscillator systems, surface tension and viscosity of liquids, thermal conductivity of bad conductors, black body radiation, interference, diffraction and polarization of light, Planck's constant determination, photoelectric effects, studies of a power source characteristics, charging discharging of a capacitor, electromagnetic induction, Study of AC circuit elements of inductor and capacitor, and analysis of the behavior of RC, LR and LCR circuits, Measurement of phase by superposition.

Department of Textile Technology

TTC410 Colloquium (TT)
3 credits (0-3-0)
Pre-requisites: Registered for TTT410
Evaluation will be based on practical training and presentation.

TTD310 Mini Project (TT)
3 credits (0-0-6)
Pre-requisites: EC 80
Project type design/fabrication work under the guidance of a faculty member. Prior to registration, a detailed plan of work should be submitted by the student(s) to the head of the department.

TTD411 Major Project Part 1 (TT)
3 credits (0-0-6)
Pre-requisites: EC 120
Formation of project team (up to two students and up to two faculty guides); formulation of work plan; completing targetted work for the semester and presentation of complete work of progress for award of grade.

TTD412 Major Project Part 2 (TT)
7 credits (0-0-14)
Pre-requisites: TTD411
Continuation of planned tasks started in Project Part 1, TTD411, to completion, thesis writing and presentation of complete work for the award of grade.

TTL211 Structure and Physical Properties of Fibres
3 credits (3-0-0)
Pre-requisites: PHL110 / MAL110 / CYL120
Molecular architecture, configuration, conformation, amorphous and crystalline phases, glass transition, plasticization, crystallization, melting, factors affecting Tg and Tm. Basic structure of a fibre-one dimensional oriented, semicrystalline, structure of fibrils. Role of molecular entanglement on fibre formation. Formation of structure in viscose and thermoplastic fibres i.e. PET, nylon, PP, and acrylic. Methods of investigating physical structure of fibres such as WAXD, SAXD, DSC, DMA/TMA, FTIR, birefringence, and sonic modulus.

Moisture absorption properties. Rate of moisture absorption, Heat of sorption, water retention and swelling. Theories of moisture absorption- general view, absorption in crystalline and amorphous regions, quantitative theories. Theories of mechanical properties of natural and man-made fibres, viscoelastic behaviour, comparison of properties of various fibres. Fibre friction. Optical properties, Introduction to electrical properties such as dielectric properties and static charge generation. Thermal properties – heat-setting.

TTL212 Manufactured Fibre Technology
4 credits (3-1-0)
Pre-requisites: CYL120 / MAL110 / PHL110
Polymerization of nylon-6, nylon-66, poly(ethylene terephthalate), and polyacrylonitrile. Important reactions and their kinetic rate equations. Batch versus continuous reactors. Modification of PET and nylons.

Introduction to polymer transport phenomena, Polymer rheology, Shear flow through a capillary, elongational flow in a spinning line. Melt instabilities. Melt spinning lines, stress induced crystallization in high speed melt spinning. Characteristic features of PET, polyamide and polypropylene spinning. Spin finish and its components. Wet and dry spinning processes. Effect of parameters on fibre breakage and fibre structure. Importance of dry jet wet spinning of PAN.

Introduction to drawing and heatsetting in thermoplastic fibres.

TTL221 Yarn Manufacture - I
4 credits (3-1-0)
Pre-requisites: CYL120 / MAL110 / PHL110
Impurities in natural fibres. Separation of trash and lint. Pre-baling operations for wool. Purpose of opening, cleaning, mixing and blending of fibres. Opening elements. Principles of fibre opening in blow room and card. Sequence of opening machines. Principles of cleaning. Influence of process parameters on opening and cleaning. Analysis of opening and cleaning processes. Principles and methods of fibre mixing and blending. Mass transportation. Collection of waste. Objectives and principles of drafting. Purpose and principle of condensation of fibres. Causes of mass variation of fibrous assembly and control. Automation and recent developments.

TTL222 Yarn Manufacture - II
4 credits (3-1-0)
Pre-requisites: TTN110
Fibre fractionation and combing. Sequence of operations in a rectilinear comber. Comber machine elements. Preparation of fibre assembly for combing. Theory of fibre fractionation. Twist and yarn strength. Flyer twisting; types and design aspects of flyers. Principles of ring twisting; design aspects of spindles, rings and travellers. Doubling and twisting of yarns. Twist insertion using rotors. Yarn formation using air-jets. Twisting by friction drums. TFO and three for one twisting. Formation of laps. Packing of slivers in cans. Winding of rovings; Principle and design aspects of builder motion in roving frame. Formation of cop build packages in ring frame. Package formation in rotor, air-jet, friction spinning and TFO twisting machines. Automation and recent developments in spinning machinery .

TTL231 Fabric Manufacture - I
4 credits (3-1-0)
Pre-requisites: CYL120 / MAL110 / PHL110
Introduction to various fabric manufacturing methods. Yarn preparation for fabric formation. Winding: objectives, types, basic features, and automation. Different types of packages. Pirn winding: objectives, types, basic features and automation. Warping: Objectives, comparison of various types of warping machine, basic features, creels and control devices. Sizing: Objectives, features of sizing machine, machine elements and process parameters, sizing materials, size preparation and application, size fibre interaction. Drawing-in and knotting.

Weaving: Loom elements, classification of looms, primary, secondary and auxiliary motions of loom, multiple boxes, over and under picking, beat-up, take up, let-off, weft stop and warp stop motion, weft feeler, warp protecting device and box motion. Cam design for shedding and picking. Dobbies and Jacquards: classification, mechanism and design developments. Automatic loom, basic features, pirn changing and shuttle changing mechanism. Loom winder and box loader.

Fabric structure: classification, notation of weave, draft and peg plan, plain weave with its derivatives and ornamentation, basic twill and satin weaves. Analysis of simple fabrics and calculations pertaining to yarn requirements.

Calculation for production and efficiency related to winding, warping, sizing and weaving.

TTL232 Fabric Manufacture - II
4 credits (3-1-0)
Pre-requisites: TTN110

Shuttleless Looms: Principles of weft insertion, power of picking, velocity and acceleration and picking elements, energy consumed, timings, drive to sley and healds, fabrics quality and productivity of projectile, rapier, air-jet and water-jet looms. Comparison of various weft insertion systems. Theoretical analysis of weft insertion in shuttle less looms. Principles of fabric formation on two phase, multiphase, circular and narrow fabric weaving. Carpets: basic features and manufacturing process of hand/machine knotted, woven (Brussel, Wilton, Axminster) and Tufted carpet. Leno weaving, Triaxial weaving. Multiphase weaving. Denim manufacturing.

Basic weft and warp knitted constructions; primary and secondary knitting elements; sequence of loop formation on warp and weft knitting machines; relation between machine gauge and yarn count; productivity of knitting machines; geometry of a loop in plain knitted fabric; control of loop length, fabric weight and dimensions. Properties of knitted fabric. Nonwoven fabrics: Definitions and classifications; production technology, selection criteria and important properties of fibres used. Different types of webs and bonding techniques. Production and properties of needle punched, stitch bonded, adhesive bonded, spunlaced, spun bonded and meltblown fabrics.

TTL241 Technology of Textile Preparation and Finishing
3 credits (3-0-0)
Pre-requisites: CYL120 / MAL110 / PHL110

Natural and added impurities in textiles. Singeing, desizing, scouring, bleaching, mercerisation and optical whitening of cotton. Combined preparatory processes Carbonisation, scouring and bleaching of wool, degumming of silk. Preparation of synthetic fibres and blends, heat setting. Machinery for preparation of textiles. Surfactants and their application. Introduction to chemical and mechanical finishes. Chemical finishes for hand modification. Biopolishing, easy care, oil, water and soil repellent finishes. Fire retardancy, antimicrobial finishes. Finishes for wool. Mechanical finishes like shrinkproofing and calendering; Raising, sueding and emerising. Low liquor application techniques and machinery; Stenters and dryers.

TTL242 Technology of Textile Colouration
4 credits (3-1-0)
Pre-requisites: TTN110

The principles of dyeing and printing of textile materials. Basic characteristics of dyes, chemical structure of dyes, and classification of dyes. Dyeing equipment and the specific dyes and procedures used to dye textiles. Evaluation of Fastness. Methods of printing namely, roller, screen, transfer, ink jet and the preparation of printing paste. Direct, discharge and resist printing styles. Physical chemistry of fibre/fabric dyeing. Physicochemical theories of the application of dyestuffs to textile and related materials, including the thermodynamics and kinetic principles involved.

Discussion of colour science and computer match prediction in dyeing fibres, yarns, and fabrics. Objective specification of colour, colour difference measurements, and various colour spaces. Based on colour theory and numerical analysis, computer match prediction algorithms. Setting of Pass/Fail criterion and shade sorting. Colour communication. Using computer colour matching software.

TTL310 High Performance Fibrous Structures and Composites
3 credits (3-0-0)
Pre-requisites: EC 60

Introduction to fibres for high performance composites. Different fibre architectures used for composites and their characteristics and properties. Influence of fibre architectures on the properties of composites. Unidirectional, planar, 3D and net-shaped performing. Introduction to matrix types and their properties. Polymeric matrices for rigid and flexible composites. Reinforcing materials and the effect of their geometry on the properties of composites. The fibre-matrix interface; role of coupling agents. Mechanism of stress transfer. Toughness and thermal behaviour of composites. Various techniques of composites design and fabrication. Composites for structural engineering, electrical, civil, aerospace, defense, automobile, sporting goods and other applications. Design and analysis of textile structural composites.

TTL311 High Performance and Specialty Fibres
3 credits (3-0-0)
Pre-requisites: TTL211 / TTL212 / TTP211

Polymerization, spinning and properties of aromatic polyamides, high molecular weight polyester, rigid rod and ladder polymers such as BBL, PBZT, PBO, PBI. Manufacturing of carbon fibres from PAN precursors, viscose and pitch fibres. Glass fibres. Liquid crystal fibres. Gel spinning of polyethylene. Hollow and profile fibres, design of spinnerette for such fibres. Membrane technology. Blended and bicomponent fibres. Medical textiles. Superabsorbent fibres. Plasma modification. Radiation processing. Industrial tapes. Biaxially oriented films and film fibres. Barrier films and coatings.

TTL321 Mechanics of Spinning Machinery
3 credits (2-1-0)
Pre-requisites: TTL211 & TTL222

Types of gears. Nomenclature of spur and helical gears. Conjugate action and involute tooth profile. Interference. Force analysis in gear drives. Thrust loads. Bevel and worm gears. Velocity ratio of epicyclic gear trains. Differential gearing in roving frame and comber. Design of cone drums for scutcher and roving frame. Flat, V, round and timing belts. Tape drives. Belt drives for special purposes. Adjustment of belt tensions. Chain drives and polygonal effect. Analysis of tensions, torque, bending forces and power transmission in drives. Jaw, friction, cone and centrifugal clutches. Block and other brakes. Force analysis in clutches and brakes. Sliding contact bearings, friction in journal bearings. Classification and use of ball and roller bearings. Equivalent bearing load and load-life relationship. Design of transmission shaft and drafting rollers: Safety factor, tensile, compressive, shear, bending and torsional stresses. Design for static load, lateral and torsional rigidities. Balancing of machines and vibrations, flexible spindles.

TTL322 Mechanics of Spinning Processes
3 credits (3-0-0)
Pre-requisites: TTL221 & TTL 222

Forces acting on fibre during opening and cleaning processes. Carding process. Analysis of cylinder load and transfer efficiency. Fibre configuration in card and drawn sliver. Fibre straightening and hook removal. Sliver irregularity. Fibre movement in drafting field. Suppression of drafting wave. Drafting force. Roller slip, roller eccentricity and vibration. Fibre fractionation in comber. Analysis of forces on yarn and traveller.

Spinning tension in ring and rotor spinning. Twist flow in ring and rotor spinning. End breaks during spinning. False twisting principles. Blending of fibres. Evaluation of blending efficiency.

TTL323 Process Control in Spinning
3 credits (3-0-0)
Pre-requisites: TTL221 & TTL222

Importance of process control. Control of mixing quality and cost using LP. Bale management. Control of cotton contamination. Control of cleaning efficiency and waste in blow room and card. Control of waste in comber. Control of neps in sliver. Control of imperfections and faults in yarns. Control of yarn count and count CV%. Control of strength, and strength CV%. Control of periodic mass variations. Machine and energy audit. Analysis and interpretation of statistical data. Total quality control.

TTL324 Spinning of Man-made Fibres and Blends
3 credits (3-0-0)
Pre-requisites: TTL221 & TTL222

Significance of manmade fibre sector. Fibre characteristics and spinnability of manmade fibres. Fibre properties and end uses. Relationship between fibre properties and yarn quality and yarn characteristics. Role of spin finish and fibre crimp in processing. Blending and its objectives. Estimation of blend intimacy and blend irregularity and factors affecting them. Migration. Selection of blend constituents. Rotor, Friction and Air-jet spinning. Process changes for spinning of dope-dyed and fibre-dyed fibres. Effect of blend composition on yarn properties. Processing of man-made fibres and blends on cotton and worsted system of spinning. Production of bulk yarn.

TTL331 Fabric Structure and Analysis
3 credits (2-0-2)
Pre-requisites: TTL231 / TTL232 / TTL221 / TTL222

Introduction to various conventional fabrics like poplin, sheeting, cheese cloth, damask, denim, drill and jean, and gabardine etc. Characteristics and building up of granite weaves. Diamond and diaper weaves. Geometric patterns in checker board weaves. Colour effects in woven fabrics. Honeycomb and huckaback weaves. Leno and gauge structure. Study of whipcord and Bedford cord. Pique. Wadded structure. Extra warp and extra weft figuring. Detailed treatment of backed and double clothes. Interchanging warp and weft structure with figure effects. Center stitched double fabrics. Warp and weft pile fabrics. Velvet and velveteen. Analysis of fabrics referred to above for constructing weave (with draft and peg plan), constructional details and loom particulars etc. Computerized designing. Overview of Indian traditional woven textile designs.

TTL332 Computer Aided Fabric Manufacturing
3 credits (2-0-2)
Pre-requisites: TTL231 & TTL232

Electronic Dobby: Working principle, machine parameters, microelectronics electronics, design features, drive arrangement, systems for pattern data transfer and design development. Electronic Jacquard: working principle, constructional variants, various electronic jacquard systems, selection system, pattern data, transfer and management. CAD for dobby, jacquard, label and carpet: Design algorithm, development of Jacquard designs, process of drafting and sketch design, development of figures, composition of design, geometric ornamentation, arrangement of figures, weave simulation.

Practicals: Working on electronic dobby and electronic Jacquard, working on CAD, development of various designs for Jacquard, level and carpet. Development of design samples.

TTL333 Process Control in Weaving
3 credits (3-0-0)
Pre-requisites: TTL231 & TTL232

Importance and consideration for evolving a system for process control. Machine and energy audit. Housekeeping and material handling. Statistical interpretation of data on waste and quality. Controls for quality, machine stoppage and productivity in winding, warping, sizing, drawing, prin winding and weaving. Standard norms for settings speeds and production rates. Fabric defects and their control. Control and norms of hard waste in various processes. Care, selection and consumption norms of accessories. Importance and types of maintenance, maintenance schedule in winding, warping sizing and loom shed. Machine audit: Energy norms in winding, warping sizing and loom shed and scope of its control. Calculations pertaining to production, efficiency and machine allocation in winding, warping, pirn winding, sizing and loom shed.

TTL341 Polymers and Surfactants for Textiles
3 credits (3-0-0)
Pre-requisites: CYL230 / TTL241 / TTL242

Surfactants, Classification and organic chemistry of surfactants, micellization. Application of surfactants in textiles-emulsification, foams, wetting, solid dispersions in liquids, solubalization, detergency etc. Applications of polymers in textiles. Properties and requirements for polymers for sizes, thickeners, binders, adhesive, coating polymers and finishing agents. Chemistry of following polymer/copolymer systems – preferred polymerization technique, desirable comonomers). Commercial process, properties and specific applications: Modified natural polymers-starch/ cellulose/ Guar gum based polymers, poly acrylic/ methacrylic acid, poly (vinyl acetate) and Poly (vinyl alcohol), polyurethanes, Poly (vinyl chloride)/ PVDC/ Fluoro polymers, rubbers/ styrene based polymers,poly (siloxanes) and other related polymers.

TTL351 Apparel Technology
3 credits (2-0-2)
Pre-requisites: TTL231 / TTL232 / TTL241 / TT242

Concept of clothing design and proportion. Fabric properties and their effect on garment properties, production and quality. Anthropometrics; Clothing sizes. Pattern making and grading. Principles of marker making; spreading and cutting. Cutting methods. Quality control in the cutting room. Stitch classification, seam types and their applications. Sewing faults, their causes and remedies. Choice of sewing needles and threads. Principles and comparison of machines available for a variety of sewing operations. Work aids-folders, special presser feet, feeding systems. Interlinings-classification and application. Fusing and pressing machines. Garment breakdown analysis. Clothing production systems and material handling. Garment dyeing and finishing.

TTL352 Clothing Science
3 credits (3-0-0)
Pre-requisites: TTL211 / TTL232 / TTL231

Factors involved in the study of clothing. General functional description of clothing. Physiological and psychological aspects of fabric comfort. Heat and moisture relations in clothing. Physical properties of clothing and clothing materials in relation to comfort; thermal resistance, water vapor resistance, wicking and air-permeability. Influence of environmental conditions of the protective performance of garments. Field studies on the thermal protection of clothing.

Bending and shear proeprties, clothing fit and drape. Fabric friction, static electricity and comfort. Aesthetic aspects of clothing. Influence of fiber yarn characteristics and fabric construction parameters on clothing comfort. Current trends and new developments in the study of clothing. New materials and finishes, new techniques, new concepts.

TTL361 Textile Testing

3 credits (3-0-0)
Pre-requisites: TTL211 / TTL212 / TTL221 / TTL232

Introduction to textile testing. Selection of samples for testing. Random and biased samples. The estimation of population characteristics from samples and the use of confidence intervals. Determination of number of tests to be carried out to give chosen degree of accuracy. Significant testing of means and variance. Quality control charts and their interpretation. Standard tests, analysis of data and test reports.

Measurement of length, fineness and crimp of fibres. Determination of maturity, foreign matter, and moisture content of cotton. Measurement of twist, linear density and hairiness of yarn. Evenness testing of silvers, rovings and yarns. Analysis of periodic variations in mass per unit length. Uster classimat. Spectrogram and V-L curve analysis. Tensile testing of fibres, yarns and fabrics. Automation in tensile testers. Tearing, bursting and abrasion resistance tests for fabrics. Pilling resistance of fabrics. Bending, shear and compressional properties of fabrics. Fabric drape and handle. Crease and wrinkle behaviour. Air, water and water-vapour transmission through fabrics. Thermal resistance of fabrics. Testing of interlaced and textured yarns. Special tests for carpets and nonwoven fabrics.

TTL362 Theory of Textile Structures

5 credits (3-2-0)
Pre-requisites: TTL211 / TTL221 / TTL222 / TTL232

Types of yarn, Consolidation mechanism, Influence of fibre parameters on yarn structure, Coaxial helix model, Significance of twist, Yarn contraction, Influence of fibre properties and process parameters on yarn diameter and density, Packing of fibres in yarn, spinning–in coefficient, fibre migration, stress–strain behaviour of filament and staple yarns, Failure mechanism of staple yarn, Geometry folded yarn Elements of fabric geometry. Flexible and rigid thread models. Crimp interchanges in woven fabrics and crimp balance of elastic threads. Practical applications of cloth geometry. Fabric sett, cover and areal density. Fabric deformation in tension (uniaxial and biaxial). Bending behaviour of fabric: bending hysterisis, clustering ratio, bending of set and unset fabric, bending in bias direction. Shear, drape, buckling and compressional behaviour, mechanical properties of knitted fabric. Fabric mechanical property in relation of making up.

TTL363 Technical Textiles

4 credits (3-1-0)
Pre-requisites: TTL211 / TTP211 / TTL222 / TTL232

Growth of industrial textiles. Engineering textile structures for industrial purposes. Properties and use of textiles in the design of flexible composites like tyres, hoses and belts. Use of textiles in rigid composites, properties and applications. Textiles in filtration. Agricultural application of textiles. Textiles in civil engineering applicaitions. Design, production, properties and application of coated fabrics. Flame retardant fibers and fabrics and their use in protective clothings. Textiles in miscellaneous industrial applications.

TTL364 Intelligent and Functional Textile

2 credits (2-0-0)
Pre-requisites: TTL211 / TTP211 / TTL232 / TTL222

Definition of smart and intelligent textiles. Passive and active functionality. Textile with high protection and comfort properties. Extreme winter clothing with low heat transmission, heat absorbing, heat storing systems. Phase change materials, incorporation of PCMs in fibres and fabrics. Breathable textile. Multifunctional textiles with incorporated electronics for integrated communication, music, health monitoring, defence support functions, wearable computers. Environmentally sensitive textiles-photochromic and thermochromic (chameleonic) fabrics, camouflage (radar shielding) fabrics, variable heat absorption surfaces, stimuli sensitive polymers such as temperature, pH, ionic, magnetic sensitive materials, design and their applications to textile. Fibres as solar cells, Recent advances in multifunctional textiles.

TTL365 Costing and its Application in Textiles

4 credits (3-1-0)
Pre-requisites: EC 60

Costing as an aid to management. Cost terms related to income measurement, profit planning and cost control for textile industry. Costing of materials, labour and factory overheads and their control; methods of inventory costing for textile industry, accounting of labour, factory over head absorption rate, overhead cost allocation in a composite mill. Job-order costing for a garment industry. Batch costing. Process costing; waste cost and its control in a textile mill. Joint and by-product costing. Unit cost; costs of yarns and fabrics, fabric processing cost. Absorption and variable costing; short-term decision making. Profit planning; cost-volume-profit-analysis, break-even point, contribution margin, margin of safety and capital budgeting. Cost control; standard costs, cost and revenue variances. Financial information; balance sheet and profit and loss account. Statement of changes in financial position. Ratio analysis.

TTL724 Textured Yarn Technology

3 credits (3-0-0)
Pre-requisites: EC 90

Principles of texturing and modern classification; False twist texturing process- mechanisms and machinery, optimization of texturing parameters, barre', structure-property correlation of textured yarns; Draw-texturing- the need and fundamental approaches; Friction texturing- the need and development, mechanics of friction texturing, latest development in twisting devices, optimization of quality parameters. Noise control in texturing.

Air jet texturing - Principle, mechanisms, development of jets and machinery, process optimization and characterization, air jet texturing of spun yarns.

Air interlacement - Principle and mechanism, jet development and characterization.

Bulked continuous filament yarns - Need, principle, technology development.

Hi-bulk yarns - Acrylic Hi-bulk yarn production, mechanism and machines involved, other such products.

Solvent and chemical texturing - Need, texturing of synthetic and natural fibres.

TTL744 Environment Management in Textile and Allied Industries
3 credits (3-0-0)
Pre-requisites: EC 90

Importance of ecological balance and environmental protection; Definition of waste and pollutant; Pollutant categories and types; International and Indian legislation and enforcing agencies in pollution control; Waste management approaches; Environmental Management Systems – ISO 14000; Environmental impact along the textile chain from fibre production to disposal: Toxicity of intermediates, dyes and other auxiliaries etc.; Pollution load from different wet processing operations; Textile effluents and their characterisation; Technology and principles of effluent treatment; Advanced colour removal technologies, Recovery and reuse of water and chemicals; Air and noise pollution and its control; Eco labelling schemes; Industrial hygiene and safe working practices; Analytical testing of eco and environmental parameters; Eco friendly textile processing: waste minimisation, standardisation and optimisation, process modification; safe and ecofriendly dyes and auxiliaries; Industrial hygiene and safe working practices; Solid waste (fibre and polymer) recycling; Fibre waste modification; Environmental management systems: ISO 14000; Certification and criteria; case studies.

TTL762 Management of Textile Production
3 credits (3-0-0)
Pre-requisites: EC 90

Indian textile industry senario, production and exports, handloom sector. Textile Policy. Sicknes in Textile industry, analysis and options. Production planning and control; product mix linear programming concepts. Inventory control models. Replacements and maintenance problems. Techniques of project evaluation. Mill planning. Forecasting, concept and time series models. Management information systems. Sequencing. Assignment techniques. Method study. Marketing management research and planning. Zero defect concept. Modernization.

TTL773 Design of Experiments and Statistical Techniques
3 credits (3-0-0)
Pre-requisites: EC 90

Objectives and principles of experimental design. Experimental design terminology. Increasing accuracy of experiments. Completely randomized designs. Blocking designs Latin square designs. Analysis of variance (ANOVA). Two-level and three-level factorial designs. Complete 2n factorial and fractional factorial designs. Response surface designs. Central composite and Box-Behnken designs. Use of statistical packages. Fitting data. Linear regression with one and more variables. Polynomial models. Correlation and coefficient of determination. Partial correlation. Rank correlation Coefficient of concordance. Acceptance sampling by attributes and variables. OC curves. Average run length. Control charts. Choice of sample size.

TTN110 Introduction to Textile Technology
2 credits (0-0-4)

This course is an introduction to second year level courses in the department. The students are encouraged to self learn basic principles of relevant technology and its technical jargon by conducting simple experiments, making observations, and reading brief handouts. This includes learning the importance of textile materials and structures in comparison to other known structural materials such as metals, ceramics, concrete, etc. Introduction to development of various structures of textile, such as fibres, yarn, fabric, and their conversion into everyday to technically critical applications. A trip to a textile industry and short seminar series by students will make an integral part of this course.

TTP200 Design of Textile Products and Processes
2 credits (0-0-4)
Pre-requisites: TTN110 / MEL110 / MEL120

Individual or group of students would be offered predefined product or process design project under the guidance of a faculty members. Emphasis of the projects set should be on achieving set objectives using known technological components, rather than new or fundamental research.

TTP211 Introduction to Fibres
2 credits (1-0-2)
Pre-requisites: PHL110 / MAL110 / CYL120

Classification of fibres-natural and manmade. Basic structure of a fibre. General properties of a fibre such as moisture absorption, tenacity, elongation, initial modulus, yield point, toughness, elastic recovery.

Detailed chemical and physical structure of natural fibres-cotton, wool and silk, their basic properties. Introduction to important bast fibres.

Laboratory exercises would include experiments on fibre identification through physical appearance, microscopic-optical SEM, and burning behaviour. Chemical identification through solvent treatment and FTIR. Identification using DSC (melting point and glass transition temperature), density measurement.

TTP212 Manufactured Fibre Technology Laboratory
1 credit (0-0-2)
Pre-requisites: CYL120 / MAL110 / PHL110

Experiments related to fibres production processes. For example, determination of moisture in chips. Effect of moisture and temperature on MFI of PET and PP. Melt spinning of PET, nylon-6 filament yarn on laboratory spinning machines. Single and two stage drawing of the as spun yarns and POY. Demonstration of high speed spinning machine. Heat setting of PET and nylon drawn yarns on heaters, in oil bath and steam. Effect of temperature, slack/taut condition on heatsetting. Determination of structure and mechanical properties of as spun, POY, drawn and heat set yarns using DSC, x-ray, FTIR, density, sonic modulus. Determination of polymer solution rheology using Brookfield rheometers and ball-fall method. Effect of shear rate, temperature on viscosity of solutions. Wet spinning or dry jet wet spinning of PAN copolymers. Demonstration of false twist and air jet texturing processes. Determination of structure of textured yarn under microscope.

TTP221 Yarn Manufacture Laboratory - I
1 credit (0-0-2)
Pre-requisites: CYL120 / MAL110 / PHL110

Practicals related to the theory course TTL211.

TTP222 Yarn Manufacture Laboratory - II
1 credit (0-0-2)
Pre-requisites: TTN110

Practicals related to the theory course TTL222.

TTP231 Fabric Manufacture Laboratory - I
1 credit (0-0-2)
Pre-requisites: CYL120 / MAL110 / PHL110

Experiments related to TTL231.

TTP232 Fabric Manufacture Laboratory - II
2 credits (0-0-4)
Pre-requisites: TTN110
Experiments related to TTL232.

TTP241 Technology of Textile Preparation and Finishing Laboratory
1.5 credits (0-0-3)
Pre-requisites: CYL120 / MAL110 / PHL110
Practicals dealing with desizing, scouring and whitening of cotton textiles. Combined preparatory processes. Carbonising, scouring and bleaching of wool and desizing of silk. Finishes for handle modification, functional finishes such as crease recovery, flame retardant, rot proofing of cotton and milling of wool.

TTP242 Technology of Textile Colouration Laboratory
1.5 credits (0-0-3)
Pre-requisites: TTN110
The principles of dyeing and printing of textile material. Dyeing equipment and the specific dyes and procedures used to dye textiles. Evaluation of Fastness. Methods of printing namely, roller, screen, transfer, ink jet and the preparation of printing paste. Direct, discharge and resist printing styles.

TTP311 Simulation of Fibre Production Processes
3 credits (1-0-4)
Pre-requisites: TTL212
Reaction rate equations for condensation polymerization, radical polymerization for batch and continuous stirred tank reactors, application of generating functions for formation of differential equations for infinite number of chains, analytical and numerical solutions of equations, force balance in melt spinning line, formation of differential equations on force dynamics, solutions using computational methods, modelling of coagulation process in wet spinning and other fibre forming processes.

TTP361 Textile Testing Laboratory
1 credit (0-0-2)
Pre-requisites: TTL211 / TTL212 / TTL221 / TTL232
Experiments related to course TTL261.

TTR310 Professional Practices (TT)
2 credits (0-1-2)
Pre-requisites: EC 60
Overview of the state of art technology and practices in the industry presented by senior professionals from the industry.

TTS310 Independent Study (TT)
3 credits (0-3-0)
Pre-requisites: EC 80
Research oriented activities or study of subjects outside regular course offerings under the guidance of a faculty member. Prior to registration, a detailed plan of work should be submitted to the head of the department for approval.

TTT410 Practical Training (TT)
Non credit
Pre-requisites: EC 90 at the end of 5th sem.
Fifty (50) working days or 400 hours of practical training and presentation.

TTV301 Special Module in Yarn Manufacture
1 credit (1-0-0)
Pre-requisites: TTN110 and EC 60
The course aims at introducing new or highly specialized technological aspects in yarn manufacture. The course topic and content is likely to change with each offering depending upon the current requirement and expertise available with the department including that of the visiting professionals.

TTV302 Special Module in Fabric Manufacture
1 credit (1-0-0)
Pre-requisites: TTN110 and EC 60
The course aims at introducing new or highly specialized technological aspects in fabric manufacture. The course topic and content is likely to change with each offering depending upon the current requirement and expertise available with the department including that of the visiting professionals.

TTV303 Special Module in Textile Chemical Processing
1 credit (1-0-0)
Pre-requisites: TTN110 and EC 60
The course aims at introducing new or highly specialized technological aspects in textile chemical processing. The course topic and content is likely to change with each offering depending upon the current requirement and expertise available with the department including that of the visiting professionals.

TTV304 Special Module in Fibre Science
1 credit (1-0-0)
Pre-requisites: TTN110 and EC 60
The course aims at introducing new or highly specialized technological aspects in fiber science. The course topic and content is likely to change with each offering depending upon the current requirement and expertise available with the department including that of the visiting professionals.

TTV305 Special Module in Textile Technology
1 credit (1-0-0)
Pre-requisites: TTN110 and EC 60
The course aims at introducing new or highly specialized technological aspects in textile technology. The course topic and content is likely to change with each offering depending upon the current requirement and expertise available with the department including that of the visiting professionals.

Centre for Atmospheric Sciences

ASL410 Numerical Simulation of Atmospheric and Oceanic Phenomena
4 credits (3-0-2)
Pre-requisites: EC 90

Laws governing the motion of atmosphere and ocean, density stratification and static stability, equations of motion of a rotating fluid, scale analysis, hydrostatic approximation, vorticity and divergence, a coordinate system for planetary scale motion, Saint-venant (shallow-water) equations; Waves and instabilities; sound waves, surface gravity waves, internal gravity waves, Rossby waves, vertically propagating waves, barotropic and baroclinic instability; Numerical methods: (a) Finite difference methods - advection equation, stability analysis, oscillation equations, (b) Galerkin Methods - transform method, application of spectral and finite element methods to barotropic vorticity equation. Boundary layers: Prandtl layer, Ekman layer, Monin-Obukhov similarity theory and surface layer, Closure assumption, eddy diffusion and K-theory, one-dimensional models of boundary layer. Objective analysis and initialization: data preparation, need for initialization of numerical models, dynamic and normal mode initialization, variational methods and four-dimensional data assimilation.

Centre for Biomedical Engineering

BML330 Topics on Safety Principles for Engineers
4 credits (3-0-2)
Pre-requisites: EC 60

Value theory-Risk and Reliability-Decision theory. Injury and damage control. Epidemiology of accidents. Human tolerance to energy inputs. Biomedical/biomechanical aspects of long term exposure to hazardous environment. Socio-technical aspects of safety standards. Case studies of well known disasters.

Centre for Energy Studies

ESL300 Self-organizing Dynamical System
3 credits (3-0-0)
Pre-requisites: EC 60

Dynamical systems dissipative and area preserving; patterns in Hamiltonian dynamics invariants and symmetry; KAM theorem/coherent structures, complexity and pattern formation, Belousov-Zhabutinsky reaction, Landau-Ginzburg/ mean-field models; scaling fractals, cellular automata, wavelet transforms; phase transitions and order parameter; criticality the border of order and chaos; entropy and direction of time; negentropic systems; self-organised criticality; lattice models, examples: neural networks, electrical circuits, management systems, astrophysical systems, plasma and magnetic surface systems, biological systems.

ESL340 Non-Conventional Source of Energy
4 credits (3-0-2)
Pre-requisites: EC 60

Global and National Energy Scenarios, Forms and Characteristics of renewable energy sources. Solar radiation, flat plate collectors, solar concentrators. Thermal Applications of solar energy. Photovoltaics technology and applications. Energy Storage. Energy from biomass. Thermochemical, biochemical conversion to fuels. Biogas and its applications. Wind characteristics, resource assessment. Horizontal and vertical axis wind turbines. Electricity generation and water pumping. Micro/Mini hydropower system; water pumping and conversion to electricity. Hydraulic ram pump. Ocean Thermal Energy Conversion (OTEC), Geothermal; Tidal; and Wave Energies. Material aspects of Renewable Energy Technologies and systems.

Centre for Rural Development and Technology

RDL340 Technology and Community Development
4 credits (3-1-0)
Pre-requisites: EL 60

Concepts of appropriateness of technology to community, based on region specific factors. Technology assessment: Techno economic evaluation, energy audit, short and long term impacts of technology on environment and society. Basic needs and technology alternatives for sustainable development. Technology choices in agriculture (modern system, organic farming, permaculture, natural farming, equipments, implements and devices, water management); energy (renewable resources, biomass production, conversion and utilization, social forestry); housing (low cost materials, designs and habitats); health care (traditional practices, water and sanitation); rural industries (based on traditional and emerging technologies). Issues of Technology transfer.

INDIAN INSTITUTE OF TECHNOLOGY DELHI

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do hereby undertake that as a student at IIT Delhi :

(1) I will not give or receive aid in examinations; that I will not give or receive unpermitted aid in class work, in preparation of reports, or in any 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 myself uphold the spirit and letter of the Honour Code.

I realize that some examples of misconduct which are regarded as being in violation of the Honour Code include :

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- ☞ unpermitted collaboration;
- ☞ plagiarism;
- ☞ revising and resubmitting a marked quiz or examination paper for re-grading without the instructor's knowledge and consent;
- ☞ giving or receiving unpermitted aid on take-home examinations;
- ☞ representing as one's own work the work of another, including information available on the Internet;
- ☞ giving or receiving aid on an academic assignment under circumstances in which a reasonable 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. _____

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INDIAN INSTITUTE OF TECHNOLOGY DELHI
Hauz Khas, New Delhi - 110 016
Ph.: 011 26597268, 26591714, Fax: 011 26582277, 26582037
Website: www.iitd.ac.in