

# **UNIVERSITY OF DELHI**

**NETAJI SUBHAS INSTITUTE OF TECHNOLOGY**

**CHOICE BASED CREDIT SYSTEM**

**SCHEME OF COURSES**

**FOR**

**B. E. (MECHANICAL ENGINEERING)**

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**PREAMBLE**

**I. INTRODUCTION**

Higher education is very important for the growth and development of any country. It is a living organ and requires continuous changes to ensure the quality of education. National Knowledge Commission and University Grants Commission have recommended many academic reforms to address the challenges of today's networked globalized world. People are coming together with the help of new technologies which is resulting towards new aspirations, expectations, collaborations and associations. The concept of "work in isolation" may not be relevant and significant anymore. The UGC guidelines on adoption of Choice Based Credit System may be an important step to revamp the processes, systems and methodologies of Higher Educational Institutions (HEIs). The teacher centric mode be changed to learner centric mode. Class room teaching and learning be made effective, relevant and interesting. Concepts and theories be explained with examples, experimentation and related applications.

A culture of discussions, arguments, interpretations, counter-interpretations, re-interpretations and opposing interpretations must be established. Research should not be confined only to redefinition, extension and incremental change. Innovation and creativity should become an epicenter for all research initiatives. The most important capital is the human capital and thus the ultimate objective is to develop good human beings with utmost integrity and professionalism for this new world.

The Choice Based Credit System supports the grading system which is considered to be better than conventional marking system. It is followed in many reputed institutions in India and abroad. The uniform grading system facilitates student mobility across institutions within and across countries and also enables potential employers to assess the performance of students. The Choice Based Credit System makes the curriculum interdisciplinary and bridges the gap between professional and liberal education.

**II. CHOICE BASED CREDIT SYSTEM**

The Indian Higher Education Institutions have been moving from the conventional annual system to semester system. Currently many of the institutions have already introduced the Choice Based Credit System. The semester system accelerates the teaching-learning process and enables vertical and horizontal mobility in learning. The credit based semester system provides flexibility in designing curriculum and assigning credits based on the course content and hours of teaching. The Choice Based Credit System provides a 'cafeteria' type approach

in which the students can take courses of their choice, learn at their own pace, undergo additional courses to acquire more than the required credits and adopt an interdisciplinary approach to learning.

**A. Programme**

This scheme and courses are related to four year Mechanical Engineering programme with following Programme Educational Objectives (PEO).

**Program Educational Objectives (PEOs)**

The program educational objectives of the mechanical engineering undergraduate program are to educate graduates who will be ethical, productive and contributing members of society. As they progress after graduation, our alumni will do the following:

1. Use their engineering knowledge for success in
  - a) Technical careers in industry, academia, government research and development, engineering education or other organizations,
  - b) Nontechnical careers in areas such as law, medicine, business, public policy, secondary education, service industries, management etc.
  - c) Careers involving entrepreneurship
2. Use lifelong learning skills to
  - a) Take advantage of professional development opportunities in their disciplines
  - b) Develop new skill sets and acquire knowledge for exploring and developing new areas of expertise.
  - c) Be able to adapt to changing global markets and workforce trends
3. Engage in professional and personal service by
  - a) Using their engineering background to solve technical and societal problems
  - b) Developing new knowledge and products that foster sustainable economic development and culminates in improvement in the quality of life
  - c) Promoting the practice of mechanical engineering as a source of societal good.

**B. Types of Courses**

Courses are the subjects that comprise the Mechanical Engineering Programme.

1. A course may be designed to comprise lectures, tutorials, laboratory work, field work, outreach activities, project work, vocational training, viva, seminars, term papers, assignments, presentations, self-study, etc. or a combination of some of these components.
2. The learning outcomes of each course will be defined before the start of a semester.
3. Courses are of three kinds: Core, Elective and Foundation.
  - i. **Core Course (CC):** This is a course which is to be compulsorily studied by a student as a core requirement to complete the requirement of B.E. Manufacturing Processes and Automation Engineering.
  - ii. **Elective Course:** An elective course is a course which can be chosen from a pool of courses. It is intended to support the discipline of study by providing an expanded scope, enabling exposure to another discipline/domain and nurturing a student's proficiency and skill. An elective may be of following types:
    - a) **Discipline Centric Elective (ED):** It is an elective course that adds proficiency to the students in the discipline.
    - b) **Generic Elective (EG):** It is an elective course taken from other engineering disciplines and enhances the generic proficiency and interdisciplinary perspective of students.
    - c) **Open Elective (EO):** It is an elective course taken from non-engineering disciplines that broadens the perspective of an engineering student.
  - iii. **Foundation Course:** A Foundation course leads to knowledge enhancement and provides value based training. Foundation courses may be of two kinds:
    - a) **Compulsory Foundation (FC):** It is based upon content that leads to fundamental knowledge enhancement in sciences, humanities, social sciences and basic engineering principles. They are mandatory for all disciplines.
4. Each course contributes certain credits to the programme. A course can be offered either as a full course (4 credits) or as a half course (2 credits). A full course is conducted with 3 hours of lectures and either 1 hour of tutorial or 2 hours of practical work per week. A half course is conducted with 2 hours of lectures.
5. A student of undergraduate programme has to accumulate about 50% credits from Core courses; about 20% credits from Foundation courses; and the remaining credits from Elective courses to become eligible for award of the degree.

6. A course (full/half) may also be designed without lectures or tutorials. However, such courses may comprise of field work, workshop, engineering drawing, outreach activities, project work, vocational training, seminars, self-study, sports, skills enhancement etc. or a combination of some of these.
7. A project work/dissertation is considered as a special course involving application of the knowledge gained during the course of study in exploring, analyzing and solving complex problems in real life applications. A candidate completes such a course with an advisory support by a faculty member.
8. Apart from the above courses Audit courses may be offered. They do not carry credits but aim at explaining knowledge, or bridging deficiency in knowledge or skill.

**C. Examination and Assessment**

The following system will be implemented in awarding grades and CGPA under the CBCS system.

1. **Letter Grades and Grade Points:** A 10-point grading system shall be used with the letter grades as given in Table 1:

**Table1: Grades and Grade Points**

<b>Letter Grade</b>	<b>Grade point</b>
O (Outstanding)	10
A+ (Excellent)	9
A (Very Good)	8
B+ (Good)	7
B (Above average)	6
C (Average)	5
P (Pass)	4
F (Fail)	0
Ab (Absent)	0

2. **Fail grade:** A student obtaining Grade F shall be considered fail and will be required to reappear in the examination. If the student does not want to reappear in an **elective course** (that is, EG, ED, EO, FE *but not* CC or FC courses) then he/she can re-register afresh for a new elective course.
3. **Audit course:** For audit courses, ‘Satisfactory’ or ‘Unsatisfactory’ shall be indicated instead of the letter grade and this will not be counted for the computation of SGPA/CGPA.

- 4. Fairness in assessment:** The CBCS promotes continuous evaluation system where the weightage of end semester examinations should not be more than 60%. The departments shall design its own methods for continuous evaluation. It shall have the flexibility and freedom in designing the examination and evaluation methods that best fits the curriculum, syllabi and teaching-learning methods. In this regard, checks and balances will be implemented to ensure fair and effective assessment and examination process.
- 5. Computation of SGPA and CGPA:** The following procedure shall be used to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

- i. The SGPA is the ratio of sum of the product of the number of credits and the grade points scored by a student in all the courses of a semester to the sum of the number of credits of all the courses undergone by a student:

$$SGPA (S_i) = \frac{\sum C_i \times G_i}{\sum C_i}$$

Where  $C_i$  is the number of credits of the  $i^{\text{th}}$  course and  $G_i$  is the grade point scored by the student in the  $i^{\text{th}}$  course.

- ii. The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme:

$$CGPA = \frac{\sum C_i \times SGPA(S)_i}{\sum C_i}$$

Where  $S_i$  is the SGPA of the  $i^{\text{th}}$  semester and  $C_i$  is the total number of credits in that semester.

- iii. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.
- iv. CGPA shall be converted into percentage of marks, if required, by multiplying CGPA with 10.

### **III. PROGRAMME STRUCTURE**

1. The B.E. Mechanical Engineering programme consists of 8 semesters, normally completed in 4 years. The total span period cannot exceed 8 years.
2. The courses offered in each semester are given in the *Semester-wise Course Allocation* scheme for B.E. Mechanical Engineering.

3. The courses under FC and common pool of electives offered for students of all disciplines under FE, EG and EO categories are listed under separate tables in the scheme. The discipline centric courses under CC and ED categories are listed separately.
4. A course may have pre-requisite course(s) that are given in the *Semester-wise Course Allocation scheme*.
5. A student can opt for a course only if he/she has successfully passed its pre-requisite(s).
6. A student has to register for all courses before the start of a semester.
7. After second year a student may register for courses leading to a minimum of 16 credits and a maximum of 28 credits. Normally a student registers for courses leading to 22 credits.
8. After second year a student may register for courses for a minimum number of credits as prescribed in the scheme with a maximum of 28 credits. Normally a student registers for courses leading to 22 credits.
9. B.E. Mechanical Engineering programme consists of 176 credits. A student shall be awarded the degree if he / she has earned 168 or more credits.

#### **IV. COURSE CODIFICATION**

The codes for various undergraduate programmes are as follows:

- i. Biotechnology: BT
- ii. Computer Engineering: CE
- iii. Electronics and Communication Engineering: EC
- iv. Instrumentation and Control Engineering: IC
- v. Information Technology: IT
- vi. Manufacturing Processes and Automation Engineering: MA
- vii. Mechanical Engineering: ME

**Departmental Course Codes:** The codes for departmental core courses and discipline-specific electives are specific to each discipline. The first two characters are derived from departmental codes listed above. The third character is 'C' for core courses and 'D' for discipline-specific courses. This is followed by a 2-digit sequence number:

- i. MECyy: Core Course
- ii. MEDyy: Discipline-centric Elective Course

**Common Course Codes:** The lists for courses offered under Compulsory Foundation (FC), Foundation Electives (FE), and Open Electives (EO), will follow a common code as shown below. The 3-digit sequence number 'yyy' is taken from the respective tables of different types of courses.



- iii. FCyyy: Foundation Compulsory Course
- iv. FEyyy: Foundation Elective Course
- v. EOyyy: Open Elective Course

**Generic Electives:** A student May take a course under the category of Generic Elective (EG) offered by any department of the institute under the category of Core Course (CC), and discipline centric elective (ED). However, such options shall be offered to the students as per prescribed guidelines of the institute.

**V. EVALUATION SCHEME**

The courses are evaluated on the basis of continuous assessment, mid-semester examinations and end-semester examinations. The weightage of each of these modes of evaluation for the different types of courses are as follows:

<b>Type of Course</b>	<b>Continuous Assessment (CA), Theory</b>	<b>Mid-Semester Exam (MS), Theory</b>	<b>End-Semester Exam (ES), Theory</b>	<b>Continuous Assessment (CA), Lab</b>	<b>End-semester Exam (ES), Lab</b>
FE courses	As specified in Table 3 of Foundation Electives				
CC/FC/ED/EG/EO Theory with Tutorial	25	25	50	Nil	Nil
CC/FC/ED/EG/EO Theory with Practical	15	15	40	15	15
Project I and Project II	Nil	Nil	Nil	40	60
Training	Nil	Nil	Nil	40	60
Non-Credit Courses 1*	-	-	-	-	-
1*: The distribution of marks and the minimum marks required for getting “Satisfactory” for Non-credit courses will be determined by the Department.					

## **VI. EVALUATION AND REVIEW COMMITTEE**

The Committee of Courses and Studies in each department shall appoint one or more Evaluation-cum-Review Committees (ERC), each committee dealing with one course or a group of courses. This ERC consists of all faculty members who are likely to teach such course(s) in the group.

The ERC has the following functions-

- (i) To recommend appointment of paper setters/examiners of various examinations at the start of each semester.
- (ii) To prepare quizzes, assignments, test papers etc. for Continuous Assessment (CA), Mid-Semester examination (MS) and End Semester (ES) examination and to evaluate them. Normally, each concerned faculty member, who is also a member of ERC, will do this job for his/her class. However, in exceptional circumstances any part of the work may be entrusted to some other member of the ERC.
- (iii) To consider the individual representation of students about evaluation and take remedial action if needed. After scrutinizing, ERC may alter the grades awarded upward/downward. The decision of the ERC shall be final.
- (iv) To moderate assignments, quizzes etc. for courses given by each of the concerned faculty members for his/her class with a view to maintain uniformity of standards.
- (v) To review and moderate the Mid-Semester (MS) and End-Semester ES results of each course with a view to maintain uniformity of standards.
- (vi) To lay guidelines for teaching a course.

## **VII. ATTENDANCE, PROMOTION AND DETENTION RULES**

1. A student should normally attend all the classes. However, a student will be allowed to appear in the examination if he/ she has put in a minimum of 75% attendance separately in each course for which he / she has registered. A relaxation up to a maximum of 25% may be given on the production of satisfactory evidence that (a) the student was busy in authorized activities, (b) the student was ill.
2. A student should submit the evidence to the fact 1(a) and / or 1(b) above within seven working days of resuming the studies. Certificates submitted later will not be considered.
3. No relaxation in attendance beyond 25% is permitted in any case.
4. A student with satisfactory attendance will be promoted to the even semester irrespective of his/ her results in the odd semester examinations.

5. If a student fails to secure a minimum of 22 credits after the completion of second semester, he/ she will not be allowed to register in the third semester till he / she secures a minimum of 22 credits.
6. If a student fails to secure a minimum of 44 credits after the completion of fourth semester, he / she will not be allowed to register in the fifth semester till he / she secures a minimum of 44 credits.
7. There shall be no supplementary examinations. A student who has failed in a course will have to re-register for the course in a subsequent year.
8. If a student fails in any core course during the first four semesters (without repeating a year), he/she will have to re-register for such courses after the fourth semester.
9. If the student does not want to reappear in an **elective course** (that is, EG, ED, EO, FE *but not* CC or FC courses) then he/she can re-register afresh for a new elective course.
10. After second year a student may register for courses leading to a minimum of as prescribed in the scheme and a maximum of 28 credits. Normally a student registers for courses leading to 22 credits.

#### **VIII. DECLARATION OF RESULTS**

1. The B.E. Mechanical Engineering programme consists of 176 credits. A student will be awarded the degree if he/she has earned 168 or more credits.
2. CGPA will be calculated on the basis of the best 168 credits earned by the student.
3. The candidate seeking re-evaluation of a course shall apply for the same on a prescribed proforma along with the evaluation fee prescribed by the University from time to time only for the End Semester Examination within seven days from the date of declaration of result.
4. The Institution/University may cancel the registration of all the courses in a given semester if
  - i. The student has not cleared the dues to the institution/hostel.
  - ii. A punishment is awarded leading to cancellation of the student's registration.

#### **IX. CURRICULUM MODIFICATION**

The curriculum will be updated regularly within a period of 5 to 10 years since last revision, to keep pace with the advancements in the field of Mechanical engineering.

#### **X. CENTRAL ADVISORY COMMITTEE**

There shall be a Central Advisory Committee consisting of the following—

- a) Dean, Faculty of Technology, Chairman
- b) Head of Institution

- c) Dean, Under Graduate Studies
- d) Dean, Post Graduate studies
- e) Heads of Departments

This Committee shall have the following functions-

1. Lay guidelines for executing all the provisions and stipulations of the programme.
2. Give an interpretation of the rules in case of differences of opinion, which shall be binding on all.

**PROGRAMME OUTCOMES (POs)**

1. An ability to apply knowledge of mathematics, probability, statistics, science, electronics, electrical and mechanical engineering as applicable to measurements and instrumentation.
2. An ability to design and conduct experiments, as well as to organize, analyze and interpret data to produce meaningful conclusions and recommendations.
3. An ability to design and analyse hardware and software systems of different instruments, components of instruments, or processes to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
4. An ability to work individually or as a member with responsibility to function on multi-disciplinary teams like mechanical and electronic streams.
5. An ability to identify, formulate and solve computing problems, accounting for the interaction between hardware and software elements of measurements and instruments.
6. An understanding of professional, legal, and ethical issues and responsibilities.
7. An ability to communicate effectively in speech and in writing, including documentation of measurements and instruments.
8. An ability to show the understanding of impact of engineering solutions in a global on the society, economic & environmental.
9. Demonstrate an ability to acquire new knowledge in the computing discipline and to engage in life-long learning.
10. Knowledge of contemporary issues in the social sciences and the humanities using computational tools.
11. An ability to use the techniques, skills, and modern engineering tools necessary for computer engineering practice.
12. An ability to compete in National level competitive examinations for higher studies and jobs.
13. An Ability to acquire Entrepreneurship and Leadership qualities.

**SEMESTER-WISE COURSE ALLOCATION**

<b>B.E. MECHANICAL ENGINEERING-SEMESTER I</b>												
<b>Course Code</b>	<b>Type</b>	<b>Courses</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>	<b>Evaluation Scheme (Percentage weights)</b>					<b>Pre-requisites</b>
							<b>Theory</b>			<b>Practical</b>		
							<b>C A</b>	<b>M S</b>	<b>ES</b>	<b>CA</b>	<b>ES</b>	
FC001	FC	Mathematics-I	3	1	0	4	25	25	50	-	-	None
FC002	FC	Computer Programming	3	0	2	4	15	15	40	15	15	None
FC003	FC	Electrical and Electronics Engineering	3	0	2	4	15	15	40	15	15	None
FC004	FC	Physics	3	0	2	4	15	15	40	15	15	None
FC005	FC	English –I	2	0	0	2	25	25	50	-	-	None
FExxx 1*	FE	Foundation Elective	-	-	-	2	-	-	-	-	-	-
			<b>23/25</b>			<b>20</b>						
			<b>2*</b>									
<p>1*: The course codes, LTP distribution and Evaluation Scheme for Foundation Electives are given in Table 3.</p> <p>2*: The actual weekly load depends upon the elective chosen by the student under FE (Refer Table 3)</p>												

<b>B.E. MECHANICAL ENGINEERING-SEMESTER II</b>												
<b>Course Code</b>	<b>Type</b>	<b>Course</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>	<b>Evaluation Scheme (Percentage weights)</b>					<b>Pre-requisites</b>
							<b>Theory</b>			<b>Practical</b>		
							<b>CA</b>	<b>M S</b>	<b>ES</b>	<b>C A</b>	<b>ES</b>	
FC006	FC	Mathematics-II	3	1	0	4	25	25	50	-	-	None
FC007	FC	English - II	2	0	0	2	25	25	50	-	-	None
MEC01	CC	Chemistry	3	0	2	4	15	15	40	15	15	None
MEC02	CC	Engineering Mechanics	3	0	2	4	25	25	50	-	-	None
MEC03	CC	Workshop Technology	2	0	4	4	15	15	40	15	15	None
MEC04	CC	Engineering Graphics	2	0	4	4	-	-	-	30	70	None
FE xxx 1*	FE	Elective Foundation	-	-	-	2	-	-	-	-	-	-
			<b>30/32</b>				<b>24</b>					
			<b>2*</b>									
<p>1*: The course codes, LTP distribution and Evaluation Scheme for Foundation Electives are given in Table 3.</p> <p>2*: The actual weekly load depends upon the elective chosen by the student under FE (Refer Table 3)</p>												

<b>B.E. MECHANICAL ENGINEERING- AUDIT COURSES AFTER SEMESTER II</b>					<b>Evaluation Scheme</b>	
<b>Course Code</b>	<b>Type</b>	<b>Course</b>	<b>LTP</b>	<b>Credits</b>	<b>Theory CA-MS-ES</b>	<b>Practical CA-ES</b>
<b>ACxxx</b>	<b>Audit</b>	Audit Courses can be floated during summer break after 2 <sup>nd</sup> semesters on: (I) Courses for improvement: These will not be shown on the degree. (II) Courses on new themes: These will be shown on the degree.	-	NIL	The evaluation scheme and minimum grades for getting “Satisfactory” level, will be decided by the Department. Student has to achieve the minimum grades prescribed for getting “Satisfactory” level.	
AC: Audit course						



<b>B.E. MECHANICAL ENGINEERING-SEMESTER III</b>												
<b>Course No.</b>	<b>Type</b>	<b>Course</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>	<b>Evaluation Scheme (Percentage weights)</b>					<b>Pre-requisites</b>
							<b>Theory</b>			<b>Practical</b>		
							<b>C A</b>	<b>M S</b>	<b>ES</b>	<b>CA</b>	<b>ES</b>	
MEC05	CC	Machine Drawing	2	0	4	4	15	15	40	15	15	None
MEC06	CC	Manufacturing Processes-I	3	0	2	4	15	15	40	15	15	None
MEC07	CC	Mathematics - III	3	1	0	4	25	25	50	-	-	None
MEC08	CC	Thermal Engineering	3	0	2	4	15	15	40	15	15	None
MEC09	CC	Science of Materials	3	1	0	4	25	25	50	-	-	None
FE <sub>xxx</sub> 1*	FE	Elective Foundation	-	-	-	2	-	-	-	-	-	-
			<b>26/28</b>			<b>22</b>						
			<b>2*</b>									
<p>1*: The course codes, LTP distribution and Evaluation Scheme for Foundation Electives are given in Table 3.</p> <p>2*: The actual weekly load depends upon the elective chosen by the student under FE (Refer Table 3).</p>												

<b>B.E. MECHANICAL ENGINEERING-SEMESTER IV</b>												
<b>Course No.</b>	<b>Type</b>	<b>Course</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>	<b>Evaluation Scheme (Percentage weights)</b>					<b>Pre-requisites</b>
							<b>Theory</b>			<b>Practical</b>		
							<b>C A</b>	<b>M S</b>	<b>ES</b>	<b>C A</b>	<b>ES</b>	
MEC10	CC	Kinematics & Dynamics of Machines	3	0	2	4	15	15	40	15	15	None
MEC11	CC	Mechanics of Solids	3	0	2	4	15	15	40	15	15	None
MEC12	CC	Fluid Mechanics	3	0	2	4	15	15	40	15	15	None
MEC13	CC	Manufacturing Processes-II	3	0	2	4	15	15	40	15	15	None
MEC14	CC	Management of Manufacturing Systems	3	1	0	4	25	25	50	-	-	None
FExxx 1*	FE	Elective Foundation	-	-	-	2	-	-	-	-	-	-
			<b>26/28</b>			<b>22</b>						
			<b>2*</b>									

1\*: The course codes, LTP distribution and Evaluation Scheme for Foundation Electives are given in Table 3.

2\*: The actual weekly load depends upon the elective chosen by the student under FE (Refer Table 3).

<b>B.E. MECHANICAL ENGINEERING- AUDIT COURSESAFTER SEMESTER IV</b>					<b>Evaluation Scheme</b>	
<b>Course No.</b>	<b>Type</b>	<b>Course</b>	<b>LTP</b>	<b>Credits</b>	<b>Theory CA-MS-ES</b>	<b>Practical CA-ES</b>
<b>ACxx</b>	<b>Audit</b>	Audit Courses can be floated during summer break after 4 <sup>th</sup> semester on: (i) Courses for improvement: These will not be shown on the degree. (ii) Courses on new themes : These will be shown on the degree.	-	NIL	The evaluation scheme and minimum grades for getting “Satisfactory” level, will be decided by the Department. Student has to achieve the minimum grades prescribed for getting “Satisfactory” level.	
AC: Audit Course						

<b>B.E. MECHANICAL ENGINEERING-SEMESTER V</b>												
<b>Course No.</b>	<b>Type</b>	<b>Course</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>	<b>Evaluation Scheme (Percentage weights)</b>					<b>Pre-requisites</b>
							<b>Theory</b>			<b>Practical</b>		
							<b>C A</b>	<b>M S</b>	<b>ES</b>	<b>CA</b>	<b>ES</b>	
MEC15	CC	Industrial Engineering	3	0	2	4	15	15	40	15	15	None
MEC16	CC	Refrigeration & Air-conditioning	3	0	2	4	15	15	40	15	15	None
MEC17	CC	Transducer and Measurement	3	0	2	4	15	15	40	15	15	None
MEC18	CC	Control Systems	3	0	2	4	15	15	40	15	15	None
MEDxx 1*	EG/E D/EO	Elective (s)	-	-	-	-	-	-	-	-	-	-
						<b>16-28</b>						
						<b>2*</b>						<b>3*</b>
<p>1*: The LTP allocation, Evaluation Scheme and Pre-requisites for Electives are given in Tables 4-6. The course code will depend upon student's choice of elective(s).</p> <p>2*: The actual weekly load will depend upon the elective(s) chosen by the student.</p> <p>3*: A student may register for courses leading to a minimum of 16 credits and a maximum of 28 credits. Normally a student registers for courses leading to 22 credits.</p>												

<b>B.E. MECHANICAL ENGINEERING-SEMESTER VI</b>												
<b>Course No.</b>	<b>Type</b>	<b>Course</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>	<b>Evaluation Scheme (Percentage weights)</b>					<b>Pre-requisites</b>
							<b>Theory</b>			<b>Practical</b>		
							<b>C A</b>	<b>M S</b>	<b>ES</b>	<b>C A</b>	<b>ES</b>	
MEC19	CC	Heat & Mass Transfer	3	1	0	4	25	25	50	-	-	None
MEC20	CC	Fluid Systems	3	0	2	4	15	15	40	15	15	None
MEC21	CC	Machine Element Design	3	0	2	4	15	15	40	15	15	None
MEC22	CC	Mechanical Vibration	3	0	2	4	15	15	40	15	15	None
MEDxx 1*	EG/E D/EO	Elective (s)	-	-	-	-	-	-	-	-	-	-
			<b>2*</b>			<b>16-28</b> <b>3*</b>						
<p>1*: The LTP allocation, Evaluation Scheme and Pre-requisites for Electives are given in Tables 4-6. The course code will depend upon student's choice of elective(s).</p> <p>2*: The actual weekly load will depend upon the elective(s) chosen by the student.</p> <p>3*: A student may register for courses leading to a minimum of 16 credits and a maximum of 28 credits. Normally a student registers for courses leading to 22 credits.</p>												

<b>B.E. MECHANICAL ENGINEERING - INDUSTRIAL VISIT/TRAINING AFTER SEMESTER VI</b>												
<b>Course No.</b>	<b>Type</b>	<b>Course</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>	<b>Evaluation Scheme (Percentage weights)</b>					<b>Pre-requisites</b>
							<b>Theory</b>			<b>Practical</b>		
							<b>C A</b>	<b>M S</b>	<b>ES</b>	<b>C A</b>	<b>ES</b>	
MEC23 *1	CC	Training	- -	-	-	2	-	-	-	40	60	None

\*1: Students will undergo Training in the industry or research organization/reputed institute after VI Semester. This will be evaluated as a VII Semester course during end-semester examination.  
Industrial Training gives exposure to students on the working of the industry, on research direction & practical applications of Mechanical Engineering and on work ethics.

<b>B.E. MECHANICAL ENGINEERING-SEMESTER VII</b>												
<b>Course No.</b>	<b>Type</b>	<b>Course</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>	<b>Evaluation Scheme (Percentage weights)</b>					<b>Pre-requisites</b>
							<b>Theory</b>			<b>Practical</b>		
							<b>C A</b>	<b>M S</b>	<b>ES</b>	<b>C A</b>	<b>ES</b>	
MEC23 1*	CC	Training	-	-	-	2	-	-	-	40	60	None
MEC24 2*	CC	Project-I	-	-	4	4	-	-	-	40	60	None
MEC25	CC	Product Design	2	0	4	4	15	15	40	15	15	None
MEDxx 3*	EG/E D/EO	Elective(s)	-	-	-	-	-	-	-	-	-	-
			<b>4*</b>			<b>6-28</b> <b>5*</b>						

1\*: Training undertaken by students during the Summer vacation after sixth Semester will be evaluated as a VII Semester subject during end-semester examination.

2\*: Project work is based on the students' ability to understand, design and implement the fundamental concepts of the basic sciences, mathematics, engineering subjects and human values.

3\*: The LTP allocation, Evaluation Scheme and Pre-requisites for Electives are given in Tables 4-6. The course code will depend upon the elective(s) chosen by the student.

4\*: The actual weekly load will depend upon the elective(s) chosen by the student.

5\*: A student may register for courses leading to a minimum of 10 credits and a maximum of 28 credits. Normally, a student registers for courses leading to 22 credits.

<b>B.E. MECHANICAL ENGINEERING-SEMESTER VIII</b>												
<b>Course No.</b>	<b>Type</b>	<b>Course</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>	<b>Evaluation Scheme (Percentage weights)</b>					<b>Pre-requisites</b>
							<b>Theory</b>			<b>Practical</b>		
							<b>C A</b>	<b>M S</b>	<b>ES</b>	<b>C A</b>	<b>ES</b>	
MEC26 1*	CC	Project-II	-	-	-	4	-	-	-	40	60	None
MEDxx 2*	EG/E D/EO	Elective(s)	-	-	-	-	-	-	-	40	60	-
			<b>3*</b>			<b>4-28</b> <b>4*</b>						
<p>1*: Project work is based on the students' ability to understand, design and implement the fundamental concepts of various basic sciences, mathematics, human values and engineering subjects.</p> <p>2*: The LTP allocation, Evaluation Scheme and Pre-requisites for Electives are given in Tables 3-6.</p> <p>3*: The actual weekly load will depend upon the elective(s) chosen by the student.</p> <p>4*: A student may register for courses leading to a minimum of 4 credits and a maximum of 28 credits. Normally, a student registers for courses leading to 22 credits.</p>												



**TABLE-3 LIST OF FOUNDATION ELECTIVES**

Code	Name of Foundation Elective	LTP Allocation			Evaluation Scheme Theory (T), Practical (P)					Pre-Requisites
		L	T	P	CA	MS	ES	CA	ES	
					(T)	(T)	(T)	(P)	(P)	
FE001	Sports-I	0	0	4	-	-	-	60	40	None
FE002	Sports-II	0	0	4	-	-	-	60	40	FE001
FE003	NSS	0	0	4	-	-	-	60	40	None
FE004	NCC	0	0	4	-	-	-	60	40	None
FE005	Corporate Social Responsibility	2	0	0	25	25	50	-	-	None
FE006	Environmental Sciences	2	0	0	25	25	50	-	-	None
FE007	Environment development and Society	2	0	0	25	25	50	-	-	None
FE008	Spoken Skills in English	2	0	0	25	25	50	-	-	None
FE009	Financial Literacy	2	0	0	25	25	50	-	-	None
FE010	Introduction to Indian society	2	0	0	25	25	50	-	-	None
FE011	Soft Skills and Personality Development	0	0	4	-	-	-	60	40	None
FE012	Business Communication and Presentation Skills	2	0	0	-	-	-	60	40	None
FE013	Theatre	0	0	4	-	-	-	60	40	None

**Appendix - XI**

FE014	Dance	0	0	4	-	-	-	60	40	None
FE015	Yoga	0	0	4	-	-	-	60	40	None
FE016	Digital Film Making	0	0	4	-	-	-	60	40	None
FE017	Workshop (Electrical and Mechanical)	0	0	4	-	-	-	60	40	None
FE018	Music	0	0	4	-	-	-	60	40	None
FE019	Sociology of development	0	0	4	-	-	-	60	40	None
FE020	Universal Human Values 1: Self and Family	2	0	0	25	25	50	-	-	None
FE021	Universal Human Values 2: Self Society and Nature	2	0	0	25	25	50	-	-	FE020

<b>TABLE 4- PART A: LIST OF DISCIPLINE CENTRIC ELECTIVES WITH TUTORIAL</b>							
<b>LTP Allocation</b>			<b>Evaluation Scheme</b>				
<b>L</b>	<b>T</b>	<b>P</b>	<b>CA</b>	<b>MS</b>	<b>ES</b>	<b>CA</b>	<b>ES</b>
<b>3</b>	<b>1</b>	<b>0</b>	<b>25</b>	<b>25</b>	<b>50</b>	<b>-</b>	<b>-</b>
<b>Code</b>	<b>Name of Elective</b>		<b>Pre-Requisites</b>				
MED01	Value Engineering		None				
MED02	Power Plant Practice		MEC08, MEC12, MEC20				
MED03	Solar Energy		MEC08, MEC19, MEC07				
MED04	Reliability Engineering		MEC07, MEC15				
MED05	Industrial Quality Control		MEC15				
MED06	Design of Experiments		None				
MED07	Material Management		FC002, MEC15				
MED08	Ergonomics		MEC15				
MED09	Optimization Techniques		MEC07				
MED10	Micro Electro Mechanical Systems (MEMS)		MEC11				
MED11	Composite Materials		MEC09				
MED12	Micro/ Nano Machining		MEC13				
MED13	Advanced FMS		MEC13				

<b>TABLE 4: PART B: LIST OF DISCIPLINE CENTRIC ELECTIVES WITH PRACTICAL</b>							
<b>LTP Allocation</b>			<b>Evaluation Scheme</b>				
<b>L</b>	<b>T</b>	<b>P</b>	<b>CA</b>	<b>MS</b>	<b>ES</b>	<b>CA</b>	<b>ES</b>
<b>3</b>	<b>0</b>	<b>2</b>	<b>15</b>	<b>15</b>	<b>40</b>	<b>15</b>	<b>15</b>
<b>Code</b>	<b>Name of Elective</b>		<b>Pre-Requisites</b>				
MED21	Automotive Engineering		MEC05, MEC10, MEC21				
MED22	Finite Element Methods		MEC08, MEC12, MEC11				
MED23	Fracture Mechanics		MEC02, MEC11				
MED24	Gear Technology		MEC10				
MED25	Industrial Drives		FC003				
MED26	Rapid Prototyping and Tooling		MEC14				
MED27	Modern Methods of Manufacturing		MEC06, MEC13				
MED28	Industrial Tribology		MEC21				
MED29	Automation in Manufacturing		MEC03, MEC06				
MED30	Mechatronics		FC003, MEC17, MEC18				
MED31	Artificial Intelligence		MEC07				
MED32	Robotics		MEC10				

**TABLE-5: GENERIC ELECTIVES (EG)**

**A STUDENT MAY TAKE ANY COURSE OFFERED BY ANY DEPARTMENT OF THE INSTITUTE UNDER THE CATEGORIES OF CORE COURSE (CC) AND DISCIPLINE CENTRIC ELECTIVE (ED). HOWEVER, SUCH OPTIONS SHALL BE OFFERED TO A STUDENT AS PER PRESCRIBED GUIDELINES OF THE INSTITUTE.**

**TABLE-6: LIST OF OPEN ELECTIVES**

LTP Allocation			Evaluation Scheme				
L	T	P	CA	MS	ES	Int.	Ext.
3	1	0	25	25	50	-	-
Code	Name of Elective	L	T	P	Pre-requisites		
EO001	Technical Communication	3	1	0	None		
EO002	Disaster Management	3	1	0	None		
EO003	Basics of Finance Management	3	1	0	None		
EO004	Basics of Human Resources Management	3	1	0	None		
EO005	Project Management	3	1	0	None		
EO006	Basics of Corporate Law	3	1	0	None		
EO007	Biological computing	3	1	0	None		
EO008	Basic of social science	3	1	0	None		
EO009	Entrepreneurship	3	1	0	None		
EO010	Social work	3	1	0	None		
EO011	IP and Patenting	3	1	0	None		
EO012	Supply Chain Management- Planning and logistics	3	1	0	None		
EO013	Organization Development	3	1	0	None		
EO014	Industrial Organization and Managerial Economics	3	1	0	None		
EO015	Global Strategy and Technology	3	1	0	None		
EO016	Engineering System Analysis and Design	3	1	0	None		
EO017	Biology for Engineers	3	1	0	None		
EO018	Energy, Environment and Society	3	1	0	None		
EO019	Public Policy and Governance	3	1	0	None		

<b>OPEN ELECTIVES</b>					
<b>Course Code</b>	<b>Course name</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Pre-requisites</b>
EO020	Numerical Methods	3	0	2	None
EO021	Mathematical Statistics	3	1	0	None
EO022	Abstract and Linear Algebra	3	1	0	None
EO023	Optimization Techniques	3	1	0	None
EO024	Introduction to Mathematical Software and Programming Languages	2	0	4	None
EO025	Mathematical Finance	3	1	0	None
EO026	Quantum Electronics	3	0	2	None
EO027	Laser Systems and Applications	3	0	2	None
EO028	Optoelectronics and Photonics	3	0	2	None
EO029	Electromagnetic Theory and Waveguide	3	0	2	None
EO030	Polymer Science and Technology	3	0	2	None
EO031	Semiconductor Physics and Devices	3	0	2	None
EO032	Elements of Fibre Optics	3	0	2	None
EO033	Material Physics	3	0	2	None
EO034	Advanced Electromagnetic Theory and Relativity	3	0	2	None
EO035	Fibre and Integrated Optics	3	0	2	None
EO036	Condensed Matter Physics	3	0	2	None
EO037	Microwave	3	0	2	None
EO038	Fundamentals of Instrumentation and experimental techniques in Physics	3	0	2	None
EO039	Lasers and Photonics	3	0	2	None

SYLLABUS OF FOUNDATION CORE COURSES

Course No.	Title of the Course	Course Structure	Pre-Requisite
FC001	Mathematics I	L-T-P: 3-1-0	None
<b>COURSE OUTCOMES (COs)</b> <ul style="list-style-type: none"><li>Analyze and test infinite series for its convergence.</li><li>Find Taylor's series expansion, maxima &amp; minima of functions of one and more variables.</li><li>Calculate length, area, radius of curvature, surface of revolution and volume of revolution.</li><li>Calculate area of a given region and volume enclosed by a surface.</li></ul>			
<b>COURSE CONTENT</b> <p><b>Infinite Series:</b> Tests for convergence of series (Comparison, Integral, Ratio's, Raabe's, Logarithmic and nth root), Alternating series, Absolute convergence, Conditional convergence.</p> <p><b>Function of Single Variable:</b> Hyperbolic functions, Taylor's and Maclaurin's theorems with remainder terms, Polar Curves, Angle between tangent and radius vector, Curvature and Radius of Curvature, Asymptotes, Curve tracing, Applications of definite integral to area, arc length, surface area and volume of revolution (in Cartesian, parametric and polar co-ordinates).</p> <p><b>Function of Several Variables:</b> Partial Derivatives, Differentiability, Total differential, Euler's theorem, Jacobian, Taylor's theorem, Maxima and Minima for functions of two or more variables, Extreme values, Lagrange's method of undetermined multipliers, Differentiation under the integral sign.</p> <p><b>Multiple Integrals:</b> Evaluation of double integral (in Cartesian and polar co-ordinates) change of order of integration, integration by change of variables and its applications in area, mass, and volume. Triple integral (in Cartesian, cylindrical and spherical co-ordinates) and its application in volume.</p>			
<b>SUGGESTED READINGS</b> <ul style="list-style-type: none"><li>G. B. Thomas and R. L. Finney, "Calculus and Analytic Geometry", Pearson Education.</li><li>R. K. Jain and S. R. K. Iyenger, "Advanced engineering mathematics", Narosa.</li><li>Erwin Kreyszig, "Advanced engineering mathematics", Wiley.</li><li>Michael Greenberg, "Advanced engineering mathematics", Pearson Education.</li></ul>			



<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
FC002	Computer Programming	L-T-P: 3-0-2	None
<p><b>COURSE OUTCOMES (COs)</b></p> <ul style="list-style-type: none"> <li>• To understand the basic terminology program structures used in computer programming to solve real world problems.</li> <li>• To learn the process of representing problems and writing, compiling and debugging programs.</li> <li>• To develop programming skills in using different types of data, decision structures, loops functions, pointers, data files and dynamic memory allocation/de-allocation.</li> <li>• To understand the need for continuing to learn new languages to solve complex problems in different domains.</li> </ul>			
<p><b>COURSE CONTENT</b></p> <p><b>C Programming Language</b></p> <p><b>Thinking like a programmer:</b> problem solving. Components of a problem, algorithm, checking for errors and inconsistencies, writing a pseudocode.</p> <p><b>Boolean Logic:</b> Binary Number systems and codes and operations.</p> <p><b>Introduction to programming&amp; Basics of C:</b> Concepts of Algorithm and Flowcharts, Process of compilation, Basic features of C Language like Identifier, Keywords, Variable, data types, Operators and Expression, basic screen and keyboard I/O, Control Statements, iteration, nested loops, Enumerated data types, bitwise operators, C Preprocessor statements.</p> <p><b>Arrays and Pointers:</b> One and multidimensional dimensional arrays, strings arrays, operations on strings, Array and Pointers, Pointers and strings, Pointer to Pointer, other aspect of pointers, User Defined Data Types: Structures, Unions, bit fields.</p> <p><b>Functions:</b> Concept of modular programming, Using functions, Scope of data, Recursive functions, Pointers and functions, Command line arguments.</p> <p><b>Linked List:</b> Dynamic memory allocation, singly link list, traversing, searching, insertion, and deletion.</p> <p><b>Files:</b> Types of files, working with files, usage of file management functions.</p> <p><b>C++ Programming Language</b></p> <p><b>Moving from C to C++:</b> Concepts of Object Orientation, Objects, classes, encapsulation, data abstraction, inheritance, delegation, and software reuse. Inheritance visibility rules using public, private, protected, member functions: Constructors / destructors, operator (::), accessing member functions within a class, new, delete.</p>			

**Friend functions and classes**, static data and functions, function templates, pointers within a class, and passing / returning objects as arguments.

**Functions Polymorphism** – virtual functions, function overloading, variable definition at the point of use, reference variables, strict type checking, default arguments, type conversion.

**Exception handling**, streams based I/O.

**Trends:** Kinds of programming languages.

**Guidelines for practical work based on programming concepts:**

Programs for temperature conversion, area of triangle, counting frequencies of letters, words to understand the basic data types, input-output, control flags.

Programs for decision making using selection, looping, processing of arrays for sorting, searching, string manipulations, matrix operations.

Programs for parameter passing to functions, returning values, interactions among functions, pointer with arrays, strings, call by reference.

Programs using structure, pointers and files for linked lists, inventory management etc.

Program using bit wise operators to simulate the combinational circuits.

Program showing the concept of objects, access specifiers and inheritance.

**SUGGESTED READINGS**

- B. W. Kernighan and D.M. Ritchie, "The C programming language", Prentice Hall.
- Herbert Schildt, "C: The Complete Reference", Tata McGraw Hill.
- Let us C, by Yashwant Kanitkar, Publisher – BPB Publication
- Byron Gottfried, "Schaum's Outline of Programming with C", Tata McGraw Hill
- Budd, "Object Oriented Programming", Addison Wesley.
- D. Samantha, "Object oriented Programming in C++ and Java", PHI.
- Stroustrup, "Programming in C++", Special Edition, Addison Wesley.

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
FC003	Electrical and Electronics Engineering	L-T-P: 3-0-2	None
<b>COURSE OUTCOMES (COs)</b> <ul style="list-style-type: none"><li>• To understand the basic concepts of magnetic, AC &amp; DC circuits.</li><li>• To learn the basics of semiconductor diodes, BJTs.</li><li>• Will be able to analyze basic electrical and electronic circuits.</li></ul>			
<b>COURSE CONTENT</b> <p><b>D.C. Circuits and Theorems:</b> Ohm's Law, KCL, KVL Mesh and Nodal Analysis, Circuit parameters, energy storage aspects, Superposition, Thevenin's, Norton's, Reciprocity, Maximum Power Transfer Theorem, Millman's Theorem, Star-Delta Transformation. Application of theorem to the Analysis of dc circuits.</p> <p><b>A.C.Circuits:</b> R-L, R-C, R-L-C circuits (series and parallel), Time Constant, Phasor representation, Response of R-L, R-C and R-L-C circuit to sinusoidal input Resonance-series and parallel R-L-C Circuits, Q-factor, Bandwidth.</p> <p><b>Magnetic Circuits:</b> Magnetomotive Force, Magnetic Field Strength; Permeability, Reluctance, Permeance, Analogy between Electric and Magnetic Circuits.</p> <p><b>Semiconductor Diodes and Rectifiers:</b> Introduction, general characteristics, energy levels, extrinsic materials n &amp; p type, ideal diode, basic construction and characteristics, DC &amp; AC resistance, equivalent circuits, drift &amp; diffusion currents, transition &amp; diffusion capacitance reverse recovery times, temperature effects, diode specifications, different types of diodes (Zener, Varactor, Schouky, Power, Tunnel, Photodiode &amp; LED), Half wave &amp; full wave rectifiers. Switched Mode Power Supply.</p> <p><b>Bipolar junction transistor:</b> Introduction, Transistor, construction, transistor operations, BIP characteristics, load line, operating point, leakage currents, saturation and cut off mode of operations, Eber-Moll's model.</p> <p><b>Bias Stabilization:</b> Need for stabilization, fixed bias, emitter bias, self bias, bias stability with respect to variation in <math>I_{co}</math> <math>V_{BE}</math> &amp; <math>\beta</math>, Stabilization factors, thermal stability.</p>			
<b>SUGGESTED READINGS</b> <ul style="list-style-type: none"><li>• Vincent Del Toro, "Electrical Engineering Fundamentals", Phi Learning.</li><li>• Mittle and Mittal, "Basic Electrical Engineering", TMH.</li><li>• Boylestad and Nashelsky, "Electronic Devices and Circuit Theory", Pearson</li><li>• Millman &amp; Grabel, "Microelectronics", TMH.</li></ul>			

Course No.	Title of the Course	Course Structure	Pre-Requisite
FC004	Physics	L-T-P: 3-0-2	None
<b>COURSE OUTCOMES (COs)</b> <ul style="list-style-type: none"><li>• Knowing important concepts and phenomena linked to relativity, waves and oscillations and be able to do analytical and numerical calculations for faithful measurements, observations and gravitational wave communications.</li><li>• The course is helpful to the students in understanding various optical wave phenomena which are required for optical &amp; electromagnetic wave communications and in optical devices.</li><li>• Concepts of Laser and Optical Fiber for modern developments in physics which are helpful in designing and developing new devices used in optical communications, medicine, environment, industries and related physics.</li></ul>			
<b>COURSE CONTENT</b> <p><b>Relativity:</b> Special Relativity, Lorentz Transformations, Velocity addition, Time dilation, Length Contraction, Variation of mass with velocity, Mass and energy, Relativistic momentum and relativistic energy, General theory of relativity, Einstein's theory of Gravitation, Gravitational waves, Gravity and Light.</p> <p><b>Oscillations and Waves:</b> Damped and forced oscillations, Sharpness of resonance, Q-factor, Application in resonance, Acoustic waves, Pressure wave equations, Intensity pressure relation, Acoustic impedance, Reflection and transmission of acoustic waves, Impedance matching; Ultrasonic and its applications.</p> <p><b>Optics:</b> Interference: Interference due to thin films, Newton's rings, and determination of the wavelength of sodium light, Interference due to wedge shaped film. Diffraction: Fraunhofer diffraction due to single slit and N Slits, Plane transmission grating, Rayleigh criterion of resolution, Resolving power of a grating, Polarization: Polarization in light, Birefringence, Nicol prism, Quarter and half wave plates, Production and analysis of plane, Circularly and elliptically polarized light, Optical rotation, specific rotation, Polarimeter.</p> <p><b>Quantum Theory of Light:</b> Hertz's Experiments- Light as an Electromagnetic Wave, Blackbody radiation, Light Quantization, Compton Effect , X-rays.</p> <p><b>LASERS :</b> Absorption and emission of radiation, Main features of a laser, Spatial and temporal coherence, Einstein Coefficients, condition for light amplification, Basic requirement for Laser, Population Inversion - Threshold Condition, Line shape function , Optical Resonators , Three level and four level systems. Classification of Lasers: Solid State Laser-Ruby laser and Gas Laser- He-Ne laser (Principle, Construction and working), Optical properties of semiconductor,</p>			

Semiconductor laser (Principle, Construction and working), Applications of lasers in the field of medicine, Industry, Environment and Communication.

**Fibre Optics :** Need for fiber Optic Communication, Physical nature of Optical fiber, Theory of Light propagation in optical fiber, Acceptance angle and numerical aperture, Step index and graded index fibers, Single mode and multimode fibers, Losses in optical fiber, Optical Fiber cables and bundles, Dispersion in optical fibers: Intermodal and Intra-modal dispersion.

**TERM WORK Experiments:** Any ten experiments based on the theory course or related subject as above. For examples: Wavelength by diffraction grating, Newton's rings experiments and bi-prism assembly, resolving power of a Telescope, Nodal-Slide assembly, specific rotation of cane sugar by Polari meter, dispersive power of Prism, Wavelength of He-Ne laser by diffraction, refractive index for O-ray and E-ray, Brewster's law, Ultrasonic interferometer, numerical aperture of an optical fiber, other experiments based on LASER and optical fiber.

**SUGGESTED READINGS**

- Beiser, Shobhit Mahajan, "Concepts of Modern Physics", McGraw Hill.
- Serwey , Moses, Moyer, "Modern Physics", Cengage Learning.
- D. S. Mathur, "Mechanics", S. Chand & co.
- Jenkins and White, "Fundamentals of Optics", McGraw Hill.
- N. Subramaniam and Brij Lal, "A Text Book of Optics", S Chand.
- Indu Prakash, "A Text Book of Practical Physics, Volume-1," , Kitab Mahal Publication.

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
FC005	English I	L-T-P: 2-0-0	None
<b>COURSE OUTCOMES (COs)</b> <ul style="list-style-type: none"><li>• The course will focus on the four integral skills of language, improving the proficiency levels in all of them and to learn to use language as a tool for effective communication.</li><li>• This course will widen the understanding of the learners in all genres of literature (short stories, poetry, autobiographies..) with the help of expository pieces .</li><li>• The course will strive to equip the learner with the ability to express oneself and be understood by others with clarity and precision, in both written and spoken forms.</li><li>• This course will encourage creative use of language through translation, paraphrasing and paragraph writing.</li></ul>			
<b>COURSE CONTENT</b> <ul style="list-style-type: none"><li>• Practice in dictation, punctuation and spellings, listening and reading comprehension.</li><li>• Practice with well-formed sentences with stress on remedial grammar.</li><li>• Exercises in unseen comprehension, paraphrasing, paragraph writing &amp; summarizing.</li><li>• Reinforcement in letter writing, preparing CVs, writing book reviews.</li><li>• Exposure to the nuances and usages of the language through newspapers and magazines as an exercise to be in line with current form of language used.</li><li>• Proficiency in spoken English with focus on confidence building and standard pronunciation through language lab sessions.</li></ul> <b>Literature</b> <ol style="list-style-type: none"><li>1. Sadat Hasan Manto: Toba Tek Singh,</li><li>2. Abdul Kalam: Wings of Fire (excerpts)</li><li>3. Jhumpa Lahiri: The Namesake (excerpts)</li><li>4. Khaled Hosseini: The Kite Runner (excerpts)</li><li>5. Mohan Rakesh: Halfway House</li></ol> <b>Language Skills</b> <ol style="list-style-type: none"><li>1. Dictation, punctuation and spellings, listening and reading comprehension.,</li><li>2. Correspondence(formal &amp; informal)</li><li>3. Reading editorials, columns, speeches &amp; essays</li></ol>			
<b>SUGGESTED READINGS</b> <ul style="list-style-type: none"><li>• Margaret M Maison, “Examine Your English”, Orient Blackswan.</li></ul>			

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
FC006	Mathematics II	L-T-P: 3-1-0	None
<b>COURSE OUTCOMES (COs)</b>			
<ul style="list-style-type: none"> <li>• Solve system of equations and know the concepts of eigenvalue and eigenvector.</li> <li>• Know the concepts of Ordinary Differential Equations and its applications.</li> <li>• Know the concepts of Special Functions.</li> <li>• Know the concepts of Laplace Transforms and its application to solve Differential Equations</li> </ul>			
<b>COURSE CONTENT</b>			
<p><b>Matrices:</b> Rank, inverse and normal form of a matrix using elementary transformations, consistency of linear system of equations; linear dependence/ independence, linear transformations, eigenvalues and eigenvectors of a matrix, Cayley-Hamilton theorem, diagonalization.</p> <p><b>Ordinary Differential Equations:</b> Second &amp; higher order linear differential equation with constant coefficients, general solution of homogenous and non- homogenous equations, Euler-Cauchy equation, Application to mass- spring system and electrical circuits. Power series method.</p> <p><b>Special Functions:</b> Beta and Gamma functions, Dirichlet's Integral. Legendre equation, Legendre polynomials and its properties, Bessel equation, and Bessel function of first kind and its properties, ber and bei functions.</p> <p><b>Laplace Transforms:</b> Basic properties, Laplace transform of derivatives and integrals. Laplace of periodic functions. Laplace transforms solution of IVP and simultaneous linear differential equations, unit step function, Dirac-Delta function. Inverse Laplace transform, Convolution theorem.</p>			
<b>SUGGESTED READINGS</b>			
<ul style="list-style-type: none"> <li>• G. B. Thomas and R. L. Finney, "Calculus and Analytic Geometry", Pearson Education.</li> <li>• R. K. Jain and S. R. K. Iyenger, "Advanced engineering mathematics", Narosa.</li> <li>• Erwin Kreyszig, "Advanced engineering mathematics", Wiley.</li> <li>• Michael Greenberg, "Advanced engineering mathematics", Pearson Education.</li> </ul>			

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
FC007	English II	L-T-P: 2-0-0	None
<b>COURSE OUTCOMES (COs)</b> <ul style="list-style-type: none"><li>• The course will focus on the four integral skills of language, improving the proficiency levels in all of them and to learn to use language as a tool for effective communication.</li><li>• This course will widen the understanding of the learners in all genres of literature (short stories, poetry, autobiographies.) with the help of expository pieces .</li><li>• The course will strive to equip the learner with the ability to express oneself and be understood by others with clarity and precision, in both written and spoken forms.</li><li>• This course will encourage creative use of language through translation, paraphrasing and paragraph writing.</li><li>• Along with the above, the course will also build confidence and encourage the students to use a standard spoken form of English in order to prepare them to face job interviews, workplace and in higher studies.</li></ul>			
<b>COURSE CONTENT</b> <p><b>Literature</b></p> <ol style="list-style-type: none"><li>1. Anton Chekov: The Bet</li><li>2. Guy de Maupassant: The Necklace</li><li>3. D H Lawrence: Odour of Chrysanthemums</li><li>4. R K Narayan: Malgudi Days</li><li>5. Sarojini Naidu: Bangle Sellers</li><li>6. Rupert Brooke: The Soldier/Siegfried Sassoon: Suicide in the Trenches</li></ol> <p><b>Language Skills</b></p> <ol style="list-style-type: none"><li>1. translation, paragraph writing, paraphrasing, summarizing,</li><li>2. comprehension</li><li>3. Presentations/book reviews/reading exercises</li></ol>			
<b>SUGGESTED READINGS</b> <ul style="list-style-type: none"><li>• Martin Hewing, “Advanced English Grammar”, Cambridge University Press.</li><li>• Meenakshi Raman &amp; Sangeeta Sharma, “Technical Communication”, Oxford University Press.</li><li>• Renu Gupta, “A Course in Academic Writing”, Orient Blackswan.</li></ul>			



SYLLABUS OF CORE COURSES

Course No	Title of the Course	Course Structure	Pre-Requisite
MEC01	Chemistry	L-T-P:3-0-2	None
<b>COURSE OUTCOMES (COs)</b> After completion of the course the students will be able to <ul style="list-style-type: none"><li>• Understand the basic concept of Physical, Inorganic and Organic Chemistry</li><li>• Understand the concepts of Polymers, Metals and Alloys</li><li>• Understand the concept of Thermal Methods and their applications and basic the basic principles of Green Technology</li><li>• Perform titrimetric analysis</li><li>• Learn different titration methods by performing experiments</li></ul>			
<b>COURSE CONTENT</b> <p style="text-align: center;"><b>THEORY</b></p> <b>Electrochemistry &amp; Catalysis</b> : Transport No., Nernst Equation of electrode Potential, Reference electrodes, Subsidiary Electrodes, Concentration Cell, Batteries & Fuel Cells, Kinetics of Catalysis <b>Phase Rule</b> : Deduction of Phase Rule, Basic Definition and Explanation, Phase Diagram of some simple systems (Water & Sulphur), Phase transportation of Cu-Ni, Ag-Pb and some binary systems <b>Thermal Method of Analysis</b> : Elementary discussions of TGA, DTA & DSC <b>Inorganic Chemistry</b> : Transition Metal complexes, Crystal Field Theory, synthesis & property of Metallurgy, Ferrous & Non-Ferrous Alloys <b>Electronic Effects</b> : Inductive Effect, Hyper conjugation & Resonance and their effect on physical & chemical properties of molecules, Mechanisms of some Reactions <b>Polymers</b> : Effect of polymer structure on properties and production, Technical Applications and synthesis of some thermoplastic and thermoset resins, Natural Rubber, Elastomers, Inorganic Polymers, Ion-exchange Polymers, Conducting Polymers, Bio-degradable Polymers, Molecular Weight of Polymers <b>Spectroscopy</b> : Infrared, Ultra-Violet and Visible and NMR Spectroscopy and their applications <b>Analytical Chemistry</b> : Chromatographic Methods of Separation, Gas Chromatography, HPLC & Potentiometric methods <b>Green Technology</b> : Introduction, Basic Principles of Green Technology, concept of atom economy, Tools of Green Technology, zero waste Technology			

**PRACTICALS**

1. To find the strength (gm/lit.) of a given copper sulphate solution, iodometrically.
2. To find the strength of given potassium dichromate solution using Mohr's salt solution as an intermediate and potassium ferricyanide as an external indicator.
3. Determination of strength (gm/lit.) of a given solution of potassium dichromate with ferrous ammonium sulphate solution using N-Phenyl anthranilic acid as internal indicator.
4. To determine the strength (gm/lit.) of sulphuric acid and oxalic acid in a given solution using NaOH and  $\text{KMnO}_4$  solutions.
5. To determine the percentage of sodium carbonate in a given sample of commercial caustic soda solution.
6. Argentometric Titrations (i) Volhardic Method  
(ii) By Mohr's method
7. Estimation of silver nitrate against potassium Thiocyanate using ferric indicator.
8. To estimate the strength of barium chloride in a given solution using sodium carbonate and hydrochloric acid solutions.
9. To determine the percentage of calcium carbonate in precipitated chalk using hydrochloric acid and NaOH solutions.
10. To determine the strength of Calcium by EDTA – Complex metric Titration
11. To determine the strength of Hydrochloric acid, conduct metrically by titrating against standard sodium hydroxide solution.
12. To determine the strength of Mohr's salt against solution of potassium dichromate.

**SUGGESTED READINGS**

- K. J. Laidler, "Chemical Kinetics"
- R. T. Morrison & R. N. Boyd, "Organic Chemistry"
- J. D. Lee, "Concise Inorganic Chemistry"
- A. I. Vogel, "Quantitative Inorganic Chemistry"
- Jain and Jain, "Engineering Chemistry"
- Balram Pani, "Engineering Chemistry"
- Shashi Chawla, "Engineering Chemistry"

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MEC02	Engineering Mechanics	L-T-P:3-0-2	None

**COURSE OUTCOMES (COs)**

- Understand the basic laws of engineering mechanics.
- Analyze mechanics of rigid solids and solve problems using classical methods.
- Understand behavior of rigid bodies under dynamic conditions with/without friction force.

**COURSE CONTENT**

**UNIT I: Basics and Statics of Particles**

Introduction – Units and Dimensions – Laws of Mechanics – Lami’s theorem, Parallelogram and triangular Law of forces — Vectorial representation of forces – Vector operations of forces -additions, subtraction, dot product, cross product – Coplanar Forces – rectangular components – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility .

**UNIT II: Equilibrium of Rigid Bodies**

Free body diagram – Types of supports –Action and reaction forces –stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon’s theorem – Single equivalent force -Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions

**UNIT III: Properties of Surfaces and Solids**

Centroids and centre of mass– Centroids of lines and areas - Rectangular, circular, triangular areas by integration – T section, I section, - Angle section, Hollow section by using standard formula – Theorems of Pappus - Area moments of inertia of plane areas – Rectangular, circular, triangular areas by integration – T section, I section, Angle section, Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem –Principal moments of inertia of plane areas – Principal axes of inertia-Mass moment of inertia –mass moment of inertia for prismatic, cylindrical and spherical solids from first principle – Relation to area moments of inertia.

**UNIT IV: Dynamics of Particles**

Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion - Newton’s laws of motion – Work Energy Equation– Impulse and Momentum – Impact of elastic bodies.

**UNIT V: Friction and Elements of Rigid Body Dynamics**

Friction force – Laws of sliding friction – equilibrium analysis of simple systems with sliding friction – wedge friction-. Rolling resistance -Translation and Rotation of Rigid Bodies – Velocity and acceleration – General Plane motion of simple rigid bodies such as cylinder, disc/wheel and sphere.

**SUGGESTED READINGS**

- A K Tayal, “Engineering Mechanics (Statics and Dynamics)”, Umesh Publications.
- D S Kumar, “Engineering Mechanics (Statics and Dynamics)”, Kataria sons.
- U.C. Jindal, “Applied Mechanics and Strength of Materials”, Galgotia Publications.
- James M Gere, “Mechanicals of Materials”, CENGAGE Learning Custom Publishing.
- Ferdinand Beer and Russel Johnson, “Mechanics of Materials”, McGraw-Hill.
- R K Bansal, “A Textbook of Strength of Materials”, Laxmi Publication.

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MEC03	Workshop Technology	L-T-P:2-0-4	None

**COURSE OUTCOMES (COs)**

- To understand the importance of different engineering materials, their compositions, properties and applications.
- To introduce the basics of ferrous and non-ferrous metals; their methods of extraction from their respective ores and different uses of these metals/alloys.
- Introduction to foundry practice; different types of casting process, their uses and limitations, casting defects.
- Introduction to welding, classification of welding methods, brief introduction about different types of welding technique, welding defects.
- To provide brief introduction about forging, difference between hot and cold forging, forging defects, tools used in forging, different types of presses.
- Learn about the hand tools and operations used in bench work and fitting, sheet metal work

**COURSE CONTENT**

Materials : Compositions, Properties and uses of Wrought iron, Pig iron, Cast iron, Malleable iron, S.G. iron carbon and alloy steels, Copper, Aluminum, Lead, Brass Bronze, Duralumin, bearing metals, high temperature metals, cutting tool materials.

Casting Processes : Principles of metal casting: Pattern materials, types and allowance; Study of moulding, sand moulding, tools, moulding materials, classification of moulds, description and operation of cupola: special Casting processes e.g. die-casting, permanent mould casting, centrifugal casting, investment casting.

Smithy and Forging: Basic operations e.g. upsetting, fullering, flattening, drawing, swaging; tools and appliances; drop forging, press forging.

Metal Joining : Welding principles, classification of welding techniques; Oxyacetylene Gas welding, equipment and field of application, Arcwelding, metal arc, Carbon arc, submerged arc and atomic hydrogen arc welding, Electric resistance welding : spot, seem, butt, butt seam and precession welding; Flux; composition, properties and function, Electrodes;

Types of joints and edge preparation. Brazing and soldering, Sheet Metal Work: Common processes, tools and equipment's; metals used for sheets, standard specification for sheets.

Bench Work and Fitting: Fitting, sawing, chipping, thread cutting (die), tapping; Study of hand tools, Marking and marking tools.

**SUGGESTED READINGS**

- S.K Hajra Choudhary, “Elements of Workshop Technology Vol-1”, Media Promoters Pvt Ltd.
- P.N. Rao, “Manufacturing Technology Vol-1”, Tata McGraw Hill.
- B S Raghuwanshi, "A course in Workshop Technology", Dhanpat Rai.
- Kalpakjian, "Manufacturing Engineering and technology", Pearson.

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MEC04	Engineering Graphics	L-T-P:2-0-4	None
<p><b>COURSE OUTCOMES (COs)</b></p> <p>On Completion of the course the student are able to:</p> <ul style="list-style-type: none"> <li>• Perform free hand sketching of basic geometrical constructions and multiple views of objects.</li> <li>• Do orthographic projection of lines and plane surfaces solids.</li> <li>• Draw projections of section of solids and development of surfaces.</li> <li>• Prepare isometric and perspective sections of simple solids.</li> <li>• Read and interpret drawings of simple machine parts/ sectional views in first and third angle of projection systems.</li> <li>• Improve their visualization skills so that they can propose these skills in developing new products.</li> <li>• Communicate ideas and information through engineering drawing.</li> </ul>			
<p><b>COURSE CONTENT</b></p> <p>Introduction:</p> <p>Instruments and their uses: letterings construction and uses of various scales: dimensioning as per I.S.I. 696-1972.</p> <p>Engineering Curves: Parabola; hyperbola; ellipse; cycloid, involute; spiral; helix and loci of points of simple moving mechanism (4-bar chain)</p> <p>Projections:</p> <p>Straight lines; Planes and solids; development of surfaces of right and oblique solids; section of solids, interpenetration and intersection of solids; isometric and oblique parallel projection of solids.</p>			
<p><b>SUGGESTED READINGS</b></p> <ul style="list-style-type: none"> <li>• N D Bhatt, “Engineering Drawing”, Charotar.</li> <li>• P S Gill, “Engineering Drawing”, Kataria Sons.</li> <li>• R K Dhawan, “A Text Book of Engineering Drawing”, S. Chand.</li> </ul>			

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MEC05	Machine Drawing	L-T-P:2-0-4	None
<b>COURSE OUTCOMES (COs)</b> After taking this course students should be able to: <ul style="list-style-type: none"><li>• Describe the theory of projections and computer graphics.</li><li>• Apply various concepts of engineering graphics like dimensioning, conventions and standards related to machine drawings in order to become professionally efficient.</li><li>• Read and interpret assembly drawings with moderate complexity.</li><li>• Explain the conventions and the methods of assembly drawings.</li><li>• Develop visualization skills so that they can apply these skills in developing new products.</li><li>• Construct simple assembly drawings and prepare detailed part drawings using CAD packages like AutoCAD.</li><li>• Communicate ideas and information through technical drawing.</li></ul>			
<b>COURSE CONTENT</b> Review of lettering, dimensioning: standards; orthographies and sectional views. Selection and indication of fits and tolerances; Indian standards. Different kinds of threaded fasteners and their uses: locking arrangements, thread forms and their uses. Drawing of simple assemblies and machine parts-assembly, and disassembly. Sketching from models of assemblies and parts. Computer graphics.			
<b>SUGGESTED READINGS</b> <ul style="list-style-type: none"><li>• S C Sharma, "Machine Drawing", Standard Publishers Distributors.</li><li>• P S Gill, "A Text Book of Machine Drawing", Kataria Sons.</li><li>• Laxmi Narayanan, "Machine Drawing", Jain Brothers.</li></ul>			



<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MEC06	Manufacturing Processes I	L-T-P:3-0-2	None

**COURSE OUTCOMES (COs)**

- To understand the importance of different engineering materials, their compositions, properties and applications.
- To introduce the basics of ferrous and non-ferrous metals; their methods of extraction from their respective ores and different uses of these metals/alloys.
- Introduction to foundry practice; different types of casting process, their uses and limitations, casting defects.
- Introduction to welding, classification of welding methods, brief introduction about different types of welding technique, welding defects.
- To provide brief introduction about forging, difference between hot and cold forging, forging defects, tools used in forging, different types of presses.
- Learn about the hand tools and operations used in bench work and fitting, sheet metal work

**COURSE CONTENT**

**Powder Metallurgy:**

Introduction. Production of metal powders. Compaction and sintering processes. Secondary and finishing operations. Economics, advantages, and applications of powder metallurgy. Recent advances and application case studies.

**Metal Casting:**

Introduction: Brief History, Advantages and Limitations, Applications Patterns: Pattern materials, allowances, types of pattern, color code scheme

Sand Casting: Green and dry sand casting process, types of sand, molding sand and its properties, molding sand composition.

Cores: Use, core material, types of cores, advantages and limitations, core prints, chaplets

Gating and Riser System: Element of gating systems, types of gates, Riser design considerations

Special Molding Processes: Carbon dioxide molding process, Investment casting process, Die casting process, shell molding process, Vacuum-Sealed casting process

Casting defects: Causes and remedies of defects such as blowholes, pinholes, blisters, hot tears, cold shut, metal penetration,

Melting Practices: cupola: charge calculations, construction; other furnaces: working of induction furnace, crucible furnace, and reverberate furnace

Casting of non ferrous metals, recent advances and application case studies.

**Joining:**

Introduction: Principles of joining, general applications. Classification of joining operations. Classification based on type of joints, application of filler material, source of energy, fusion and pressure welding processes. Various joining processes such as welding, brazing and soldering.

Soldering and brazing: Difference between both the processes, consumables used, methods of brazing, fluxes used, their purpose and flux residue treatment.

Arc welding power sources; Conventional welding transformers, rectifiers & current and voltage. Inverter based power sources. The influence of these power sources on welding. Arc characteristics, self adjustment of welding arc. Arc welding operations. Manual metal arc(MMA) or shielded metal arc (SMA) welding: Equipment requirement, electrodes for welding of structural steels, coating constituents and their functions, types of coatings; ISI electrode classification for plain carbon steel (IS 815:1974 & IS 814:1991), current and voltage selection for electrodes. Submerged arc welding (SAW): Process details, consumables such as fluxes and wires for welding mild steel, variations in submerged arc welding process like single wire, tandem wire, parallel wires, field of applications. Gas metal arc welding (GMAW) or MIG/MAG welding: Process details, shielding gases, electrode wires, their sizes, and welding current ranges. TIG welding: Process details, power sources requirements, electrode sizes and materials, current carrying capacities of different electrodes, shielding gases, application of process. Plasma arc welding, Key hole technique. Metal transfer studies in arc welding. Solid phase joining operations, science of solid phase joining, types of solid phase joining operations – cold friction, hot forge, ultrasonic & diffusion joining, Friction stir welding and processing.

Chemical welding – Gas & thermit welding

Resistance welding: General principle of heat generation in resistance welding, application of resistance welding processes. Process details and working principle of spot, seam, and projection welding, percussion welding electrode materials, shapes of electrodes, electrode cooling, selection of welding currents, voltages, II manufacture of resistance seam welded (RSW) tubes by seam welding. Electro slag and electro gas welding.

Electron beam welding and laser welding and their applications.

**SUGGESTED READINGS**

- S.K Hajra Choudhary, “Elements of Workshop Technology Vol-1”, Media Promoters Pvt Ltd.
- P.N. Rao, “Manufacturing Technology Vol-1”, Tata McGraw Hill.
- B S Raghuwanshi, "A course in Workshop Technology", Dhanpat Rai.
- Kalpakjian, "Manufacturing Engineering and technology", Pearson.
- A Ghosh and AK Malik, "Manufacturing science", EWP.

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MEC07	Mathematics III	L-T-P:3-1-0	None
<p><b>COURSE OUTCOMES (COs)</b></p> <ul style="list-style-type: none"> <li>• Represent vectors analytically and geometrically, and compute dot and cross products for presentations of lines and planes,</li> <li>• Analyze vector functions to find derivatives, tangent lines, integrals, arc length, and curvature,</li> <li>• Compute limits and derivatives of functions of 2 and 3 variables,</li> <li>• Apply derivative concepts to find tangent lines to level curves and to solve optimization problems,</li> <li>• Evaluate double and triple integrals for area and volume,</li> <li>• Determine gradient vector fields and find potential functions,</li> <li>• Evaluate line integrals directly and by the fundamental theorem</li> </ul>			
<p><b>COURSE CONTENT</b></p> <p>Vector analysis: Triple product of vectors, differentiation. Operator's gradient. Divergent and cur 1, Integration of vector fields. Green, Stokes and Gauss theorems.</p> <p>Functions of complex variables: Analytic functions, Harmonic conjugate. Conformal mapping, Cauchy integral theorem, Residue theorem.</p> <p>Special functions; Beta and Gamma functions, Bessel functions; Legendre functions/polynomials.</p> <p>Partial differential equations.</p> <p>Statistics and probability theory; Mathematical Statistics, graphical representation of samples, mean and variance. Random processes, random variables, mean, variance, expectation, Various distributions-</p> <p>Binomial, Poisson, Several random variables - co-relations.</p> <p>Theory of sampling and sampling distributions.</p> <p>Optimization involving single and multiple variables. Introduction to Operation Research. Linear Programming - graphical and simplex method. Queuing theory. Dynamic Programming.</p> <p>Numeral analysis; Solution of linear equations, algebraic eigenvalue problem, polynomial equation, differentiation and integration. Calculus of variations.</p>			
<p><b>SUGGESTED READINGS</b></p> <ul style="list-style-type: none"> <li>• G. B. Thomas and R. L. Finney, "Calculus and Analytic Geometry", Pearson Education.</li> <li>• R. K. Jain and S. R. K. Iyenger, "Advanced engineering mathematics", Narosa.</li> <li>• Erwin Kreyszig, "Advanced engineering mathematics", Wiley.</li> <li>• Michael Greenberg, "Advanced engineering mathematics", Pearson Education.</li> </ul>			

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MEC08	Thermal Engineering	L-T-P:3-0-2	None

**COURSE OUTCOMES (COs)**

- Understand the basic concepts of thermodynamic such as temperature, pressure, system, properties, process, state, cycles and equilibrium.
- Understand the thermodynamic laws & its applications in the field of energy technology notably in internal combustion engine, gas turbine, air conditioning refrigeration, compressors etc.
- Analyze the power cycles such as Rankin cycle and its modifications, Otto cycle, Diesel cycle, Brayton cycle etc.
- Analyze the energy transfer through mass, heat and work for closed and control volume systems.
- Analyze the thermal efficiencies of heat engines such as Carnot and Rankine cycles and the coefficients of performance for refrigerators.

**COURSE CONTENT**

Basic concepts: Introduction to the Basic definitions of Engineering Thermodynamics. Thermodynamic systems: Closed, open and isolated systems. Microscopic and Macroscopic view. Intensive and Extensive properties. Zeroth law of Thermodynamics. Phase, State, Process, Cycle. Point functions and Path functions. Equation of state. Work and Heat. First Law of Thermodynamics: Internal energy - a property arising from the First Law of Thermodynamics. Reversible Non flow processes p-v diagrams. Concept of Flow work, Enthalpy. Analysis of unsteady flow and steady flow processes and their applications. Throttling process.

Second Law of Thermodynamics: Limitations of First law and necessity of Second Law of Thermodynamics. Clausius and Kelvin Planck statements. Reversible and Irreversible processes. Carnot cycle, Reversed Carnot cycle. Clausius inequality. Entropy - a property arising from the Second law of Thermodynamics. Expressions for change in entropy during various processes and representations on t-s diagrams.

Availability and Irreversibility: High grade and low grade energy. Available and unavailable energy. Dead state. Loss of available energy due to Heat transfer through a Finite temperature difference. Availability. Reversible work and Irreversibility. Availability in non-flow systems and steady flow systems. Second law efficiency.

Thermodynamic Property Relations: Helmholtz and Gibbs function. Mathematical conditions for exact differentials (Properties). Maxwell Relations. Clapeyron Equation.

Properties of a Pure Substance: Phase equilibrium of a pure substance on t-v diagram. Normal boiling point of a pure substance. Saturation states. Compressed liquid. P-v & p-t diagram of a

pure substance. Saturated steam, Dry and saturated steam, Superheated steam. Use of Steamtables and Mollier diagram. Different processes of vapour on p-v and t-s diagrams. Measurement of Dryness fraction.

Gas Power Cycles: Carnot cycle, Otto cycle, Diesel cycle, Dual cycle, Stirling cycle, Ericsson cycle and Brayton cycle.

Vapour Power Cycles: Carnot cycle. Simple Rankine cycle. Effect of various parameters on the efficiency of Rankine cycle. Reheat and Regenerative cycles

**SUGGESTED READINGS**

- P.K. Nag, "Engineering Thermodynamics", Tata McGraw Hill.
- Sonntag/Vanhyllene, "Fundamentals of Thermodynamics", Wiley.
- Gordon Rosers, "Yon Mahew; Engineering Thermodynamics", Addison Wesley.
- Y.V.C. Rao, "Engineering Thermodynamics", Khanna Publications.
- E. Gutra, "Basic Thermodynamics", Narosa Publications.
- M.L. Mathur, "Mehta F.S. Thermal Engineering", Jain Brothers.
- R.K. Rajput, "Thermal Engineering", Laxmi Publications.
- Dhombkudwar Kothandaraman, "A Course in Thermal Engineering", Dhanpat Rai Publications.

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MEC09	Science of Materials	L-T-P:3-1-0	None
<b>COURSE OUTCOMES (COs)</b> After taking this course students are able to: <ul style="list-style-type: none"><li>• Summarize significance of material science and its role in manufacturing.</li><li>• Classify different engineering material (metals, plastics, composites).</li><li>• Describe phase diagram and heat treatment processes.</li><li>• Identify properties of engineering materials by various testing methods.</li><li>• Develop concept of diffusion, mechanical properties and high temperature material problems.</li><li>• Select a material for a specific use based on consideration of cost, performance and application.</li></ul>			
<b>COURSE CONTENT</b> Phase diagram: Iron-carbon diagram, fundamentals of heat treatment, heat treatment processes, anstentizing, annealing, normalizing, tempering. Hardening and hardenability, carburizing, carbonitriding, nitriding, induction and flame hardening, heat treatment of non-ferrous alloys. Material testing: Tensile, torsion, hardness and impact testing; creep and fatigue-factors affecting; ductile and brittle behavior and transition temperature. Composites: classification, micro-mechanics of fibre and particle reinforced composites, strength, stiffness and factors affecting, failure modes. Plastics: Thermosetting and Thermoplastic, properties and applications. Selection criteria of engineering materials and alloys for high strength, high temperature, antifriction, corrosive resistance, electrical, magnetic and space applications.			
<b>SUGGESTED READINGS</b> <ul style="list-style-type: none"><li>• William D. Callister, David G. Rethwisch, "Materials Science and Engineering: An Introduction", Wiley.</li></ul>			

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MEC10	Kinematics & Dynamics of Machines	L-T-P:3-0-2	None

**COURSE OUTCOMES (COs)**

- To understand the function of a mechanism in common machine tools.
- To know the kinetics involved in the study of relative velocity and acceleration among the links of a mechanism.
- To understand the dynamics involved in the study of displacement, velocity, acceleration and jerk of a mechanism.
- To study the various possible motions between CAM-FOLLOWER assemblies.
- Design of gears according to shape, size and their velocity ratio.
- Balancing of rotating masses in different conditions.
- To study undamped & damped motion in longitudinal/transverse/torsional vibration.

**COURSE CONTENT**

Review of Kinematics and kinetics of a particle in plane motion- Cartesian and polar coordinates. Tangent and normal components: work-energy principle.

Kinematics of a particle in space motion-Cartesian, cylindrical and spherical coordinates, rotating set of coordinates.

Kinematics and kinetics of a rigid body in plane motion. Kinematics and kinetics of interconnected rigid bodies. Rotating set of coordinates, Coriolis component; work-energy principle. Conservation principles.

Linkages, kinematic pair, inversion and equivalent linkages: Velocity and acceleration analysis of planar mechanisms-analytical and graphical methods, instantaneous centers and velocity analysis.

Kinematics of higher pair mechanisms:—

CAM — Nomenclature, follower motions, graphical and analytical methods of synthesis of cam profiles, pressure angle.

GEARS — Introduction, law of gearing, synthesis of tooth profile, undercutting and interference; simple compound and epicyclic gear trains.

Dynamic analysis of single and multiple degrees of freedom systems. Dynamics of planar mechanisms with special reference to slider-crank, mechanism and internal combustion engines.

BALANCING: — Static and dynamic, single and multi-cylinder engines.



**SUGGESTED READINGS**

- Joseph Edward Shigley and John Joseph, “Theory of Machines and Mechanism”, Oxford University Press.
- S. S. Ratan, “Theory of Machines”, McGraw Hill.

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MEC11	Mechanics of Solids	L-T-P:3-0-2	None
<b>COURSE OUTCOMES (COs)</b> <ul style="list-style-type: none"><li>• Analyze the forces in machines and structures, understanding of frictional forces.</li><li>• Classify basic engineering mechanics concepts required for predicting behavior of static structures.</li><li>• To understand first and second moment of areas to find out centroid and moment of inertia for different geometries.</li><li>• Model the problem using free-body diagrams (FBD) and accurate equilibrium equations.</li><li>• Identify and choose various types of loading and support conditions that act on structural systems and also reactions offered.</li><li>• Communicate the solution to all problems in an organized and coherent manner and elucidate the meaning of the solution in the context of the problem.</li><li>• Determine internal actions in statically determinate structures and draw internal action diagrams–Shear</li><li>• Force (SFD) and Bending Moment Diagrams (BMD) for these structures.</li><li>• To understand theory of simple bending and its applications in deflection of beams.</li><li>• To calculate power transmitted by circular shafts using concept of torsion.</li><li>• To understand combined effect of direct, bending and shear stresses.</li><li>• Solve the problems related to the theory of elasticity, concepts of stress and strain, strength and stiffness, deformations and displacements, strain energy, and load carrying capacity.</li><li>• Predict the behavior of the solid bodies subjected to various types of loading.</li><li>• Design machine elements using theories of deformable bodies.</li><li>• To calculate stresses in columns subjected to different loading conditions.</li></ul>			
<b>COURSE CONTENT</b> <p><b>Analysis of Stresses and Strains:</b> Concept of stress, normal stress and shear stress, nine Cartesian components of stress at a point, sign convention and notation, equations of equilibrium, equality of shear stresses on mutually perpendicular planes and their planes of action, stress circle; Concept of strain, normal and shear strain, two dimensional state of strain, Poisson’s ratio, volumetric strain, strain circle.</p> <p><b>Stress-Strain Relationships:</b> Hooke’s law and its application to isotropic materials, elastic constants and their relationships, plane stress and plain strain conditions.</p>			

**Mechanical Properties:** Uniaxial tension test to determine yield and ultimate strength of materials, stress-strain diagram, proof stress, ductile and brittle materials, hardness and impact strength; Conditions affecting mechanical behavior of engineering materials.

**Members in Uniaxial State of Stress:** Uniform cross-section and tapered bars subjected to uniaxial tension and compression, composite bars and statically indeterminate bars, thermal stresses;

**Members Subjected to Axi-symmetric Loads:** Stresses and strains in thin cylindrical shells and spheres under internal pressure, stresses in thin rotating rings.

**Members Subjected to Torsional Loads:** Torsion of solid and hollow circular shafts, stepped and composite shafts, close-coiled helical springs subjected to axial loads.

**Members Subjected to Flexural Loads:** Statically determinate beams, support reactions, relationship between load, shear force and bending moment, shear force and bending moment diagrams; Theory of flexure for initially straight beams, distribution of bending stresses across the beam cross-section, principal stresses in beams; Equation of elastic curve for the loaded beam, relationship between bending moment, slope and deflection; Calculation of deflection by integration.

**Members Subjected to Combined Loads:** Short struts subjected to eccentric loads, shafts subjected to combined bending, torsion and axial thrust.

**Elastic Stability of Columns:** Euler's theory of initially straight columns, critical loads for different end condition of columns, eccentric loading, columns with small initial curvature, empirical formulae.

**Theories of failure:** Strain energy, energy methods, Principle of virtual work.

#### **SUGGESTED READINGS**

- James M Gere, "Mechanicals of Materials", CENGAGE Learning Custom Publishing.
- Ferdinand Beer and Russel Johnson, "Mechanics of Materials", McGraw-Hill.
- R. K. Bansal, "A Textbook of Strength of Materials", Laxmi Publication..

Course No	Title of the Course	Course Structure	Pre-Requisite
MEC12	Fluid Mechanics	L-T-P:3-0-2	None
<p><b>COURSE OUTCOMES (COs)</b></p> <ul style="list-style-type: none"> <li>• Understand the fundamental concept of the fluid mechanics.</li> <li>• Apply the basic equations of fluid statics to determine forces on planar and curved surfaces that are submerged in a static fluid.</li> <li>• Analyze the Stability of floating and submerged bodies.</li> <li>• Analyze fluid flow problems with the application of the momentum and energy equations.</li> <li>• A knowledge of boundary layer flow.</li> <li>• Capability to analyze pipe flows as well as open channel flows.</li> </ul>			
<p><b>COURSE CONTENT</b></p> <p><b>Introduction:</b> Fluid and flow definitions and types; Properties of fluids i.e. mass density, specific weight, specific gravity, viscosity etc.; Continuum concept; Lagrangian &amp; Eulerian approach.</p> <p><b>Fluid Statics:</b> Pascal’s Law; Hydrostatic Law; Manometry; Forces on plane and curved surfaces; stability of floating and submerged bodies; Relative equilibrium.</p> <p><b>Fluid Kinematics:</b> Classification of fluid flows; Flow lines; Continuity equation; Stream function; Potential function; Rotational flow rotation and vorticity; Flow Nets.</p> <p><b>Fluid Dynamics:</b> Concept of system and control volume; Euler’s equation; Bernoulli’s equation; Derivation of Navier Stokes’s equation; Venturimeter, orificemeter, Rotameter and Mouthpieces; Pitot tube.</p> <p><b>Boundary layer Flow:</b> Boundary layer concept; Displacement; Momentum and Energy thickness; Von-Karman momentum integral equation; Laminar and Turbulent boundary layer flows; Drag on a flat plate; Boundary layer separation and control. Streamlined and bluff bodies; lift and drag on a cylinder and an airfoil.</p> <p><b>Turbulent Flow:</b> Reynold’s experiments; Prandtl mixing length hypothesis; Velocity distribution in pipes; Concept of smooth and rough pipes; Pipe friction factor relations.</p> <p><b>Flow in Pipes:</b> Various losses in pipe line and their measurement; Hagen-Poiseuilli law; Total and Hydraulic gradient line; Pipes in series and parallel; Concept of equivalent pipe; Power transmission through pipes.</p> <p><b>Flow in open channels:</b> Classification of open channels; Flow analysis; Empirical relations; Economical sections for maximum discharge; Most economical channels i.e. rectangular, trapezoidal and circular; Hydraulic Jump.</p>			

**SUGGESTED READINGS**

- Streeter V L and Wylie E B, “Fluid Mechanics”, McGraw Hill.
- I H Shames, “Mechanics of Fluids”, McGraw Hill.
- R.K Bansal, “Fluid Mechanics and Hydraulic Machines”, Laxmi Publications.
- D.S. Kumar, “Fluid Mechanics and Fluid Power Engineering”, S.K. Kataria and Sons.

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MEC13	Manufacturing Processes II	L-T-P:3-0-2	None

**COURSE OUTCOMES (COs)**

- Student learns the concepts of metal cutting and its vital role in manufacturing Processes.
- Student will be able to relate the ideas conveyed, to the industrial applications.
- Student becomes confident in expressing his/her views on the importance of manufacturing processes.
- Student learns about vast variety of machine tools available along with their right usage point.
- Student can apply the knowledge gained to understand, analyse and develop academic projects.
- Student can maturely utilize the knowledge gained in solving manufacturing related issues.

**COURSE CONTENT**

Review of metal cutting.

Turning: Taper turning. Turret and Caps ton lathes, autos

Milling: Vertical, horizontal and universal milling machines, indexing, gear cutting; milling cutters-geometry and specifications.

Grinding: Surface and cylindrical grinding, centre less grinding, grinding wheels, construction and specifications; mechanics of grinding; tool grinding.

Drilling: Drilling tool geometry, drilling machines.

**Special Machines** (a) Gear hobbing Gear geometry, gear generation and hobbing, gear grinding.

(b) Boring machines: Cylindrical boring and lapping.- (c) Profile cutting and machinery.

**Mechanics of Metal Cutting:** Review, cutting forces, factors affecting cutting forces, tool dynamometers, geometry and characteristics.

**Tool Materials:** Effect of alloying materials, tool life-factors affecting tool life, selection of tool material.

**Unconventional Machining:** Limitation of conventional machining processes - chemical, electric discharge, electron beam, laser beam, ion beam, plasma, explosive. Automation and NC machines.

**SUGGESTED READINGS**

- S. K Hajra Choudhary, “Elements of Workshop Technology: Machine tools Vol-2”, Media Promoters Pvt Ltd.
- P.N. Rao, “Manufacturing Technology - Vol. 2”, Tata McGraw Hill.

- AB Chattopadhyay, "Machining and Machine tools", Wiley.
- PH Joshi, "Machine tools Handbook", McGraw Hill.

Course No	Title of the Course	Course Structure	Pre-Requisite
MEC14	Management of Manufacturing Systems	L-T-P:3-1-0	None
<p><b>COURSE OUTCOMES (COs)</b></p> <ul style="list-style-type: none"> <li>• Explain to students why information systems are so important today for business and management;</li> <li>• Evaluate the role of the major types of information systems in a business environment and their relationship to each other;</li> <li>• Assess the impact of the Internet and Internet technology on business electronic commerce and electronic business;</li> <li>• Identify the major management challenges to building and using information systems and learn how to find appropriate solutions to those challenges;</li> <li>• Learn the core activities in the systems development process; • Cultivate skills and experience in the development and implementation of information systems projects.</li> </ul>			
<p><b>COURSE CONTENT</b></p> <p>Introduction: production functions, productivity and quality management conforming to ISO - 9000 systems. Plant organization: organization, principles of organization, organization structure - line and staff organizations.</p> <p>Plant location, layout: process layout, product layout and combination layout - methods of layout, economics of layout.</p> <p>Production planning and control: types of products, demand, demand forecasting, marketing strategies. Scheduling and control of scheduling; production control.</p> <p>Inspection and quality control: objectives, kinds of inspection of raw <i>material</i> and finished product; SQM, sampling; control charts and their applications.</p> <p>Work and method study: definition and concepts; method study - procedures, symbols, advantages. Flow process charts. Motion study - micro motion, SIMO charts, procedures system concepts value and ABC</p> <p>Analysis: system concepts, classification, analysis, techniques.</p> <p>Industrial maintenance - types, organization of maintenance department. Breakdown and preventive maintenance.</p> <p>Inventory control and replacement analysis: introduction, replacement policy and methods adopted; EOQ.</p> <p>Management concepts - development of management principles, scientific management, human relations aspects.</p>			



Industrial psychology, personnel management, and labour relations, methods of remuneration.  
Project Management - CPM and PERT

**SUGGESTED READINGS**

- S K Sharma, “Industrial Engineering & Operations Management”, S. K. Kataria.

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MEC15	Industrial Engineering	L-T-P:3-0-2	None

**COURSE OUTCOMES (COs)**

On Completion of the course the student will be able to

- Predict facility location and network models.
- Interpret and solve data from aggregate output planning models. Knowledge of human factors in engineering and various jobs designs.
- Select and analyze an inventory control model based upon given data. Understanding of manufacturing resource and just-in-time planning.
- Apply the Industrial Engineering concept in the industrial environment.
- Manage and implement different concepts involved in methods study and understanding of work content in different situations.
- Describe different aspects of work system design and facilities design pertinent to manufacturing industries.
- Identify various cost accounting and financial management practices widely applied in industries.
- Develop capability in integrating knowledge of design along with other aspects of value addition in the conceptualization and manufacturing stage of various products.
- The students will be able to do managerial works assigned to them in industries.

**COURSE CONTENT**

**Basic Concepts of Industrial Engineering:** Definition, Objectives, Method study, Principle of motion economy, Techniques of method study - Various charts, THERBLIGS, Work measurement - various methods, Time Study - PMTS, determining time, Work sampling, Numerical Problems.

**Productivity, Workforce & Information Management:** Productivity - Definition, Various methods of measurement, Factors effecting productivity, Strategies for improving productivity, Various methods of Job evaluation & merit rating, Various incentive payment schemes, Behavioral aspects, Financial incentives. MIS, Importance of MIS, Organizational & information system structure, Role of MIS in decision making.

**Manufacturing Cost Analysis:** Fixed & variable costs, Direct, indirect & overhead costs, & Job costing, Recovery of overheads, Standard costing, Cost control, Cost variance Analysis - Labour, material, overhead in volume, rate & efficiency, Break even Analysis, Marginal costing & contribution, Numerical Problems.

**Materials Management:** Strategic importance of materials in manufacturing industries, Relevant costs, Inventory control models - Economic order quantity (EOQ), Economic batch quantity (EBQ) with & without shortage, Purchase discounts, Sensitivity analysis, Inventory control systems - P,Q,Ss Systems, Service level, Stock out risk, determination of order point & safety stock, Selective inventory control - ABC, FSN, SDE, VED and three dimensional, Numerical Problems.

**Sales Forecasting:** Importance, Objectives, Forecasting and Prediction, Types, Classification of Forecasting Methods, Forecast Errors, Costs and Accuracy of Forecasts, Numerical Problems.

**Production Planning & Control (PPC):** Objectives & variables of PPC, Aggregate planning - Basic Concept, its relations with other decision areas, Decision options - Basic & mixed strategies, Master production schedule (MPS), Scheduling Operations Various methods for line & intermittent production systems, Gantt chart, Sequencing - Johnson algorithm for n-Jobs-2 machines, n- Jobs-3 machines, 2 Jobs n-machines, n-Jobs m-machines Various means of measuring effectiveness of PPC, Introduction to JIT, Numerical Problems.

**SUGGESTED READINGS**

- Chary, “Production & Operations Management”, TMH.
- Sadagopan, “Management Information Systems”, PHI.
- S.S. Buffa, “Modern Production Management”, John Wiley.
- Schroeder, “Operations Management”, McGraw Hill ISE.
- Monks, “Operation Management”, McGraw Hill ISE.
- Martinich, John, “Production & Operations Management”, Wiely SE.
- Turner, Mize, Chase, “Industrial & Systems Engineering”, Prentice Hall Pub.

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MEC16	Refrigeration & Air-Conditioning	L-T-P:3-0-2	None

**COURSE OUTCOMES (COs)**

On Completion of the course the student will be able to

- Evaluate the performance of the vapour compression refrigeration system.
- Describe the types of compressors, condensers, evaporators and expansion valves.
- Distinguish the desirable properties of refrigerants and select the alternate refrigerants.
- Present the properties, applications and environmental issues of different refrigerants
- Perform the calculations for various psychometric process using psychrometric chart and equations.
- Perform the calculations to find effective and grand sensible heat factor.
- Estimate the total load for domestic, industrial and central air-conditioning systems.
- Name the elements of a typical heating ventilation and air-conditioning systems.
- Illustrate the fundamental principles and applications of refrigeration and air conditioning system
- Obtain cooling capacity and coefficient of performance by conducting test on vapor compression refrigeration systems
- Explain different types of Basic Refrigeration cycles and its applications in multi compressor and multi evaporator systems

**COURSE CONTENT**

Air Refrigeration: Brief History of Refrigeration. Refrigerating Machine-Second Law of Thermodynamics---Interpretation. Carnot Cycle, Reversed Carnot Cycle, Heat Engine, Refrigerating Machine, Heat Pump, and COP. Unit of Refrigeration. Bell Coleman Cycle, Dense Air System, Reversed Brayton Cycle, Air Refrigeration Cycle for Aircraft. Ram Compression. Comparison of various cooling systems for aircraft.

Vapour Compression Refrigeration System: Simple Saturated Cycle. T-s, P-h, h-s, P-v diagrams. COP. Dry and Wet Compression. Effect of operating parameters. Effect of undercooling and superheating. Liquid-Suction Heat Exchanger. Actual vapour compression cycle. Details of various types of Compressors, Condensers, Expansion devices and Evaporators. Matching of Components.

Refrigerants: ASHRAE Nomenclature. Eco Friendly Refrigerants, Thermodynamic Requirements of a Good Refrigerant. Introduction to Azeotropic & Non Azeotropic Refrigerant Mixtures (NARM)

Compound Vapour Compression System: Concepts of (i) Liquid Flash cooler, (ii) Flash Inter cooler. Optimum Interstate Pressure.

Multiple Evaporators and Compressors: Use of Individual Expansion valves, back pressure valves and multiple expansion valves.

Miscellaneous: Vapor Absorption System: Thermal refinements, Practical vapor absorption system Electrolux Refrigerator.

Steam Jet Refrigeration: System components and analysis.

Cascade Refrigeration: Limitations of vapour compression system for low temperature refrigeration. Cascade staging. Dry ice.

Controls: Sensing and Actuating Elements H.P/L.P cut out, Thermostat, Solenoid valve, Humidistat, Anemometer etc.

Psychometric: Brief History of Air Conditioning. Working substance in Air Conditioning.

Dalton's Law of Partial Pressures. Psychometric Properties and Psychometric Chart.

Psychometric Processes, Concept of Room Sensible Heat Factor, Grand Sensible Heat Factor, Apparatus Dew point, Effective Sensible Heat Factor. High Latent Heat Load applications,

Summer & Winter Air Conditioning Comfort Air Conditioning: Factors influencing Human comfort. Concept of Effective Temperature. Factors governing optimum effective temperature.

Heat Load Estimation: Inside and outside design conditions. Solar heat gain through glass and Structures. Occupancy load, lighting load and miscellaneous loads. Infiltration and Ventilation.

Summary of Heat Loads. Duct Design: Transmission and distribution of air flow. Types of supply air outlets, Mechanism of flow of air through outlets. Pressure drop and friction loss in ducts. Rectangular equivalents of circular ducts. Method of Duct design.

### **SUGGESTED READINGS**

- P L Ballany, "Refrigeration & Air Conditioning", Khanna Publisher.
- C.P. Arora, "Refrigeration & Air Conditioning", Tata McGraw Hill.
- Domkundewar & Arora, "A Course in Refrigeration & Air conditioning", Dhanpat Rai & Co.
- Marsh & Olivo, "Principles of Refrigeration", C.B.S Publications.
- Paul Lang, "Principles of Air Conditioning", C.B.S Publications.

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MEC17	Transducers and Measurements	L-T-P:3-0-2	None
<b>COURSE OUTCOMES (COs)</b> <ul style="list-style-type: none"><li>• After successful completion of the course, student will be able to understand the basic concepts of measurement and measuring systems analyze detailed construction and working of various analog and digital instruments understand various types of transducers, their working and applications.</li></ul>			
<b>COURSE CONTENT</b> <p>Performance characteristics: accuracy, sensitivity, precision, linearity, resolution, hysteresis. Static and dynamic characteristics.</p> <p>Basic principles of operation of voltmeter, ammeter. Digital voltmeter, A.C. and RMS measurements. Multimeters-analog and digital. Digital phase meters. Counters-pulse counters. CRO and its applications. Multichannel oscilloscopes. Frequency response measurement. Spectrum analyser.</p> <p>Resistance transducers, Strain gages. Capacitance transducers and their applications.</p> <p>Piezoelectric Phenomenon, crystals, its applications. Configurations, sensitivity, coefficients, ferroelectric and applications.</p> <p>Feedback transducers - applications, advantages Elastic transducers - springs, bellows, diaphragms, thin plates, membranes, Bourdon tubes - special features and applications. LVDT, capacitive pickups, hot wire anemometers, thermo emf transducers, temperature transducers. Hall Effect transducers, Optical Pyrometers. Accelerometers and vibration pickups.</p>			
<b>SUGGESTED READINGS</b> <ul style="list-style-type: none"><li>• V. S. Murty, “Transducers and Instrumentation”, Phi Learning Pvt. Ltd.</li></ul>			

Course No	Title of the Course	Course Structure	Pre-Requisite
MEC18	Control Systems	L-T-P:3-0-2	None
<p><b>COURSE OUTCOMES (COs)</b></p> <ul style="list-style-type: none"> <li>• Represent the mathematical model of a system.</li> <li>• Determine the response of different order systems for various step inputs.</li> <li>• Analyze the stability of the system.</li> </ul>			
<p><b>COURSE CONTENT</b></p> <p><b>Control System Types:</b> Open loop and closed loop control systems illustrations, block representation, signal terminology, explanation with illustrations of servomechanism, regulating system, Linear and non-linear controls, Continuous and sampled data controls, Digital control.</p> <p><b>Mathematical Modelling and System Representation:</b> Differential equations of physical systems such as mechanical, electrical, electromechanical, thermal, pneumatic, liquid level etc. analogous systems, Transfer function, Block <i>diagram</i> representation and reduction technique, signal flow graph-construction, terminology, algebra and Mason's gain formula, effects of feedback on variation of system parameters, system dynamics and effect of disturbances. System state space equation.</p> <p><b>Control System Components:</b> Potentiometers, Synchros, Armature and field controlled D.C servomotor, A.C servomotor, stepper motor, rotating amplifiers, magnetic amplifiers, tachogenerators.</p> <p><b>Time Domain Analysis:</b> Standard test signals, transient response of first and second order systems, transient response specific control action on system performance, performance index concept and error performance indices- ISE, ITSE, IAE, ITAE, Root locus technique concept, construction rules and root contours.</p> <p><b>Frequency Domain Analysis:</b> Concept of frequency response, Frequency response plots-polar plot, Bode plots, Log magnitude vs. phase angle plot, performance specifications, correlation between time and frequency responses.</p> <p><b>Stability Analysis:</b> Concept of stability, conditions for stability. Routh-Hurwitz criterion, Nyquist criterion, Gain and phase margin. Constant M and N loci, Use of Nichols chart for performance evaluation. Controllability and observability using state space concept.</p> <p><b>Compensation Techniques:</b> Control systems using compensation networks such as, Lag, Lead, Lag-lead networks via frequency domain techniques.</p>			
<p><b>SUGGESTED READINGS</b></p> <p>I. J. Nagrath, "Control Systems Engineering", New Age</p>			

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MEC19	Heat & Mass Transfer	L-T-P:3-1-0	None

**COURSE OUTCOMES (COs)**

- Knowledge of basic laws of heat transfer.
- Ability to apply principles of heat and mass transfer to basic engineering systems
- Ability to understand and solve conduction, convection and radiation problems
- Ability to design and analyze the performance of heat exchangers.
- Knowledge of air compressors, gas turbines, steam nozzles and steam turbines.
- Ability to evaluate diffusion and convective Mass transfers occurring in different applications

**COURSE CONTENT**

**Conduction:** One dimensional steady state conduction. Simple convection. Overall heat transfer coefficient. Simple cases of Heat Transfer through, homogenous and composite plane walls, cylinders and spheres with constant and variable thermal conductivity. Critical thickness of insulation. Heat transfer from Fins of uniform cross section.

**Convection:** Concept of Hydrodynamic and Thermal boundary layers. Application of Dimensional analysis to Free and Forced convection. Important Dimensions- less numbers.

**Heat transfer during Change of Phase:** Film condensation and Drop wise condensation. Flow regimes. Heat transfer coefficient for Film Condensation. Boiling: Classification. Boiling regimes. Heat transfer correlations in boiling.

**Heat exchangers:** Types of Heat exchangers. LMTD and NTU methods exchangers Design. Simple calculations.

**Radiation:** Kirchoffs law. Planck's distribution law. Wein's displacement law. Stefan-Boltzmann's relation. Configuration factor. Radiant heat interchange between black and greysurfaces. Solar Radiation, Radiation shielding.

**Air Compressors:** Classification. Single stage Reciprocating compressor, Isothermal efficiency, adiabatic efficiency. Clearance volume, volumetric efficiency. Actual indicated diagram. Multistage compression with intercooling. Rotary Compressors: Roots Blower, Rotary vane compressor. Centrifugal and Axial flow compressor.

**Gas Turbines:** Gas Power Cycles–Thermal refinements. Performance of Gas turbines, combined cycle. Principles of Jet Propulsion. Turbojet and Turbo-prop engines, Rocket engines.

**Steam Nozzles:** Application of Nozzles. Types of Nozzles. Expansion of steam through a Nozzle. Effect of friction. Critical pressure ratio. Areas at Throat & Exit for maximum discharge conditions. Performance at Off- design conditions.



**Steam Turbines:** Classification. Impulse and Reaction Turbines. Compounding of steam turbines. Velocity diagrams. Conditions for maximum efficiency. Governing of steam turbines. Losses in steam turbines. Reheat Factor.

**Introduction to Mass Transfer:** Mass and mole concentrations, molecular diffusion, eddy diffusion, Molecular diffusion from an evaporating fluid surface, Introduction to mass transfer in laminar and turbulent convection Combined heat and mass transfer, the wet and dry thermometer

**SUGGESTED READINGS**

- R. Yadav, “Steam Turbines”, Asia Publications.
- D.S. Kumar; “Heat & Mass Transfers”, S.K. Kataria & Sons.
- M. L. Mathur, F.S. Mehta, “Thermal Engineering”, Jain Publication.
- R.K. Rajput, “Thermal Engineering”, Laxmi Publication.
- J.P. Holman, “Heat Transfers”, McGraw Hill.
- Arora Domkundwar, “A Course in heat & Mass Transfer”, Dhanpat Rai & Co.
- P.L. Ballaney, “Thermal Engg.” DhanpatRai Publications.

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MEC20	Fluid Systems	L-T-P:3-0-2	None
<b>COURSE OUTCOMES (COs)</b> After taking this course students will be able to: <ul style="list-style-type: none"><li>• Understand the application of momentum principle of impact of jets on plane and curved surfaces</li><li>• Describe the working of different types of hydraulic turbines &amp; also able to calculate the efficiency of the hydraulic turbines.</li><li>• Describe the working of different types of hydraulic pumps &amp; also able to calculate the efficiency of the hydraulic pumps.</li><li>• Describe the hydraulic power transmission</li><li>• Describe comparison of pneumatic and hydraulic Systems</li></ul>			
<b>COURSE CONTENT</b> Introduction: Euler’s equations for turbo machines; impulse and reaction forces due to fluid systems on stationery and moving system of vanes; jet propulsion. Water Turbines: Classification; Pelton, Francis, Propeller and Kaplan turbines; velocity triangles; efficiency, draft tubes, governing. Performance of Fluid Machines: Similarity laws applied to roto-dynamic machines; specific speed, unit quantities, Characteristic curves; use of models; cavitation and attendant problems in turbo-machines; selection of turbines hydroelectric plants Pumps: Centrifugal pumps, velocity triangles; efficiency, turbine pumps; axial and mixed flow pumps. Hydraulic Power Transmission: Transmission of hydraulic power through pipe lines; water hammer; precautions against water hammer in turbine and pump installations; hydraulic ram. Power Hydraulics: Positive pumps; gear, vane, screw, variable delivery pumps, valves; flow control, pressure control, direction control, solenoid operated valve, hydraulic circuits, (meter-in, meter-out, bleed-off), fluid coupling and torque converter. Pneumatic Power: Basic principles, comparison of pneumatic and hydraulic Systems.			
<b>SUGGESTED READINGS</b> <ul style="list-style-type: none"><li>• Streeter V L and Wylie E B, “Fluid Mechanics”, McGraw Hill.</li><li>• I H Shames, “Mechanics of Fluids”, McGraw Hill.</li><li>• R.K. Bansal, “Fluid Mechanics &amp; Hydraulic Machines”, Laxmi Publication.</li><li>• D.S. Kumar, “Fluid Mechanics &amp; Fluid Power Engineering”, S.K. Kataria &amp; Sons.</li></ul>			

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MEC21	Machine Element Design	L-T-P:3-0-2	None

**COURSE OUTCOMES (COs)**

- To introduce different design disciplines and various steps involved in a design process.
- To provide a detailed insight to students about engineering design and how it is different from other design disciplines.
- To introduce various types of mechanical elements like springs, bearings, shafts, brakes, clutches, gears etc. to the students and brief explanation about their manufacturing process.
- To introduce theories of failure, mechanical properties of material, stress-strain diagram for ductile and brittle materials.
- Introduction to dynamic stress, calculation of endurance limit.
- To develop an aptitude among the students that how different products and components that they see in their daily life can be manufactured and fabricated.
- To provide detailed introduction about different types of permanent and temporary fasteners and calculation of stresses using mathematical equations.
- To develop ability among students to use the knowledge of mathematics, mechanics of solids and other reengineering disciplines like Computer Aided Design and Finite Element Analysis in solving engineering problems and to have a better design aptitude.
- After the completion of the course students should develop a know-how that how different mechanical elements can be combined together to develop a simple machine.

**COURSE CONTENT**

Introduction: Principles of mechanical design, systematic design process, aesthetic and ergonomic considerations in design, use of standards in design. Manufacturing consideration in design, casting, machining, forging Dynamic and fluctuating stresses, fatigue failure and endurance limit, stress concentration, causes and remedies in design Factor of safety Tolerances and types of fits Selection of material.

Design of Elements: Cotter and knuckle joints; screwed fastenings, bolted and riveted joints under direct and eccentric loads, initial tightening loads in bolts.

Welded joints, strength of welded joints, eccentrically loaded joints, welded joints subjected to bending moment and torsion.

Shafts, keys and couplings –design of rigid and pin bushed flexible couplings. Levers design Pipes, cylinder and design of pipe joints.

Translation screws: force analysis and design of various types of power screws springs, uses and design of close coiled helical springs shot pining of springs. Classification of Gears, spur gears. Friction Clutches & Brakes: Common friction materials, shoe, band, cone and disc brakes Their characteristics and design, friction clutches. Bearings and Lubrication: Types of sliding bearing, materials, type of lubrication, design of sliding bearing, selection and application of rolling bearing, seals.

**SUGGESTED READINGS**

- Maleeve Hartman and O.P. Grover, “Machine Design”, CBS Publication & Publishers.
- V.B Bhandari, “Machine Design”, Tata McGraw Hill.
- P.C. Sharma and D.K Aggarwal., “Machine Design”, S.K. Kataria& Sons
- Mahadevan, “Design Data Book”, CBS Publication & Publishers
- I.E. Shigley & C.R. Mischke, "Mechanical Engineering Design", Tata McGraw Hill Co. Inc.

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MEC22	Mechanical Vibrations	L-T-P:3-0-2	None
<b>COURSE OUTCOMES (COs)</b>			
<p>An introductory course in linear mechanical vibrations where students acquire the ability to</p> <ul style="list-style-type: none"> <li>• Formulate mathematical models of problems in vibrations using Newton's second law or energy principles,</li> <li>• Determine a complete solution to mechanical vibration problems using mathematical or numerical techniques, and</li> <li>• Determine physical and design interpretations from the results</li> </ul>			
<b>COURSE CONTENT</b>			
<p>1. FUNDAMENTALS OF VIBRATION  Review of Single degree system - Response to arbitrary periodic excitations - Duhamel's Integral – Impulse Response function – Virtual work - Lagrange's equation - Single degree freedom forced vibration with elastically coupled viscous dampers - System Identification from frequency response - Transient Vibration – Laplace transformation formulation.</p> <p>2. TWO DEGREE OF FREEDOM SYSTEMS  Free vibration of spring - coupled system - mass coupled system - Bending vibration of two degree of freedom system - forced vibration - Vibration Absorber - Vibration isolation.</p> <p>3. MULTI-DEGREE OF FREEDOM SYSTEM  Normal mode of vibration - Flexibility Matrix and Stiffness matrix - Eigen values and eigen vectors – orthogonal properties – Modal matrix-Modal Analysis - Forced Vibration by matrix inversion – Modal damping in forced vibration - Numerical methods for fundamental frequencies</p> <p>4. VIBRATION OF CONTINUOUS SYSTEMS  Systems governed by wave equations - Vibration of strings – vibration of rods - Euler Equation for Beams - Effect of Rotary inertia and shear deformation - Vibration of plates.</p> <p>5. EXPERIMENTAL METHODS IN VIBRATION ANALYSIS  Vibration instruments - Vibration exciters Measuring Devices - Analysis - Vibration Tests - Free and Forced Vibration tests. Examples of Vibration tests - Industrial case studies.</p> <p>6. PRACTICALS</p>			
<b>SUGGESTED READINGS</b>			
<ul style="list-style-type: none"> <li>• Thomson, W.T., "Theory of Vibration with Applications", CBS Publishers and Distributors.</li> </ul>			

- Rao, J.S., & Gupta, K. , "Introductory Course on Theory and Practice of Mechanical Vibrations", New Age International Ltd.
- Den Hartog, J.P. "Mechanical Vibrations", Dover Publication.
- Rao, S.S., "Mechanical Vibrations", Addison Wesley Longman.

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MEC25	Product Design	L-T-P:2-0-4	None
<b>COURSE OUTCOMES (COs)</b> <ul style="list-style-type: none"><li>• To introduce different design disciplines and various steps involved in a design process.</li><li>• To provide a detailed insight to students about engineering design and how it is different from other design disciplines.</li><li>• To introduce various types of mechanical elements like springs, bearings, shafts, brakes, clutches, gears etc. to the students and brief explanation about their manufacturing process.</li><li>• To introduce theories of failure, mechanical properties of material, stress-strain diagram for ductile and brittle materials.</li><li>• Introduction to dynamic stress, calculation of endurance limit.</li><li>• To develop an aptitude among the students that how different products and components that they see in their daily life can be manufactured and fabricated.</li><li>• To provide detailed introduction about different types of permanent and temporary fasteners and calculation of stresses using mathematical equations.</li><li>• To develop ability among students to use the knowledge of mathematics, mechanics of solids and other reengineering disciplines like Computer Aided Design and Finite Element Analysis in solving engineering problems and to have a better design aptitude.</li><li>• After the completion of the course students should develop a know-how that how different mechanical elements can be combined together to develop a simple machine.</li></ul>			
<b>COURSE CONTENT</b> <p>Introduction, development processes and organizations, opportunity identification. Product planning. Identifying customer needs. Product specifications. Concept generation. Concept selection. Concept testing. Product architecture. Industrial design</p> <p>Design for environment. Design for manufacturing. Prototyping. Robust design. Patents and intellectual property. Design of services. Product development economics. Managing projects.</p>			
<b>SUGGESTED READINGS</b> <ul style="list-style-type: none"><li>• Karl T. Ulrich and Steven D. Eppinger, “Product Design and Development”, McGraw-Hill.</li></ul>			

**SYLLABUS OF FOUNDATION ELECTIVES**

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
<b>FE001</b>	<b>Sports-I</b>	<b>0L-0T-4P</b>	<b>None</b>
<b>COURSE OUTCOMES (CO):</b>			
To evolve a higher education system that is suitability blended with provision for knowledge values and skill practice where every student learns in without sacrificing his/her creativity.			
<b>COURSE CONTENT:</b>			
<b>(Any Two out Of 4 Components)</b>			
<b>A. INTRODUCTION TO PHYSICAL EDUCATION IN THE CONTEMPORARY CONTEXT (Any Two)</b>			
<ol style="list-style-type: none"> <li>1. Learn and demonstrate the technique of Suryanamaskar.</li> <li>2. Develop Physical Fitness through Calisthenics / Aerobics / Circuit-Training / Weight-Training and demonstrate the chosen activity.</li> <li>3. Select any one game available in the college and learn different techniques involved in its play</li> </ol>			
<b>B. CORE PHYSICAL EDUCATION-: FITNESS, WELLNESS AND NUTRITION (Any Two)</b>			
<ol style="list-style-type: none"> <li>1. Measurement of Fitness Components – Leg-raise for Minimal Strength (Muscular Strength); Sit-ups Muscular Endurance); Harvard Step Test, Run and Walk Test (Cardiovascular Endurance); Sit and Reach Test (Flexibility)</li> <li>2. Measuring height, weight, waist circumference and hip circumference, Calculation of BMI (Body Mass Index) and Waist-Hip Ratio</li> <li>3. Engage in at least one wellness programme and write a report on it.</li> </ol>			
<b>C. CORE PHYSICAL EDUCATION-: POSTURE, ATHLETIC CARE AND FIRST AID (Any Two)</b>			
<ol style="list-style-type: none"> <li>1. Demonstrate Stretching and Strengthening Exercises for Kyphosis, Scoliosis, Lordosis, Knock Knees, Bow Legs, Flat Foot, Back Pain and Neck Pain</li> <li>2. Illustration and Demonstration of Active and Passive Exercises</li> <li>3. Asanas with Therapeutic Value (Any five asanas): Karnapeedasana, Padmasana, Dhanurasana, Sarvangasana, Paschimottanasana, Chakrasana, Halasana, Matsyasana, Ardhamatsyendrasana, Usthrasana, Mayurasana, Shirshasana, Vajrasana.</li> <li>4. Practice P.R.I.C.E. in First Aid.</li> </ol>			
<b>D. SPORTS ADMINISTRATION &amp; MANAGEMENT (Any Two)</b>			



1. Demonstration of Supervision activities in Sports Management.
2. Demonstration of skills of Management.
3. Demonstration of fixtures of various kinds in sports competitions.
4. Demonstration of technical and non-technical purchase procedure.

**SUGGESTED READINGS:**

1. Graham, G., ``Teaching Children Physical Education : Becoming a Master Teacher. Human Kinetics,`` Champaign, Illinois, USA.
2. Corbin, C. B., G. J. Welk, W. R Corbin, K. A. Welk, ``Concepts of Physical Fitness: Active Lifestyle for Wellness,`` McGraw Hill, New York, USA.
3. Anspaugh, D.J., G. Ezell and K.N. Goodman, `` Teaching Today Health,`` Mosby Publishers
4. Beotra, Alka, ``Drug Education Handbook on Drug Abuse in Sports,`` Applied Nutrition Sciences, Mumbai.
5. Ammon,R., Southall , R.M. and Blair, D.A., ``Sports Facility Management, ``West Virginia, USA: Fitness Information Technology Publishers.

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
<b>FE002</b>	<b>Sports-II</b>	<b>0L-0T-4P</b>	<b>FE001</b>

**COURSE OUTCOMES (CO):**

To evolve a higher education system that is suitability blended with provision for knowledge values and skill practice where every student learns in without sacrificing his/her creativity.

**COURSE CONTENT:**

**(Any Two out Of 4 Components)**

**A. Sports for all (Any Two)**

1. To participate in any intramural Tournaments (one team game and one Individual Game) of choice.
2. To participate/ attend at least 15 hours in Fitness training at Field or at Gymnasium.
3. Participate in at least one track and one field event on Annual Sports day.
4. To participate in Inter College Tournament

**B. MEDIA AND CAREERS IN PHYSICAL EDUCATION (Any Two)**

1. Organize an event / intramural / tournament in your college.
2. Prepare a News Report of an observed Sports competition.
3. Create a presentation on any topic from Physical Education using an audio-visual aid.
4. Demonstrate Warming-up / Conditioning / Cooling-down exercises.

**C. MANAGEMENT OF AEROBICS & GROUP TRAINING (Any Two)**

1. Measurement of Fitness Components – Leg-raise for Minimal Strength (Muscular Strength); Sit-ups (Muscular Endurance); Harvard Step Test or Run and Walk Test (Cardiovascular Endurance); Sit and Reach Test (Flexibility)
2. Measurement of Pulse Rate / Heart Rate at Radial Artery and Carotid Artery, Calculation of Target Heart Rate
3. Developing a 5-10 minute routine of aerobics with appropriate music for each component of health related physical fitness

**D. SPORTS INDUSTRY & MARKETING (Any Two)**

1. Identify an issue or a trend in the sports industry: o Players in professional or college sports o Ownership
2. Marketing Plan: Environmental Factors and Product Plan Draft, Paper bibliography/works cited.
3. Sponsorship proposal
4. Developing a budget plan for an event
5. Athlete branding

**SUGGESTED READINGS:**

1. Covey, S. , `` 7 Habits of Highly Effective People, `` Covey Publications, USA
2. Magill, R.A., `` Motor Learning and Control: Concepts and Applications,`` McGraw Hill Publication.
3. Masteralexis, L.P., C. Barr and M. Humms, ``Principles and Practices of Sport Management,`` Jones and Bartlett Publisher
4. Bishop, J.G., ``Fitness through Aerobics,`` Benjamin Cummings USA.
5. Brown K.M., `` Physical Activity and Health: An Interactive Approach,`` Jones and Bartlett Publisher
6. Cornwell. T.B, `` Sponsorship in marketing: Effective communications through sports, arts and events, `` Routledge Publishers
7. DeGarris, L., ``Sports Marketing: A Practical Approach,`` Routledge Publishers, USA

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
<b>FE003</b>	<b>National Service Scheme (NSS)</b>	<b>0L-0T-4P</b>	<b>None</b>

**COURSE OUTCOMES (CO):**

1. Develop among them a sense of social and civic responsibility;
2. Utilize their knowledge in finding practical solution to individual and community problems;
3. Identify the needs and problems of the community and involve them in problem solving process;
4. Utilize their knowledge in finding practical solution to individual and community problems;
5. Develop capacity to meet emergencies and natural disasters

**COURSE CONTENT:**

**Unit-I Introduction to NSS:** Orientation and structure of NSS, History of Social Reforms in Modern India: Brahma Samaj, Arya Samaj, Satya Shodhak Samaj: Principles and Functions

**Unit-II Regular activities:** Distribution of working hours- association between issues and programs- community project- urban rural activities, association- modes of activity evaluation

**Unit-III concept of society-** development of Indian society: Features- Division of labors and cast system in India; Features of Indian constitution; Provisions related to social integrity and development

**Unit – IV N.S.S. Regular Activities**

A) College campus activities

B) N.S.S.activities in Urban and Rural areas

C) Role of Non-Government Organisation (NGO) in social Reforms

i) Red Cross

ii) Rotary

**SUGGESTED READINGS:**

1. National Service Scheme Manual, Govt. of India
2. Training Programme on National Programme scheme, TISS.
3. Orientation Courses for N.S.S. programme officers, TISS.
4. Ram Ahuja, ``Social Problems in India,`` Rawat Publication.
5. History of Social Reforms in Maharashtra, Ed. J. Y. Bhosale, S. U. Kolhapur.

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
<b>FE004</b>	<b>National Cadet Corps (NCC)</b>	<b>0L-0T-4P</b>	<b>None</b>
<b>COURSE OUTCOMES (CO):</b>  1. Develop among them a sense of social and civic responsibility; 2. Utilize their knowledge in finding practical solution to individual and community problems; 3. Identify the needs and problems of the community and involve them in problem solving process; 4. Utilize their knowledge in finding practical solution to individual and community problems; 5. Develop capacity to meet emergencies and natural disasters;			
<b>COURSE CONTENT:</b>  <b>UNIT I: Introduction to NCC, National Integration &amp; Awareness:</b> Religions, Culture, Traditions and Customs of India, National Integration: Importance and Necessity, Freedom Struggle.  <b>UNIT II: Adventure Training:</b> – Obstacle course, Slithering, Trekking, Cycling, Rock Climbing, Para Sailing, gliding, Scuba Diving- methods and use.  <b>UNIT III: Environment Awareness and Conservation: Natural Resources</b> – Conservation and Management. Water Conservation and Rainwater Harvesting  <b>UNIT IV: Personality Development and Leadership:</b> Introduction to Personality Development, Factors Influencing /Shaping Personality: Physical, Social, Physiological, Philosophical and Psychological, Self Awareness Know yourself/ Insight, Change Your Mind Set, Communication Skills: Group Discussion / LECTURETTES (Public Speaking), Leadership Traits, Types of Leadership			
<b>SUGGESTED READINGS:</b>  1. Bhogle Anita & Bhogle Harsha, ``The Winning way, Learning from sports for managers,`` Westland Publications 2. Sharma Robin, `` The leader had no title, `` Simon and Schuster Ltd.			

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
<b>FE005</b>	<b>Corporate social responsibilities</b>	<b>2L-0T-0P</b>	<b>None</b>
<b>COURSE OUTCOMES (CO):</b>  1. The course will help students to understand corporate and emerging social responsibility for the corporate in reference to India and global situation 2. The course will support students to prepare themselves to work with corporate understanding collective aspiration of the society, individual and corporate social responsibility.			
<b>COURSE CONTENT:</b>  <b>UNIT I:</b> Corporate social responsibility in Indian context and International: CSR – Definition, concepts, Approaches of CSR, overview of corporate social responsibility and corporate social accountability, SR Tools, National and International CSR activities, corporate philanthropy, drivers of CSR, difference between corporate governance, corporate philanthropy and CSR  <b>UNIT II:</b> Business ethics and corporate social responsibility: Concept of business ethics – meaning, Importance and factors influencing business ethics. Corporate Governance – meaning, significance, principles and dimensions. Ethical decision – making in different culture, consumer protection, environment protection, gender issues in multiculturalism, ethics and corruption, ethics and safety. Business benefits of CSR  <b>UNIT III:</b> Legislative measures of CSR: Corporate, labor, stake holders, Environmental and pollution. Social Accounting, Social Auditing, SA: 8000 and Corporate Social Reporting.			
<b>SUGGESTED READINGS:</b>  1. Harsh Srivastava, `` The business of social responsibility,`` books for change 2. CV. Baxi and Ajit Prasad,`` Corporate social responsibility – concepts and cases,`` Excel Books 3. Dr. M. Mahmoudi,`` Global strategic management,`` Deep & Deep Publications Pvt. Ltd. 4. S K. Bhatia,`` International Human resource management – Global perspective,`` Deep & Deep Publications Pvt. Ltd. 5. J.P. Sharma, ``Governance, Ethics and Social responsibility of business, `` Ane books Ltd. 6. Kotler Philip and Lee Nancy, `` Corporate social responsibility; doing the most good for your company,`` John Wiley 7. Simpson, Justine and Taylor, John R, `` Corporate Governance Ethics and and CSR,`` Kogan Page Publishers			

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
<b>FE006</b>	<b>Environmental Sciences</b>	<b>2L-0T-0P</b>	<b>None</b>

**COURSE OUTCOMES (CO):**

1. Recognize major concepts in environmental sciences and demonstrate in-depth understanding of the environment.
2. Develop analytical skills, critical thinking, and demonstrate problem-solving skills using scientific techniques.
3. Demonstrate the knowledge and training for entering graduate or professional schools, or the job market.

**COURSE CONTENT:**

**UNIT I: Environmental Studies: Ecosystems, Bio-diversity and its Conservation**

(i) The Multidisciplinary Nature of Environmental Studies Definition, scope and importance of Environmental Studies. Biotic and a biotic component of environment, need for environmental awareness.

(ii) Ecosystems: Concept of an ecosystem, structure and function of an ecosystem, producers, consumers and decomposers, energy flow in the ecosystem, ecological succession, food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structures and function of different ecosystem

(iii) Bio-diversity and its Conservation: Introduction to biodiversity —definition: genetic, species and ecosystem diversity, Bio-geographical classification of India, Value of biodiversity: Consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, national and local levels, India as a mega-diversity nation, Hot-spots of biodiversity, Threats to biodiversity : Habitat loss, Poaching of wildlife, man wildlife conflicts, rare endangered and threatened species(RET) endemic species of India, method of biodiversity conservation: In-situ and ex-situ conservation.

**UNIT II: Natural Resources: problems and prospects**

(i) Renewable and Non-renewable Natural Resources

Concept and definition of Natural Resources and need for their management



- Forest resources: Use and over-exploitation, deforestation, case studies, timber extraction, mining, dams and their effects on forests and tribal people.
- Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems, Water conservation, rain water harvesting, watershed management.
- Mineral resources: Uses are exploitation, environmental effects of extracting and using mineral resources, case studies.
- Food resources: World food problems, changes causes by agriculture and over-grazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.
- Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, Urban problems related to energy, case studies.
- Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

**UNIT III: Environmental Pollution Control:** Environmental Pollution, Definition, types, causes, effects and control measures of (a) Air pollution, (b) Water pollution, (c) Soil pollution, (d) Marine pollution, (e) Noise pollution, (f) Thermal pollution. Nuclear hazards. Solid waste and its management: causes, effects and control measures of urban and industrial waste.

**UNIT IV:** Disaster Management, Social Issues, Human Population and the Environment. Social Issues, Human Population and the Environment, Sustainable development, Climate change, global warming, acid rain, ozone layer depletion, Environmental ethics: Issues and possible solutions, Consumerism and waste products, , Wasteland reclamation. Population growth, problems of urbanisation.

**SUGGESTED READINGS:**

1. E. Barucha, `` Textbook of Environmental Studies for Undergraduate Courses,`` Universities Press (India) Pvt. Ltd.
- 2 . S. Chawla, `` A Textbook of Environmental Studies,`` McGraw Hill Education Private Limited.

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
<b>FE007</b>	<b>Environmental Development and Society</b>	<b>2L-0T-0P</b>	<b>None</b>
<b>COURSE OUTCOMES (CO):</b>  <ol style="list-style-type: none"><li>1. To sensitize the students regarding the relationship between human society and ecosystem.</li><li>2. To help students understand the various approaches to the study of environment and ecosystem.</li><li>3. To create awareness among the students regarding environmental degradation and the importance of development and sustainable Development.</li></ol>			
<b>COURSE CONTENT:</b>  <b>UNIT I. Basic Issues and Approaches</b>  <ol style="list-style-type: none"><li>a. Importance of the study of ecology and society</li><li>b. The relation between Environment and Development</li><li>c. Conceptual clarifications: social ecology; sustainable development; sustainability.</li><li>d. Approaches: Realism, Appropriate Technology, Ecofeminism</li></ol> <b>UNIT II. People and Natural Resources: Unequal Access and Shrinking Commons</b>  <ol style="list-style-type: none"><li>a. Water: depleting water resources &amp; pollution; unequal distribution of water –(utilization of water for commercial crops, industrial use, power generation), the big dams debate.</li><li>b. Forest: Colonial policy, diverting resources for mining and other commercial and industrial use, monoculture and loss of biodiversity, rights of forest dwelling communities.</li><li>c. Land: modern technology, green revolution, biotechnology and impact on land, shrinking commons and its effects on rural poor.</li></ol> <b>UNIT III. Environmental issues and Problems.</b>  <ol style="list-style-type: none"><li>a. Environmental Pollution: Air, Water, Noise, Land and Radioactive Pollution</li></ol>			

- b. Problems of urban environment (pollution, health, industrial accidents (e.g. Bhopal), occupational hazards)
- c. Climate change/Global warming.

**UNIT IV. Role of Environmental Movements and the State.**

- a. Environmental Movements in India – Chipko, Narmada Bachao Andolan, Chilka Lake Orissa, are some examples.

**SUGGESTED READINGS:**

1. Chandna R.C, `` Environmental Awareness,`` Kalyani Publishers.
2. Agarwal S.K, `` Environmental Issues and Themes,`` APH Publishing corporation.
3. Barry John, `` Environment and social theory,`` Routledge.
4. Gadgil, Madhav and Ramachandra Guha, `` Ecology and Equity: The use and Abuse of Nature in contemporary India,`` OUP.
5. Gole Prakash, `` Nature conservation and sustainable development in India,`` Rawat publications .

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
<b>FE008</b>	<b>Spoken Skills in English</b>	<b>2L-0T-0P</b>	<b>None</b>
<b>COURSE OUTCOMES (CO):</b>  <ol style="list-style-type: none"><li>1. This course will focus on oral &amp; presentation skills of students with practice sessions in the language lab.</li><li>2. This course will develop confidence building in oral skills of learners.</li><li>3. It will seek to encourage the day to day conversations/dialogues and communicative needs of learners with ample practice in the lab.</li><li>4. The theory class will boost practice in ample language exercises to encourage oral skills.</li><li>5. This will also involve practice sessions in interview skills, group discussions &amp; pair work.</li><li>6. Basics of communication</li></ol>			
<b>COURSE CONTENT:</b>  <ul style="list-style-type: none"><li>• Practice on listening and reading comprehension</li><li>• Language lab practice for group discussion and interviews</li><li>• Definition and discussion on communication &amp; the barriers in communication with practical training to use language as a tool for sharing, discussing, handling and convincing others.</li></ul>			
<b>SUGGESTED READINGS:</b>  Everyday English I & II Cambridge University Press/Foundation books			

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
<b>FE009</b>	<b>Financial Literacy</b>	<b>2L-0T-0P</b>	<b>None</b>

**COURSE OUTCOMES (CO):**

1. To provide in-depth knowledge of the banking and Principles of Investment, financial planning.
2. Help students in understanding stocks, sell strategy, mutual fund options, investing in education, planning for the future, purchasing your first home, taxes and tax planning, life insurance options, health insurance, property insurance, estate planning, and keeping money in perspective.

**COURSE CONTENT:**

**UNIT I: Banking-** Definition, Role of Bank in growth of saving and Investment, Types of banks , Services offered by banks, Deposits and Loans, Types of A/c, Opening a bank A/c, How to Transact with banks, KYC norms, (A/c opening form, Address Proof), How to read bank statement, Banking products and services, Calculating Interests – Saving, FD, Simple and Compound Interest, Power of compounding Loans, Types of loans, taking a home loan, Definition of EMI, Calculation of EMI, Post office-Account and transactions, Basic of foreign Exchange, Importance and Use of Foreign Exchange, Regulator Role of RBI, mutual funds.

**UNIT II: Investment:** Principles of Investment – Safety, Liquidity and Return, Investment plans, Hybrid plans-Ulip, SIP and VIP of mutual funds, index funds

**UNIT III: Financial Planning-** Meaning, Household financial health checkup, Important life stages, Medical and other Emergencies, ; Insurance, Meaning, Need and Wants, Loss protection, Life, non-life and health, Benefits of Insurance, Term plans, Social obligations Budgeting, Buying a house, Plan a vacation, Retirement planning, Price of procrastination, Market and financial instruments, Primary market, Secondary market, Financial Statement analysis,

**UNIT IV: Scams, Fraud Schemes-**Insider trading, Money laundering; Consumer protection and redressal mechanism, Rights of Consumers, Applicable to financial services, Filing a complaint, Complain to entity concerned, Regulators, Arbitration, Consumer courts, Govt. Websites-(PG Portals), Investor Associations, Taxes, Meaning, Need of Taxes, Types of taxes, How taxes impact income, Income, wealth and gift tax, Service tax, STT, Stamp Duty, Tax planning v/s tax evasion, Tax rates, Tax free bonds, Tax saving investment

**SUGGESTED READINGS:**

1. Braunstein, Sandra, and Carolyn Welch, `` Financial literacy: An overview of practice, research, and policy," Fed. Res. Bull.
2. Cole, Shawn A., and Gauri Kartini Shastry, `` Smart money: The effect of education, cognitive ability, and financial literacy on financial market participation," Harvard Business School, 2009.
3. Study material of NSE.
4. Gitman, joehnk and Billingsley, `` Personal financial planning," Cengage Learning
5. Madura Jeff, `` Personal finance student edition," Prentice Hall PTR.

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
<b>FE010</b>	<b>Introduction to Indian Society</b>	<b>2L-0T-0P</b>	<b>None</b>
<b>COURSE OUTCOMES (CO):</b>  To acquaint the students with the emergence and understanding of Indian Society, theoretical underpinnings of the complexity of society and also with the whole discourse contextualizing Sociology in India.			
<b>COURSE CONTENT:</b>  <b>1. Unit –I Conceptualizing Indian Society:</b> Hindu society and Diverse society ( Regional, Linguistic, Religious diversities); Peoples of India-  Groups and Communities ; Unity in diversity; Ethnicity and ethnic identities.  <b>2. Unit –II Theoretical perspectives I:</b> Indological/ Textual (G.S. Ghurye, L. Dumont Structural – Functional M.N. Srinivas, S.C. Dube).  Marxian (D.P. Mukherjee, A.R. Desai)  <b>3. Unit –III Theoretical perspectives II:</b> Civilizational view (N.K. Bose, Surajit Sinha). Subaltern perspective (B.R. Ambedkar, David Hardiman).			
<b>SUGGESTED READINGS:</b>  1. Robert W. Stern, `` Introduction: Change, the societies of India and Indian society'' Cambridge University Press 2. Dhanagare. D.N,`` Themes and perspectives in Indian sociology,`` Rawat Publication. 3. Dube. S.C.`` The Indian Villages,`` R and K Publication 4. Dumont. Louis Homo Hyerrchicus,`` The Caste System and its implications,`` Vikas publications. 5. Hardiman, David,`` The coming of the Devi :Adivasi Assertion in western India,`` Oxford University Press. 6. Marrott. Mckim,`` India through Hindu categories ,`` Sage publication. 7. Momin. A. R,`` The legacy of G.S. Ghurye. A cemennial festschrift,`` Popular prakashan.			

8. Mukherjee. D.P, `` Diversities,`` Peoples publication house.
9. Singh. Y, `` Indian Sociology social conditioning and emerging concerns,`` Vistaar publication.
10. Singh. Y, `` Modernisation of Indian tradition,`` Thomson press.
11. Singh. K.S. `` The Peoples of India. An introduction,`` Seagull books.
12. Srinivas. M.N, `` India's Villages,`` Asia publishing house.
13. Singh Y, `` Identity & Theory in Indian Sociology,`` Rawat Publication.



<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
<b>FE011</b>	<b>Soft Skills and Personality Development</b>	<b>1L-0T-2P</b>	<b>None</b>
<b>COURSE OUTCOMES (CO):</b> Enable students to develop a basic English workplace vocabulary, comprehend sentences spoken or written in English and enables them to confidently converse in simple English.			
<b>COURSE CONTENT:</b> <b>Unit 1:</b> Conceptual Understanding of Communication; Cognition and Re-Cognition; Types of communication: Oral, Verbal, Non-verbal, Kinesics, Interpersonal, Group and Mass Communication, Communion, Barriers to communication; Values and Belief system. <b>Unit 2 :</b> Spoken Communication; Art of debating, Elocution, Stage Anchoring, Group Discussion; Interviews; Quiz; Use of Jargon, Slangs and Vocabulary for effective Communication; Voice Modulation and Intonation; Clarity; Brevity; Articulation of thought and speech; Assertiveness; Affirmation. <b>Unit 3 :</b> Written Communication, KISS rule; Resume writing; Letter writing; Taking notes; Recording minutes and preparing proceedings of meetings; Role of empathy and compassion. <b>Unit 4 :</b> Self-assessment; Self awareness; Self-esteem, Self-confidence; Perception and observation skills; Benefits of Meditation and Self-Hypnosis, Goal setting and career planning. Practical: Debate, Declamation; Presentation exercises and written communication exercises.			
<b>SUGGESTED READINGS:</b> 1. Barker. A, `` Improve Your Communication Skills,`` Kogan Page India Pvt Ltd. 2. Adrian Doff and Christopher Jones, `` Language in Use (Upper-Intermediate),`` Cambridge University. 3. John Seely, `` The Oxford Guide to Writing and Speaking,`` Oxford University Press. 4. Shiv Khera, `` You Can Win,`` Macmillan Books.			

5. Stephen Covey, `` 7 Habits of Highly Effective People,`` Simon and Schuster
6. John Collin, `` Perfect Presentation ,`` Video Arts Marshal.
7. Jenny Rogers, `` Effective Interviews,`` Video arts Marshal.
8. Robert Heller, `` Effective Leadership: Essential Manager Series,`` DK Publishing.

Course No.	Title of the Course	Course Structure	Pre-Requisite
FE012	<b>Business Communication and Presentation Skills</b>	<b>1L-0T-2P</b>	<b>None</b>
<p><b>COURSE OUTCOMES (CO):</b></p> <p>To develop management communication skills in the students that will help the students to face future endeavors and will also help in their interviews.</p>			
<p><b>COURSE CONTENT:</b></p> <p><i>Unit-I:</i></p> <p><b>Identity Management Communication:</b>– Face to Face Impression Management &amp; Mediated Communication (Self Introduction &amp; Self-Promoting– Over Stating And Under Stating – Strategies to Overcome Communicative Inhibitions – Creating Positive Self-image through words - Appearance- Verbal and Non Verbal Manners) – Giving Polite Yet Assertive Responses – Responsive strategies to handle criticism - Accepting Failure and Declaring Success.</p> <p>Unit-II</p> <p><b>Business Presentations:</b>– Oral and Power Point Presentations; Preparing Successful Presentations; Assessing Audience, Making Effective Use of Visual Aids, Delivering Presentation, Using Prompts, Handling With Questions and Interruptions, Mock Presentations.</p> <p>Unit-III</p> <p><b>Oratory Skills:</b> – Group Discussion, Extempore, Mock Parliament and Mock Press.</p> <p>Unit-IV</p> <p><b>Interview Management:</b> – Resume Preparation, Types of Interviews, Preparing For Interviews, Facing Interviews, Handling Tough &amp; Tricky Questions, Reviewing Performance, Participating In Mock Interviews</p>			
<p><b>SUGGESTED READINGS:</b></p> <ol style="list-style-type: none"> <li>1. Lori Harvill Moore, `` Business Communication,`` Bookboon.</li> <li>2. John Thill, Courtland L. Bovee , `` Excellence in Business Communication,`` Pearson Prentice Hall</li> </ol>			

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
<b>FE013</b>	<b>Theatre</b>	<b>0L-0T-4P</b>	<b>None</b>
<b>COURSE OUTCOMES (CO):</b>  Our goal is to nurture artist-scholars who are well read in dramatic literature, who understand the social and historical contexts of that literature, who appreciate contemporary performance and dance, who think critically, who master discipline-specific skills, and who make compelling artistic choices on stage.			
<b>COURSE CONTENT:</b>  <b>Unit 1 :</b> Concept of Acting in Indian Classical theatre. Western styles of theatre acting.  <b>Unit 2 :</b> Basics of the following: Acting in Grotowski’s Poor Theatre, Modern concept of Actor training with reference to Meyerhold, Bertold Brecht and Constantin Stanislavsky; Artaudian acting, Theatre of Cruelty; Theatre of Absurd.  <b>Unit 3 :</b> Acting for Camera –Knowledge of camera frames and movement within the confines of a frame, blocking, difference between theatre and Camera acting, Concentration.  <b>Unit 4 :</b> Acting consistently for different takes, acting scenes out of order, Auditions, acting exercises. Art of Dubbing.			
<b>SUGGESTED READINGS:</b>  1. Boleslavsky, Richard, `` Acting: the First Six Lessons,`` New York Theatre Arts. 2. Hagen, Uta, `` Respect for Acting,`` Macmillan Press. 3. Hodge, Alison, `` Twentieth Century Actor Training,`` London and New York. 4. Routledge ,Stanislavski, Konstantin, `` An Actor’s Work: A Student’s Diary,`` Trans. and ed. Jean 5. Jeremiah Comey , `` The Art of Film Acting,`` Focal Press . 6. Philips B Zarrilli, `` Acting (Re) Considered,`` Routeledge . 7. Cathy Hassey, `` Acting for Film,`` Allworth Press			

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
<b>FE014</b>	<b>Dance</b>	<b>0L-0T-4P</b>	<b>None</b>

**COURSE OUTCOMES (CO):**

This course will provide the student with the fundamentals necessary for advanced dance skills. Further, this course will develop student appreciation of dance as an art form and lifetime activity. Designed to familiarize students with technique, the student will also study vocabulary, different forms of dance, issues in dance and the history pertaining to the world of dance. The student will develop kinesthetic awareness, movement memory, creative abilities and aesthetic appreciation of various dance forms. The enhancement and the development and maintenance of physical fitness, self-confidence, self-discipline and independence with the body by providing informal showings during class are the goals expected to be achieved. Each student should leave this class having been encouraged, esteemed, and take with them a new appreciation of dance.

**COURSE CONTENT:**

- Basic workout
- Introduction to Hip Hop and B-Boying with a simple choreography
- Exercise like: Rolling, jumping, moving shoulders. Footwork, Floor steps, Beat knowledge.
- Freestyle combination along with House dance style.
- Expressions class: Body expressions, Face expressions.
- Introduction of Contemporary Dance. Basic exercise of Contemporary Dance. Exercise for flexibility, Floor steps, Spinning and Balancing.
- Introduction to Jazz. Basic exercise and proper routine practice.

**SUGGESTED READINGS:**

1. Jonathan Burrows, ``A Choreographer's Handbook,`` Routledge
2. Jacqueline M. Smith-Autard, ``Dance Composition: A Practical Guide to Creative Success in Dance Making,`` Routledge

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
<b>FE015</b>	<b>Yoga</b>	<b>0L-0T-4P</b>	<b>None</b>
<b>COURSE OUTCOMES (CO):</b> Students will learn about the importance of yoga in their lives. They will be exposed various types of yoga, their health benefits.			
<b>COURSE CONTENT:</b> <b>UNIT-I</b> Origin of Yoga & its brief development, Meaning of Yoga & its importance, Yoga as a Science of Art (Yoga Philosophy), Meaning of meditation and its types and principles. <b>UNIT- II</b> Classification of Yoga/Types of Yoga, Hatha Yoga , Raja Yoga, Laya Yoga, Bhakti Yoga, Gyan Yoga, Karma Yoga, Asthang Yoga. <b>UNIT –III</b> Principles of Yogic Practices, Meaning of Asana, its types and principles, Meaning of Pranayama, its types and principles, Meaning of Kriya its types and principles. <b>UNIT -IV</b> Yogic therapies and modern concept of Yoga, Naturopathy, Hydrotherapy, Electrotherapy, Messotherapy, Acupressure, acupuncture, Meaning and importance of prayer, Psychology of mantras, Different mudras during prayers.			
<b>SUGGESTED READINGS:</b> 1. William Broad, `` The Science of Yoga: The Risks and the Rewards,`` Simon and Schuster 2. Swami Vishnu Devananda, `` The Complete Illustrated Book of Yoga,`` Harmony			

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
<b>FE016</b>	<b>Digital Film Making</b>	<b>0L-0T-4P</b>	<b>None</b>
<b>COURSE OUTCOMES (CO):</b>			
Students will learn about various technicalities involved in digital film making. They will also expose to history of cinema, preproduction etc.			
<b>COURSE CONTENT:</b>			
<b>Unit 1 – History of Cinema, Research &amp; Script</b>			
Early Cinema, Development of Classical Indian & Hollywood Cinema, History of Global Film including European Film (1930-present), Origin of Classical narrative cinema-Soundless film, Exploration of film and analysis of the three-part beginning, middle and end of story, <b>Research</b> (Finding and Collecting materials and facts related to your story. Where and How to find the materials related to your story. Things to consider before sketching down your story), <b>Script (Scriptwriting Process and its various phases), Film Grammar for Scriptwriting.</b>			
<b>Unit 2 – Pre-Production</b>			
<b>Digital Video Cinematography:</b> Introduction to Digital Video Cinematography Cinematography, Interactivity and emotions through Cinematography, Building blocks, Compositions, Lenses and Cameras, Types of lenses: Zoom Lens, Prime Lens, Types of Cameras: HD Cameras, Basics of Film Camera, Difference between, Film Camera and Digital Camera, DSLR and HD SLR Cameras, Lighting, Psychology of light, Visual Environment, Directional Effect of Light, Lighting design process, Three-point lighting, High-Key lighting, Low Key lighting, Construction of a Shot, Color, Contrast, Deep Focus, Shallow Focus, Depth of Field, Exposure, Racking focus, Frame Rate, Telephoto shot, Zoom shot.			
<b>Unit 3- Digital Video Editing</b>			
Effective Editing, Principles of Video Editing, Non-Linear Editing (NLE) Concept, The Three-Point Edit, Non-Linear Editing (NLE) Techniques, Working in the Timeline, Transitions, Key framing, Applying Filters, Ingesting.			
<b>Unit-4Advanced Editing Techniques</b>			
NLE Compositing, Color Correction & Color Grading, Working on Audio, Titling			
<b>SUGGESTED READINGS:</b>			
1. Mark Brindle and Chris Jones, `` The Digital Filmmaking Handbook,`` Quercus			

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
<b>FE017</b>	<b>Workshop (Electrical and Mechanical)</b>	<b>0L-0T-4P</b>	<b>None</b>
<b>COURSE OUTCOMES (CO):</b>  1. Student will be able to make various joints in the given object with the available work material. 2. The students will be able to understand various wiring connections			
<b>COURSE CONTENT:</b>  <b>Mechanical Workshop Experiments</b>  1. BLACKSMITH  2. CARPENTRY  3. FITTING  4. FOUNDRY  5. WELDING <b>Electrical workshop Experiments</b> 1. STUDY & PERFORMANCE OF DIFFERENT TYPES OF WIRE JOINTS  2. STUDY AND PERFORMANCE OF STAIRCASE WIRING  3. STUDY AND PERFORMANCE OF SERIES AND PARALLEL CONNECTION OF FLOURESCENT TUBE LIGHT  4. STUDY AND PERFORMANCE OF GODOWN WIRING  5. SERIES AND PARALLEL CONNECTION OF BULBS AND POWER SOCKETS BY SINGLE SWITCH AND MULTI SWITCHES.			



**SUGGESTED READINGS:**

1. Hajra Choudhury, Hazra Choudhary and Nirjhar Roy, ``Elements of Workshop Technology, vol. I, `` Media promoters and Publishers Pvt. Ltd.
2. W A J Chapman, Workshop Technology, `` Part -1, 1st South Asian Edition,`` Viva Book Pvt Ltd.
3. P.N. Rao, ``Manufacturing Technology, Vol.1,`` Tata McGraw Hill
4. Kaushish J.P., `` Manufacturing Processes, `` Prentice Hall

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
<b>FE018</b>	<b>Music</b>	<b>0L-0T-4P</b>	<b>None</b>
<b>COURSE OUTCOMES (CO):</b>  The student will be familiarized with the basic terms used in Indian classical music. Also it familiarizes with the life history of some dignitaries in the field of music. This course also throws some light on the ancient music and its origins in India.			
<b>COURSE CONTENT:</b>  <b>Unit 1 :</b> Study of the following terms:- Mela (Thāt), ĀshrayRāga, Rāga, Lakshana, Shruti, Alankar, Gamak, Vadi-SamvādiAnuvādi-Vivādi, Vakraswara, Varjit-Swara.  <b>Unit 2 :</b> Biographies & contributions of the following:- Jaidev, MansinghTomar, Abdul Karim Khan, Tyagaraja, Pt. Bhatkhande, Pt. Ravi Shankar  <b>Unit 3 :</b> Study of following Rāgas&TālaRāga- Yaman, Jaunpuri, Khamaj. Tāla- Ektāl, Jhaptāl  <b>Unit 4 :</b> General discussion and definition of the following:-  a. Khyāl, MaseetKhani – Razakhani gat, Dhrupad, Tarana, Meend, Soot, Murki, Kan, Khatka, Krintan, Harmony, Melody.  b. Writing of Bhatkhande Swarlipi Paddhati.  c. Writing of Tālasand Compositions in Notation.  d. Detailed study of Rāgas (Rāga- Bihag, Malkauns, Vrindavani Sarang) and comparative study of Rāgas.  e. Essay, Shastriya Sangeet (Classical Music) & SugamSangeet( Light Music )  <b>Unit 5 :</b> Vedic Music – Samvedic Sangeet, Swara, Vadya, Bhakti, Vikār .  General study of Natyashastra, SangeetRatnakar.			
<b>SUGGESTED READINGS:</b>  1. Vasant and Laxmi Narayan Garg, `` Sangeet Visharad,`` Sangeet Karyalay			

2. Sarat Chandra Pranjpayee and Chowbhamda ,`` BhartiyaSangeetkaltihas,`` Surbharti Prakashan
3. Bharat Muni,`` NatyaShastra,``
4. Sharangdeva ,`` SangeetRatnakar,``
5. Sharad Chandra Pranjpayee ,`` Sangeet Bodh,``
6. Thakur Jaidev Singh ,`` Indian Music,`` Sangeet research academy
7. V. N. Bhatkhande,`` Mallika Part II & III,`` KramikPustak.
8. V. N. Patwardhan,`` RaagVigyan,``
9. RaginiTrivedi,`` Ragvibodha Mishrabani, Vol. I & II,``

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
<b>FE019</b>	<b>Sociology of Development</b>	<b>2L-0T-0P</b>	<b>None</b>
<b>COURSE OUTCOMES (CO):</b>  The course introduces the students to the issues pertaining to development in the contemporary context. It familiarizes and discusses the theories and models of development and their alternatives and critiques. It also introduces the concept of social exclusion that has emerged in the development discourse in the era of globalization.			
<b>COURSE CONTENT:</b>  <ol style="list-style-type: none"><li>1. Concepts Progress, Growth, Modernization and Development</li><li>2. Development Theory Adam Smith, Karl Marx, Talcott Parsons.</li><li>3. Development of Underdevelopment, Dependency and World Capitalist System- A.G.Frank, Paul Baran, Samir Amin, Immanuel Wallerstein.</li><li>4. Critique and Alternative to Development</li><li>5. Gender and Development, Culture and Development, Environment and Development, Human Development Index, Gender Development Index Gandhi and Schumacher on Alternative development model Appropriate Technology, Sustainable Development</li><li>6. Understanding India's Development Debate on the Development Model in India: Nehru, Gandhi, Ambedkar,</li><li>7. New Economic Policy</li><li>8. Disparities in Development: Class, Caste, Gender, Tribe, Region and Religion</li><li>9. Social Exclusion in the era of Globalization</li><li>10. Social Exclusion: Minorities and the other Marginalized Development of the Marginalized: Perspectives and Challenges</li></ol>			
<b>SUGGESTED READINGS:</b>  <ul style="list-style-type: none"><li>• Debal K. Singha Roy, `` Social Development and the Empowerment of Marginalized Groups,`` Sage Publications</li><li>• Desai, A.R., `` Essays on Modernisation of Underdeveloped Societies Vol I and II,`` Thacker and Company Ltd.</li><li>• Dereze Jean and SenAmartya, `` India Development and Participation,`` Oxford University Press.</li><li>• Preston, P. W., `` Development Theory An Introduction,`` Blackwell Publishers, Oxford.</li></ul>			

Course No.	Title of the Course	Course Structure	Pre-Requisite
FE020	Universal Human Values 1: Self and Family	2L-0T-0P	None

**COURSE OUTCOMES (CO):**

**1. Sensitization of student towards issues in all dimensions of life**

There are a whole range of issues which one faces in life towards which the young students are generally unfamiliar and therefore insensitive. Almost all the concerns - environmental, societal, familial or personal, are result of human action. Sensitization towards them therefore is an important step.

**2. Inculcation of Self Reflection.**

Human action is governed by various internal factors primarily the beliefs one holds, and therefore 'looking-in' becomes essential, to see what beliefs one is holding, whether they are really true or not, if they are not true, then what could be the process to get the "right" belief and then further validate it.

Most of the young people are somehow trained to look only —outsidell. The motivation and the skill to look inside are missing. Inculcation of self reflection in students will result in them becoming more responsible, honest and trustworthy. Lack of such dualities in individuals is major concern of organizations, institutions and society in general.

**3. Understanding (Clarity) of Human Relationships and Family.**

It will try to show that relationships and material prosperity are the basic desire for a human being. Two global problems which we face today are war (including terrorism) and imbalance in nature (global warming). If we look at reasons for war, the fundamental cause is: Human Being is in opposition to other Human Being. Therefore one is willing (or gets compelled) to exploit others. This is due to lack of understanding of relationships.

**4.Exposure to Issues in Society and nature (larger manmade systems and Nature).**

- To show that the fundamental reasons for imbalance in nature are: pollution and resource depletion. Both these aspects are result of consumerist model of development.

- To show how harmony can be ensured at following levels of our living: Individual, human –human relationships, larger society, Various social systems like education system, economic system, political system and others, and rest of the nature.

**5. Development of Commitment and Courage to Act.**

If the understanding is right, then the actions become right. Commitment and courage to act are considered consequences of right understanding in an individual. In the course, an attempt will be made to build right understanding in the individual, and then further plan of actions will also be discussed in order to implement the understanding in various life situations in the right manner.

**At the end of the course, students are expected to become more aware of their self and their relationships and would have better reflective and discerning ability. They would also become more sensitive to their surroundings including both people and nature, with commitment towards what they believe in (human values).**

**It is hoped that they would be able to apply what they have learnt to their own self in different ordinary day-to-day settings in real life with higher commitment and courage.**

**COURSE CONTENT:**

1. Motivation and Objectives of Human Values Course.

Introduction to the objectives of the course. Content and process of the course including mode of conduct. Daily life as lab for the course. Activities in the course.

2. Purpose of Education How human being has a need for Knowledge, what should be the content of knowledge, how the content should be discussed in education. Complimentarily of skills and values, how the current education system falls short.

3. Peers Pressure, Social Pressure In various dimensions of life, how do these things work. What is the way out? In the context of education, peer pressure etc. movie —TaareZameen Parl can be used.

4. Concept of Competition and Excellence How competition leads to degradation of self and relationships. How excellence is the basic need of a human being. What is excellence? Movie —Fearlessll can be used to discuss the concept.

5. Time Management:

How does one deal with myriads of activities in college? Focus of the mind.

6. Concept of Preconditioning. How preconditioning affects our thinking, behavior, work,

relationships, society and nature. How do we develop pre-conditioning?

What are the various sources of preconditioning? How do we evaluate our Preconditioning?

How do we come out of it?

7. Concept of Natural Acceptance in Human Being. What is natural acceptance? How can the concept of natural acceptance be used to evaluate our preconditioning. Universal nature of natural acceptance. Are anger, jealousy, hatred natural? How do we feel when we experience them? Which feelings are natural for a human being and which are not?

8. Understanding Relationships.

a) Are relationships important? What is the role of relationships in our life? If relationships are important then why they are important? If they are important then why it is the case that we are not discussing them?

What are the notions/conditions and factors which stop us to explore more into relationships. Relationships in family and extended family. Dealing with anger. Show film —Right Here, Right Nowl.

b) Basic expectations in relationships. Seven types of relations.

c) Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.

d) Nine universal values in human relationships. Trust as the founding value.

e) Concept of acceptance. Unconditional acceptance in relationships.

f) Our preconditioning affecting our relationships. Our relationships with subordinate staff, with people of opposite gender, caste, class, race. Movie —Dharmll(set in Varanasi) can be used to show the conflict between reconditioning and relationships. How relationships have the power to force a person to change his preconditioning.

9. Concept of prosperity

Material goods and knowledge of one's physical needs is essential for feeling of prosperity. What role others have played in making material goods available to me: Identifying from one's own life.

10. Idea of Society. What is a society? What constitutes a society? What systems are needed for a society to work? What is the purpose of society and various systems which are working in it? How understanding of Human Nature is important in order to understand the purpose of Society and various social systems? And what happens when this understanding is lacking?

11. Idea of decentralization of politics, economics, education, justice etc. Its comparison with centralized systems. The idea of Swaraj. Various social initiatives by NGOs, social organizations and other people. (If time permits)

12. Balance in nature

a) Balance which already exists in nature.

b) How human beings are disturbing the balance. Resource depletion and pollution.

Our own role in wastage of electricity, water and in use of plastics. Waste management.

(Show episode on city waste from Satyameva Jayate 2.)

c) Issues like global warming, animal extinction. Show —Story of Stuff documentary film.

—Home film can also be used.

**SUGGESTED READINGS:**

1. Annie Leonard, `` The Story of Stuff,`` Free Press
2. Mohandas Karamchand Gandhi, `` The Story of My Experiments with Truth,`` Beacon Press
3. J Krishnamurthy, `` On Education,`` Official repository
4. Hermann Hesse ,`` Siddhartha,`` Bantam Books
5. ThichNhatHanh, `` Old Path White Clouds,`` Parallax Press
6. On Education - The Mother Aurobindo Ashram Publication
7. Anne Frank, `` Diaries of Anne Frank ,``
8. G S Banhatti `` Life and Philosophy of Swami Vivekananda,`` Atlantic
9. Swami Vivekanand `` Swami Vivekananda on Himself,`` Advaita Ashram
10. E. F Schumacher, `` Small is Beautiful: Economics as if people mattered,`` Harper Pereennial.
11. Cecile Andrews , `` Slow is Beautiful,`` New society publishers
12. A.Nagaraj, `` Jeevan Vidya: Ek Parichaya,`` Jeevan Vidya Prakashan.
13. A.N. Tripathi, `` Human Values,`` New Age Intl. Publishers.
14. Dharampal, `` Rediscovering India,`` Other India Press
15. Mohandas K. Gandhi, `` Hind Swaraj or Indian Home Rule,`` Navjeevan publication house
16. Maulana Abdul Kalam Azad, `` India Wins Freedom,`` Stosius Inc
17. Ramakrishna kiveevani , `` Romain Rolland
- 18 Romain Rolland , ``Vivekananda`` Advait ashram.
19. Romain Rolland , ``Gandhi`` Srishti Publishers & Distributors.
20. Paramhansa Yogananda, `` Autobiography of a Yogi,`` ,`` Rider publication.
21. Sahasrabudhe, ``Gandhi and Question of Science,`` Other India Press.



<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
<b>FE021</b>	<b>Universal Human Values 2: Self, Society and Nature</b>	<b>2L-0T-0P</b>	<b>FE020</b>
<b>COURSE OUTCOMES (CO):</b>  <ol style="list-style-type: none"><li>1. Sensitization of student towards issues in society and nature.</li><li>2. Understanding (or developing clarity) of nature, society and larger systems, on the basis of human relationships and resolved individuals.</li><li>3. Strengthening of self reflection.</li><li>4. Development of commitment and courage to act.</li></ol> <p>At the end of the course, students are expected to become more aware of their surroundings, society, social problems and their sustainable solutions, while keeping human relationships and human nature in mind. They would have better critical ability. They would also become sensitive to their commitment towards what they believe in (humane values. humane r learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction relationships and humane society). It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.</p>			
<b>COURSE CONTENT:</b> In Universal Human Values 2 course, the focus is more on understanding society and nature on the basis of self and human relationships. and motivation for the course.-conditioning, and natural acceptance. -existence of self and body. Identifying needs and satisfying needs of self and body. Self observations. Handling peer pressure family. Hostel and institute as extended family. Real life examples. -student relationship. Shraddha. Guidance. Goal of education. – material order, plant order, animal order and human order. Salient features of each. Human being as cause of imbalance in nature. (Film “Home” can be used.) – water, food, mineral resources. Pollution. Role of technology. Mutual enrichment not just recycling. on of needs of the self and needs of the body. Right utilization of resources. Understanding the purpose they try to fulfil.			

Recapitulation on society. Five major dimensions of human society. Fulfilment of the individual as major goal. Justice in society. Equality in human relationships as naturally acceptable. Establishment of society with abhaya (absence of fear). being through holistic education in just order.

**SUGGESTED READINGS:**

1. R R Gaur, R Sangal, G P Bagaria, "Human Values and Professional Ethics "Excel Books, New Delhi.
- 2 . A Nagaraj , "Jeevan Vidya: EkParichaya, " Jeevan VidyaPrakashan, Amarkantak.
- 3 . A.N. Tripathi , "Human Values," New Age Intl. Publishers, New Delhi, .
4. Annie Leonard, "The Story of Stuff" Simon and Schuster.
5. Mohandas Karamchand Gandhi, " The Story of My Experiments with Truth " Beacon Press.
6. J Krishnamurthy, " On Education " Official repository.
7. Hermann Hesse, "Siddhartha " Bantan press.
8. ThichNhatHanh, " Old Path White Clouds " parallax press.
9. On Education - The Mother Aurobindo Ashram Publication.
- 10 . Diaries of Anne Frank – Anne Frank
11. G.S Banhatti, "Life and Philosophy of Swami Vivekananda," Atlantic publisher.
12. Swami Vivekananda , "Swami Vivekananda on Himself," Advait publication.
13. E. F Schumacher , "Small is Beautiful: Economics as if people mattered,"Harper Pereinnial.
14. Cecile Andrews , "Slow is Beautiful" New society publishers.
15. J C Kumarappa, "Economy of Permanence" Serve seva sangh prakashan.
16. Pandit Sunderlal , "Bharat Mein Angreji Raj"
17. Mahatma and the Rose plant
- 18 . M.Gandhi, "The Poet and the Charkha" Mani Bhavan
19. Dharampal, "Rediscovering India" other India press.
- 20 .Mohandas K. Gandhi , "Hind Swaraj or Indian Home Rule," Navjeevan publication house.
21. Arvind Kejriwal , "Swaraj" Harper publication.
- 22 . Maulana Abdul Kalam Azad, "India Wins Freedom."Stosius Inc.
23. Romain Rolland , "Ramakrishna kijeemani,"Advait Ashram.
24. Romain Rolland , "Vivekananda" Advait ashram.
25. Romain Rolland , "Gandhi" Srishti Publishers & Distributors.
- 26 . ParamhansaYogananda, " Autobiography of a Yogi," Rider publication.
27. Sahasrabudhe, "Gandhi and Question of Science,"Other India Press.

**SYLLABUS OF DISCIPLINE CENTRIC ELECTIVES**

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MED01	Value Engineering	L-T-P:3-1-0	None
<b>COURSE OUTCOMES (COs)</b> <ul style="list-style-type: none"><li>• Understand the basics of Value Engineering (VE) to ensure that a standardized method is used for VE applications to projects</li><li>• Understand the appropriate time to apply VE for building design projects</li><li>• Gain an understanding of the total decision-making methodology of value engineering</li><li>• Learn of the “SAVE International Value Methodology Standard” and the convention to be followed for application of VE to projects</li><li>• Acquire the necessary information on VE to recognize the benefits resulting from their adoption as a standard practice within an organization.</li></ul>			
<b>COURSE CONTENT</b> <p>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</p> <p>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.</p> <p>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.</p> <p>Creative thinking and creative judgment, 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.</p>			
<b>SUGGESTED READINGS</b> <ul style="list-style-type: none"><li>• S.S. Iyer, “Value Engineering”, New Age International.</li><li>• Miles, Lawrence D., “Technology of Value Analysis and Engineering”, McGraw Hill.</li><li>• Mudge Arthur E., “Value Engineering: Systematic Approach”, Mcgraw Hill.</li></ul>			

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MED02	Power Plant Practice	L-T-P:3-1-0	MEC08, MEC12, MEC20
<b>COURSE OUTCOMES (COs)</b>			
<ul style="list-style-type: none"> <li>• Knowledge of steam power plant.</li> <li>• Knowledge of gas turbine plant&amp;nuclear power plant.</li> <li>• Knowledge of super thermal power plant.</li> <li>• Knowledge of important instruments on steam generator and turbine.</li> <li>• Ability to estimate the cost of power generation.</li> </ul>			
<b>COURSE CONTENT</b>			
<p>Steam Generator Plant: Fuel handling systems, Indian coals, combustion of coal in furnaces; fluidized bed combustion; High pressure heavy duty boilers, Super critical and once through boilers influence of operating conditions on layout of evaporator, superheater, reheater and economizer; dust collectors; ash disposal, fans and draft systems.</p> <p>Turbine Plane: Layout of turbine plant room, corrosion in condensers and boilers, feed water treatment; feed heating and de aeration system; cooling water systems and cooling towers.</p> <p>Other Power Plant: General layout of I.C. Engines and turbine power plants, types, gas turbine plants, fields of application, Nuclear power plants, power reactors and nuclear steam turbines; handling of nuclear waste and safety measures, peak load power generation methods.</p> <p>Control: Important instruments on steam generator and turbine; drum water level control, combustion control and super heat temperature control; testing of power plants and heat balance.</p> <p>Economics: Planning for power generation in India, super thermal power plants, estimation of cost of power generation; choice of plant site.</p>			
<b>SUGGESTED READINGS</b>			
<ul style="list-style-type: none"> <li>• Arora &amp; Domkundwar, “A course in Power Plant Engineering”, Dhanpat Rai &amp; Sons.</li> <li>• Black Veatch, “Power Plant Engineering”, CBS Publisher.</li> <li>• Nag P K, “Power Plant Engineering”, Mc Graw Hill.</li> </ul>			

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MED03	Solar Energy	L-T-P:3-1-0	MEC08, MEC19, MEC07
<b>COURSE OUTCOMES (COs)</b> <ul style="list-style-type: none"><li>• Knowledge of solar radiation.</li><li>• Ability to measure solar radiation and its estimation.</li><li>• Knowledge of design consideration and performance of flat plate and focusing collectors.</li><li>• Knowledge of mathematical models of various solar systems and components.</li><li>• Knowledge of solar energy applications.</li></ul>			
<b>COURSE CONTENT</b> <p>Selected topics in Heat Transfer: Heat transfer modes, properties and radiation characteristics of opaque and partially transparent media.</p> <p>Solar Radiation: Origin, nature and availability of solar radiation, measurements of solar radiation data and its estimation, effects of receiving surface orientation and motion.</p> <p>Components, process and system modes: Design consideration and performance of flat plate and focusing collectors; energy storage components, water storage, packed bed and phase change energy storage; mathematical models of various solar systems and components.</p> <p>Application: Solar water heating, solar air heaters, solar space heating and cooling, solar pumps, solar thermal power, solar furnaces and solar distillation.</p>			
<b>SUGGESTED READINGS</b> <ul style="list-style-type: none"><li>• H.P. Garg and J. Prakash, “Solar Energy fundamental and Applications”, Tata McGraw Hill Publishing Co. Ltd.</li><li>• Magal, “Solar Power Engineering”, Tata McGraw Hill Publishing Co. Ltd.</li></ul>			

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MED04	Reliability Engineering	L-T-P:3-1-0	MEC07, MEC15

**COURSE OUTCOMES (COs)**

- Understand the basic concepts of quality, reliability & safety.
- Compute measures of reliability of products and systems.
- Analyze failure data and perform Failure Modes, Effects and Criticality Analysis.
- Conduct a Fault Tree Analysis.
- Construct and analyze reliability block diagrams.
- Identify component importance.
- Use redundancy to achieve reliability

**COURSE CONTENT**

Fundamentals of Reliability & Maintenance: Reliability, Reliability Improvement, Redundancy, Element Redundancy. Unit Redundancy, Standby Redundancy, Reliability cost trade off. Maintenance, Scope of Responsibilities, Types of maintenance, Maintenance planning & control, Maintainability & Availability, Failure modes and the Bath Tub Curve.

Failure Data Analysis, Hazard Models & System Reliability: Failure Data, Mean Failure rate, Mean time to failure (MTTF), Mean time between failures (MTBF), GraPrentice Hall Indiacal plots, MTTF in terms of failure density, Reliability in terms of hazard rate and failure density. Constant Hazard model, Linearly Increasing Hazard and the Weibull Model. Instantaneous repair system, Mean time to repair (MTTR), Reliability and Availability function. Series configuration, Parallel configuration, Mixed configuration, A r – out – of – n – structure, mean time to failure of system, Fault tree construction, Calculation of reliability from Fault tree.

Systematic Maintenance: Codification & Cataloguing, History cards, Instruction manual and operating manuals, Job planning, Job manuals & Job scheduling, Job cards and Job procedures, Maintenance organization, Centralized & Decentralized organization, Captive maintenance, Replacement models, Spare part management.

Condition Monitoring Techniques & Modern Concepts: Leakage monitoring, Lubricant monitoring techniques, Ferrography, Spectroscopy, Cracks monitoring, Thickness monitoring, corrosion monitoring, Thermography. Terrotechnology, Failure mode effect analysis, Failure mode effect & critically analysis, Total productive maintenance, Computer managed maintenance system, Case studies.

**SUGGESTED READINGS**

- L.S.Srinath, “Reliability Engineering”, Affiliated East-West Press Ltd.
- S.K. Srivastava, “Industrial Maintenance Management”, S. Chand & Co. Ltd.
- E. Balaguruswamy, “Reliability Engineering”, Tata McGraw Hill Publishing Co.
- Charles E. Ebling, “Reliability & Maintainability Engg.”, Tata McGraw Hill Publishing Co.

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MED05	Industrial Quality Control	L-T-P:3-1-0	MEC15
<b>COURSE OUTCOMES (COs)</b> <ul style="list-style-type: none"><li>• Student can maturely utilize the knowledge gained in solving quality related issues.</li><li>• Student learns about the various quality control techniques prevalent in industry along with their applications</li><li>• Student understands the basic concepts of quality, its cost and value of quality, standardization.</li><li>• Student learns the importance of quality certifications and the awarding agencies involved.</li><li>• Student learns the role and importance of computer in controlling the quality related issues of quality certifications and the awarding agencies involved.</li><li>• Student learns the role and importance of computer in controlling the quality related issues</li></ul>			
<b>COURSE CONTENT</b> <p>Introduction to quality, quality planning and control, specification, tolerances and process capabilities, random and relative assembly system, total quality concepts, TQM models, six sigma, Quality circles, Quality function deployment.</p> <p>Analysis of variance and covariance, design of sampling investigations and experiments Two stage sampling, random block, Latin square, correlation and regression analysis control charts, significance tests. Designs of sampling, inspection by attributes and variables, sequential analysis.</p>			
<b>SUGGESTED READINGS</b> <ul style="list-style-type: none"><li>• J.M. Juran, "Quality Control Handbook", McGraw-Hill Inc.</li><li>• Lawrence S. Aft, "Fundamentals of Industrial Quality Control", CRC Press.</li></ul>			



<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MED06	Design of Experiments	L-T-P:3-1-0	None
<b>COURSE OUTCOMES (COs)</b> On Completion of the course the student will be able to <ul style="list-style-type: none"><li>• Understand the importance of statistical design of experiments and benefits in R&amp;D</li><li>• Learn the experimental designs most widely used in practice</li><li>• Choose an appropriate experimental design based on the study objectives</li><li>• Construct and implement the design selected</li><li>• Analyze the data collected based on the design used and its underlying assumptions</li><li>• Interpret the results of the experiment and report the conclusions</li></ul>			
<b>COURSE CONTENT</b> Objectives, principles, terminologies, guidelines, and applications of design of experiments. Completely randomized design. Randomized block design. Latin square design. Two level and three level full factorial designs. Fractional factorial designs. Robust design. Mixture experiments. Central composite and Box-Behnken designs. Response surface methodology. Multi-response optimization. Analysis of variance. Statistical test of hypothesis. Analysis of multiple linear regression. Use of statistical software packages.			
<b>SUGGESTED READINGS</b> <ul style="list-style-type: none"><li>• Douglas C. Montgomery, “Design and Analysis of Experiments”, John Wiley &amp; Sons.</li></ul>			

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MED07	Material Management	L-T-P:3-1-0	MEC15, FC002
<b>COURSE OUTCOMES (COs)</b> <ul style="list-style-type: none"><li>• Understand concepts of productivity and material management</li><li>• Understand Vendor Development</li><li>• Understand the role of decision making</li></ul>			
<b>COURSE CONTENT</b> <p>Productivity and materials management cost Reduction and Value Improvement. Purchasing, Vender development Make or Buy Decisions, Stores Management, Materials Management , value Engineering, International Material Information system and Decision Making, Purchase of capital equipment, spare parts Management, Obsolete surplus and scrap Management, Material planning and budgeting, Contract Management and legal aspects.</p> <p>Inventory Management, ABC-VED analysis various inventory Models, P-models Q-models, Static and Dynamic models Quantity discount under demand and lead time uncertainty, Management of in process and finished good inventory, optimal stocking and issuing policies, Inventory management of perishable commodities. Decision of inventory Distribution systems, standardization and codification.</p> <p>Product quality and reliability failure date analysis and life testing, maintainability and availability. Use of software like Dot Net, MATLAB etc.</p>			
<b>SUGGESTED READINGS</b> <ul style="list-style-type: none"><li>• Gopalakrishnan P, “Handbook of Materials Management”, Phi Learning.</li><li>• J. R. Tony Arnold, “Introduction to Materials Management”, Pearson.</li></ul>			

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MED08	Ergonomics	L-T-P:3-1-0	MEC15
<b>COURSE OUTCOMES (COs)</b> On Completion of the course the student will be able to <ul style="list-style-type: none"><li>• Describe the best combinations of man, machine and working stations in industries to enhance production and efficiency.</li><li>• Outline different communication systems like Man-Man and Man-Machine systems and different information processes.</li><li>• Design workstation and work surface, etc.</li><li>• Control the effect of Environmental stressors like Noise, vibration, Heat and illuminations, etc.</li><li>• Accept the engineering challenges regarding the needs of human beings in daily life about machines and systems which are possible for the discomforts in machines and systems.</li><li>• Explain the processes, methods and develop experimental setups for the measurements of working conditions, environment, postures and space, etc.</li><li>• Minimize the discomforts and provide the maximum possible comforts to the working conditions, workstations and best suited postures etc.</li><li>• Paraphrase International standards used in ergonomics.</li></ul>			
<b>COURSE CONTENT</b> Introduction, Measurement of productivity, Method study, principles of motion economy, Macro motions analysis, work measurement, Time study, performance rating, standard allowances, work sampling, PMT MTM standard data system. Ergonomics: Man machine system, types of displays, autooxy presentation of information and speech communication Man-machine dynamics, Design of control, layout of workplace environmental effects and anthropometry.			
<b>SUGGESTED READINGS</b> <ul style="list-style-type: none"><li>• O. P. Khanna, “Work Study: Motion and Time Study”, Dhanpat Rai Publication.</li><li>• Barnes, “Motion and Time Study Design and Measurement of Work”, Wiley.</li></ul>			

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MED09	Optimization Techniques	L-T-P:3-1-0	MEC07

**COURSE OUTCOMES (COs)**

On Completion of the course the student will be able to

- Identify necessity and development of mathematical models for various industries.
- Describe basic optimization and simulation techniques applied to various industries.
- Predict the industrial systems under the conditions of certainty, uncertainty and risk.
- Propose a queuing model based upon given data.
- Derive the network models and understanding of reliability concept.
- Demonstrate cost effective strategies in various applications in industry.
- Explain the importance and phases of Operation Research.
- Form the Linear programming model and solve it by graphical method and simplex algorithms.
- Recognize the balanced and unbalanced transportation models and predict optimum solution by MODI method.
- Outline and solve the shortest route, minimal spanning tree and maximal flow network problems.
- Construct the CPM and PERT networks

**COURSE CONTENT**

Introduction: historical development, engineering applications; statement of problem-objective function, constraints, classification, techniques. Single variable optimization, multivariable optimization with equality and inequality constraints.

Linear programming: Formulations of linear programs, graphical method, simplex method, simplex algorithm, sensitivity analysis. Duality, decomposition principle.

Mathematical statement of transportation problem, methods of finding Basic Feasible Solution, test of optimality, MODI'S method for optimal solution, variation in transportation problem. Network Analysis: Project planning and control with PERT-CPM

Decision analysis: decision under certainty, risk probability and uncertainty; AHP- assigning weight and consistency test of AHP. Meta-heuristics: Definition of heuristic and meta-heuristic algorithms; introduction to Tabu search, Simulated Annealing and Genetic algorithms.

**SUGGESTED READINGS**

- Hillier F S and Liberman G J, “Introduction to Operations Research concept and cases”, TMH.
- Taha H, “Operations research”, PHI.
- Heera and Gupta, “Operations Research”, S. Chand.
- Sen RP, “Operations Research-Algorithms and Applications”. PHI Learning.

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MED10	Micro Electro Mechanical Systems	L-T-P:3-0-2	MEC17, MEC18
<b>COURSE OUTCOMES (COs)</b> <ul style="list-style-type: none"><li>• At the end of the course, the student shall be able to</li><li>• Classify and distinguish FMS and other manufacturing systems including job-shop and mass production systems.</li><li>• Explain processing stations and material handling systems used in FMS environments.</li><li>• Design and analyze FMS using simulation and analytical techniques.</li><li>• Understand tool management in FMS.</li><li>• Analyze the production management problems in planning, loading, scheduling, routing and breakdown in a typical FMS.</li></ul>			
<b>COURSE CONTENT</b> <p>Overview of MEMS &amp; Microsystems; MEMS and Microsystems, typical products, evolution of microsystem, microsystem and microelectronics, miniaturization, applications.</p> <p>Working principles of Microsystems; Introduction, micro sensors, micro actuation, micro accelerometers, microfluidics.</p> <p>Engineering Science for Microsystem Design and Fabrication; Atomic structure, ionization, molecular theory, doping of semiconductors, diffusion, and plasma physics, electro chemistry, quantum physics.</p> <p>Engineering Mechanics for Microsystems Design</p> <p>Materials for MEMS</p> <p>Microsystem Fabrication Processes; Photolithography, ion implantation, diffusion, oxidation, chemical vapor deposition, physical vapor deposition, deposition by epitaxy, etching.</p> <p>Overview of Micro-manufacturing.</p> <p>Microsystem Design.</p> <p>Microsystem Packaging</p>			
<b>SUGGESTED READINGS</b> <ul style="list-style-type: none"><li>• Nadim Maluf, “An Introduction to Microelectromechanical Systems Engineering”, Artech House Publishers.</li><li>• <u>James J. Allen</u>, “Micro Electro Mechanical System Design”, CRC Press.</li></ul>			

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MED11	Composite Materials	L-T-P:3-0-2	MEC09

**COURSE OUTCOMES (COs)**

On Completion of the course the student will be able to

- Have knowledge of the types and properties of composites used in engineering.
- Have knowledge in processing and fabrication of structural composites.
- Analyze the effects of various load or displacement boundary conditions by applying laminate analysis to composite structures.
- Understand the differences in matrix materials and the implications for composites as substitute materials in design to meet several competing requirements
- Describe the need, characteristics and applications of composite materials.
- Summarize the importance of surface treatments of fibers and adding fillers and additives to the composite materials.
- Manipulate the interaction between fiber and matrix in a unidirectional lamina under tensile and compressive loading.
- Explain the experimental techniques used for evaluating the fatigue and impact properties.
- Discuss the mechanical behavior of composites due to variation in temperature and moisture.
- Choose the most appropriate manufacturing process for fabricating composite components.
- Identify and design composite materials and structures in various engineering applications

**COURSE CONTENT**

**Introduction:** Classification of various composite materials.

**Reinforcements: Fibers:** fabrication, properties and applications of glass fibers, boron fibers, carbon fibers, organic fibers, Kevlar fibers, ceramic fibers, metallic fibers (metallic glasses).

**Particulates:** Properties and application of SiC, Al<sub>2</sub>O<sub>3</sub>, Si<sub>3</sub>N<sub>4</sub> and TiC particulates. Matrix

**Materials:** Properties of common polymer, metallic and ceramic matrix materials.

**Metal Matrix Composites:** Solid state, liquid state and in-situ fabrication techniques of MMCs, Discontinuous reinforcement of MMCs, Properties and applications of MMCs.

**Ceramic Matrix Composites:** Fabrication, properties and interfaces in CMCs. Toughness of CMCs, applications of CMCs. Carbon Fiber Composites: Fabrication, properties and interfaces.

**Mechanics of Composite Materials:** Density, mechanical properties, prediction of elastic constants, transverse stresses, and thermal properties. Mechanics of load transfer from matrix to fibers, relationship between engineering constants, analysis of laminated composites.

**Strength, Fracture and Design of Composites:** Tensile and compressive strength of composites, Fracture modes in composites, Strength of orthotropic lamina, maximum stress theory, maximum strain criterion, maximum work criterion.

**SUGGESTED READINGS**

- S.W. Tsai and H.T. Hahn, “Introduction to Composite Materials”, Technomic Publishing Co.
- Robert M. Jones, “Mechanics of Composite Materials”, McGraw-Hill.
- A.K. Kaw, “Mechanics of composite materials”, CRC Press.
- R.J. Crawford, “Plastic Engineering”, Butterworth-Heinemann publications.
- P.K. Mallick, “Fiber-Reinforced Composites- Materials, Manufacturing and Design”, Marcel Dekker, Inc.



<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MED12	Micro/ Nano Machining	L-T-P:3-0-2	MEC13
<b>COURSE OUTCOMES (COs)</b> On Completion of the course the student will be able to <ul style="list-style-type: none"><li>• Calculate power requirements and process performance in laser micromachining</li><li>• Calculate selectivities and etch rates in IC/MEMS device manufacture</li><li>• Be aware of the hazards involved in dealing with toxic/dangerous materials such as HF in IC manufacture or Class 4 lasers in manufacturing</li><li>• Develop and present a conceptual design solution to a precision machine operating in the micro and nano range</li><li>• Be aware of techniques for advanced nano polymer materials processing, nano materials, and coatings</li><li>• Examine materials under SEM and draw conclusions on issues associated with inspection of micro components</li></ul>			
<b>COURSE CONTENT</b> An overview of micro and nano mechanical systems and their applications in Mechanical Engineering, MEMS Micro fabrication methods, Silicon Micromachining methods, Laser, Electron and Ion beam micromachining methods, Mechanical Micromachining techniques, Nano manufacturing methods, nanomaterial and nano metrology.			
<b>SUGGESTED READINGS</b> <ul style="list-style-type: none"><li>• J. Paulo Davim, Mark J. Jackson, “Nano and Micromachining”, Wiley.</li></ul>			

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MED13	Advanced FMS	L-T-P:3-0-2	MEC13
<b>COURSE OUTCOMES (COs)</b> On Completion of the course the student will be able to <ul style="list-style-type: none"><li>• Classify and distinguish FMS and other manufacturing systems including job-shop and mass production systems.</li><li>• Explain processing stations and material handling system used in FMS environments.</li><li>• Design and analyze FMS using simulation and analytical techniques.</li><li>• Understand tool management in FMS.</li><li>• Analyze the production management problems in planning, loading, scheduling, routing and breakdown in a typical FMS.</li><li>• Develop familiarity with transformation and manufacturing systems.</li><li>• Describe role of computers in manufacturing industries.</li></ul> Explain the need and importance of PLC and microcontrollers used in various equipments.			
<b>COURSE CONTENT</b> Introduction to FMS: Definition of FMS – types and configuration concepts – types of flexibility and performance measures. Functions of FMS host computer – FMS host and area controller function distribution. Development and implementation of FMS: Planning phases – integration – system configuration – FMS layouts – simulation – FMS project development steps. Project management – equipment development – host system development – planning - hardware and software development. Distributed numerical control: DNC system – communication between DNC computer and machine control unit – hierarchical processing of data in DNC system – features of DNC system. Automated material handling: Function - types – analysis of material handling equipments. Design of conveyor and AGV systems. Automated storage: Storage system performance – AS/RS – carousel storage system – WIP storage – interfacing handling storage with manufacturing. Programmable logic controllers: Components of the PLC – PLC operating cycle – additional capabilities of a PLC – programming the PLC - Ladder logic diagrams, counters etc– Industrial process control using PLC. FMS rationale: Economic and technological justification for FMS – GT, JIT – operation and evaluation – personnel and infra structural aspects – typical case studies – future prospects.			

**SUGGESTED READINGS**

- Parrish D. J, “Flexible manufacturing”, Butterworth – Heinemann Ltd.
- Groover M. P, “Automation, production systems and computer integrated manufacturing”, Prentice Hall India (P) Ltd.
- Shivanand H. K., Benal M. M and Koti V, “Flexible manufacturing system”, New Age International (P) Limited. Publishers.
- Kusiak A., “Intelligent manufacturing systems”, Prentice Hall, Englewood Cliffs.
- Considine D. M. & Considine G. D, “Standard handbook of industrial automation”, Chapman and Hall.
- Viswanadhan N. and Narahari Y, “Performance modelling of automated manufacturing systems”, Prentice Hall India (P) Ltd.
- Ranky P. G, “The design and operation of FMS”, IFS Pub.

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MED21	Automotive Engineering	L-T-P:3-0-2	MEC05, ME10, MEC21
<b>COURSE OUTCOMES (COs)</b>			
<ul style="list-style-type: none"> <li>• Knowledge of the characteristics of various power plants (Petrol engines, Diesel engines, CNG LPG engine, Gas turbine).</li> <li>• Knowledge of constructional details of C.I. and S.I. engines.</li> <li>• Knowledge of vehicular performance.</li> <li>• Knowledge of performance requirements of various vehicles like Passenger cars, heavy duty trucks etc.</li> <li>• Knowledge of two wheel and four wheel drive vehicles.</li> <li>• Knowledge of transmission systems.</li> <li>• Knowledge of general arrangement of Dead axle and axle-less transmission.</li> </ul>			
<b>COURSE CONTENT</b>			
<p>Power Plant: Selection of power plant for automotive vehicle, requirements of vehicle. Characteristics of various power plants (Petrol engines, Diesel engines, CNG LPG engine, GasTurbines); constructional details of C.I. and S.I. engines, crank shafts, connecting rods, pistons, Piston pins, piston rings, valves mechanisms, manifolds, air cleaners, mufflers, radiators and oil filters.</p> <p>Vehicular Performance: Load, air and grade resistance; matching of engine output and demand power, performance requirements of various vehicles like Passenger cars, heavy duty trucks etc. performance characteristics of internal combustion engines, drive effectiveness relationship for 2 wheel and 4 wheel drive vehicles.</p> <p>Transmission Systems: Transmission requirements, general arrangement of clutch, gear box and rear axle transmission, general arrangement of rear engines and vehicles with live axles. General arrangement of Dead axle and axle-less transmission, De-Dion drive, arrangement of front engine and front wheel drives, four wheel drive transmission.</p>			
<b>SUGGESTED READINGS</b>			
<ul style="list-style-type: none"> <li>• R. K. Rajput A Text Book of Automobile Engineering”, Laxmi Publication.</li> </ul>			

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MED22	Finite Element Methods	L-T-P:3-0-2	MEC08, MEC12, MEC11
<b>COURSE OUTCOMES (COs)</b>			
<ul style="list-style-type: none"> <li>• Students to understand the basics of finite element analysis and its applications in engineering with one, two and three dimensional elements.</li> <li>• To provide the fundamental concepts of the theory of the finite element method</li> <li>• To obtain an understanding of the fundamental theory of the FEA method;</li> <li>• To develop the ability to generate the governing FE equations for systems governed by partial differential equations;</li> <li>• To understand the use of the basic finite elements for structural applications using truss, beam, frame, and plane elements; and</li> <li>• To understand the application and use of the FE method for heat transfer problems</li> </ul>			
<b>COURSE CONTENT</b>			
<p>Discretization and the Direct Stiffness Method. Basic concepts of structural modeling Review of the stiffness method of structural analysis. Modeling stiffness, loads and displacement boundary conditions.</p> <p>Advanced modeling: general constraints, sub structuring. Formulation of Finite Elements Mathematical interpretation of finite elements, vibrational formulation.</p> <p>Development of continuum elements, shape functions, consistent loads. Isoperimetric elements for plane stress. Numerical integration Convergence requirements.</p> <p>Computer Implementation of the Finite Element Method Preprocessing: model definition. Element level calculations. Equation assembly. Equation solver.</p> <p>Post processing: strain and stress recovery.</p>			
<b>SUGGESTED READINGS</b>			
<ul style="list-style-type: none"> <li>• Saeed Moaveni, “Finite Element Analysis - Theory and Applications with Analysis”, Pearson.</li> <li>• Robert D Cook, “Concepts and Applications of Finite Element Analysis”, Wiley.</li> <li>• J Reddy, “An Introduction to the Finite Element Method”, Mcgraw Hill Series.</li> <li>• S S Rao, “The Finite Element Method in Engineering”, Butterworth-Heinemann.</li> </ul>			

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MED23	Fracture Mechanics	L-T-P:3-0-2	MEC11
<b>COURSE OUTCOMES (COs)</b> <ul style="list-style-type: none"><li>• The course will treat linear and nonlinear fracture mechanics principles and their applications to structural design.</li><li>• Fracture phenomena in metals and nonmetals will be discussed and testing methods will be highlighted. In the end computer assisted techniques for fracture study will be discussed</li><li>• Predict material failure for any combination of applied stresses.</li><li>• Estimate failure conditions of a structure</li><li>• Determine the stress intensity factor for simple components of simple geometry</li><li>• Predict the likelihood of failure of a structure</li></ul>			
<b>COURSE CONTENT</b> <p>Fracture: an overview, theoretical cohesive strength, defect population in solids, stress concentration factor, notch strengthening, elements of fracture mechanics, Griffiths crack theory, stress analysis of crack, energy and stress field approaches, plane strain and plane stress fracture toughness testing, crack opening displacement, elastic-plastic analysis, J-integral, ductile-brittle transition, impact energy fracture toughness correlation, microstructural aspects of fracture toughness, environmental assisted cracking, cyclic stress and strain fatigue, fatigue crack propagation, analysis of engineering failures.</p>			
<b>SUGGESTED READINGS</b> <ul style="list-style-type: none"><li>• Ted L. Anderson, T. L. Anderson, “Fracture Mechanics: Fundamentals and Applications”, CRC Press.</li><li>• M. Janssen, “Fracture Mechanics”, VSSD.</li></ul>			

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MED24	Gear Technology	L-T-P:3-0-2	None
<b>COURSE OUTCOMES (COs)</b> On Completion of the course the student will be able to <ul style="list-style-type: none"><li>• Identify functional characteristics of various machine elements.</li><li>• Design and analyze cams, gears and gear trains.</li><li>• Analysis &amp; Synthesis of gear mechanisms</li></ul>			
<b>COURSE CONTENT</b> Types of gears, Geometric and Kinetics characteristics, Undercutting and interference correction, Non-Circular gears. Design of tools to make gear teeth Kinds and cases of gear failures Special Design Problems; Center distance problem, profile modification, problem Combined bending and Torsion of pinions with large length to diameter ratio, high speed gearing. Geneva Mechanisms (Analysis & Synthesis). Gear Trains (Analysis & Synthesis) Some example of optimal kinematics system Design; Gear Set design Design of sub-system consisting of Geneva wheel and elliptical gears for reduction of maximum acceleration of the wheel.			
<b>SUGGESTED READINGS</b> <ul style="list-style-type: none"><li>• D.W. Dudley, “Practical Gear Design”, Tata McGraw Hill Co. Inc.</li><li>• S.S. Rattan, “Theory of Machines”, Tata McGraw Hill.</li><li>• AGMA (American Gear Manufacturing Association) Standards.</li></ul>			

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MED25	Industrial Drives	L-T-P:3-0-2	FC003
<b>COURSE OUTCOMES (COs)</b> On Completion of the course the student will be able to <ul style="list-style-type: none"><li>• Select a drive for a particular application based on power rating.</li><li>• Select a drive based on mechanical characteristics for a particular drive application.</li><li>• Operate and maintain solid state drives for speed control of DC machines.</li><li>• Operate and maintain drives for speed control 3 phase induction motor.</li><li>• Understand the operation of the converter / chopper fed dc drive and to solve simple problems.</li><li>• Student can able to understand the operation of both classical and modern induction motor drives.</li><li>• Apply this skills to design the current and speed controllers for a closed loop solid-state DC motor drive</li><li>• Student can understand the concept of AC and DC drive system</li></ul>			
<b>COURSE CONTENT</b> Introduction to electric drives, Selection of drives, drive characteristics. Thyristor controlled drives. Basic of variable speed drives, D.C. drives: Analytics of fully/half controlled/converter controlled D.C. devices. Dual converter fed DC. Drives. Reversing and braking of thyristor controlled D.C. drives. Analysis and control of inverter fed A.C. drives, Vector controlled Induction motor drives. Braking of A.C. drives. Switch reluctance motors, PMDC drives.			
<b>SUGGESTED READINGS</b> <ul style="list-style-type: none"><li>• Sarkar B. N. “Fundamentals of Industrial Drives”, PHI Learning Pvt. Ltd.</li><li>• G. K. Dubey, “Fundamentals of Electrical Drives”, CRC Press.</li></ul>			



<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MED26	Rapid Prototyping and Tooling	L-T-P:3-0-2	MEC14
<b>COURSE OUTCOMES (COs)</b> On Completion of the course the student will be able to <ul style="list-style-type: none"><li>• Describe product development, conceptual design and classify rapid prototyping systems.</li><li>• Apply the basic principles of rapid prototyping (RP), rapid tooling (RT) technologies to product development.</li></ul>			
<b>COURSE CONTENT</b> Overview of Rapid Prototyping - definitions, evolution Processes, Principles, Materials, Resources CAD for Rapid Prototyping Case Studies - Building the Prototype Description: The method of course delivery will be split into lectures and student presentations, with a series of projects in parallel. Everyone will get the opportunity to learn popular rapid prototyping technologies. This course will have a decision-based design / CAD basis, rather than a materials processing / physical prototyping basis. That is, the focus will be on the usage of RP technologies in product development, with an emphasis on their selection. The course will be structured into three modules: Selection of RP technologies. First-cut attributes and scales for selecting an appropriate technology. Survey of RP technologies with some hands-on training. Short reports and presentations on individual surveys. In-depth development of analytical &/or experimental models for RP technology. The analytical or experimental model should lead to at least one selection attribute and scale. Geometric modeling issues and methods for RP, highlighting the CAD-RP interface. Reports and presentations on development of attributes and scales for one RP technology. Application of RP selection method in 3-week design project (groups of 3-4). RP case studies in industry. Reports and presentations.			

**SUGGESTED READINGS**

- Marshall Burns, “Automated Fabrication: Improving Productivity in Manufacturing”, Prentice Hall.
- Jerome L. Johnson, “Principles of Computer Automated Fabrication”, Palatino Press, Inc.
- Lamont Wood, “Rapid Automated Prototyping: An Introduction”, Industrial Press.
- Paul F. Jacobs, “Rapid Prototyping and Manufacturing: Fundamentals of Stereolithography”, Society of Manufacturing Engineers.
- Larry Binstock, “Rapid Prototyping Systems: Fast Track to Product Realization”, Society of Manufacturing Engineers.
- Detlef Kochan, “Solid Freeform Manufacturing”, Elsevier Science.
- Paul F. Jacobs, “Stereolithography and Other RP&M Technologies: From Rapid Prototyping to Rapid Tooling”, Society of Manufacturing Engineers.
- Chua Chee Kai and Leong Kah Fai, “Rapid Prototyping: Principles and Applications in Manufacturing”, John Wiley & Sons, Inc.

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MED27	Modern Methods of Manufacturing	L-T-P:3-0-2	MEC06, MEC13
<p><b>COURSE OUTCOMES (COs)</b>            After taking this course students should be able to:</p> <ul style="list-style-type: none"> <li>• Identify the need and to examine different functional elements of various advanced manufacturing processes and to identify the typical applications these modern manufacturing processes.</li> <li>• Examine and evaluate the unconventional manufacturing methods and their classification to use to the right manufacturing method for the right product</li> <li>• Formulate real production problems creatively, especially in design considerations like material selection and process identification which is very important in the designing of new components.</li> <li>• Demonstrate the ability to collect data of a given process/system, interpret, analyse data and make some conclusions for the different applications in the industry using variety of modern manufacturing methods such as unconventional machining (EDM, ECM, ECDM, IBM, EBM, PAM etc), micro/nano finishing operations (MRF, AFF, MAF, MRAFF, MFP etc), micro casting, micro forming, additive manufacturing etc.</li> <li>• Design a process for day to day changing need of market in terms of applications and huge material choices due to advancement in materials technology.</li> </ul>			
<p><b>COURSE CONTENT</b>            Systems of manufacturing: batch, mass, cellular and flexible. Concepts of computer integrated manufacturing system. Use of robots in manufacturing and assembly. Needs and roles of newer processes. Evaluation of processes and their relation to productivity. Recent advances in metal cutting, joining, coating; Process based on concentration of energy in the forms of beam etc. Metal forming; Processes sophisticated control of metallurgical parameters, Processing environment, deformation rate etc; Processes based on chemical interactions, solid phase bonding and joining operations. Micro &amp; Nano fabrication technologies. Layered manufacturing, classification and description of layered manufacturing processes. Applications of layered manufacturing. Non conventional advanced manufacturing processes. Hybrid manufacturing processes and their applications.</p>			
<p><b>SUGGESTED READINGS</b></p> <ul style="list-style-type: none"> <li>• Mikell P. Groover, "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems", John Wiley &amp; Sons.</li> <li>• V K Jain, "Advanced machining processes", Allied Publishers Pvt. Ltd.</li> <li>• PC Panday, H S Shan, "Modern Machining Processes", Tata McGraw Hill.</li> </ul>			

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MED28	Industrial Tribology	L-T-P:3-0-2	MEC21
<p><b>COURSE OUTCOMES (COs)</b></p> <p>On Completion of the course the student will be able to</p> <ul style="list-style-type: none"> <li>• Define the basic principles of tribology-friction, wear and lubrication.</li> <li>• Explain the friction characteristic of metals and non-metals.</li> <li>• Describe the importance and general concept of topography of engineering surfaces.</li> <li>• Differentiate the different types of wear in sliding contacts.</li> <li>• Assess the types of lubricants for Industrial applications.</li> <li>• Explain the concepts of hydrodynamic, hydrostatic, elasto-hydrodynamic and lubrication.</li> <li>• Implement the basic knowledge of surface modification process to reduce wear.</li> <li>• Rate the potential economic savings that could be achieved through the development and adoption of better engineering practices for minimizing the unnecessary wear, friction and breakdowns associated with tribological failures</li> </ul>			
<p><b>COURSE CONTENT</b></p> <p>Introduction to tribology and its historical background. Factors influencing Tribological phenomena. Engineering surfaces – Surface characterization, Computation of surface parameters. Surface measurement techniques. Apparent and real area of contact. Contact of engineering surfaces- Hertzian and non-hertzian contact. Contact pressure and deformation in non-conformal contacts. Genesis of friction, friction in contacting rough surfaces, sliding and rolling friction, various laws and theory of friction. Stick-slip friction behaviour, frictional heating and temperature rise. Friction measurement techniques. Wear and wear types. Mechanisms of wear - Adhesive, abrasive, corrosive, erosion, fatigue, fretting, etc., wear of metals and non-metals. Wear models - asperity contact, constant and variable wear rate, geometrical influence in wear models, wear damage. Wear in various mechanical components, wear controlling techniques. Introduction to lubrication. Lubrication regimes. Introduction to micro and nano-tribology.</p>			
<p><b>SUGGESTED READINGS</b></p> <ul style="list-style-type: none"> <li>• Theo Mang, Kirsten Bobzin, Thorsten Bartels, “Industrial Tribology: Tribosystems, Friction, Wear and Surface Engineering”, Lubrication”, Wiley VCH.</li> </ul>			

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MED29	Automation in Manufacturing	L-T-P:3-0-2	MEC03, MEC06
<p><b>COURSE OUTCOMES (COs)</b></p> <p>On Completion of the course the student will be able to</p> <ul style="list-style-type: none"> <li>• Become familiar with the different types automation and study both technological and economic issues involved in automatic manufacturing of products.</li> <li>• Develop an understanding of programmable or flexible manufacturing and its suitability for various manufacturing environments.</li> <li>• Learn about the modern techniques and devices used for the monitoring and control of manufacturing systems including programming of programmable logic controllers and their interfacing with various sensors and actuators.</li> <li>• Understand the major components of mechatronic systems used in automation such as commonly used sensors and common techniques for sensor interfacing and protection circuits.</li> </ul>			
<p><b>COURSE CONTENT</b></p> <p>Introduction to Automation of different manufacturing processes. Types of systems - mechanical, electrical, electronics; Data conversion devices, transducers, signal processing devices, relays, contactors and timers. Sensors and their interfaces; Hydraulics &amp; Pneumatic Systems design and their application to manufacturing equipment; Sequence operation of hydraulic and pneumatic cylinders and motors; Electro Pneumatic &amp; Electro Hydraulic Systems design, Relay Logic circuits, Feedback control systems, PID Controller; Drives and mechanisms of an automated system: stepper motors, servo drives. Ball screws, linear motion bearings, electronic camming and gearing, indexing mechanisms, tool magazines, and transfer systems. Programmable Logic Controllers, I/Os, system interfacing, ladder logic, functional blocks, structured text, and applications. Human Machine Interface &amp; SCADA; Motion controller and their programming, PLCOpen Motion Control blocks, multi axes coordinated motion, CNC control; RFID technology and its application; Machine vision and control applications. Modular Production Systems – Distribution, Conveying, Pick &amp; Place etc.</p> <p>Laboratory work will be hands-on design and operation of automatic systems.</p>			
<p><b>SUGGESTED READINGS</b></p> <ul style="list-style-type: none"> <li>• Yusuf Altintas, “Manufacturing Automation Metal Cutting Mechanics, Machine Tool Vibrations, and CNC Design”, Cambridge University Press.</li> </ul>			

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MED30	Mechatronics	L-T-P::3-0-2	FC003, MEC17, MEC18

**COURSE OUTCOMES (COs)**

On Completion of the course the student will be able to

- Understand the mechanisms of commonly used actuators and how to select a proper set of sensors and actuators for a practical mechatronic system.
- Identification of key elements of mechatronics system and its representation in terms of block diagram
- Understanding the concept of signal processing and use of interfacing systems such as ADC, DAC, digital I/O
- Development of PLC ladder programming and implementation of real life system
- Explain the concepts of mechatronic systems, adoptive control, man-machine interface and mechatronic design.
- Summaries the concepts of mechanical and electronic actuation systems.
- Explain the working of stepper and servo motors.
- Write the programme for programmable logic controllers and discuss case studies of mechatronic systems.
- The students will be able to feel the importance of this subject as mechanical engineering students. They will be able to understand the need of the subject for industries. To some extent they will be able to design the basic circuit of a mechatronic system.

**COURSE CONTENT**

Introduction to Mechatronics. Hydraulic and Pneumatic actuator systems, operational characteristics and performance of hydraulic based actuation systems including linear devices, rotary devices, flow control valves, pressure control valves, I-P and P-I converters ancillary devices (accumulator, amplifiers etc.)

Electrical actuation systems: Operational characteristic and application of electrical actuation components for application like, AC/DC motors, stepper motors, relays, push buttons, switches, etc.

Programmable Logic Controllers and applications: PLC structures, PLC languages, programming of PLC, Interfacing PLC with actuators, open loop and closed loop control using PLC. Some case Studies like auto focus camera, printer, programming washing machine, optical mar reader (OMR) etc.

**SUGGESTED READINGS**

- N.P. Mahalik, “Mechatronics: Principles, concepts and applications”, Tata McGraw-Hill,
- Appuu Kuttan K K, “Introduction To Mechatronics” Oxford University.
- Rajput R K, “A Textbook Of Mechatronics”, S, Chand.

<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MED31	Artificial Intelligence	L-T-P:3-0-2	MEC07
<b>COURSE OUTCOMES (COs)</b> On Completion of the course the student will be able to <ul style="list-style-type: none"><li>• Apply artificial intelligence techniques, including search heuristics, knowledge representation, planning and reasoning</li><li>• Describe the key components of the artificial intelligence (AI) field</li><li>• Explain and solve problems by applying a suitable search method</li><li>• Compare minimax search and alpha-beta pruning in game playing</li><li>• Describe and list the key aspects of planning in artificial intelligence</li></ul>			
<b>COURSE CONTENT</b> Basic of artificial neural Networks, Activation & Synaptic Dynamics, Feed forward Neural Networks, Feed Back neural Networks, Neural Networks for linear & nonlinear Dynamic System, Modeling and control, Basics of Fuzzy logic expert systems ,fuzzy sets & control theory, Fuzzy systems as inference engines, Fuzzy systems as function approximates, model based fuzzy control learning based fuzzy control classical fuzzy control problem inverted pendulum. Fuzzy modeling & tracking control of nonlinear systems stability of fuzzy controller's examples of fuzzy control system Design, Neuro fuzzy systems.			
<b>SUGGESTED READINGS</b> <ul style="list-style-type: none"><li>• Stuart Russell, "Artificial Intelligence: A Modern Approach (3rd Edition)", Pearson.</li><li>• Thomas H. Cormen, "Introduction to Algorithms, 3rd Edition (MIT Press)", The MIT Press.</li></ul>			



<b>Course No</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
MED32	Robotics	L-T-P:3-0-2	MEC10
<p><b>COURSE OUTCOMES (COs)</b></p> <p>On Completion of the course the student will be able to</p> <ul style="list-style-type: none"> <li>• Understand various types of robots for industrial applications.</li> <li>• List out the classification of robots and explain the structure of robot.</li> <li>• Use the homogeneous transformation matrices in robotics</li> <li>• Compare the different types of grippers used in robotics.</li> <li>• Use the vacuum cups and magnetic grippers in mechatronic systems.</li> <li>• Explain the working principle of touch, tactile proximity, and range and sniff sensors.</li> <li>• Explain the various techniques of machine vision system.</li> <li>• Understand the complete design procedure of the robot.</li> <li>• Select correct mechanism for operation of the robot.</li> </ul> <p style="padding-left: 40px;">Select necessary actuators, sensors, control for satisfactory performance of the robot</p>			
<p><b>COURSE CONTENT</b></p> <p>Introduction, Applications, classification, Basic components of a robot system, Specifications, Robot Anatomy, Coordinate frames, mapping, and transforms, Euler angle axis representation, Direct kinematics model, Denavit Hartenberg notation, Inverse kinematics, Manipulator Differential Motion &amp; statics, Dynamic modeling ,Lagrange -Euler formulation, Newton-Euler formulation, Inverse dynamics, Trajectory planning, control of Manipulators, PID control, computed torque control feed forward control, AI control, Sensors in Robotics, Robotic Vision, Robot Software &amp; Programming, Robotic system overall Design.</p>			
<p><b>SUGGESTED READINGS</b></p> <ul style="list-style-type: none"> <li>• K.S Fu R.C. Gonzalez, C.S. G. Lee, “Robotics control sensing vision and Intelligence”: McGraw Hill Book Company.</li> <li>• Robert, J. Schilling, “Fundamentals of Robotics: Analysis &amp; control”, PHI Private Ltd.</li> <li>• Richard D. Klaffer, “Robotic Engineering: An Integrated Approach”, P.H.I Private Limited.</li> <li>• Dr. Surender Kumar Dr. S.K. Mukherjee, “Robotic Engineering”, SatyaPrakashan,</li> <li>• SatyaRanjan Deb, “Robotics Technology and Flexible Automation”, Tata MC-Graw Hill Publishing Comp. Limited.</li> <li>• J. J. Craig, “Introduction to Robotics Mechanics &amp; Control”, Addison Wesley.</li> </ul>			

**SYLLABUS OF OPEN ELECTIVES**

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO001	Technical Communication	L-T-P:3-1-0	None
<b>COURSE OUTCOMES (CO):</b> <ol style="list-style-type: none"><li>1. The course will improve writing and documentation skills of students with emphasis on the importance of effective communication with focus on choice of words, formation of proper sentence structures and writing styles.</li><li>2. This will enhance the students capability to prepare technical documents and correspondence.</li><li>3. The course will equip the student with good communications skills for placements, preparing SOPs and CVs.</li><li>4. The course will sensitize the students towards research ethics, copyright and plagiarism.</li></ol>			
<b>COURSE CONTENT:</b> <ul style="list-style-type: none"><li>• Definition of communication, meaning, importance &amp; process of communication, objectives, types, C's of communication, barriers to communication</li><li>• human &amp; non -human communication, distinctive features of human languages</li><li>• Business correspondence-definition, meaning and importance of business communication, business letters- purchase, enquiry, quotation, order, followup, acceptance-refusal</li><li>• Emphasis on (i) paragraph writing, its kinds, coherence &amp; cohesion<ul style="list-style-type: none"><li>(ii)writing a paragraph/thesis: selection of topic and its development</li><li>(iii) writing reports, manuals, notices, memos, agendas, minutes</li><li>(iv)Interviews, speeches, presentations,</li></ul></li><li>• research ethics, methodologies, copyright, plagiarism</li></ul>			
<b>SUGGESTED READINGS:</b> <ol style="list-style-type: none"><li>1. Martin Hewing, ``Advanced English Grammar,`` Cambridge University Press</li><li>2. Meenakshi Raman and Sangeeta Sharma, ``Technical Communication,`` Oxford University Press</li></ol>			

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO002	Disaster Management	L-T-P:3-1-0	None

**COURSE OUTCOMES (CO):**

1. Demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

**COURSE CONTENT:**

**Unit -I: Introduction**

Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.

Repercussions Of Disasters And Hazards: Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem.

Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

**Unit -II: Disaster Prone Areas In India**

Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics

**Unit -III: Disaster Preparedness And Management**

Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

**Unit -IV: Risk Assessment**

Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.

**Unit -V: Disaster Mitigation**

Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

**SUGGESTED READINGS:**

1. R. Nishith, Singh AK, `` Disaster Management in India: Perspectives, issues and strategies,`` New Royal book Company
2. Sahni, Pardeep, ``Disaster Mitigation Experiences And Reflections,`` Prentice Hall Of India
3. Goel S. L., ``Disaster Adminastration And Management Text And Case Studies,`` Deep & Deep Publication

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO003	Basics of Financial Management	L-T-P:3-1-0	None
<b>COURSE OUTCOMES (CO):</b>  The course's objective is to provide a theoretical framework for considering corporate finance problems and issues and to apply these concepts in practice. In this course, you will enhance your knowledge and understanding of financial management. You will learn how managers should organize their financial transactions effectively and with integrity and how to give everybody the ability and confidence to tackle common financial problems in practice. It will also provide adequate preparation for future finance classes.			
<b>COURSE CONTENT:</b>  <b>Unit I</b>  Nature, scope and objectives of financial management, Time value of money, Risk and return (including Capital Asset Pricing Model).  <b>Unit II</b>  Long term investment decisions: The Capital Budgeting Process, Cash Flow Estimation, Payback Period Method, Accounting Rate of Return, Net Present Value (NPV), Net Terminal Value, Internal Rate of Return (IRR), Profitability Index.  <b>Unit III</b>  Financing Decisions: Sources of long-term financing, Estimation of components of cost of capital, Methods for calculating Cost of Equity, Cost of Retained Earnings, Cost of Debt and Cost of Preference Capital, Weighted Average Cost of Capital (WACC). Capital Structure-Theories of Capital Structure (Net Income, Net Operating Income, MM Hypothesis, Traditional Approach). Operating and Financial leverage. Determinants of capital structure  <b>Unit IV</b>			

Dividend Decisions: Theories for Relevance and irrelevance of dividend decision for corporate valuation-Walter's Model, Gordon's Model, MM Approach, Cash and stock dividends. Dividend policies in practice.

**Unit V**

Working Capital Decisions: Concepts of Working Capital, Operating & Cash Cycles, sources of short term finance, working capital estimation, cash management, receivables management, inventory management.

**SUGGESTED READINGS:**

1. Khan, M.Y. and P.K. Jain, ``Financial Management: Text and Problems,`` Tata McGraw Hill
2. Srivastava, Rajiv, and Anil Mishra, ``Financial Management,`` Oxford University Press
3. Chandra, P., ``Financial Management-Theory and Practice,`` Tata McGraw Hill.
4. Horne, Van; James C., John Wachowicz, ``Fundamentals of Financial Management,`` Pearson Education.

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO004	Basics of Human Resource Management	L-T-P:3-1-0	None
<b>COURSE OUTCOMES (CO):</b>  This course is designed to provide students with an understanding of human resource management (HRM) functions within organizations, including an appreciation of the roles of both HRM specialists and line managers in designing and implementing effective HRM policies and practices.			
<b>COURSE CONTENT:</b>  <b>Unit - I</b>  Evolution and growth of human resource management (with special reference to scientific management and Human relations approaches).Role of HR in strategic management.Nature.objectives, scope, and functions of HR management.  <b>Unit - II</b>  Challenges of HR (the changing profile of the workforce - knowledge workers, employment opportunities in BPOs, IT and service industries, Flexi options), Workforce diversity (causes, paradox, resolution of diversity by management).  <b>Unit III</b>  HRD; Human resource management as a profession.Concepts of line-staff in the structure of human resource department and the role of human resource manager.  <b>Unit - IV</b>  Manpower planning -objectives, elements, advantages, process. Job design - (simplification, rotation, enlargement, enrichment and approaches}.Job analysis.Job evaluation.  <b>Unit - V</b>			

Recruitment (factors affecting, sources, policy, evaluation). Selection(procedure, tests, interviews). Placement and Induction.

**SUGGESTED READINGS:**

1. Aswathappa K., ``Human Resource and Personnel Management,`` Tata McGraw-Hill
2. Chhabra T.N., ``Human Resource Management,`` Dhanpat Rai and Co.
3. Saiyadain S. Mirza, `` Human Resource Management,`` Tata Mc-Graw Hill
- 4.Chadha, N.K, ``Human Resource Management-issues, case studies, experiential exercises,`` Sri Sai Printographers



<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO005	Project Management	L-T-P:3-1-0	None
<b>COURSE OUTCOMES (CO):</b>  In this comprehensive course, student will learn the fundamentals of project management: how to initiate, plan, and execute a project that meets objectives and satisfies stakeholders. This course provides a step-by-step guide to planning and executing a project and to develop a manageable project schedule.			
<b>COURSE CONTENT:</b>  <b>Unit-I</b>  Objectives of Project Planning, monitoring and control of investment projects. Relevance of social cost benefit analysis, identification of investment opportunities. Pre-feasibility studies.  <b>Unit-II</b>  Project Preparation: Technical feasibility, estimation of costs, demand analysis and commercial viability, risk analysis, collaboration arrangements; financial planning; Estimation of fund requirements, sources of funds.Loan syndication for the projects.Tax considerations in project preparation and the legal aspects.  <b>Unit-III</b>  Project appraisal: Business criterion of growth, liquidity and profitability, social cost benefit analysis in public and private sectors, investment criterion and choice of techniques. Estimation of shadow prices and social discount rate.  <b>Unit-IV</b>  Project review/control-Evaluation of project. PERT/CPM.resource handling/leveling.  <b>Unit-V</b>  Cost and Time Management issues in Project planning and management , success criteria and success factors, risk management.			
<b>SUGGESTED READINGS:</b>			

1. Ravi Ravindran, `` Operations Research and Management Science Handbook,’’ CRC Press
2. Harold Kerzner, ``Applied Project Management: Best Practices on Implementation,’’ John Wiley & Sons
3. Goodpasture, J. C., ``Quantitative Methods in Project Management,’’ J Ross Publishing
4. Meredith, J. R. and Mantel Jr., S. J., ``Project Management: A Managerial Approach,’’ John Wiley
5. Clifford Gray, ``Project Management,’’ Richard D. Irwin

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO006	Basics of Corporate Law	L-T-P:3-1-0	None

**COURSE OUTCOMES (CO):**

The objective of this Course is to provide in-depth knowledge of the Corporate laws and process related to integrate these aspects of management studies in decision making within an organization; analyze and interpret management information; make decisions based on the information available; communicate information effectively; understand and apply the theoretical aspects of accounting methods used for collecting, recording and reporting financial information; explain and appraise the taxation laws which govern corporations and individuals.

**COURSE CONTENT:**

**Unit I: Introduction :** Administration of Company Law, characteristics of a company; common seal; lifting of corporate veil; types of companies including private and public company, government company, foreign company, one person company, small company, associate company, dormant company, producer company; association not for profit; illegal association; formation of company, promoters and their legal position, pre incorporation contract and provisional contracts; on-line registration of a company.

**Unit II: Documents:** Memorandum of association and its alteration, articles of association and its alteration, doctrine of constructive notice and indoor management, prospectus, shelf prospectus and red herring prospectus, misstatement in a prospectus; GDR; book building; issue, allotment and forfeiture of shares, calls on shares; public offer and private placement; issue of sweat capital; employee stock options; issue of bonus shares; transmission of shares, buyback and provisions regarding buyback; share certificate; D-Mat system; membership of a company.

**Unit III: Management and Meetings:** Classification of directors, additional, alternate and adhoc director; women directors, independent director, small shareholders' director; director identity number (DIN); appointment, who can appoint a director, disqualifications, removal of directors; legal position, powers and duties; key managerial personnel, managing director, manager; meetings of shareholders and board; types of meeting, convening and conduct of meetings, requisites of a valid meeting; postal ballot, meeting through video conferencing, e-voting; committees of board of directors – audit committee, nomination and remuneration

committee, stakeholders relationship committee, corporate social responsibility committee; prohibition of insider trading.

**SUGGESTED READINGS:**

1. Hicks, Andrew & Goo S.H., ``Cases and Material on Company Law,’’ Oxford University Press
2. Gowar, LCB, ``Principles of Modern Company Law,’’ Stevens & Sons, London.
3. Majumdar, A.K., and G.K. Kapoor, ``Company Law and Practice,’’ Taxmann
4. Hanningan, Brenda, ``Company Law,’’ Oxford University Press
5. Sharma, J.P., ``An Easy Approach to Corporate Laws,’’ Ane Books Pvt. Ltd
9. Ramaiya, ``A Guide to Companies Act,’’ Lexis Nexis Buttersworth wadhwa
6. Kannal, S., and V.S. Sowrirajan, ``Company Law Procedure,’’ Taxman’s Allied Services (P) Ltd.

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO007	Biological Computing	L-T-P:3-1-0	None
<b>COURSE OUTCOMES (CO):</b>  1. To understand computing in context of biological systems 2. To understand computing languages needed to solve biological problems 3. To acquire computational skills for analysis of biological processes through grid computing 4. To gain knowledge of different biological databases and their usage 5. To gain innovative insight into DNA computing			
<b>COURSE CONTENT:</b>  <b>Introduction</b> , Orientation and UNIX,  <b>Python:</b> Introduction to Variables and Control flow, Python II - Parsing In and Output, Python III - Scripting and Functions, Python IV- Number Crunching and Plotting,  <b>Grid computing</b> , Biogrid, R basics and Visualization, Unix for fast text processing, SQL, Database  <b>Biological databases</b> , R for speed, R for fun, Local BLAST, Unit Testing and Code Correctness  <b>DNA computing</b> ,			
<b>SUGGESTED READINGS:</b>  1. H. Bolouri, R. Paton, `` Computations in cells & tissues,`` Springer  2. Haubold, Bernhard, Wiehe, Thomas, `` Introduction to Computational Biology: An Evolutionary Approach,`` Springer			

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO008	Basics of Social Sciences	L-T-P:3-1-0	None
<b>COURSE OUTCOMES (CO):</b>  <b>Social science</b> is a major category of academic disciplines, concerned with society and the relationships among individuals within a society. It in turn has many branches, each of which is considered a "social science".			
<b>COURSE CONTENT:</b>  <b>Unit I:</b> Economics, political science, human geography, demography and sociology.  <b>Unit II:</b> Humanities, anthropology, archaeology, jurisprudence, psychology, history, and linguistic.  <b>Unit III:</b> Political science, economics, sociology, international politics and scientific methodology.			
<b>SUGGESTED READINGS:</b>  1. A.C. Kapoor, "Principles of Political Science," S. Chand Publications 2. A.K. Sharma, "Issues in Social Demography," Mittal Publications 3. Kathy S. Stolley, "The Basics of Sociology," Greenwood Press. 4. Paul M. Muchinsky, "Psychology Applied to Work," Thomson Learning Inc			

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO009	Entrepreneurship	L-T-P:3-1-0	None
<b>COURSE OUTCOMES (CO):</b>			
This Course Aims at Instituting Entrepreneurial skills in the students by giving an overview of who the entrepreneurs are and what competences are needed to become an entrepreneur.			
<b>COURSE CONTENT:</b>			
<b>Unit I-Introduction:</b>			
Concept and Definitions, Entrepreneur v/s Intrapreneur; Role of entrepreneurship in economic development; Entrepreneurship process; Factors impacting emergence of entrepreneurship; Managerial versus entrepreneurial Decision Making; Entrepreneur v/s Investors; Entrepreneurial attributes and characteristics; Entrepreneurs versus inventors; Entrepreneurial Culture; Women Entrepreneurs; Social Entrepreneurship; Classification and Types of Entrepreneurs; EDP Programmes; Entrepreneurial Training; Traits/Qualities of an Entrepreneurs.			
<b>Unit II- Creating Entrepreneurial Venture:</b>			
Generating Business idea- Sources of Innovation, methods of generating ideas, Creativity and Entrepreneurship; Challenges in managing innovation; Business planning process; Drawing business plan; Business plan failures; Entrepreneurial leadership- components of entrepreneurial leadership; Entrepreneurial Challenges; Legal issues – forming business entity, considerations and Criteria, requirements for formation of a Private/Public Limited Company, Intellectual Property Protection- Patents Trademarks and Copyrights – importance for startups, Legal Acts Governing Business in India.			
<b>Unit III-Functional plans:</b>			
Marketing plan– for the new venture, environmental analysis, steps in preparing marketing plan, marketing mix, contingency planning; Organizational plan – designing organization structure and Systems; Financial plan – pro forma income statements, pro forma cash budget, funds Flow and Cash flow statements; Pro forma balance sheet; Break Even Analysis; Ratio Analysis.			

**Unit IV- Entrepreneurial Finance:**

Debt or equity financing, Sources of Finance- Commercial banks, private placements, venture capital, financial institutions supporting entrepreneurs; Lease Financing; Funding opportunities for Startups in India.

**Unit V- Enterprise Management:**

Managing growth and sustenance- growth norms; Factors for growth; Time management, Negotiations, Joint ventures, Mergers & acquisitions.

**SUGGESTED READINGS:**

1. Kumar, Arya, `` Entrepreneurship: Creating and Leading an Entrepreneurial Organization'', Pearson
2. Hishrich., Peters, ``Entrepreneurship: Starting, Developing and Managing a New Enterprise,`` Irwin
3. Taneja, ``Entrepreneurship,`` Galgotia Publishers.
4. Barringer, Brace R., and R. Duane, ``Entrepreneurship,`` Pearson Prentice Hall
5. Hisrich, Robert D., Michael Peters and Dean Shephered, ``Entrepreneurship,`` Tata McGraw Hill
6. Lall, Madhurima, and Shikha Sahai, ``Entrepreneurship,`` Excel Books
7. Charantimath, Poornima, ``Entrepreneurship Development and Small Business Enterprises,`` Pearson Education



<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO010	Social work	L-T-P:3-1-0	None

**COURSE OUTCOMES (CO):**

In this course students will learn about various methods of social work, about community organization, social welfare administration, Problems pertaining to Marriage, Family and caste

**COURSE CONTENT:**

**Unit 1.Social work**

Philosophy and Methods. Social work: Meaning, Objectives, Scope, Assumptions & Values; History of Social work in U.K. U.S.A.and India, philosophy of Social Work. Democratic (Equality, Justice Liberty & Fraternity) and Humanitarian (Human Rights) Matrix.Social works as a profession.

**Unit 2. Methods of Social work**

Meaning, Scope Principles, Processes (Psychosocial study, Assessments, treatment-goal formulation and techniques), Evaluation, Follow-up and Rehabilitation. Social Groups work: Meaning, Objective, Principles, Skills, Processes (Study, Diagnosis, treatment and evaluation), Programme, Planning and Development, Role of Social group worker, Leadership Development.

**Unit 3 Community organization**

Meaning, Objective, Principles, Approaches, Roles of Community Organization Worker.

**Unit 4 Social Welfare Administration**

Meaning Scope, Auspices-Private and Public, Principles, Basic Administrative Processes and Practice decision making communication, planning.organisation, budgeting and financial control, reporting. Social work Research: Meaning objectives, types, scope, scientific method, Selection and formulation of the problem Research Design Sampling, Sources and Methods of Data Collection, Processing of Data, analysing and interpretation, Report writing. Social Action: Meaning, Scope, approaches (Sarvodaya, Antyodaya etc.) and Strategies.

**Unit 5 Work in India Problem pertaining to Marriage, Family and caste**

Dowry- child Marriage, Divorce, Families with working couples, Disorganised Families, Families with Emigrant Heads of the Households, Gender Inequality, Authoritarian Family structure, Major Changes in Caste systems and problem of casteism. Problems Pertaining of Weaker Sections. Problems of Children, Women Aged. Handicapped and Backward Classes (SCs, STs, and other Backward Classes). Problems of Deviance: Truancy Vagrancy and Juvenile Delinquency, Crime, White Colla Crime, Organized Crime, Collective Violence, Terrorism, Prostitution and Sex Related Crimes. Social Vices: Alcoholism. Drug Addiction, Beggary, Corruption and communalism. Problems of Social Structure : Poverty, Unemployment, Bonded Labour, Child Labour. Fields of Social work India : Child Development, Development of Youth, Women's Empowerment, Welfare of aged, Welfare of Physically. Mentally and Social Handicapped, Welfare of backward Classes (Scs, STs and Other

Backward Classes) Rural Development Urban Community Development, Medical And Psychiatric Social work, Industrial Social work, Social Security offender Reforms.

**SUGGESTED READINGS:**

1. Rajni Bedi, ``Social Work: An Introductory Text Book,`` Regal Publication
2. Sanjay Bhattacharya, ``Social Work: An Integrated Approach,`` Deep and Deep Publication
3. Nitesh Dhawan, ``Social work perspective Philosophy and Methods,`` Bharat Book Center
4. P. R. Gautam, ``Social Work: Methods Practices And Perspectives,`` Centrum Press

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO011	Intellectual Property and Patenting	L-T-P:3-1-0	None

**COURSE OUTCOMES (CO):**

The objective of this Course is to provide in-depth knowledge of the laws and process related to Trademarks, Copyrights and other forms of IPs with focus on Patents, the Indian and International Patent filing procedure, drafting patent application and conducting prior art searches. Students will be exposed to the technical, management and legal aspects of IP and Patents.

**COURSE CONTENT:**

**UNIT I: Introduction:** Historical and philosophical background of patents and other intellectual property, Patent System: the Constitution, Congress, Patent Office (PTO), and courts; Analyzing and understanding judicial opinions

**UNIT II: Comparative overview of patents, copyrights, trade secrets, and trademarks:** Legal fundamentals of patent protection for useful inventions, Design and plant patents, Legal fundamentals of copyright protection, Similarity and access, Expression vs. ideas and information, merger, Fair use of copyrighted works (e.g., for classroom use), Contributory copyright infringement, Critical differences between patent and copyright protection, Copyright infringement distinguished from plagiarism, Legal fundamentals of trade-secret protection, Legal fundamentals of trademark protection

**UNIT III: Requirements and limitations of patentability:** New and useful: (A) The legal requirement of novelty (B) First to invent vs. first inventor to file, The legal requirement of non-obviousness.

**UNIT IV: The process of applying for a patent ("patent prosecution"):** Anatomy of a patent application, Adequate disclosure, The art of drafting patent claims, Patent searching: (A) Purposes and techniques, Actions for patent infringement, Interpretation of claims, Doctrine of equivalents, Product testing as a possibly infringing use, Doctrine of exhaustion

**SUGGESTED READINGS:**

1. Robert H. Rines, ``Create or Perish: The Case for Inventions and Patents,`` Acropolis.

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO012	Supply Chain Management- Planning and Logistics	L-T-P:3-1-0	None
<p><b>COURSE OUTCOMES (CO):</b></p> <p>Supply chain management consist of all parties (including manufacturer, marketer, suppliers, transporters, warehouses, retailers and even customers) directly or indirectly involved in fulfillment of a customer. The main objective is to acquaint the students with the concepts and tools of supply chain management and logistics as relevant for a business firm.</p>			
<p><b>COURSE CONTENT:</b></p> <p><b>Unit I</b></p> <p><b>Introduction:</b> Concept of supply chain management (SCM) and trade logistics; Scope of logistics; Logistic activities – an Overview; Contribution of logistics at macro and micro levels; SCM and trade logistics; Business view of SCM; Concept, span and process of integrated SCM; Demand management – methods of forecasting; Supply chain metrics (KPIs), performance measurement and continuous improvement; Product development Process and SCM; Strategic role of purchasing in the supply chain and total customer satisfaction; Types of purchases; Purchasing cycle.</p> <p><b>Unit II</b></p> <p><b>Managing Relationship:</b> Role of Relationship marketing in SCM; Managing relationships with suppliers and customers; Captive buyers and suppliers; Strategic partnerships; Supplier-retailer collaboration and alliances.</p> <p><b>Unit III</b></p> <p><b>Focus Areas of Logistics and Supply Chain management:</b> Transportation-Importance of effective transportation system; Service choices and their characteristics; inter-modal services; Transport cost characteristics and rate fixation; In-company management vs. out-sourcing; World sea borne trade; International shipping- characteristics and structure; Liner and tramp operations; Liner freighting; Chartering-Types, principles and practices; Development in sea</p>			

transportation-Unitization, containerisation, inter and multimodal transport; CFC and ICD. Air transport: Set up for air transport and freight rates; Carriage of Goods by sea -Role and types of cargo intermediaries. Warehousing and inventory management: Reasons for warehousing; Warehousing evaluation and requirements; Warehousing location strategies; Inventory management principles and approaches; Inventory categories -EOQ, LT, ICC; Material management systems and techniques – JIT purchasing, manufacturing and in-bound logistics; Packing and marking; Control and communication.

**Unit IV**

**IT Enabling Logistics and Supply Chain:** Technology in logistics – EDI, bar Coding, RFID etc., data warehousing, electronic payment transfers; Business management systems; TRADITIONAL ERP, SPECIAL ERP, MR, DRP, PDM, EIP, CPFR, WMS, TMS; Re-engineering the supply chain- Future directions.

**Unit V**

**Trends and Challenges in logistics and supply chain management:** Third party logistic outsourcing –challenges and future directions.

**SUGGESTED READINGS:**

1. M. Christopher, ``Logistics and Supply Chain Management,’’ Prentice Hall.
2. Handfield and Nicholas, Jr, `` Introduction to Supply Chain Management,’’ Prentice Hall.
3. Jhon J Coyle, C. Jhon and Langley, Brian J Gibs, ``Logistics approach to Supply Chain Management,’’ Cengage Learning.

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO013	Organization Development	L-T-P:3-1-0	None
<b>COURSE OUTCOMES (CO):</b>			
<p>Organisation Development is a growing field of Human Resource Management. It has its foundations in a number of behavioural and social sciences .</p>			
<b>COURSE CONTENT:</b>			
<p>1. Organizational Systems and Human Behaviour - Developing a basic knowledge of how organizations and groups function as systems; introducing and discussing various theoretical approaches and issues.</p> <p>2. Interpersonal and Consulting Skills - Increasing effectiveness as a change agent by providing a variety of opportunities in order to increase self-awareness, practice alternative ways of approaching personal and interpersonal problem-solving and develop basic consulting and interviewing skills.</p> <p>3. Introduction to Organization Development - Introducing some basic theories, models and methods in the field of organization development, especially those relating to the role of consultant and strategies for change.</p> <p>4. Intervention and Change in Organizations - Consolidating and further developing consulting skills and strategies</p> <p>5. Action Research Project - Carrying out a change activity in an organization, while also researching the effects and/or the process. This provides participants with an opportunity to consolidate and demonstrate skills and knowledge gained in other units of the course</p>			
<b>SUGGESTED READINGS:</b>			
<ol style="list-style-type: none"> <li>1. Wendell L. French, Cecil H. Bell Jr., Veena Bohra, "Organization development," Pearson Prentice Hall.</li> <li>2. Donald L. Anderson, "Organization Development: The process of leading organizational change," Sage Publications, Inc.</li> <li>3. W. Warner Burke, Debra A. Noumair, "Organization Development: A process of learning and changing," Pearson Education Ltd.</li> </ol>			

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO014	Industrial Organization and Managerial Economics	L-T-P:3-1-0	None
<b>COURSE OUTCOMES (CO):</b>  This course help students in understanding the basics of management and Industrial organization			
<b>COURSE CONTENT:</b>  <b>Unit I:</b> Principles of management, General idea, various functions, scope of engineering. Organisation structure, Types, merits and demerits. <b>Unit II:</b> Plant location and layout, Factors effecting location, types of layout. Production planning and control, Sequence of planning and control of production. Scheduling , routing, despatching., Methods Study, Methods analysis, time study methods of rating. <b>Unit III:</b> General idea of personnel management, Industrial psychology, job evaluation and monitoring. Business decision making and forward planning. Demand and demand forecasting of production analysis- prices and pricing decision-profit and capital, management. Analysis of inter-industry relation, macro-economics and business.			
<b>SUGGESTED READINGS:</b>  1. Lawrence L. Bethel ,“Industrial organization and management” McGraw-Hill 2. Ralph Currier Davis,“Industrial organization and management” Harper & Row 3. James L. Riggs, Lawrence L. Bethel,“Industrial organization and management” McGraw-Hill 4. Richard Hines Lansburgh, William Robert Spriegel, “Industrial management” John Wiley 5. Harold T. Amrine, John A Ritchey, Colin L. Moodie, Joseph F. Kmec, ”Manufacturing Organization and Management” Pearson Education India.			

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO015	Global Strategies and Technology	L-T-P:3-1-0	None
<b>COURSE OUTCOMES (CO):</b>			
<b>Course Objectives</b> This subject focuses on the specifics of strategy and organization of the multinational company, and provides a framework for formulating successful and adaptive strategies in an increasingly complex world economy.			
<b>COURSE CONTENT:</b> Globalization of industries, the continuing role of country factors in competition, organization of multinational enterprises, and building global networks Analysis of competitive situations from the general management point of view, including fit between key environmental forces and the firm's resources, and changes in these over time. Formulating and implementing strategy based on that analysis. Developing and leveraging a firm's core competencies to gain long-term sustainable advantage.			
<b>SUGGESTED READINGS:</b> <ol style="list-style-type: none"><li>1. Kazuyuki Motohashi ,”Global Business Strategy” Springer</li><li>2. M. Pinedo, I. Walter, “Global Asset Management: Strategies, Risks, Processes, and Technologies” SimCorp, strategylab</li><li>3. Frank McDonald and Richard Thorpe, “ Organizational Strategy and Technological Adaptation to Global Change” Macmillan Business</li><li>4. Prashant Palvia, Shailendra C. Jain Palvia, Albert L. Harris ,” Managing Global Information Technology : Strategies and Challenges</li><li>5. McDonald, Frank, Thorpe, Richard, “Organizational Strategy and Technological Adaptation to Global Change” Macmillan Business</li></ol>			



<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO016	Engineering System analysis and Design	L-T-P:3-1-0	None
<b>COURSE OUTCOMES (CO):</b>  The students will learn about system definitions and role of system analyst. They will learn about system modeling and design. They will be exposed to System Implementation and Maintenance issues.			
<b>COURSE CONTENT:</b>  <b>Unit 1</b>  System definition and concepts: Characteristics and types of system, Manual and automated systems  Real-life Business sub-systems: Production, Marketing, Personal, Material, finance Systems models types of models: Systems environment and boundaries, Real time and distributed systems, Basic principles of successful systems  <b>Unit 2</b>  Systems analyst: Role and need of systems analyst, Qualifications and responsibilities, Systems Analyst, agent of change.  Various phases of systems development life cycle: Analysis, Design, Development, Implementation, Maintenance  <b>Unit3</b>  Systems Design and modeling:Process modeling, Logical and physical design, Design representation, Systems flowcharts and structured charts, Data flow diagrams, Common diagramming conventions and guidelines using DFD and ERD diagrams. Data Modeling and systems analysis, designing the internals: Program and Process design, Designing Distributed Systems  <b>Unit 4</b>			

User Interfaces – Relational Analysis – Database design – program design– structure chart – HIPO – SSADM – Alternate Life cycles – Prototypes.

**Unit 5**

System Implementation and Maintenance: Planning considerations, Conversion methods, producers and controls, System acceptance Criteria, System evaluation and performance, Testing and validation, Systems quality Control and assurance, Maintenance activities and issues.

**SUGGESTED READINGS:**

- 1) Haryszkiewicz, ``Introduction to Systems Analysis and Design,’’ Prentice Hall India
- 2) James A Senn , ``Analysis and Design of Information Systems,’’ McGraw Hill

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO017	Biology For Engineers	L-T-P:3-1-0	None
<p><b>COURSE OUTCOMES (CO):</b></p> <ol style="list-style-type: none"> <li>1. General understanding of organization in biological systems</li> <li>2. Conceptual knowledge of functioning in biological systems</li> <li>3. Clarity about relevance of Biology to engineering graduates</li> <li>4. Understanding human body as a study-model for engineering students</li> <li>5. Understanding electrical, chemical and magnetic forces, and communication networks in human body</li> </ol>			
<p><b>COURSE CONTENT:</b></p> <p><b>Unit I: Principles of Biology:</b> Form and Function, Modularity and Incremental Changes, Genetic Basis, Competition and Selection, Biological Hierarchies, Biological complexity vs simplicity</p> <p><b>Unit II: Biological Responses:</b> Need for Water, Oxygen, Food, Nutrients, Heat Sources and Sinks, Adaptation to their Environments, Waste tolerance, Response to Chemical and Mechanical Stresses, Optimization to Save Energy and Nutrient Resources, <b>Allometric Relationships from Evolutionary Pressure</b></p> <p><b>Biology for Engineering Solutions:</b> Systems Approach, Relationships between Engineering and Biology, The Completed Design</p> <p><b>Biological Systems and Dynamics: Basic principles,</b> Qualitative and quantitative description of Human Body, Modeling of Human Body: Compartments, Fluid streams, Production sources, The Hemodynamic System, Cheyne-Stokes Respiration,</p> <p><b>Neural system:</b> Action Potentials and Ion Channels, Ficks Law, Ohms Law and the Einstein Relation, Cellular Equilibrium: Nernst and Goldman, Equivalent Circuits, Dendrites;</p> <p><b>Mathematical Neurodynamics:</b> Hodgkin, Huxley and the Squid Giant Axon FitzHugh-Nagumo Model, Fixed Points and Stability of a One-Dimensional Differential Equation, Nullclines and Phase Plane, Pitchfork and Hopf Bifurcations in Two Dimensions</p> <p>Excitability</p> <p>Bioelectric and biomagnetic phenomena and their measurements</p>			
<p><b>SUGGESTED READINGS:</b></p>			

1. T. Johnson, `` Biology for Engineers,`` CRC Press
2. Michael Small, `` Dynamics of Biological system,`` CRC Press
3. Johnny T. Ottesen, MS Olufsen, JK Larsen, ``Applied Mathematical Models and Human Physiology,`` Society for Industrial and Applied Mathematics

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO018	Energy, Environment and Society	L-T-P:3-1-0	None
<b>COURSE OUTCOMES (CO):</b>  The objective is to aware students about various renewable resources, Basics of energy, environmental Impact of Energy sources. Students will also learn about the role of appropriate Technology in Transformation of Society			
<b>COURSE CONTENT:</b>  <b>Unit 1</b> Technology and Development  Introduction to Technology, Appropriate Technology, Role of Appropriate Technology in Transformation of Society, Importance of Technology Transfer, Impact of technology on Society.  <b>Unit 2</b> Energy Basics  Importance of Energy in achieving Maslow's hierarchy of Needs, Human Development Index and Energy Consumption, Current Energy Trends, Demand and Supply of Energy in World and Nepal, Introduction to Global warming, Clean Development Mechanism, and Sustainability Issues, Conventional and Non-Conventional/Renewable Energy Sources,., Conventional Energy Sources: Fossil fuel, Nuclear Energy  <b>Unit 3</b> Renewable Energy Sources  Solar radiation, Solar thermal energy, Solar Cell (Photovoltaic Technology), Hydropower Water sources and power , Water turbines and hydroelectric plants, Hydro Power Plant Classification (pico, micro, small, medium, large), Wind Energy , Availability of Wind Energy sources, Wind turbines, wind parks and power control, Geothermal Energy, Sources of Geothermal Energy, Uses of Geothermal Energy, .Bio-mass and Bio-energy, Synthetic fuels from the biomass ,Thermo-chemical, physio-chemical and bio-chemical conversion, Bio-fuel cells , Hydrogen Energy and Fuel Cell , Basics of electrochemistry, Polymer membrane electrolyte (PEM) fuel cells, Solid oxide fuel cells (SOFCs) , Hydrogen production and storage.			

**Unit 4** Environmental Impact of Energy sources : Emission hazard, Battery hazard, Nuclear hazard

**Unit 5** Energy Storage

Forms of energy storage, Hybrid vehicles, Smart grid systems, Batteries, Super-capacitors

**SUGGESTED READINGS:**

1) A. B. Saxena, ``A Textbook of Energy, Environment, Ecology and Society,`` New Age Publication

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO019	Public Policy and Governance	L-T-P:3-1-0	None
<b>COURSE OUTCOMES (CO):</b> Students will be introduced to Public Policy and Administrative governance. They will also learn about Administrative Governance.			
<b>COURSE CONTENT:</b> <b>Unit 1</b> Introduction to Public Policy and Administrative Governance: Introduction to public policy, econometrics for policy research, policy analysis, economics for public decision making. <b>Unit 2</b> Public Bureaucracy in Theory and Practice: Benefit cost analysis, public budgeting, revenue and expenditures, managing and leading public service organisations. <b>Unit 3</b> Administrative Governance: The Challenge of Policy Implementation, public and non-profit programme evaluation. <b>Unit 4</b> Non-state Actors in Policy-making and Administrative Governance: governance in twenty-first century, Social Diversity and the Question of “Difference” in Policy-making and administrative Governance			
<b>SUGGESTED READINGS:</b> 1. John Shields and B. Mitchell Evans., `` <i>Shrinking the State: Globalization and Public administration reform,</i> ’’ Halifax: Fernwood 2. Beryl Radin, Beyond Machiavelli, `` Policy Analysis Reaches Midlife,’’ Georgetown University Press 3. Frank R. Baumgartner, Jeffrey M. Berry, Marie Hojnacki, and David C. Kimball, ``Lobbying and Policy Change: Who Wins, Who Loses, and Why,’’ University of Chicago Press. 4. Timothy Conlan, Paul Posner, and David Beam, ``Pathways of Power: The dynamics of National Policymaking,’’ Georgetown University press.			

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO020	Numerical Methods	L-T-P:3-0-2	None
<b>COURSE OUTCOMES (CO):</b>			
1. Write program and solve algebraic & transcendental equations and system of equations. 2. Analyze data through interpolation and able to write programs for Numerical Integration. 3. Write programs to solve Ordinary Differential Equations and Partial Differential Equations.			
<b>COURSE CONTENT:</b>			
<p><b>Solution of Algebraic and Transcendental Equations:</b> Bisection method, Regula Falsi method, Secant methods, Newton's method, Rate of convergence, Fixed-point iteration method.</p> <p><b>System of Linear Algebraic Equations:</b> Gauss elimination method, Gauss-Jordan method, Crout's method, Jacobi's method, Gauss-Seidel method, Relaxation method.</p> <p><b>Interpolation:</b> Finite difference operators, Interpolating polynomials using finite difference (Newton forward, Newton backward, Stirling and Bessels). Lagrange polynomials, divided difference</p> <p><b>Numerical Differentiation and Integration:</b> Derivatives from differences tables, Higher order derivatives, Newton-Cotes integration formula, Trapezoidal rule, Simpson's rules and error estimation, Romberg's Integration.</p> <p><b>Numerical Solution of Ordinary Differential Equations:</b> Taylor series method, Euler and Modified Euler method, Runge-Kutta methods, Milne's method.</p> <p><b>Numerical Solution of Partial Differential Equations:</b> Finite difference approximations of partial derivatives, Solution of Laplace equation and Poisson's method (Standard 5-point formula only), One-dimensional heat equation (Schmidt method, Crank-Nicolson method) and Wave equation.</p> <p><b>Practical:</b> Based on the above methods using C / C++</p>			
<b>SUGGESTED READINGS:</b>			
1 Curtis F. Gerald and Patrick G. Wheatley, ``Applied Numerical Analysis,`` Pearson, Education Ltd. 2 E. Balagurusamy, ``Numerical Method,`` Tata McGraw Hill 3 M. K. Jain, S. R. K. Iyenger and R. K. Jain, ``Numerical Methods for Scientific and Engg. Computations,`` Wiley Eastern Ltd. 4. S. S. Sastry, ``Introductory Methods of Numerical Analysis,`` Prentice hall India			



<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO021	Mathematical Statistics	L-T-P:3-1-0	None
<p><b>COURSE OUTCOMES (CO):</b></p> <ol style="list-style-type: none"> <li>1. Collect and analyze the data using statistical techniques.</li> <li>2. Describe sampling distributions of sample means and sample proportions</li> <li>3. Estimate unknown parameters of the population from a sample.</li> <li>4. Construct confidence intervals for mean difference of means and proportions; and perform hypothesis tests for means.</li> </ol>			
<p><b>COURSE CONTENT:</b></p> <p>Random Variable, Moments, Rectangular distribution, Exponential distribution, Beta distribution of first and second kind, Gamma distribution, Marginal and Conditional probabilities, Tchebycheff's and Markov's inequalities, Important theoretical Distributions: Binomial, Poisson, Normal and Multinomial distributions and their properties, Fitting of Normal Distribution by Method of ordinates and Method of areas, Dirichlet distribution, Moment Generating Functions and Cumulants, Weak Law of Large Numbers, Central Limit Theorem.</p> <p><b>Method of least square:</b> Fitting a straight line, Parabola and Exponential Curves.</p> <p><b>Bivariate distribution:</b> Correlation and Regression, Probable Error, Rank Correlation.</p> <p>Simple sampling of Attributes: Large samples, Mean and S.D. in simple sampling of attributes, Test of significance for large samples, Standard error, Null Hypothesis, Confidence Limits, Chi-Square Distribution, Degree of Freedom, m. g. f. of Chi square distribution, Level of Significance, Test of Goodness of Fit, Test of Independence, Coefficient of Contingency, Yate's Correction for Continuity.</p> <p><b>Sampling of Variables:</b> Small samples, t-Distribution, Test of significance of the mean of random sample from Normal population, F-Distribution, ANOVA: Analysis of variance, meaning and definition, Variance within and between classes, One criterion of Classification and problems based on it.</p>			
<p><b>SUGGESTED READINGS:</b></p> <ol style="list-style-type: none"> <li>1. Walpole, "Probability and Statistics for Engineers and Scientists," Prentice Hall</li> <li>2. S. M. Ross, "Introduction to Probability and Statistics for Engineers and Scientists," Academic Press.</li> </ol>			

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO022	Abstract and Linear Algebra	L-T-P:3-1-0	None
<b>COURSE OUTCOMES (CO):</b>			
<ol style="list-style-type: none"> <li>1. Know the concepts of Group theory and its applications</li> <li>2. Know the concept of Rings</li> <li>3. Know the concepts of Vector Spaces and Linear Transformations</li> </ol>			
<b>COURSE CONTENT:</b>			
<p><b>GROUPS:</b> Binary operation, Group, Finite and Infinite Groups, Order of a Group, Additive and Multiplicative groups of integers (mod m). Composition table, Subgroup, Permutation group, Cyclic permutation, even and odd permutations, Cayley's Theorem, Isomorphism, Automorphism, homomorphism, Lagrange's Theorem, Quotient Group, Cyclic Group, Normal Subgroup, Centre of a group, Normalizer, Homomorphism, Isomorphism.</p> <p><b>RINGS:</b> Rings, Integral domain, Field, Theorems on Rings, Integral domain and Fields, Subrings, Left and Right Ideals, Quotient Ring, Homomorphism, Isomorphism, Kernel of a homomorphism.</p> <p><b>VECTOR SPACES:</b> Vector space and its examples, Subspaces, Linear combinations, Linear spaces, Linear dependence and Linear Independence, Cauchy-Schwarz's inequality, Minkowski inequality, Basis, Dimension and simple examples. Linear Transformation, Isomorphism, Nullity and Rank, Linear functional, Linear operators, Dual Space, Dual Basis, Annihilator, Transpose of a Linear map.</p>			
<b>SUGGESTED READINGS:</b>			
<ol style="list-style-type: none"> <li>1. I. N. Herstein, ``Topics in Algebra, '' Wiley Publishing</li> <li>2. J. B. Fraleigh, ``A First Course in Algebra, '' Narosa Publication</li> </ol>			

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO023	Optimization Techniques	L-T-P:3-1-0	None
<b>COURSE OUTCOMES (CO):</b> <ul style="list-style-type: none"><li>• Know the concepts of Linear Programming</li><li>• Know the concept of Non-linear Programming</li><li>• Know the concepts of Dynamite Programming</li></ul>			
<b>COURSE CONTENT:</b> <p>Linear programming, Duality Theory, dual Simplex method, Revised Simplex method, Sensitive analysis.</p> <p>Integer Programming, Cutting plane algorithm.</p> <p>Branch and bound technique, travelling salesman problem.</p> <p>Nonlinear Programming, Kuhn-Tucker conditions, quadratic programming, Wolfe's algorithm.</p> <p>Dynamite programming, Deterministic and stochastic examples. Advanced queuing Models, Finite source queues, Balking and Reneging, Priority queue disciplines.</p>			
<b>SUGGESTED READINGS:</b> <ol style="list-style-type: none"><li>1. Hamdy Taha, ``Operations Research, An Introduction,`` Pearson Education</li><li>2. J R Fletcher, ``Practical Methods of Optimization,`` Wiley Publishing</li></ol>			

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO024	Introduction to Mathematical Software and Programming Languages	2L-0T-4P	None
<b>COURSE OUTCOMES (CO):</b> <ul style="list-style-type: none"><li>• Know using different Mathematical Software to solve Engineering Problems.</li><li>• Know preparing Texts/ Reports / Dissertation and presentations using Latex</li></ul>			
<b>COURSE CONTENT:</b> <p>Use of MATHEMATICA, MATLAB, MATHCAD, MAPLE, STASTITICA, LATEX, and other application software packages to study models of simultaneous equations, eigenvalues and eigenvectors, system of linear and non-linear differential equations, stability analysis, numerical integration, regression analysis, etc.</p>			
<b>SUGGESTED READINGS:</b> <ol style="list-style-type: none"><li>1. Online Manuals of the related Software.</li></ol>			

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO025	Mathematical Finance	L-T-P:3-1-0	None

**COURSE OUTCOMES (CO):**

Mathematical Methods for Finance covers topics from calculus and linear algebra that are fundamental for the study of mathematical finance. Students successfully completing this course will be mathematically well prepared to study quantitative finance at the graduate level.

**COURSE CONTENT:**

Basic principles: Comparison, arbitrage and risk aversion, Interest (simple and compound, discrete and continuous), time value of money, inflation, net present value, internal rate of return (calculation by bisection and Newton-Raphson methods), comparison of NPV and IRR. Bonds, bond prices and yields, Macaulay and modified duration, term structure of interest rates: spot and forward rates, explanations of term structure, running present value, floating-rate bonds, immunization, convexity, puttable and callable bonds.

Asset return, short selling, portfolio return, (brief introduction to expectation, variance, covariance and correlation), random returns, portfolio mean return and variance, diversification, portfolio diagram, feasible set, Markowitz model (review of Lagrange multipliers for 1 and 2 constraints), Two fund theorem, risk free assets, One fund theorem, capital market line, Sharpe index. Capital Asset Pricing Model (CAPM), betas of stocks and portfolios, security market line, use of CAPM in investment analysis and as a pricing formula, Jensen's index. Forwards and futures, marking to market, value of a forward/futures contract, replicating portfolios, futures on assets with known income or dividend yield, currency futures, hedging (short, long, cross, rolling), optimal hedge ratio, hedging with stock index futures, interest rate futures, swaps. Lognormal distribution, Log-normal model / Geometric Brownian Motion for stock prices, Binomial Tree model for stock prices, parameter estimation, comparison of the models. Options, Types of options: put / call, European / American, pay off of an option, factors affecting option prices, put call parity.

**SUGGESTED READINGS:**

1. David G. Luenberger , ``Investment Science, ‘‘ Oxford University Press

<p>2. John C. Hull, ``Options, Futures and Other Derivatives,`` Prentice Hall India</p> <p>3. Sheldon Ross, `` An Elementary Introduction to Mathematical Finance,`` Cambridge University Press</p>
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Course No.	Title of the Course	Course Structure	Pre-Requisite
EO026	Quantum Electronics	L-T-P:3-0-2	None

**COURSE OUTCOMES (CO):**

This course imparts understanding of various mechanisms in semiconductor, laser, maser and optical fibre communication using quantum mechanics as fundamental tool. It prepares students to take advanced courses in the related fields and finally equips students to take up R&D and higher studies. This course is very useful in designing electronic and optical communication devices for using in optical communications, medicine, environment, industries and related fields.

**COURSE CONTENT:**

1. Semiconductor Laser

Homojunction laser: Population inversion at a junction; Emission spectra; The basic semiconductor laser; Heterojunction: Formation of ideal heterojunctions between (a) a p-type wide band-gap semiconductor and an n-type narrower band-gap semiconductor, (b) an n-type wide band-gap semiconductor and a p-type narrower band-gap semiconductor, (c) wide and lightly doped narrower band gap n-type semiconductors; Anderson's model of ideal heterojunction. Heterojunction laser: Single and double heterojunction laser; Analysis of carrier confinement in a single heterojunction laser.

2. Electrons in quantum structures

Energy level and wave functions for quantum well, quantum wire and quantum dot; Density of states for quantum well, quantum wire and quantum dot; Modulation | doped quantum well; Multiple quantum well; Coupling between quantum wells. Super lattice: The concept of a super

lattice; Kronig-Penney model of a super lattice | zone folding, Tight binding approximation for a super lattice.

3. Quantum Semiconductor Laser

Light amplification in quantum well; Modulation bandwidth; Strained quantum well laser; Quantum wire laser; Blue quantum well laser.

4. Electro-optic effect in quantum structures

Franz-Keldysh effect in Semiconductor; Electro-optic effect in quantum wells; Electro-optic effect in super lattice.

5. Parallel and Perpendicular Transport in Quantum Structures

High field electron transport|Hot electrons in quantum structures; Double barrier resonant-tunneling structures; Super lattices and ballistic injection devices.

6. Quantum Transistor

Resonant-tunneling unipolar and bipolar transistor; Velocity modulation and quantum interference transistor.

7. Guided wave optics

(a) Waveguide modes, Modes characteristics for a planar waveguide, Step index planar waveguide, Maxwell equations in inhomogeneous media: TE modes and TM modes, Radiation modes, Guided modes, Leaky modes, Quasi modes.

(b) Propagation in optical fibre, Numerical aperture, Pulse dispersion in fibres, Scalar wave equation and modes of the fibre, Modal analysis for a step index fibre.

8. Masers

Ammonia beam maser, Energy levels, Methods for population inversion, Maser operation.

9. Coherent interactions of a radiation field and an atomic system

(a) Induced resonant transitions, Inclusions of decay phenomena, Rotating wave approximation, Exact Rabi Solution in the strong field, Rabi flopping, Dressed state picture.

(b) Density matrix, Rate equation for density matrix, Optical Bloch equations, Vector model of density matrix, The Bloch sphere.

10. Semiclassical laser theory

Electromagnetic field equations, Expansion in normal modes of a cavity, Lamb's self-consistency equations, Density matrix equations, Polarization of the medium, Single mode operation, Non-linear effect in polarization, Hole burning, Steady state power, Frequency pulling and pushing.

**SUGGESTED READINGS:**

1. Mitin, Kochelap and Strosio, ``Quantum Heterostructures: Microelectronics and Optoelectronics,’’ Cambridge University Press
2. Martinez-Duart, Martin-Palma, Agullo-Rueda, ``Nanotechnology for Microelectronics and Optoelectronics,’’ Elsevier Science
3. A. Yariv, ``Quantum Electronics,’’ John Wiley
4. A.K. Ghatak and K. Thyagarajan, ``Optical Electronics,’’ Cambridge University Press
5. O. Svelto, ``Principles of Lasers,’’ Springer
6. P. Bhattacharyya, ``Semiconductor Optoelectronics Devices,’’ Prentice Hall
7. R. W. Boyd, ``Nonlinear Optics,’’ Academic Press
8. B. G. Streetman and S. Banerjee, ``Solid State Electronic Devices,’’ Prentice Hall India
9. T. Suhara, ``Semiconductor laser fundamentals,’’ CRC Press
10. S. M. Sze, ``Physics of Semiconductor Devices,’’ Wiley Publishing
11. J. Orton, ``The Story of Semiconductors,’’ Oxford University Press
12. Rogers, Pennathur, Adams, ``Nanotechnology: Understanding Small Systems,’’ CRC Press



<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO027	Laser Systems and Applications	L-T-P:3-0-2	None
<b>COURSE OUTCOMES (CO):</b> <p>The concept and understanding of laser action are helpful in designing and developing new devices used in optical communications, medicine, environment, industries and related physics. It also gives value addition in the students' understanding of the basic principles involved. It prepares students to take advanced courses in the related fields and finally equips students to take up R&amp;D in the related field.</p>			
<b>COURSE CONTENT:</b> <p><b>Introduction:</b> Review of elementary quantum physics, Schrodinger equation, concept of coherence, absorption, spontaneous emission and stimulated emission processes, relation between Einstein's A and B coefficients, population inversion, pumping, gain, optical cavities.</p> <p><b>Lasers &amp; Laser Systems:</b> Main components of Laser, principle of Laser action, introduction to general lasers and their types. Three &amp; four level Lasers, CW &amp; Pulsed Lasers, atomic, ionic, molecular, excimer, liquid and solid state Lasers and systems, short pulse generation and Measurement.</p> <p><b>Applications:</b> Laser applications in medicine and surgery, materials processing, optical communication, metrology and LIDAR and holography( recording and reconstruction).</p>			
<b>SUGGESTED READINGS:</b> <ol style="list-style-type: none"><li>1. K.R. Nambiar, "Laser Principles, Types and Application," New Age International.</li><li>2. S. A. Ahmad, "Laser concepts and Applications," New Age International.</li></ol>			

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO028	Optoelectronics and Photonics	L-T-P:3-0-2	None
<b>COURSE OUTCOMES (CO):</b>			
<p>This course imparts understanding of various mechanisms in semiconductor laser, photonics and optical fibre communication. It prepares students to take advanced courses in the related fields and finally equips students to take up R&amp;D and higher studies. This course is very useful in designing opto-electronic and optical communication devices for using in optical communications, medicine, environment, industries and related fields.</p>			
<b>COURSE CONTENT:</b>			
<p>Semiconductor lasers for optical fiber communications, Fabry-Perot cavity, heterostructure semiconductor lasers, single frequency semiconductor lasers, semiconductor lasers for coherent systems. Distributed feedback in Ga-As-P lasers. Device structure and fabrication, photodetectors for fiber optics, reverse bias photo-detectors, dark current, quantum efficiency, signal to noise ratio, types of detectors. Receivers for digital fiber optic communication systems: basic</p> <p>components, detectors for digital fiber optic receivers, PIN diode, Avalanche photodiode, Front ends for digital fiber optic receivers, equalizer for optical communication, receivers, PIN-FET receivers for longer wavelength communication systems. Coherent optical fiber transmission systems, coherent detection principles, comparison of direct and coherent performance, homodyne and heterodyne systems. Non linear process in optical fibers, phase matching in waveguide, phase matched harmonic generation in waveguides. Second harmonic generation (SHG) in integrated optics, Cerenkov configuration SHG. Optical fiber sensor and devices, intensity modulation through light interruption, distributed sensing with fiber optics. Basic principles of interferometric optical fiber sensor, signal processing in mono mode fiber optic sensor, photonic band gap materials.</p>			
<b>SUGGESTED READINGS:</b>			
<ol style="list-style-type: none"> <li>1. G. Keiser, ``Optical fiber communication,`` McGraw-Hill.</li> <li>2. J. Senior, ``Optical fiber Communication,`` Prentice- Hall International</li> <li>3. S.O. Kasap, ``Optoelectronics and Photonics: Principles and Practices,`` Pearson Education</li> </ol>			

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO029	Electromagnetic Theory and Waveguides	L-T-P:3-0-2	None
<b>COURSE OUTCOMES (CO):</b> <p>This course imparts understanding of various mechanisms in the propagation of electromagnetic waves through space and wave guides. The understanding of various electromagnetic laws are helpful in designing and developing new devices used in optical communications, industries and related field. It prepares students to take advanced courses in the related fields and finally equips students to take up R&amp;D and higher studies.</p>			
<b>COURSE CONTENT:</b> <p>Electrostatics; Boundary value problems Dielectrics, Steady currents, Magnetostatics; Time varying fields, Maxwell's equations, Lorentz force equation and motion of charges, Plane electromagnetic waves. Waveguides and resonant cavities, fields at the surface of and within a conductor, cylindrical cavities and waveguides, modes in a rectangular waveguide, energy flow and attenuation in waveguides, perturbation of boundary conditions, resonant cavities, power losses in a cavity, Earth and ionosphere as resonant cavity, dielectric waveguide.</p>			
<b>SUGGESTED READINGS:</b> <ol style="list-style-type: none"><li>1. Griffiths D. J., ``Introduction to Electrodynamics,`` Prentice- Hall Pvt.Ltd.</li><li>2. J. D. Kraus, ``Electromagnetics,`` Tata McGraw Hill.</li></ol>			

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO030	Polymer Science & Technology	L-T-P:3-0-2	None
<b>COURSE OUTCOMES (CO):</b> 1. To know about polymer science and technology. 2. To have an understanding of nanotechnology in polymers.			
<b>COURSE CONTENT:</b> Polymer Chemistry, Polymer Physics, Polymer Technology, Polymer Characterization, Polymer Engineering and Rheology, Polymer Processing, Polymer Testing and properties, Polymer Composites, Polymer Blends and Alloys, Rubber Technology, Polymer Processing, Polymers in Packaging, Nanotechnology in Polymers, Engineering Plastics and Specialty Polymers, New innovations in Polymers.  Practical related to above theory.			
<b>SUGGESTED READINGS:</b> 1) P. J. Flory, ``Introduction to polymer Chemistry, `` Asian Books 2) Miles & Briston, ``Polymer Technology,`` J. G. Chemical Publishing Company 3) R. T. Fenner , ``Principle of Polymer Processing, `` Maxwell McMillan International Edn 4) Stephen L. Rosen, ``Fundamental principles of polymer materials practices for engineers, Plastics Materials,`` Barnes & Noble 5) Joel Frados, Van Nostrand, ``Plastics Engineering Handbook,`` Reinhold, New York 6) Morton & Jones, ``Polymer Processing,`` Chapman & Hall.			

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO031	Semiconductor Physics and Devices	L-T-P:3-0-2	None
<b>COURSE OUTCOMES (CO):</b>  This course is very helpful in understanding the various phenomena/mechanisms which are very useful in designing electronic devices, energy storage devices and other transistor based devices used in all sphere of life. It prepares students to take advanced courses in the related fields and finally equips them to take up R&D and higher studies.			
<b>COURSE CONTENT:</b>  Semiconductor Physics; Semiconductor, Bonds in Semiconductors, Energy band, Effect of temperatures on Semiconductor, Hole currents, Intrinsic & extrinsic semiconductor, Majority and minority carriers, p-n junction, Volt- ampere characteristics of p-n junction. Semiconductor Diode: Semiconductor diode, Crystal diode rectifiers, Half wave rectifiers, Efficiency of half wave rectifier, Full wave rectifier, Centre tap full wave rectifier, Ripple factor, Filter Circuits, Voltage stabilization, Zener diode, Zener diode as Voltage stabilizer. Transistors: Transistors, Transistors connections, Common base connection, Common emitter connection, common collector connection, Comparison of transistor connections, Transistor as an amplifier in CE arrangement, Transistor load line analysis, Operating point, Cut off and saturation points, Applications of Common base amplifier, Bipolar junction Transistors, Hybrid Parameters, Field effect Transistor: JFET/MESFET, MOSFET, Unipolar Devices.			
<b>SUGGESTED READINGS:</b>  1. Joseph Lindmayer and Charles Y. Wrigly, ``Fundamentals of Semiconductor Devices,`` Litton Educational Publishing Inc.  2. S. M. Sze, ``Physics of Semiconductor Devices,`` John Wily & Sons.  3. A. K. Sharma, ``Semiconductor Electronics,`` New Age International (P) Limited Publisher.			

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO032	Elements of Fiber Optics	L-T-P:3-0-2	None
<b>COURSE OUTCOMES (CO):</b>  This course imparts understanding of various mechanisms in optical fibre communication. Concepts of Optical Fiber waveguides are helpful in designing and developing new devices used in optical communications, medicine, environment, industries and related physics. It prepares students to take advanced courses in the related fields and finally equips students to take up R&D and higher studies.			
<b>COURSE CONTENT:</b>  Over view of optical fiber communications, the evolution of fiber optics systems, elements of an optical fiber transmission links. Electromagnetic analysis of optical waveguides, classification of modes for a planar waveguide, TE and TM modes in a symmetric step index planar waveguide, power associated with a mode, excitation of guided modes, Maxwell equations in inhomogeneous media: TE and TM modes in planar waveguide. Leaky modes, leakage of power from the core, bending loss in optical waveguides. Optical fiber waveguides, optical fiber types, numerical aperture, pulse dispersion in step index fibers, scalar wave equations and modes of a fiber, Modal analysis for a step index fiber and graded-index fiber. Linearly polarized modes, power flow, multi mode fibers with optimum profiles, single mode fiber, propagation modes in single mode fibers, fiber materials, fiber fabrication. Vapor-deposition methods, Fiber optic cables, optical fiber connections, joints and couplers, signal degradation in optical fiber, absorption loss, radiation loss, attenuation, signal distortion in optical waveguides, pulse broadening, mode coupling.			
<b>SUGGESTED READINGS:</b>  1. G. Keiser and J. Senior, ``Optical fiber communication`` McGraw Hill 2. A. K. Ghatak, ``Introduction to Optical fiber,`` Cambridge University Press			

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO033	Material Physics	L-T-P:3-0-2	None

**COURSE OUTCOMES (CO):**

1. Given a type of material, be able to qualitatively describe the bonding scheme and its general physical properties, as well as possible applications.
2. Given a type of bond, be able to describe its physical origin, as well as strength. Be able to qualitatively derive a material's Young's modulus from a potential energy curve.
3. Given the structure of a metal, be able to describe resultant elastic properties in terms of its 1D and 2D defects.
4. Given a simple set of diffraction data, be able to index the peaks and infer the structure.
5. Be able to describe a polymer's elastic behavior above and below the glass transition.
6. Be able to do simple diffusion problems.

**COURSE CONTENT:**

## 1. Overview of materials

Crystalline and amorphous materials, glasses, semiconductors, compound semiconductors, solar energy materials, luminescent and optoelectronic materials, polymer, liquid crystals, ceramics, classification according to bonding | Pauling and Philips theories.

## 2. Synthesis and preparation of materials

Single crystal growth, zone refining, doping techniques of elemental and compound semiconductors, fabrication and control of thin films, PVD and CVD processes, principles of polymer processing, preparation of ceramics powders | mechanical and chemical methods.

## 3. Characterization of materials

Defects and microstructures; Diffraction techniques: X-ray diffraction | structure determination from XRD data; Neutron diffraction; Thermal methods: DTA, TGA, DSC; Microscopy: TEM, SEM; Optical spectroscopy: UV and IR; Nuclear techniques: NMR, ESR, Mossbauer and Positron annihilation. Heat treatments, quenching and annealing; Radiation damage.

## 4. Phase transition in materials

Thermodynamics and phase diagrams, statistical theories of phase transitions, critical phenomena, calculation of critical exponents for van der Waals gas and ferromagnets; Diffusion in solids, variation of diffusion constant with temperature.

5. Mechanical properties

Deformation and fracture, Deformation at low and high temperature, Intrinsically hard materials.

6. Spinodal decomposition

Spinodal curve, Free energy of composition fluctuations, Kinetics of Spinodal decomposition.

7. Electrical properties of alloys, ceramics, and conducting polymer

Resistivity variation of metals at low and high temperature, Kondo effect; Effect of pressure on resistivity, resistivity variation in ceramics and conducting polymer; Ferroelectricity, Landau-Ginzburg theory of ferroelectricity; Piezoelectricity.

8. Magnetic properties of different materials

Antiferromagnetism, ferrimagnetism, magnons, thermal properties of magnons, magnetic storage, applications as capacitors, transducers, sensors, memories, displays; Quantum Hall effect.

9. Glasses

Definitions, properties of glass transition, tunnelling states, calculation of specific heat from tunneling states and from a model two level system having random energy gap, theories for glass transition.

10. Non-crystalline semiconductors

Classifications, electrical properties, temperature variation of dc conductivity, ac conductivity, magnetoresistance, Colossal magnetoresistance (CMR).

11. Exotic solids

Structure and symmetries of liquids, liquid crystals, amorphous solids; Aperiodic solids and quasicrystals; Fibonacci sequence; Penrose lattices and their extensions in 3 dimensions; Special carbon solids, fullerenes and tubules, formation and characterization of fullerenes and tubules, single wall and multiwall carbon tubules; Electronic properties of tubules; Carbon nanotubule based electronic devices, Definition and properties of nanostructured materials. methods of



synthesis of nano-structured materials; Special experimental techniques for characterization of materials; Quantum size effect and its applications.

**SUGGESTED READINGS:**

1. C. Kittel, ``Introduction to Solid State Physics'' Wiley
2. R. Zallen, ``The Physics of Amorphous Solids'' Wiley Classic
3. N. F. Mott and E.A. Davies, ``Electronic Processes in Non-crystalline Materials'' Oxford Classic
4. C. N. R. Rao and B. Raveau, ``Colossal Magnetoresistance, Charge Density and Related Properties of Manganese oxides,`` World Scientific
5. J. M. Yeomans, ``Statistical Mechanics of Phase Transitions'' Clarendon Press
6. R. E. Prange and S. M. Girvin (editors), ``The Quantum Hall Effect'' Springer
7. H. P. Klug and L. E. Alexander, `` X-ray Diffraction Procedures'' Wiley

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO034	Advanced Electromagnetic Theory and Special Relativity	L-T-P:3-0-2	None
<b>COURSE OUTCOMES (CO):</b>  This course imparts understanding of various mechanisms in the propagation of electromagnetic waves through space and wave guides. The understanding of various electromagnetic laws are helpful in designing and developing new devices used in optical communications, industries and related field. It prepares students to take advanced courses in the related fields and finally equips students to take up R&D and higher studies.			
<b>COURSE CONTENT:</b>  Maxwell's equations, wave equations in scalar and vector potential, solutions of scalar and vector wave equations by Fourier analysis. Relativistic motion in electromagnetism, postulates of special theory of relativity, Lorentz transformation, relativistic mechanics, contraction of length, dilation of time, magnetism as relativistic effect, four vector, co-variance of Maxwell's equations, Lienard-Wiechert potentials and the field of a uniformly moving electron, radiation from an accelerated charge, cyclotron synchrotron, Bremsstrahlung and Cerenkov radiations. Scattering and absorption of electromagnetic waves, antenna, radiated power and angular distribution of radiation, electric dipole radiation.			
<b>SUGGESTED READINGS:</b>  1. R. Resnik, ``Introduction to Special Relativity,`` Wiley Eastern Ltd.  2. J. D. Jackson , ``Classical Electrodynamics`` John Wiley & Sons			

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO035	Fiber and Integrated Optics	L-T-P:3-0-2	None
<b>COURSE OUTCOMES (CO):</b>  This course imparts understanding of various mechanisms in optical fibre communication. Concepts of Optical Fiber waveguides are helpful in designing and developing new devices used in optical communications, medicine, environment, industries and related physics. It prepares students to take advanced courses in the related fields and finally equips students to take up R&D and higher studies.			
<b>COURSE CONTENT:</b>  Modes in an asymmetric planer waveguides. Ray analysis of planer waveguide, W. K. B. analysis of inhomogeneous planer waveguide, strip waveguides, periodic waveguide-coupled mode analysis, and rectangular core waveguides metal clad waveguides. Anisotropic polarizer, leaky modes in a planer structure. Polarization maintaining fibers and their applications different types of polarization maintaining fibers, high birefringent fibers, single polarization single mode fibers. Integrated optic devices: electro-optic effect, phase modulator, polarization modulators and wavelength filters. The Mach Zehnder Interferometric modulator, logic operations, optical directional coupler, leaky mode, metal clad polarizer.			
<b>SUGGESTED READINGS:</b>  1. A. W. Snyder and J. D. Love, ``Optical Wave guide Theory`` Chapman and Hall. 2. A. K. Ghatak, `` Introduction to optical fiber``, Cambridge University Press.			

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO036	Condensed Matter Physics	L-T-P:3-0-2	None

**COURSE OUTCOMES (CO):**

This course aims to establish fundamental concepts in condensed matter physics, and applies the physics you have learned previously (in particular quantum mechanics, classical mechanics, electromagnetism and statistical mechanics) to these real-world materials. The structure and properties of solids including thermal and electrical properties are described.

**COURSE CONTENT:**

1. Symmetry in crystals

Concepts of point group; Point groups and Bravais lattices; Crystal symmetry | space groups; Symmetry and degeneracy | crystal field splitting; Kramer's degeneracy; Quasicrystals: general idea, approximate translational and rotational symmetry of two-dimensional Penrose tiling, Frank-Casper phase in metallic glass.

2. Lattice dynamics

Classical theory of lattice vibrations in 3-dimensions under harmonic approximation; Dispersion relation: acoustical and optical, transverse and longitudinal modes; Lattice vibrations in a monatomic simple cubic lattice; Frequency distribution function; Normal coordinates and phonons; Occupation number representation of the lattice Hamiltonian; Thermodynamics of phonons; The long wavelength limits of the acoustical and optical branches; Neutron diffraction by lattice vibrations; Debye-Waller factor; Atomic displacement and melting point; Phonon-phonon interaction, interaction Hamiltonian in occupation number representation; Thermal conductivity in insulators.

3. Density Functional Theory

Basics of DFT, Comparison with conventional wave function approach, Hohenberg-Kohn Theorem; Kohn-Sham Equation; Thomas-Fermi approximation and beyond; Practical DFT in a many body calculation and its reliability.

4. Electronic properties: I

The Boltzmann transport equation and relaxation time; Electrical conductivity of metals | impurity scattering, ideal resistance at high and low temperatures, U-processes; Thermo-electric effects;

Thermal conductivity; The Wiedemann-Franz law.

#### 5. Electronic properties: II

Electronic properties in a magnetic field; Classical theory of magneto-resistance; Hall effect and magneto-resistance in two-band model; K-space analysis of electron motion in a uniform magnetic field; Idea of closed, open and extended orbits, cyclotron resonance; Azbel-Kaner resonance; Energy levels and density of states in a magnetic field; Landau diamagnetism; de Haas-van Alphen effect; Quantum Hall effect.

#### 6. Optical properties of solids

The dielectric function: the dielectric function for a harmonic oscillator, dielectric losses of electrons, Kramers-Kronig relations; Interaction of phonons and electrons with photons; Interband transition | direct and indirect transition; Absorption in insulators; Polaritons; One-phonon absorption; Optical properties of metals, skin effect and anomalous skin effect.

#### **SUGGESTED READINGS:**

1. M. Tinkham, "Group Theory and Quantum Mechanics," Dover Publications
2. M. Sachs, "Solid State Theory" McGraw Hill
3. A. O. E. Animalu, "Intermediate Quantum Theory of Crystalline Solids" Prentice Hall
4. N. W. Ashcroft and N. D. Mermin, "Solid State Physics" Brooks
5. J. M. Ziman, "Principles of the Theory of Solids" Cambridge University Press
6. C. Kittel, "Introduction to Solid State Physics," Wiley

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO037	Microwave	L-T-P:3-0-2	None

**COURSE OUTCOMES (CO):**

1. Helping the students to gain insight into the subject, to develop suitable hardware/software that addresses the industrial/social problems effectively.
2. Knowledge about Microwave Solid State Devices.
3. Ability to identify and study the performance of Wave Guides and Resonators
4. Study the performance of various components used in microwave engineering.
5. Designing of Microwave filters
6. Knowledge about Microwave Measurements.
7. To motivate the students towards professionalism effective communication skills and team work.

**COURSE CONTENT:**

1. Transmission line and waveguide

Interpretation of wave equations; Rectangular wave guide | TE and TM modes, power transmission, excitation of modes; Circular waveguide | TE, TM and TEM modes, power transmission, excitation of modes. Microstrip lines | characteristic impedance, loss and Q of microstrip lines, coplanar strip lines and shielded strip lines.

2. Component

Scattering parameter and scattering matrix, properties of S-parameter; Quality factor and Q-value of a cavity resonator, Q-value of a coupled cavity; Wave guide tees, magic tee, hybrid ring, couplers; Ferrites and Faraday's rotation, gyrator, circulator, isolator and terminator;  $\lambda/4$  section filter, tuner and sliding short.

3. Measurement

Smith chart, single stub and double stub matching; Microwave bridge, measurement of frequency, attenuation and phase; Measurement of dielectric parameters of amorphous solids | dielectric constant, ac conductivity, resistivity, insertion loss, return loss, shielding coefficient. Measurement of microstrip line parameters.

4. Source

Conventional sources & their limitations.

(a) Vacuum tube sources | Klystron, reex klystron, travelling wave tubes and switching tubes; Magnetrons, FWCFA and Gyrotrons.

(b) Microwave transistors and FETs, Gunn, IMPATT, TRAPATT and parametric devices.

(c) Laser | Laser processes, Pockels-Cell; Laser modulators, infrared radiation and sources.

#### 5. Antenna

Transmitting and receiving antennas, antenna gain, resistance and bandwidth; Antenna dipoles, straight, folded and broadband dipoles; Beam width and polarisation; Antenna coupling.

#### 6. Microwave integrated circuit

Materials and fabrication technique; MOSFET fabrication, memory construction, thin film formation, planar resistor, planar inductor and planar capacitor formation; Hybrid integrated circuit formation.

#### **SUGGESTED READINGS:**

1. Samyel Y. Liao, ``Microwave Devices and Circuits`` Prentice hall publication,
2. Herbert J. Reich, ``Microwave Principles,`` Van Nostrand
3. K. C. Gupta, ``Microwaves,`` New Age publisher.
4. M. L. Sisodia and G. S. Raghubanshi, ``Microwave Circuits and Passive Device`` New Age publisher.
5. N. Mercuvitz, ``Waveguide Handbook`` IET
6. S. M. Sze, ``Physics of Semiconductor Devices`` John Wiley publisher.
7. R. E. Collins, ``Foundations of Microwave Engineering`` Wiley publication.
8. J. D. Ryder, ``Network Lines and Fields`` Prentice Hall publication.
9. Royal Signals, ``Handbook of Line Communication`` The War Office
10. W. Frazer, ``Telecommunications`` Macdonald
11. J. D. Kraus, ``Antenna`` Tata Mc Graw Hill publication.

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO038	Fundamentals of Instrumentation and experimental techniques in Physics	L-T-P:3-0-2	None
<b>COURSE OUTCOMES (CO):</b>			
<p>The knowledge of various measurement instruments and techniques are very helpful in the scientific laboratories, organizations and industries for faithful measurements, characterizations and interpretation of data with high accuracy. It also gives value addition in the students' understanding of the basic principles involved. It prepares students to take advanced courses in the related fields and finally equips students to take up higher studies and R&amp;D in the related field</p>			
<b>COURSE CONTENT:</b>			
<p>Physical Measurement: Sources of uncertainty and experimental error, Systematic and random error, Analysis of repeated measurements, Distribution functions, Propagation of error, Analysis of data. Optical measurements and the electromagnetic spectrum, Temperature transducers and linear position sensors.</p> <p>Signal to noise considerations: Fluctuations and noise measurement systems, Noise in frequency domain, Signal to Noise and experimental design, Frequency and bandwidth considerations, Signal to noise enhancement, Digital and auto correlation methods.</p> <p>Vacuum techniques: Characteristics and applications of vacuum, Vacuum systems-pumps and gauges, pumping speed, Thin film techniques, Film thickness monitors and measurements.</p> <p>Optical Instruments: Spectroscopic Instrumentation, visible and infrared spectroscopy, Spectrometer design- lenses and refractive optics, Dispersive elements. Lasers and fibre optics.</p> <p>X-ray Measurement: X-ray Fluorescence- line spectra, fine structure, Absorption and emission processes, X-ray production, X-ray diffraction and crystallography- powder diffraction spectra, information available from spectra.</p> <p>Analytical Instrumentation: Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), Environmental Scanning Electron Microscope (ESEM), Surface Analytical</p>			



Methods-Auger Electron spectroscopy, X-ray photo electron spectroscopy (XPS) and secondary ion mass spectrometer (SIMS). X-ray fluorescence, Tunneling scanning microscope.

Occupational Health and Safety : Occupational health and safety, Chemical substances- Storage and Disposal, Work hazardous materials information system(WHMIS). Safety from electromagnetic radiation, General Electrical and testing standards- CSA approval, General laboratory and workshop practice.

**SUGGESTED READINGS:**

1. Michael Sayer and Abhai Mansingh, ``Measurement, Instrumentation and Experiment Design in Physics and Engineering'' Prentice-Hall India

<b>Course No.</b>	<b>Title of the Course</b>	<b>Course Structure</b>	<b>Pre-Requisite</b>
EO039	Lasers and Photonics	L-T-P:3-0-2	None
<b>COURSE OUTCOMES (CO):</b>  The understanding of Laser, Photonics and Optical Fiber are helpful in designing and developing new devices used in optical communications, solar energy devices, medicine, environment, industries and related physics. It also gives value addition in the students' understanding of the basic principles involved. It prepares students to take advanced courses in the related fields and finally equips students to take up higher studies and R&D in the related field			
<b>COURSE CONTENT:</b>  Properties of Lasers, Absorption, Spontaneous emission and stimulated emission processes, relation between Einstein's A and B coefficients, population inversion, pumping, gain, Working principle of laser, Optical cavities. Ruby Laser, Helium Neon Laser, Semiconductor Laser. Three & four level Lasers, CW & Pulsed Lasers, atomic, ionic, molecular, excimer, liquid and solid state Lasers and systems, short pulse generation and Measurement. Laser applications in medicine and surgery, materials processing, optical communication, metrology and LIDAR and holography( recording and reconstruction)  Photonics : Basics of Solid state lighting- LED- Photodetectors, photovoltaic cell, Junction & avalanche photodiodes, photo transistors, thermal detectors, Solar cells- I-V characteristics, Optic fibre- principle of propagation, numerical aperture, optical communication system. Industrial, medical and technological applications of optical fibre. Fibre optic sensors- basics of Intensity modulated and phase modulated sensors.			
<b>SUGGESTED READINGS:</b>  1. K.R. Nambiar, "Laser Principles, Types and Application" New Age International  2. G.Keiser, "Optical fiber communication," McGraw-Hill.			

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