HINDUSTAN
INSTITUTE OF TECHNOLOGY & SCIENCE
(DEEMED TO BE UNIVERSITY)

DEPARTMENT OF MECHANICAL ENGINEERING

CURRICULUM AND SYLLABUS

Under CBCS

(Applicable for Students admitted from Academic Year 2018-19)

B. Tech. Mechanical Engineering

DEPARTMENT OF MECHANICAL ENGINEERING

SCHOOL OF MECHANICAL SCIENCES

HINDUSTAN INSTITUTE OF TECHNOLOGY & SCIENCE
VISION AND MISSION

MOTTO

"TO MAKE EVERY MAN A SUCCESS AND NO MAN A FAILURE."

VISION

To be an International Institute of Excellence, providing a conducive environment for education with a strong emphasis on innovation, quality, research and strategic partnership blended with values and commitment to society.

MISSION

- To create an ecosystem for learning and world class research.
- To nurture a sense of creativity and innovation.
- To instill highest ethical standards and values with a sense of professionalism.
- To take up activities for the development of Society.
- To develop national and international collaboration and strategic partnership with industry and institutes of excellence.
- To enable graduates to become future leaders and innovators.

VALUE STATEMENT

- Integrity, Innovation, Internationalization

DEPARTMENT OF MECHANICAL ENGINEERING

VISION AND MISSION

VISION

To excel in innovation and collaborative research, promoting technical and entrepreneurial skills.

MISSION

The Mechanical Engineering program continuously strives,

M1. To provide a conducive academic environment with contemporary and innovative curricula imparting high quality education

M2. To offer state of the art laboratory infrastructure to enhance fundamental research

M3. To maintain an environment to work closely with industries to materialize collaborative and applied research

M4. To impart technical, managerial and lifelong learning skills, embedded with ethical values and social relevance.

PROGRAMME EDUCATIONAL OBJECTIVES (PEO'S):

PEO1. Successful career and adaptability to industry: Graduates will have in-depth knowledge appropriate to the discipline of Mechanical Engineering which enables them to pursue higher studies and academic research.

PEO2. Modern design tools and multi-disciplinary project execution: Graduates will attain professionalism and shall be industry adaptive through a degree structure that is relevant to industry, and responsive to changes in technology and the needs of the society with noble attitude and social responsibility.

PEO3. Contribution to mechanical field and lifelong learning: Graduates will posses multi and inter disciplinary knowledge and excel in innovation and teamwork with entrepreneurial capabilities

PROGRAM OUTCOMES [PO's]

PO 1 **:** Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex Mechanical engineering problems.

PO 2 **:** Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3 **:** Design/development of solutions: Design solutions for complex Mechanical engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4 **:** Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, 5analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5 **:** Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools that are relevant to Mechanical engineering, including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6 **:** The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the Mechanical engineering practice.

PO 7 **:** Environment and sustainability: Understand the impact of the Mechanical engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8 **:** Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the Mechanical engineering practice.

PO 9 **:** Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10 **:** Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 11 **:** Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12 **:** Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOME (PSO's)

PSO 1 : Apply their acquired knowledge in the field of thermal and manufacturing sciences to provide solutions for engineering problems using current technology.

PSO 2 : Apply the concepts of design, analysis and implementation of mechanical systems and processes to provide solutions to the real world situations.

ACADEMIC REGULATIONS FOR

B. TECH. / B. TECH. (HONS.) DEGREE PROGRAMME

TABLE OF CONTENTS

I. PREAMBLE

As per the recommendations of UGC, the Hindustan Institute of Technology and Science (HITS) has introduced Choice Based Credit System (CBCS) from the academic year 2015-16. Choice Based Credit System (CBCS) is a proven, flexible mode of learning in higher education which facilitates a student to have guided freedom in selecting his/her own choices of courses in the curriculum for completing a degree program. This revision of regulations, curriculum and syllabi has been carried out further to make it more flexible and adaptive to the technology advancements happening in the world. CBCS offers a flexible system of learning.

The system permits a student to

(i) Learn at their own pace through flexible registration process

(ii) Choose electives from a wide range of courses offered within and outside their departments

(iii) Undergo additional courses and acquire more than required number of credits to obtain B. Tech (Hons)

(iv) Undergo additional courses in their special areas of interest and earn additional credits to obtain B. Tech with Minor Specialization

(v) Adopt an interdisciplinary approach in learning

(vi) Avail transfer of Credits

(vii) Gain Non – CGPA credits to enhance skill/employability by taking up additional project work, entrepreneurship, co-curricular and vocational training.

(viii) Make the best use of the expertise of available faculty.

(ix) Learn and earn credits through MOOC and Project Based Learning

(x) Enhance their Knowledge, Skill and Attitude through participation in innovative Curriculum Design, Delivery and Assessments.

The Curriculum is designed to take into the factors listed in the Choice Based Credit System (CBCS) with focus on Project Based Learning and Industrial Training so as to enable the students become eligible and fully equipped for employment in industries choose higher studies or entrepreneurship.

II. DEFINITIONS AND NOMENCLATURE

In these Regulations, unless the context otherwise requires:

1. “Programme” means Degree Programme like B.Tech. Degree Programme.
2. “Discipline” means specialization or branch of B.Tech. Degree Programme, (e.g. Civil Engineering).
3. “Course” means a theory or practical subject that is normally studied in a semester, (e.g. Mathematics, Physics, etc.).

4. "Vice – Chancellor of HITS" means the Head of the Institution.
5. "Registrar" is the Head of all Academic and General Administration of the Institute.
6. "Dean Academics" means the authority of the University who is responsible for all academic activities of various programmes and implementation of relevant rules of these Regulations pertaining to the Academic Programmes.
7. "Controller of Examinations" means the authority of the University who is responsible for all activities related to the University Examinations, publication of results, award of grade sheets and degrees.
8. "Dean – Student Affairs" is responsible for all student related activities including student discipline, extra and co – curricular activities, attendance and meetings with class representatives, Student Council and parent – teacher meet.
9. "HoD" means the Head of the Department concerned.
10. "Institute" means Hindustan Institute of Technology and Science (HITS), Chennai.
11. "TCH" means Total Contact Hours – refers to the teaching – learning periods.
12. "DEC" means Department Exam Committee.
13. "BoS" means Board of Studies.
14. "BoM" means Board of Management.
15. "ACM" means Academic Council meeting the highest authoritative body for approval for all Academic Policies.
16. "Class Teacher" is a faculty of the class who takes care of the attendance, academic performance and the general conduct of the students of that class.
17. "CIA" is Continuous Internal Assessment which is assessed for every student for every course during the semester.
18. "ESE" is End Semester Examination conducted by the Institute at the End of the Semester for all the courses of that semester.
19. "AICTE" means All India Council for Technical Education.
20. "UGC" means University Grants Commission.
21. "MHRD" means Ministry of Human Resource Development, Govt. of India.

ACADEMIC REGULATIONS FOR B. Tech. / B.Tech. (Hons.)
Under Choice Based Credit System (CBCS)
(Effective from Academic year 2018 - 19)

1.0 Vision, Mission and Objectives

The Vision of the Institute is "To make every man a success and no man a failure".

1.1 The Mission of the institute is

- To create an ecosystem that promotes learning and world class research.
- To nurture creativity and innovation.
- To instil highest ethical standards and values.
- To pursue activities for the development of the Society.
- To develop national and international collaborations with institutes and industries of eminence.
- To enable graduates to become future leaders and innovators.

Value Statement

Integrity, Innovation, Internationalization

1.2 Further, the Institute always strives

- To train our graduates with the latest and the best in the rapidly changing fields of Architecture, Engineering, Technology, Management studies, Science and Humanities and Liberal Arts.
- To develop graduates, with a global outlook, possessing Knowledge, Skills and Attitude and capable of taking up challenging responsibilities in the respective fields.
- To mould our graduates as citizens with moral, ethical and social values so as to fulfil their obligations to the nation and the society.
- To promote research in the field of Architecture, Engineering, Technology, Management studies, Science and Humanities and Liberal Arts and Allied disciplines.

1.3 Aims and Objectives of the Institute are focused on

- Providing state of the art education in Engineering, Technology, Applied Sciences and Management studies.
- Keeping pace with the ever – changing technological scenario and help the graduates to gain proper direction to emerge as competent professionals fully aware of their commitment to the society and the nation.
- To inculcate a flair for Research, Development and Entrepreneurship.

2.0 Admission

The admission policy and procedure shall be decided from time to time by the Board of Management (BOM) of the Institute, based on the guidelines issued by the UGC/ Ministry of Human Resource Development (MHRD), Government of India. The number of seats in each of the B. Tech. degree programme will be decided by the Board of Management of the Institute as per the directives of AICTE/ UGC / MHRD, Government of India, taking into account, the market demands. Seats are also made available up to 20% of the sanctioned intake for Non – Resident Indians and foreign nationals, who satisfy the admission eligibility norms of the Institute.

2.1. Eligibility for Admission

(i) Regular Entry

Passed 10 + 2 examination with Physics and Mathematics as compulsory subjects along with one of the other subjects as Chemistry/ Biotechnology/ Biology/ Technical Vocational course.

The candidates should have obtained the minimum marks as per AICTE norms.

(ii) Lateral Entry

The candidates possessing a Diploma in Engineering/Technology in the relevant discipline of specialization with minimum 50% marks awarded by the State Boards of Technical Education, India or any other competent authority as accepted by the Board of Management of the Institute as equivalent thereto are eligible for admission to the 3rd Semester of the B. Tech degree programme.

2.2 The candidate has to fulfil all the prescribed admission requirements / norms of the Institute.

2.3. In all matters relating to admission to the B. Tech degree programme, the decision of the Board of Management of the Institute shall be final.

2.4. At any time after admission, if found that a candidate has not fulfilled one or many of the requirements stipulated by the Institute, or submitted forged certificates, the Institute has the right to revoke the admission and forfeit the fee paid. In addition, legal action may be taken against the candidate as decided by the Board of Management.

3.0 Student Discipline

Every student is required to observe utmost discipline and decorum both inside and outside the campus and not to indulge in any activity which may affect adversely the prestige reputation of the Institute.

3.1 Any act of indiscipline of a student reported to the Dean (Student affairs) and Head of the Department will be referred to a Discipline Committee constituted for the purpose. The Committee will enquire into the charges and decide on a suitable punishment if the charges are substantiated. The committee will also authorize the Dean (Student Affairs) to recommend to the Vice-Chancellor for the implementation of the decision. The student concerned may appeal to the Vice-Chancellor, whose decision will be the final.

3.2 Ragging in any form is a criminal and non-bailable offence in our country. The current State and Central legislations provide stringent punishments including imprisonment. Once the involvement of a student(s) is established in ragging, offending fellow students/staff, harassment of any nature to the fellow students/staff etc. the student(s) will be liable to be dismissed from the Institute, as per the laid down procedures of the UGC / Govt. /Institute. Every senior student of the Institute, along with their parent, shall give an undertaking every year in this regard and the same should be submitted at the time of Registration.

4.0 Structure of the B. Tech Degree Programme

4.1 All B. Tech. degree Programmes will have the curriculum and syllabi (for 4 years) as approved by the respective Board of Studies and Academic Council of the Institute.

4.2 Credits are the weightages, assigned to the courses based on the following general pattern:

One Lecture / Tutorial period per week	--- 1 credit
Up to Three periods of Practical per week	--- 1 credit
4 periods of Practical per week	--- 2 credits

4.3 The curriculum for B. Tech. programme is designed to have a minimum of **165 credits + 4 Non – CGPA credits** that are distributed across eight semesters of study for the award of degree.

Choice Based Credit System (CBCS) was introduced from the Academic year 2015-16 in the curriculum to provide the students, a balanced approach to their educational endeavour.

Under CBCS, the degree programme will consist of the following categories of courses:

i) **General Core foundation** (**CF**) courses comprising of
- Humanities courses;
- Basic Sciences (BS)including Physics, Chemistry and Mathematics;
- Engineering Sciences (ES), including Basic Engineering courses such as Material Science, Basic Workshop, Engineering Drawing, Engineering Graphics, Digital systems, etc.

ii) **Compulsory Courses (CC) consist of the following.**

a. **Professional Core (PC)** courses: These courses expose the students to the foundation of Engineering topics related to the chosen programme of study comprising of theory and Practical/ field work/ Design project/ Project.

b. **Departmental Elective** (**DE**): These courses enable the students to take up a group of courses of their interest in the area of specialization offered by the parent Department / School.

iii) **Non –Departmental Electives (NE):** These courses are offered by Engineering and Non-Engineering departments (across the disciplines) other than their parent Department. Two groups of Electives are available under NE namely, Engineering Electives, offered by the Engineering Departments and Open Electives, offered by the Non – Engineering departments.

iv) **Indexed Journal / Conference Publications:** If a student publishes a research paper as main author in indexed Journal / Conference, the same can be considered as equivalent to two – credit course under NE.

v) **Non-CGPA courses:** These courses are offered in certain semesters are compulsory, but are not used for calculation of GPA and CGPA. However, the credits will be mentioned in the grade sheet.

4.4 Non – CGPA courses

The student shall select any two courses /activity listed in **Table 1** during the course of study. The student has to make his / her own efforts for earning the credits. The grades given will be Pass / Fail (P/F). The respective class teachers have to encourage, monitor and record the relevant activities of the students, based on the rules issued from time to time by the Institute and submit the End semester report to the Head of the Department.

Table 1. Non – CGPA Courses

No.	Course / Activity	Credits
1.	Start ups	2
2.	Industrial Training	2
3.	Technical conference, seminar, competitions, Professional Societies	2
4.	Management courses	2
5.	Technical Certification Course	2
6.	Sports	2
7.	NCC	2
8.	NSS	2
9.	YRC	2
10.	Art and Cultural activities	2
11.	English Proficiency Certification	2
12.	Aptitude Proficiency Certification	2
13.	Foreign Languages Level II and above	2
14.	Publication in Conferences / Seminar	2

4.5 A student must earn compulsorily, the credits mentioned under each category shown in **Table 2** and also a minimum total of **169 credits - 165 credits (CGPA) + 4 credits (Non CGPA)** for the award of B. Tech. degree. For Lateral entry students, the 41 credits required for first and second semester of B. Tech shall be deemed to have been earned based on their curriculum in the diploma course. They have to earn a minimum of **128 credits (124 credits + 4 Non CGPA credits)** for the award of B. Tech. degree.

4.6 Students are eligible for award of **B.Tech.(Hons)** upon successful completion of **181 credits (165 regular credits + 12 Additional Credits+ 4 Non CGPA credits)** maintaining a CGPA of 8.0 during their period of study (4 years) and no history of arrears as detailed in clause 7.0.

4.7 Students are eligible for the award of **B.Tech. with Minor specialisation** upon successful completion of 12 additional credits totalling **181 credits (165 regular credits + 12 Additional Credits+ 4 Non – CGPA credits)** as detailed in clause 8.0

Table 2. Distribution of Credits

No.	Category	Credits	Percentage
1	Basic Sciences (BS)	32	20
2	Humanities Courses (HS)	7	4
3	Professional Core (PC)	90	53
4	Department Elective (DE)	15	9
5	Non – Department Electives (NE)	10	6
6	Design Project	3	2
7	Internship	1	0.5
8	Project	8	5
9	Comprehension	1	0.5
	Total Credits	**165**	**100**
NON – CGPA			
10	Professional Development	4	---

4.8 The medium of instruction is English for all courses, examinations, seminar presentations and project reports.

5.0 Faculty Advisor

To help the students in planning their selection of courses and programme of study and for getting general advice on the academic programme, the concerned department will assign a certain number of students to a Faculty member who will be called their Faculty Advisor. Such Faculty Advisor will continue to mentor the students assigned to him/her for the entire duration of the programme.

5.1 Class Committee

5.2 Every section / batch of the B. Tech. Degree programme will have a Class Committee consisting of Faculty and students.

5.3 The constitution of the Class Committee will be as follows:

a. One Professor not associated with teaching the particular class shall be nominated by the Head of the Department to act as the Chairman of the Class Committee as approved by the Dean Academics.
b. Course coordinator of each of the lecture – based courses (for common courses).
c. Class teacher of the class.

d. All Faculty handling the courses for that class in the semester.
e. Workshop Superintendent (for first two semesters); as applicable.
f. Four students from the respective class nominated by Head of the Department
g. Faculty Advisors of the respective class.

5.4 Course committee

A course committee shall be constituted by the HOD for all the common courses, with the faculty who are teaching the courses and with a Professor of the core department as the Chairman. The Course committee shall meet periodically to ensure the quality of progression of the course in the semester.

5.5 The basic responsibilities of the Class Committee and Course committee are

a. To review periodically the progress of the students.
b. To discuss issues concerning curriculum and syllabi and the conduct of the classes.
c. To inform the students about the method of assessment as recommended by the Department Exam Committee ("DEC") at the beginning of the semester. Each class committee / course committee will communicate its recommendations and the minutes of the meetings to the Head of the Department, Dean (Academics) and the Dean (Student Affairs).
d. To conduct meetings at least thrice in a semester as per the Academic Plan issued by the Dean – Academics.
e. To review the academic performance of the students including attendance, internal assessment and other issues like discipline, maintenance etc.

6.0 Registration for courses in a Semester

A student will be eligible for registration of courses only if he/she satisfies the regulation clause 12.0 (progression), and clause 13.0 (maximum duration) and has cleared all dues to the Institute, Hostel and Library up to the end of the previous semester provided that student is not debarred from enrolment on disciplinary grounds.

6.1 The institute follows a flexible Choice Based Credit System and Slot based table. Accordingly, the students shall be given the option for selecting their courses, credits, teachers, slots and create their time table. The student is given the option of selecting the number of credits to undergo in a semester, subject to the curriculum requirements of minimum and maximum.

Except for the first year courses, registration for a semester will be done during a specified week before the start of the semester as per the Academic Schedule.

Late registration /enrolment will be permitted by the Dean – Academics for genuine cases, on recommendation by the Head of the respective department, with a late fee as decided from time to time.

6.2 The student shall make the choice of course in consultation with the Faculty Advisor and as stipulated from time to time.

6.3 Students shall have to pay additional fee as prescribed, for registering in certain elective courses under Non - Departmental Electives courses offered by certain specific Departments and for higher level Foreign Languages, as decided from time to time.

7.0 B. Tech, (Honours) Programme

A new academic programme B.Tech. (Hons.) is introduced in order to facilitate the students to choose additionally the specialized courses of their choice and build their competence in a specialized area. The features of the new programme, include:

a. B.Tech. students in regular stream can opt for B.Tech. (Hons.), provided they have a CGPA of 8.0 up to the end of fourth semester without any history of arrears.
b. The students opting for this program have to take four additional courses of their specialization of a minimum of 3 credits each from 5^{th} to 8^{th} semesters with not more than 2 additional courses in a semester.
c. The list of such additional courses offered by the various Departments of the respective school will be announced in the beginning of the academic year to facilitate the registration process.
d. The student can also opt for post graduate level courses
e. The faculty advisor will suggest the additional courses to be taken by the students based on their choice and level of their academic competence.
f. Students who have obtained “E” or “U” or “RC” / “RA” grade or “DE” category (vide clause 16.0 – Grading) in any course, including the additional credit courses, are not eligible for B.Tech. (Hons) degree.
g. The students have to pay the requisite fee for the additional courses.

8.0 B. Tech with Minor specialization:

Students, who are desirous of pursuing their special interest areas other than the chosen discipline of Engineering / Technology/ Arts/ Fashion/ Humanities/ Management/ Basic Sciences, may opt for additional courses in minor specialisation groups offered by a

department other than their parent department. Such students shall select the stream of courses offered with pre – requisites by the respective departments and earn a Minor Specialization.

a. The number of credits to be earned for Minor specialization is 12 credits.

b. The students are permitted to register for their minor specialization courses from the V semester onwards subject to a maximum of two additional courses per semester.

c. The list of such additional courses offered by the various departments and the schedule will be announced in the beginning of the academic year to facilitate the registration process.

d. The students have to pay the requisite fee for the additional courses.

9.0 Attendance

The faculty handling a course must finalise the attendance, 3 calendar days before the last instructional day of the course and submit to the HoD through the class teacher.

a. A student with less than 75% attendance (Total Contact Hours - "TCH") in any course, will **not** be permitted to appear for the end-semester examination in that particular course, irrespective of the reason for the shortfall of the attendance. The student is however permitted to avail **Academic Leave** up to 10% for attending academic related activities like, Industrial Visits, Seminars, Conferences, Competitions etc., with the prior approval of the HoD. After the event, the student should submit the relevant documents for proof to the HoD for approval of the Academic Leave.

b. The remaining 25% allowance in attendance is given to account for activities under NCC / NSS / Cultural / Sports/ Minor Medical exigencies etc.

c. A student with an attendance ("TCH" – Total Contact Hours) between 40% and 75% in any course will fall under the category "RC", which means Repeat the Course during the Summer / Winter break. Students under "RC" category will **not** be permitted to attend the Regular End Semester Examinations for that course. During the Summer / Winter break, the regular courses of the respective semester will be offered as Summer/Winter Courses, to enable the students to get required attendance and internal assessment marks to appear in the Repeat examination.

d. Students under "RC" category in any course shall attend, the immediately following Summer / Winter course as detailed in clause 11.1. The detailed schedule of the Summer / Winter courses offered in every semester will be announced during the end of that semester. The student who have obtained "RC" has to select their appropriate slots and courses, optimally to attend the courses.

e. The student, whose attendance falls below 40% for a course in any semester, will be categorized as "RA", meaning detained in the particular course for want of

attendance and they will not be permitted to write the End semester exam for that course. The procedure for repeating the course categorized as "RA" is mentioned in Clause 11.2.

9.1 Additional condonation may be considered in rare and genuine cases which includes, approved leave for attending select NCC / Sports Camps, cases requiring prolonged medical treatment and critical illness involving hospitalization.

For such select NCC / Sports Camps prior permission for leave shall be obtained by the respective faculty coordinator / Director of sports from the designated authority, before deputing the students.

9.2 For medical cases, submission of complete medical history and records with prior information from the parent / guardian to Dean (Student Affairs) is mandatory. The assessment of such cases will be done by the attendance sub – committee on the merit of the case and put up recommendations to the Vice – Chancellor. Such condonation is permitted **only twice** for a student in the entire duration of the programme.

The Vice-Chancellor, based on the recommendation of the attendance sub - committee may then give condonation of attendance, only if the Vice-Chancellor deems it fit and deserving. But in any case, the condonation cannot exceed 10%.

10.0 Assessment Procedure

Every course shall have two components of assessment namely,

a. Continuous Internal Assessment "CIA": This assessment will be carried out throughout the semester as per the Academic Schedule.
b. End Semester Examination "ESE": This assessment will be carried out at the end of the Semester as per the Academic Schedule.

The weightages for the various categories of the courses for CIA and ESE is given in Table 3.

Table 3 Weightage of the CIA and ESE for various categories of the courses

No.	Category of Courses	CIA weightage	CIA Minimum	ESE	ESE Minimum	Passing minimum (CIA + ESE)
1	Theory Course	50%	40%	50%	50%	45%
2	Practical Course	80%	50%	20%	50%	50%
3	Theory Course with Practical Components	60%	40%	40%	50%	45%
4	Department Elective (DE)/ Non – Department Elective (NE)	50%	40%	50%	50%	45%
5	Design Project	100%	50%	---	---	50%
6	Comprehension	100%	50%	---	---	50%
7	Internship	100%	50%	---	---	50%
8	Project and Viva Voce	50%	50%	50%	50%	50%

10.1 Theory Course / DE / NE Assessment weightages

The general guidelines for the assessment of Theory Courses, Department Electives "DE" and Non – Department Electives "NE" shall be done on a continuous basis is given in Table 4.

Table 4(a): Weightage for Assessment

No.		Assessment Theory, DE, NE courses	Weightage Theory, DE, NE courses	Duration
1.	CIA	First Periodical Assessment	5%	1 period
2.		Second Periodical Assessment	10%	1 Period
3.		Third Periodical Assessment	10%	1Period
4.		Seminar/Assignments/Project	15%	--
5.		Surprise Test / Quiz etc.,	10%	--
6.	ESE	End Semester Exam	50%	2 to 3 hours

10.2 Practical Course: For practical courses, the assessment will be done by the course teachers as below:

Weekly assignment/Observation / lab records and viva as approved by the Department Exam Committee "DEC"

a. Continuous Internal Assessment -- 80%
b. End Semester Examination -- 20%

10.3 Theory courses with practical Component: For theory courses with practical component the assessment will be calculated as follows as approved by the "DEC".

a. Continuous Internal Assessment -- 60%
b. End Semester Exam -- 40%

Table 4(b): Weightage for Assessment

No.		Assessment Theory, DE, NE courses	Weightage Theory, DE, NE courses	Duration
1.	CIA	First Periodical Assessment	10%	1 period
2.		Second Periodical Assessment	10%	1 Period
3.		Third Periodical Assessment	10%	1Period
4.		Practical Assessment	30%	----
5.	ESE	End Semester Exam	40%	2 to 3 hours

10.4 Design Project – Assessment

The general guidelines for assessment of Design Project is given in Table 5.

Table 5: Assessment pattern for Design Project

No.	Review / Examination scheme	Broad Guidelines	Weightage
1.	First Review	Concept	20%
2.	Second Review	Design	30%
3.	Third Review	Experiment/Analysis	20%
4.	Project report and Viva – Voce	Results and Conclusion	30%

10.5 Comprehension – Assessment

The general guidelines for assessment of Comprehension is given in Table 6.

Table 6: Assessment pattern for Comprehension

No.	Review / Examination scheme	Broad Guidelines	Weightage
1.	First Periodical Assessment – MCQ	Basic Sciences	20%
2.	Second Periodical Assessment – MCQ	Core Engineering	50%
3.	Third Periodical Assessment – Presentation	Emerging Areas	30%

10.6 Internship

A student has to compulsorily attend Summer / Winter internship during 3rd year for a minimum period of one month.

In lieu of Summer / Winter internship, the student is permitted to register for undertaking case study / project work under an engineering faculty of the Institute and carry out the project for minimum period of one month.

In both the cases, the internship report in the prescribed format duly certified by the faculty in-charge shall be submitted to the HoD. The evaluation will be done through presentation and viva. The course will have a weightage of one credit or as defined in the respective curriculum.

10.7 For final year Project / Dissertation / Design Project/ Internship, the assessment will be done on a continuous basis as given in Table 7

Table 7: Assessment of Project work

No.	Review / Examination scheme	Weightage
1.	First Review	10%
2.	Second Review	20%
3.	Third Review	20%
4.	Project report and Viva – Voce	50%

For the final year project and Viva – Voce end semester examination, the student shall submit a Project Report in the prescribed format issued by the Institute. The first three reviews will be conducted by a Committee constituted by the Head of the Department. The end – semester assessment will be based on the project report and a viva on the project conducted by a Committee constituted by the Registrar / Controller of examination. This may include an external expert.

10.8 For Non – CGPA courses, the assessment will be graded "Satisfactory/Not Satisfactory" and grades as Pass/Fail will be awarded.

10.9 Flexibility in Assessment

The respective Departments under the approval of the Department Exam Committee (DEC) may decide the mode of assessment, based on the course requirements.

10.10 A student securing **less than the minimum** specified internal assessment marks in any course (clause 10.0, Table 3), will **not be permitted** to appear for the end-semester examination in that particular course and will be graded under **"RC"** category for that course. This will be denoted in the grade sheet as "RC", till the course is successfully completed in the subsequent semester(s).

11.0 Procedures for Course Repetition / Repeat Examinations

11.1 Summer / Winter Course: - for "RC" Category

a. Students under RC category i.e.
   i. Attendance between 40% and 75% in any course(s) OR
   ii. CIA marks less than the prescribed minimum as specified in 10.0 Table 3 in any course(s) OR
   iii. Falls under both 1 and 2 above

are eligible for registering for the **Summer / Winter Course** which will be conducted during the Summer / Winter break, to improve their Attendance and/or CIA marks in the courses, by paying the **prescribed registration fee fixed from time to time.**.

b. The Odd semester regular courses will be offered only in the Winter and the even semester regular courses will be offered only in the Summer.
c. **RC** students shall register by payment of prescribed fee and attend the classes during the summer / winter break and take assessments to earn minimum internal marks (clause 10.0, Table 3) and/or required attendance, to become eligible for writing the Repeat Examinations (Clause 11.3).
d. The revised CIA marks shall not exceed 60% of the total internal weightage for any repeat course.
e. Re- Registration for 'RC' category

The students under "RC" category who **fail to improve** their attendance and/or CIA marks and **not** become eligible to write the Repeat Examination through the immediate summer/winter course are permitted to **re – register** for the Summer / Winter course again under "RC" category whenever it is offered in the subsequent semester(s) during their period of study by **paying 50% of the prescribed registration fee** as mentioned in Clause 11.1 (a). It is the responsibility of the student to fix the appropriate slots in the Summer / Winter course time table. The student will not be able to register if he/she is unable to fix the slots in the time table. The course will remain in the "RC" category until he / she successfully completes that course.

11.2 Course – Repetition - "RA" Category

a. Students who secure attendance less than **40%** in any course(s) in a semester will be categorized under "RA" - meaning **Repeat the course(s)** for want of minimum attendance. The CIA marks obtained by the students placed under RA category will become null and void.

b. "RA" category students shall re-register for the same course once again whenever it is offered in the subsequent regular semesters and has to secure required minimum attendance and minimum internal assessment marks to become eligible to appear in the end semester examination for that course, by paying the requisite fee.

c. It is the responsibility of the student to schedule their time table to include the "RA" courses without affecting the attendance of the regular courses of the current semester.

d. Normally, a student will be permitted to register for not more than 3 "RA" courses in a semester. However, the students who wish to register for more than 3 "RA" courses are permitted to register only if the student finds suitable slots for doing the course within the framework of the time table for the regular semester. Request for registrations of additional RA courses over and above 3 in a semester shall be got approved by the respective HoDs.

e. The student has the option to drop their regular courses proportionally in their regular semester during the course registration process without affecting the minimum credit requirement specified. Such dropped courses will be categorized as "RA". However, the student has to complete the dropped courses in the subsequent semesters.

f. It is the responsibility of the student to fix the slots for "RA" courses within the framework of the time table and slot availability without affecting his/her regular courses.

g. Detention

A student who secure RC or RA or both in all the theory courses prescribed in a semester shall repeat the semester by registering for the semester in the next academic year. However, he/she is permitted to appear for arrear examination as per eligibility.

11.3 Repeat Examinations

a. Normally, the results of the End Semester Examinations for Regular Theory courses are announced within a period of 10 days after the last regular examination.

b. During the even semester, the Repeat Examinations will be conducted for even semester courses and during the Odd semester the Repeat Examinations will be conducted for Odd semester courses.

c. The schedule for the Repeat Examinations will be notified through the Academic Calendar which will be published at the beginning of every academic year.
d. The students under "RC" category, who have secured the requisite attendance and internal assessment marks as applicable, by successfully completing the Summer / Winter course, are eligible to register for the Repeat Examinations.
e. The students who fail to secure a pass or being absent for genuine reasons in their End Semester Examination for the regular courses are permitted to appear for the Repeat Exams by paying the prescribed fee.
f. For the **Supplementary examinations (refer: Clause 15.2)**, the students with "U" grade in any course (refer clause 10.0 Table 3 and Clause 16.1) shall register by paying requisite fee and appear in the Repeat Examinations.
g. The students who wish to apply for the revaluation of their answer scripts (Regular/ Supplementary / Repeat Examinations) should apply immediately after the announcement of results.

12.0 Progression to higher semester

12.1 B.Tech.– Regular: Student has to satisfy the following conditions as laid down in Table 8 for progression from one academic year to next.

Table 8. Minimum Eligibility for progression B.Tech.- Regular

To enroll for semester	Minimum no. of credits to be earned for progression
3	NIL
5	15 credits* in Theory courses in 1st, 2nd and 3rd Semesters
7	30 credits* in Theory courses up to 5th Semester

** Credit calculation is applicable for Theory / Theory integrated lab only*

If a student fails to satisfy the above clause 12.1 in an academic year, the student has to take a break in study until they become eligible for progression

12.2 B.Tech.- Lateral Entry

Student has to satisfy the following conditions as laid down in Table 9 for progression from one academic year to next.

Table 9. Minimum Eligibility for progression B.Tech.- Lateral Entry

To enroll for semester	Minimum no. of credits to be earned
5	NIL
7	15 credits* in Theory courses in 3rd, 4th and 5th Semesters

**Credit calculation is applicable for Theory / Theory integrated lab only*

If a student fails to satisfy the above clause 12.2 in an academic year, the student has to take a break in study until they become eligible for progression

12.3 If a student is in **RC** category (due to lack of minimum CIA marks **as specified in clause no. 10. Table 3**) or **RA** category (due to lack of minimum attendance as specified in clause 9.0 e) **in all theory courses prescribed in a semester**, he/she will be detained and will not be allowed to proceed to the next semester. He/she has to re-register for all the courses in the following academic year only.

13.0 Maximum Duration of the Programme

A student may complete the programme at a slower pace than the regular pace, but in any case in **not more than 6 years for B. Tech**, **and not more than 5 years for lateral entry students excluding the semesters withdrawn as per clause 14.0.**

A student completing the B.Tech. programme during the extended period will not be eligible for Institute ranking.

14.0 Temporary Withdrawal from the Programme

a. A student is permitted to take a break, up to a maximum of 2 semesters, during the entire programme to clear the backlog of arrears.
b. A student may be permitted by the Vice- Chancellor to withdraw from the entire programme for a maximum of two semesters for reasons of ill health, Start – up venture or other valid reasons as recommended by a committee consisting of Head of Department, Dean (Academic) and Dean (Student Affairs).

15.0 Declaration of results

15.1 A student shall secure the minimum marks as prescribed in Clause 10.1(Table 3) in all categories of courses in all the semesters to secure a pass in that course.

15.2 **Supplementary Examinations:** If a candidate fails to secure a pass in a course and gets a "U" grade as per clause 16.1 he/she shall register and pay the requisite fee for re-appearing in the End Semester Examination during the following semester(s). Such examinations are called Supplementary Examinations and will be conducted along with the Regular /Repeat Examinations. The Supplementary Exams for the Odd semester courses will be conducted during the odd semester and supplementary exams for the even semester courses will be conducted during the even semester only. The student need not attend any contact course. The Internal Assessment marks secured by the candidate will be retained for all such attempts.

15.3 A candidate can apply for the revaluation of his/her end semester examination answer script in a theory course, after the declaration of the results, on payment of a prescribed fee.

15.4 If a candidate fails to secure a pass in Practical/Theory with Practical component / Design Project / Internship / Comprehension courses, due to not satisfying the minimum passing requirement ("U" grade) – as per clause 16.1 he/she shall register for the courses by paying the prescribed fee in the subsequent semester when offered by the departments.

15.5 Revaluation is **not** permitted for Practical/Theory with Practical component/Design Project / Internship / Comprehension courses. However, only for genuine grievances as decided by the Exam Grievance Committee a student may be permitted to apply for revaluation.

15.6 After 5 years, i.e., completion of one year (2 semesters) from the normal duration of the programme, the internal assessment marks obtained by the candidate will not be considered in calculating the passing requirement. A candidate who secures 50% in the end semester examination will be declared to have passed the course and earned the specified credits for the course irrespective of the score in internal assessment marks earned in that course.

15.7 Candidate who earns required credits for the award of degree after 5 years for B.Tech. programme (on expiry of extended period of 2 semesters over and above normal duration of course) he/she will be awarded only *second class* irrespective of his/her CGPA. However, the period approved under temporary withdrawal, if any, from the programme (13.0) will be excluded from the maximum duration as mentioned above.

15.8 Semester Abroad Programme: Students who are allowed to undergo internship or Training in Industries in India or abroad during their course work or attend any National / International Institute under semester abroad programme (SAP) up to a maximum of 2 semesters will be granted credit transfer for the Course Work/project work done by them in the Industry /Foreign Institute as per the recommendations of the credit transfer committee. The leave period of the students for International internships / Semester Abroad programme etc., will be accounted for attendance.

16.0 Grading

16.1 A grading system as shown in Table 10 will be followed.

Table 10: Grading system

Range of Marks	Letter Grade	Grade Points	Remarks
90 – 100	S	10	Outstanding
80-89	A	09	Excellent
70-79	B	08	Very Good
60-69	C	07	Good
50-59	D	06	Average
45 – 49	E	05	Pass
<45	U	00	To Reappear for end-semester examination
--	RC	00	**Repeat Course (Summer / Winter) due to** Attendance deficiency (between 40% and 75%) and/or I. Lack of minimum CIA marks as specified in clause 10.0 Table 3
--	RA	00	Repeat the course due to (i) Lack of minimum attendance (below 40%) in regular course
	--	00	**DETAINED** "RC" or "RA" or both in all registered theory courses of a semester. The student is detained and has to repeat the entire semester. Clause 12.3

16.2 GPA and CGPA

GPA is the ratio of the sum of the product of the number of credits Ci of course "i "and the grade points P_i earned for that course taken over all courses "i" registered and successfully completed by the student to the sum of Ci for all "i". That is,

$$GPA = \frac{\sum_i C_i P_i}{\sum_i C_i}$$

CGPA will be calculated in a similar manner, in any semester, considering all the courses enrolled from the first semester onwards.

16.3 The Grade card will not include the computation of GPA and CGPA for courses with letter grade **RA, RC** and **U** until those grades are converted to the regular grades.

16.4 A course successfully completed cannot be repeated.

17.0 Grade Sheet

17.1 Letter grade

Based on the performance, each student is awarded a final letter grade at the end of the semester in each course. The letter grades and corresponding grade points are given in Table 10.

17.2 A student is considered to have completed a course successfully and earned credits if he/she secures a letter grade other than **U, RC, RA** in that course.

17.3 After results are declared, grade sheet will be issued to each student which will contain the following details:

a. Program and discipline for which the student has enrolled.
b. Semester of registration.
c. The course code, name of the course, category of course and the credits for each course registered in that semester
d. The letter grade obtained in each course
e. Semester Grade Point Average (GPA)
f. The total number of credits earned by the student up to the end of that semester in each of the course categories.
g. The Cumulative Grade Point Average (CGPA) of all the courses taken from the first semester.
h. Credits earned under Non CGPA courses.
i. Additional credits earned for B. Tech (Hons.) and B. Tech with Minor specialization.

18.0 Class/Division

18.1 Classification is based on CGPA and is as follows:

CGPA ≥ 8.0: First **Class with distinction**
6.5 ≤ CGPA <8.0: **First Class**
5.0 ≤ CGPA <6.5: **Second Class.**

18.2 (i) Further, the award of **'First class with distinction'** is subject to the candidate becoming eligible for the award of the degree having passed the examination in all the courses in his/her first appearance with effect from II semester, within the minimum duration of the programme.

(ii) The award of **'First Class'** is further subject to the candidate becoming eligible for the award of the degree having passed the examination in all the courses **within 5 years for B. Tech programmes**

(iii) The period of authorized break of the programme (vide clause 14.0) will not be counted for the purpose of the above classification.

(iv) To be eligible for award of **B. Tech (Hons.)** the student must have earned additional 12 credits in the relevant Engineering courses offered by the Departments of the respective Schools, thereby a total of **181 credits (165 regular credits + 12 additional credits + 4 Non CGPA credits) and should have 8.0 CGPA without any history of arrears and should not have secured E, RC, RA, U, in any course during the entire programme.**

(v) To be eligible for award of **B. Tech with Minor Specialization**, the student must have earned additional 12 credits in the relevant courses offered by other than the parent department and has successfully earned **181 credits (165 regular credits + 12 Additional credits + 4 Non CGPA Credits)**

19.0 Transfer of credits

19.1. Within the broad framework of these regulations, the Academic Council, based on the recommendation of the Credit Transfer Committee so constituted may permit students to transfer part of the credit earned in other approved Universities of repute & status in the India or abroad.

19.2 The Academic Council may also approve admission of students who have completed a portion of course work in another approved Institute of repute under lateral entry based on the recommendation of the credit transfer committee on a case to case basis.

19.3 Admission norms for working Professional:

Separate admission guidelines are available for working / experienced professionals for candidates with the industrial / research experience who desire to upgrade their qualification as per recommendation of Credit Transfer Committee.

20.0 Eligibility for Award of the B.Tech. /B. Tech (Hons)/ B. Tech with Minor Specialization Degree

20.1 A student shall be declared to be eligible for award of B. Tech. /B. Tech (Hons) / B. Tech degree with Minor specialization if he/she has satisfied the clauses 4.6 /7.0 / 8.0 respectively within the stipulated time (clause 13, 14).

a. Earned the specified credits in all the categories of courses (vide clause 4.6) as specified in the curriculum corresponding to the discipline of his/ her study ;
b. No dues to the Institute, Hostels, Libraries etc.; and
c. No disciplinary action is pending against him / her.

The award of the degree shall be recommended by the Academic Council and approved by the Board of Management of the Institute.

21.0 Change of Discipline

21.1 If the number of students in any discipline of B.Tech. programme as on the last instructional day of the First Semester is less than the sanctioned strength, then the vacancies in the said disciplines can be filled by transferring students from other disciplines subject to eligibility. All such transfers will be allowed on the basis of merit of the students. The decision of the Vice-Chancellor shall be final while considering such requests.

21.2 All students who have successfully completed the first semester of the course will be eligible for consideration for change of discipline subject to the availability of vacancies and as per norms.

22.0 Power to modify

Notwithstanding all that has been stated above, the Academic Council is vested with powers to modify any or all of the above regulations from time to time, if required, subject to the approval by the Board of Management.

B.TECH – MECHANICAL ENGINEERING									
(165 - CREDIT STRUCTURE)									
SEMESTER - I									
SL. NO	COURSE CATEGORY	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
1	BS	MEA4101/ ELA4101	Engineering Graphics and Computer aided Design / Professional English and soft skills	1	1	2	3	1	4
2	BS	MAA4101	Matrices and calculus	3	0	2	4	1	5
3	BS	PHA4101/ CYA4101	Engineering Physics / Engineering Materials	3	0	0	3	1	3
4	PC	CSA4101	Problem Solving Using C* / Sustainable Engineering Systems	2	0	2*	3/2	1	4/3
5	PC	MEB4101	Engineering and Design	3	0	0	3	1	3
6	BS	GEA4131	Engineering Immersion Lab	0	0	2	0.5	2	2
7	BS	PHA4131/ CYA4131	Engineering Physics Lab / Materials Chemistry Lab	0	0	2	1	0	2
Total				**12**	**1**	**10**	**17.5/ 16.5**	**7**	**23/ 22**
***Project based Learning**									
SEMESTER - II									
SL. NO	COURSE CATEGORY	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
1	BS	MAA4117	Analytical Mathematics	3	0	2	4	0	5
2	BS	PHA4101/ CYA4101	Engineering Physics / Engineering Materials	3	0	0	3	1	3
3	BS	MEA4101/ ELA4101	Engineering Graphics and Computer aided Design / Professional English	1	1	2	3	1	4
4	PC	CSA4101	Sustainable Engineering Systems / Problem Solving Using C*	2	0	2*	2/3	1	3/4
5	PC	EEB4101	Introduction to Digital Systems	3	0	0	3	1	3
6	PC	MEB4116	Engineering Mechanics	3	1	0	4	1	4
7	PC	MEB4117	Manufacturing Technology – I	3	0	0	3	1	3
8	BS	PHA4131/ CYA4131	Engineering Physics Lab / Materials Chemistry Lab	0	0	2	1	0	2
9	BS	GEA4131	Engineering Immersion Lab	0	0	2	0.5	2	2
Total				**18**	**2**	**10**	**23.5/ 24.5**	**6**	**26**

SEMESTER - III									
SL. NO	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1	BS	MAA4201	Partial Differential Equations and Transforms	3	1	0	4	0	4
2	PC	MEB4201	Engineering Thermodynamics	3	1	0	4	2	4
3	PC	MEB4202	Fluid Mechanics and Machinery	3	0	0	3	2	3
4	PC	MEB4203	Manufacturing Technology – II	3	0	0	3	2	3
5	DE		Department Elective – I	3	0	0	3	0	3
6	NE		Non Department Elective – I	2	0	0	2	0	2
7	PC	MEB4231	Fluid Mechanics and Machinery Lab	0	0	2	1	1	2
8	PC	MEB4232	Manufacturing Technology Lab	0	0	2	1	1	2
9	PC	MEB4233	Design Project-I	0	0	2	1	0	2
Total				**17**	**2**	**6**	**22**	**8**	**25**

SEMESTER - IV									
SL. NO	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1	PC	MAA4216	Probability and Statistics	3	1	0	4	0	4
2	PC	MEB4216	Thermal Engineering	3	0	0	3	2	3
3	PC	MEB4217	Strength of Materials	3	0	0	3	2	3
4	PC	MEB4218	Engineering Metrology and Measurements	3	0	0	3	2	3
5	BS	GEA4216	Professional ethics and life skills	2	0	0	2	1	2
6	DE		Department Elective-II	3	0	0	3	0	3
7	NE		Non Department Elective – II	2	0	0	2	0	2
8	PC	MEB4241	Thermal Engineering Lab I	0	0	2	1	0	2
9	PC	MEB4242	Strength of Materials Lab	0	0	2	1	0	2
10	PC	MEB4243	Engineering Metrology and Measurements Lab	0	0	2	1	0	2
11	PC	MEB4244	Design Project-II	0	0	2	1	0	2
Total				**19**	**1**	**8**	**24**	**7**	**28**

SEMESTER - V									
SL. NO	COURSE CATEGORY	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
1	PC	MAA4301	Optimization Techniques	3	1	0	4	0	4
2	PC	MEB4301	Design of Machine Elements	3	0	0	3	2	3
3	PC	MEB4302	Mechanics of Machines	3	0	0	3	1	3
4	PC	MEB4303	Gas Dynamics and Jet Propulsion	3	0	0	3	1	3
5	PC	MEB4304	Mechatronics and Pneumatics	3	0	0	3	1	3
6	DE		Department Elective-III	3	0	0	3	0	3
7	NE		Non Department Elective-III	2	0	0	2	0	2
8	PC	MEB4331	Dynamics Lab	0	0	2	1	0	2
9	PC	MEB4332	Thermal Engineering Lab –II	0	0	2	1	0	2
10	PC	MEB4333	Mechatronics and Pneumatics Lab	0	0	2	1	0	2
11	PC	MEB4334	Design Project-III	0	0	2	1	0	2
Total				**20**	**1**	**8**	**25**	**5**	**30**
SEMESTER - VI									
SL. NO	COURSE CATEGORY	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
1	PC	MEB4316	Computer Aided Design and Manufacturing	3	0	0	3	2	3
2	PC	MEB4317	Design of Mechanical Transmission System	3	0	0	3	2	3
3	PC	MEB4318	Composites and Smart Materials	3	0	0	3	2	3
4	PC	MEB4319	Nano Technology	3	0	0	3	2	3
5	BS	GEA4304	Business Economics	2	0	0	2	1	2
6	DE		Department Elective-IV	3	0	0	3	0	3
7	NE		Non Department Elective–IV	2	0	0	2	0	2
8	PC	MEB4341	Computer Aided Design and Manufacturing Lab	0	0	2	1	0	2
9	PC	MEB4342	Composites and Smart Materials Lab	0	0	2	1	0	2
10	PC	MEB4343	Design Project-IV	0	0	2	1	0	2
11	PC	MEB4344	Comprehension	1	0	0	1	0	1
Total				**20**	**0**	**6**	**23**	**9**	**26**

SEMESTER - VII									
SL. NO	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1	PC	MEB4401	Heat and Mass Transfer	3	0	0	3	2	3
2	PC	MEB4402	Finite Element Methods	3	0	0	3	2	3
3	PC	MEB4403	Robotics and Automation	3	0	0	3	1	3
4	PC	MEB4404	Additive Manufacturing Technology	3	0	0	3	2	3
5	NE		Non Department Elective–V	2	0	0	2	0	2
6	DE		Department Elective-V	3	0	0	3	0	3
7	PC	MEB4431	Heat Transfer Lab	0	0	2	1	1	2
8	PC	MEB4432	Computer Aided Simulation and Analysis Lab	0	0	2	1	1	2
9	PC	MEB4433	Robotics and Automation Lab	0	0	2	1	1	2
10	PC	MEB4434	Design Project-V	0	0	2	1	0	2
11	PC	MEB4435	Internship	0	0	0	1	0	0
Total				**17**	**0**	**8**	**22**	**10**	**25**

SEMESTER - VIII									
SL. NO	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1	PC	MEB4441	Project & Viva - voce	0	0	24	8	0	
Total				**0**	**0**	**24**	**8**	**0**	
Total							**165**		

LIST OF DEPARTMENTAL ELECTIVES WITH GROUPING - SEMESTER WISE									
SEM	COURSE CATEGORY	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
3	DE	MEC4251	Non Destructive Testing Methods	3	0	0	3		3
3	DE	MEC4252	Reverse Engineering	3	0	0	3		3
3	DE	MEC4253	Mechanical Metallurgy	3	0	0	3		3
3	DE	MEC4254	Unconventional Machining Process	3	0	0	3		3
3	DE	MEC4255	Computer Integrated Manufacturing	3	0	0	3		3
3	DE	MEC4256	I C Engine & Stream Turbine	3	0	0	3		3
3	DE	MEC4257	Process Planning and Cost Estimation	3	0	0	3		3
4	DE	MEC4266	Refrigeration and Air conditioning	3	0	0	3		3
4	DE	MEC4267	Power plant Engineering	3	0	0	3		3
4	DE	MEC4268	Computational Fluid Dynamics	3	0	0	3		3
4	DE	MEC4269	Heat Treatment of Metals and Alloys	3	0	0	3		3
4	DE	MEC4270	Mechanical Vibration	3	0	0	3		3
4	DE	MEC4271	Modern Concepts of Engineering Design	3	0	0	3		3
4	DE	MEC4272	Characterization of Materials	3	0	0	3		3
5	DE	MEC4351	Structure and Properties of Materials	3	0	0	3		3
5	DE	MEC4352	Engineering Economics and cost Analysis	3	0	0	3		3
5	DE	MEC4353	Tool Design	3	0	0	3		3
5	DE	MEC4354	Applied Hydraulics and Pneumatics	3	0	0	3		3
5	DE	MEC4355	Automobile Engineering	3	0	0	3		3
5	DE	MEC4356	Operations Research	3	0	0	3		3
5	DE	MEC4357	Maintenance Engineering &condition Monitoring	3	0	0	3		3
6	DE	MEC4366	Tribology in Design	3	0	0	3		3
6	DE	MEC4367	Quality and Reliability Engineering	3	0	0	3		3
6	DE	MEC4368	Productivity Management and Re-Engineering	3	0	0	3		3
6	DE	MEC4369	Polymer Science and Engineering	3	0	0	3		3
6	DE	MEC4370	Advanced IC Engine	3	0	0	3		3
6	DE	MEC4371	Creep And Fatigue Behavior of Materials	3	0	0	3		3
6	DE	MEC4372	Production Planning and Control	3	0	0	3		3
6	DE	MAA4303	Numerical Methods	2	0	2	3		3
7	DE	MEC4451	Dynamics and Control	3	0	0	3		3
7	DE	MEC4452	Modal Analysis of Mechanical Systems	3	0	0	3		3
7	DE	MEC4453	New Product Design and Development	3	0	0	3		3
7	DE	MEC4454	Advanced strength of Materials	3	0	0	3		3
7	DE	MEC4455	Thermal Turbo Machines	3	0	0	3		3
7	DE	MEC4456	Power Metallurgy	3	0	0	3		3
7	DE	MEC4457	Renewable source of Energy	3	0	0	3		3
7	DE	MEC4458	Lean Manufacturing	3	0	0	3		3

LIST OF NON DEPARTMENTAL ELECTIVES OFFERED BY MECHANICAL DEPARTMENT WITH GROUPING - SEMESTER WISE									
SEM	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
3	NE	MED4281	Applied Thermodynamics for Engineers	3	0	0	3		3
3	NE	MED4282	Power developing machines for transportation sector	3	0	0	3		3
3	NE	MED4283	Modern Manufacturing Techniques	3	0	0	3		3
3	NE	MED4284	CNC Machines and Controls	3	0	0	3		3
4	NE	MED4291	Unconventional Machining Processes	3	0	0	3		3
4	NE	MED4293	Computer Workstation Ergonomics	3	0	0	3		3
4	NE	MED4294	Energy and safety aspects of mechanical system for buildings	3	0	0	3		3
5	NE	MED4381	Mechanical Measurements	3	0	0	3		3
5	NE	MED4382	Fundamentals of Computer Integrated Manufacturing	3	0	0	3		3
5	NE	MED4383	Fundamentals of Engineering Design	3	0	0	3		3
5	NE	MED4384	Basic Refrigeration and Air-conditioning	3	0	0	3		3
6	NE	MED4391	Fundamentals of Power Plant Technology	3	0	0	3		3
6	NE	MED4392	Industrial Automation	3	0	0	3		3
6	NE	MED4393	Mechatronics System Design	3	0	0	3		3
6	NE	MED4394	Virtual Instrumentation	3	0	0	3		3
7	NE	MED4481	Design of Building Automation	3	0	0	3		3
7	NE	MED4482	Industrial Safety& Maintenance Engineering	3	0	0	3		3
7	NE	MED4483	Quality Control and Reliability Engineering	3	0	0	3		3
7	NE	MED4484	Applied Hydraulics and Pneumatics	3	0	0	3		3
7	NE	MED4485	Non-destructive Testing Methods	3	0	0	3		3

SEMESTER – I

COURSE TITLE	ENGINEERING GRAPHICS AND COMPUTER AIDED DESIGN			CREDITS	3
COURSE CODE	MEA4101	COURSE CATEGORY	BS	L-T-P-S	1- 1- 2- 1
CIA	60%			ESE	40%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
Upon completion of this course, Students should be able to		
1	Understand drafting and computer aided drafting. Remember the commands used in AutoCAD to generate simple drawings.	1,3,5,10,11
2	Explain details in a drawing and apply the knowledge to solve simple problems involving straight lines, planes and solids	1,3,5,10,11
3	Understand and Visualize solid objects and apply AutoCAD software commands to generate the graphic models	1,3,5,10,11
4	Apply the 3D model commands to generate and solid object	1,3,5,10,11
5	Apply the viewing AutoCAD commands to generate top view, front view and additional or sectional views.	1,3,5,10,11
6	Student can able to develop any graphical model of geometrical and simple mechanical objects in AutoCAD software.	1,3,5,10,11

Prerequisites : Nil

MODULE 1: BASICS OF ENGINEERING GRAPHICS (12)

Importance of graphics - BIS conventions and specifications - drawing sheet sizes - Lettering – Dimensioning - Scales. Drafting methods - introduction to Computer Aided Drafting – Computer Hardware – Workstation – Printer and Plotter – Introduction to software for Computer Aided Design and Drafting – Exposure to Solid Modelling software – Geometrical Construction-Coordinate Systems/Basic Entities – 3D printer. Projection methods and Projections of solid. (Solids in simple positions and axis inclined to one plane only)

Suggested Reading: Solid modeling Software commands

MODULE 2: VISUALIZATION, ORTHOGRAPHIC PROJECTIONS AND FREE HAND SKETCHING (15)

Visualization concepts and Free Hand sketching: Visualization principles —Representation of Three Dimensional objects — Pictorial Projection methods - Layout of views- Free hand sketching of multiple views from pictorial views of objects. Drafting of simple Geometric Objects/Editing

General principles of presentation of technical drawings as per BIS - Introduction to Orthographic projections - Naming views as per BIS - First angle projection method. Conversion to orthographic views from given pictorial views of objects, including dimensioning – Drafting of Orthographic views from Pictorial views.

Suggested Reading: CAD software commands for sketching a drawing

MODULE 3: GEOMETRICAL MODELING ISOMETRIC VIEWS AND DEVELOPMENT OF SURFACES (15)

Principles of isometric projection and solid modelling. Isometric drawing – Iso Planes and 3D Modelling commands. Projections of Principal Views from 3-D Models. Solid Modelling – Types of modelling - Wire frame model, Surface Model and Solid Model – Introduction to graphic software for solid modelling. Development of Surfaces.

***Suggested Reading**: Surface modeling and solid modeling commands*

MODULE 4: COMPUTER AIDED DESIGN AND DRAFTING (15)

Preparation of solid models of machine components like slide block, solid bearing block, bushed bearing, gland, wall bracket, guide bracket, shaft bracket, jig plate, shaft support (open type), vertical shaft support etc using appropriate modelling software.

2D views and sectional view, computer aided drafting and dimensioning. Generate 2D drawing from the 3D models – generate and develop the lateral surfaces of the objects. Presentation Techniques of Engineering Drawings – Title Blocks – Printing/Plotting the 2D/3D drawing using printer and printing solid object using 3D printer.

***Suggested Reading**: CAD commands for modeling and views generation*

MODULE 5: SIMPLE DESIGN PROJECTS - COMPUTER AIDED DESIGN AND DRAFTING (15)

Creation of engineering models and their presentation in standard 2D form, 3D Wire-Frame and shaded solids, meshed topologies for engineering analysis, tool-path generation for component manufacture, geometric dimensioning and tolerancing. Use of solid-modelling software for creating associative models at the components and assembly levels in their respective branch of engineering like building floor plans that include: windows, doors, fixtures such as WC, Sink, shower, slide block, etc. Applying colour coding according to drawing practice.

Suggested Reading: CAD commands for modeling and views generation

TEXT BOOKS

1	Jeyapoovan T, Engineering Drawing and Graphics Using AutoCAD, 7th Edition, Vikas Publishing House Pvt Ltd., New Delhi, 2016

REFERENCE BOOKS

1	Introduction to AutoCAD – 2D and 3D Design, A.Yarmwood, Newnes Elsevier, 2011
2	Engineering Drawing and Graphic Technology-International Edition, Thomas E. French, Charles J. Vierck, Robert J. Foster, McGraw-Hill, 2014
3	Engineering Drawing and Design, Sixth Edition, C. Jensen, J.D. Helsel, D.R. Short, McGraw-Hill, 2012
4	Technical Drawing-Fourteenth Edition, F. E. Giesecke, A. Mitchell, H. C. Spencer, I.L. Hill, J.T. Dygdon, J.E., Novak, Prentice-Hall, 2012,
5	Bhatt N.D and Panchal V.M, Engineering Drawing: Plane and Solid Geometry, Charotar Publishing House, 2017.
6	Warren J. Luzadder and Jon. M. Duff, Fundamentals of Engineering Drawing, Prentice Hall of India Pvt. Ltd., Eleventh Edition, 2016.

E BOOKS	
1	http://keralatechnologicaluniversity.blogspot.in/2015/06/engineering-graphics-j-benjamin-pentex-free-ebook-pdf-download.html
2	http://keralatechnologicaluniversity.blogspot.in/2015/06/engineering-graphics-p-i-varghese.html
MOOC	
1	http://nptel.ac.in/courses/112103019/
2	http://nptel.ac.in/courses/105104148/

COURSE TITLE	**PROFESSIONAL ENGLISH AND SOFT SKILLS**			**CREDITS**	**3**
COURSE CODE	**ELA4101**	**COURSE CATEGORY**	**BS**	**L-T-P-S**	**1-1-2-1**
CIA	**60%**			**ESE**	**40%**
LEARNING LEVEL	**BTL – 6**				

CO	**COURSE OUTCOMES**	**PO**
Upon completion of this course students should be able to		
1.	Understanding the importance of professional communication and applying the knowledge.	10,12
2.	Integrate the knowledge of phonetics, enhancing the listening skills in formal and real-life situations; enhance pronunciation skills based on the knowledge of phonetics.	10,12
3.	Construct appropriate sentences in English Language, applying grammatical rules and mastery in syntax. Develop reading skills and derive the contextual meaning, case studies and analyzing problems	10,12
4.	Integrate creativity in the writing skills both in formal and informal situations, related to environment, society and multidisciplinary environments	10,12
5.	Imbibing soft skills to excel in interpersonal skills essential for workplace	10,12

Prerequisites : Plus Two English-Intermediate Level

MODULE 1 – THE ELEMENTS OF COMMUNICATION (9)

Importance of communication through English -Process of communication and factors that influence speaking- Importance of audience and purpose- Principles of Communication-comparing general communication and business Communication-Professional Communication-barriers to communication –strategies to overcome communication barriers-formal and informal communication

Suggested Activities:

Self-introduction-short Conversations-Situational communication-dialogue writing -Language Functions-analyse the speech and comment-distinguish formal and informal style of communication-using bias-free language- news reports.

Suggested Reading:

Rogerson, Trish Stott & Derek Utley.2011

Elements of Effective Communication: 4th Edition, Plain and Precious Publishing, USA, by Randal S. Chase (Author), Wayne Shamo (Author)

Effective Communication Skills, MTD Training & Ventus Publishing (e book)

MODULE 2 – AURAL –ORAL COMMUNICATION IN ENGLISH (9)

Vowels- diphthongs- consonants - International Phonetic Alphabet (IPA) ; phonemic transcription (simple words)-syllable division and word stress –enunciation-GIE script(General Indian English)-neutral accent- sentence rhythm and weak forms - contrastive stress in sentences to highlight different words - intonation varieties of Spoken English : Standard Indian, American and British-Speaking to Communicate-speech acts - Language Patterns

(Note: This unit should be taught in a simple, non-technical manner, avoiding technical terms as far as possible).

Suggested activities: (Audio CD) Listen and repeat, listen to the sentences and fill in the blanks, Listening to passages and answering questions, marking the stressed syllable, phonemic script of simple words, sentence rhythm and intonation (rising tone and falling tone), short speeches. Individual presentations-dynamics of a group discussion

Suggested sources:

Cambridge IELTS , Professional Speaking Skills by Aruna Koneru, Oxford Press, Face to face series Cambridge University Press, Speaking Effectively, Cambridge University Press, Jeremy Comfort, Pamela

MODULE 3 - GRAMMAR AND DEVELOPMENT OF READING SKILLS (9)

Noun Phrase, Verb Phrase, Tense and Aspect, Articles, Pronouns and determiners, Sentence Pattern, interrogative and negative sentences-subject verb agreement -Vocabulary-word formation: prefixes and suffixes, reading passages-inductive vs deductive reading-newspaper articles-comprehension passages –cloze reading-annotating-editing

Suggested Activities:

Identify the errors in sentences, grammar exercises, book reviews, mini project on suggested reading activity - reading technical passages based on students area of specialization answering questions- reading passage for identifying the contextual meaning

Suggested sources:

Skills for the TOEFL IBT Test, Collins IELTS, Cambridge books Practical English Usage by Michael Swan , Cambridge University Press

MODULE 4 - EFFECTIVE WRITING AND BUSINESS COMMUNICATION (9)

Paragraph writing- topic sentence-connectives - process writing-Memoranda-Business letters-Resumes /Visumes and job applications-drafting a report-agenda and minutes of the meeting-ATR-project proposals-email etiquette- interpreting visual data(bar chart, pie chart, line graphs)

Suggested activities:

Writing short paragraph based on environment protection, societal issues, health, cultural contexts

etc., identifying topic sentences, linking pairs of sentences, cause and effect exercises, formal letters, e mails, drafting project proposals, drafting agenda, minutes of the meeting

Suggested sources:

Cambridge Advanced English, Newspapers, library books, IELTS,IELTS Academic Writing 1,New Insights into IELTS, CUP

MODULE 5 – SOFT SKILLS (9)

Introducing Soft Skills &Life Skills- Myers Briggs Type Indicator – the Big Five Model Personality - Employability Skills- Workplace Etiquette- Professional Ethics -Time Management-Stress Management- Lateral Thinking (De Bono's Six Thinking Hats) and Problem Solving Skills

Suggested Activities:

Mock interviews, GD's, short oral presentation, lateral thinking puzzles, Case analysis and self-study assignments, Worksheet activities.

Suggested Sources:

Soft Skills and Employability Skills by Sabina Pillai and Agna Fernandez, Cambridge University Press, 2018.

Soft Skills for Everyone by Jeff Butterfield, Cengage Learning Education and personality development, K. Manoharan English for Life and the Workplace through the LSRW&T skills

Lateral Thinking skills by Edward De Bono

TEXT BOOKS

1.	An Introduction to Profession English and Soft Skills with audio CD by Dr. Bikram K. Das et al. Published by Cambridge University Press. 2009

REFERENCE BOOKS

1.	Soft Skills & Employability Skills by Sabina Pillai and Agna Fernandez published by Cambridge University Press 2018.
2.	Embark, English for Undergraduates by Steve Hart et al, Cambridge University Press,2016, Edition
3.	Skills for the TOEFL IBT Test, Collins, 2012 edition
4.	Soft Skills for Everyone by Jeff Butterfield, Cengage Learning, 2010 edition
5.	English for Life and the Workplace Through LSRW&T skills, by Dolly John, Pearson Publications, 2014 edition
6.	Professional Speaking Skills by Aruna Koneru, Oxford Publications.
7.	The official Cambridge guide to IELTS for Academic and General Training, Cambridge University Press, 2014 edition.
8.	Cambridge BEC Vantage, Self-Study edition, Practice Tests, CUP, 2002
9.	English for Business Studies, 3rd edition, Ian Mackenzie, Cambridge University Press
10.	Education and Personality Development by Dr. P.K.Manoharan, APH Publishing Corporation, 2015
11.	Speaking Effectively by Jeremy Comfort et al, Cambridge University Press, 2011.

E BOOKS	
1.	https://www.britishcouncil.in/english/courses-business
2.	http://www.bbc.co.uk/learningenglish/english/features/pronunciation
3.	http://www.bbc.co.uk/learningenglish/english/
4.	http://www.antimoon.com/how/pronunc-soundsipa.htm
5.	http://www.cambridgeenglish.org/learning-english/free-resources/write-and-improve/
6.	Oneshopenglish.com
7.	Breakingnews.com
MOOC	
1	https://www.mooc-list.com/tags/english
2	https://www.mooc-list.com/course/adventures-writing-stanford-online
3	http://www.cambridgeenglish.org/learning-english/free-resources/mooc/

COURSE TITLE	**MATRICES AND CALCULUS (Common for all Departments)**			**CREDITS**	**4**
COURSE CODE	**MAA4101**	**COURSE CATEGORY**	**BS**	**L-T-P-S**	**3-0-2-1**
CIA	**60%**			**ESE**	**40%**
LEARNING LEVEL	**BTL- 4**				

CO	**COURSE OUTCOMES**	**PO**
1.	Able to study the concepts of matrices and apply them in related engineering problems.	1,3,4,6,12
2.	Capable to use the features of Differential Calculus in optimization problems.	1,3,4,6,12
3.	Able to extend the concepts of integral calculus in finding area and volume.	1,3,4,6,12
4.	Skilled to solve ordinary differential equations in engineering problems.	1,3,4,6,12

Prerequisites : Nil

MODULE 1: MATRICES (13L+2P)

Characteristic equation – Eigenvalues and Eigenvectors – Properties – Cayley Hamilton theorem (Statement only) – Verification and inverse of the matrix using Cayley Hamilton theorem- Diagonalization of matrices using similarity transformation. Suggested Reading: Basics of Matrices

Lab 1: Eigenvalues and Eigenvectors, Verification and inverse using Cayley Hamilton theorem- Diagonalization

MODULE 2: DIFFERENTIAL CALCULUS (13L+2P)

Methods of differentiation of functions – Product and Quotient rules – Inverse trigonometric functions – Implicit function – parametric form. Partial differentiation – Total differentiation- Taylor's series – Maxima and minima of functions of two variables

Suggested Reading: Basics of Differentiation

Lab 2: Taylor's series – Maxima and minima of functions of two variables

MODULE 3: INTEGRAL CALCULUS (13L+2P)
Integration – Methods of integration – Substitution method – Integration by parts – Integration using partial fraction – Bernoulli's formula. Applications of Integral Calculus: Area, Surface and Volume. **Suggested Reading:** Basics of Integrations **Lab 3: Applications of Integral Calculus: Area, Surface area and Volume.**
MODULE 4: ORDINARY DIFFERENTIAL EQUATIONS (13L+2P)
Second order differential equations with constant coefficients – Particular integrals – e^{ax}, $Sinax, Cosax, x^m$, e ax Cos bx, e ax Sin bx. Solutions of homogeneous differential equations with variable coefficients – Variation of parameters. **Suggested Reading**: Basics of Differential Equations. **Lab 4: Solution of Second order differential equations.**
LAB/MINI PROJECT/FIELD WORK
Theory with practical classes

TEXT BOOKS	
1	Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014
2	Bali N. P and Manish Goyal, "A Text book of Engineering Mathematics", Eighth Edition, Laxmi Publications Pvt Ltd., 2011.
3	Chandrasekaran A, "A Text book of Engineering Mathematics I", Dhanam Publications, Chennai, 2010
REFERENCE BOOKS	
1	Srimantha Pal and Bhunia, S.C, "Engineering Mathematics" Oxford University Press, 2015.
2	Weir, M.D and Joel Hass, Thomas' Calculus, 12th Edition, Pearson India, 2016.
3	Advanced Engineering Mathematics With Matlab, Third Edition, 2011 by CRC Press.
E BOOKS	
1	http://nptel.ac.in/courses/111105035/
2	https://www.edx.org/.../introduction-engineering-mathematics-utarlingtonx-engr3
MOOC	
1.	https://www.mooc-list.com/tags/engineering-mathematics

COURSE TITLE	ENGINEERING PHYSICS (AERO, MECH, AUTO, CHEMICAL, BIOTECH, CIVIL)			CREDITS	3
COURSE CODE	PHA4101	COURSE CATEGORY	BS	L-T-P-S	3-0-0-1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1.	Solve basic problems in mechanics and also understand the properties of matter.	1,2,4,6,12
2.	Have a knowledge of acoustics and ultrasonics which would facilitate in acoustical design of buildings and also be able to employ ultrasonics as an engineering tool.	1,2,4,6,12
3.	Knowledge on fundamental concepts of Quantum physics	1,2,4,6,12
4.	Fundamental knowledge on semiconductors and discrete devices.	1,2,4,6,12
5.	Understand the concept, working and application of lasers and fiber optics.	1,2,4,6,12

Prerequisites: Knowledge in fundamentals of physics at higher secondary level.

MODULE 1 – PROPERTIES OF MATTER AND HEAT (9L)

Elasticity - types of moduli of elasticity - Young's modulus - Rigidity modulus - Bulk modulus - Factors affecting elasticity - twisting couple on a wire - Torsional pendulum - determination of rigidity modulus of a wire - depression of a cantilever - Young's modulus by cantilever - uniform and non-uniform bending.

Thermal conductivity – experimental determination of thermal conductivities of good and bad conductors – Forbe's method – theory and experiment – Lee's disc method for bad conductors

MODULE 2 – ACOUSTICS AND ULTRASONICS (9L)

Classification of sound - characteristics of musical sound – intensity - loudness - Weber Fechner law - Decibel - Reverberation - Reverberation time, derivation of Sabine's formula for reverberation time(Jaeger's method) - absorption coefficient and its determination - factors affecting acoustics of building (Optimum reverberation time, loudness, focusing, echo, echelon effect, resonance and noise) and their remedies - Ultrasonics- production – Magnetostriction and Piezoelectric methods – properties – applications.

MODULE 3 – QUANTUM PHYSICS (9L)

Black body radiation- Planck's theory (derivation) – Deduction of Wien's displacement law and Rayleigh – Jean's law from Planck's theory – Compton effect – Theory and experimental verification – Schrödinger's wave equation – Time independent and time dependent equations – Physical significance of wave function – Particle in a one dimensional box Extension to 3 dimension (no derivation)

MODULE 4 –CRYSTAL PHYSICS AND MAGNETISM (9L)

Crystal - Lattice - Unit cell - Bravais lattice - Lattice planes - Miller indices - 'd' spacing in cubic lattice - Calculation of number of atoms per unit cell - Atomic radius - coordination number - Packing factor for SC, BCC, FCC and HCP structures.

Magnetic dipole moment - atomic magnetic moments- magnetic permeability and susceptibility -

Types of magnetism: diamagnetism - paramagnetism - ferromagnetism - antiferromagnetism – ferrimagnetism - domain structure – hysteresis - hard and soft magnetic materials – applications.	
MODULE 5 – PHOTONICS AND FIBRE OPTICS (9L)	
Principle of lasers - Stimulated absorption - Spontaneous emission, stimulated emission - population inversion - pumping action - active medium - laser characteristics – Nd-Yag laser -CO_2 laser - Semiconductor laser - applications - optical fiber - principle and propagation of light in optical fibers - Numerical aperture and acceptance angle - types of optical fibers - single and multimode, step index and graded index fibers - fiber optic communication system.	
LAB / MINI PROJECT / FIELD WORK	
NA	
TEXT BOOKS	
1.	P.Mani, “Engineering Physics”, Vol-I & II, Dhanam Publications, Chennai. (2011)
2.	Gaur R.K. and Gupta S.L., “Engineering Physics”, 8th edition, Dhanpat Rai publications (P) Ltd., New Delhi. (2010)
REFERENCE BOOKS	
1.	Arthur Beiser, "Concepts of Modern Physics", Tata Mc Graw – Hill Publications. (2007)
2.	Rajendran V. Marikani A., “Applied Physics for engineers”, 3rd edition, Tata Mc Graw –Hill publishing company Ltd., New Delhi. (2003)
E BOOKS	
1	https://www.bookyards.com/en/book/details/13921/Elements-Of-Properties-Of-Matter
2	http://iopscience.iop.org/book/978-1-6817-4585-5
3	https://www.springer.com/in/book/9783319206295
MOOC	
1	http://nptel.ac.in/courses/115106061/
2	http://nptel.ac.in/courses/117101054/12

COURSE TITLE	ENGINEERING MATERIALS (Common to ALL Branches of Engineering)			CREDITS	3
COURSE CODE	CYA4101	COURSE CATEGORY	BS	L-T-P-S	3-0-0-1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
Upon completion of this course students should be able to		
1.	Suggest suitable metals for alloying.	1,2,4,6,12
2.	Identify the materials apt for engineering applications.	1,2,4,6,12
3	Select high temperature materials for engineering applications.	1,2,4,6,12
4.	Map the properties of nanomaterials with their applications.	1,2,4,6,12
5.	Suggest suitable materials for electronic applications.	1,2,4,6,12

Prerequisites: Knowledge in fundamentals of chemistry at higher secondary level.

MODULE 1 – CRYSTAL STRUCTURE AND PHASE RULE (9L)

Basic Crystal Systems – Types, characteristics, examples – Space lattice, Unit cell – types – X-ray diffraction and crystal structure.

Basic terminology - Derivation of Gibbs Phase rule- Phase diagrams: One component system (water), Two component system –- Reduced phase rule: Simple Eutectic system, examples, Phase diagram: Ag-Pb system, Pb-Sn system – Applications of phase rule.

MODULE 2 – POWDER METALLURGY, INORGANIC MATERIALS AND COMPOSITES. (9L)

Steel – Composition, types, heat-treatment, Abrasives – Classification, Properties, Uses - Refractories – Classification, Properties, Applications. Glasses – Properties, Types, Specialty glasses.

Composites - Introduction - Definition – Constituents – Classification - Fiber-reinforced Composites – Types and Applications.

Powder Metallurgy – Preparation of metal/alloy– Advantages and limitations.

MODULE 3 – NANOMATERIALS AND MOLECULAR SIEVES (9L)

Introduction – Synthesis of Nanomaterials - Bottom-up and Top-down approaches – Methods of preparation – Sol-gel process, Gas-phase condensation, Chemical Vapour Deposition. Properties **–** Optical, Electrical, Magnetic, Chemical properties (introduction only). Characterization **–** FE-SEM, TEM (Principle and Applications only).

Zeolite Molecular sieves – composition, structure, classification - applications – ion exchange, adsorption, separation, laundry, catalysis.

MODULE 4 – MATERIALS FOR ELECTRONIC APPLICATONS (9L)

Liquid Crystals- Introduction – Characteristics – Classification- Thermotropic crystals- - Polymorphism in Thermotropic Liquid Crystals – Molecular arrangement in various states of Liquid Crystals, Lyotropic Liquid Crystals- Applications.

Conducting and Super conducting Organic electronic materials - Applications.

Engineering plastics: Polycarbonate – Properties and uses- Conducting Polymers: Classification, Intrinsic Conducting Polymers, Extrinsic Conducting Polymers, Applications - Biodegradable Polymers, examples and applications.

MODULE 5 – LUBRICANTS, ADHESIVES AND EXPLOSIVES (9L)	
Lubricants – Mechanism of Lubrication, Classification and Properties, Semi Solid Lubricants, Solid Lubricants, MoS_2 and Graphite - Adhesives – Development of Adhesive strength, Physical and Chemical factors influencing adhesive action, Classification of Adhesives – Epoxy Resin (Preparation, Properties and Applications). Explosives – Requisites, Classification, Precautions during storage – Rocket propellants – Requisites - Classification.	
LAB / MINI PROJECT/FIELD WORK	
NA	
TEXT BOOKS	
1	P.C. Jain and Monicka Jain, Engineering Chemistry, Dhanpat Raj Publishing Company (P) Ltd, New Delhi – 2012
2	Puri, Sharma and Pathania, Principles of Physical Chemistry, Vishal Publishing Co. Jalandar, 2004.
3	Composite materials, K.K. Chawala, 3rd ed., (2012) Springer-Verlag, New York
4	Nanocomposite Science and Technology, P. M. Ajayan, L. S. Schadler, P. V. Braun, (2003), Wiley-VCH Verlag GmbH Co. KGaA, Weinheim.
5	Mechanics and Analysis of Composite Materials, V.V. Vasiliev and E.V. Morozov, (2001), Elsevier Science Ltd, The Boulevard, Langford Lane, Kidlington, Oxford OX5 lGB, UK.
E BOOKS	
1	http://www.erforum.net/2016/01/engineering-chemistry-by-jain-and-jain-pdf-free-ebook.html
2	https://abmpk.files.wordpress.com/2014/02/book_maretial-science-callister.pdf `
MOOC	
1	https://www.edx.org/course/materials-science-engineering-misisx-mse1x
2	https://www.mooc-list.com/tags/materials-science

COURSE TITLE	PROBLEM SOLVING USING C			CREDITS	3
COURSE CODE	CSA4101	COURSE CATEGORY	PC	L-T-P-S	2-0-2-0
CIA	60%			ESE	40%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
Upon completion of this course, the students will be able to		
1	Describe the basics of digital computer and programming languages.	1,2,8,12
2	Demonstrate problem solving techniques using flowchart, algorithm/pseudo code to solve the given problem.	1,2,3,5,12
3	Design and Implement C program using Control Statements and Functions.	1,2,3,5,9,10,12
4	Design and Implement C program using Pointers and File operations.	1,2,3,12
5	Identify the need for embedded C in real-time applications.	1,2,6,12

Prerequisites: Nil

MODULE 1 – PROGRAMMING LANGUAGES AND PROBLEM SOLVING TECHNIQUES (6L+6P)

Introduction – Fundamentals of digital computers - Programming languages -Programming Paradigms – Types of Programming Languages – Language Translators – Problem Solving Techniques: Algorithm – Flow Chart - Pseudo code.

Practical Component:

Drawing Flowcharts using E- Chart & Writing pseudo code for the following problems

(i) Greatest of three numbers

(ii) Sum of N numbers

(iii) Computation of nCr

MODULE 2: FUNDAMENTALS OF C (6L+6P)

Evolution of C -Why C language - Applications of C language - Data Types in C – Operators and Expressions – Input and Output statements in C – Decision Statements – Loop Control Statements.

Practical Component:

(i) Program to illustrate arithmetic and logical operators

(ii) Program to read and print data of different types

(iii) Program to calculate area and volume of various geometrical shapes

(iv) Program to compute biggest of three numbers

(v) Program to print multiplication table

(vi) Program to convert days to years, months and days

(vii) Program to find sum of the digits of an integer.

MODULE 3: FUNCTIONS, ARRAYS AND STRINGS (6L+6P)

Functions – Storage Class – Arrays – Strings and standard functions - Pre-processor Statements.

Practical Component:

(i) Program to compute Factorial, Fibonacci series and sum of n numbers using recursion

(ii) Program to compute sum and average of N Numbers stored in an array

(iii) Program to sort the given n numbers stored in an array

(iv) Program to search for the given element in an array
(v) Program to do word count
(vi) Program to insert a substring in a string
(vii) Program to concatenate and compare two strings
(viii) Program using pre-processor statements

MODULE 4: POINTERS, STRUCTURES AND UNION (6L+6P)

Pointers – Dynamic Memory allocation – Structure and Union – Files.

Practical Component:

(i) Program to compute sum of integers stored in a 1-D array using pointers and dynamic memory allocation
(ii) Program to read and print records of a student/payroll database using structures
(iii) Program to simulate file copy
(iv) Program to illustrate sequential access file
(v) Program to illustrate random access file

MODULE 5: INTRODUCTION TO EMBEDDED C (6L+6P)

Structure of embedded C program - Data Types - Operators - Statements - Functions - Keil C Compiler.

Practical component:

Simple programs using embedded C

LAB / MINI PROJECT / FIELD WORK

NA

TEXT BOOKS

1.	Jeyapoovan T, “Fundamentals of Computing and Programming in C”, Vikas Publishing house, 2015.
2.	Mark Siegesmund, "Embedded C Programming", first edition, Elsevier publications, 2014.

REFERENCE BOOKS

1.	Ashok Kamthane, “Computer Programming”, Pearson Education, 7th Edition, Inc 2017.
2.	Yashavant Kanetkar, “Let us C”, 15th edition, BPP publication, 2016.
3.	S.Sathyalakshmi, S.Dinakar, “Computer Programming Practicals – Computer Lab Manual”, Dhanam Publication, First Edition, July 2013.

E BOOKS

1.	https://en.wikibooks.org/wiki/C_Programming

MOOC

1.	https://onlinecourses.nptel.ac.in/noc18-cs10/preview
2.	http://nptel.ac.in/courses/106105085/2
3.	https://www.udemy.com/c-programming-for-beginners/
4.	https://www.coursera.org/specializations/c-programming

COURSE TITLE	SUSTAINABLE ENGINEERING SYSTEMS (Common to ALL Branches of Engineering)			CREDITS	2
COURSE CODE	GEA4102	COURSE CATEGORY	BS	L-T-P-S	2-0-0-1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
Upon completion of this course students should be able to		
1.	learn the principles of sustainability with case studies.	2,3,6,7,8,9,10,12
2.	understand assessing technologies and their impact on environment.	2,3,6,7,8,9,10,12
3	learn the concept of Green Engineering and to apply in their projects at higher semesters.	2,3,6,7,8,9,10,12
4.	Management of natural resources and waste management from various types of industries.	2,3,6,7,8,9,10,12
5.	learn water technology and behavioral aspects of humans.	2,3,6,7,8,9,10,12

Prerequisites: Knowledge in fundamentals of chemistry at higher secondary level.

MODULE 1 – PRINCIPLES OF SUSTAINABLE SYSTEMS (5L)

Sustainability Definitions - Principles of Sustainable Design, Sustainable Engineering -Frameworks for Applying Sustainability Principles - Summary & Activities.

MODULE 2 – TECHNOLOGY DEVELOPMENT AND LIFECYCLE ASSESSMENT (5L)

Technology as a part of anthropogenic environment - Technology readiness levels (TRL) – technical metrics - Emerging, converging, disruptive technologies - Life Cycle Assessment (LCA) methodology - Summary & Activities.

MODULE 3 – GREEN ENGINEERING (5L)

Principles of Green Engineering - Frameworks for assessment of alternatives - Green Engineering examples - Multifunctional Materials and Their Impact on Sustainability - Summary & Activities.

MODULE 4 – RESOURCE MANAGEMENT TECHNOLOGIES (5L)

Waste management purpose and strategies - Recycling: open-loop versus closed-loop thinking - Recycling efficiency - Management of food waste and composting technologies - E-waste stream management - Reuse and redistribution programs - LCA approach to waste management systems - Summary and Activities.

MODULE 5 – SUSTAINABLE WATER AND WASTEWATER SYSTEMS (5L)

Water cycle - Water conservation and protection technologies - Water treatment systems Metrics for assessment of water management technologies-Summary & Activities.

MODULE 6 - BEHAVIORAL ASPECTS AND FEEDBACKS (5L)

Collaborative Decision Making - Role of Community and Social Networking - Human Factor in Sustainability Paradigm - Summary & Activities.

TEXT BOOKS

1.	Vanek, F.M., and L.D. Albright, Energy Systems Engineering. Evaluation and Implementation, McGraw Hill, 2008.
2.	C.U. Becker, Sustainability Ethics and Sustainability Research, Springer 2012.
3.	J.B. Guinee et al., Life Cycle Assessment: Past, Present, and Future, Environ. Sci. Technol., 2011, 45, 90-96.
4.	Anastas, P.T., Zimmerman, J.B., Innovations in Green Chemistry and Green Engineering, Springer 2013.
5.	Solid Waste Technology & Management, Volume 1 & 2, Christensen, T., Ed., Wiley and Sons., *2010.*
6.	Sterman, J.D., in Sustainability Science: The Emerging Paradigm, Weinstein, M.P. and Turner, R.E. (Eds.), Springer Science+Business Media, LLC 2012.
E BOOKS	
1.	David T. Allen, David R. Shonnard, Sustainable Engineering Concepts, Design and Case Studies, Pearson Education, December 2011. (ISBN: 9780132756587)
2.	Gerald Jonker Jan Harmsen, Engineering for Sustainability 1st Edition, A Practical Guide for Sustainable Design, Elsvier 2012. (**ISBN:** 9780444538475).
MOOC	
1.	https://www.coursera.org/learn/sustainability
2.	https://www.academiccourses.com/Certificate/Sustainability-Studies/India/
3.	https://onlinecourses.nptel.ac.in/noc18_ce08/preview
4.	https://www.coursera.org/learn/ecosystem-services

COURSE TITLE	ENGINEERING AND DESIGN	CREDIT	3

COURSE CODE	MEB4101	COURSE CATEGORY	PC	L-T-P-S	3- 0-0-1
CIA	60%			ESE	40%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
Upon completion of this course		
1	Students will be able to appreciate the different elements involved in good designs and to apply them in practice when called for.	1,2,5,12
2	Students will be aware of the product oriented and user oriented aspects that make the design a success.	1,2,5,12
3	Students will be aware of the product oriented and user oriented aspects that make the design a success	1,2,5,12
4	Students will have a broader perspective of design covering function, cost, environmental sensitivity, safety and other factors other than engineering analysis.	1,2,5,12
5	Students learn economic and environmental Issues, trade aspects and IPR	1,2,5,12

Prerequisites : Nil

MODULE 1- INTRODUCTION TO MECHANICAL ENGINEERING DESIGN (7+2 PERIODS)

Design and its objectives; Design constraints, Design functions, Design means and Design from; Role of Science, Engineering and Technology in design; Engineering as a business proposition; Functional and Strength Designs. Design form, function and strength; How to initiate creative designs Initiating the thinking process for designing a product of daily use. Need identification; Problem Statement; Market survey-customer requirements; Design attributes and objectives; Ideation; Brain storming approaches; arriving at solutions; Closing on to the Design needs.

Project: An Exercise in the process of design initiation. A simple problem is to be taken up to examine different solutions- Ceiling fan Group Presentation and discussion

MODULE 2-PROCESSES IN DESIGN IN MECHANICAL SYSTEMS (7+2 PERIODS)

Design process- Different stages in design and their significance; Defining the design space; Analbgies and "thinking outside of the box"; Quality function deployment-meeting what the customer wants; Evaluation and choosing of a design. Design Communication; Realization of the concept into a configuration, drawing and model. Concept of "Complex is Simple". Design for function and strength.

Design detailing- Material selection, Design visualization- Solid modelling; Detailed 2D drawings; Tolerance; Use of standard items in design; Research needs in design; Energy needs of the design, both in its realization and in the applications.

Project: An exercise in the detailed design of any two products

MODULE 3 – PROTOTYPE OF MECHANICAL PARTS (4+5 PERIODS)

Prototyping- rapid prototyping; testing and evaluation of design; Design modifications; Freezing the design; Cost analysis. Engineering the design - From prototype to product. Planning; Scheduling; Supply chains; inventory; handling; manufacturing/construction operations; storage; packaging; shipping; marketing; feed-back on design

Project: List out the standards organizations. Prepare a list of standard items used in any engineering

specialization. Develop any design with over 50% standard items as parts

MODULE 4- QUALITY ASPECTS IN MECHANICAL ENGINEERING DESIGN (4+5 PERIODS)

Design for "X"; covering quality, reliability, safety, manufacturing/construction, assembly, maintenance, logistics, handling; disassembly; recycling; re-engineering etc.

Project: Example: List out the design requirements(x) for designing a rocket shell of 3-meter diameter and 8-meter length. Design mineral water bottles that could be packed compactly for transportation.

MODULE 5 – USER CENTRED DESIGNS IN MECHANICAL ENGINEERING (4+5 PERIODS)

Product centered and user centered design. Product centered attributes and user centered attributes. Bringing the two closer. Example: Smart phone. Aesthetics and ergonomics. Value engineering, Concurrent engineering, Reverse engineering in design; Culture based design; Architectural designs; Motifs and cultural background; Tradition and design; Study the evolution of Wet grinders; Printed motifs; Role of colours in design. Make sharp corners and change them to smooth curves-check the acceptance. Design as a marketing tool; Intellectual Property rights - Trade secret; patent; copy-right; trademarks; product liability. Group presentation of any such products covering all aspects that could make or mar it.

Project: Examine the possibility of value addition for an existing product.

TEXT BOOKS

1	Philip Kosky, Robert Balmer, William Keat – George Wise, Explore Engineering, 4th Edition, Academic Press, Elsevier, 2010

REFERENCE BOOKS

1	Balmer, R. T., Keat, W. D., Wise, G., and Kosky, P., Exploring Engineering, Third Edition: An Introduction to Engineering and Design - [Part 3 - Chapters 17 to 27], ISBN13: 978-0124158917 ISBN-10: 0124158919
2	Dym, C. L., Little, P. and Orwin, E. J., Engineering Design - A Project based introduction - Wiley, ISBN-978-1-118-32458-5
3	Eastman, C. M. (Ed.), Design for X Concurrent engineering imperatives, 1996, XI, 489 p. ISBN 978-94-011-3985-4 Springer
4	Haik, Y. And Shahin, M. T., Engineering Design Process, Cengage Learning, ISBN-13: 978-0-495-66816-9
5	Pahl, G., Beitz, W., Feldhusen, J. and Grote, K. H., Engineering Design: A Systematic Approach, 3rd ed. 2007, XXI, 617p., ISBN 978-1-84628-319-2
6	Voland, G., Engineering by Design, ISBN 978-93-325-3505-3, Pearson India

COURSE TITLE	ENGINEERING IMMERSION LAB			CREDIT	0.5
COURSE CODE	GEA4131	COURSE CATEGORY	BS	L-T-P-S	0-0-2-2
CIA	80%			ESE	20%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able		
1	to Identify and use of tools, Types of joints used in welding, carpentry and plumbing operations.	1,2,4,6,12
2	Have hands on experience on basic fabrication techniques such as carpentry and plumbing practices.	1,2,4,6,12
3	Have hands on experience on basic fabrication techniques of different types of welding and basic machining practices.	1,2,4,6,12

SLOT X - LIST OF EXPERIMENTS

I. MECHANICAL ENGINEERING WORKSHOP

1. Welding: Arc welding: Butt joints
2. Lap joints.
3. Machining: Facing
4. Turning

II. AUTOMOBILE ENGINEERING

1. Dismantling and Studying of two stroke gasoline engine.
2. Assembling of two stroke gasoline engine.
3. Dismantling and Studying of four stroke gasoline engine
4. Assembling of four stroke gasoline engine.

III. AERONAUTICAL ENGINEERING

1. Study of Flow Pattern around Various Objects.
2. Force measurement on Aircraft
3. Model
4. Determination of Young's Modulus for Aluminum Cantilever Beam
5. Binary Addition & Subtraction using Microprocessor

IV. CIVIL ENGINEERING

1. Plumbing- Basic Pipe Connection using valves, couplings and elbows.
2. Carpentry – Sowing, Planning and making common Joints.
3. Bar Bending
4. Construction of a 50 cm height brick wall without mortar using English Bond.

SLOT Y - LIST OF EXPERIMENTS

V.ELECTRICAL ENGINEERING

1. Study of tools and accessories.
2. Study of cables.
3. Staircase wiring, Tube light and Fan connection.
4. Measurement of energy using single phase energy meter.

VI. ELECTRONICS ENGINEERING

1. Study of Active and Passive Components.
2. Study of Logic Circuits.
3. Making simple circuit using Electronic Components.

4. Measuring of parameters for signal using CRO.

VII. COMPUTER SCIENCE

1. Troubleshooting different parts of the computer peripherals, Monitor, Keyboard & CPU.
2. Installation of various operating systems, their capabilities, Windows, Unix, Linux.
3. Installation of commonly used software like MS Office
4. Assembling digital computer.

VIII. MECHATRONICS ENGINEERING

1. Study of Key Elements of Mechatronics Systems
2. Sensors – Load Cell, Thermocouple
3. Actuators – Linear & Rotary Actuators
4. Interfacing & Measurements – Virtual Instrumentation

REFERENCE BOOKS

1	Jeyapoovan T and Saravanapandian M., Engineering practices lab manual, 4th Edition, Vikas publishing House, New Delhi, 2015.
2	Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.
3	Ibrahim Zeid, CAD/CAM Theory and Practice, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2011
4	Robert Quesada, Jeyapoovan T., Computer Numerical Control Machining and Turning Centers, Pearson Education, New Delhi, 2006

METHOD OF ALLOCATION FOR ENGINEERING IMMERSION LAB

SLOT X : MECH, AERO, AUTO, CIVIL EXPERIMENTS

SLOT Y : EEE, ELECTRONICS, CSE, MECHATRONICS EXPERIMENTS

- EVERY CLASS OF
  - GROUP A (AERO, AUTO, MECH, MCT, CHEM, BIO, CIVIL
  - GROUP B (CSE, IT, ECE, EEE, AEROSPACE)

GETS DIVIDED INTO 4 SUB - GROUPS NAMELY a, b, c, d -- EACH CONSISTING OF 15 TO 20 STUDENTS MAX.

- FOR EXAMPLE: **GROUP A STUDENTS WILL OCCUPY SLOT X**
  - WEEK 1 : SLOT X ---
    - ✓ a – MECH; b – AUTO; c – AERO ; d – CIVIL
  - WEEK 2 : SLOT X ---
    - ✓ b – MECH; c – AUTO; d – AERO ; a – CIVIL
- THE ABOVE SCHEDULE WILL BE ON ROTATION EVERY MONTH (ONE CYLCE PER MONTH)
- **GROUP B STUDENTS WILL OCCUPY SLOT Y**
  - WEEK 1 : SLOT Y ---
    - ✓ a – EEE; b – ECE; c – CSE ; d – MCT
  - WEEK 2 : SLOT Y ---
    - ✓ b – EEE; c – ECE; d – CSE ; a – MCT
- THE ABOVE SCHEDULE WILL BE ON ROTATION EVERY MONTH (ONE CYLCE PER MONTH)

COURSE TITLE	ENGINEERING PHYSICS LABORATORY	CREDIT	1

	(Common to all engineering branches)				
COURSE CODE	**PHA4131**	**COURSE CATEGORY**	**BS**	**L-T-P-S**	**0-0-2-0**
CIA	**80%**			**ESE**	**20%**
LEARNING LEVEL	**BTL-3**				

CO	**COURSE OUTCOMES**	**PO**
Upon completion of this course students should be able to		
1.	analyze material's elastic properties	1,2,3,4
2.	determine thermal conductivity of bad conductor	1,2,3,4
3.	measure coefficient of viscosity of liquids	1,2,3,4
4.	determine wavelength of laser	1,2,3,4
5.	describe V-I characteristics of diode	1,2,3,4

Prerequisites: Knowledge in basic physics practical at higher secondary level.

List of Experiments (Any Five Experiments)

1. Torsional Pendulum – Determination of rigidity modulus of the material of a wire.
2. Non Uniform Bending – Determination of Young's Modulus.
3. Uniform Bending – Determination of Young's Modulus.
4. Viscosity – Determination of co-efficient of viscosity of a liquid by Poiseuille's flow.
5. Lee's Disc – Determination of thermal conductivity of a bad conductor.
6. Air – Wedge – Determination of thickness of a thin wire
7. Spectrometer – refractive index of a prism
8. Semiconductor laser – Determination of wavelength of laser using grating
9. Semiconductor diode – VI characteristics

TEXT BOOK

1. P. Mani, engineering Physics Practicals, Dhanam Publications, Chennai, 2005

REFERENCE BOOKS

1. Glenn V.Lo, Jesus Urrechaga - Aituna, Introductory Physics Laboratory Manual, Part-I, Fall 2005 Edition.
2. P. Kulkarni, Experiments in Engineering Physics Bachelor of Engineering and Technology, Edition 2015

E BOOK

1	http://www.aurora.ac.in/images/pdf/departments/humanities-and-sciences/engg-phy-lab-manual.pdf

COURSE TITLE	**MATERIALS CHEMISTRY LABORATORY**	**CREDITS**	**1**

	(Common to ALL branches of Engineering)				
COURSE CODE	**CYA4131**	**COURSE CATEGORY**	**BS**	**L-T-P-S**	**0-0-2-0**
CIA	**80%**			**ESE**	**20%**
LEARNING LEVEL	**BTL-3**				

CO	COURSE OUTCOMES	PO
1.	Students learn to characterize basic properties of refractory ceramics	1,2,4,6
2.	On completion of this course, students learn to prepare resins and composites.	1,2,4,6
3.	Students learn to estimate metal ions present in samples using instrumental techniques.	1,2,4,6
4.	On completion of the course the students learn to develop adsorption isotherm.	1,2,4,6
5.	Students learn to find properties of lubricants and other oil samples.	1,2,4,6

Prerequisites: Knowledge in basic chemistry practical at higher secondary level.

LAB / MINI PROJECT/FIELD WORK

1. Construction of Phenol-Water Phase diagram.
2. Determination of viscosity of polymer using Ostwald Viscometer.
3. Preparation of urea-formaldehyde resin.
4. Determination of porosity of a refractory.
5. Determination of Apparent Density of porous solids.
6. Determination of Viscosity Index of lubricants.
7. Estimation of dye content in the effluent by UV-Visible spectrophotometry.
8. Determination of viscosity of oil using Red-Wood Viscometer.
9. Determination of Copper / iron content in the alloy by colorimetry.
10. Estimation of sodium and potassium ions by Flame Photometry.
11. Verification of Beer-Lambert's law using gold nanoparticles.
12. Determination of adsorption isotherm for acetic acid on activated charcoal.

REFERENCE BOOKS

1.	J. Mendham, R.C. Denney, J.D. Barnes and N.J.K. Thomas, Vogel's Textbook of Quantitative Chemical Analysis, 6th Edition, Pearson Education, 2009
2.	D.P. Shoemaker and C.W. Garland, Experiments in Physical Chemistry, 8th edition, McGraw Hill, London, 2008
3.	S. Sumathi, Laboratory work book for Engineering Chemistry Practical, 2015
4.	Laboratory Manual of Testing Materials, William Kendrick Hatt and Herbert Henry Scofield, Andesite Press, 2017

E BOOKS

1.	http://www.erforum.net/2016/01/engineering-chemistry-by-jain-and-jain-pdf-free-ebook.html

MOOC

1	https://ocw.mit.edu/courses/chemistry/5-111-principles-of-chemical-science-fall-2008/video-lectures/lecture-32/
2	https://www.coursetalk.com/providers/coursera/courses/introduction-to-chemistry-1

SEMESTER II

COURSE TITLE	ANALYTICAL MATHEMATICS (Except Aeronautical and Aerospace Engineering)			CREDITS	4
COURSE CODE	MAA4117	COURSE CATEGORY	BS	L-T-P-S	3-0-2-0
CIA	60%			ESE	40%
LEARNING LEVEL	BTL- 1-4				

CO	COURSE OUTCOMES	PO
1	Able to obtain basic knowledge on Spatial Dimensions	1,2,4, 12
2	Able to familiar with the terminology of Vector Calculus	1,2,4, 12
3	Able to understand the performance of Laplace Transform and its applications	1,2,4, 12
4	Able to understand the knowledge on Fourier Series	1,2,4, 12
5	Able to understand the process flow of Complex variable	1,2,4, 12

Prerequisites : Nil

MODULE 1: MULTIPLE INTEGRALS (10L+2P)

Double integration – Cartesian and polar co-ordinates – Change of order of integration. Area as a double integral – Triple integration in Cartesian coordinates – Volume as a triple integral – Change of variables between Cartesian and polar coordinates.

Suggested Reading: Line Integrals

Lab: Area and Volume of double integration and triple integration**.**

MODULE 2: VECTOR CALCULUS (10L+2P)

Gradient, Divergence and Curl – Unit normal vector, Directional derivative – angle between surfaces – Solenoidal and Irrotational vector fields. Green's theorem - Gauss divergence theorem and Stoke's theorem (without proof) – Verification and evaluation of the above theorems - Simple applications to regions such as square, rectangle, triangle, cuboids and rectangular parallelopipeds.

Suggested Reading: Basics of Vectors

Lab: Area using Green's theorem and Volume using Gauss divergence theorem

MODULE 3: LAPLACE TRANSFORMS (10L+2P)

Laplace transform – Conditions of existence – Transform of elementary functions – properties – Transforms of derivatives– Initial and final value theorems – Transform of periodic functions. Inverse Laplace transforms using partial fraction and convolution theorem. Solution of linear ODE of second order with constant coefficients.

Suggested Reading: Basics of Transform

Lab: Finding Laplace and Inverse Laplace Transform of Elementary Functions, Solutions of Ordinary differential equations using Laplace transform

MODULE 4: FOURIER SERIES (10L+2P)

Dirichlet's Conditions – General Fourier Series – Odd and even functions – Half range sine and cosine series –Harmonic Analysis.

Suggested Reading: Basics of series

Lab: Fourier series Expansion of simple functions, Harmonic Analysis

MODULE 5: COMPLEX VARIABLES (10L+2P)	
Functions of a complex variable – Analytic function – Cauchy - Riemann equations (Statement only) – Properties of analytic function (Statement only) – Construction of Analytic functions by Milne – Thomson method. **Suggested Reading**: Complex Numbers **Lab:** Complex Numbers	
LAB/MINI PROJECT/FIELD WORK	
Theory with practical classes	
TEXT BOOKS	
1	Kreyszig Erwin, "Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2	A.P.Santhakumaran, P.Titus, Engineering Mathematics - II, NiMeric Publications, Nagercoil, 2012
3	Chandrasekaran A, Engineering Mathematics- II, Dhanam Publication, 2014
4	Raj Kumar Bansal,Ashok Kumar Goel, Manoj Kumar Sharma, "MATLAB© and its Applications in Engineering", Pearson Publication, Second Edition, 2016.
REFERENCE BOOKS	
1	Sastry, S.S, —Engineering Mathematics", Vol. I & II, PHI Learning Pvt. Ltd, 4th Edition, New Delhi, 2014
2	Wylie, R.C. and Barrett, L.C., —Advanced Engineering Mathematics —Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.
3	Dean G. Duffy., "Advanced Ebgineering Mathematics with MATLAB©", CRC Press, Third Edition 2013.
E BOOKS	
1	http.// nptel.ac.in/courses/122104017/28
2	https://www.khanacademy.org/.../double-integrals.../double-integral.
3	nptel.ac.in/courses/115101005/downloads/lectures-doc/Lecture-1.pdf
4	nptel.ac.in/syllabus/122104017/
5	nptel.ac.in/courses/111105035/22
6	nptel.ac.in/syllabus/111103070/
MOOC	
1	https://www.edx.org/course/introduction-engineering-mathematics-utarlingtonx-engr3-0x

COURSE TITLE	ENGINEERING MATERIALS (Common to ALL Branches of Engineering)			CREDITS	3
COURSE CODE	CYA4101	COURSE CATEGORY	BS	L-T-P-S	3-0-0-1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
Upon completion of this course students should be able to		
1.	Suggest suitable metals for alloying.	1,2,4,6,12
2.	Identify the materials apt for engineering applications.	1,2,4,6,12
3	Select high temperature materials for engineering applications.	1,2,4,6,12
4.	Map the properties of nanomaterials with their applications.	1,2,4,6,12
5.	Suggest suitable materials for electronic applications.	1,2,4,6,12

Prerequisites: Knowledge in fundamentals of chemistry at higher secondary level.

MODULE 1 – CRYSTAL STRUCTURE AND PHASE RULE (9L)

Basic Crystal Systems – Types, characteristics, examples – Space lattice, Unit cell – types – X-ray diffraction and crystal structure.

Basic terminology - Derivation of Gibbs Phase rule- Phase diagrams: One component system (water), Two component system –- Reduced phase rule: Simple Eutectic system, examples, Phase diagram: Ag-Pb system, Pb-Sn system – Applications of phase rule.

MODULE 2 – POWDER METALLURGY, INORGANIC MATERIALS AND COMPOSITES. (9L)

Steel – Composition, types, heat-treatment, Abrasives – Classification, Properties, Uses - Refractories – Classification, Properties, Applications. Glasses – Properties, Types, Specialty glasses.

Composites - Introduction - Definition – Constituents – Classification - Fiber-reinforced Composites – Types and Applications.

Powder Metallurgy – Preparation of metal/alloy– Advantages and limitations.

MODULE 3 – NANOMATERIALS AND MOLECULAR SIEVES (9L)

Introduction – Synthesis of Nanomaterials - Bottom-up and Top-down approaches – Methods of preparation – Sol-gel process, Gas-phase condensation, Chemical Vapour Deposition. Properties **–** Optical, Electrical, Magnetic, Chemical properties (introduction only). Characterization **–** FE-SEM, TEM (Principle and Applications only).

Zeolite Molecular sieves – composition, structure, classification - applications – ion exchange, adsorption, separation, laundry, catalysis.

MODULE 4 – MATERIALS FOR ELECTRONIC APPLICATONS (9L)

Liquid Crystals- Introduction – Characteristics – Classification- Thermotropic crystals- - Polymorphism in Thermotropic Liquid Crystals – Molecular arrangement in various states of Liquid Crystals, Lyotropic Liquid Crystals- Applications.

Conducting and Super conducting Organic electronic materials - Applications.

Engineering plastics: Polycarbonate – Properties and uses- Conducting Polymers: Classification, Intrinsic Conducting Polymers, Extrinsic Conducting Polymers, Applications - Biodegradable Polymers, examples and applications.

MODULE 5 – LUBRICANTS, ADHESIVES AND EXPLOSIVES (9L)	
Lubricants – Mechanism of Lubrication, Classification and Properties, Semi Solid Lubricants, Solid Lubricants, MoS_2 and Graphite - Adhesives – Development of Adhesive strength, Physical and Chemical factors influencing adhesive action, Classification of Adhesives – Epoxy Resin (Preparation, Properties and Applications). Explosives – Requisites, Classification, Precautions during storage – Rocket propellants – Requisites - Classification.	
LAB / MINI PROJECT/FIELD WORK	
NA	
TEXT BOOKS	
1	P.C. Jain and Monicka Jain, Engineering Chemistry, Dhanpat Raj Publishing Company (P) Ltd, New Delhi – 2012
2	Puri, Sharma and Pathania, Principles of Physical Chemistry, Vishal Publishing Co. Jalandar, 2004.
3	Composite materials, K.K. Chawala, 3rd ed., (2012) Springer-Verlag, New York
4	Nanocomposite Science and Technology, P. M. Ajayan, L. S. Schadler, P. V. Braun, (2003), Wiley-VCH Verlag GmbH Co. KGaA, Weinheim.
5	Mechanics and Analysis of Composite Materials, V.V. Vasiliev and E.V. Morozov, (2001), Elsevier Science Ltd, The Boulevard, Langford Lane, Kidlington, Oxford OX5 lGB, UK.
E BOOKS	
1	http://www.erforum.net/2016/01/engineering-chemistry-by-jain-and-jain-pdf-free-ebook.html
2	https://abmpk.files.wordpress.com/2014/02/book_maretial-science-callister.pdf `
MOOC	
1	https://www.edx.org/course/materials-science-engineering-misisx-mse1x
2	https://www.mooc-list.com/tags/materials-science

COURSE TITLE	ENGINEERING PHYSICS (AERO, MECH, AUTO, CHEMICAL, BIOTECH, CIVIL)			CREDITS	3
COURSE CODE	PHA4101	COURSE CATEGORY	BS	L-T-P-S	3-0-0-1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1.	Solve basic problems in mechanics and also understand the properties of matter.	1,2,4,6,12
2.	Have a knowledge of acoustics and ultrasonics which would facilitate in acoustical design of buildings and also be able to employ ultrasonics as an engineering tool.	1,2,4,6,12
3.	Knowledge on fundamental concepts of Quantum physics	1,2,4,6,12
4.	Fundamental knowledge on semiconductors and discrete devices.	1,2,4,6,12
5.	Understand the concept, working and application of lasers and fiber optics.	1,2,4,6,12

Prerequisites: Knowledge in fundamentals of physics at higher secondary level.

MODULE 1 – PROPERTIES OF MATTER AND HEAT (9L)

Elasticity - types of moduli of elasticity - Young's modulus - Rigidity modulus - Bulk modulus - Factors affecting elasticity - twisting couple on a wire - Torsional pendulum - determination of rigidity modulus of a wire - depression of a cantilever - Young's modulus by cantilever - uniform and non-uniform bending.

Thermal conductivity – experimental determination of thermal conductivities of good and bad conductors – Forbe's method – theory and experiment – Lee's disc method for bad conductors

MODULE 2 – ACOUSTICS AND ULTRASONICS (9L)

Classification of sound - characteristics of musical sound – intensity - loudness - Weber Fechner law - Decibel - Reverberation - Reverberation time, derivation of Sabine's formula for reverberation time(Jaeger's method) - absorption coefficient and its determination - factors affecting acoustics of building (Optimum reverberation time, loudness, focusing, echo, echelon effect, resonance and noise) and their remedies - Ultrasonics- production – Magnetostriction and Piezoelectric methods – properties – applications.

MODULE 3 – QUANTUM PHYSICS (9L)

Black body radiation- Planck's theory (derivation) – Deduction of Wien's displacement law and Rayleigh – Jean's law from Planck's theory – Compton effect – Theory and experimental verification – Schrödinger's wave equation – Time independent and time dependent equations – Physical significance of wave function – Particle in a one dimensional box Extension to 3 dimension (no derivation)

MODULE 4 –CRYSTAL PHYSICS AND MAGNETISM (9L)

Crystal - Lattice - Unit cell - Bravais lattice - Lattice planes - Miller indices - 'd' spacing in cubic lattice - Calculation of number of atoms per unit cell - Atomic radius - coordination number - Packing factor for SC, BCC, FCC and HCP structures.

Magnetic dipole moment - atomic magnetic moments- magnetic permeability and susceptibility -

Types of magnetism: diamagnetism - paramagnetism - ferromagnetism - antiferromagnetism – ferrimagnetism - domain structure – hysteresis - hard and soft magnetic materials – applications.	
MODULE 5 – PHOTONICS AND FIBRE OPTICS (9L)	
Principle of lasers - Stimulated absorption - Spontaneous emission, stimulated emission - population inversion - pumping action - active medium - laser characteristics – Nd-Yag laser -CO_2 laser - Semiconductor laser - applications - optical fiber - principle and propagation of light in optical fibers - Numerical aperture and acceptance angle - types of optical fibers - single and multimode, step index and graded index fibers - fiber optic communication system.	
LAB / MINI PROJECT / FIELD WORK	
NA	
TEXT BOOKS	
1.	P.Mani, “Engineering Physics”, Vol-I & II, Dhanam Publications, Chennai. (2011)
2.	Gaur R.K. and Gupta S.L., “Engineering Physics”, 8th edition, Dhanpat Rai publications (P) Ltd., New Delhi. (2010)
REFERENCE BOOKS	
1.	Arthur Beiser, "Concepts of Modern Physics", Tata Mc Graw – Hill Publications. (2007)
2.	Rajendran V. Marikani A., “Applied Physics for engineers”, 3rd edition, Tata Mc Graw –Hill publishing company Ltd., New Delhi. (2003)
E BOOKS	
1	https://www.bookyards.com/en/book/details/13921/Elements-Of-Properties-Of-Matter
2	http://iopscience.iop.org/book/978-1-6817-4585-5
3	https://www.springer.com/in/book/9783319206295
MOOC	
1	http://nptel.ac.in/courses/115106061/
2	http://nptel.ac.in/courses/117101054/12

COURSE TITLE	PROFESSIONAL ENGLISH AND SOFT SKILLS			CREDITS	3
COURSE CODE	ELA4101	COURSE CATEGORY	BS	L-T-P-S	1-1-2-1
CIA	60%			ESE	40%
LEARNING LEVEL	BTL – 6				

CO	COURSE OUTCOMES	PO
Upon completion of this course students should be able to		
6.	Understanding the importance of professional communication and applying the knowledge.	10,12
7.	Integrate the knowledge of phonetics, enhancing the listening skills in formal and real-life situations; enhance pronunciation skills based on the knowledge of phonetics.	10,12
8.	Construct appropriate sentences in English Language, applying grammatical rules and mastery in syntax. Develop reading skills and derive the contextual meaning, case studies and analyzing problems	10,12
9.	Integrate creativity in the writing skills both in formal and informal situations, related to environment, society and multidisciplinary environments	10,12
10.	Imbibing soft skills to excel in interpersonal skills essential for workplace	10,12

Prerequisites : Plus Two English-Intermediate Level

MODULE 1 – THE ELEMENTS OF COMMUNICATION (9)

Importance of communication through English -Process of communication and factors that influence speaking- Importance of audience and purpose- Principles of Communication-comparing general communication and business Communication-Professional Communication-barriers to communication –strategies to overcome communication barriers-formal and informal communication

Suggested Activities:

Self-introduction-short Conversations-Situational communication-dialogue writing -Language Functions-analyse the speech and comment-distinguish formal and informal style of communication-using bias-free language- news reports.

Suggested Reading:

Rogerson, Trish Stott & Derek Utley.2011

Elements of Effective Communication: 4th Edition, Plain and Precious Publishing, USA, by Randal S. Chase (Author), Wayne Shamo (Author)

Effective Communication Skills, MTD Training & Ventus Publishing (e book)

MODULE 2 – AURAL –ORAL COMMUNICATION IN ENGLISH (9)

Vowels- diphthongs- consonants - International Phonetic Alphabet (IPA) ; phonemic transcription (simple words)-syllable division and word stress –enunciation-GIE script(General Indian English)-neutral accent- sentence rhythm and weak forms - contrastive stress in sentences to highlight different words - intonation varieties of Spoken English : Standard Indian, American and British-Speaking to Communicate-speech acts - Language Patterns

(Note: This unit should be taught in a simple, non-technical manner, avoiding technical terms as far as possible).

Suggested activities: (Audio CD) Listen and repeat, listen to the sentences and fill in the blanks, Listening to passages and answering questions, marking the stressed syllable, phonemic script of simple words, sentence rhythm and intonation (rising tone and falling tone), short speeches. Individual presentations-dynamics of a group discussion

Suggested sources:

Cambridge IELTS , Professional Speaking Skills by Aruna Koneru, Oxford Press, Face to face series Cambridge University Press, Speaking Effectively, Cambridge University Press, Jeremy Comfort, Pamela

MODULE 3 - GRAMMAR AND DEVELOPMENT OF READING SKILLS (9)

Noun Phrase, Verb Phrase, Tense and Aspect, Articles, Pronouns and determiners, Sentence Pattern, interrogative and negative sentences-subject verb agreement -Vocabulary-word formation: prefixes and suffixes, reading passages-inductive vs deductive reading-newspaper articles-comprehension passages –cloze reading-annotating-editing

Suggested Activities:

Identify the errors in sentences, grammar exercises, book reviews, mini project on suggested reading activity - reading technical passages based on students area of specialization answering questions- reading passage for identifying the contextual meaning

Suggested sources:

Skills for the TOEFL IBT Test, Collins IELTS, Cambridge books Practical English Usage by Michael Swan , Cambridge University Press

MODULE 4 - EFFECTIVE WRITING AND BUSINESS COMMUNICATION (9)

Paragraph writing- topic sentence-connectives - process writing-Memoranda-Business letters-Resumes /Visumes and job applications-drafting a report-agenda and minutes of the meeting-ATR-project proposals-email etiquette- interpreting visual data(bar chart, pie chart, line graphs)

Suggested activities:

Writing short paragraph based on environment protection, societal issues, health, cultural contexts etc., identifying topic sentences, linking pairs of sentences, cause and effect exercises, formal letters, e mails, drafting project proposals, drafting agenda, minutes of the meeting

Suggested sources:

Cambridge Advanced English, Newspapers, library books, IELTS,IELTS Academic Writing 1,New Insights into IELTS, CUP

MODULE 5 – SOFT SKILLS (9)

Introducing Soft Skills &Life Skills- Myers Briggs Type Indicator – the Big Five Model Personality - Employability Skills- Workplace Etiquette- Professional Ethics -Time Management-Stress Management- Lateral Thinking (De Bono's Six Thinking Hats) and Problem Solving Skills

Suggested Activities:

Mock interviews, GD's, short oral presentation, lateral thinking puzzles, Case analysis and self-

study assignments, Worksheet activities.

Suggested Sources:

Soft Skills and Employability Skills by Sabina Pillai and Agna Fernandez, Cambridge University Press, 2018.

Soft Skills for Everyone by Jeff Butterfield, Cengage Learning Education and personality development, K. Manoharan English for Life and the Workplace through the LSRW&T skills

Lateral Thinking skills by Edward De Bono

TEXT BOOKS	
2.	An Introduction to Profession English and Soft Skills with audio CD by Dr. Bikram K. Das et al. Published by Cambridge University Press. 2009
REFERENCE BOOKS	
12.	Soft Skills & Employability Skills by Sabina Pillai and Agna Fernandez published by Cambridge University Press 2018.
13.	Embark, English for Undergraduates by Steve Hart et al, Cambridge University Press,2016, Edition
14.	Skills for the TOEFL IBT Test, Collins, 2012 edition
15.	Soft Skills for Everyone by Jeff Butterfield, Cengage Learning, 2010 edition
16.	English for Life and the Workplace Through LSRW&T skills, by Dolly John, Pearson Publications, 2014 edition
17.	Professional Speaking Skills by Aruna Koneru, Oxford Publications.
18.	The official Cambridge guide to IELTS for Academic and General Training, Cambridge University Press, 2014 edition.
19.	Cambridge BEC Vantage, Self-Study edition, Practice Tests, CUP, 2002
20.	English for Business Studies, 3rd edition, Ian Mackenzie, Cambridge University Press
21.	Education and Personality Development by Dr. P.K.Manoharan, APH Publishing Corporation, 2015
22.	Speaking Effectively by Jeremy Comfort et al, Cambridge University Press, 2011.
E BOOKS	
8.	https://www.britishcouncil.in/english/courses-business
9.	http://www.bbc.co.uk/learningenglish/english/features/pronunciation
10.	http://www.bbc.co.uk/learningenglish/english/
11.	http://www.antimoon.com/how/pronunc-soundsipa.htm
12.	http://www.cambridgeenglish.org/learning-english/free-resources/write-and-improve/
13.	Oneshopenglish.com
14.	Breakingnews.com
MOOC	
1	https://www.mooc-list.com/tags/english
2	https://www.mooc-list.com/course/adventures-writing-stanford-online
3	http://www.cambridgeenglish.org/learning-english/free-resources/mooc/

COURSE TITLE	ENGINEERING GRAPHICS AND COMPUTER AIDED DESIGN			CREDITS	3
COURSE CODE	MEA4101	COURSE CATEGORY	BS	L-T-P-S	1- 1- 2- 1
CIA	60%			ESE	40%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
Upon completion of this course, Students should be able to		
1	Understand drafting and computer aided drafting. Remember the commands used in AutoCAD to generate simple drawings.	1,3,5,10,11
2	Explain details in a drawing and apply the knowledge to solve simple problems involving straight lines, planes and solids	1,3,5,10,11
3	Understand and Visualize solid objects and apply AutoCAD software commands to generate the graphic models	1,3,5,10,11
4	Apply the 3D model commands to generate and solid object	1,3,5,10,11
5	Apply the viewing AutoCAD commands to generate top view, front view and additional or sectional views.	1,3,5,10,11
6	Student can able to develop any graphical model of geometrical and simple mechanical objects in AutoCAD software.	1,3,5,10,11

Prerequisites : Nil

MODULE 1: BASICS OF ENGINEERING GRAPHICS (12)

Importance of graphics - BIS conventions and specifications - drawing sheet sizes - Lettering – Dimensioning - Scales. Drafting methods - introduction to Computer Aided Drafting – Computer Hardware – Workstation – Printer and Plotter – Introduction to software for Computer Aided Design and Drafting – Exposure to Solid Modelling software – Geometrical Construction-Coordinate Systems/Basic Entities – 3D printer. Projection methods and Projections of solid. (Solids in simple positions and axis inclined to one plane only)

Suggested Reading: Solid modeling Software commands

MODULE 2: VISUALIZATION, ORTHOGRAPHIC PROJECTIONS AND FREE HAND SKETCHING (15)

Visualization concepts and Free Hand sketching: Visualization principles —Representation of Three Dimensional objects — Pictorial Projection methods - Layout of views- Free hand sketching of multiple views from pictorial views of objects. Drafting of simple Geometric Objects/Editing

General principles of presentation of technical drawings as per BIS - Introduction to Orthographic projections - Naming views as per BIS - First angle projection method. Conversion to orthographic views from given pictorial views of objects, including dimensioning – Drafting of Orthographic views from Pictorial views.

Suggested Reading: CAD software commands for sketching a drawing

MODULE 3: GEOMETRICAL MODELING ISOMETRIC VIEWS AND DEVELOPMENT OF SURFACES (15)

Principles of isometric projection and solid modelling. Isometric drawing – Iso Planes and 3D Modelling commands. Projections of Principal Views from 3-D Models. Solid Modelling – Types of modelling - Wire frame model, Surface Model and Solid Model – Introduction to graphic software for solid modelling. Development of Surfaces.

***Suggested Reading**: Surface modeling and solid modeling commands*

MODULE 4: COMPUTER AIDED DESIGN AND DRAFTING (15)

Preparation of solid models of machine components like slide block, solid bearing block, bushed bearing, gland, wall bracket, guide bracket, shaft bracket, jig plate, shaft support (open type), vertical shaft support etc using appropriate modelling software.

2D views and sectional view, computer aided drafting and dimensioning. Generate 2D drawing from the 3D models – generate and develop the lateral surfaces of the objects. Presentation Techniques of Engineering Drawings – Title Blocks – Printing/Plotting the 2D/3D drawing using printer and printing solid object using 3D printer.

***Suggested Reading**: CAD commands for modeling and views generation*

MODULE 5: SIMPLE DESIGN PROJECTS - COMPUTER AIDED DESIGN AND DRAFTING (15)

Creation of engineering models and their presentation in standard 2D form, 3D Wire-Frame and shaded solids, meshed topologies for engineering analysis, tool-path generation for component manufacture, geometric dimensioning and tolerancing. Use of solid-modelling software for creating associative models at the components and assembly levels in their respective branch of engineering like building floor plans that include: windows, doors, fixtures such as WC, Sink, shower, slide block, etc. Applying colour coding according to drawing practice.

Suggested Reading: CAD commands for modeling and views generation

TEXT BOOKS

1	Jeyapoovan T, Engineering Drawing and Graphics Using AutoCAD, 7th Edition, Vikas Publishing House Pvt Ltd., New Delhi, 2016

REFERENCE BOOKS

1	Introduction to AutoCAD – 2D and 3D Design, A.Yarmwood, Newnes Elsevier, 2011
2	Engineering Drawing and Graphic Technology-International Edition, Thomas E. French, Charles J. Vierck, Robert J. Foster, McGraw-Hill, 2014
3	Engineering Drawing and Design, Sixth Edition, C. Jensen, J.D. Helsel, D.R. Short, McGraw-Hill, 2012
4	Technical Drawing-Fourteenth Edition, F. E. Giesecke, A. Mitchell, H. C. Spencer, I.L. Hill, J.T. Dygdon, J.E., Novak, Prentice-Hall, 2012,
5	Bhatt N.D and Panchal V.M, Engineering Drawing: Plane and Solid Geometry, Charotar Publishing House, 2017.
6	Warren J. Luzadder and Jon. M. Duff, Fundamentals of Engineering Drawing, Prentice Hall of India Pvt. Ltd., Eleventh Edition, 2016.

E BOOKS	
1	http://keralatechnologicaluniversity.blogspot.in/2015/06/engineering-graphics-j-benjamin-pentex-free-ebook-pdf-download.html
2	http://keralatechnologicaluniversity.blogspot.in/2015/06/engineering-graphics-p-i-varghese.html
MOOC	
1	http://nptel.ac.in/courses/112103019/
2	http://nptel.ac.in/courses/105104148/

COURSE TITLE	**SUSTAINABLE ENGINEERING SYSTEMS (Common to ALL Branches of Engineering)**			**CREDITS**	**2**
COURSE CODE	**GEA4102**	**COURSE CATEGORY**	**BS**	**L-T-P-S**	**2-0-0-1**
CIA	**50%**			**ESE**	**50%**
LEARNING LEVEL	**BTL-3**				

CO	**COURSE OUTCOMES**	**PO**
Upon completion of this course students should be able to		
1.	Learn the principles of sustainability with case studies.	1,2,4,6,12
2.	Understand assessing technologies and their impact on environment.	1,2,4,6,12
3	Learn the concept of Green Engineering and to apply in their projects at higher semesters.	1,2,4,6,12
4.	Management of natural resources and waste management from various types of industries.	1,2,4,6,12
5.	Learn water technology and behavioral aspects of humans.	1,2,4,6,12

Prerequisites: Knowledge in fundamentals of chemistry at higher secondary level.

MODULE 1 – PRINCIPLES OF SUSTAINABLE SYSTEMS	**(5L)**
Sustainability Definitions - Principles of Sustainable Design, Sustainable Engineering -Frameworks for Applying Sustainability Principles - Summary & Activities.	
MODULE 2 – TECHNOLOGY DEVELOPMENT AND LIFECYCLE ASSESSMENT	**(5L)**
Technology as a part of anthropogenic environment - Technology readiness levels (TRL) – technical metrics - Emerging, converging, disruptive technologies - Life Cycle Assessment (LCA) methodology - Summary & Activities.	
MODULE 3 – GREEN ENGINEERING	**(5L)**
Principles of Green Engineering - Frameworks for assessment of alternatives - Green Engineering examples - Multifunctional Materials and Their Impact on Sustainability - Summary & Activities.	
MODULE 4 – RESOURCE MANAGEMENT TECHNOLOGIES	**(5L)**
Waste management purpose and strategies - Recycling: open-loop versus closed-loop thinking -	

Recycling efficiency - Management of food waste and composting technologies - E-waste stream management - Reuse and redistribution programs - LCA approach to waste management systems - Summary and Activities.	
MODULE 5 – SUSTAINABLE WATER AND WASTEWATER SYSTEMS (5L)	
Water cycle - Water conservation and protection technologies - Water treatment systems Metrics for assessment of water management technologies-Summary & Activities.	
MODULE 6 - BEHAVIORAL ASPECTS AND FEEDBACKS (5L)	
Collaborative Decision Making - Role of Community and Social Networking - Human Factor in Sustainability Paradigm - Summary & Activities.	
TEXT BOOKS	
1.	Vanek, F.M., and L.D. Albright, Energy Systems Engineering. Evaluation and Implementation, McGraw Hill, 2008.
2.	C.U. Becker, Sustainability Ethics and Sustainability Research, Springer 2012.
3.	J.B. Guinee et al., Life Cycle Assessment: Past, Present, and Future, Environ. Sci. Technol., 2011, 45, 90-96.
4.	Anastas, P.T., Zimmerman, J.B., Innovations in Green Chemistry and Green Engineering, Springer 2013.
5.	Solid Waste Technology & Management, Volume 1 & 2, Christensen, T., Ed., Wiley and Sons., *2010.*
6.	Sterman, J.D., in Sustainability Science: The Emerging Paradigm, Weinstein, M.P. and Turner, R.E. (Eds.), Springer Science+Business Media, LLC 2012.
E BOOKS	
1.	David T. Allen, David R. Shonnard, Sustainable Engineering Concepts, Design and Case Studies, Pearson Education, December 2011. (ISBN: 9780132756587)
2.	Gerald Jonker Jan Harmsen, Engineering for Sustainability 1st Edition, A Practical Guide for Sustainable Design, Elsvier 2012. (**ISBN:** 9780444538475).
MOOC	
1.	https://www.coursera.org/learn/sustainability
2.	https://www.academiccourses.com/Certificate/Sustainability-Studies/India/
3.	https://onlinecourses.nptel.ac.in/noc18_ce08/preview
4.	https://www.coursera.org/learn/ecosystem-services

COURSE TITLE	PROBLEM SOLVING USING C			CREDITS	3
COURSE CODE	CSA4101	COURSE CATEGORY	PC	L-T-P-S	2-0-2-0
CIA	60%			ESE	40%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
Upon completion of this course, the students will be able to		
1	Describe the basics of digital computer and programming languages.	1,2,8,12
2	Demonstrate problem solving techniques using flowchart, algorithm/pseudo code to solve the given problem.	1,2,3,5,12
3	Design and Implement C program using Control Statements and Functions.	1,2,3,5,9,10,12
4	Design and Implement C program using Pointers and File operations.	1,2,3,12
5	Identify the need for embedded C in real-time applications.	1,2,6,12

Prerequisites: Nil

MODULE 1 – PROGRAMMING LANGUAGES AND PROBLEM SOLVING TECHNIQUES (6L+6P)

Introduction – Fundamentals of digital computers - Programming languages -Programming Paradigms – Types of Programming Languages – Language Translators – Problem Solving Techniques: Algorithm – Flow Chart - Pseudo code.

Practical Component:

Drawing Flowcharts using E- Chart & Writing pseudo code for the following problems

(i) Greatest of three numbers

(ii) Sum of N numbers

(iii) Computation of nCr

MODULE 2: FUNDAMENTALS OF C (6L+6P)

Evolution of C -Why C language - Applications of C language - Data Types in C – Operators and Expressions – Input and Output statements in C – Decision Statements – Loop Control Statements.

Practical Component:

(i) Program to illustrate arithmetic and logical operators

(ii) Program to read and print data of different types

(iii) Program to calculate area and volume of various geometrical shapes

(iv) Program to compute biggest of three numbers

(v) Program to print multiplication table

(vi) Program to convert days to years, months and days

(vii) Program to find sum of the digits of an integer.

MODULE 3: FUNCTIONS, ARRAYS AND STRINGS (6L+6P)

Functions – Storage Class – Arrays – Strings and standard functions - Pre-processor Statements.

Practical Component:

(i) Program to compute Factorial, Fibonacci series and sum of n numbers using recursion

(ii) Program to compute sum and average of N Numbers stored in an array

(iii) Program to sort the given n numbers stored in an array

(iv) Program to search for the given element in an array
(v) Program to do word count
(vi) Program to insert a substring in a string
(vii) Program to concatenate and compare two strings
(viii) Program using pre-processor statements

MODULE 4: POINTERS, STRUCTURES AND UNION (6L+6P)

Pointers – Dynamic Memory allocation – Structure and Union – Files.

Practical Component:

(i) Program to compute sum of integers stored in a 1-D array using pointers and dynamic memory allocation
(ii) Program to read and print records of a student/payroll database using structures
(iii) Program to simulate file copy
(iv) Program to illustrate sequential access file
(v) Program to illustrate random access file

MODULE 5: INTRODUCTION TO EMBEDDED C (6L+6P)

Structure of embedded C program - Data Types - Operators - Statements - Functions - Keil C Compiler.

Practical component:

Simple programs using embedded C

LAB / MINI PROJECT / FIELD WORK

NA

TEXT BOOKS

1.	Jeyapoovan T, “Fundamentals of Computing and Programming in C”, Vikas Publishing house, 2015.
2.	Mark Siegesmund, "Embedded C Programming", first edition, Elsevier publications, 2014.

REFERENCE BOOKS

1.	Ashok Kamthane, “Computer Programming”, Pearson Education, 7th Edition, Inc 2017.
2.	Yashavant Kanetkar, “Let us C”, 15th edition, BPP publication, 2016.
3.	S.Sathyalakshmi, S.Dinakar, “Computer Programming Practicals – Computer Lab Manual”, Dhanam Publication, First Edition, July 2013.

E BOOKS

1.	https://en.wikibooks.org/wiki/C_Programming

MOOC

1.	https://onlinecourses.nptel.ac.in/noc18-cs10/preview
2.	http://nptel.ac.in/courses/106105085/2
3.	https://www.udemy.com/c-programming-for-beginners/
4.	https://www.coursera.org/specializations/c-programming

COURSE TITLE	INTRODUCTION TO DIGITAL SYSTEMS			CREDITS	3
COURSE CODE	EEB4101	COURSE CATEGORY	PC	L-T-P-S	3- 0- 0- 1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1	To understand basic operation in digital systems and instruments.	1,2,4,6
2	To gain knowledge on basic functioning of sensors and display units.	1,2,4,6
3	To familiarize the concepts of signal processing and converting elements.	1,2,4,6
4	To acquire the knowledge of microcontrollers and applications	1,2,4,6
5	To attain the basic concepts of consumer electronics and communication devices.	1,2,4,6

Prerequisites : Physics and Mathematics

MODULE 1 – INTRODUCTION TO DIGITAL SYSTEMS (9L)

Analog& Digital signals - Need for digital instruments – Elements of digital instruments – Number systems: - Binary, Hexadecimal - Logic gates - Boolean algebra (Identities and Properties) - Digital controllers (ON-OFF).

Suggested Reading: Basics of number systems.

MODULE 2 –SENSORS AND DISPLAYS (9L)

Sensors and Transducers –Classification, Potentiometer, Strain Gauge, Piezoelectric Sensor, Linear Variable Differential Transformer, Resistance temperature detectors (RTD), Thermocouples, Tactile transducers - Displays: - Light Emitting Diode (including OLED) displays.

Suggested Reading: Primary sensing elements, introduction to displays.

MODULE – 3 : SIGNAL CONDITIONING CIRCUITS (9L)

D.C. Bridge- Unbalanced, Push-Pull configuration, Operational amplifiers- Inverting, Non-Inverting, Instrumentation Amplifier, Active filters: - Low pass, High pass - Analog to Digital Converter – Successive Approximation, Digital to Analog Converter - Weighted Resistor.

Suggested Reading: Basic network theorems.

MODULE – 4 :INTRODUCTION TO MICRO CONTROLLERS (9L)

Introduction: Memory types, peripheral devices- Microcontroller (8 bit), Architecture, Graphics Processing Unit (GPU) - Applications: -Interfacing of Digital Input/Output, Analogue Input/Output, Display. Introduction to Programmable Logic Controller (PLC) and PID (Proportional + Integral + Derivative) Controller.

Suggested Reading: Hobby electronics with Microcontroller interface.

MODULE 5 – CONSUMER ELECTRONICS AND COMMUNICATION SYSTEM (9L)

Consumer Electronics: Television, Mobile Phones, Air conditioners, Refrigerators, Washing Machine. (Block diagram approach only.)

Communication System: Satellite communication, Global Positioning Systems, Global System for Mobile. (Block diagram approach only.)

Suggested Reading: Consumer Electronics User Manuals.

LAB / MINI PROJECT/FIELD WORK	
Field trip to consumer electronics industry.	
TEXT BOOKS	
1	Digital Fundamentals, Thomas l. Floyd, 11th edition, Pearson 2014.
2	Op-amps and Linear Integrated Circuits,Ramakant A. Gayakwad,4th edition,Prentice Hall, 2015.
3	Electronic Instrumentation and Measurements, David A. Bell, Oxford University Press, 2013.
4	The 8051 Microcontroller And Embedded Systems Using Assembly And C, SepehrNaimi, SarmadNaimi, Muhammad Ali Mazidi, Second edition, 2017.
5	Programmable Logic Controllers, Frank D. Petruzella, McGraw-Hill Education, 2016.
REFERENCE BOOKS	
1.	Digital Logic and Computer Design, M. Morris Mano, Prentice-Hall, 2016
2.	Linear Integrated Circuits, Roy Choudhury, New Age International Publishers, 4th edition, 2011
3.	C and 8051, Thomas W. Schultz, Thomas W. Schultz Publishers, 4th edition,2008
4.	Consumer Electronics, S.P Bali, Pearson Education Asia Pvt., Ltd., 2008 Edition
5.	Global Mobile Satellite Communications Applications (For Maritime, Land and Aeronautical Applications Volume 2), 2nd edition, Springer, 2018
E BOOKS	
1	http://www.ee.iitm.ac.in/~giri/pdfs/EE4140/textbook.pdf
2	https://electronics.howstuffworks.com/home-audio-video-channel.htm
3	http://nptel.ac.in/courses/106108099/Digital%20Systems.pdf
4	http://nptel.ac.in/courses/112103174/pdf/mod2.pdf
5	http://www.nptel.ac.in/courses/Webcourse-contents/IISc-BANG/Microprocessors %20and%20Microcontrollers/pdf/Teacher_Slides/mod3/M3L6.pdf
6	http://nptel.ac.in/courses/108105063/pdf/L-09(SS)(IA&C)%20((EE)NPTEL).pdf
7	http://nptel.ac.in/courses/Webcourse-contents/IIT-KANPUR/microcontrollers/micro /ui/Course_home2_5.html

COURSE TITLE	ENGINEERING MECHANICS			CREDITS	4
COURSE CODE	MEB4116	COURSE CATEGORY	PC	L-T-P-S	3 1 0 2
CIA	50%			ESE	50%
LEARNING LEVEL	BTL – 2				

CO	COURSE OUTCOMES	PO
On completion of this course, students will be able to:		
1	Memorize and remember all the basic laws and principles of mechanics.	1,2,3,4,9,12
2	Analyze the problems related to machine structures and friction.	1,2,3,4,9,12
3	Apply concepts of geometrical properties such as centroid, center of gravity and moment of inertia.	1,2,3,4,9,12
4	Solve engineering problems on Statics in case of equilibrium conditions.	1,2,3,4,9,12
5	Solve problems on dynamics, momentum and impulse.	1,2,3,4,9,12

Prerequisites : NIL

MODULE 1: INTRODUCTION TO MECHANICS AND FORCE SYSTEM **12 hours**

Statics: Fundamental concepts, Units & dimensions, Laws of mechanics, System of forces – parallelogram, triangle and polygon law of forces – resultant of a force system - - resultant of a concurrent, coplanar and parallel force system – resolution and composition of forces - Lami's theorem – transmissibility of forces - moment of a force – physical significance of moment - Varignon's theorem – resolution of a force into force and couple – equivalent system of forces – Equilibrium of rigid body in two dimensions - Problems.

Suggested Reading: *Forces in space – addition of concurrent forces in space – equilibrium of a particle in space*

MODULE 2: FRICTION **12 hours**

Frictional resistance – classification of friction – limiting friction - laws of friction – coefficient of friction - angle of friction – angle of repose - cone of friction – properties, advantages and disadvantages of friction - free body diagram - equilibrium of a body on an inclined plane - ladder friction – wedge friction – belt friction. Simple machines - concept of lifting machines - law of lifting machine – efficiency - Problems.

Suggested Reading: *Mechanical advantages – velocity ratio and their relationship.*

MODULE 3: PROPERTIES OF SURFACES AND SOLIDS **12 hours**

Properties of planar surfaces – Centroid and second moment of area - Parallel and perpendicular axis theorem – Centroid and Moment of Inertia of composite plane figure - Polar Moment of Inertia – Radius of gyration - Mass moment of inertia of cylinder and thin disc (No derivations required) - Product of inertia – principal axes and Principal Moment of Inertia - Theorems of Pappus and Guldinus – Problems.

Suggested Reading: Determination of Centroids of Volumes by Integration (derivations).

MODULE 4: BASICS OF DYNAMICS	12 hours
Definition – kinematics and kinetics – displacements, velocity and acceleration- Equations of motion - Types of motion – Rectilinear motion of a particle with uniform velocity, uniform acceleration, varying acceleration – motion curves – motion under gravity – relative motion – curvilinear motion of a particle – projectiles – angle of projection – range – time of flight and maximum height. Newton's second law of motion – linear momentum – D Alembert's principle, Dynamics equilibrium - Problems. ***Suggested Reading:*** *Work energy equation of particles– law of conservation of energy – principle of work and energy.*	
MODULE 5: IMPULSE MOMENTUM AND IMPACT OF ELASTIC BODIES	**12 hours**
Impulsive force – Impulse – linear impulse and momentum – Equations of momentum – principle impulse and momentum – impulsive motion – conservation of momentum. Definition – Time of compression, restitution, collision – law of conservation of momentum – Co-efficient of restitution – types of impact – collision of elastic bodies by direct central impact and oblique impact – Problems – MATLAB©, basics, Application in collision problems, simple programming. ***Suggested Reading:*** *Collision of small body with a massive body – loss of kinetic energy.*	

TEXT BOOKS

1	Beer, F. P and Johnston Jr. E.R., Vector Mechanics for Engineers (In SI Units): Statics and Dynamics‖, 11thEdition, Tata McGraw-Hill Publishing company, New Delhi, 2017.
2	Timoshenko S. & Young D. H., Engineering Mechanics, Mc-GrawHill, 2015.
3	Shames I. H., Engineering Mechanics, Statics and Dynamics, Pearson Prentice, 2016.
4	Rao V. and J. Srinivas, Solving Engineering Mechanics Problems with MATLAB©, ISBN:1906574340 9781906574345, 2nd edition, New age international (P) limited, New Delhi, 2015.

REFERENCE BOOKS

1	Bhavikatti, S. S and Rajashekarappa, K.G., Engineering Mechanics, New Age International (P) Limited Publishers, 2016.
2	Hibbeller, R.C and Ashok Gupta, Engineering Mechanics: Statics and Dynamics‖, 14th Edition, Pearson Education 2017.
3	Benjamin J., Engineering Mechanics, Pentex Book Publishers and Distributors, 2015.
4	Boresi & J. Schmidt, Engineering Mechanics: Statics and Dynamics, 3/e, Cengage learning, 2016.
5	Kumar K. L., Engineering Mechanics, Tata Mc-GrawHill Publishing Company Limited, 2015.
6	Tayal A. K., Engineering Mechanics- Statics and Dynamics, Umesh Publications, 2016.
7	Irving H. Shames and Krishna Mohana Rao. G., Engineering Mechanics – Statics and Dynamics, 7th Edition, Pearson Education Pvt. Ltd., 2016.
8	Jaget Babu, Engineering Mechanics, Pearson Prentice Hall, 2015.
9	Meriam J.L. and Kraige L.G., Engineering Mechanics - Statics - Volume 1, Dynamics- Volume 2, 8th Edition, John Wiley & Sons, 2016.

10	Rajasekaran S and Sankarasubramanian G., Engineering Mechanics Statics and Dynamics, 6th Edition, Vikas Publishing House Pvt. Ltd., 2015.
E BOOKS	
1	https://sites.google.com/.../popularebookfreetop659/-pdf-engineering-mechanics-statics
2	www.springer.com › Home › Engineering › Mechanics
3	https://www.amazon.in/Text-Book-Engineering-Mechanics/dp/9381069123
4	https://www.topfreebooks.org/free-engineering-ebooks-online-mechanical-engineering/`
5	https://www.studynama.com/.../453-Engineering-mechanics-pdf-lecture-notes-ebook-
6	https://themech.in/mechanical/mechanical-engineering-complete-ebooks-free-download/
7	www.faadooengineers.com/threads/17024-Engineering-mechanics-Pdf-Free-Download
8	https://www.pdfdrive.net/engineering-mechanics-books.html
MOOC	
1	https://swayam.gov.in/courses/public
2	https://www.iitm.ac.in/content/nptel-open-online-course-noc-0 https://sites.google.com/view/nptelmits/departments/mechanical-engineering
3	nptel.ac.in/courses/122104015/
4	nptel.ac.in/courses/112103108/
5	nptel.ac.in/courses/112103109/
6	freevideolectures.com › Mechanical › IIT Guwahati
7	freevideolectures.com › Mechanical › IIT Kanpur
8	https://swayam.gov.in/courses/public

COURSE TITLE	MANUFACTURING TECHNOLOGY-I			CREDITS	3
COURSE CODE	MEB4117	COURSE CATEGORY	PC	L-T-P-S	3 0 0 2
CIA	50%			ESE	50%
LEARNING LEVEL	BTL- 4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Differentiate the type of metal casting process and should able to demonstrate casting process	1,2,5
2	Apply the knowledge of required fabrication process for their own design project	1,2,5
3	Demonstrate the bulk deformation process like rolling, forging and extrusion	1,2,4,5,10,12
4	Apply the knowledge of sheet metal forming for their own design project	1,2,5,12
5	Demonstrate the forming and shaping of the plastic	1,2,5,12

Prerequisites : Nil

MODULE 1: METAL CASTING PROCESSES (10)

Sand casting - Sand moulds - Type of patterns - Pattern materials - Pattern allowances- Types of Moulding sand - Properties - Core making - Methods of Sand testing - Moulding machines - Types of moulding machines - Melting furnaces - Working principle of Special casting processes - Shell, investment casting - Ceramic mould - Lost Wax process - Pressure die casting - Centrifugal casting - CO2 process - Sand Casting defects - Inspection methods.

Suggested Reading: *Taxonomy of the manufacturing processes, Contemporary trends and practices in metal casting process*

MODULE 2: FABRICATION PROCESS (10)

Fusion welding processes - Types of Gas welding - Equipments used - Flame characteristics - Filler and Flux materials - Arc welding equipments - Electrodes - Coating and specifications - Principles of Resistance welding - Spot/butt, seam welding - Percusion welding - Gas metal arc welding - Flux cored - Submerged arc welding - Electro slag welding - TIG welding - Principle and application of special welding processes - Plasma arc welding - Thermit welding - Electron beam welding - Friction welding - Diffusion welding - Flame cutting - Weld defects - Brazing and soldering process - Methods and process capabilities - Filler materials and fluxes - Types of Adhesive bonding

Suggested Reading: *Promising advanced welding processes that have the potential to develop further and support the green manufacturing trend*

MODULE 3: BULK DEFORMATION PROCESSES (10)

Hot working and cold working of metals - Forging processes - Open and close die forging - Characteristics of the process - Types of Forging Machines - Typical forging operations - Rolling of metals - Flat strip rolling - Types of Rolling mills - Shape rolling operations - Tube piercing - Defects in rolled parts - Principles of Extrusion - Types of Extrusion - Hot and Cold extrusion -Principle of rod and wire drawing - Equipments used

Suggested Reading: *Advanced techniques in bulk deformation process, Significant Variables in a Deformation Process*

MODULE 4: SHEET METAL FORMING PROCESSES (8)	
Sheet metal characteristics - Typical shearing operations, bending and drawing operations - Stretch forming operations - Formability of sheet metal - Test methods - Working principle and application of special forming processes - Hydro forming - Rubber pad forming - Metal spinning - Explosive forming - Magnetic pulse forming - Peen forming - Super plastic forming - Process characteristics ***Suggested Reading:*** *Forming of fan for vacuum cleaners, An Approach for Modeling Sheet Metal Forming for Process Controller Design*	
MODULE 5: FORMING AND SHAPING OF PLASTICS (7)	
)Types of plastics - Characteristics of forming and shaping processes - Moulding of Thermoplastics Working principles and typical applications of - Injection moulding - Plunger and screw machines Blow moulding - Rotational moulding - Film blowing - Extrusion - Typical industrial applications Thermoforming - Processing of Thermosets - Working principles and typical applications Compression moulding - Transfer moulding - Bonding of Thermoplastics - Fusion and solvent methods - Induction and Ultrasonic methods. ***Suggested Reading:*** *Agile new plastics change shape with heat, Research on eco-friendly plastics for manufacturing process*	
TEXT BOOKS	
1	Hajra Choudhury, Elements of Workshop Technology, Vol. I and II, Media Promotors Pvt Ltd., Mumbai, 2010.
2	Serope Kalpak jain, Steven R.Schmid, Manufacturing Engineering and Technology, Pearson Education, Inc. 7th Edition, 2013.
REFERENCE BOOKS	
1	Manufacturing Technology, P.N. Rao, Tata McGraw-Hill Publishing Limited, 2010.
2	Elements of Manufacturing Processes, B.S. Magendran Parashar & R.K. Mittal, Prentice Hall of India, 2011.
3	A Text book of production technology, P.C. Sharma, S. Chand and Company, 2010.
4	A Textbook of Manufacturing Technology,R.K. Rajput, Laxmi Publications; Second edition (2016)
E BOOKS	
1	https://books.google.co.in/books/about/Manufacturing_Technology.html?id=fSHZ AgAAQBAJ&redir_esc=y
2	https://books.google.co.in/books?id=6wFuw6wufTMC&printsec=frontcover &redir_esc=y#v=onepage&q&f=false- R.K.Rajput
3	https://books.google.co.in/books?id=COpTAAAAMAAJ&q=manufacturing+technology &dq=manufacturing+technology&hl=en&sa=X&ved=0ahUKEwiqqa6SltDZAhVLvrwKH fikBFwQ6AEILDAB- David L. Goetsch
MOOC	
1	https://www.coursera.org/learn/advanced-manufacturing-process-analysis?siteID=.GqSdLGGurk-ihvgV6WlX0vV4OvPhJzUQ&utm_content=10&utm_ medium=partner s&utm_source=linkshare&utm_campaign=*GqSdLGGurk

2	https://www.coursera.org/learn/manufacturing-process-fusion-360?siteID=.GqSdLGGurk-raM8i73q9gPGjzghYEJbgQ &utm_content=10&utm_medium=partners&utm_ source=linkshare&utm_campaign=*GqSdLGGurk
3	https://www.fun-mooc.fr/courses/course v1:ENSCachan+20014+session02/about
4	https://www.edx.org/course/fundamentals-manufacturing-processes-mitx-2008 x-?source=aw&awc=6798_1520081220_4c266c011b90221d93f594ab6136cb0a&utm_source=aw&utm_medium=affiliate_partner&utm_content=text-link&utm_term=425997_CoToNet,%20Unip.%20Lda

SEMESTER III

COURSE TITLE	PARTIAL DIFFERENTIAL EQUATIONS AND TRANSFORMS (Common For all Department)			CREDITS	4
COURSE CODE	MAA4201	COURSE CATEGORY	BS	L-T-P-S	3-1-0-0
CIA	50%			ESE	50%
LEARNING LEVEL	BTL:1- 4				

CO	COURSE OUTCOMES	PO
Upon completion of this course students should be		
1	Able to obtain basic knowledge in signal & Image Processing	1,2,5,11
2	Able to obtain the knowledge of Vibration Analysis and Heat analysis in one dimension	1,2,5
3	Able to obtain the knowledge of Heat analysis in two dimension	1,2,5
4	Able to understand the process Filter and analysis of linear system	1,2,5,11
5	Able to obtain knowledge Complex Frequency Domain	1,2,5,11

Prerequisites : Nil

MODULE 1: PARTIAL DIFFERENTIAL EQUATIONS (9L+3T)

Formation of partial differential equations by elimination of arbitrary constants, arbitrary functions – Solution of standard types of first order partial differential equations – Lagrange's linear equation – Linear partial differential equations of second order with constant coefficients.

Suggested Reading: Partial Differentiation

MODULE 2: ONE DIMENSIONAL WAVE AND HEAT FLOW EQUATION (9L+3T)

Classification of second order linear partial differential equations – Solutions of one dimensional wave equation (without proof) – One dimensional heat flow equation (without proof) and application in string and rod problems.

Suggested Reading: Partial Differential Equations, Half range sine series.

MODULE 3: TWO DIMENSIONAL HEAT FLOW EQUATION (9L+3T)

Steady state solution of two dimensional heat equations and applications in finite plates and infinite plates problems.

Suggested Reading: Partial Differential Equations, Half range sine series.

MODULE 4: FOURIER TRANSFORM (9L+3T)

Fourier Integral Theorem (without proof) – Fourier transform pair – Sine and Cosine transforms – Properties – Transforms of Simple functions – Convolution theorem – Parseval's identity.

Suggested Reading: Basic integration.

MODULE 5: Z-TRANSFORM AND DIFFERENCE EQUATIONS (9L+3T)	
Z-Transform – Elementary Properties – Inverse Z-Transform – Convolution theorem – Formation of Difference equations – Solution of difference equations using Z-Transform **Suggested Reading**: Basic calculus	
LAB/MINI PROJECT/FIELD WORK	
Theory only	
TEXT BOOKS	
1	P. Sivarama Krishna Das, C. Vijayakumari., "Transforms and partial differential equations", Pearson Publication, 2016.
2	Grewal. B.S., "Higher Engineering Mathematics", 42nd Edition, Khanna Publishers, Delhi, 2012.
3	Chandrasekaran A, "A Text Book of Transforms and Partial Differential Equations", Dhanam Publication, 2015
4	Raj Kumar Bansal,Ashok Kumar Goel, Manoj Kumar Sharma, "MATLAB© and its Applications in Engineering", Pearson Publication, Second Edition, 2016.
REFERENCE BOOKS	
1	Bali.N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 7th Edition, Laxmi Publications Pvt Ltd , 2007.
2	Datta.K.B., "Mathematical Methods of Science and Engineering", Cengage Learning India Pvt Ltd, Delhi, 2013.
3	Veerarajan. T., "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt. Ltd., New Delhi, Second reprint, 2012.
4	Dean G. Duffy., "Advanced Engineering Mathematics with MATLAB©", CRC Press, Third Edition 2013.
E BOOKS	
1	nptel.ac.in/courses/122107037/
2	nptel.ac.in/courses/122107037/22
MOOC	
1	https://www.mooc-list.com/tags/laplace-transforms
2	https://www.edx.org/course/introduction-differential-equations-bux-math226-1x-1

COURSE TITLE	ENGINEERING THERMODYNAMICS			CREDITS	4
COURSE CODE	MEB4201	COURSE CATEGORY	PC	L-T-P-S	3 1 0 2
CIA	50%			ESE	50%
LEARNING LEVEL	BTL - 4 (Analysis)				

CO	COURSE OUTCOMES	PO
Upon completion of this course students should be able		
1	to relate the concepts of Energy (Heat & Work) in real life situations and Apply energy transformation in flow & non flow processes. to Analyze and solve first law problems in a methodical fashion with respect to closed and open systems	1,2,3,4,5,6, 7, 9, 12 , PSO1
2	to Validate the concepts of degradation of energy and its effect in practical applications	1,2,3,4,5,6, 7, 9, 12 , PSO1
3	to Demonstrate the concepts of sensible heat, Latent heat to use steam tables for solving problems to Analyze and evaluate the performance of vapour power cycles and to describe binary vapour cycles.	1,2,3,4,5,6,7, 9, 12
4	to differentiate ideal and real gases and to demonstrate its properties to do basic analysis of the properties of gas mixtures to evaluate the thermodynamic relations	1,2,3,4,5,6, 7, 9, 12
5	to Evaluate the properties of air and water vapour mixtures using psychrometric chart and to demonstrate the various psychrometric processes	1,2,3,4,5,6, 7,9, 12

Prerequisites : Nil

MODULE 1: BASIC CONCEPTS & FIRST LAW OF THERMODYNAMICS 12

Thermodynamic systems, concepts of continuum, basic definitions, heat and work, zeroth law, First law, SFEE, First Law for closed and open systems.

Suggested Reading: IC engine Indicator diagram and problems associated MEP, IP, BP. Solving SFEE applications using Matlab©

MODULE 2: SECOND LAW OF THERMODYNAMICS 12

Second law of thermodynamics Statements, reversibility, causes of irreversibility, Carnot cycle, reversed Carnot cycles. Thermodynamic Temperature Scale, entropy, Clausius inequality, Entropy change in isothermal and adiabatic processes. Isentropic processes.

Suggested Reading: Concepts of Exergy, Solving combined heat engines and refrigerator problems using Matlab ©

MODULE 3: PROPERTIES OF PURE SUBSTANCE 12

Properties of pure substances, PVT surface, Steam tables, calculation of properties, Carnot cycle for steam and ideal efficiency. Rankine cycle with dry, saturated and superheated steam. Reheat and Regenerative cycles. Binary vapour power cycles (descriptive treatment only)

Suggested Reading: Binary vapour cycles and combined cycles. Simulation of Rankine cycle with reheat and regeneration using Matlab

MODULE 4: GAS MIXTURES AND THERMODYNAMIC RELATIONS	12
Ideal and real gases, Avagadro's law, compressibility. Dalton's and Amagat's law, properties of gas mixtures, Maxwell relations, Clausius Clapeyron equations, Joule Thomson Coefficient. ***Suggested Reading***: Ideal and real gases, Plotting compressibility chart using Matlab©	
MODULE 5: PSYCHROMETRY	**12**
Psychrometry and psychrometric charts, property calculations of air vapour mixtures. Psychrometric processes - Adiabatic mixing, evaporative cooling. ***Suggested Reading***: Air water vapour mixture property calculation and plotting using Matlab©.	
TEXT BOOKS	
1	Cengel & Boles. Thermodynamics: an Engineering Approach, 8th Edition. McGraw Hill.2017
2	Nag, P.K., Engineering Thermodynamics, 6th Edition, Tata McGraw-Hill Publishing Company Limited New Delhi, 2017.
REFERENCE BOOKS	
1	Holman J.P, Thermodynamics, 4th Edition, McGraw-Hill Book Company, New York,1988.
2	Rao, Y.V.C., Thermodynamics,4th Edition,Wiley Eastern Ltd.,New Delhi,2003.
3	Moran and Shapairo, Principles of Engineering Thermodynamics, 8th Edition, Wiley, 2015
4	Rajput R K "A text book of Engineering Thermodynamics", S. Chand publishers, 2016.
5	Stephen J Chapman, Matlab programing for Engineers, Cengage publishers, 4th edition, 2012.
E BOOKS	
1	http://engineeringstudymaterial.net/ebook/schaum-outline-of-thermodynamics-for-engineers/
2	http://engineeringstudymaterial.net/ebook/basics-and-applied-thermodynamics/
3	http://www.freebookcentre.net/physics-books-download/Thermodynamics-Fundamentals-and-Its-Application-in-Science.html
MOOC	
1	http://nptel.ac.in/courses/112103016/
2	http://nptel.ac.in/courses/112106133/
3	http://nptel.ac.in/courses/112104113/
4	http://nptel.ac.in/courses/112105123/

COURSE TITLE	FLUID MECHANICS AND MACHINERY			CREDITS	3
COURSE CODE	MEB4202	COURSE CATEGORY	PC	L-T-P-S	3 0 0 2
CIA	50%			ESE	50%
LEARNING LEVEL	BTL- 4 (Analysis)				

CO	COURSE OUTCOMES Upon completion of this course student should be able to	PO
1	Apply the basic concepts of fluid mechanics in real life	1,2,4,5,12
2	Measure the fluid pressure for experimental work using pressure gauge and manometers	1,2,4,5,12
3	Do flow visualization using smoke or dye, to identify the type of flow in the pipe or open channel	1,2,4,5,10,12
4	Apply the conservation principles of mass, momentum to fluid flow systems with emphasis on fluid dynamics	1,2,4,5,12
5	Apply the Bernoulli's equation in Venturi meter, Orifice meter and Pitot tube construct the velocity diagram using Euler's equation for different turbines and pumps to calculate the energy transfer.	1,2,4,5,12

Prerequisites : Applied Mathematics

MODULE 1: BASIC CONCEPTSAND PROPERTIES **9**

Fluid–Definition, distinction between solid and fluid-Units and dimensions-Properties of fluids-density, specific weight, specific volume, specific gravity, temperature, viscosity, compressibility, vapour pressure, capillary and surface tension - Fluid statics: concept of fluid static pressure, absolute and gauge pressures - pressure measurements by manometers and pressure gauges.

Suggested Reading*: Hydrostatic forces on a submerged plane and curved surfaces – centre of pressure –stability of floating and submerged bodies*.

MODULE 2: FLUID KINEMATICSAND FLUID DYNAMICS **9**

Fluid Kinematics-Flow visualization-lines of flow-types of flow-velocity field and acceleration-continuity equation (one and three dimensional differential forms)-Equation of streamline-stream function-velocity potential function-circulation-flow net–fluid dynamics-equations of motion - Euler's equation along a streamline - Bernoulli's equation – applications - Venturi meter, Orifice meter, Pitot tube- dimensional analysis- Buckingham's π theorem-applications- similarity laws and models.

Suggested Reading*: Ideal fluid flow- Uniform flow, source flow- sink flow and free vortex flow*

MODULE 3: INCOMPRESSIBLE FLUID FLOW **9**

Viscous flow - Navier-Stoke's equation (Statement only) - Shear stress, pressure gradient relationship - laminar flow between parallel plates - Laminar flow through circular tubes (Hagen poiseulle's) - Hydraulic

and energy gradient - flow through pipes - Darcy -weisback's equation - piperoughness-frictionfactor-Moody'sdiagram-minorlosses-flowthroughpipesinseriesand in parallel - power transmission - Boundary layer flows, boundary layer thickness, boundary layer separation - drag and lift coefficients.

Suggested Reading*: derive continuity and momentum equation for incompressible fluid flow*

MODULE 4: HYDRAULIC TURBINES	9
Hydroturbine: Definition and classification - exchange of energy - Euler's equation for turbo machines - Construction of velocity vector diagrams - Head and specific work - components of energy transfer - degree of reaction. Pelton turbine- Francis turbine- Propeller turbine - Kaplan turbine - working principles - velocity triangles - work done - specific speed - efficiencies - performance curve for turbines. ***Suggested Reading**: draft tube for reaction turbine*	
MODULE 5: HYDRAULIC PUMPS	**9**
Pumps: definition and classifications - Centrifugal pump: classifications, working principle, velocity triangles, specific speed, efficiency and performance curves - Reciprocating pump: classification, working principle, indicator diagram, work saved by air vessels and performance curves - cavitation in pumps - rotary pumps: working principles of gear and vane pumps ***Suggested Reading**: diffusers for centrifugal pump and cavitation in diffusers, Plot H-Q Characteristics curve for the centrifugal for different RPM using MATLAB©*	
MINI PROJECT/FIELD WORK	
Field visit to Kundah hydroelectric power house and Museum in Nilgiris District and report submission	
TEXT BOOKS	
1	Streeter, V.L., and Wylie, E.B., "*Fluid Mechanics*", McGraw-Hill, New Delhi 2010
2	Kumar, K.L., "*Engineering Fluid Mechanics*", S Chand & Company (P)Ltd, 2015.
3	Modi, P.N., and Seth, S.M., "Hydraulics and Fluid Mechanics including Hydraulic Machine", (20^{th} edition), Standard Book House, New Delhi, 2013.
REFERENCE BOOKS	
1	Anderson, John D. *Fundamentals of Aerodynamics.* 6^{th} ed. New York, NY: McGraw-Hill, 2016.
2	White, F.M., "*Fluid Mechanics*", Tata McGraw-Hill, 5th Edition, New Delhi, 2010.
3	Ramamirtham,S., "*Fluid Mechanics and Hydraulics and Fluid Machines*", Dhanpat Rai and Sons, 9^{th} edi, 2014.
4	Som,S.K., and Biswas,G. ,"*Introduction to Fluid Mechanics and Fluid Machines*", Tata McGraw-Hill, 3^{rd} ed., New Delhi,2011.
E BOOKS	
1	https://books.google.co.in/books/about/Fluid_Mechanics.html?id=K5-rK6HUoo8C - Streeter, V.L.
2	https://books.google.co.in/books/about/Engineering_Fluid_Mechanics.html?id=qZaf 8XVAPGQC - K L Kumar
3	https://books.google.co.in/books?id=FzQz6A6SnyoC - R K Bansal
4	https://books.google.co.in/books/about/Fluid_Mechanics.html?id=egk8SQAACAAJ-White F M
5	https://books.google.co.in/books/about/INTRO_TO_FLUID_MECH_FLUID_ MACHINES.html?
MOOC	
1	https://www.mooc-list.com/course/introduction-%C3%A0-la-m%C3%A9canique-des-fluides-
2	http://nptel.ac.in/courses/112105182/
3	http://nptel.ac.in/courses/112105183/
4	http://nptel.ac.in/courses/112105171/1
5	http://nptel.ac.in/courses/112104117/
6	https://swayam.gov.in/

COURSE TITLE	MANUFACTURING TECHNOLOGY - II			CREDITS	3
COURSE CODE	MEB4203	COURSE CATEGORY	PC	L-T-P-S	3 0 0 1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL - 4 (Analysis)				

CO	COURSE OUTCOMES	PO
1	Conceptual understanding of metal cutting processes involved in the manufacture of parts. Able to estimate the cutting forces, tool life in orthogonal metal cutting. Able to establish the relationship between cutting conditions and surface finish.	1,12
2	Understanding of constructional and operational features of different lathes. Able to devise the turning operations using conventional and special purpose Lathes	1,9,12
3	Understanding of constructional and operational features of shaping, planning, milling and boring machines. Able to devise the plain surface machining using reciprocating & milling machines.	1,2,5
4	Understanding of constructional and operational features of different grinding and gear cutting machines. Able to devise the grinding and gear cutting operations for different jobs.	1,2,5
5	Control of Machine tools using Numerical control. Understanding of part-programming and process plan of components using Computerized Numerical Control (CNC) for complex parts.	1,2,6

Prerequisites : Manufacturing Technology-I

MODULE 1: THEORY OF METAL CUTTING **08**

Introduction to material removal processes - theory of metal cutting: chip formation, orthogonal metal cutting, cutting tool materials, tool wear, tool life, surface finish, cutting fluids - Types of machine tools

Suggested Reading: *Coolants and its influence on metal cutting, type of coolants and their properties*

MODULE 2: CENTRE LATHE AND SPECIAL PURPOSE LATHES **10**

Centre lathe, constructional features, cutting tools, various operations, taper turning methods, thread cutting methods, special attachments, machining time and power estimation.

Capstan and turret lathes - automatic lathes: semi-automatic, automats - single spindle: cutting off, Swiss type, automatic screw type - multi spindle; cutting off, bar type.

Suggested Reading: *Tool layout and cam design for automats*

MODULE 3: MILLING, RECIPROCATING & HOLE MAKING MACHINES **10**

Milling: types, milling cutters, operations - Reciprocating machine tools: shaper, planer, slotter - Hole making machine tools: drilling, reaming, boring, tapping.

Suggested Reading: *Jig boring machine, Deep hole drilling machine*

MODULE 4: ABRASIVE GRINDING, BROACHING AND GEAR CUTTING	10
Abrasive processes: grinding wheel - specifications and selection, types of grinding process- cylindrical grinding, surface grinding, centerless grinding - honing, lapping, super finishing, polishing and buffing, abrasive jet grinding Sawing machine: hack saw, band saw, circular saw; broaching machines: broach construction push, pull, surface and continuous broaching machines, gear cutting: forming, generation, shaping, hobbing. ***Suggested Reading:*** *Thread grinding, thread milling and thread rolling – process-wise merits and limitations*	
MODULE 5: CNC MACHINE TOOLS AND PART PROGRAMMING	**07**
Numerical control (NC) machine tools - CNC: types, constructional details, special features. Part programming fundamentals - manual programming - computer assisted part programming- APT language. ***Suggested Reading:*** *Drives, Feedback devices, Interpolator systems, Control loop circuit elements in point to point (PTP) and contouring system, Interpolation schemes for linear and circular interpolations.*	

TEXT BOOKS	
1	Rao, P. N. *Manufacturing Technology: Metal Cutting and Machine Tools*, Tata McGraw-Hill, New Delhi, 2013.
2	Hajra Choudhary, S. K, *Elements of Work Shop Technology - Vol. II,* Media Promoters & Publishers Pvt. Ltd., Mumbai, 2010.
3	Rajput R.K, *A Text Book of Manufacturing Technology*, Lakshmi Publications, II Edition, 2016.
4	Sharma P.C, *A Text Book of Production Engineering*, S. Chand and Co. Ltd, 2010.
REFERENCE BOOKS	
1	HMT, *Production Technology*, Tata McGraw-Hill, 2017.
2	Richerd R. Kibbe, John E. Neely, Roland O. Merges and Warren J. White, *Machine Tool Practices*, Prentice Hall of India, 10th Edition, 2014.
3	Milton C.Shaw, *Metal Cutting Principles*, Oxford University Press, Second Edition, 2012.
4	Roy. A. Lindberg, *Process and Materials of Manufacture,* Fourth Edition, PHI/Pearson Education 2015.
E BOOKS	
1	https://books.google.co.in/books?id=9Lyoo2qKTHwC&pg=PP12&lpg=PP12&dq – *Manufacturing Technology: Metal Cutting and Machine Tools by P.N.Rao*
2	https://books.google.co.in/books/about/Manufacturing_Technology_II.html?id=4-I0IoGxJrAC *By Dr. R.Kesavan, B. Vijaya Ramanath*
3	http://www.faadooengineers.com/threads/38937-want-pdf-of-Manufacturing-Technology-by-R-K-Rajput-Laxmi-Publication
4	http://www.e-booksdirectory.com/details.php?ebook=5689 - Manufacturing Processes and Materials: Exercises by Miltiadis A. Boboulos
5	http://www.erforum.net/2015/11/manufacturing-technology-by-p-n-rao.html
MOOC	
1	https://www.mooc-list.com/tags/manufacturing
2	https://www.openlearning.com/courses/manufacturing-technology-course-mooc
3	https://www.mooc-list.com/course/fundamentals-manufacturing-processes-edx

COURSE TITLE	FLUID MECHANICS AND MACHINERY LABORATORY			CREDITS	1
COURSE CODE	MEB4231	COURSE CATEGORY	PC	L-T-P-S	0-0-2-1
CIA	80%			ESE	20%
LEARNING LEVEL	BTL - 4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	calibrate venturimeter, orifice meter and pitot tube.	1,2,4,5,9,12
2	calculate the head loss due to friction in the pipe for pumping power requirement.	1,2,4,5,9,12
3	Conduct experiment to measure the friction factor of the given pipe to calculate the hydraulic resistance	1,2,4,5,9,12
4	Student can able to identify the type of turbine with known specific speed	1,2,4,5,9,12
5	conduct experiment to measure the performance of the various centrifugal pump and positive displacement pump	1,2,4,5,9,12

	List of Experiments (Any 10 Experiments)
1	D etermination of the Coefficient of discharge of given Orifice meter
2	Determination of the Coefficient of discharge of given Venturi meter.
3	Calculation of the rate of flow using Rota meter.
4	Determination of friction factor for a given set of pipes.
5	Conducting experiments to find the laminar to turbulent transition for a flow in a pipe.
6	Performing a n experiment and drawing the characteristic curves of submergible pump
7	Conducting an experiment and drawing the characteristic curves of centrifugal pump
8	Conducting an experiment and drawing the characteristic curves of reciprocating pump.
9	Conducting an experiment and drawing the characteristic curves of Gear Oil pump.
10	Performing a n experiment and drawing the characteristic curves of Jet pump
11	Conducting an experiment and drawing the characteristic curves of Francis turbine.
12	Conducting anexperiment and drawing the characteristic curves of Kaplan turbine.
13	Performing a n experiment and drawing the characteristic curves of Turgo Impulse Wheel
14	Plot system curve and H-Q Characteristic curve for given piping system with pump for different speed using Matlab®

LIST OF EQUIPMENTS (For a batch of 30 students)			
1.	Orifice meter setup	8	Reciprocating pump setup
2.	Venturi meter setup	9	Gear oil pump setup
3.	Rotameter setup	10	Jet pump
4.	Reynolds Apparatus	11	Pelton wheel setup
5.	Pipe Flow analysis setup	12	Francis turbine setup
6.	submergible pump setup	13	Kaplan turbine setup
7.	Centrifugal pump	14	Turgo Impulse Wheel

COURSE TITLE	MANUFACTURING TECHNOLOGY LAB			CREDITS	1
COURSE CODE	MEB4232	COURSE CATEGORY	PC	L-T-P-S	0-0-2-1
CIA	80%			ESE	20%
LEARNING LEVEL	BTL – 4				

CO	COURSE OUTCOMES	PO
	Upon successful completion of this course the student should be able to	
1	Select the right tool, machining condition and relevant measurement	1,2,5, 12
2	Learn the Applications of mechanics of metal cutting	1,2,5, 12
3	Have knowledge on milling and drilling and grinding operations	1,2,5, 12
4	Know the methods and applications of various machining operations	1,2,5, 12
5	Understanding the CNC hardware and CNC Programming	1,2,5, 12

LIST OF EXERCISES	
1	Two or More Metal Cutting Experiments (Example: Shear Angle Measurement, Cutting Force
2	Measurement, Cutting Temperature Measurement, Tool Wear Measurement, Life Measurement etc.)
3	Measurement of tool life using Matlab©
4	One or More Exercises in Milling Machines (Example: Milling Polygon Surfaces, Gear milling, Keyway milling, Helical Groove milling etc.)
5	Two or More Exercises in Grinding / Abrasive machining (Example: Surface Grinding, Cylindrical Grinding, Centreless Grinding, Lapping, Honing etc.)
6	Two or More Exercises in Machining Components for Assembly of different fits. (Example: Machining using Lathes, Shapers, Drilling, Milling, Grinding Machines etc.)
7	One or More Exercises in Capstan or Turret Lathes
8	One or More Exercises in Gear Machining (Example: Gear Cutting, Gear Shaping, Gear Hobbing etc.)
9	One or More Exercises in CNC Machines (Example: CNC Programming, CNC Tooling, CNC Machining etc.)

MATLAB ASSIGNMENTS

1. Glass Tube Manufacturing Process
2. Compensator Design for a Set of Plant Models
3. Fault Diagnosis of Centrifugal Pumps using Steady State Experiments
4. Robust Tuning of Mass-Spring-Damper System
5. Modeling a Kanban Production System
6. Generalized Extreme Value Distribution
7. Test Real-Time Application

LIST OF EQUIPMENTS (For a batch of 30 students)

1.	Centre Lathes	5	Surface Grinding Machine
2.	Turret and Capstan Lathe	6	Tool Dynamometer
3.	Horizontal Milling Machine	7	Gear Hobbing Machine
4.	Vertical Milling Machine	8	CNC Lathe (Trainer or Industrial Type)

COURSE TITLE	DESIGN PROJECT I			CREDITS	1
COURSE CODE	MEB4233	COURSE CATEGORY	PC	L-T-P-S	0-0-2-0
CIA	80%			ESE	20%
LEARNING LEVEL	BTL - 6				

CO	COURSE OUTCOMES	PO
	Upon successful completion of this course the student should be able to	
1	design and fabricate a mini device/ machine/ equipment using the knowledge acquired in the previous semesters	1,2,3,5,8,9 ,10,11,12
2	Complete understanding of making a product is achieved for solving practical problem	1,2,5,12
3	Gain knowledge on preparing a technical drawing, technical report and technical presentation skill.	1, 2, 3, 5, 8, 9, 10,11,12

NOTE:

- The students in convenient groups of not more than 4 members have to take one small item for design and fabrication. Every project work shall have a guide who is the member of the faculty of the institution.
- The item chosen may be small machine elements (Example-screw jack, coupling, machine vice, cam and follower, governor etc), attachment to machine tools, tooling (jigs, fixtures etc), small gear box, automotive appliances, agricultural implements, simple heat exchangers, small pumps, hydraulic /pneumatic devices etc.
- The students are required to design and fabricate the chosen item and demonstrate its working apart from submitting the project report. The report should contain assembly drawing, parts drawings, process charts relating to fabrication.

ASSESSMENT (%)	
Continuous Assessment	**80**
Viva-voce	**20**
Total	**100**

SEMESTER IV

COURSE TITLE	PROBABILITY AND STATISTICS (Department of IT, Auto, Mechanical, Mechatronics, Civil)			CREDITS	4
COURSE CODE	MAA4216	COURSE CATEGORY	PC	L-T-P-S	3-1-0-0
CIA	50%			ESE	50%
LEARNING LEVEL	BTL:1 – 4				

CO	COURSE OUTCOMES	PO
	Upon successful completion of this course the student should be	
1	Able to understand basic knowledge on Probability and one dimensional random variable	1,2,4,5,12
2	Able to understand discrete and continuous distributions	1,2,4,5,12
3	Able to understand two dimensional random variables	1,2,4,5,12
4	Able to understand the process flow of testing the Error	1,2,4,5,12
5	Able to obtain knowledge on design of experiments	1,2,4,5,12

Prerequisites : NIL

MODULE 1: PROBABILITY AND RANDOM VARIABLES (9L+3T)

Axioms of Probability- Bayes' Theorem -Random variables – Moments – Moment generating functions.

Suggested Reading: Basic Probability

MODULE 2: STANDARD DISTRIBUTIONS (9L+3T)

Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions

Suggested Reading: Discrete and Continuous Functions

MODULE 3: TWO-DIMENSIONAL RANDOM VARIABLES (9L+3T)

Joint distribution – Marginal and conditional distribution – Co-variance – Correlation and Regression

Suggested Reading: Random Variables

MODULE 4: TESTING OF HYPOTHESIS (9L+3T)

Sampling distributions – Testing of Hypothesis – Small samples – t Test, F Test and Chi-square Test – Large samples – Single mean – Difference in means – single proportion and difference in proportions.

Suggested Reading: Sampling Problems

MODULE 5: DESIGN OF EXPERIMENTS (9L+3T)

Analysis of variance – One Way Classification – Completely Randomized block design – Two Way Classification – Randomized block design – Latin Square design

Suggested Reading: Analysis of variance

LAB/MINI PROJECT/FIELD WORK	
Theory only	
TEXT BOOKS	
1	Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata McGraw Hill, 4th Edition, 2007.
2	Johnson. R.A. and Gupta. C.B., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 7th Edition, 2007
3	A. Chandrasekaran, G. Kavitha, "Probability, Statistics, Random Processes and Queuing Theory", Dhanam Publications, 2014
4	Raj Kumar Bansal,Ashok Kumar Goel, Manoj Kumar Sharma, "MATLAB© and its Applications in Engineering", Pearson Publication, Second Edition, 2016.
REFERENCE BOOKS	
1	Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum's Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition, 2004 .
2	Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2012.
3	Dean G. Duffy., "Advanced Engineering Mathematics with MATLAB©", CRC Press, Third Edition 2013.
E BOOKS	
1	http.// nptel.ac.in/courses/IIT-MADRAS/Principles_of_Communication1/Pdfs/1_5.pdf https://www.khanacademy.org
MOOC	
1	https://www.edx.org/course/introduction-probability-science-mitx-6-041x-2

COURSE TITLE	THERMAL ENGINEERING			CREDITS	3
COURSE CODE	MEB4216	COURSE CATEGORY	PC	L-T-P-S	3 0 0 2
CIA	50%			ESE	50%
LEARNING LEVEL	BTL – 4				

CO	COURSE OUTCOMES	PO
	At the end of the course the students will able to	
1	Demonstrate the understanding of various components of IC engines and Hybrid vehicles	1,2,3,4,5,6,7,9, 12
2	Analyse different types of steam nozzles and to assess the performance of steam turbines	1,2,3,4,5,6,7,9, 12
3	Identify, Relate, Analyse and Evaluate the performance of the gas power cycles	1,2,3,4,5,6,7,9, 12
4	Analyse the performance of single and multistage reciprocating compressors and to Demonstrate various types of rotary compressors	1,2,3,4,5,6,7,9, 12
5	Evaluate the performance of refrigeration systems (using different refrigerants), To do basic calculations of air conditioning using psychrometric chart and To describe absorption systems.	1,2,3,4,5,6,7,9, 12

Prerequisites : Engineering Thermodynamics

MODULE 1: CONVENTIONAL AND HYBRID VEHICLES **9**

Conventional vehicles: Classification - Components. Actual and theoretical p-V diagram. Ignition Systems, Diesel pump and injector system, MPFI, CRDI. - Knocking in SI and CI Engines. Lubrication and Cooling systems:

Hybrid Vehicles: Components, hybrid traction, hybrid drive-train topologies, Energy Storage: Battery storage, Fuel Cell, Super Capacitor and Flywheel based energy, Hybridization of different energy storage devices. Matching the electric machine and the internal combustion engine.

***Suggested Reading*:** Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV). Generation of Heat balance sheet for 4 stroke engines using Matlab©.

MODULE 2: GAS POWER CYCLES **9**

Carnot, Otto, Diesel, Dual cycles, difference between ideal and real cycles; Gas turbine cycles, methods of improving performance - inter-cooling, reheat and regenerative cycles.

***Suggested Reading*:** Simulation of Otto, Diesel and Dual cycles using Matlab©.

MODULE 3: STEAM NOZZLES AND STEAM TURBINES **9**

Convergent and convergent-divergent nozzles - Isentropic flow - Effect of Friction. General flow analysis. Critical pressure ratio and maximum mass flow.

General principle of Impulse and Reaction Turbines, Compounding of steam turbines - Stage efficiency, Overall efficiency and re-heat factor. Multi-Stage Turbines (descriptive treatment only)

Suggested Reading: visit to steam power station,

MODULE 4: AIR COMPRESSOR	9
Classification and working principle. Work of compression with and without clearance. Volumetric efficiency, Isothermal efficiency and isentropic efficiency of reciprocating air compressors. Multistage air compressors, Rotary compressors (Descriptive treatment only). ***Suggested Reading*:** Simulation of Air compressor using Matlab©.	
MODULE 5: REFRIGERATION AND AIR-CONDITIONING	**9**
Vapour Compression Refrigeration cycle – ideal and actual cycles, performance calculations. Working principle of vapour absorption system. (Description only). Summer and winter air conditioning systems – for dry and humid weather. Concept of RSHF, GSHF, ESHF using psychrometric chart. Cooling Load calculations. **Suggested Reading**: visit to mall or cold storage air conditioning, Simulation of VCR Cycle and cooling load calculations using Matlab©.	

TEXT BOOKS	
1	Rajput. R. K., "Thermal Engineering" S.Chand Publishers, 2010
2	Domkundwar. And Kothandaraman.C.P., "A course in thermal Engineering", Fifth Edition, "Dhanpat Rai & Co , 2016
REFERENCE BOOKS	
1	Sarkar, B.K,"Thermal Engineering" Tata McGraw-Hill Publishers, 2017
2	Domkundwar and Arora, "Refrigeration and Air Conditioning ," Dhanpat Rai & Co, 2014
3	Ganesan V.." Internal Combustion Engines" , Third Edition, Tata Mcgraw-Hill 2017
4	Rudramoorthy, R, "Thermal Engineering ",Tata McGraw-Hill, New Delhi, 2017
5	Mehrdad Ehsani and Yimin Gao, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, 2nd Edition, 2010.
6	Stephen J Chapman, Matlab programing for Engineers, Cengage publishers, 4th edition, 2012.
E BOOKS	
1	https://books.google.co.in/books?id=YLNGv0bVay0C&dq=thermal+engineering
2	https://books.google.co.in/books/about/Thermal_Engineering.html?id=65gxCX2dC84C
MOOC	
1	http://www.nptelvideos.com/mechanical/
2	http://nptel.ac.in/courses/112106133/

COURSE TITLE	STRENGTH OF MATERIALS			CREDITS	3
COURSE CODE	MEB4217	COURSE CATEGORY	PC	L-T-P-S	3 0 0 2
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	understand the basic principles of structural elasticity, including statically determinate and indeterminate systems, and the factors which affect their strength and stiffness.	1,2
2	demonstrate an understanding of the relationships between loads, member forces and deformations and material stresses and strains.	1,2,3
3	possess the contemporary analytical, experimental and computational tools needed to solve the engineering problems.	1,2,3,5
4	analyze and design structural members subjected to tension, compression, torsion, bending and combined stresses using the fundamental concepts of stress, strain and elastic behaviour of materials.	1,2,3,4
5	have acquired the independent judgment required to interpret the results of the engineering problems.	1,2,5,12

Prerequisites : Applied Mathematics

MODULE 1: STRESS, STRAIN AND DEFORMATION OF SOLIDS **9**

Rigid and Deformable bodies - Strength, Stiffness and Stability - Stresses; Tensile, Compressive and Shear - Deformation of simple and compound bars under axial load - Thermal stress - Elastic constants - Strain energy and unit strain energy - Strain energy in uniaxial load.

Suggested Reading: *Statically determinate – indeterminate, Stress on inclined planes under axial loading.*

MODULE 2: BEAMS - LOADS AND STRESSES **9**

Types of beams: Supports and Loads - Shear force and Bending Moment in beams - Cantilever, simply supported and Overhanging beams - Stresses in beams - Theory of simple bending - Stress variation along the length and in the beam section - Effect of shape of beam section on stress induced - Shear stresses in beams.

Suggested Reading: *Shear force – bending moment – continuous beam, bending of unsymmetrical beams - composite.*

MODULE 3: TORSION **9**

Analysis of torsion of circular bars - Shear stress distribution - Bars of Solid and hollow circular section - Stepped shaft - Twist and torsion stiffness - Compound shafts - Fixed and simply supported shafts - Application to close-coiled helical springs - Maximum shear stress in spring section including Wahl Factor - Deflection of Close-coil helical springs under axial loads - Design of helical coil springs - stresses in helical coil springs under torsion loads

Suggested Reading: *Torsion – rectangular shaft – thin walled shaft, strain energy due to torsion.*

MODULE 4: BEAM DEFLECTION	9
Elastic curve of Neutral axis of the beam under normal loads - Evaluation of beam deflection and slope: Double integration method, Macaulay Method, and Moment-area Method -Columns - End conditions - Equivalent length of a column - Euler equation - Slenderness ratio - Rankine formula for columns ***Suggested Reading**: Instability – failure mode - Necking – tensile member – plastic buckling – Study of a beam under loads in MATLAB©.*	
MODULE 5: ANALYSIS OF STRESSES IN TWO DIMENSIONS	**9**
Biaxial state of stresses - Thin cylindrical and spherical shells - Deformation in thin cylindrical and spherical shells - Biaxial stresses at a point - Stresses on inclined plane - Principal planes and stresses - Mohr's circle for biaxial stresses - Maximum shear stress - Strain energy in bending and torsion. ***Suggested Reading:** Mohr's circle – plane stress – plane strain - Fracture – ductile specimen – brittle specimen.*	

TEXT BOOKS	
1	Popov E.P, " *Mechanics of Materials* ", Pearson Education India; Second edition, 2015.
2	Beer F. P. and Johnston R, "*Mechanics of Materials*", McGraw-Hill Book Co, Seventh Edition, 2015.
3	Stephen Timoshenko, "*Theory of Elasticity*", McGraw Hill Education, Third edition, 2017.
REFERENCE BOOKS	
1	Nash W.A, "*Theory and problems in Strength of Materials*", Schaum Outline Series, McGrawHill Book Co, New York, 2013.
2	Bansal RK, "*A textbook of Strength of* materials" Laxmi Publications; Sixth edition, 2017.
3	Rattan SS, "*Strength of Materials*", McGraw Hill Education., Third Edition, 2017.
4	U. C. Jindal, "*Strength of Materials*", Pearson Education, Second edition, 2017.
5	Hibbeler,R.C, "*Mechanics of materials*" Pearson Education, 10th edition, 2016.
E BOOKS	
1	https://goo.gl/ArHdiY - Popov E.P
2	https://goo.gl/EgypX3 - Beer F. P. and Johnston R
3	https://goo.gl/VroJEj - R K Bansal
4	https://goo.gl/bqvlA8 - Rattan S S
MOOC	
1	https://goo.gl/lCHuKR
2	http://nptel.ac.in/courses/112107147/
3	http://nptel.ac.in/courses/112107146/
4	http://nptel.ac.in/courses/112101095/
5	http://nptel.ac.in/courses/112106141/
6	http://nptel.ac.in/courses/105105108/

COURSE TITLE	ENGINEERING METROLOGY AND MEASUREMENTS			CREDITS	3
COURSE CODE	MEB4218	COURSE CATEGORY	PC	L-T-P-S	3 0 0 2
CIA	50%			ESE	50%
LEARNING LEVEL	BTL- 3				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	students acquire knowledge on concepts of measurements	1,2,6
2	students acquire knowledge on linear and angular measurements techniques	1,2,5
3	students acquire knowledge on form measurements techniques	1,2,4
4	students acquire knowledge on uses of laser assisted metrology techniques	1,2,5,12
5	students acquire knowledge on techniques for measurements of physical quantities	1,2,5,12

Prerequisites : Engineering Physics

MODULE 1: CONCEPT OF MEASUREMENT **9**

General concept–Generalized measurement system-Units and standards-measuring instruments-sensitivity, readability, range of accuracy, precision-static and dynamic response- repeatability-systematic and random errors-correction, calibration, interchangeability.

Suggested Reading: *limits, fits, tolerances, Manufacturing cost and tolerances*

MODULE 2: LINEAR AND ANGULAR MEASUREMENT **9**

Definition of Metrology - Linear measuring instruments: Vernier, Micrometer, internal measurement, Slip gauges and classification, Interferometery, optical flats, limit gauges-Comparators: Mechanical, pneumatic and electrical types, applications. Angular measurements: Sine bar, optical bevel protractor, angle Deckkor – Taper measurements

Suggested Reading:*Statistical analysis of experimental data, Regression analysis*

MODULE 3: FORM MEASUREMENT **9**

Measurement of screw threads-Thread gauges, floating carriage micrometer-measurement of gear-tooth thickness-constant chord and base tangent method-Gleason gear testing machine – radius measurements-surface finish, straightness, flatness and roundness measurements.

Suggested Reading: *Quality standard principle, Design of experiments*

MODULE 4: LASERANDADVANCES IN METROLOGY **9**

Precision instruments based on laser-Principles- Laser Interferometer-application in linear, angular measurements and machine tool metrology Coordinate measuring machine (CMM)- Constructional features – types, applications – digital devices- computer aided inspection.

Suggested Reading: *Importance of nano dimension, Importance of nano metrology*

MODULE 5: MEASUREMENT OF POWER, FLOW AND TEMPERATURE RELATED PROPERTIES **9**

Force, Torque, Power - Mechanical, Pneumatic, Hydraulic and Electrical type. Flow measurement:- Venturi, Orifice, Rotometer, Pitottube. Temperature: Bimetallic strip, Thermometers, Thermocouples, Electrical resistance Thermister.

Suggested Reading: *Errors in temperature measurement, testing quality assurance sciences using Matlab©*	
TEXT BOOKS	
1	Richard S Figliola, Donald E Beasley, Theory and Design for Mechanical Measurements, 6th Edition, 2014, Wiley India
2	Anand Bewoor & Vinay Kulkarni, Metrology and Measurement, McGraw-Hill, 2017
3	R K Jain, Mechanical Measurement and Metrology, Khanna Publisher Mechanical, 2009
REFERENCE BOOKS	
1	Graham T.Smith Machine Tool Metrology: An Industrial Handbook 1st ed. 2016 Edition, Kindle Edition
2	Engineering Metrology and Measurement, N V Raghavendra and Krishnamurthy, Oxford University Press, 15 oct 2013
3	BeckwithT.G, and N. Lewis Buck, "Mechanical Measurements", Addison Wesley, 2009.
E BOOKS	
1	https://books.google.co.in/books?id=3sMeAQAAIAAJ- D. M. Anthony
2	https://books.google.co.in/books?isbn=0198085494- Raghavendra,, Krishnamurthy,
3	https://books.google.co.in/books?id=n2xRAAAAMAAJ. Kenneth John Hume
4	https://books.google.co.in/books?isbn=8185749825- R. K. Rajput
MOOC	
1	http://nptel.ac.in/courses/112106138/
2	http://nptel.ac.in/courses/112106179/
3	https://www.mooc-list.com/course/accounting-business-decision-making-measurement-and-operational-decisions-coursera
4	https://cosmolearning.org/courses/mechanical-measurements-and-metrology/
5	https://swayam.gov.in/courses/4523-mechanical-measurement-system

COURSE TITLE	PROFESSIONAL ETHICS AND LIFE SKILLS			CREDITS	2
COURSE CODE	GEA4216	COURSE CATEGORY	BS	L-T-P-S	2-0-0-1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL - 3				

CO	COURSE OUTCOMES	PO
1	An understanding of business ethics, levels, myths, use and train oneself to be ethical.	6,8,12
2	Knowledge on Ethical principles, reasoning, roles & responsibilities.	6,8,12
3	An understanding of stake holder theory, Individual and corporate responsibilities towards stake holders.	6,8,12
4	Understanding on Corporate responsibilities towards Product Safety & Reliability and environment friendly approach.	6,8,12
5	Understanding between the Employee & Corporate on responsibilities on aspects of contracts, equal opportunity , Affirmative action, sexual harassment etc.,	6,8,12

Prerequisites : An open mind to understand ethical practices

MODULE 1 - HUMAN VALUES (6L)

Definition of ethics-Morals values and ethics – integrity-Work ethics- Service learning-Civic virtue-Respect for others-Caring-Sharing-Honesty-Courage-Valuing time-Cooperation-Commitment-Empathy-Self-confidence-Character-Spirituality-Introduction to Yoga and meditation for professional excellence and stress management.

Suggested Reading: Case study of Discovery failure

MODULE 2 - ENGINEERING ETHICS (6L)

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.

Suggested Reading: Study the Bhopal gas tragedy

MODULE 3- SAFETY, RESPONSIBILITIES AND RIGHTS (6L)

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

Suggested Reading: Chernobyl explosion, Nuclear and thermal power plant issues

MODULE 4 - LIFE SKILLS (6L)

Definition, Relevance, Types of values, changing concepts of values-aims and values of value education- basic etiquette-morals and values in life-dealing with people. Personal values – Self – Strengths (self-confidence, self-assessment, self-reliance, self-discipline, determination, self-restraint, contentment, humility, sympathy and compassion, gratitude, forgiveness) Weaknesses

Suggested Reading: Influences - Peer pressure, familial and societal expectations, media

MODULE 5 - SOCIETIES IN PROGRESS (6L)	
Definition of society; Units of society; Communities – ancient and modern – Agents of change – Sense of survival, security, desire for comfort and ease sense of belonging, social consciousness and responsibility **Suggested Reading**: Personal value and professional value of Engineers on societies perception	
LAB / MINI PROJECT / FIELD WORK	
NA	
TEXT BOOKS	
1	Subramanian R., Professional ethics, Oxford University press
REFERENCE BOOKS	
1	Megan J. Murphy (Editor), Lorna Hecker (Editor), Ethics and Professional Issues in Couple and Family Therapy
2	Andrew Belsey (Editor), Ruth Chadwick (Editor), Ethical Issues in Journalism and the Media (Professional Ethics)
3	Warwick Fox (Editor), Ethics and the Built Environment (Professional Ethics)
4	RuchikaNath, Value Education, APH Publishing Corporation, New Delhi, 2012
5	Manoharan P.K., Education and Personality Development, APH Publishing Corporation, New Delhi, 2012
E BOOKS	
1	https://www.bkconnection.com/static/Business_Ethics_EXCERPT.pdf
2	https://bookboon.com/en/business-ethics-ebook
MOOC	
1	https://www.mooc-list.com/course/global-impact-business-ethics-coursera

COURSE TITLE	THERMAL ENGINEERING LAB -I			CREDITS	1
COURSE CODE	MEB4241	COURSE CATEGORY	PC	L-T-P-S	0 0 2 0
CIA	80%			ESE	20%
LEARNING LEVEL	BTL- 4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	evaluate the performance and efficiency of air blower	1,2,5,12
2	Calculate the cop of the refrigeration and A/C plant	1,2,5,12
3	Conduct experiment on reciprocating air compressor and refrigeration system	1,2,5,12
4	Study the performance of walk in cooler and cooling tower	1,2,5,12
5	conduct experimental analysis on solar flat plate collector and LPG refrigerator	1,2,5,12

LIST OF EXPERIMENTS	
1	Performance characteristics of a constant speed air blower.
2	Verification of fan laws and static efficiency of air blower.
3	C.O.P. of a Refrigeration plant.
4	Performance test on A/C plant.
5	Performance test on single/two stage reciprocating air compressor with Matlab© coding.
6	Capillary optimization for a Refrigeration System using Matlab© and Simulink©.
7	Performance analysis of Walk-in cooler
8	Performance test on a Cooling Tower
9	Performance analysis of a Solar Flat Plate Collector
10	Performance test on a LPG Refrigerator
11	Performance test on Vertical Axis wind turbine

MATLAB ASSIGNMENTS

1. Solving a Heat Transfer Problem With Temperature-Dependent Properties
2. Inhomogeneous Heat Equation on a Square Domain
3. Heat Conduction in a Spherical Multidomain Geometry with Nonuniform Heat Flux
4. Heat Distribution in a Circular Cylindrical Rod
5. Gain-Scheduled Control of a Chemical Reactor
6. Nonlinear State Estimation of a Degrading Battery System
7. Single Hydraulic Cylinder Simulation
8. Two Cylinder Model with Load Constraints

LIST OF EQUIPMENTS (For a batch of 30 students)

1.	Air Blower	7	Single/two stage reciprocating air compressor
2.	Cooling Tower	8	Vapour Compression Refrigeration test rig
3.	Solar Flat Plate Collector	9	Vapour compression Air Conditioning test rig
4.	Refrigeration unit with Capillary optimization	10	Axial-fan with vertical axis wind turbine
5	LPG Refrigerator		
6	Walk-in cooler		

COURSE TITLE	STRENGTH OF MATERIALS LABORATORY			CREDITS	1
COURSE CODE	MEB4242	COURSE CATEGORY	PC	L-T-P-S	0 0 2 0
CIA	80%			ESE	20%
LEARNING LEVEL	BTL- 4				

CO	COURSE OUTCOMES	PO
	Upon successful completion of this course the student should be able to	
1	Conduct experiments to find out different properties of metals and alloys	1,2,5,12
2	Compare the properties of metals before and after the heat treatment.	1,2,5,12
3	Conduct experiment to measure the deflection of a beam	1,2,5,12
4	Student can able to measure the strain using rosette strain gauge	1,2,5,12
5	Conduct experiments to calculate the strength of different components like springs beams etc	1,2,5,12

	LIST OF EXPERIMENTS
1	Tension test on a mild steel rod
2	Double shear test on Mild steel and Aluminium rods
3	Torsion test on mild steel rod
4	Impact test on metal specimen
5	Hardness test on metals - Brinell and Rockwell Hardness Number
6	Deflection test on beams
7	Compression test on helical springs
8	Strain Measurement using Rosette strain gauge
9	Effect of hardening- Improvement in hardness and impact resistance of steels.
10	Tempering- Improvement Mechanical Properties Comparison a. Unhardened specimen b. Quenched Specimen and c. Quenched and tempered specimen
11	Microscopic Examination of a. Hardened samples and b. Hardened and tempered samples. c. Deflection test on Beams in MATLAB©

MATLAB ASSIGNMENTS

1. Solving a Heat Transfer Problem With Temperature-Dependent Properties
2. Inhomogeneous Heat Equation on a Square Domain
3. Heat Conduction in a Spherical Multidomain Geometry with Nonuniform Heat Flux
4. Heat Distribution in a Circular Cylindrical Rod
5. Gain-Scheduled Control of a Chemical Reactor
6. Nonlinear State Estimation of a Degrading Battery System
7. Single Hydraulic Cylinder Simulation
8. Two Cylinder Model with Load Constraints

	LIST OF EQUIPMENTS (For a batch of 30 students)
1.	Universal Tensile Testing machine with double shear attachment-40Ton Capacity-1 No
2	Torsion Testing Machine (60 NM Capacity) - 1 No

3	Impact Testing Machine (300 J Capacity) - 1 No
4	Brinell Hardness Testing Machine - 1 No
5	Rockwell Hardness Testing Machine - 1 No
6	Spring Testing Machine for tensile and compressive loads (2500 N) - 1 No
7	Metallurgical Microscopes - 3 Nos
8	Muffle Furnace (800^0C) - 1 No
9	MATLAB© – 30 No

COURSE TITLE	**ENGINEERING METROLOGYAND MEASUREMENTS LABORATORY**			**CREDITS**	**1**
COURSE CODE	**MEB4243**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**0 0 2 0**
CIA	**80%**			**ESE**	**20%**
LEARNING LEVEL	**BTL- 4 (Analysis)**				

CO	**COURSE OUTCOMES**	**PO**
Upon successful completion of this course the student should be able to		
1	calibrate Vernier / Micrometer / Dial Gauge.	1,2,4,9,12
2	calculate the taper angle	1,2,4,9,12
3	calculate the pitch, thread angle using profile projector	1,2,5,9,12
4	calculate the force and torque	1,2,4,5,9,12
5	measurement of Displacement (Strain Gauge / LVDT/ Wheatstone Bridge)	1,2,4,9,12

LIST OF EXPERIMENTS	
1	Calibration of Vernier / Micrometer / Dial Gauge
2	Checking Dimensions of part using slip gauges
3	Measurement of Gear Tooth Dimensions
4	Measurement of Taper Angle using sine bar /Tool Makers microscope
5	Measurement of Straightness and flatness
6	Measurement of Thread parameters
7	Checking the limits of dimensional tolerances using comparators (Mechanical / Pneumatic / Electrical)
8	Measurement of Temperature using Thermocouple / Pyrometer
9	Measurement of Displacement (Strain Gauge / LVDT/ Wheatstone Bridge)
10	Measurement of Force
11	Measurement of Torque
12	Measurement of Vibration / Shock
13	Measurement of Coordinates for the given component using coordinate measuring machine

LIST OF EQUIPMENTS (For a batch of 30 students)	
1.	Micrometer - 5
2	Vernier Height Gauge - 2
3	Vernier Depth Gauge - 2
4	Slip Gauge Set - 1
5	Gear Tooth Vernier - 1
6	Sine Bar - 2
7	Bevel Protractor - 1
8	Floating Carriage Micrometer - 1
9	Profile Projector - 1
10	Mechanical / Electrical / Pneumatic
11	Comparator
12	Temperature Measuring Setup
13	Displacement Measuring Setup
14	Force Measuring Setup
15	Torque Measuring Setup
16	Vibration / Shock Measuring
17	Coordinate Measuring Machine
18	Autocollimator
19	Coordinate Measuring Machine
20	Tool makers Microscope
21	Dial gauge Calibration

COURSE TITLE	DESIGN PROJECT II			CREDITS	1
COURSE CODE	MEB4244	COURSE CATEGORY	PC	L-T-P-S	0 0 2 0
CIA	80%			ESE	20%
LEARNING LEVEL	BTL- 4				

CO	COURSE OUTCOMES	PO
	Upon successful completion of this course the student should be able to	
1	design and fabricate a mini device/ machine/ equipment using the knowledge acquired in the previous semesters	1,2,3,5,6,8, 9,10, 11,12
2	Complete understanding of making a product is achieved for solving practical problem	1,2,5,6,12
3	Gain knowledge on preparing a technical drawing, technical report and technical presentation skill.	1,2,3,5,6,8, 9,10, 11,12
	NOTE	
1	The students in convenient groups of not more than 4 members have to take one small item for design and fabrication. Every project work shall have a guide who is the member of the faculty of the institution.	
2	The item chosen may be small machine elements (Example-screw jack, coupling, machine vice, cam and follower, governor etc), attachment to machine tools, tooling (jigs, fixtures etc), small gear box, automotive appliances, agricultural implements, simple heat exchangers, small pumps, hydraulic /pneumatic devices etc.	
3	The students are required to design and fabricate the chosen item and demonstrate its working apart from submitting the project report. The report should contain assembly drawing, parts drawings, process charts relating to fabrication.	

- The item chosen may be small machine elements (Example-screw jack, coupling, machine vice, cam and follower, governor etc), attachment to machine tools, tooling (jigs, fixtures etc), small gear box, automotive appliances, agricultural implements, simple heat exchangers, small pumps, hydraulic /pneumatic devices etc.

	ASSESSMENT (%)
1	**Continuous Assessment - 80**
2	**Viva-voce - 20**
3	**Total - 100**

SEMESTER V

COURSE TITLE	OPTIMIZATION TECHNIQUES (Except CSE)			CREDITS	4
COURSE CODE	MAA4301	COURSE CATEGORY	PC	L-T-P-S	3-1-0-0
CIA	50 %			ESE	50 %
LEARNING LEVEL	BTL:1-4				

CO	COURSE OUTCOMES	PO
1	Able to understand the concept of optimization	1,2,4,5,12
2	Able to understand the linear programming problems	1,2,4,5,12
3	Able to understand the integer programming problems	1,2,4,5,12
4	Able to understand the assignment and transportation problems	1,2,4,5,12
5	Able to understand the designs of networks	1,2,4,5,12

Prerequisites : Nil

MODULE 1: INTRODUCTION TO OPTIMIZATION (9L+3T)

Introduction to operations research – objective – scope of OR – Limitations of OR – Introduction and formulation of linear programming – Solving LPP using Graphical method.

Suggested Reading: Basics of inequalities

MODULE 2: LINEAR PROGRAMMMING PROBLEM (9L+3T)

Solving LPP using simplex method – Big-M method – Two phase method – conversion of primal to dual.

Suggested Reading: System of equations

MODULE 3: INTEGER PROGRAMMING (9L+3T)

Integer programming – Cutting plane method – Gomory's Mixed integer method – Branch and Bound method

Suggested Reading: System of equations

MODULE 4: ASSIGNMENT AND TRANSPORTATION PROBLEM (9L+3T)

Hungarian Method – Maximization and unbalanced assignment problem – Basic feasible solution of transportation problem – Modi method – Degeneracy – Unbalanced Transportation problem.

Suggested Reading: Arithmetic Calculation

MODULE 5: PERT AND CPM (9L+3T)

Network diagram – Representation – Labeling – CPM – PERT probabilities of CPM – PERT probabilities of project duration.

Suggested Reading: Basics of graphs

TEXT BOOKS

1	Chandrasekaran A, "A Text book of Operation Research", Dhanam Publications, Chennai, 2017
2	V. Sundaresan, K. S. Ganapathy Subramanian, K. Ganesan, "Resource Management Techniques", A. R. Publications, 2004
3	S. D. Sharma, "Operation Research", Kedarnath Ramnath & Co, 2002

REFERENCE BOOKS	
1	Hamdy A. Taha, "Operations Research: An Introduction (9th Edition)", Prentice Hall, 2010
2	*D S Hira & Prem Kumar Gupta, "Introduction to Operations Research", S. Chand Publishing, 2012*
E BOOKS	
1	http://nptel.ac.in/courses/112106134/1
2	https://onlinecourses.nptel.ac.in/noc17_mg10/preview
MOOC	
1	https://www.edx.org/course/operations-management-iimbx-om101-1x

COURSE TITLE	DESIGN OF MACHINE ELEMENTS			CREDITS	3
COURSE CODE	MEB4301	COURSE CATEGORY	PC	L-T-P-S	3 0 0 2
CIA	50 %			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
1	Analyze and design power screws with respect to torque requirements, overhauling, and column buckling.	1.2.3,4,6,12
2	Analyze and design bolted connections with respect to static and dynamic axial loads.	1.2.3,4,6,12
3	Analyze and design bolted riveted, pinned, welded, brazed, soldered, and glued joints with respect to static and dynamic shear and bending loads.	1.2.3,4,6,12
4	Analyze and design full cylindrical hydrodynamic bearings using design charts and custom software.	1.2.3,4,6,12
5	Compute equivalent radial loads for rolling contact bearings and select appropriate bearings for the application using printed and electronic catalogue data.	1.2.3,4,6,12
6	Analyze and design spur gears with respect to tooth bending strength and surface strength specifications and apply three different theories to the design of shafts subject to combined static and dynamic loads.	1.2.3,4,6,12

Prerequisites : Engineering Physics

MODULE 1 INTRODUCTION TO THE DESIGN PROCESS 12

Factor influencing machine design, selection of materials based on mechanical properties - Direct, Bending and torsion stress equations - Impact and shock loading - calculation of principle stresses for various load combinations, eccentric loading - Design of curved beams - crane hook and 'C' frame Factor of safety - theories of failure - stress concentration - fatigue strength and the S-N diagram - Soderberg, Goodman and Gerber relations.

Self-Study: International standards for fits and tolerances

MODULE 2 DESIGN OF SHAFTS AND COUPLINGS	12
. Design of solid and hollow shafts based on strength, rigidity and critical speed - Design of keys and key ways - Design of rigid and flexible couplings - Introduction to gear and shock absorbing couplings - design of knuckle joints. *Self-study: study on cotter joints*	
MODULE 3: DESIGN OF FASTENERS AND WELDED JOINTS	**12**
Threaded fasteners - Design of bolted joints including eccentric loading - Design of welded joints for pressure vessels and structures - theory of bonded joints. Self-study: study of welding on dissimilar materials	
MODULE 4: DESIGN OF SPRINGS AND LEVERS	**12**
Design of helical, leaf, disc and torsion springs under constant loads and varying loads - Concentric torsion springs - Belleville springs - Design of Levers. Self-study: study of composite leaf spring	
MODULE 5: DESIGN OF BEARINGS AND FLYWHEELS	**12**
Design of bearings - sliding contact and rolling contact types. - Cubic mean load - Design of journal bearings - McKee's equation - Lubrication in journal bearings - calculation of bearing dimensions Design of flywheels involving stresses in rim and arm. Self-study: study on hydrodynamic gas bearing and its applications	

TEXT BOOKS	
1	Juvinall R. C., Marshek K.M., Fundamentals of Machine component Design - John Wiley & Sons Fifth Edition, 2012.
2	Bhandari, V.B., Design of Machine Elements, Tata McGraw-Hill Publishing Company Ltd., 2010.
REFERENCE BOOKS	
1	Norton R.L, Design of Machinery, McGraw-Hill Book co, 2004.
2	Orthwein W, Machine Component Design, Jaico Publishing Co, 2013.
3	Ugural A.C, Mechanical Design - An Integral Approach, McGraw-Hill Book Co, 2004.
E BOOKS	
1	https://books.google.co.in/books?isbn=1118987683
2	https://www.google.co.in/search?tbo=p&tbm=bks&q=isbn:1259083519
3	https://books.google.co.in/books?isbn=007742171X
4	https://books.google.co.in/books?isbn=8172247737
MOOC	
1	http://nptel.ac.in/courses/112106137/
2	http://nptel.ac.in/courses/112105125/
3	http://www.nptelvideos.in/2012/12/design-of-machine-elements.html

COURSE TITLE	MECHANICS OF MACHINES			CREDITS	3
COURSE CODE	MEB4302	COURSE CATEGORY	PC	L-T-P-S	3 0 0 1
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Apply the theory of mechanism, the concepts of mobility, degrees of freedom and inertia and analyze the velocity and accelerations in mechanisms.	1,2,4,6,7,9,10
2	Apply the concept of friction in machine components and mechanisms.	1,2,4,5,6,7,9,10,
3	Analyze the effect of speed and torque in gears.	1,2,4,6,7,9,10,
4	Evaluate the effect of gyroscope on Automobiles, ships and airplanes.	1,2,4,6,9,10
5	Distinguish the effect of Dynamics of undesirable free and damped vibrations.	1,2,4,5,6,7,9,10,

Prerequisites : Engineering Physics, Strength of Materials

MODULE 1: KINEMATICS OF LINKAGE MECHANISMS **9**

Kinematic link, pair and chain – Degrees of freedom - Inversions – Applications – Kinematic analysis of simple mechanisms – Determination of velocity and acceleration – Graphical method – Velocity and acceleration polygons.

Suggested Reading*: Computer applications in the kinematic analysis of simple mechanisms.*

MODULE 2: FRICTION **9**

Friction in screw and nut– Plate and disc clutches – Belt (flat and V) and rope drives. Ratio of tensions – Effect of centrifugal and initial tension – Condition for maximum power transmission – Open and crossed belt drive.

Suggested Reading*: Friction aspects in Brakes, Friction in vehicle propulsion and braking.*

MODULE 3: GEARING AND CAMS **9**

Toothed gearing – Nomenclature of spur and helical gears – Gear trains: Simple, compound gear trains and epicyclic gear trains - Determination of speed and torque - Cams – Types of cams – Design of profiles – Knife edged, flat faced and roller ended followers with and without offsets for various types of follower motions

Suggested Reading*: Helical, Bevel, Worm, Rack and Pinion gears (Basics only), Differentials*

MODULE 4: BALANCING AND GYROSCOPIC COUPLE **9**

Static and dynamic balancing – Single and several masses rotating in same and different planes – Gyroscopic forces and Torques - Gyroscopic stabilization - Gyroscopic effects in Automobiles, ships and airplanes.

Suggested Reading*: Balancing machines-Field balancing of discs and rotors.*

MODULE 5: SINGLE DEGREE FREE VIBRATION	9
Single degree of freedom - Free vibration - Equations of motion - natural frequency - Types of Damping - Damped vibration critical speeds of simple shaft – Torsional systems; Natural frequency of two and three rotor systems. ***Suggested Reading**: Vibration measurement and FFT Analysis using MATLAB©*	
TEXT BOOKS	
1	John J. Uicker. Jr, Gordon R. Pennock, and Joseph E. Shigley, "Theory of Machines and Mechanisms", 4th Edition, Oxford University Press, 2014.
2	Rattan, S.S, "Theory of Machines", 4th Edition, Tata McGraw-Hill, 2014.
3	Khurmi, R.S.,"Theory of Machines", 14th Edition, S Chand Publications, 2015.
REFERENCE BOOKS	
1	Thomas Bevan, "Theory of Machines", 3rd Edition, Pearson, 2009.
2	William L. Cleghorn,and Nikolai Dechev "Mechanisms of Machines", 2nd Edition, Oxford University Press,2014
3	Benson H. Tongue, "Principles of Vibrations", 2nd Edition, Oxford University Press, 2007
4	Robert L. Norton, "Kinematics and Dynamics of Machinery", 2nd Edition, McGraw-Hill Education - Europe, 2012.
5	Allen S. Hall Jr., "Kinematics and Linkage Design", Prentice Hall, 9th edition, 2014.
E BOOKS	
1	NPTEL Courhttps://books.google.com/books/about/Theory_of_Machines_3_e.html?id=yq0ucr...
2	The Theory of Machines: A Text-book for Engineering Students · Thomas Bevahttps://docs.google.com/file/d/0B5dLUIZfysmqMXBhakRyODhublU/edit
MOOC	
1	Thehttps://docs.google.com/file/d/0B5dLUIZfysmqMXBhakRyODhublU/editories of Machine - S.s.Rattan.pdf. Theories of Machine ...n Snippet view –

COURSE TITLE	GAS DYNAMICS AND JET PROPULSION			CREDITS	3
COURSE CODE	MEB4303	COURSE CATEGORY	PC	L-T-P-S	3 0 0 1
CIA	50 %			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES Upon completion of this course student should able to	PO
1	explain the basic fundamental concepts of compressible fluid flow, jet propulsion and rocket propulsion phenomena	1,2,12
2	understand the subsonic, sonic and supersonic flows through nozzles and diffusers for air, gases and vapour, isentropic flow through variable area with and without shock waves, flow in constant area ducts with friction and flow in constant area duct with heat transfer	1,2,3,4,7
3	apply the concepts to one-dimensional flow problems by making appropriate assumptions and by applying sensible boundary conditions	1,2,3,12
4	Apply the concepts to one dimensional isentropic and non-isentropic flow involving normal shocks.	1,2,5,12
5	Apply the concepts to one dimensional flow in constant area ducts with friction and with heat transfer	1,2,3,4,5,12
6	Student can able to do wider understanding of the compressible fluid flow problems and practical applications.	1,2,3,4,7,12

Prerequisites : Engineering Thermodynamics, Thermal Engineering

MODULE 1: COMPRESSIBLE FLOW - FUNDAMENTALS **9**

Energy and momentum equations for compressible fluid flows, various regimes of flows, reference velocities, stagnation state, velocity of sound, critical states, Mach number, critical Mach number, types of waves, Mach cone, Mach angle, effect of Mach number on compressibility

Suggested Reading*: Infinitesimal pressure waves (sound waves), Non-steep pressure waves with finite amplitude, Steep pressure waves (shock waves), and Expansion waves*.

MODULE 2: FLOW THROUGH VARIABLE AREA DUCTS **9**

Isentropic flow through variable area ducts, T-s and h-s diagrams for nozzle and diffuser flows, area ratio as a function of Mach number, mass flow rate through nozzles and diffusers, effect of friction in flow through nozzles.

Suggested Reading*: Comparison of isentropic and adiabatic processes for expansion and compression processes*

MODULE 3: FLOW THROUGH CONSTANT AREA DUCTS **9**

Flow in constant area ducts with friction (Fanno flow) - Fanno curves and Fanno flow equation, variation of flow properties, variation of Mach number with duct length.

Flow in constant area ducts with heat transfer (Rayleigh flow), Rayleigh line and Rayleigh flow equation, variation of flow properties, maximum heat transfer.

Isothermal flow with friction in constant area ducts

Suggested Reading*: Variation of flow properties for isothermal flow with friction*

MODULE 4: NORMAL SHOCK	9
Governing equations, variation of flow parameters like static pressure, static temperature, density, stagnation pressure and entropy across the normal shock, Prandtl - Meyer equation, impossibility of shock in subsonic flows, flow in convergent and divergent nozzle with shock, normal shock in Fanno and Rayleigh flows, flow with oblique shock (elementary treatment only) ***Suggested Reading**: Wind tunnel and Supersonic wind tunnel used for observing flow and shocks; Plot the variations of flow properties from entry to exit of a diffuser / nozzle undergoing normal shock waves using MATLAB©*	
MODULE 5: JET PROPULSION	**9**
Aircraft propulsion, types of jet engines, energy flow through jet engines, study of turbojet engine components-diffuser, compressor, combustion chamber, turbine and exhaust systems, performance of turbojet engines, thrust, thrust power, propulsive and overall efficiencies, thrust augmentation in turbojet engine, ram jet and pulse jet engines. Rocket propulsion, rocket engines thrust equation, effective jet velocity specific impulse, rocket engine performance, solid and liquid propellants, comparison of different propulsive systems ***Suggested Reading**: Air breathing engines, Emerging trends like Scramjet, Difference between turbojet engines, ramjet engines, pulsejet engines and scramjet engines.*	
TEXT BOOKS	
1	Ethirajan Rathakrishnan, Gas Dynamics, Sixth Edition, PHI Learing Private Limited, Delhi, 2017
2	Patrick H Oosthuizen, William E. Carscallen, Introduction to Compressible Fluid Flow, Second Edition, CRC Press, Taylor and Francis Group, 2014.
3	V. Babu, Fundamentals of Gas Dynamics, Second Edition, John Wiley and Sons Limited, UK, 2015.
4	Shih-I Pai, Introduction to the Theory of Compressible Flow, Literary Licensing, LLC, 2013
5	Forrest E Ames, An Introduction to Compressible Flow, Momentum Press, 2018.
6	S. M. Yahya, Fundamentals of Compressible Flow: With Aircraft and Rocket Propulsion, Fourth Edition, New Age Science, 2012
REFERENCE BOOKS	
1	Frank M White, Viscous Fluid Flow, Third Edition, Tata McGraw Hill Education Private Limited, New Dehli, 2011
2	H. Cohen, G.F.C. Rogers, Paul Straznicky, H.I.H. Saravanamuttoo, Andrew Nix, Gas Turbine Theory, Prentice Education Limited, 2017
3	Frank M White, Fluid Mechanics, Tata McGraw-Hill, 5th Edition, New Delhi, 2010.
4	I.G. Currie, Fundamental Mechanics of Fluids, Fourth Edition, CRC Press, Taylor and Francis Group, USA, 2013.
E BOOKS	
1	https://books.google.co.in/books?id=-zTOBQAAQBAJ&printsec=frontcover&dq= compressible +flow&hl=en& sa=X&ved=0ah UKEwiBsr GzrMrZAhUKtI 8KHUvbD YUQ6 AEIPz AI#v=onepage&q= compressible% 20flow&f=false Patrick H Oosthuizen, William E. Carscallen
2	https://books.google.co.in/books?id=GVjiDQAAQBAJ&printsec=frontcover &dq =Ethirajan +Rathakrishna n&hl=en&sa=X&ved=0ahUKEwjK9 qbhrcrZAhU HN48KHaGMB UIQ6AEIK jAE#v=onep age&q=Ethirajan%20 Rathakrishnan&f=false -- Ethirajan Rathakrishnan

3	https://books.google.co.in/books?id=nCeSQAAACAAJ&dq=compressible +flow+yahya&hl=en&sa=X&ved=0ahUKEwjZi9_crsrZAhUFpY8KHewV BHwQ6AEIHzAC --- S.M.Yahya
4	https://books.google.co.in/books?id=Op7mBQAAQBAJ&printsec=front cover&d q=yahya +fourth+e dition,+Fundamental+of+compressible+ flow&hl=en &sa=X&ved =0ahUKEwi B3JmxsMrZAhUFsY8KHQm MBTU4FBDoAQg1MAY#v=onepage&q&f=false --- V. Babu
5	https://books.google.co.in/books?id=hvEmDwAAQBAJ&dq=yahya+ fourth+edition ,+Fund am ental+of+compressible+flow&hl=en&sa= X&ved= 0ahUKEw i0ldeurs rZAhUdS 48KHd8TBU kQ6AEIPDAH ---- H. Cohen, G.F.C. Rogers, Paul Straznicky, H.I.H. Saravanamuttoo, Andrew Nix
6	https://books.google.co.in/books?id=vTlJnAEACAAJ&dq= Compressi ble+Flow&hl= en&sa =X&ved=0a hUKEwj__uTXssrZAhX EMY8KHZYEDTQ4FBDoAQgzMAY --- Shih-I Pai
MOOC	
1	http://nptel.ac.in/courses/112106056/
2	http://nptel.ac.in/courses/112103021/
3	http://nptel.ac.in/courses/112106166/
4	http://nptel.ac.in/courses/101106040/
5	http://nptel.ac.in/courses/101106044/
6	http://nptel.ac.in/courses/101101002/
7	http://nptel.ac.in/courses/101104019/
8	http://nptel.ac.in/courses/101103004/
9	http://scpd.stanford.edu/search/publicCourseSearchDetails.do? method=load&courseId=11396
10	https://www.mooc-list.com/course/hypersonics-shock-waves-scramjets-edx
11	https://www.my-mooc.com/en/mooc/hypersonics-shock-waves-scramjets-uqx-hypers301x-2/

COURSE TITLE	MECHATRONICS & PNEUMATICS			CREDITS	3
COURSE CODE	MEB4304	COURSE CATEGORY	PC	L-T-P-S	3 0 0 1
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Select an appropriate sensor for certain tasks	1,2,3,5,12
2	Know various actuation systems existing in industries. Design the Building blocks of Mechanical, Electrical, Fluid and Thermal Systems.	1,2,3,5
3	Control loops and various modes of control and designing of linear control systems	1,2,3,4,5,12
4	Understand and apply the concepts of PLC	1,2,5,12
5	Understand and apply the design process a Mechatronics system	1,2,3,4,5,9, 12

Prerequisites : Basic Electrical and Electronics Engineering

MODULE 1: MECHATRONICS, SENSORS AND TRANSDUCERS **9**

Introduction to Mechatronics Systems – Measurement Systems – Control Systems – Microprocessor based Controllers.

Sensors and Transducers–Performance Terminology–Sensors for Displacement, Position and Proximity; Velocity, Motion, Force, Fluid Pressure, Liquid Flow, Liquid Level, Temperature, Light Sensors – Selection of Sensors

Suggested Reading:*Detailed design and development of strain gauge, load cell and accelerometers*

MODULE 2: PNEUMATICS AND ACTUATION SYSTEMS **9**

Pneumatic Components: Air supply unit and distribution unit, Control valves, Linear and rotary actuators - applications - Speed control circuits, synchronizing circuit, Electro Pneumatic circuits, Pneumatic and Electro Pneumatic Sequential circuit design for simple applications using cascade method.

Electrical Actuation Systems – Mechanical Switches – Solid State Switches – Solenoids – D.C Motors – A.C Motors – Stepper Motors.

Suggested Reading: *Learning Pneumosim software and designing virtual pneumatic circuits using the software.*

MODULE 3: SYSTEM MODELS AND CONTROLLERS **9**

Building blocks of Mechanical, Electrical, Fluid and Thermal Systems, Rotational–Translational Systems, Electromechanical Systems – Hydraulic – Mechanical Systems.

Continuous and discrete process Controllers–Control Mode–Two–Step mode–Proportional Mode–Derivative Mode–Integral Mode–PID Controllers–Digital Controllers–Velocity Control–Adaptive Control – Digital Logic Control – Micro Processors Control.

Suggested Reading: *Learning Matlab© control toolbox and designing a PID controller for actuating robot arm.*

MODULE 4: PROGRAMMING LOGIC CONTROLLERS	9
Programmable Logic Controllers–Basic Structure–Input/Output Processing Programming–Mnemonics–Timers, Internal relays and counters–Shift Registers–Master and Jump Controls–Data Handling –Analogs Input / Output – Selection of a PLC Problem. ***Suggested Reading:*** *PLC for temperature control inside a room*	
MODULE 5: DESIGN OF MECHATRONICS SYSTEM	**9**
Stages in designing Mechatronics Systems–Traditional and Mechatronic Design-Possible Design Solutions, Fuzzy Logic control and artificial neural network in mechatronics – algorithms-man machine interface- case studies ***Suggested Reading:*** *Case study of household washing machine and refrigerator.*	
TEXT BOOKS	
1	W. Bolton, "Mechatronics", Pearson Education, 4th Edition, 2016.
2	Alciatore, David G., M. B. Histand, " Mechatronics and Measurement systems, 4th Edition, 2010
REFERENCE BOOKS	
1	S. K. Singh, R. Purohit, "Industrial Engineering, Robotics and Mechatronics", Made Easy Publications, 2016.
2	T. Thakur, " Mechatronics", Oxford University Press, 2016.
3	I. L. Krivits, G. V. Krejnin, "Pneumatic Actuating Systems for Automatic Equipment" Taylor and Francis, 2016.
4	W. Bolton, "Mechatronics: Electronic Control Systems for Mechanical and Electrical Engineering" Pearson Education. 4th Edition, 2010.
E BOOKS	
1	https://books.google.co.in/books?id=3h5Hb9l0xYC&printsec=frontcover&dq=mechatronics+in+action hl=en&sa=X&ved=0ahUKEwjRkoGBtNTZAhWBRo8KHQsHC x0Q6AEIJjAA#v=onepage&q=mechatron ics%20in%20action&f=false – D. Bradley, D. W. Russel
2	https://books.google.co.in/books?id=LAlkDAAAQBAJ&printsec=frontcover&dq= mechatronics+in+a tion&hl=en&sa=X&ved=0ahUKEwjRkoGBtNTZAhW BRo8K HQsHCx0Q6A EIKzAB #v=onepage&q=me chatronics%20in%20action&f=false - Peter Hehenberger
3	https://engineeringstudymaterial.net/ebook/essentials-of-mechatronics-by-john/ - John Billingsley
4	https://engineeringstudymaterial.net/ebook/mechatronics-introduction-by-robert/ - Robert H. Bishop
MOOC	
1	http://nptel.ac.in/courses/112105047/
2	http://nptel.ac.in/courses/112102011/
3	http://nptel.ac.in/courses/112102011/
4	http://nptel.ac.in/courses/112105046/

COURSE TITLE	DYNAMICS LAB			CREDITS	1
COURSE CODE	MEB4331	COURSE CATEGORY	PC	L-T-P-S	0 0 2 0
CIA	80%			ESE	20%
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	develop the concept of various measurement methods	1,2,3,5,7,10
2	know about the laws governing the dynamics of machines such as Balancing of Rotating and Reciprocating Mass	1,2,3,10
3	know about Jump phenomenon in Cams	1,2,3,7,10
4	know about sensitivity, effort in governors	1,2,3,5,7
5	know about different types of vibrations and its applications.	1,2,3,5,7,10

LIST OF EXPERIMENTS	
1	Governors - Determination of sensitivity, effort, etc. for Watt, Porter, Proell, Hartnell governors
2	Cam - Study of jump phenomenon and drawing profile of the cam.
3	Motorised Gyroscope-Verification of laws -Determination of gyroscopic couple.
4	Whirling of shaft-Determination of critical speed of shaft.
5	Balancing of reciprocating masses.
6	Balancing of rotating masses.
7	Determination of moment of inertia by oscillation method for connecting rod and flywheel.
8	Vibrating system - Spring mass system-Determination of damping co-efficient of single degree of freedom system.
9	Determination of influence co-efficients for multidegree freedom suspension system.
10	Determination of transmissibility ratio - vibrating table.
11	Determination of torsional frequencies for compound pendulum and flywheel system with Moment of inertia.
12	Transverse vibration -free- Beam. Determination of natural frequency and deflection of beam

MATLAB ASSIGNMENTS

1. System Dynamics Specifications
2. Vehicle Dynamics Visualization
3. Structural Dynamics of Tuning Fork
4. Dynamics of Damped Cantilever Beam
5. Modeling Objects with Identical Dynamics Using For Each Subsystem
6. Represent Nonlinear Dynamics Using MATLAB File for Grey-Box Estimation
7. Compensator Design for a Set of Plant Models
8. Control of a Two-Tank System

LIST OF EQUIPMENTS (For a batch of 30 students)	
1.	Cam analyzer.
2	Motorised gyroscope.
3	Governor apparatus - Watt, Porter, Proell and Hartnell governors.
4	Whirling of shaft apparatus.
5	Dynamic balancing machine.
6	Static and dynamic balancing machine.
7	Vibrating table
8	Vibration test facilities apparatus

COURSE TITLE	THERMAL ENGINEERING LAB-II			CREDITS	1
COURSE CODE	MEB4332	COURSE CATEGORY	PC	L-T-P-S	0 0 2 0
CIA	80%			ESE	20%
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Conduct experiments on fuels and lubricants and understand its properties.	1,2,5,12
2	Perform an experiment to analyze the heat balance of an IC engine and understand the significance of the performance, combustion and emission parameters.	1,2,5,12
3	Conduct an experiment to measure the friction power and indicated horse power in an engine	1,2,5,12
4	Student can able to identify the quality of steam based on the dryness fraction	1,2,5,12
5	Conduct experiment to plot the performance and energy balance of the steam generator and steam turbine	1,2,5,12

LIST OF EXPERIMENTS	
1	Conducting an experiment and drawing the valve timing diagram for a diesel engine
2	Conducting an experiment and drawing the port timing diagram for a gasoline engine
3	Conducting a performance test on 4-stroke diesel engine and plotting its performance characteristics curves.
4	Conducting heat balance test on 4-stroke diesel engine and plotting it on a pie chart.
5	Conducting a Morse test on multi-cylinder gasoline engine and estimating the indicated power of each engine.
6	Determination of frictional power of a diesel engine by conducting a retardation test on a slow speed diesel engine.
7	Determination of viscosity of the fuel by using Redwood Viscometer.
8	Determination of flash point and fire point of the fuel.

9	Emission analysis of exhaust of an IC engine using gas analyser
10	Combustion analysis of the diesel engine and plotting the pressure Vs crank angle at various load conditions
11	Determination of dryness fraction of the steam using calorimeter and estimating the quality of steam.
12	Conducting an experiment on performance and energy balance test on a steam generator
13	Conducting an experiment on performance and energy balance test on a steam turbine
14	Plot the performance characteristic curves for given a given fuel at various load conditions using Matlab®

LIST OF EQUIPMENTS (For a batch of 30 students)	
1.	Red Wood Viscometer
2	Apparatus for Flash and Fire Point
3	I.C Engine - 2 stroke and 4 stroke model
4	4-stroke diesel engine with mechanical Loading
5	4-stroke diesel engine with hydraulic Loading
6	4-stroke diesel engine with electrical Loading
7	Multi-cylinder gasoline engine
8	Single cylinder Petrol Engine
9	Combustion analysis setup for CI Engine
10	Emission gas analyser
11	Data Acquisition system with any one of the above engines
12	Steam Boiler with turbine and calorimeter setup

COURSE TITLE	MECHATRONICS AND PNEUMATICS LABORATORY			CREDITS	1
COURSE CODE	MEB4333	COURSE CATEGORY	PC	L-T-P-S	0 0 2 0
CIA	80%			ESE	20%
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	understand how to construct pneumatic circuits for different industrial applications	1,2,3,4,5,12
2	know how to operate electro pneumatic circuits	1,2,3,4,5,12
3	learn softwares and use them for real time problems	1,2,3,4,5,12
4	understand how a stepper motor can be controlled using PLC	1,2,5,12
5	know how to design virtual instruments to control temperature, fluid flow etc.	1,2,5,12

LIST OF EXPERIMENTS	
1	Design and testing of pneumatic circuits for different applications
2	Design of circuits with logic sequence using Electro pneumatic trainer kits.
3	Simulation of basic Hydraulic, Pneumatic and Electric circuits using software.
4	Circuits with multiple cylinder sequences in Electro pneumatic using PLC.
5	Servo controller interfacing for open loop
6	Servo controller interfacing for closed loop
7	Stepper motor interfacing with 8051 Micro controller (ii)full step resolution (ii) half step resolution
8	Modeling and analysis of basic electrical, hydraulic and pneumatic systems using LAB VIEW
9	Computerizeddataloggingsystemwithcontrolforprocessvariableslikepressureflowand temperature.

MATLAB ASSIGNMENTS

1. Pneumatic Motor Circuit
2. Pneumatic Actuation Circuit
3. Pneumatic Actuator with Humidity
4. Robust Control of an Active Suspension
5. Friction Modeling: MATLAB File Modeling of Static SISO System

LIST OF EQUIPMENTS (For a batch of 30 students)	
1.	Basic PneumaticTrainer Kit with manual and electrical
2	Basic PneumaticTrainer Kit with PLC control
3	HYDROSIM & PNEUMOSIM Software /Automation
4	8051 - Microcontroller kit with stepper motor and drive
5	LABVIEW software
6	LAB VIEW software with Sensors to measure Pressure,
7	Flow rate, direction, speed, velocity and force.

COURSE TITLE	DESIGN PROJECT III			CREDITS	1
COURSE CODE	MEB4334	COURSE CATEGORY	PC	L-T-P-S	0 0 2 0
CIA	80%			ESE	20%
LEARNING LEVEL	BTL-6				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	design and fabricate a mini device/ machine/ equipment using the knowledge acquired in the previous semesters	1,2,3,5,8,9, 10,11,12
2	complete understanding of making a product is achieved for solving practical problem	1,2,5,6,12
3	gain knowledge on preparing a technical drawing, technical report and technical presentation skill.	1,2,3,5,6,8, 9,10,11,12

	NOTE
1	The students in convenient groups of not more than 4 members have to take one small item for design and fabrication. Every project work shall have a guide who is the member of the faculty of the institution.
2	The item chosen may be small machine elements (Example-screw jack, coupling, machine vice, cam and follower, governor etc), attachment to machine tools, tooling (jigs, fixtures etc), small gear box, automotive appliances, agricultural implements, simple heat exchangers, small pumps, hydraulic /pneumatic devices etc.
3	The students are required to design and fabricate the chosen item and demonstrate its working apart from submitting the project report. The report should contain assembly drawing, parts drawings, process charts relating to fabrication.

	ASSESSMENT (%)
1	**Continuous Assessment - 80**
2	**Viva-voce - 20**
3	**Total - 100**

SEMESTER VI

COURSE TITLE	COMPUTER AIDED DESIGN & MANUFACTURING			CREDITS	3
COURSE CODE	MEB4316	COURSE CATEGORY	PC	L-T-P-S	3 0 0 2
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	understand the concept of computer graphics and CAD	1,2,3,5,12
2	understand the concept of numerical control and manufacturing	1,3,5,12
3	understand Graphic Standards and data exchange	1,2,3,5,12
4	can develop CNC programs	1,2,5,12
5	can implement of CAD and CAM on real time applications	1,2,3,4,5,12

Prerequisites : Engineering Graphics and Computer Aided Design, Manufacturing Technology II

MODULE 1: DESIGN AND GEOMETRIC MODELING **9**

Introduction to Design process - CAD. Geometric Modeling: Types - Wireframe, surface and solid modeling. Solid modeling techniques: CSG and B-rep - Operations: Boolean - Extrude - Sweep - Revolve. Mathematical Representation- Line - Circle -Ellipse - Parabola - Cubic Spline, Bezier and B-spline (Basic treatment only).

Suggested Reading: *NURBS Curve*

MODULE 2: CONCEPTS OF COMPUTER GRAPHICS **9**

Coordinate systems - Transformations: translation, scaling, reflection, rotation -Concatenated transformation - Inverse transformation. Clipping-Hidden line removal -Visibility Techniques-Algorithm-Shading - Enhancement- Colouring - color models- Rendering.

Suggested Reading: *Composite Transformation*

MODULE 3: SOFTWARE PACKAGES AND LATEST TECHNOLOGY **9**

Standards for computer graphics – Graphical Kernal System (GKS) – Open Graphics Library (OpenGL) - Brief outline of data exchange standards – GES, STEP, CALS etc – communication standards. Commercial solid modeling packages: Salient features - Technical comparison -Modules and tools.

Suggested Reading: Initial Graphics Exchange Specification (IGES)

MODULE 4: COMPUTER AIDED MANUFACTURING **9**

Introduction to computer aided manufacturing – Numerical Control – Computer Numerical Control machines - CNC programming – computer assisted part programming - manufacturing cell – flexible manufacturing system (FMS) – components FMS – layouts of FMS – introduction to Computer integrated manufacturing and CAM software.

Suggested Reading: *Group technology using FMS*

MODULE 5: IMPLEMENTATION OF CAD AND CAM	9
Implementation of CAD in - CAM - CIM - RPT, kinematic analysis, Manufacturability Analysis, simulation and Animation – Types – Techniques. ***Suggested Reading:*** *Mass property calculation*	
TEXT BOOKS	
1	Ibrahim Zeid, "CAD / CAM - Theory and Practice 2E", Tata Mcgraw-Hill, NewDelhi, 2010.
2	P. Radhakrishnan, S. Subramanyan, V. Raju "CAD/CAM/CIM", New Age International, 2015.
REFERENCE BOOKS	
1	Newman and Sproull R.F, "Principles of interactive computer graphics", TataMcgraw-Hill, New Delhi, 2004.
2	Donald Hearn and M. Pauline Baker "Computer Graphics", Prentice Hall, Inc., 2nd edition 2009.
3	Chriss Mcmahon and Jimmie Browne, "CAD/CAM", Addision Wesley, New York, 2000.
4	Mikell.P.Groover, "CAD/CAM: Computer-Aided Design and Manufacturing", Prentice hall of India Pvt. Ltd.,New Delhi.2008.
5	Kant vajpayee S, "Principles of computer integrated manufacturing", Prentice Hall, India, 2007.
6	Tien-chien chang, Richard A wysk, Hsu-pin wang, "Computer-Aided Manufacturing", Pearson Edition, 2009.
7	M.M.M. Sarcar, K. Mallikarjuna Rao, K. Lalit narayan "computer aided design and manufacturing", prentice hall of India, 2008.
8	R. J. M. Hague, P. E. Reeves, "Rapid Prototyping, Tooling and Manufacturing", Rapra Technology LTD, UK, 2000.
E BOOKS	
1	https://books.google.co.in/books?isbn=0070151342
2	https://books.google.co.in/books?id=AZhRAAAAMAAJ
3	https://books.google.co.in/books?isbn=8122412483
MOOC	
1	http://www.nptel.ac.in/courses/Webcourse-contents/IIT-Delhi/Computer%20Aided%20Design%20&%20ManufacturingI/index.htm

COURSE TITLE	DESIGN OF MECHANICAL TRANSMISSION SYSTEM			CREDITS	3
COURSE CODE	MEB4317	COURSE CATEGORY	PC	L-T-P-S	3 0 0 2
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	select the Belts, Pulleys, Wire ropes, Transmission Chains and Sprockets for different applications.	1,2,3,4,6,12
2	design Pulleys and Sprockets.	1,2,3,4,6,12
3	know about Gear Terminology and various types of Gears and its applications.	1,2,3,4,6,12
4	design Gear Boxes, Cam and Clutches.	1,2,3,4,6,12

Prerequisites : Design of Machine Element, Mechanics of Machines

MODULE 1: DESIGN OF TRANSMISSION SYSTEMS FOR FLEXIBLE ELEMENTS **9**

Selection of V belts and pulleys - selection of Flat belts and pulleys - Wire ropes and pulleys Selection of Transmission chains and Sprockets. Design of pulleys and sprockets.

Suggested Reading*: Timing belt drive*

MODULE 2: SPUR GEARS AND PARALLEL AXIS HELICAL GEARS **9**

Gear Terminology-Speed ratios and number of teeth-Force analysis -Tooth stresses - Dynamic effects - Fatigue strength - Factor of safety - Gear materials - Module and Face width-power rating calculations based on strength and Darabiling considerations - Parallel axis Helical Gears - Pressure angle in the normal and transverse plane- Equivalent number of teeth-forces and stresses. Estimating the size of the helical gears.

Suggested Reading*: Cross helical gear*

MODULE 3: BEVEL, WORM AND CROSS HELICAL GEARS **9**

Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears.

Worm Gear: Merits and demerits- terminology. Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair.

Crossed helical gear: Terminology - helix angles - Estimating the size of the pair of cross helical gears.

Suggested Reading: *Bevel gear in Differential unit*

MODULE :4 DESIGN OF GEAR BOXES **9**

Geometric progression - Standard step ratio - Ray diagram, kinematics layout -Design of sliding mesh gear box - Constant mesh gear box. - Design of multi speed gear box.

Suggested Reading*: Gear box with worm gears.*

MODULE :5 DESIGN OF CAM, CLUTCHES AND BRAKES **9**

Cam Design: Types-pressure angle and under cutting base circle determination-forces and surface contain stresses.

Design of plate clutches -axial clutches-cone clutches-internal expanding rim clutches-internal and external shoe brakes. ***Suggested Reading**:* Simulation of clutch mechanism using Matlab©-simulink	
TEXT BOOKS	
1	Juvinall R. C., Marshek K.M., Fundamentals of Machine component Design - John Wiley & Sons Fifth Edition, 2012.
2	Bhandari, V.B., Design of Machine Elements, Tata McGraw-Hill Publishing Company Ltd., 2010.
REFERENCE BOOKS	
1	Maitra G.M., Prasad L.V., Hand book of Mechanical Design, II Edition, Tata McGraw-Hill, 2009.
2	Shigley J.E and Mischke C. R., Mechanical Engineering Design, McGraw-Hill International Editions,New Delhi 2010.
3	Prabhu. T.J., Design of Transmission Elements, Mani Offset, Chennai, 2015.
4	Norton R.L, Design of Machinery, McGraw-Hill Book co, 2004.
5	Hamrock B.J., Jacobson B., Schmid S.R., Fundamentals of Machine Elements, McGraw-Hill Book Co., 2014.
6	Darle Dudley, Handbook of Practical Gear Design, CRC press, 2002.
E BOOKS	
1	https://books.google.co.in/books?isbn=1118987683
2	https://books.google.co.in/books?isbn=1259083519
3	https://books.google.co.in/books?isbn=0074602381
4	https://books.google.co.in/books?isbn=1482247488
MOOC	
1	https://onlinecourses.nptel.ac.in/noc18_me16/preview
2	http://nptel.ac.in/courses/112106137/
3	http://nptel.ac.in/courses/112105125/
4	http://www.nptelvideos.in/2012/12/design-of-machine-elements.html

COURSE TITLE	COMPOSITE AND SMART MATERIALS			CREDITS	3
COURSE CODE	MEB4318	COURSE CATEGORY	PC	L-T-P-S	3 0 0 2
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Classify different composite materials based on the composition and structure of the composite material	1,12
2	Choose from different manufacturing techniques for making of composites based on type of application	1,3,5,12
3	Evaluate composite elastic properties based on micro-mechanical behaviour	1,12
4	Analyze the composites for their mechanical properties based on macro-mechanical behaviour	1,3,5,12
5	Examine the composite for their failure mechanisms	1,3,5,12
6	Formulate A, B and D matrices of Composite laminates based on Kirchoff's hypothesis and propose different laminate types	1,2,5,12
7	List different metal matrix reinforcements and base materials along with their applications	1,12
8	Decide the manufacturing technique in the making of metal matrix composites	1,3,12

Prerequisites : Engineering Chemistry

MODULE 1: INTRODUCTION TO COMPOSITES **9**

Fundamentals of composites - need for composites - Enhancement of properties - classification of composites- Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) - Reinforcement - Particle reinforced composites, Fibre reinforced composites.

***Suggested Reading**: Applications of various types of composites*

MODULE 2: POLYMER MATRIX COMPOSITES **9**

Polymer matrix resins - Thermosetting resins, thermoplastic resins - Reinforcement fibres Rovings - Woven fabrics - Non woven random mats - various types of fibres. PMC processes - Hand lay up processes - Spray up processes - Compression moulding - Reinforced reaction injection moulding - Resin transfer moulding - Pultrusion - Filament winding - Injection moulding.

***Suggested Reading:** Fibre reinforced plastics (FRP), Glass fibre reinforced plastics (GFRP).*

MODULE 3: METAL MATRIX COMPOSITES **9**

Characteristics of MMC, Various types of Metal matrix composites Alloy vs. MMC, Advantages, Limitations, Metal Matrix, Reinforcements - particles - fibres. Effect of reinforcement - Volume fraction - Rule of mixtures. Processing of MMC - Powder metallurgy process - diffusion bonding - stir casting - squeeze casting.

***Suggested Reading:** Applications of MMC*

MODULE 4: CERAMIC MATRIX COMPOSITES	9
Engineering ceramic materials - properties - advantages - limitations - applications of Monolithic ceramics - Need for CMC - Ceramic matrix - Various types of Ceramic Matrix composites- oxide ceramics - non oxide ceramics - aluminium oxide - silicon nitride - reinforcements - particles- fibres- whiskers. Sintering, Hot pressing - Cold isostatic pressing (CIPing) - Hot isostatic pressing (HIPing). ***Suggested Reading:*** *Thermal analysis of ceramic matrix composites*	
MODULE 5: ADVANCES IN COMPOSITES	**9**
Carbon /carbon composites - Advantages of carbon matrix - limitations of carbon matrix Carbon fibre - chemical vapour deposition of carbon on carbon fibre perform. Sol gel technique. ***Suggested Reading:*** *Composites for aerospace applications.*	

TEXT BOOKS	
1	M. Balasubramanian, Composite Materials and Processing,CRC Press, New York,2013.
2	K. K. Chawla, Composite Science and Engineering, 3rd Edition, Springer Verlag,2012.
REFERENCE BOOKS	
1	Maitra G.M., Prasad L.V., Hand book of Mechanical Design, II Edition, Tata McGraw-Hill, 2009.
2	Shigley J.E and Mischke C. R., Mechanical Engineering Design, McGraw-Hill International Editions,New Delhi 2010.
3	Prabhu. T.J., Design of Transmission Elements, Mani Offset, Chennai, 2015.
4	Norton R.L, Design of Machinery, McGraw-Hill Book co, 2004.
5	Hamrock B.J., Jacobson B., Schmid S.R., Fundamentals of Machine Elements, McGraw-Hill Book Co., 2014.
6	Darle Dudley, Handbook of Practical Gear Design, CRC press, 2002.
E BOOKS	
1	https://books.google.co.in/books?isbn=1118987683
2	https://books.google.co.in/books?isbn=1259083519
3	https://books.google.co.in/books?isbn=0074602381
4	https://books.google.co.in/books?isbn=1482247488
MOOC	
1	https://onlinecourses.nptel.ac.in/noc18_me16/preview
2	http://nptel.ac.in/courses/112106137/
3	http://nptel.ac.in/courses/112105125/
4	http://www.nptelvideos.in/2012/12/design-of-machine-elements.html

COURSE TITLE	NANO TECHNOLOGY			CREDITS	3
COURSE CODE	MEB4319	COURSE CATEGORY	PC	L-T-P-S	3 0 0 2
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	understand the new concepts of Nano Science and Technology	1,3,12
2	knowledge on synthesis of Nano materials and their applications	1,3,5,12
3	understand the functions and properties of carbon Nano tubes	1,3
4	understand the various characterization techniques applicable for Nano materials	1,3,5,12
5	provide knowledge on social impact of Nano industry	1,6,7,8,11

Prerequisites : Engineering Materials

MODULE 1: INTRODUCTION TO NANOTECHNOLOGY **9**

Background, Basic concepts of Quantum wire-Quantum well-Quantum, nanotechnology and nano-machines - types, top down and bottom up techniques, Molecular nanotechnology, atomic manipulation-nanodots, self-assembly, Dip pen nanolithography, Applications of nanomaterials in various fields.

Suggested Reading: Analysis Nano- Sized Magnetic Materials Using MATLAB©

MODULE 2: NANOMATERIALS **9**

Preparation of Nanomaterials-Plasma arcing, Chemical Vapor Deposition, Sol-gels techniques, Electrodeposition, Ball Milling, Natural Nanomaterials. Optically useful nanostructured polymers, Photonic Crystals.

Suggested Reading: Application of MATLAB© for Nanocomposite System

MODULE 3: CARBON NANO TUBES **9**

Carbon tubes-types of nanotubes, formation of nanotubes, Assemblies, purification of Carbon nanotubes, Properties of nanotubes, applications of nanotubes, Core shell and hybrid nanocomposites

Suggested Reading: Application of MATLAB© for Molecular Dynamics Simulation Studies of Nano-Oscillators

MODULE :4 CHARACTERIZATION TECHNIQUES **9**

Simple details of characterization tools- SEM, TEM, AFM. X-ray diffraction – X-ray fluorescence spectroscopy – Thermogravimetric Analysis (TGA) – Differential Thermal Analysis (DTA) – Differential Scanning Calorimetry (DSC), Applications of diffraction techniques to nanomaterials; Grain size, phase formation, texture, stress analysis.

Suggested Reading: Application of MATLAB© in Adsorption of Ne Atoms on CNTs

MODULE 5: HEALTH IMPACT OF NANOMATERIALS **9**

Sources of Nanoparticles; Epidemiological Evidence; Entry Routes into the Human Body – Lung, Intestinal Tract, Skin; Nano particle Size - Surface and Body Distribution; Effect of Size and Surface

Charges; Nanoparticles, Thrombosis and Lung Inflammation, Nanoparticles and Cellular Uptake; Nanoparticles and the Blood-Brain Barrier. *Suggested Reading: Application of MATLAB© for Solvation Studies of CNTs or FCNTs*	
TEXT BOOKS	
1	T.Pradeep, "*A Text Book of Nanoscience and Nanotechnology*", Tata McGraw Hill, New Delhi, 2012.
2	C.P. Poole, and Owens F.J., "*Introduction to Nanotechnology"*, John Wiley, 2003.
3	G. Cao, Y. Wang, "*Nanostructures & Nanomaterials: Synthesis, Properties &Applications"*, 2nd Edition, Imperial College Press, 2011.
4	Challa S. S. R. Kumar, "*Nanomaterials - Toxicity, Health and Environmental Issues"*, Wiley-VCH publisher, 2006
REFERENCE BOOKS	
1	H.S. Nalwa, "*Encyclopedia of Nanoscience and Nanotechnology"*, American Scientific Publishers, 2004.
2	W.Gaddard, D.Brenner, S.Lysherski and G.J.Infrate(Eds.), "*Handbook of NanoScience, Engg. and Technology"*, CRC Press, 2012.
3	Michael J. O. Connell, "*Carbon Nanotubes: Properties and Applications*", CRC Press, 2006.
4	Sam Zhang, L. Li, A. Kumar, "*Materials Characterization Techniques*", CRC Press, 2009.
5	M. Zafar Nyamadzi, "*A Reference handbook of nanotoxicology"*, Dominant publisher, 2008.
E BOOKS	
1	https://books.google.co.in/books?id=TzdmAgAAQBAJ&lpg=PP1&dq=isbn%3A1259007324&pg=PP1#v= onepage&q&f=false
2	https://books.google.co.in/books?id=XfzgEoY9SNkC&lpg=PP1&dq=isbn%3A0471079359&pg=PP1#v=onep age&q&f=false
3	https://books.google.co.in/books?id=HRvNTjo4tZQC&lpg=PP1&dq=isbn%3A9814322504&pg=PP1#v=onepage&q&f=false
MOOC	
1	http://nptel.ac.in/courses/118102003/
2	http://nptel.ac.in/courses/118104008/
3	http://nptel.ac.in/courses/104103019/9
4	http://nptel.ac.in/courses/103103033/43

COURSE TITLE	BUSINESS ECONOMICS			CREDITS	2
COURSE CODE	GEA4304	COURSE CATEGORY	BS	L-T-P-S	2 0 0 2
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-2				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Demonstrate an understanding the introduction of economics	1,10,11,12
2	Demonstrating to know knowledge about cost analysis	5,10,11,12
3	Able to build knowledge about consumer's and producer's behavior	8,11,12
4	Enabling to know about budget	8,10,11,12
5	Educate about financial services	8,10,11,12

Prerequisites : Basic Economics

MODULE 1: INTRODUCTION TO ECONOMICS

Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics

MODULE 2: COST ANALYSIS

Types of Cost, Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis, Economies of Scale Cost Classification

MODULE 3: CONSUMER'S AND PRODUCER'S BEHAVIOUR

Consumer Behavior: Law of Diminishing Marginal utility – Equi marginal Utility – Consumer's Equilibrium - Indifference Curve – Production: Law of Variable Proportion – Laws of Returns to Scale – Producer's equilibrium – Economies of Scale Cost Classification

MODULE 4: BUDGET

Process of budgeting in India –classification of budgets trends – evaluation systems – types of deficits – fiscal policy – indicators –– taxation – centre, state and local – public debt and management.

MODULE 5: FINANCE

Basics of finance and financial environment – instruments of financial markets – financial intermediation – investment banking and brokerage services – securities – types of securities – market for securities – how and where traded – initial public offering (IPO) – secondary markets – trading on exchanges and trading with margins.

TEXT BOOKS

1	S. Shankaran, Business Economics, Margham Publications, 2012.
2	H.L. Ahuja, Business Economics – Micro & Macro, 2016, Sultan Chand & Sons, New Delhi – 55.

REFERENCE BOOKS

1	S.A.Ross, R.W.Westerfield, J.Jaffe and Roberts: Corporate Finance, McGraw-Hill.
2	Joseph E Stiglitz: Economics of the Public Sector.

E BOOKS

1	https://sites.google.com/site/readbookpdf7734/pdf-download-business-economics-by---mark-taylor-read-online
2	https://bookboon.com/en/economics-ebooks

COURSE TITLE	COMPUTER AIDED DESIGN AND MANUFACTURING LABORATORY			CREDITS	1
COURSE CODE	MEB4341	COURSE CATEGORY	PC	L-T-P-S	0 0 2 0
CIA	80%			ESE	20%
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Can prepare solid model and assemble any mechanical component using CAD software	1,3,5,12
2	Can develop CNC program for any component for real time machining using CAD/CAM software	1,2,5,12

	LIST OF EXPERIMENTS
	COMPUTER AIDED DESIGN (CAD) 30
1	**DRAWING STANDARDS** Code of practice for technical Drawing, BIS specifications–Welding symbols, riveted joints, keys, and fasteners–Reference to hand book for the selection of standard components like bolts, nuts, screws, keys etc.
2	**INTRODUCTIONTO GRAPHIC SOFTWARE FOR DESIGN** Drawing, Editing, Dimensioning, Plotting Commands, Layering concepts, Limits, Fits and Tolerances incorporated in design and drawing.
3	**PREPARATION OF SOLID MODELS AND ASSEMBLY** Screw Jack Tailstock of Lathe Stuffing box Piston and connecting rod Plummer block Machine vice Stop valve
4	**COMPUTER AIDED MANUFACTURING (CAM) 15** **1**. MANUALPART PROGRAMMING (Using G and M Codes) in CNC lathe 1.1 Part programming for Linear and Circular interpolation, Chamfering and Grooving 1.2 Part programming using standard canned cycles for Turning, Facing, Taper turning and Thread cutting 2. MANUALPART PROGRAMMING (using G and M codes) in CNC milling 2.1 Part programming for Linear and Circular interpolation and Contour motions. 2.2 Part programming involving canned cycles for Drilling, Peck drilling, and Boring. 3. SIMULATIONAND NC CODE GENERATION NC code generation using CAD/CAM software – Pos processing for standard CNC Controls like FANUC, Hiedenhain etc.

LIST OF EQUIPMENTS **(For a batch of 30 students)**	
Hardware	
1	Computer server

2	Computer nodes or systems (Intel i3 or higher with 2GB or higher RAM)networked to the server
3	Plotter
4	Laser Printer
5	Trainer CNC lathe
6	Trainer CNC milling
Software	
1	CAD/CAM Software (Pro –E or IDEAS or Unigraphics or CATIA or Solidworks)
2	CAM Software (CNC programming and tool path simulation for FANUC, Sinumeric and Heiden controller)

COURSE TITLE	**COMPOSITES AND SMART MATERIALS LAB**			**CREDITS**	**1**
COURSE CODE	**MEB4342**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**0 0 2 0**
CIA	**80%**			**ESE**	**20%**
LEARNING LEVEL	**BTL-3**				

CO	**COURSE OUTCOMES**	**PO**
Upon successful completion of this course the student should be able to		
1	develop the skills in synthesize composites	1,3,5,9,12
2	familiarize in the test requirements of the composites	1,5,11,12
3	develop an ability to conduct mechanical test and determine the properties of the composites	1,5,11,12
4	familiarize in use of codes and standards in materials processing and testing	1,5,11,12
LIST OF EXPERIMENTS		
1	Manufacturing of composites a. Hand Lay-up techniques b. Vaccum Bag Moulding c. Compression moulding	
2	Inspection of composites	
3	Estimation of resin / fiber fraction by Burn off method using muffle furnace	
4	Estimation of void content of reinforced composites.	
5	Tensile test of composite specimen as per the ASTM procedure.	
6	Compression test of composite specimen as per the ASTM procedure.	
7	Laminar shear strength of composite specimen as per the ASTM procedure.	
8	Flexural bend test of composite specimen as per the ASTM procedure.	
9	Determine the critical buckling loads for given specimen using Buckling Test.	
10	Determine the changes in dimensions of the graphite-reinforced polymer composite cube using MATLAB©.	

LIST OF EQUIPMENTS (For a batch of 30 students)	
1	Muffle Furnace
2	Hydraulic Press 50T
3	Vaccum bag moulding apparatus
4	Weighing Scale
5	Universal Testing Machine
6	Ultrasonicator
7	Band Saw
8	Flat Mould
9	Dead Weights

COURSE TITLE	DESIGN PROJECT - IV			CREDITS	1
COURSE CODE	MEB4343	COURSE CATEGORY	PC	L-T-P-S	0 0 2 0
CIA	80%			ESE	20%
LEARNING LEVEL	BTL-6				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Design and fabricate a mini device/ machine/ equipment using the knowledge acquired in the previous semesters	1,2,3,5,8,9,10,11,12
2	Complete understanding of making a product is achieved for solving practical problem	1,2,5,6,12
3	Gain knowledge on preparing a technical drawing, technical report and technical presentation skill.	1,2,3,5,6,8,9,10,11,12

NOTE	
1	The students in convenient groups of not more than 4 members have to take one small item for design and fabrication. Every project work shall have a guide who is the member of the faculty of the institution.
2	The item chosen may be small machine elements (Example-screw jack, coupling, machine vice, cam and follower, governor etc), attachment to machine tools, tooling (jigs, fixtures etc), small gear box, automotive appliances, agricultural implements, simple heat exchangers, small pumps, hydraulic /pneumatic devices etc.
3	The students are required to design and fabricate the chosen item and demonstrate its working apart from submitting the project report. The report should contain assembly drawing, parts drawings, process charts relating to fabrication.

ASSESSMENT (%)	
1	**Continuous Assessment - 80**
2	**Viva-voce - 20**
3	**Total - 100**

COURSE TITLE	COMPREHENSION			CREDITS	1
COURSE CODE	MEB4344	COURSE CATEGORY	PC	L-T-P-S	1 0 0 0
CIA	80%			ESE	20%
LEARNING LEVEL	BTL-6				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	ability to understand and comprehend any given problem related to mechanical engineering field to face competitive exam for Job, GATE, IES etc.	1,2,3,5,8,9,10,11,12
2	Appreciate all major subject required to clear written exam and to face interview.	1,2,5,6,12

	NOTE
1	A student will have to appear for a MCQ Test and Comprehensive Viva-Voce examination covering all the subjects before a board of examiners.

	ASSESSMENT (%)
1	**Continuous Assessment (MCQ) - 80**
2	**Final VIVA - 20**
3	**Total - 100**

SEMESTER VII

COURSE TITLE	HEAT AND MASS TRANSFER			CREDITS	3
COURSE CODE	MEB4401	COURSE CATEGORY	PC	L-T-P-S	3 0 0 2
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	explain the basic mechanisms of heat transfer and steady state and unsteady conduction in solids.	1,2,5
2	explain about the types of convection and correlations to solve problems on free and forced convection	1,2,5
3	study and solve problems on phase change heat transfer like boiling and condensation and to design a heat exchanger.	1,2,5,
4	explain the mode of heat transfer, radiation and to study about combined heat transfer with convection and radiation.	1,2,5
5	apply the principles of various modes of heat transfer in practical applications	1,2,5,
6	study about Mass transfer and how heat transfer and mass transfer are analogous.	1,2,5

Prerequisites : Engineering Thermodynamics, Thermal Engineering

MODULE 1: CONDUCTION **9**

Basic Concepts–Mechanism of Heat Transfer – Conduction ,Convection and Radiation– General Differential equation of Heat Conduction– Fourier Law of Conduction– Cartesian and Cylindrical Coordinates – One Dimensional Steady State Heat Conduction – Conduction through Plane Wall, Cylinders and Spherical systems – Composite Systems – Conduction with Internal Heat Generation– Extended Surfaces–Unsteady Heat Conduction–Lumped Analysis–Use of Heisler's Chart.

***Suggested Reading**: Numerical methods in conduction, Transient conduction in semi infinite solids, two dimensional conduction problems using MATLAB©, Transient conduction problems using MATLAB©.*

MODULE 2: CONVECTION **9**

Basic Concepts–Convective Heat Transfer Coefficients–Boundary Layer Concept–Types of Convection–Forced Convection–Dimensional Analysis– External Flow–Flow over Plates, Cylinders and Spheres–Internal Flow–Laminar and Turbulent Flow–Combined Laminar and Turbulent Heat Transfer – Flow over Bank of tubes–Free Convection–Dimensional Analysis–Flow over Vertical Plate, Horizontal Plate, Inclined Plate, Cylinders and Spheres

***Suggested Reading**: Transition and turbulence in Free convection, Combined Free and Forced Convection.*

MODULE 3: PHASE CHANGE HEAT TRANSFER & HEAT EXCHANGERS	9
Nusselt's theory of condensation-pool boiling,flow boiling,correlations in boiling and condensation. Types of Heat Exchangers–LMTD Method of heat Exchanger Analysis– Effectiveness– NTU method of Heat Exchanger Analysis–Overall Heat Transfer Coefficient– Fouling Factors. ***Suggested Reading***: Influence of the presence of non condensable gases in condensation, Pressure drop and pumping power in the design of heat exchanger,Compact heat exchangers	
MODULE 4: RADIATION	**9**
Basic Concepts, Laws of Radiation – Stefan Boltzman Law, Kirchoff Law – Black Body Radiation–Grey body radiation Shape Factor Algebra–Electrical Analogy–Radiation Shields –Introduction to Gas Radiation. ***Suggested Reading:*** *Coefficient of Radiant heat transfer and Radiation combined with convection, Radiation from vapours and flames.*	
MODULE 5: MASS TRANSFER	**9**
Basic Concepts–Diffusion Mass Transfer– Fick's Law of Diffusion–Steady state Molecular Diffusion– Convective Mass Transfer–Momentum, Heat and Mass Transfer Analogy–Convective Mass Transfer Correlations. ***Suggested Reading****: Simultaneous heat and mass transfer, Lewis relation.*	

TEXT BOOKS	
1	R.C. Sachdeva, "*Fundamentals of Heat and Mass Transfer*", New age International Publishers, Fifth edition, 2017.
2	R.K.Rajput, "*Heat and Mass Transfer*", S.Chand Publishers, Fifth Edition, 2012.
3	Dr.D.S.Kumar, "*Heat and Mass Transfer", S.K.Kataria & Sons, 2013.*
REFERENCE BOOKS	
1	J.P.Holman, "Heat Transfer", McGraw Hill Publishers, 10th edition, 2017.
2	Yunus A.Cengel, "*Heat and Mass Transfer – Fundamentals & Applications",* Fifth edition, 2017.
3	P.K.Nag, "*Heat and Mass Transfer", Mcgraw Hill Edition, 3 edition, 2011.*
4	Ozisik .M.N, "*HeatTransfer*", McGraw-Hill Book Co., 1994.
5	Incropera F.P, *"Principles of Heat and Mass Transfer",* Wiley India, 7 th edition,2016.
E BOOKS	
1	https://books.google.co.in/books?isbn=0070634513- J.P.Holman
2	https://books.google.co.in/books?isbn=0073398187- Yunus A.Cengel
3	https://books.google.co.in/books?isbn=0070702535- P.K.Nag
4	https://books.google.co.in/books?isbn=0070664609- Ozisik, M.N.
5	https://books.google.co.in/books?isbn=0470917865 – Incropera F.P.
MOOC	
1	https://www.mooc-list.com/course/heat-transfer-saylororg
2	http://nptel.ac.in/courses/112108149/
3	http://nptel.ac.in/courses/112101097/
4	http://nptel.ac.in/courses/112101002/
5	http://nptel.ac.in/courses/103103032/

COURSE TITLE	FINITE ELEMENT METHODS			CREDITS	3
COURSE CODE	MEB4402	COURSE CATEGORY	PC	L-T-P-S	3 0 0 2
CIA	50%			SEE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Explain the Mathematical Modeling of field problems in Engineering	1,2,5
2	Study the One Dimensional Second Order Equations	1,2,5
3	Apply Galarkin approach, Temperature effects stress strain relations, plane problems of elasticity and element equations	1,2,4,5,10,12
4	Apply axisymmetric formulation, Element stiffness matrix and force vector, Galarkin approach and Problems	1,2,5,12
5	Do numerical integration and application to plane stress problems, Matrix solution techniques Solutions Techniques to Dynamic problems, Introduction to Analysis Software	1,2,5,12

Prerequisites : Strength of Materials, Numerical Methods, Engineering Mechanics

MODULE 1: INTRODUCTION **9**

Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.

***Suggested Reading**:* Application to bar element, Application to the continuum.

MODULE 2: ONE DIMENSIONAL PROBLEMS **9**

One Dimensional Second Order Equations - Derivation of Shape functions and Stiffness matrices and force vectors- Galarkin approach - Assembly of stiffness matrix and load vector - Solution of problems from solid mechanics and heat transfer-Finite element equations - Longitudinal vibration frequencies and mode.

Suggested Reading: - Applications to plane trusses, Quadratic shape functions.

MODULE 3: TWO DIMENSIONAL CONTINUUM **9**

Introduction - Finite element modelling - Scalar valued problem - Poisson equation -Laplace equation - Triangular elements - Element stiffness matrix - Force vector - Galarkin approach - Temperature effects - stress strain relations – plane problems of elasticity – element equations – assembly – need for quadrature formulae – transformations to natural coordinates – Gaussian quadrature – example problems in plane stress, plane strain using MATLAB© and Abaqus.

Suggested Reading: Structural mechanics applications.

MODULE 4: AXISYMMETRIC CONTINUUM **9**

Axisymmetric formulation - Element stiffness matrix and force vector - Galarkin approach - Body forces and temperature effects - Stress calculations - Boundary conditions - Applications to cylinders under internal or external pressures - Rotating discs - Plate and shell elements.

Suggested Reading: Axisymmetric applications.

MODULE 5: ISOPARAMETRIC FORMULATION	9
Natural co-ordinate systems – Isoparametric elements with mat lab coding – Shape functions for iso parametric elements – One and two dimensions– Numerical integration and application to plane stress problems - Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software. ***Suggested Reading***: Application of four node quadrilateral.	
TEXT BOOKS	
1	C Krishnamoorthy, Finite Element Analysis: Theory and Programming, McGraw Hill Education; 2nd edition, 2017.
2	Anand V. Kulkarni, A PRIMER ON FINITE ELEMENT ANALYSIS, Laxmi Publications, First edition, 2017.
3	Daryl L. Logan, A First Course in the Finite Element Method CL Engineering; Oxford, 6th edition, 2016.
4	Nam-Ho Kim, Introduction to Nonlinear Finite Element Analysis, 4th Edition, Springer; 2015.
5	Reddy J.N., An Introduction to Finite Element Method, McGraw-Hill International Student Edition, 2010.
6	David V Hutton, Fundamentals of Finite Element Analysis, McGraw-Hill Int. Ed, 2005.
REFERENCE BOOKS	
1	Randy Shih, *Introduction to Finite Element Analysis Using SOLIDWORKS Simulation*, SDC Publications, 2016.
2	A.J DaviesRao S.S., *The Finite Element Method with An Introduction Partial Differential Equations* by Oxford, Second edition 2017.
3	Salome Meca, Syllignakis Stefanos, Petr Vosynek,, Finite Element Analysis, Aster Kindle Edition, Amazon Digital Services LLC, 2018.
4	Mary Kathryn Thompson, John Martin Thompson, Butterworth-Heinemann; *ANSYS and Matlab© Mechanical APDL for Finite Element Analysis* 1st Edition, Kindle Edition, 1 edition (2017).
E BOOKS	
1	https://books.google.co.in/books/about/Applied_Finite_Element_Analysis.html?id=wzZ7BkQgMnAC - G. Ramamurty
2	https://books.google.co.in/books/about/Finite_Element_Analysis.html?id=M0cK 4Tocx9MC - C. S. Krishnamoorthy
3	https://books.google.co.in/books/about/The_Finite_Element_Method_in_Engineering.html?id=nBgZqyepUGwC - S. S. Rao
4	https://books.google.co.in/books/about/Finite_Element_Analysis.html?id=CwO KP1a70Y4C - S. S. Bhavikatti
MOOC	
1	https://onlinecourses.nptel.ac.in/noc16_me02/preview
2	http://nptel.ac.in/courses/112104193/
3	http://nptel.ac.in/courses/112104193/4
4	https://onlinecourses.nptel.ac.in/noc16_me10/preview
5	http://nptel.ac.in/courses/112104116/3
6	http://nptel.ac.in/courses/112104205/

COURSE TITLE	ROBOTICS AND AUTOMATION			CREDITS	3
COURSE CODE	MEB4403	COURSE CATEGORY	PC	L-T-P-S	3 0 0 1
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	summarize the types, principles and applications of industrial robots	1,2,3
2	design the drive mechanism and power transmission method used in robot based on applications, Elaborate types of end effectors and grippers.	1,2,3
3	summarize and select sensors for industrial robots for sensing the environmental variables, related to various applications.	1,3,7
4	developing an application oriented robot by applying the concepts of kinematics and programming language.	1,2,5,12
5	selection of suitable robot configuration for a manufacturing environment.	1,3,7,12

Prerequisites : Basics Electrical and Electronics Engineering, Mechatronics and Pneumatics

MODULE 1: INTRODUCTION **9**

Definition of Robot, History of robotics, Robot Anatomy, Robot configurations: Polar, Cartesian, cylindrical and Jointed-arm configuration, Robot motions, Joints, Work volume, Applications of Robots – material handling and processing.

Suggested Reading: Recent developments in industrial robots

MODULE 2: DRIVE SYSTEMS AND END EFFECTORS **9**

Robot drive mechanisms – hydraulic, pneumatic and electric drives, power transmission methods, Construction of Manipulators, Classification of End effectors, grippers – mechanical, pneumatic, hydraulic, vacuum gripper, fingered grippers, internal and external gripper, selection of grippers and design considerations, simulate and visualize robot arm motion using Simscape multibody of Matlab©, Simulink® schematic of the speed reducer model.

Suggested Reading: Interfacing of drive system with a microcontroller

MODULE 3: ROBOT SENSORS AND MACHINE VISION SYSTEM **9**

Sensor characteristics, Position sensors, Displacement sensor, Velocity sensor, Acceleration sensors, Force and Pressure sensors, Torque sensors, Touch and tactile sensor, Proximity sensors, Machine Vision System - Introduction to Machine vision, sensing and digitizing function in Machine vision, Image processing and analysis, application of Vision systems in robotics, acquiring and logging sensor data using Simulink of Matlab© ***Suggested Reading:*** Building a robot that avoids obstacles

MODULE 4: ROBOT MOTION ANALYSIS AND ROBOT PROGRAMMING **9**

Translations, Rotations and Transformations - Forward and reverse transformation, homogeneous transformations – coordinate system transformations using Matlab© - Forward and inverse Kinematics Of three & four Degree of Freedom Robot Arm, Robot Arm dynamics, manipulator path control, manipulator algorithms using Matlab©

Robot programming and languages: Methods of programming, lead-through programming

methods, textual robot languages – motion commands, sensor commands, end effector commands, graphical simulation facilities, artificial intelligence – knowledge representation-algorithms for path planning ***Suggested Reading:*** Robotic arm manipulation (kinematics & control)	
MODULE 5: AUTOMATION	**9**
History of Automation, Reasons for automation, Automation systems, Types of automation – Fixed, Programmable and Flexible automation, Automation strategies, Automated Manufacturing Systems - Components, classification and overview of manufacturing Systems, Flexible Manufacturing Systems, Types of FMS, Robot cell, Robot process automation, ***Suggested Reading:***PLCused in an automation.	
TEXT BOOKS	
1	Mikell P. Groover, Mitchell Weiss, "Industrial Robotics, Technology, Programming and Applications ", McGraw Hill International Editions, 1st Edition, 2012
2	Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, "Robotic Engineering - An Integrated Approach", Prentice Hall India, 2012.
REFERENCE BOOKS	
1	Saeed B. Niku, “Introduction to Robotics: Analysis, Systems, Application” , Pearson education, 2011.
2	Deb S R, "Robotics Technology and Flexible Automation", Tata McGraw Hill, New Delhi, 2010
E BOOKS	
1	**http://www.robotics.org/**
2	**http://www.robotbooks.com/general-robotics-links.htm**
3	https://books.google.co.in/books?id=P1ljICxFA_AC&printsec=frontcover#v=onepage&q&f=false
MOOC	
1	https://www.mooc-list.com
2	http://nptel.ac.in/courses/112101098/

COURSE TITLE	ADDITIVE MANUFACTURING TECHNOLOGY			CREDITS	3
COURSE CODE	MEB4404	COURSE CATEGORY	PC	L-T-P-S	3 0 0 2
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Apply the principles of this manufacturing process to produce the product.	1,2,5
2	Identify the characteristics of those materials and tools that can be used for this process.	1,2,5
3	Handle the softwares applicable to the product.	1,2,4,5,10,12
4	Identify areas of applications for this process.	1,2,5,12
5	do research in medical and bio-additive manufacturing	1,2,5,12
6	Infer principles of working of additive manufacturing systems and controls	1,2,5,12

Prerequisites : Engineering Graphics and Computer aided design

MODULE 1: INTRODUCTION **9**

Overview –Need-Classification -Additive Manufacturing Technology in product development- Materials for Additive Manufacturing Technology – Tooling – Applications.

Suggested Reading*: 3D printing , 3D Scanning, parametric equation for line, triangle, circle and Plot using Matlab©,*

MODULE 2: CAD & REVERSE ENGINEERING **9**

Basic Concept – 3D Design- Digitization techniques – Model Reconstruction – Data Processing for Additive Manufacturing Technology: CAD model preparation- Design to STL format conversion – Part Orientation and support generation – Model Slicing –Tool path Generation

Suggested Reading*:* Software practice for Additive Manufacturing Technology: Flash Print/ Auto Maker.

MODULE 3: LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS **9**

Classification – Liquid based system – Stereolithography Apparatus (SLA)- Principle, process, advantages and applications - Solid based system –Fused Deposition Modeling - Principle, process, advantages and applications

Suggested Reading*: Laminated Object Manufacturing.*

MODULE 4: POWDER BASED ADDITIVE MANUFACTURING SYSTEMS **9**

Selective Laser Sintering – Principles of SLS process - Process, advantages and applications, Three Dimensional Printing - Principle, process, advantages and applications- Laser Engineered Net Shaping (LENS), Electron Beam Melting.

Suggested Reading*: Powder production technique, characterisation technique*

MODULE 5: MEDICAL AND BIO-ADDITIVE MANUFACTURING **9**

Customized implants and prosthesis: Design and production. Bio-Additive Manufacturing-

Computer Aided Tissue Engineering (CATE) – Case studies. ***Suggested Reading**: Application in* Medical, Biomedical, Dental, Bio-printing, Tissue & Organ Engineering and many others	
TEXT BOOKS	
1	Chua C.K., Leong K.F., and Lim C.S., 3D Printing and Additive Manufacturing: Principles and Applications: Fifth Edition of Rapid Prototyping, World Scientific Publisher, 2017
2	Gebhardt A., Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing, Hanser Publications, 1st edition, 2011.
REFERENCE BOOKS	
1	Ian Gibson, David Rosen, Brent Stucker., — Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing 2nd ed. Springer, 2015 Edition
2	Liou L.W. and Liou F.W., —Rapid Prototyping and Engineering applications : A tool box for prototype development‖, CRC Press, 2007.
3	Clifford T Smyth., — Functional Design for 3D Printing: Designing 3d printed things for everyday use - 3rd edition, Clifford Smyth, 2017
E BOOKS	
1	https://www.newcastlesys.com/the-essentials-of-lean-manufacturing-ebook
2	www.vebridge.com/contact-us/lean-manufacturing-ebook/
MOOC	
1	https://www.edx.org/course/lean-production-tumx-qpls3x

SEMESTER VII

COURSE TITLE	HEAT TRANSFER LAB			CREDITS	1
COURSE CODE	MEB4431	COURSE CATEGORY	PC	L-T-P-S	0 0 2 1
CIA	80%			ESE	20%
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Calculate the thermal conductivity of materials plane section under steady state	1,2,5,12
2	Calculate the thermal conductivity of insulation for a lagged pipe	1,2,5,12
3	Differentiate the conduction between plane wall and composite wall	1,2,5,12
4	Conduct experiment based on convection like free and forced convection	1,2,5,12
5	Conduct experiments to find radiation heat transfer from black and non black surfaces	1,2,5,12
6	Conduct experiments on heat exchangers like parallel and counter flow type, shell & tube type.	1,2,5,12

LIST OF EXPERIMENTS	
1	Thermal conductivity measurement by Guarded Plate Method
2	Thermal conductivity of pipe insulation using Lagged Pipe apparatus
3	Thermal conductivity measurement in composite wall apparatus
4	Natural convection heat transfer from a vertical cylinder
5	Forced convection inside a tube
6	Heat transfer from pin fin (both natural & free convection modes)
7	Determination of Stefan Boltzman's constant
8	Determination of emissivity of Grey surface
9	Effectiveness of Parallel/Counter flow heat exchanger
10	Determination of overall heat transfer coefficient and effectiveness of Shell & Tube heat exchanger.
11	Steady state conduction problem using MATLAB©.

MATLAB ASSIGNMENTS

1. Nonlinear Heat Transfer In a Thin Plate
2. Solving a Heat Transfer Problem With Temperature-Dependent Properties
3. Determining Heat Transfer and Mass Flow Rate in a Ramjet Combustion Chamber
4. Heat Conduction in a Spherical Multidomain Geometry with Nonuniform Heat Flux
5. Temperature Control in a Heat Exchanger

LIST OF EQUIPMENTS (For a batch of 30 students)	
1	Guarded Plate apparatus
2	Lagged pipe apparatus

3	Composite wall apparatus
4	Natural convection- vertical cylinder apparatus
5	Forced convection inside tube apparatus
6	Pin – fin apparatus
7	Stefan-Boltzman's apparatus
8	Emissivity measurement apparatus
9	Parallel and Counter flow heat exchanger apparatus
10	Shell and Tube heat exchanger apparatus

COURSE TITLE	**COMPUTER AIDED SIMULATION AND ANALYSIS LABORATORY (Common To Mech,Aero &Auto)**			**CREDITS**	**1**
COURSE CODE	**MEB4432**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**0 0 2 1**
CIA	**80%**			**ESE**	**20%**
LEARNING LEVEL	**BTL-4**				

CO	**COURSE OUTCOMES**	**PO**
Upon successful completion of this course the student should be able to		
1	determination of stress, nodal displacements and reactions of different bar and truss.	1,2,5,10,12
2	compute the shear force and bending moment diagram for the cantilever, simply supported and fixed beam with different load	1,2,5,10,12
3	modal analysis of cantilever, simply supported and fixed beam for free vibration	1,2,5,10,12
4	thermal analysis for the 2-D heat conduction and convection for the temperature distribution within the rectangular plate.	1,2,5,10,12

LIST OF EXPERIMENTS	
1	Stress analysis of bar of constant cross-section area.
2	Stress analysis of bars of tapered cross section area.
3	Stress analysis of stepped bar.
4	Stress analysis of composite stepped bar.
5	Stress analysis and nodal displacements of Two bar Truss
6	Stress analysis and nodal displacements of Four bar Truss
7	Stress analysis and nodal displacements of multiple bar Truss
8	Compute the shear force and bending moment diagram for the cantilever, simply supported and fixed beam with point load
9	Compute the shear force and bending moment diagram for the simply supported beam with Uniformly distributed load
10	Compute the shear force and bending moment diagram for the simply supported beam with

	Uniformly varying load
11	Modal analysis of cantilever, simply supported and fixed beam for free vibration.
12	Stress analysis of rectangular plate with hole subjected to axial load Stress analysis of rectangular plate with multiple hole subjected to axial load
13	Thermal analysis for the 2-D heat conduction for the temperature distribution within the rectangular plate.
14	Thermal analysis for the 2-D heat convection for the temperature distribution within the rectangular plate.
15	Develop a program to find the response of a multidegree-of-freedom system using modal analysis.
16	Develop a program to find the response of a multidegree-of-freedom system using modal analysis.
LIST OF EQUIPMENTS (For a batch of 30 students)	
HP Pro6200 – 30 systems	
1	Mother board : Intel i5
2	Processor: 3.1 GHz
3	RAM : 4 GB
4	HDD : 500 GB
5	Monitor : 18.5”LCD
6	Key board & Mouse: PS/2
ACER- 30 systems	
1	Mother board : Intel i3
2	Processor: 3.6 GHz
3	RAM : 4 GB
4	HDD : 500 GB
5	Monitor : 18.5”LCD
6	Key board & Mouse: PS/2

COURSE TITLE	ROBOTICS AND AUTOMATION LAB			CREDITS	1
COURSE CODE	MEB4433	COURSE CATEGORY	PC	L-T-P-S	0 0 2 1
CIA	80%			ESE	20%
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Know about different types of robots and their applications	1,2,5,12
2	Know about different types of kinematics and select a suitable robot for a specific application.	1,2,5,12
3	Know about sensors usage	1,2,5,12
4	Do basic programming in Robots	1,2,5,12
5	Know about Robot Vision	1,2,5,12

LIST OF EXPERIMENTS	
1	Study of different types of robots based on configuration and application.
2	Study of different type of links and joints used in robots
3	Study of components of robots with drive system and end effectors.
4	Simulate and Visualize Robot Arm Motion using Simscape - Matlab©
5	Programming of Industrial Robot for material handling application
6	Programming of industrial robot for processing application
7	Interfacing of conveyor with industrial robot and exercises related to robot – conveyor systems
8	Robot programming exercises for various applications (Point-to-point and continuous path programming)
9	Teaching to robot using teach pendant
10	Design a Pick and Place Robotics Application with MATLAB© and Simulink
11	Vision inspection and sorting
12	Simulation of welding, painting and de-burring
13	Developing robotic applications with robotics system toolbox of Matlab©,
14	Test robotics algorithms on a physical robot Using MATLAB© and Simulink

MATLAB ASSIGNMENTS

1. Path Following for a Differential Drive Robot
2. Robot Arm with Virtual Reality Scene
3. Mapping With Known Poses
4. Plan a Reaching Trajectory With Multiple Kinematic Constraints
5. Generate a Standalone ROS Node from Simulink®
6. Get Started with ROS
7. Connect to a ROS-enabled Robot from Simulink®
8. Feedback Control of a ROS-enabled Robot

LIST OF EQUIPMENTS (For a batch of 30 students)	
1	Any one type of robot configuration with at least five degree of freedom.
2	Robot programming software inclusive of computer system.
3	Models of different types of end effectors drive systems Links and Joints.
4	Models of different configuration robots
5	Vision system for sorting and inspection
6	Matlab© software R2017

COURSE TITLE	DESIGN PROJECT - V			CREDITS	1
COURSE CODE	MEB4434	COURSE CATEGORY	PC	L-T-P-S	0 0 2 0
CIA	80%			ESE	20%
LEARNING LEVEL	BTL-6				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Design and fabricate a mini device/ machine/ equipment using the knowledge acquired in the previous semesters	1,2,3,5,6,8, 9,10,11,12
2	Complete understanding of making a product is achieved for solving practical problem	1,2,4,5,6,12
3	Gain knowledge on preparing a technical drawing, technical report and technical presentation skill.	1,2,3,5,6,8, 9,10,11,12

NOTE	
1	The students in convenient groups of not more than 4 members have to take one small item for design and fabrication or Individual student can do Modeling and Simulation using software like Ansys, CFX, etc. Every project work shall have a guide who is the member of the faculty of the institution.
2	The item chosen may be small machine elements (Example-screw jack, coupling, machine vice, cam and follower, governor etc), attachment to machine tools, tooling (jigs, fixtures etc), small gear box, automotive appliances, agricultural implements, simple heat exchangers, small pumps, hydraulic /pneumatic devices etc. Numerical Analysis can also be done using commercially available software or developing own code.
3	The students are required to design and fabricate the chosen item and demonstrate its working apart from submitting the project report. The report should contain assembly drawing, parts drawings, process charts relating to fabrication, result analysis for numerical simulation..

ASSESSMENT (%)	
1	**Continuous Assessment - 80**
2	**Viva-voce - 20**
3	**Total - 100**

COURSE TITLE	INTERNSHIP			CREDITS	1
COURSE CODE	MEB4435	COURSE CATEGORY	PC	L-T-P-S	0 0 0 0
LEARNING LEVEL	BTL-6				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Industrial experience in design and fabricate of device/ machine/ equipment	1,2,3,5,6,8, 9,10,11,12
2	Complete understanding of making a product in the real industries is achieved	1,2,4,5,6,12
3	Gain knowledge on preparing a technical drawing, technical report and technical presentation skill.	1,2,3,5,6,8, 9,10,11,12

NOTE	
1	The students in convenient groups of not more than 4 members have to get internship in the industry during previous semester complete vacation.
2	The student should produce internship completion certificate along with the internship report during Viva-voce in front of the expert committee.

ASSESSMENT (%)	
1	**Report and Viva-voce - 100**

SEMESTER VIII

COURSE TITLE	PROJECT AND VIVA-VOCE			CREDITS	8
COURSE CODE	MEB4441	COURSE CATEGORY	PC	L-T-P-S	0 0 24 0
CIA	80%			ESE	20%
LEARNING LEVEL	BTL-6				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Design and fabricate a device/ machine/ equipment using the knowledge acquired in the previous semesters, Numerical Analysis of physical engineering problem.	1,2,3,4,5,8, 9,10,11,12
2	Numerical Analysis of physical engineering problem.	1,2,3,4,5
3	Complete understanding of making a product is achieved for solving practical problem	1,2,4,5,12
4	Gain knowledge on preparing a technical drawing, technical report and technical presentation skill.	1,2,3,5,8,9, 10,11,12

NOTE	
1	The students in convenient groups of not more than 4 members have to take one small item for design and fabrication or Individual student can do Modeling and Simulation using software like Ansys, CFX, etc. Every project work shall have a guide who is the member of the faculty of the institution.
2	The item chosen may be small machine elements (Example-screw jack, coupling, machine vice, cam and follower, governor etc), attachment to machine tools, tooling (jigs, fixtures etc), small gear box, automotive appliances, agricultural implements, simple heat exchangers, small pumps, hydraulic /pneumatic devices etc. Numerical Analysis can also be done using commercially available software or by developing own code.
3	The students are required to design and fabricate the chosen item and demonstrate its working apart from submitting the project report. The report should contain assembly drawing, parts drawings, process charts relating to fabrication, result analysis for numerical simulation..

ASSESSMENT (%)	
1	**Continuous Assessment - 80**
2	**Viva-voce - 20**
3	**Total - 100**

LIST OF DEPARTMENTAL ELECTIVES - SEMESTER III

COURSE TITLE	NON DESTRUCTIVE TESTING METHODS			CREDITS	3
COURSE CODE	MEC4251	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	know about NDT equipments and accessories	1,4,5
2	develop the NDT techniques in practical applications.	1,2,3,4,5,9
3	dompare and select various NDT techniques Based on applications	1,2,4,5,6,8,9,12

Prerequisites : Engineering Physics, Engineering Chemicstry

MODULE 1: NON DESTRUCTIVE TESTING: AN INTRODUCTION **9**

Scope of NDT, Introduction to various NDT methods Impact of NDT in disaster prevention, Comparison of Destructive and Non destructive tests, Visual Inspection, Optical aids used for Visual inspection and their applications, Applications of NDT- Inspection using ROBO NDT-A MATLAB© TOOLBOX approach Robots in NDT to speed up inspection

Suggested Reading:*International codes, and standards and their importance in NDT, Basic metallurgical processes and defects*

MODULE 2: LIQUID PENETRANT TESTING (PT) **9**

Physical principles, Procedure for Penetrant testing, Penetrant Testing materials Penetrant Testing Methods—Water washable, Post emulsifiable, Solvent removable methods Sensitivity, Advantages and Limitations, applications-

Report generation of the method using MATLAB© Report generator

Suggested Reading: *National and International Standards for Liquid Penetrant Flaw detection*

MODULE 3: EDDY CURRENT TESTING, ACOUSTIC EMISSION **9**

Principles and Instrumentation for ECT, Absolute- differential probes, Techniques of ECT-

High Sensitivity techniques,3D or phased array ECT, Sensitivity, Advantages and Limitations Applications of ECT

Principles of AET and instrumentation, Sensitivity, Advantages and Limitations of AET, Applications-Testing of metal pressure vessels, Fatigue crack detection in aerospace structures, using MATLAB©'s Image Acquisition Tool Box

Suggested Reading: *Advanced ECT methods and Standards for ECT*. Advanced AET and areas of opportunities for AE development, Standards for AET

MODULE 4: MAGNETIC PARTICLE TESTING **9**

Definitions and principles of MPT, Magnetizing techniques, Procedure used for testing a component, Equipment used for MPT, Sensitivity, Advantages and Limitations, Applications.

Suggested Reading: *Improvements in MPI, Selection of equipment for MPT,*

MODULE 5: ULTRASONIC TESTING	9
Principles of UT, Ultrasonic transducers, Inspection methods, Normal incident pulse-echo, through transmission testing, Angle-beam Pulse- Echo testing, Criteria or selection of Probes, Flaw sensitivity, Techniques for Normal Beam Inspection, law characterization Techniques, Ultrasonic law Detection Equipment, Modes of display, A Scan, B Scan and C Scan Immersion testing, Advantages and Limitations, Applications of UT - Use of Ultrasound field Simulation tool ULTRA SLIM-A MATLAB© TOOL BOX -	
Suggested Reading: *Mechanical Impedance Analysis Technique*	
TEXT BOOKS	
1	Baldev Raj,T.Jeya kumar, . M.Thavasimuthu, *Practical Non Destructive Testing,* Narosa Publishing housing, New Delhi Third edition, Reprint 2017
2	Peter J. Shull,:Non Destructive Evaluation: *Theory, Techniques and Applications,* Marcel Dekker, Inc.,New York, 2010
REFERENCE BOOKS	
1	Kraut krammer .J., Ultrasonic Testing of Materials, 2nd Edition, Springer Verlag Publication, NewYork, 2010 .
2	Peter J. Shull, Non Destructive Evaluation: Theory, Techniques and Applications Marcel Dekker, Inc, New York, 2010.
3	Schmmer Jr. L.W. Fundamentals of Ultrasonic Non destructive Evaluation, Springer Verlag Publication, New York, 2016
E BOOKS	
1	https://www.amazon.com/NonDestructiveTesting-//0471420298 PaulE.Mix
2	https://books.google.com/books/Practical Non Destructive Testing/html?id - Baldev Raj,T. Jaya kumar ,M.Thavasimuthu
3	https://www.worldscientific.com/worldscibooks/10,1142/6327 Ultrasonic and Advanced Methods for Non destructive Testing and Material characterization - C.H.Chen
4	https://www.crcpress.com/NondestructiveTesting/book/9781138075962 google - Langenberg, ReneMarklein, Klaus Meyer
MOOC	
1	https://www.class central.com/tag/non20% destructive20% testing
2	http:// online coursesnptel.ac.in/noc18mm04
3	http://nptel.ac.in/courses/114106035/35/
4	http://www.nde-ed.org/../Intro to NDT/Intro_to NDT ppt
5	http://nptel.ac.in/courses/113106070/

COURSE TITLE	REVERSE ENGINEERING			CREDITS	3
COURSE CODE	MEC4252	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	the students can able to understand need for and the various tools required for reverse engineering with exposure to the software needed for implementing reverse engineering.	1,2,6,7
2	the students can able to understand select the suitable tools and methodology for reverse engineering for any product	1,2,5
3	the students can able to understand important research challenges associated with Reverse engineering and its data processing tools.	1,2,5
4	the students can able to understand important integrating reverse engineering, reuse and specification tool environments to reverse engineering	1,2,5,12
5	the students can able to understand with various concepts in quality and reliability principles in the design of an engineering product or a service.	1,2,5,12

MODULE 1: INTRODUCTION 9 hours

Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modeling techniques: Wire frame, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation-Software for AM- Case studies.

Suggested Reading: *Scope and tasks of RE - Domain analysis- process of duplicating*

MODULE 2: TOOLS FOR REVERSE ENGINEERING 9hours

Functionality- dimensional- developing technical data - digitizing techniques - construction of surface model - solid-part material- characteristics evaluation -software and application prototyping - verification

Suggested Reading: *Stereolithography Apparatus, Fused deposition Modeling (FDM) Case studies*

MODULE 3: CONCEPTS OF REVERSE ENGINEERING 9hours

History of Reverse Engineering – Preserving and preparation for the four stage process – Evaluation and Verification- Technical Data Generation, Data Verification, Project Implementation

Suggested Reading: Selective Laser Sintering (SLS), Laser Engineered Net Shaping (LENS) *Case studies*

MODULE 4: DATA MANAGEMENT 9hours

Data reverse engineering – Three data Reverse engineering strategies – Definition – organization data issues - Software application – Finding reusable software components – Recycling real-time embedded software – Design experiments to evaluate a Reverse Engineering tool – Rule based

detection for reverse Engineering user interfaces – Reverse Engineering of assembly programs: A model based approach and its logical basics

Suggested Reading: *Liquid based and powder based 3DP systems, strength and weakness, Applications and case studies. Shape Deposition Manufacturing (SDM),*

MODULE 5: INTEGRATION OF REVERESE ENGINEERING 9hours

Cognitive approach to program understated – Integrating formal and structured methods in reverse engineering – Integrating reverse engineering, reuse and specification tool environments to reverse engineering -–coordinate measurement – feature capturing – surface and solid members

Suggested Reading: reverse engineering a simple neural network using MATLAB©

TEXT BOOKS

1	Kevin Otto & Kristin Wood, Product Design Techniques in Reverse Engineering and New Product Development, Pearson Education (LPE), 2011.
2	Reverse Engineering: Mechanisms, Structures, Systems & Materials 1st Edition by Robert W. Messler Jr. Dec 10, 2013

REFERENCE BOOKS

1	Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications : A tool box for prototype development", CRC Press, 2011.
2	Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", second edition, World Scientific Publishers, 2010.
3	Kathryn, A. Ingle, Reverse Engineering, McGraw-Hill

E BOOKS

1	https://books.google.co.in/books/about/Reverse_Engineering.html?id=1_KFldjML8wC &redir_esc=y- Vinesh Raja, Kiran J. Fernandes
2	https://books.google.co.in/books/about/Reverse_Engineering.html?id=sSkfgehm4y QC&redir_esc=y Linda M. Wills, Philip Newcomb
3	https://books.google.co.in/books?isbn=1439806314 - Wego Wang
4	https://books.google.co.in/books?isbn=1118079760 - Eldad Eilam

MOOC

1	Computer Aided Design and Manufacturing **('Mechanical Engineering' course from IIT Delhi) Video Lectures by** Prof. P.V. Madhusudan Rao, Prof. Anoop Chawla**. https://youtu.be/9dd3M2a4LKI**
2	https://ocw.mit.edu/courses/health-sciences-and-technology/hst-512-genomic-medicine-spring-2004/audio-lectures/lecture-19/
3	https://www.mooc-list.com/course/introduction-reverse-engineering-software-ost
4	https://mooc.live/reverse-engineering-and-exploit-development-online-course/

COURSE TITLE	MECHANICAL METALLURGY			CREDITS	3
COURSE CODE	MEC4253	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Understand the basics of dislocation in metals and the theory behind its formation.	1,2
2	Understand the types of fracture and the mechanisms behind the occurrence of fracture.	1,2,3
3	Recognize how alloying of metals are performed; to read on the phase diagrams and interpreting the property change due to alloying.	1,2,3,4,7,8,11, 12
4	Know about the working of the mechanical testing procedures such as tensile testing, hardness testing and torsion testing-overview on the general results obtained for metals-theory behind the failures; ASTM standards for conducting the tests.	1,2,3,4,10,12
5	Know about the working of the mechanical testing procedures such as Impact testing, fatigue testing and creep testing- overview on the general results obtained for metals-theory behind the failures; ASTM standards for conducting the tests.	1,2,3,4,10,12

Prerequisites : Engineering Physics, Engineering Chemistry

MODULE 1: PLASTIC DEFORMATION **9**

Dislocations-types, burgers vector, theoretical cohesive strength and practically measured strength, deformation by slip, critical resolved shear stress, deformation by twinning, stacking faults. Dislocation theory- dislocation loop, dislocations in cubic and hexagonal lattices, stress fields and energies of dislocations, dislocation climb, intersection of dislocations, dislocation multiplication, dislocation pile-ups. Strain hardening of single crystals.

Suggested Reading: Stress-Strain Curve, Plastic region vs Elastic region, Study on ductile and brittle materials, View dislocations under a microscope.

MODULE 2: FRACTURE **9**

Types of Fracture, Griffth's theory of brittle fracture, fractography, effect of temperature, stress raisers and strain rate on fracture behavior.

Fracture mechanics-stress intensity factor, fracture toughness, plane- strain toughness testing, crack opening displacement, probabilistic aspects of fracture mechanics.

Suggested Reading: Analyze the fractured samples and find the type of fracture, Reasons for generation of cracks in metals during loading

MODULE 3: ALLOYING THEORY AND PHASE DIAGRAMS **9**

Types of solid solutions and compounds - Hume-Rothery rules for formation of substitutional solid solutions-properties of solid solutions, Principles of solidification, Determination and uses of phase diagrams, Types of phase reactions with examples, Phase rule and its application to phase diagrams, lever rule, Detailed discussion of Fe-C equilibrium diagram, Concept of ternary phase diagrams.

Suggested Reading: Difference between solution and solid solution, saturation of salt in water

MODULE 4: MECHANICAL TESTING-I	9
Tension test- Engineering stress-strain curve and True stress-strain curve, Instability in tension, measurement of tensile properties, factors affecting flow properties, notch tensile test. Hardness test-Brinell hardness-relationship between hardness and flow curve, Vickers hardness, Rockwell hardness, microhardness tests, hardness-conversion relationships. Torsion Test-Types, torsion test Vs tension test, hot torsion test, Overview of ASTM testing standards for tension, hardness and torsion tests, compression test. *Suggested Reading: Procedures for doing tension, hardness and torsion testing. To take a case study on failures due to tension and torsion action in a material.*	
MODULE 5: MECHANICAL TESTING-II	**9**
Impact Test-Izod and Charpy tests, significance of transition–temperature curve, DBTT, factors affecting transition temperature. Overview of ASTM testing standard for impact test. Fatigue- S N curve, fatigue testing, factors affecting fatigue properties, structural features of fatigue failures, low cycle fatigue, Paris equation, Residual life estimation. Creep- creep curve, structural changes during creep, mechanisms of creep deformation, Overview of ASTM testing standard for fatigue and creep test. Few case studies on the design of damage tolerant alloys. *Suggested Reading: Practical applications where impact loading, fatigue loading and creep occurs.*	

TEXT BOOKS	
1	Dieter G. E., 'Mechanical Metallurgy', 3rd Edition, McGraw Hill, 2013.
2	Thomas H. Courtney, 'Mechanical Behavior of Materials', 2nd Edition, Overseas Press India Private Limited, 2013.
3	M. N. Shetty, 'Dislocations and Mechanical Behaviour of Materials',Prentice Hall India Learning Private Limited, 2013.
4	Norman E. Dowling, 'Mechanical Behavior of Materials', 4th Edition, Pearson Publication, 2017.

REFERENCE BOOKS	
1	Bhargava A.K. and Sharma. C. P. , 'Mechanical Behaviour and Testing of Materials', Prentice Hall India Learning Private Limited, 2011.
2	William F. Hosford, 'Mechanical Behavior of Materials', Cambridge: Cambridge University, 2010.

E BOOKS	
1	http://nozdr.ru/biblio/kolxo3/Ch/ChCm/Newnham%20R.E.%20Properties%20of%20 materials..%20Anisotropy,%20symmetry,%20structure%20(OUP,%202005) (ISBN%200198520751)(O)(391s)_ChCm_.pdf – By Robert E Newnham
2	https://books.google.com/books?id=pZL44wHzswsC&printsec=frontcover - By Joachim Roesler, Harald Harders, Martin Baeker

MOOC	
1	http://nptel.ac.in/courses/112106153/3
2	http://nptel.ac.in/courses/122102008/26
3	https://www.class-central.com/course/edx-3-032x-mechanical-behavior-of-materials-2234

COURSE TITLE	UNCONVENTIONAL MACHINING PROCESSES			CREDITS	3
COURSE CODE	MEC4254	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Understand appropriate technique to a specific requirement	1,2,5
2	Understand different machining based on mechanical energy	1,2,5
3	Execute the processes parameters of electrical energy based machining processes	1,2,4,5,10,12
4	Implement the chemical and electro chemical machining techniques	1,2,4,5,12
5	Implement plasma arc and electron beam machining processes for industrial applications.	1,2,4,5,12

Prerequisites : Engineering Physics, Engineering Materials and Manufacturing Technology I and II

MODULE 1: INTRODUCTION **05**

Unconventional machining Process - Need - clarification - Brief overview of all techniques.

Suggested Reading: Hybrid Processes

MODULE 2: MECHANICAL ENERGY BASED PROCESSES **10**

Abrasive Jet Machining - Water Jet Machining - Ultrasonic Machining. (AJM, WJM and USM).Working Principles - equipment used - Applications.

Suggested Reading: Abrasive flow machining and Magnetic Abrasive finishing

MODULE 3: ELECTRICAL ENERGY BASED PROCESSES INCOMPRESSIBLE FLUID FLOW **8**

Electric Discharge Machining (EDM)- working Principles-equipment's-Process Parameters- MRR electrode / Tool - Power Circuits- Dielectric - Flushing - Wire cut EDM - Applications.

Suggested Reading: Electron Beam Machining (EBM), ION Beam machining(IM)

MODULE 4: CHEMICAL AND ELECTRO-CHEMICAL ENERGY BASED PROCESSES **12**

Chemical Machining and Electro-Chemical Machining (CHM and ECM)-Etchants-Maskant's Techniques of applying Maskant's-Process Parameters, Principles of ECM - equipment Electrical circuit - Process Parameters-ECG and ECH Applications.

Suggested Reading Biochemical Machining (BM)

MODULE 5: THERMAL ENERGY BASED PROCESSES **8**

Laser Beam Machining (LBM), Plasma Arc Machining (PAM) and Electron Beam Machining (EBM). Principles-Equipment-Types-Beam control techniques - Applications.

Suggested Reading: Electro stream Drilling(ED)

Demonstration of CNC Laser beam cutting and Laser beam engraving

TEXT BOOKS	
1	Vijay.K. Jain Advanced Machining Processes Allied Publishers Pvt. Ltd., New Delhi (2002) ISBN 81-7764-294-4.
2	Pandey P.C. and Shan H.S. Modern Machining Processes Tata McGraw-Hill, New Delhi 2007.
3	Mc Geough, Advanced Methods of Machining Chapman and Hall, London (1998).
4	Paul De Garmo, J.T.Black, and Ronald.A.Kohser, Material and Processes in Manufacturing Prentice Hall of India Pvt. Ltd., New Delhi (8th Edition) (2001) ISBN - 81-203-1243-0.
REFERENCE BOOKS	
1	Benedict. G.F. Nontraditional Manufacturing Processes Marcel DekkerInc., NewYork(1987).
E BOOKS	
1	https://books.google.co.in/books?isbn=8177642944
2	https://books.google.co.in/books?id=xdmNVSio8jUC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false
MOOC	
1	http://nptel.ac.in/courses/112104028/

COURSE TITLE	COMPUTER INTEGRATED MANUFACTURING			CREDITS	3
COURSE CODE	MEC4255	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Understand Plant operations and need for automation	1,2,3,5,6,9,10, 12
2	Select suitable process plan for the plant	1,2,3,5,6,9,10, 12
3	Design workstation and select suitable computer control systems.	1,2,3,5,6,9,10, 12
4	Integrate the computers efficiently to the manufacturing systems.	1,2,3,5,6,9,10, 12
5	Control the shop floor effectively.	1,2,3,5,6,9,10, 12
6	Able to be comfortable with using CAD/CAM systems and with programming and operating of CNC machine Tools.	1,2,3,5,6,9,10, 12

Prerequisites : Manufacturing Technology II

MODULE 1: INTRODUCTION **09**

The meaning and origin of CIM- the changing manufacturing and management scene - External communication - Islands of automation and software-Dedicated and open systems-Manufacturing automation protocol - Product related activities of a company- Marketing engineering - Production planning - Plant operations - Physical distribution- Business and financial management.

Suggested Reading*: Company valuation and risk assessment, Manufacturing Controls*

MODULE 2: GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING 09
History of group technology- Role of G.T. in CAD/CAM integration - Part families - Classification and coding - DCLASS and MICLASS and OPITZ coding systems-Facility design using G.T. -benefits of G.T. - Cellular manufacturing. Process planning - role of process planning in CAD/CAM integration - Approaches to computer aided process planning -Variant approach and generative approaches ***Suggested Reading:*** *CAPP and CMPP process planning systems.*
MODULE 3: SHOP FLOOR CONTROL AND INTRODUCTION OF FMS 09
Shop floor control-phases - Factory data collection system -Automatic identification methods - Bar code technology-Automated data collection system. FMS-components of FMS - types -FMS workstation -Material handling and storage systems- FMS layout - Computer control systems-Application and benefits. ***Suggested Reading:*** *Handling and Storage with Manufacturing, Design Work station using MATLAB© Simulink.*
MODULE 4: CIM IMPLEMENTATION AND DATA COMMUNICATION 09
CIM and company strategy - System modelling tools -IDEF models - Activity cycle diagram - Manufacturing enterprise wheel-CIM architecture - Product data management-CIM implementation software-IOT Technologies Communication fundamentals- Local area networks -Topology - LAN implementations - Network management and installations. ***Suggested Reading:*** *- CIM open system architecture (CIMOSA)*
MODULE 5: KEY TECHNOLOGIES FOR THE INTEGRATION 09
Artificial Intelligence, Knowledge-Based Systems, Expert Systems Technology,Applications of Genetic Algorithm, Agent-Based Technology, Virtual Business, e- Commerce Technologies, Global Manufacturing Networks, Digital enterprise technologies. ***Suggested Reading:*** *Manufacturing automations protocol and technical office protocol (MAP /TOP)*

TEXT BOOKS

1	Mikell.P.Groover Automation, Production Systems and computer integrated manufacturing, Pearson Education, New Delhi, 2016.
2	Alan Weatherall , Computer Integrated Manufacturing: From Fundamentals to Implementation 2013.
3	Justin Riggs, Computer-Aided Design and Manufacturing, Willford Press; First edition 2016.

REFERENCE BOOKS

1	Thomas O. Boucher, Computer Automation in Manufacturing: An introduction, Third Edition, Springer, 2013.
2	Hermann Kühnle , Günter Bitsch , Foundations & Principles of Distributed Manufacturing: Elements of Manufacturing Networks, Cyber-Physical Production Systems and Smart Automation, First edition, Springer Education, 2015.

E BOOKS	
1	https://books.google.co.in/books?id=DREwDwAAQBAJ&lpg=PP1&dq=Mikell. P.Groover%20Automation%2C%20Production%20Systems%20and%20 computer%20integrated%20manufacturing%2C%20Pearson%20Education%2C%20 New%20Delhi%2C%202016.&pg=PP1#v=onepage&q&f=false - Mikell.P.Groover
2	https://books.google.co.in/books?id=NgKcFcJYxw8C&lpg=PP1&dq=computer%20 integrated%20manufacturing&pg=PP1#v=onepage&q=computer%20 integrated%20manufacturing&f=false - 1. Yorem koren
MOOC	
1	https://www.coursera.org/specializations/cad-design-digital-manufacturing
2	https://www.coursera.org/specializations/digital-manufacturing-design-technology
3	https://ocw.mit.edu/courses/mechanical-engineering/2-830j-control-of-manufacturing-processes-sma-6303-spring-2008/
4	https://www.coursera.org/learn/advanced-manufacturing-process-analysis
5	https://www.coursera.org/learn/intelligent-machining#syllabus
6	https://ocw.mit.edu/courses/mechanical-engineering/2-96-management-in-engineering-fall-2012/

COURSE TITLE	IC ENGINE AND STEAM TURBINE			CREDITS	3
COURSE CODE	MEC4256	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Understand and compare the basic types of engine cycles.	1,2,5
2	Understand the combustion phenomenon of SI and CI engine and its mixture requirements.	1,2,5
3	Gain knowledge to the concept of SI and CI engine combustion with respect to supercharging and scavenging.	1,2,4,5,10,12
4	Understand the basics principles of steam turbine and its nozzle flow Characteristics.	1,2,5,12
5	gain knowledge on the theories of fluid flow through turbine blades	2,3,5,11

Prerequisites : Gas dynamics and Jet Propulsion

MODULE 1: I C ENGINE **9**

Principle of working and Construction of IC engine; Comparison of air standard cycles; Air cycle analysis with variable specific heats; Introduction to fuel air cycle analysis; Availability analysis for engine processes. Suggested Reading: Actual cycles; MEP; Thermal efficiency

MODULE 2: COMBUSTION **9**

Combustion calculations related to I.C. Engine fuels. Desirable characteristics of fuels for I.C. Engine. Mixture requirements for S.I Engine; Carburation pressure drop - flow relation; fuel air ratio; complete carburettor. Petrol injection. Ignition system in S.I. Engine: Battery, Magneto, and electronic ignition systems; Fuel injection systems; Injection pumps and nozzles.

Suggested Reading: Ignition timing and spark advance, Thermodynamic modelling using Matlab©

MODULE 3: SUPERCHARGING AND SCAVENGING **9**

Theories of combustion in S.I and C. I. Engines - Methods for reduction of detonation and knock; Octane number and Cetane number. Supercharging and Scavenging: Supercharging in I.C. Engine; Supercharging limits; Scavenging of I.C. engines, two stroke S.I. and C.I. engines; Scavenging parameters; Suggested Reading: Actual scavenging; Scavenging pump, Ideal scavenging processes

MODULE 4: STEAM TURBINE **9**

Steam Generation - introduction to Boilers; Principles of action of turbines, Classification, relative advantages of turbines as prime movers, Isentropic flow through nozzle, Nozzle shape, Critical pressure ratio and maximum flow, Effect of friction in nozzle flow.

Suggested Reading : Under-expansion and over-expansion in nozzles, Supersaturated flow through nozzles

MODULE 5: FLOW THROUGH TURBINE BLADE **9**

Flow through impulse turbine blade, Velocity diagram, Blade work, Blade efficiency, Optimum velocity ratio, Multi-staging and its advantage, Velocity compounded impulse turbine, Pressure compounded impulse turbine, Reheat factor, Internal efficiency, State point locus. Flow through reaction turbine blade, Velocity diagram, Degree of reaction, Blade work, Blade height,

Suggested Reading: Stage efficiency, Optimum velocity ratio, Axial thrust in reaction turbine, erosion of turbine blades.

TEXT BOOKS	
1	V Ganesan., "Internal Combustion Engines", McGraw-Hill Education; 4th Edition, July 2017.
2	S SThipse., "Internal Combustion Engines", Jaico Publishing House; 1st Edition, Jan 2008.
3	R K Rajput., "Internal combustion Engines", Laxmi Publication; 2005.
REFERENCE BOOKS	
1	John B Heywood, "Internal Combustion Engine Fundamentals", McGraw Hill Education, 1st Edition (Indian Edition) July 2017.
2	Richard Stone, "Introduction to Internal Combustion Engines", Palgrave publishers, 4th Edition 2012.
3	John H.Weaving, "Internal Combustion Engineering: Science & Technology", Elsevier Applied Science,
E BOOKS	
1	https://books.google.co.in/books?id=u9FSAAAAMAAJ&q=IC+engine&dq=IC+engine&hl=en&sa=X&ved=0ahUKEwiLuPjhl8jZAhVGNI8KHbNvBh8Q6AEILTAB – John B Heywood
2	https://books.google.co.in/books?id=hfejAwAAQBAJ&printsec=frontcover&dq=IC+engine&hl=en&sa=X&ved=0ahUKEwiLuPjhl8jZAhVGNI8KHbNvBh8Q6AEIKDAA#v=onepage&q=IC%20engine&f=false – V Ganesan
3	https://books.google.co.in/books?id=UtxI5gXM1yQC&printsec=frontcover&dq=IC+engine&hl=en&sa=X&ved=0ahUKEwiLuPjhl8jZAhVGNI8KHbNvBh8Q6AEIODAD#v=onepage&q=IC%20engine&f=false – R K Rajput
MOOC	
1	http://nptel.ac.in/courses/101106037/
2	http://nptel.ac.in/courses/112104033/
3	http://nptel.ac.in/courses/101104014/
4	http://nptel.ac.in/courses/101104070/

COURSE TITLE	PROCESS PLANNING & COST ESTIMATION			CREDITS	3
COURSE CODE	MEC4257	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Explain the basic concepts of work study and ergonomics.	1,2,6,10
2	Develop manufacturing logic and optimize process cost	3,5,14
3	Understand and appreciate the basic concepts of cost accounting	1,2,12
4	Estimate cost for any value added activity and incorporate allowances in estimation	3,4,5
5	Develop cost estimation and analyze profitability	1,2,5,12

Prerequisites : Manufacturing Technology II

MODULE 1: WORK STUDY AND ERGONOMICS **10**

Method study - Definition - Objectives-Motion economy- Principles - Tools and Techniques- Applications - Work measurements- purpose - use - procedure - tools and techniques- Standard time -Ergonomics - principles - applications.

Suggested Reading*: Standard notations used in work measurement and motion study - case study on work measurement and motion study for any 2 industrial process*

MODULE 2: PROCESS PLANNING **10**

Approaches to process planning activities - Finished part requirements- operating sequences- machine selection - Set of documents for process planning- selection of jigs & fixtures- production time calculation - selection of cost optimal process – use of Optimization tool box in MATLAB©

Suggested Reading*: Plant layout, process flow chart for any mechanical component manufacturing units*

MODULE 3: INTRODUCTION TO COST ESTIMATION **7**

Objective of cost estimation- costing - cost accounting- classification of cost- Elements of cost.

Suggested Reading*: machine cost per hour*

MODULE 4: COST ESTIMATION **8**

Types of estimates - methods of estimates - data requirements and sources- collection of cost- allowances in estimation..

Suggested Reading*: Design cost, depreciation cost , cost of quality*

MODULE 5: PRODUCTION COST ESTIMATION **10**

Estimation of machining time – factors to calculate machining time – calculation of machining time for processes like casting, sheet metal, forging

Suggested Reading: cost estimation of any process industry

TEXT BOOKS	
1	R.K Kesavan, Process Planning and Cost Estimaion, New Age International (P) Limited, Publishers (2008)
2	Sinha.B.P., Mechanical Estimating and Costing, Tata McGraw-Hill, Publishing Co., 1995
REFERENCE BOOKS	
1	Grünig, Rudolf; Kühn, Richard; Montani, Maude, The Strategy Planning Process: Analysis, Options, Projects, Springer, 2015.
2	Russell.R.S and Tailor, B.W, Operations Management, PHI, 4th Edition, 2003.
3	Chitale.A.V. and Gupta.R.C., Product Design and Manufacturing, PHI, 2nd Edition, 2007.
E BOOKS	
1	https://www.elsevier.com/books/process-planning/scallan/978-0-7506-5129-5
2	http://www.sanfoundry.com/best-reference-books-facilities-process-planning-layout-design/
3	https://www.amazon.com/Engineering-Cost-Estimating-Phillip-Ostwald/dp/0132766272
MOOC	
1	https://onlinecourses.nptel.ac.in/noc16_ce02/announcements
2	http://nptel.ac.in/courses/105103023/35

LIST OF DEPARTMENTAL ELECTIVES - SEMESTER IV

COURSE TITLE	REFRIGERATION AND AIR CONDITIONING			CREDITS	3
COURSE CODE	MEC4266	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Explain the basic principles of refrigeration describe and compare the various refrigeration cycles	1,2,12
2	Identify the various components in Refrigeration and air conditioning systems used in application	1,2,3,12
3	Plot the various Air conditioning processes in the psychometric chart and how to use in air conditioning applications	1,2,3,4,5,12
4	Describe working principle of air conditioning systems, types and design methods.	1,2,3,5,12
5	Demonstrate the working principles of vapour absorption refrigeration system and other unconventional air conditioning systems	1,2,3,4,5,7,12

Prerequisites : Thermal Engineering

MODULE 1: REFRIGERATION CYCLE **7 hours**

Review of thermodynamic principles of refrigeration. Carnot refrigeration cycle – Vapour compression refrigeration cycle – use of P.H. charts – multistage and multiple evaporator systems – cascade system – COP comparison. Air Refrigeration cycles.
Suggested Reading: Deviations of ideal cycles from theoretical cycle – subcooling and super heating-effects of condenser and evaporator pressure on COP- multi pressure system - low temperature refrigeration.

MODULE 2: REFRIGERANTS AND SYSTEM COMPONENTS **10 hours**

Compressors – reciprocating and rotary (elementary treatment), Types of condensers, evaporators, cooling towers – Functional aspects. Refrigerants – properties – selection of refrigerants, Alternate Refrigerants, Cycling controls.
Suggested Reading: - Refrigerants Desirable properties with respect to ODP & GWP

MODULE 3: PSYCHROMETRY **10 hours**

Psychometric processes use of Psychrometric charts – Grand and Room Sensible Heat Factors – bypass factor – air washers, requirements of comfort air conditioning, summer and Winter Air conditioning.
Suggested Reading: Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temperature Thermodynamic wet bulb temperature; Psychrometric of air-conditioning processes, mixing of air streams.

MODULE 4: AIR CONDITIONING SYSTEMS 9 hours
Working principles of – Centralized Air conditioning systems, Split, Duct able split, Packaged Air conditioning, VAV & VRV Systems. Indoor Air quality, Cooling load calculation, Duct Design methods. **Suggested Reading:** Air conditioning loads: Outside and inside design conditions; Heat transfer through structure, Solar radiation, Electrical appliances, Infiltration and ventilation, internal heat load; Apparatus selection; fresh air load, human comfort & IAQ principles, effective temperature & chart, calculation of summer & winter air conditioning load; Classifications, Layout of plants; Air distribution system; Filters; Air Conditioning Systems with Controls: Temperature, Pressure and Humidity sensors, Actuators & Safety controls. Design and plot load curves of indoor summer air conditioning system using MATLAB©
MODULE 5: UNCONVENTIONAL REFRIGERATION CYCLES 9 hours
Vapour Absorption system – Steam jet refrigeration, thermo electric refrigeration. Applications in ice plant, food storage plants, milk chilling plants. **Suggested Reading:** Working principles of adsorption cooling systems - Ejector refrigeration systems- Air refrigeration - Magnetic - Vortex and Pulse tube refrigeration systems. Perform thermodynamic analysis of Vapour Absorption system and plot COP curves with respect to generator temperature using MATLAB©

TEXT BOOKS	
1	Arora, C.P., "Refrigeration and Air Conditioning", 3 rd edition, McGraw Hill, New Delhi, 2017.
2	Roy J. Dossat, "Principles of Refrigeration", 4th edition, Pearson Education Asia, 2009.
REFERENCE BOOKS	
1	Stoecker, W.F. and Jones J. W., "Refrigeration and Air Conditioning", McGraw Hill, New Delhi, 2014.
2	Andrew D, Althouse , Carl H, Turnquist, Alfred F, Bracciano., “Modern Refrigeration and Air Conditioning”, Goodheart-Willcox Publication; 20 edition 2016.
3	ASHRAE Hand book, Fundamentals, 2010.
4	Jones W.P., "Air conditioning engineering", 5 th edition, Elsevier Butterworth-Heinemann, 2001.
E BOOKS	
1	https://drive.google.com/open?id=0B7JWdKw_4Q07VWNrLVNkRXpyUmM- TROTT, WELCH.
2	https://drive.google.com/open?id=0B7JWdKw_4Q07Q3VwSlBxMFd0Vjg- REX MILLER.
3	https://drive.google.com/open?id=0B9bpsTYXP4ceTC0ycVVMX3RxSGs
MOOC	
1	http://nptel.ac.in/courses/112105128/
2	http://www.nptelvideos.in/2012/12/refrigeration-and-airconditioning.html

COURSE TITLE	POWER PLANT ENGINEERING			CREDITS	3
COURSE CODE	MEC4267	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Classify the various equipment's to improve its performance	1,6
2	Choose the modern boilers principle to increase productivity.	1,6,7
3	Compare the utilization of hydel & Nuclear power plant	1,6,7,8
4	Identify make to use of the waste heat produced from both diesel & gas turbine plant	1,6,7,8,9,11
5	Develop the technology in the application of wind & solar power plant	1,6,7,8,12
6	Inspect the economics of various power plant and reduce pollutants	1,6,7,8,12

Prerequisites : Thermal Engineering

MODULE 1: MODERN STEAM POWER PLANT 05

Modern Steam power plants: layout, selection, working ,application of Rankine cycle. auxiliary equipment, fuels and ash handling equipment Electrostatic precipitator, draught system. Furnace, boiler drum, circulation, air pre heaters, Economisers, Super heaters, Reheater, Deaerator , feed water heaters, feed water treatment .Condenser, sea water cooling system, cooling towers,

Suggested Reading: Calculate the efficiency of boiler by direct and indirect method and compare the results.

Visit to Thermal power plant

MODULE 2: MODERN STEAM BOILERS 10

Steam Boilers: Working of Super critical boilers & Circulating fluidised bed combustion boilers, materials used in sub critical & supercritical boilers, factors to be considered for selection of boilers for various fuels.

Suggested Reading: Analyse the issues in various Sub critical, supercritical CFBC boilers. Visit to Thermal Power plant.

MODULE 3: NUCLEAR AND HYDEL POWER PLANTS 8

Lay out, Nuclear Energy, Fission, Fusion Reaction, Types of Reactors, Pressurized water reactor, Boiling water reactors, Waste disposal and safety. Layout, Hydal Power Plant: Essential Elements, Selection of Turbines, Governing of turbines, Micro Hydel Development.

Suggested Reading: Constraints and remedial measures in Nuclear and hydel power plants.

Visit to Nuclear &Hydel power plant.

Model Temperature control of a boiler using SIMULINK©

MODULE 4: DIESEL AND GAS TURBIE POWER PLANT 12

Types of Diesel Plants, Components, Selection of Engine Type, Application of Gas turbine Power Plant, Fuels, gas Turbine Materials, Open and Closed Cycles, Reheating, Regeneration and intercooling, Combined cycle.Waste heat recovery boilers. Integral gasification combined cycles

(IGCC)

Suggested Reading: Reduce pollution in diesel and gas turbine power plants.

Visit to Diesel & gas turbine power plant.

MODULE 5: OTHER POWER PLANTS , VARIABLE LOAD PROBLEMS AND ENVIRONMENTAL HAZARDS **8**

Geo Thermal-OTEC- Tidal- Pumped Storage. Solar :Types of solar Thermal Power plants, Roof top solar, solar drying,Perfrmance of solar plants. Wind power plant: working principa & issues. load curves, effect of variable load on plant design and operation, load dispatch. Power station Economics analysis. Power plants Environmental issues

Suggested Reading: Environmental pollution monitoring & CFD Modelling.

Visit to all Wind & solar power plants.

TEXT BOOKS

1	P.K.Nag, Power Plant Engineering, McGraw-Hill Education ,2014
2	R.K. Rajput, A textbook on Power Plant Engineering, 5th edition, Laxmi publications,2007

REFERENCE BOOKS

1	M.M. El-Wakil, Power Plant Technology, McGraw-Hill Education ,2013
2	R.K.Rajput, Thermal Engineering, Laxmi Publication ,2010
3	V Ganeshan, Gas Turbines, McGraw Hill Education, 2010
4	William J. Kearton, Steam Turbine Theory and Practice, CBS Publication ,2011

E BOOKS

1	https://drive.google.com/open?id=0B7JWdKw_4Q07VWNrLVNkRXpyUmM- TROTT, WELCH.
2	https://drive.google.com/open?id=0B7JWdKw_4Q07Q3VwSlBxMFd0Vjg- REX MILLER.
3	https://drive.google.com/open?id=0B9bpsTYXP4ceTC0ycVVMX3RxSGs

MOOC

1	http://nptel.ac.in/courses/112105128/

COURSE TITLE	COMPUTATIONAL FLUID DYNAMICS			CREDITS	3
COURSE CODE	MEC4268	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Know the equations governing fluid flow and heat transfer.	1,2,3,4,5
2	Appreciate the tools available for solving the algebraic equations.	1,2,5,12
3	Appreciate the problems associated with discretization of incompressible flow	1,2,3,4,5,12
4	Appreciate the numerical formulations of diffusion and convection	1,2,3,4,5
5	Solve the practical problems associated with Fluid Flow and Heat Transfer using commercial software.	1,2,3,4,5

Prerequisites : Partial Differential Equation and Transforms Technique, Fluid Mechanics and Machiner

MODULE 1: GOVERNING EQUATIONS AND BOUNDARY CONDITIONS **9**

Basics of computational fluid dynamics - Governing equations of fluid dynamics - Continuity, Momentum and Energy equations - Physical boundary conditions - Time-averaged equations for Turbulent flow Turbulence -Kinetic -Energy Equations - mathematical behaviour of PDEs on CFD: Elliptic, Parabolic and Hyperbolic equations.

Suggested Reading: Laplace equation and Poissen equation

MODULE 2: DISCRETISATION AND SOLUTION METHODOLOGIES **9**

Methods of Deriving the Discretisation Equations - Taylor Series formulation - Finite difference method - Control volume Formulation. Solution methodologies: Direct and iterative methods, Thomas algorithm, Relaxation method, Alternating Direction Implicit method.

Suggested Reading: Studying the formulation of central, forward and backward schemes using Taylor series

MODULE 3: HEAT CONDUCTION **12**

Finite difference and finite volume formulation of steady/transient one-dimensional conduction equation, Source term linearization, Incorporating boundary conditions, Finite volume formulations for two and three dimensional conduction problems.

Suggested Reading: Heat conduction in a room using Ansys Fluent software.

MODULE 4: CONVECTION AND DIFFUSION **9**

Finite volume formulation of steady one-dimensional convection and Diffusion problems, Central, upwind, hybrid and power-law schemes - Discretisation equations for two dimensional convection and diffusion.

Suggested Reading: Gauss-Siedel method for central upwind scheme in C++

MODULE 5: CALCULATION OF FLOW FIELD **9**

Representation of the pressure - Gradient term and continuity equation - Staggered grid - Momentum equations - Pressure and velocity corrections - Pressure - Correction equation, SIMPLE

algorithm and its variants. Turbulence models: mixing length model, Two equation (k-ϵ) models. **Suggested Reading:** Implementing SIMPLE algorithm in Matlab©	
TEXT BOOKS	
1	C. Pozrikidis, Introduction to theoretical and computational fluid dynamics, Oxford, 2nd edition, 2012.
2	H. Lomax, T. H. Pulliam, D. W. Zingg, Fundamentals of Computational Fluid Dynamics, 2013
REFERENCE BOOKS	
1	G. D. Mallinson, S. E. Norris, "Fundamentals of Computational Fluid Dynamics, Springer, 2010.
2	Patankar, S.V., Numerical Heat Transfer and Fluid Flow, McGraw-Hill, 1980. Ane - Books Indian Edition.2009.
3	Muralidhar, K and Sundarajan .T., Computational Fluid Flow and Heat Transfer, Narosa Publishing House, New Delhi,2nd Edition 2008.
4	Versteeg, H.K, and Malalasekera, W., An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Longman, 1998
5	Ghoshdastidar, P.S., Computer Simulation of flow and heat transfer, Tata McGraw Hill Publishing Company Ltd., 1998.
6	Anderson, J.D., Computational fluid dynamics - the basics with applications, 1995.
E BOOKS	
1	http://bookboon.com/en/computational-fluid-dynamics-ebook - Naser Sayma
2	http://www.e-booksdirectory.com/details.php?ebook=2832 - Abdulnaser Sayma
3	http://www.engineering108.com/pages/Mechanical_Engineering/Computational_ Fluid_Dynamics/mason-cfd_ebooks-free-download.html - W. H. Mason
MOOC	
1	http://nptel.ac.in/courses/112107080/
2	http://nptel.ac.in/courses/112107079/
3	http://nptel.ac.in/courses/103106073/

COURSE TITLE	HEAT TREATMENT OF METALS AND ALLOYS			CREDITS	3
COURSE CODE	MEC4269	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Explain the basics of phase diagrams, different types of furnaces used and about its accessories.	1,2,3
2	Understand and analyses the various heat treating techniques for steel and knowing on the property change due to the same.	1,2,3,4,6,7,8,11
3	Identify the surface techniques that are to be used for various metals and the procedural ways for doing the same.	1,2,3,4,6,7,8,11
4	Understand and analyze the various heat-treating techniques for ferrous and nonferrous alloys and knowing the property change due to the heat treatment.	1,2,3,4,6,7,8,11
5	Appreciate on the surface defects caused due to heat treatment and the control measures to prevent them.	1,2,3,4,5,8,9,10,11,12

Prerequisites : Engineering metallurgy and materials

MODULE 1: HEAT TREATMENT EQUIPMENTS **9**

Review of phase diagrams and transformations, Furnaces, Calibration of thermocouple, Quenching methods, fixtures, control of furnace atmosphere, temperature control, Design of heat treatment furnaces.

***Suggested Reading**:Binary/Ternary pnase diagram,Types of thermocouple.*

MODULE 2: HEAT TREATMENT OF STEEL **9**

Effect of alloying elements on Fe-C diagram, Annealing (different types), normalizing, hardening - Quenching media - Martensite formation, TTT and CCT diagrams, Hardenability and measurement of hardenability-Influence of alloying elements. Tempering-Temper brittleness, Sub zero treatment-Control of retained austenite. Austempering, Martempering and Thermo-mechanical treatments.

***Suggested Reading:** Iron -Iron Carbide phase diagram, Significance of the phases present in alloys, Full annealing, Cryogenic atmosphere.*

MODULE 3: SURFACE ENGINEERING TECHNIQUES **9**

Flame and induction hardening. Carburising, nitriding, carbonitriding, boriding, electron beam and laser beam hardening. PVD and CVD processes, sputter coating, ion plating, ion implantation, spray coatings.

***Suggested Reading:** Surface engineering techniques to be choosen for a metal, Difference between plating and surface hardening.*

MODULE 4: HEAT TREATMENT OF FERROUS & NON FERROUS ALLOYS **9**

Plain carbon steel, Stainless steels, Tool steels and Cast irons, maraging steels, HSLA steels, and dual phase steels.

Heat treating of Aluminium -precipitation hardening, Copper, Magnesium and Titanium alloys, Ni-base alloys.

***Suggested Reading**: Properties of Al, Cu,Mg,Ti and Ni alloys, Non heat treatable nonferrous alloys.*

MODULE 5: INSPECTION AND QUALITY CONTROL	9
Defects during heat treatment, Causes and remedies for defects (like low hardness and strength, soft spots, oxidation and decarburization, over heating and burning, quench cracks, distortion and warping) in heat-treated parts. Design for heat treatment. ***Suggested Reading**: QC techniques*	
TEXT BOOKS	
1	Rajan.T.V , Sharma.R.C and Ashok Sharma "Heat Treatment: Principles and Techniques" 2nd Edition, Prentice Hall India Learning Private Limited, 2010.
2	Porter.D.A and Easterling.K.E "Phase Transformations in Metals and Alloys'" Taylor and Francis/CRC Press, 2017.
REFERENCE BOOKS	
1	Prabhudev. K. H.,"Handbook of Heat Treatment of Steels", Tata-McGraw Hill Publications. Co. Ltd., 2011.
2	American Society of Metals, "Metals Handbook, Volume IV", A.S.M., Metals park, Ohio, USA, 1991.
3	Karl Eric Thelning, "Steel and its heat treatment", Butterworth Publications, 2000.
4	Vijendra singh, "Physical Metallurgy", Standard Publishers distributors, 2010.
E BOOKS	
1	https://books.google.co.in/books?id=vmV1cjBtPOAC&printsec=frontcover&source =gbs_ge_summary_r&cad=0#v=onepage&q&f=false - By George E. Totten, Maurice A.H. Howes.
2	https://books.google.co.in/books?id=izvhnQAACAAJ&printsec=frontcover&sourc e=gbs_ge_summary_r&cad=0#v=onepage&q&f=false - By K. H. Prabhudev.
3	https://books.google.co.in/books?id=RMpW7fl85WEC&printsec=frontcover&sourc e=gbs_ge_summary_r&cad=0#v=onepage&q&f=false - By T. V. Rajan, C. P. Sharma, Ashok Sharm a
MOOC	
1	http://nptel.ac.in/courses/113104074/
2	http://nptel.ac.in/courses/112104219/

COURSE TITLE	MECHANICAL VIBRATION			CREDITS	3
COURSE CODE	MEC4270	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Explain the basic concepts of vibration and writing equation of motion for Single DOF systems and determining natural frequencies of vibrating bodies	1,2,12
2	Determining natural frequencies when vibrating bodies subjected to forced vibration	1,2,3,4,7
3	Writing Equation of motion for Two DOF systems and determining natural frequencies of suspension systems	1,2,3,12
4	DETERMINING natural frequencies of Multi DOF using different methods	1,2,3,4,12
5	Measure the vibration parameters through experimental approach and can do signal analysis for condition monitoring.	1,2,3,4,5,7,12

Prerequisites Mechanics of Machines

MODULE 1: BASICS OF VIBRATION **12**

Introduction: Harmonic and periodic motions – Vibration terminology – Single DOF free vibrations: Vibration model, Equation of motion – Natural Frequency – Newton's Method, Energy method, Rayleigh method and D'Alembert's principle- Viscously damped free vibration - special cases: Oscillatory, non-oscillatory and critically damped motions. Logarithmic decrement, Experimental determination of damping coefficient.

Suggested Reading:Elements of vibration, Types of vibration, Fourier series and harmonic analysis, Beats, Bifilar suspension, Trifilar suspension.

MODULE 2: SINGLE DOF FORCED VIBRATION **12**

Single DOF Forced vibrations- Forced harmonic vibration, Magnification factor, Reciprocating and Rotor unbalance, Transmissibility ratio – harmonic excitation and support motion, Vibration Isolation, Equivalent viscous damping, sharpness of resonance.

Suggested Reading: Critical speed and critical speed with damping

MODULE 3: SYSTEMS WITH TWO DOF **12**

Introduction, Principle modes and Normal modes of vibration, Two-DOF free vibrations – Generalized and Principal coordinates, Derivation of Equations of motion, Lagrange's equation, Coordinate coupling, Forced Harmonic Vibration, Applications – vehicle suspension and dynamic vibration absorber

Suggested Reading: Solutions using Laplace transform and frequency transfer functions

MODULE 4: MULTI DOF SYSTEM **12**

Introduction, Derivation of equations of motions, Influence coefficients method, Properties of vibrating system: Flexibility and stiffness matrices, Maxwell reciprocal theorem, Matrix method, Matrix-iteration method, Reyleigh method and Dunkerley's method.

Suggested Reading: Torsional vibrations of two, three and multi rotor system

MODULE 5: EXPERIMENTAL METHODS IN VIBRATION ANALYSIS	12
Vibration testing equipments: Signal generation, measuring and conditioning instruments. Signal analysis instruments, Vibration tests – Free and forced vibration tests. Suggested Reading: Examples of vibration tests – Industrial case studies, Machine condition monitoring and diagnosis, plotting measured to true accelerations	
TEXT BOOKS	
1	Rao, S.S., "Mechanical Vibrations", 6th Edition, Pearson Education Inc., Prentice Hall, 2014.
2	V.P. Singh, "Mechanical vibrations", Dhanpat Rai & company Pvt. Ltd., 5rd edition, 2016
3	G.K.Grover, "Mechanical vibrations", 8th edition, New chand and Brothers, 2013.
REFERENCE BOOKS	
1	Graham Kelly, "Scham's outline of Theory and Problems of Mechanical vibrations", Special Indian edition, Tata McGraw-Hill, 2012.
2	W.T. Thomson and Marie Dillion Dahleh, "Theory of vibration with applications" Pearson Education, 5th Edition, New Delhi, 2017.
3	A.R.Mohanty, "Machinery condition Monitoring: Principles and Practices", CRC Press, 2014.
E BOOKS	
1	https://drive.google.com/open?id=0B6pGoYzCs7PgMFF1ZzZXVGt LZHc - Alok Sinha
2	https://drive.google.com/open?id=0B4SQTWiEAAQeMFowVzh Sa2s0Rnc – William J. Bottega
3	https://drive.google.com//open?id=0B6pGoYzCs7PgYXBwc2 szNVQ4LTg – B. Balachandran
MOOC	
1	https://www.mooc-list.com/course/introduction-%C3%A0-la-m%C3%A9canique-des-vibration
2	http://nptel.ac.in/courses/112103112/
3	https://in.mathworks.com/support/learn-with-matlab-tutorials.html

COURSE TITLE	MODERN CONCEPTS OF ENGINEERING DESIGN			CREDITS	3
COURSE CODE	MEC4271	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Recall the basic product development process	1,2,5
2	Discover the IPR related issues and patent registration	1,2,5
3	Apply the design process for product development	1,2,4,5,10,12
4	Analyze the feasibility of the proposed project	1,2,5,12

Prerequisites : Nil

MODULE 1: PRODUCT DESIGN PROCESS **9**

Importance of product design - Design process - Design considerations - Morphology of design Marketing Organization for design - Computer aided engineering - Codes and standards - Design review - Technological innovation and design process - Product and process cycles -Societal considerations in design.

Suggested Reading topics: establishing markets- market segments- relevance of market research

MODULE 2: PRODUCT PLANNING AND SPECIFICATION **9**

Opportunities identification-Evaluation-Resource allocation - Pre-project planning - Customer need identification - Establishing target specification - Setting the final specification.

Suggested Reading: affinity diagrams – needs importance- establishing engineering characteristics- competitive benchmarking-

MODULE 3: CONCEPT GENERATION, SELECTION AND TESTING **9**

Activity of concept generation - Clarification of problem - External and internal searches - Concept exploration - Result analysis - Overview of selection methodologies - Concept screening - Concept scoring - Concept testing - Choice of survey population - Survey formats - measurement of customer response - Interpretation and analysis of results.

Suggested Reading: Creative thinking –creativity and problem solving- creative thinking methods

MODULE 4: PRODUCT ARCHITECTURE **9**

9 Decision making –decision theory –utility theory –decision trees –concept evaluation methods – Pugh concept selection method- weighted decision matrix –analytic hierarchy process – introduction to embodiment design –product architecture – types of modular architecture –steps in developing product architecture Product architecture - Implications - establishment - platform planning . *Suggested Reading :* system level design

MODULE 5: INDUSTRIAL DESIGN,DESIGN FOR MANUFACTURE AND PROTOTYPING **9**

Industrial design – human factors design –user friendly design – design for serviceability – design for environment Overview of Design for Manufacture process - Steps in DFM – prototyping and testing – cost evaluation –categories of cost –overhead costs – activity based costing –methods of developing cost estimates – manufacturing cost –value analysis in costing

Suggested Reading: Design review, Value analysis/engineering.

TEXT BOOKS	
1	Karl T Ulrich Steven D Eppinger, Product design and development “” New York, McGraw-Hill Education,2016
REFERENCE BOOKS	
1	G. E. Dieter, Engineering Design, McGraw – Hill International, 2013
2	Product Design Kavin N Aotto, Kritine I Wood, Prentice Hall Publications 2013
E BOOKS	
1	https://books.google.co.in/books/about/Engineering_Design.html?id=wUgqAQAAMAAJ
2	https://books.google.co.in/books?isbn=8177588214
MOOC	
1	https://onlinecourses.nptel.ac.in/noc17_me16/preview
2	https://www.edx.org/course/product-design-delft-design-approach-delftx-dda691x-1

COURSE TITLE	CHARACTERIZATION OF MATERIALS			CREDITS	3
COURSE CODE	MEC4272	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Understand the principle of metallurgical microscope and its application	1,2,4,12
2	Analyse the materials characteristics using XRD technique	1,2,5,12
3	Understand the principle and working of various electron microscopes	1,2,5,12
4	Analyse the surface characteristics of a material	1,2,4,5,12

Prerequisites : Engineering Physics

MODULE 1: METALLOGRAPHIC TECHNIQUES **8**

Macro examination -applications, metallurgical microscope - principle, construction and working, metallographic specimen preparation, optic properties - magnification, numerical aperture, resolving power, depth of focus, depth of field, different light sources lenses aberrations and their remedial measures, various illumination techniques-bright field , dark field, phase-contrast polarized light illuminations, interference microscopy, high temperature Microscopy; quantitative metallographic – Image analysis.

Suggested Reading: Theoretical and practical resolution of microscopes

MODULE 2: X -RAY DIFFRACTION TECHNIQUES	10
Crystallography basics, reciprocal lattice, X-ray generation, absorption edges, characteristic spectrum, Bragg's law, Diffraction methods – Laue, rotating crystal and powder methods. Stereographic projection. Intensity of diffracted beams–structure factor calculations and otherfactors. Diffracto meter- brief description only. Cameras -General feature and optics,nProportional, Scintillating and Geiger counters. ***Suggested Reading:*** High Resolution X-Ray Diffraction	
MODULE 3: ANALYSIS OF X-RAY DIFFRACTION	**9**
Line broadening, particle size, crystallite size, Precise parameter measurement, Phase identification, phase quantification, Phase diagram determination X-ray diffraction application in the determination of crystal structure, lattice parameter, residual stress – Quantitative phase estimation, ASTM catalogue of Materials identification. ***Suggested Reading:*** Characterization of nano particles using X-Ray Diffraction	
MODULE 4: ELECTRON MICROSCOPY	**9**
Construction and operation of Transmission electron microscope – Diffraction effects and image formation, specimen preparation techniques, Selected Area Electron Diffraction, electron-specimen interactions, Construction, modes of operation and application of Scanningelectron microscope, Electron probe micro analysis, basics of Field ion microscopy (FIB),Scanning Tunneling Microscope (STM) and Atomic Force Microscope(AFM). ***Suggested Reading:*** Chemical analysis by X-ray analysis in electron microscopes	
MODULE 5: SURFACE ANALYSIS	**9**
Surface chemical composition- Mass spectroscopy and X-ray emission spectroscopy (Principle and limitations) - Energy Dispersive Spectroscopy- Wave Dispersive Spectroscopy-Quadrapole mass spectrometer. Electron spectroscopy for chemical analysis (ESCA),Ultraviolet Photo Electron Spectroscopy (UPS), X ray Photoelectron Spectroscopy (XPS),Auger Electron Spectroscopy (AES), Electron Energy Analysers, Secondary ion massspectrometry - Applications. Unit meshes of five types of surface nets - diffraction fromdiperiodic structures using electron, Low Energy Electron Diffraction (LEED), ReflectionHigh Energy Electron Diffraction (RHEED). ***Suggested Reading:*** *Softwares in surface analysis*	

TEXT BOOKS

1	Cullity, B. D.," Elements of X-ray diffraction", Addison-Wesley Company Inc., New York,3rd Edition, 2015
2	George F. Vander Voort,"Metallography, Principles and Practice", ASM International, 2007.

REFERENCE BOOKS

1	R. E. Smallman, K. H. G. Ashbee, "Modern Metallography", Pergaman Press, 2013.
2	David B. Williams, C. Barry Carter , "Transmission Electron Microscopy: A Textbook for Materials Science, 2009
3	Raghavan, v. , "Physical Metallurgy: Principles and Practice", PHI learning pvt ltd., 2015
4	C.A. Brebbia, "Materials Characterisation VII", WIT Press, UK, 2015.

5	Haines, P.J.," Principles of Thermal Analysis and Calorimetry", Royal Society of Chemistry (RSC), Cambridge, 2016.
6	D. A. Skoog, F. James Leary and T. A. Nieman, "Principles of Instrumental Analysis", Fifth Edition, Saunders Publishing Co., 1998
E BOOKS	
1	https://books.google.co.in/books?isbn=1292040548
2	https://books.google.co.in/books?id=pVJ8AAAAIAAJ
3	https://books.google.co.in/books?id=irHkAAAAMAAJ
4	https://books.google.co.in/books?isbn=0470031506
5	https://books.google.co.in/books?isbn=1782620516
MOOC	
1	https://www.edx.org/course/materials-science-engineering-misisx-mse1x
2	https://onlinecourses.nptel.ac.in/noc18_mm02/
3	http://nptel.ac.in/courses/113106034/

LIST OF DEPARTMENTAL ELECTIVES - SEMESTER V

COURSE TITLE	STRUCTURE AND PROPERTIES OF MATERIALS			CREDITS	3
COURSE CODE	MEC4351	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Explain the basic concepts of Structure And Properties of Materials, crystallography of materials, knowing basics about Nano and isotropic materials	1,2,5
2	Recognize basic microstructure, associate terms with the appropriate structure/phenomena, and be able to differentiate between related structures/ phenomena.	1,2,3,5
3	Explain the fundamental basis for materials phenomena. Assess the effect of ferrous and non-ferrous on material properties.	1,2,5,7,10
4	Create and analysis composite material, knowing about ceramics	1,2,4,5,12
5	Poses the knowledge in polymer and elastomer and ability to create the polymer blend in MATLAB©	1,2,5,10,12

Prerequisites : Nil

MODULE 1: STRUCTURE OF SOLIDS **10 hours**

Overview of Crystal Structure – Solid Solutions-Hume Rothery Rules-Defects in Crystal - Point Defects- Line Defects-Surface Defects-Bulk Defects-Critical nucleus size and Critical Free energy-Nucleation-Homogeneous and Heterogeneous Nucleation- Growth - Single crystal -Polycrystalline Materials metallic crystalline structure- crystallography– Advancement in solidification of metals and alloys. Growth of crystals- Planar growth – dendritic growth – Solidification time - Cooling curves - Non-crystalline solids- Glass Transition Temperature-Single walled nanotubes (SWNTs) and multi walled nanotubes (MWNTs)- Isotopic materials

Suggested Reading: Allotropes of carbon, fullerene structural family,

MODULE 2: PHASE DIAGRAMS **10 hours**

Phase Rule –Unary System- Binary Phase diagrams- Isomorphous systems-Congruent phase diagrams - Free energy Composition curves- Construction -Microstructural changes 33 during cooling- Tie Line- Lever Rule- Eutectic , Peritectic, Eutectoid and Peritectoid reactions- Hume-Ruthery conditions- Invariant Reaction- Martensitic growth Kinetics -Typical Phase diagrams – Cu-Zn System – Pb-Sn system- Ag-Pt system-Iron-Iron carbide Equilibrium Diagram

Suggested Reading: super critical fluid, Isobaric **and Isothermal Transitions of fluid**

MODULE 3: FERROUS AND NON FERROUS MATERIALS **9 hours**

Classification of steels and cast iron –Microstructure– Effect of alloying elements on steel- Ferrous alloys and their applications - Factors affecting conductivity of a metal – Strengthening and degradation - Temper Designations - Electrical Resistivity in alloys – Thermal conductivity of metals and alloys - High Resistivity alloys –Some important Titanium alloys, Nickel alloys, Copper alloys, Magnesium alloys and Aluminium alloys.

Suggested Reading: Copper beryllium microstructure, complex resistivity alloy material

MODULE 4: CERAMIC AND COMPOSITE MATERIALS 8 hours
Types - Crystal Structures - Silicate Ceramics - Glasses – Glass Ceramics – Advanced ceramics- Functional properties and applications of ceramic materials – Super hard materials - Tungsten carbide and Boron nitrides – Graphene. Classification of Composites - Fibre reinforced materials – Law of mixtures – Continuous fibres – Discontinuous fibres – Particle-reinforced composites – Cermets – Dispersion strengthened materials – Structural composites- Laminar – Sandwich panel- Application of composites in various fields of technology-Smart Composites- Function of matrix- desired properties of material **Suggested Reading:** experimental or CAD analysis on natural fiber reinforcement composites
MODULE 5: POLYMERS AND ELASTOMERS 8 hours
Classification of polymer – Mechanisms of polymerisation – Copolymers – polymer blend– Defects in polymers- Thermoplastics - Thermosets – Engineering plastics - Advanced Polymeric materials - Liquid crystal polymers - Conductive polymers – smart materials- application of smart materials - High Performance fibres– Photonic polymers- -Elastomers- Applications-Electronic materials. **Suggested Reading:** simulation of self-assembling polymer blend using MATLAB© software

TEXT BOOKS	
1	William D. Callister, Jr., “Materials Science and Engineering an Introduction”, 9 Edition, John Wiley & Sons, Inc., 2013.
2	Elliot P. Douglas, “Introduction to Material Science and Engineering”, 1st Edition, Pearson, 2013
REFERENCE BOOKS	
1	Sidney H. Avner, “Introduction to Physical Metallurgy”,2nd Edition, Tata Mc-Graw-Hill Inc, 2017.
2	W.Boltan, “ Materials for Engineering”, 2nd Edition, Routledge, 2016
3	Susan Trolier-McKinstry, “Materials Engineering”, 1st Edition, Cambridge University Press, 2017
4	Tim A. Osswald “Material Science of Polymer for Engineers”, 3Edition, Hanser, 2012.
5	William F. Smith, “Structure and Properties of Engineering Alloys”, 2Edition, Mc Graw Hill India 2014
E BOOKS	
1	https://books.google.co.in/books?isbn=007048287X - V. S. R. Murthy
2	https://books.google.co.in/books?id=exF4rgEACAAJ - John Wulff
3	https://books.google.co.in/books?isbn=0191523402 - Robert E. Newnham
4	https://books.google.co.in/books?isbn=047136469X – John Wiley
MOOC	
1	http://nptel.ac.in/courses/112104203/
2	http://nptel.ac.in/courses/112108150/
3	http://nptel.ac.in/courses/112104122/10

COURSE TITLE	ENGINEERING ECONOMICS AND COST ANALYSIS			CREDITS	3
COURSE CODE	MEC4352	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Understand the basic characteristics of engineering economics and the different cost elements.	1,2,8,11
2	Understand the time value of money, and the various factors & methods available for comparing alternatives.	1,2,8,11
3	Understand how depreciation, maintenance and replacement affect the economic life of assets.	1,2,8,11

Prerequisites : Nil

MODULE 1: INTRODUCTION TO ECONOMICS 8

Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics- Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis- V-ratio, Elementary economic Analysis–Material selection for product design selection for a product, Process planning.

Suggested Reading: Engineer's role in corporate profitability, Economic viability of projects, Cost-Benefit Analysis

MODULE 2: VALUE ENGINEERING 10

Make or buy decision, Value engineering – Function, aims, Value engineering procedure. Interestformulaeandtheirapplications–Timevalueofmoney,Singlepaymentcompoundamount factor, Singlepayment present worth factor, Equal payment series sinkingfund factor,Equal paymentseriespaymentPresentworthfactor-equalpaymentseriescapitalrecoveryfactor-Uniform gradient series annual equivalent factor, Effective interest rate, Examples in all the methods.

Suggested Reading: Before- and After-Tax considerations, Compounding other than annually

MODULE 3: CASH FLOW 9

Methods of comparison of alternatives – present worth method (Revenue dominated cash flow diagram),Future worth method (Revenue dominated cash flow diagram, cost dominated

Cash cost dominated cash flow diagram), Annuale quivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method, Examples in all the methods.

Suggested Reading: Estimating capital and other investments

MODULE 4: REPLACEMENTAND MAINTENANCEANALYSIS 9

Replacement and Maintenance analysis– Types of maintenance, types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset – capital recovery with return and concept of challenger and defender, Simple probabilistic model for items

which fail completely. **Suggested Reading:** Defining capital and production costs, Fixed and variable costs	
MODULE 5: DEPRECIATION	**9**
Depreciation- Introduction, Straight line method of depreciation, declining balance method of depreciation-Sum of the years digits method of depreciation, sinking fund method of depreciation/ Annuity method of depreciation, service output method of depreciation-Evaluation of public alternatives- introduction, Examples, Inflation adjusted decisions – procedure to adjust inflation, Examples on comparison of alternatives and determination of economic life of asset. **Suggested Reading:**Types of Assets, Inflation and Indices	
TEXT BOOKS	
1	Panneerselvam, R, “Engineering Economics”, 2nd edition, Prentice Hall of India Pvt Ltd, New Delhi, 2013.
REFERENCE BOOKS	
1	Park, Chan S., “Contemporary Engineering Economics”, 6th edition, Pearson Education Ltd, 2016.
2	Newnan, Donald G., Eschenbach, Ted G., and Lavelle, Jerome P., “Engineering Economics Analysis”, 13th edition, Oxford University Press, USA, 2017.
3	Sullivan, William G., Wicks, Elin M., Koelling, C. Patrick, "Engineering Economy", 15th edition, Prentice Hall, Boston, 2012.
4	Yates, J.K.,“Engineering Economics”, CRC Press, 2016.
E BOOKS	
1	https://books.google.co.in/books?id=AY67AQAAQBAJ - “Engineering Economics”, Panneerselvam, R.
2	https://books.google.co.in/books?id=A-iVDQAAQBAJ – “Engineering Economics”, Yates, J.K.
MOOC	
1	http://www.nptel.ac.in/courses/112107209/
2	https://onlinecourses.nptel.ac.in/noc18_me35/preview

COURSE TITLE	TOOL DESIGN			CREDITS	3
COURSE CODE	MEC4353	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Recognize the materials properties, tool nomenclature and to categories the cutting tools.	1,2,3
2	Interpret the parameters of cutting tools for machining process; identify the types of jigs and fixtures.	1,2,4,5
3	Distinguish the various locating and clamping methods	1,2,4,5
4	Design the jig, fixture, press tools and molds	1,2,5

Prerequisites : Design of Machine Element

MODULE 1: PURPOSE TYPES AND FUNCTIONS OF JIGS AND FIXTURES 8

Tool design objectives - Production devices - Inspection devices - Materials used in Jigs and Fixtures - Types of Jigs - Types of Fixtures-Mechanical actuation-pneumatic and hydraulic actuation-Analysis of clamping force-Tolerance and error analysis.Non Traditional Manufacturing, Forces Developing and Acting In Machine Tools.

Suggested Reading: Estimation of Machining Time ,Conventional Cutting Tool Maths

MODULE 2: JIGS 9

Drill bushes -different types of jigs-plate latch, channel, box, post, angle plate, angular post, turnover, pot jigs-Automatic drill jigs-Rack and pinion operated. Air operated Jigs components. Design and development of Jigs for given components.Jigs For Machine Shops. Concept of Machinability and its Improvement

Suggested Reading: Material properties, classification, carbide insert type tools.

MODULE 3: FIXTURES 9

General principles of boring, lathe, milling and broaching fixtures- grinding, planning and shaping fixtures, assembly, Inspection and welding fixtures- Modular fixtures. Design and development of fixtures for given component. Fixtures For Machine Shops

Suggested Reading:Fixtures for cutting tools.

MODULE 4: PRESS WORKING TERMINOLOGIES AND ELEMENTS OF DIES AND STRIP LAY OUT 10

Press working terminology-Presses and press accessories-Computation of capacities and tonnage requirements. Elements of progressive combination and compound dies: Die block-die shoe. Bolster plate-punch plate-punch holder-guide pins and bushes - strippers - knockouts-stops -pilots-Selection of standard die sets strip lay out-strip lay out calculations. Design and manufacture of drills, hobs and gear shaper cutters.

Suggested Reading: Basic construction of moulds, types of moulds, mould damping method.

MODULE 5: DESIGN AND DEVELOPMENT OF DIES	9
Design and development of progressive and compound dies for Blanking and piercing operations. Bending dies - development of bending dies-forming and drawing dies-Development of drawing dies. Design considerations in forging, extrusion, casting and plastic dies. **Suggested Reading**: Design of dies for sheet metal components, Simulation for Industrial Control of a Sheet-Metal-Rolling Application using MATLAB©	
TEXT BOOKS	
1	Edward G Hoffman, Jigs & Fixture Design, Thomson - Delmar Learning, Singapore, 5th Edition, 2010.
2	Donaldson. C, Tool Design, Tata McGraw-Hill,4 Edition, (20 April2012)
3	P.H. JOSHI Jigs and Fixtures ,McGraw Hill Education; 3 edition (1 July 2017)
4	Hiram E Grant JIGS AND FIXTURES: Non-standard Clamping Devices McGraw Hill Education (December 1989)
5	Cyril Donaldson, George H. Lecain , VC Goold ,Tool Design (SIE)McGraw Hill Education; 4 edition (20 April 2012)
REFERENCE BOOKS	
1	Luqman M, Sheet Metal Press Tools Design Making CBS Publishing; First edition (31 January 2015)
2	Vukota Boljanovic, Sheet Metal Forming Processes and Die Design Industrial Press Inc.,U.S.; 2nd Revised edition edition (1 April 2014)
E BOOKS	
1	https://openlibrary.org/subjects/jigs_and_fixtures
2	https://books.google.co.in/books/about/Jig_and_Fixture_Design.html?id=6UFhomTE8KYC
3	SHIGLEYhttps://drive.google.com/open?id=0B7JWdKw_4Q07WGFSTk8tcGhRVm8
4	BORISKLEBANOVhttps://drive.google.com/open?id=0B7JWdKw_4Q07bEVaSE5uT3VFUTQ
MOOC	
1	http://nptel.ac.in/courses/112105126/34
2	http://freevideolectures.com/Course/2369/Manufacturing-Processes-II/35

COURSE TITLE	APPLIED HYDRAULICS & PNEUMATICS			CREDITS	3
COURSE CODE	MEC4354	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Conceptual understanding of fluid power system and fundamentals. Physics of Pascal's law, laminar and turbulent flow, Reynolds number and Darcy's equation.	1,2,5
2	Understanding the concept of hydraulics system and various components of hydraulics system like pumping theory, cylinders and Actuators.	1,2,4
3	Able to design a hydraulic circuits and understanding the concept of hydraulic valves and accumulators and its type.	1,2,3,4,5,12
4	Understanding pneumatics systems like compressor, valves, filter regulator and lubricant units and able to design a pneumatic and hydraulic circuit and understand a symbols and standard.	1,2,5
5	Able to design a pneumatic circuit system with servo motor and understanding the logic circuit and ladder diagram and PLC units .	1,2,3,5,11,12

Prerequisites : Fluid Mechanics and Machinery, Mechatronics and Pneumatic

MODULE 1: FLUID POWER SYSTEMS AND FUNDAMENTALS **9**

Introduction to fluid power, Advantages of fluid power, Application of fluid power system. Types of fluid power systems, Properties of hydraulic fluids - General types of fluids - Fluid power symbols. Basics of Hydraulics-Applications of Pascal's Law- Laminar and Turbulent flow - Reynolds number - Darcy's equation - Losses in pipe, valves and fittings.

Suggested Reading: Fluid power Industry in India, Comparison of Properties.

MODULE 2: HYDRAULIC SYSTEM & COMPONENTS **9**

Sources of Hydraulic Power: Pumping theory - Pump classification - Gear pump, Vane Pump, Piston pump, construction and working of pumps - pump performance - Variable displacement pumps. Fluid Power Actuators: Linear hydraulic actuators - Types of hydraulic cylinders - Single acting, Double acting, special cylinders like Tanden, Rodless, Telescopic, Cushioning mechanism, Construction of double acting cylinder, Rotary actuators - Fluid motors, Gear, Vane and Piston motors.

Suggested Reading: Hydrodynamic and hydrostatic pumps, Screw Pump, Cylinder Mounting Configurations, Cylinder Cushioning.

MODULE 3: DESIGN OF HYDRAULIC CIRCUITS **9**

Construction of Control Components : Direction control valve - 3/2 way valve - 4/2 way valve - Shuttle valve - check valve - pressure control valve - pressure reducing valve, sequence valve, Flow control valve - Fixed and adjustable, electrical control solenoid valves, Relays, ladder diagram.

Accumulators and Intensifiers : Types of accumulators - Accumulators circuits, sizing of accumulators, intensifier Applications of Intensifier - Intensifier circuit.

Suggested Reading: Unloading Valve, Counterbalance Valve, Proportional Valves, Regenerative Circuits, Design of Safety Circuits in Simulink software.

MODULE 4: PNEUMATIC SYSTEMS AND COMPONENTS 9

Pneumatic Components: Properties of air - Compressors - Filter, Regulator, Lubricator Unit - Air control valves, Quick exhaust valves, pneumatic actuators.

Fluid Power Circuit Design, Speed control circuits, synchronizing circuit, Pneumatic and Hydraulic circuit, Sequential circuit design for simple applications using cascade method.

Suggested Reading:Mufflers, Sizing of Compressors, Air Motors, Vacuum Suction Cup.

MODULE 5: DESIGN OF PNEUMATIC CIRCUITS 9

Servo systems - Hydro Mechanical servo systems, Electro hydraulic servo systems and proportional valves. Fluidics - Introduction to fluidic devices, simple circuits, Introduction to Electro Hydraulic Pneumatic logic circuits, ladder diagrams, PLC applications in fluid power control. Fluid power circuits; failure and troubleshooting.

Suggested Reading: Hydro-pneumatic Systems, Installation and Maintenance of Hydraulic Systems, Design a pneumatic system for sorting of components using MATLAB© software.

TEXT BOOKS

1	Anthony Esposito, Fluid Power with Applications, Pearson Education, 7th Edition, 2014.
2	Majumdar S.R., Oil Hydraulics, Tata McGraw-Hill, New Delhi 2015.

REFERENCE BOOKS

1	Majumdar S.R., Pneumatic systems - Principles and maintenance, Tata McGraw Hill, New Delhi 2013.
2	Srinivasan.R, “Hydraulic and Pneumatic controls”, Vijay Nicole, 2006.
3	James R. Daines, Fluid Power: Hydraulics and Pneumatics, Goodheart-Willcox Publisher, Second Edition, 2012.
4	James L. Johnson, Introduction to Fluid Power, First Edition, 2002.

E BOOKS

1	https://docs.zoho.com/file/2bvxi8191d4a73d1d4f05941a1f132f86ae1a - Fluid power with Applications – Anthony Esposito
2	http://pages.hydraulicspneumatics.com/fluid-power-basics?code=UM_NX7UMB3 – Fluid Power Basics
3	http://controlmanuals.com/files/Automation/Fluid-Power/TSM-363-Fluid-Power-Systems~ppt908.html
4	https://www.pdfdrive.net/industrial-fluid-power-e3104018.html

MOOC

1	https://www.mooc-list.com/course/hydraulics-%E6%B0%B4%E5%8A%9B%E5%AD%A6-edx
2	https://www.mooc-list.com/course/fundamentals-fluid-power-coursera

COURSE TITLE	AUTOMOBILE ENGINEERING			CREDITS	3
COURSE CODE	MEC4355	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Identify the different parts of the automobile	1,2
2	Explain the working of various parts like engine, transmission, clutch, brakes	1,2,5
3	Describe how the steering and the suspension systems operate	1,2,4,5,10
4	Understand the environmental implications of automobile emissions	1,2,5
5	Develop a strong base for understanding future developments in the automobile industry	1,2,5,12

Prerequisites : Nil

MODULE 1: ENGINES **9**

Constructional details of engines - engine parts - piston - different types - piston rings cylinder block, cylinder head-gudgeon pin-connecting rod-bearing bushes-different type of bearings.

Suggested Reading: History and classification of automobiles, Engine classification and trouble shooting.

MODULE 2: ENGINE AUXILLARY SYSTEM **9**

Cooling - purpose of cooling - types of cooling systems - air cooling - water cooling - steam cooling - radiator - types of radiators- constructional details thermostat-temperature indicators. Fuel systems-fuel system components-fuel tank-fuel filters and screens-fuel gauges-fuel pumps-carburettors - petrol injection system-diesel pump-injectors ignition system- battery and coil ignitionmagneto ignition.

Suggested Reading: Lubrication- purpose of lubricating systems- grading of oils- service ratings of oils- oil pumps- oil filters- oil pressure indicators.

MODULE 3: POWER TRAIN AND CONTROL SYSTEM **9**

Transmission – clutch-types of clutches-single and multi plate clutches-centrifugal clutch-fluid coupling-torque converter-gear box-sliding mesh-constant mesh-synchro mesh. Brakes- mechanical and hydraulic brakes- vacuum, servo and air brakes –different components of braking systems and their functions-constructional details. Steering mechanism – steering geometry-steering gears-worm and wheel gearspower assisted steering-wheel alignment-caster, camber, toe in, toe out; king pin inclination.

Suggested Reading: ABS, air bag, propeller shaft-universal coupling-differential-axle-semi floating, three-fourth floating, fully floating

MODULE 4: CHASSIS AND SUSPENSION **9**

Chassis and suspension – chassis lay out-road springs-shock absorbers-independent suspension – torsion bars – air suspension systems – independent rear suspension-wheel balancing-tyres and

tubes. Starting mechanism – starter drives-bendix drive-over running clutch. **Suggested Reading:** Tubless tyre**,** wheel balancing. Automobile air-conditioning.	
MODULE 5: ELECTRICAL AND MODERN TRENDS	**9**
Electrical equipments – battery-battery charging-charging circuit-regulating generator output-wiring circuit Electronic equipments Modern trends in automobiles - Hybrid cars, electric cars and solar power cars – air pollution and control – pollution rating. **Suggested Reading**: Barth and euro emission norms, Driving cycle and vehicle safety	
TEXT BOOKS	
1	R.B.Gupta, Automobile Engg, 3 rd edition 2016, SatyaPrakashan Publication.
2	N.K. Giri , Automobile Technology, 1st edition 2015, Khanna Publication.
REFERENCE BOOKS	
1	Joseph Heitner, Automotive mechanics, 2nd Edition, D.VanNostrand Company Inc., New York,2004
2	K. Newton,W. Steeds, Motor Vehicle, 13th Edition, ELBS Publishers, London,2000.
3	W.H.Crouse, D.L.Anglin, Automotive Engines, 8th Edition, McGrawHill, NewYork,1995
E BOOKS	
1	https://books.google.co.in/books?id=nBVefxD_0agC&lpg=PP1&dq=A%20text%20book%20of%20automobile%20engineering&pg=PA843#v=onepage&q=A%20text%20book%20of%20automobile%20 engineering&f=false
2	https://books.google.co.in/books?id=C8UMQDBXBQQC&lpg=PP1&dq=A%20text%20book%20of%20automobile%20engineering&pg=PP1#v=onepage&q=A%20text%20book%20of%20automobile%20engineering&f=false
MOOC	
1	https://www.edx.org/micromasters/chalmersx-emerging-automotive-technologies
2	https://www.udemy.com/automobile-engineering-from-zero-to-100-for-everyone/

COURSE TITLE	OPERATIONS RESEARCH			CREDITS	3
COURSE CODE	MEC4356	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Apply operations research techniques like L.P.P, scheduling and sequencing in industrial optimization problems.	1,2,3,5,11
2	Solve transportation problems using various OR methods.	1,2,5,11
3	Illustrate the use of OR tools in a wide range of applications in industries	1,2,5,12
4	Gain knowledge on current topics and advanced techniques In Operations Research for industrial solutions	1,2,3,5,11
5	Analyze various OR models like Inventory, Queing, and apply them for optimization	1,2,5,11

Prerequisites : Basic technical Mathematics

MODULE 1: LINEAR MODELS **9**

Formulation - Graphical Solution - Bounded and Unbounded Solutions - Simplex Method - Big M method- Duality - Two phase Method - Dual Simplex method.

Suggested Reading: Linear programming using MATLAB©

MODULE 2: ASSIGNMENT AND TRANSPORTATION MODELS **9**

Hungarian Method - Maximization and unbalanced assignment problem. Basic feasible solution of transportation problem - Mode method - Degeneracy - Unbalanced Transportation problem - Travelling Salesman Problem.

Suggested Reading: Transportationg problems using Matlab©

MODULE 3: SEQUENCING AND NETWORK MODELS **9**

Johnson's Algorithm - Two Machine and three Machine problem. Network diagram - Representation - Labelling – CPM - PERT probabilities of CPM - PERT probabilities of project duration

Suggested Reading:sheduling problems using Matlab©

MODULE 4: DECISION MODELS **9**

Game theory with saddle point and without saddle point - Dominance properties - Graphical Solutions. Replacement models – Items that deteriorate with time - When money value changes – Items that fail completely – Individual replacement and Group replacement.

Suggested Reading: decision strategy using MatLab©

MODULE 5: INVENTORY AND QUEING MODELS **9**

Purchase Model with and without Shortages - Manufacturing Model with and without shortages Probabilistic Model. Queuing models – Poisson arrivals and Exponential service times – Single channel models and Multi channel models.

Suggested Reading:queingmodles using Matlab©.

TEXT BOOKS	
1	Hamdy A Taha "Operations Research : An Introduction" 9th Edition 2016,Pearson Education.
2	J.K.Sharma" Operations Research: Thoery and Applications" 5th edition 2012,Macmillan Publishers.
REFERENCE BOOKS	
1	S.Kalavathy "Operations Research" Fourth Editon 2013,Vikas Publishing House.
2	PK Gupta,D.S.Hira"OperationsResearch"Revised edition 2014.,S.Chand Publishers.
E BOOKS	
1	https://books.google.co.in/books?isbn=8121902819
2	https://books.google.co.in/books?isbn=8121909686
MOOC	
1	https://swayam.gov.in/courses/1342-introduction-to-operations-research
2	https://onlinecourses.nptel.ac.in/noc17_mg10/preview

COURSE TITLE	MAINTENANCE ENGINEERING AND CONDITION MONITORING			CREDITS	3
COURSE CODE	MEC4357	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Understand maintenance activities and calculate machine availability	1,2,5
2	Develop preventive maintenance schedule	3,5,6
3	Understand and appreciate the basic concepts of condition monitoring	1,2,10,12
4	Identify machine faults and take corrective action	1,2,4,5,12
5	Understand the need for safety engineering and its tools	1,2,5,12

Prerequisites : Nil

MODULE 1: PRINCIPLES OF MAINTENANCE PLANNING 10

Basic Principles of maintenance planning - Objectives and principles of planned maintenance activity Importance and benefits of sound Maintenance systems - Reliability and machine availability MTBF, MTTR and MWT - Factors of availability - Maintenance organization - Maintenance economics.

Suggested Reading: computer aided maintenance management systems, RAM (Reliability, availability ,maintainability)

MODULE 2: MAINTENANCE POLICIES 9

Maintenance categories - Comparative merits of each category - Preventive maintenance, maintenance schedules, repair cycle - Principles and methods of lubrication - TPM

Suggested Reading: Statutory requirements on EHS

MODULE 3: CONDITION MONITORING	9
Condition Monitoring - Cost comparison with and without CM - On-load testing and off-load testing Methods and instruments for CM - Temperature sensitive tapes - pistol thermometers - wear-debris analysis – use of model predictive control tool box in MATLAB© Suggested Reading: vibration analysis and current signature analysis, CBM (Condition based maintenance)	
MODULE 4: REPAIR METHODS FOR BASIC MACHINE ELEMENTS	**9**
Repair methods for beds, slideways, spindles, gears, lead screws and bearings - Failure analysis Failures and their development - Logical fault location methods - Sequential fault location. Suggested Reading: Science of friction and wear	
MODULE 5: SAFETY ENGINEERING	**8**
Industrial hazards and safety – Cause of accidents and preventive measures - Safety equipment – Safety Planning Suggested Reading: Factory Act and statutory requirement on industrial safety	

TEXT BOOKS	
1	Mishra, R. C. and Pathak, K., Maintenance Engineering and Management, Second Edition, Prentice Hall of India, New Delhi, 2004.
2	Planning and control of Maintenance systems : Modelling and Analysisi, Duffuaa S: Raouf A - 2015

REFERENCE BOOKS	
1	Dhillon B.S., Engineering Maintenance: A Modern Approach, Taylor & Francis Group, 2002.
2	Methodologies and Techniques for Advanced Maintenance, Fedele, Lorenzo, 2011
3	Mishra R C and Pathak K., Maintenance Engineering and Management, PHI Learning Pvt., New Delhi 2009
4	Venkataraman, Manitenance Engineering and Management, Prentice Hall Learning Private Limited, 2007
5	Davies, Handbook of Condition Monitoring, Chapman & Hall, 1996.

E BOOKS	
1	https://www.amazon.co.uk/Maintenance-Engineering-Handbook-Eighth-Mobley/dp/0071826610
2	https://www.amazon.in/Maintenance-Engineering...K...ebook/dp/B00K7YGK8K

MOOC	
1	www.nptelvideos.com/lecture.php?id=14763
2	nptel.ac.in/courses/112107142/28

LIST OF DEPARTMENTAL ELECTIVES - SEMESTER VI

COURSE TITLE	TRIBOLOGY IN DESIGN			CREDITS	3
COURSE CODE	MEC4366	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

Prerequisites : Manufacturing Technology II

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Understand surface interaction and friction between mating materials	1,2,5
2	Understand different wear types and surface modification technique	2,3,5
3	Apply the types of lubricants in different machining processes	1,2,5
4	Understand and applying tribology in bearing	1,2,4,5,12
5	Understand and apply contacts under lubrication	1,2,5,12

MODULE 1: SURFACE INTERACTION AND FRICTION 7

Topography of Surfaces – Surface features-Properties and measurement – Surface interaction – Adhesive Theory of Sliding Friction –Rolling Friction-Friction properties of metallic and non-metallic materials – friction in extreme conditions –Thermal considerations in sliding contact, effects of friction, wear and lubrication in metal working. Abrasive Wear Resistance of Materials, Transfer films in Adhesion.

Suggested Reading: Tribology in Metal working industries, measuring surface roughness and analysing surface roughness power spectrum tool in MATLAB©

MODULE 2: WEAR AND SURFACE TREATMENT 8

Types of wear – Mechanism of various types of wear – Laws of wear –Theoretical wear models- Wear of Metals and Non metals – Surface treatments – Surface modifications – surface coatings methods- Surface Topography measurements –Laser methods – instrumentation - International standards in friction and wear measurements

Suggested Reading: Introduction to Nano Tribology, measuring dimensional surface roughness power spectrum of a profile tool or topography using MATLAB©

MODULE 3: LUBRICANTS AND LUBRICATION REGIMES 8

Lubricants and their physical properties- Viscosity and other properties of oils –Additives-and selection of Lubricants- Lubricants standards ISO,SAE,AGMA, BIS standards – Lubrication Regimes –Solid Lubrication-Dry and marginally lubricated contacts- Boundary Lubrication- Hydrodynamic lubrication –– Elasto and plasto hydrodynamic - Magneto hydrodynamic lubrication – Hydro static lubrication – Gas lubrication,

Suggested Reading: Nano Tribology, Measurement tools – fabrication techniques

MODULE 4: THEORY OF HYDRODYNAMIC AND HYDROSTATIC LUBRICATION 10

Reynolds Equation,-Assumptions and limitations-One and two dimensional Reynolds Equation- Reynolds and Somerfield boundary conditions- Pressure wave, flow, load capacity and friction

calculations in Hydrodynamic bearings-Long and short bearings-Pad bearings and Journal bearings-Squeeze film effects-Thermal considerations-Hydrostatic lubrication of Pad bearing- Pressure , flow , load and friction calculations-Stiffness considerations- Various types of flow restrictors in hydrostatic bearings

Suggested Reading: Nano Tribology, ,Seals – types of seals ,Friction in seals – characteristics

MODULE 5: HIGH PRESSURE CONTACTS AND ELASTO HYDRODYNAMIC LUBRICATION 12

Rolling contacts of Elastic solids- contact stresses – Hertz an stress equation-Spherical and cylindrical contacts-Contact Fatigue life- Oil film effects- Elasto Hydrodynamic lubrication Theory-Soft and hard EHL-Reynolds equation for Elasto hydrodynamic lubrication- - Film shape within and outside contact zones-Film thickness and friction calculation- Rolling bearings- Stresses and deflections-Traction drives

Suggested Reading :Nano Tribology, Measurement techniques – contact and non-contact type.

TEXT BOOKS

1	R. ARNELL ,Tribology: Principles and Design Applications , Springer; Softcover reprint of the original 1st ed. 1991 edition (14 June 2012)
2	J.Paulo davim Tribology in Manufacturing Technology (Materials Forming, Machining and Tribology)Springer; 2013 edition (8 September 2012)
3	Michael M. Khonsari , E. Richard Booser, Applied Tribology: Bearing Design and Lubrication (Tribology in Practice Series),Wiley; 3 edition (1 August 2017)
4	T. A. Stolarski , Tribology in Machine Design, Newnes (22 October 2013)

REFERENCE BOOKS

1	V.B.Bhandari “Design of Machine Elements “third edition. Tata McGraw hill Edition Pvt, 2012
2	Paulo Davim J, Green Manufacturing Processes and Systems (Materials Forming, Machining and Tribology) Springer; 2013 edition (31 October 2012).

E BOOKS

1	SMALLMAN,BISHOPhttps://drive.google.com/open?id=0B7JWdKw_4Q07QzJaZVpaeXBPOFU
2	https://www.whsmith.co.uk/dept/ebooks-technology-and-engineering-tribology-friction-and-lubrication-05x02119
3	https://www.ellibs.com/book/9783642036538/advanced-tribology

MOOC

1	https://www.edx.org/course/lean-production-tumx-qpls3x

COURSE TITLE	QUALITY AND RELIABILITY ENGINEERING			CREDITS	3
COURSE CODE	MEC4367	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
On completion of this course, students will be able to:		
1	Develop an understanding on quality management philosophies and frameworks for reliability in Engineering.	1,2,3,8,PSO2
2	Analyze the SQC tools, concepts of reliability, availability and maintainability	1,2,6,8,9, PSO2
3	Apply the QMS tools and Build system reliability models for different configurations	1,2,6,8, PSO2
4	Asses reliability of components and systems using field and test data	1,2,8,9, PSO2
5	Implement strategies for improving reliability of repairable and non-repairable systems	1,2,6,8,9, PSO2

Prerequisites : Statistics and Numerical Methods

MODULE 1: QUALITY **9**

Quality: Definition, History, Importance, Cost of Quality, Approaches of Quality Management. Hierarchy of Quality management: Inspection & Test, Quality Control, Quality Assurance, Total Quality Management: Definition, Models of TQM, Elements of TQM, Principles of TQM - Edward Deming's approach, PDCA cycle, Joseph M. Juran's approach, JIT, Training for Quality management - Quality Improvement Programme: Histogram, Charts, Brain-storming, Cause & Effect diagram, Pareto analysis.

Suggested Reading: Quality Function Deployment, Quality cost systems and Quality Policy Deployment.

MODULE 2: STATISTICAL QUALITY CONTROL **9**

SQC tools, Benefits of SQC, Concept of variation, Assignable & Chance causes, Attributes & variables, Frequency Distribution curve & its types. Normal Distribution curve, Problems on Frequency Distribution curve & Normal Distribution curve. Control chart for variable: Definition, Formulae & its problems. Control chart patterns, Process capability. Problems on X & R chart and Process capability. Control chart for attribute: Definition, Formulae & its problems. Problems on p-charts and c-charts.

Suggested Reading: Sampling: Definition, types of sampling, importance, benefits and limitations of sampling.

MODULE 3: QUALITY MANAGEMENT SYSTEMS **9**

Quality Assurance (QA): Introduction, Definition, Management principles in QA, Forms of QA, QA in different stages - Quality planning, QA program, QA aspect, Quality in material management, Vendor selection & development - ISO: Introduction, ISO 9000 series of standard, ISO 9001 clauses, Registration process, Benefits of ISO - ISO 9001 clauses, Registration process, Benefits of ISO - Quality survey: Scope, Types of audit, inspection methods, Quality budget, Vendor Quality Rating.

Suggested Reading: Quality Circle: Quality Circle structure, Its operation, Characteristics of Quality Circle, Basic problem solving techniques. Introduction to Six Sigma and Taguchi concepts.

MODULE 4: RELIABILITY CONCEPTS 9

Elements of probability, Reliability engineering fundamentals, Failure data analysis and examples, Failure rate, Failure density, Probability of failure, Mortality rate, mean time to failure, Reliability in terms of Hazard rate and Failure Density, examples, Useful life and wear out phase of a system, Concept of burnperiod. Hazard Models, Conditional Probabilities and examples, Multiplication rule and examples, Bayes theorem and examples.

Suggested Reading: Weibull model, system reliability, series, parallel and mixed configuration – simple problems

MODULE 5: SYSTEM RELIABILITY AND IMPROVEMENT 9

Reliability of series and parallel connected systems and examples, Logic diagrams, An r-out of -n structures, Improvement of components, Element Redundancy, Unit redundancy, Standby redundancy.

Suggested Reading: Product design – Product analysis – Product development – Product life cycles.

TEXT BOOKS

1	Douglas. C. Montgomery, "Introduction to Statistical quality control", 13th edition, John Wiley 2016.
2	Besterfield. D. H., "Quality Control", Prentice Hall, 2017.
3	John. S. Oakland. "Statistical process control", 9th edition, Elsevier, 2015.

REFERENCE BOOKS

1	Samunel. K. H., TQM - an integrated approach, Crest publishing House, 2011.
2	Grant, Eugene. I., "statistical quality control", McGraw-hill, 2013.
3	Srinath. I. S. "Reliability Engineering" Affiliated east west press, 2012.
4	MonoharMahajan, "Statistical quality control", DhanpatRai& Sons, 2014.
5	Danny Samson, "Manufacturing & Operations Strategy", Prentice Hall, 2016
6	Connor, P.D.T.O., "Practical Reliability Engineering", John Wiley, 2013.

MOOC

1	https://www.csudh.edu/qa-ms/certificates/reliability-engineering/

COURSE TITLE	PRODUCTIVITY MANAGEMENT AND RE-ENGINEERING			CREDITS	3
COURSE CODE	MEC4368	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Understand productivity concepts and its measurement methods	1,6,7,8,12
2	Learn the principles of organizational transformation	1,6,7,8,12
3	Learn the business strategy, marketing strategy	1,6,9,10,12
4	Develop Business Process Reengineering Methodologies	1,6,9,10,12
5	Implementation of Reengineering models	1,6,9,10,12

Prerequisites : Nil

MODULE 1: PRODUCTIVITY CONCEPTS AND MEASURES 9

Productivity Concepts, Partial-Factor Productivity, Total Factor Productivity, Productivity Measures,Use of Productivity Measures, Factors Affecting Productivity, Productivity Index, Improving Productivity, Productivity at the National.

Suggested Reading: Investments in physical capital, human capital and innovation drive productivity

MODULE 2: PRODUCTIVITY CONCEPTUAL FRAME WORK 9

Business strategy, Marketing strategy, Management strategy, Segmentation, Targeting, Marketing mix, Management by Objectives (MBO), Performance Objectives Productivity (POP) – Methodology and application to manufacturing and service sector.

Suggested Reading:materials management function in a firm

MODULE 3: MANAGING ORGANISATIONAL TRANSFORMATION 9

Elements of Organisational Transformation, key stages for managing organisational transformation - Types of Transformation - Improving Operation ,Strategic Transformation ,Corporate Self Renewal - Phases of Transformation

Suggested Reading:organizational goals and planning

MODULE 4: BUSINESS PROCESS RE-ENGINEERING 9

Business Process Reengineering Methodologies-Introduction into Business Reengineering, Identification of Business Processes,Selection of Business Processes, Understanding of Selected Business Processes,Redesign of the Selected Business Processes, Implementation of Redesigned Business Processes

Suggested Reading: PDCA improvement cycle in manufacturing industries

MODULE 5: RE-ENGINEERING MODELS AND IMPLEMENTATION 9

PMI LES Model, COBRA, LMI CIP Transformation Model, DSMC Q & PMP model, Moen and Nolan Strategy for process improvement, NPRDC Model- Implementation of Reengineering Projects – Success Factors and common implementation Problem – Cases.

Suggested Reading: surrogate models, product oriented models

TEXT BOOKS	
1	James Cox III, John Schleier, "Theory of Constraints for Personal Productivity Dilemmas",McGraw Hill Professional, 2010.
2	Robert D. Pritchard, Sallie J. Weaver, ElissaAshwood, "Evidence-Based Productivity Improvement" Routledge, 2012.
3	Jeffrey Magee, "The Managerial Leadership Bible" FT Press, 2015.
4	James F. Chang, "Business Process Management Systems: Strategy and Implementation", CRC Press, 2016.
5	Carolina Machado, J. Paulo Davim, "Productivity and Organizational Management", Walter de Gruyter GmbH & Co KG, 2017.
REFERENCE BOOKS	
1	Matthew P. Stephens, "Productivity and Reliability-Based Maintenance Management Purdue" University Press, 2010.
2	Productivity Measurement in the Retail and Food Industry, Asian Productivity Organization (APO), Tokyo, 2012.
3	Kurt Lehberger ,"Management Concept of Business Process Reengineering", GRIN Verlag, 2016.
4	Giles Johnston "Business Process Re-Engineering: A Simple Process Improvement Approach to Improve Business Performance "The Business Productivity Series, 2017.
E BOOKS	
1	https://books.google.co.in/books?isbn=1574440578- David J. Sumanth
2	https://books.google.co.in/books?isbn=0873893395- Joseph N. Kelada
3	https://books.google.co.in/books?isbn=038734876X- J. Browne, David O'Sullivan
4	https://books.google.co.in/books?isbn=1317463005 - Evan Berman
MOOC	
1	https://www.mooc-list.com/course/fundamentals-project-planning-and-management-coursera
2	http://nptel.ac.in/courses/112107143
3	http://nptel.ac.in/downloads/110105034/
4	http://nptel.ac.in/courses/110105033/
5	http://nptel.ac.in/courses/112107142/12
6	https://swayam.gov.in/

COURSE TITLE	POLYMER SCIENCE AND ENGINEERING			CREDITS	3
COURSE CODE	MEC4369	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Explain the basic concepts of Polymer, Nano materials and smart materials	1,2,5
2	Calculate molecular weight of the Polymer materials	1,2,4,5
3	Gaining knowledge about Transitions, crystallization in Polymers and the concept of metastable state, simulation of self-assembling polymer blend using MATLAB© software	1,2,3,5
4	Explain the Solution Properties Of Polymers and Its Size Exclusion chromatography and Confinement	1,2,5,12
5	Poses the deep knowledge in polymer and process in making polymer components and gain knowledge in Creating mould design using CAD/CAM Software Packages	1,2,5,10,12

Prerequisites : Engineering Chemistry

MODULE 1: POLYMERIZATION 09

Fundamentals of polymers – monomers – functionality - Classification – characterization –. Types of Polymerization: cationic polymerization – anionic polymerization – coordination polymerization – free radical polymerization. Copolymerization concepts - Simple condensation reactions – Extension of condensation reactions to polymer synthesis – functional group reactivity. Poly condensation – kinetics of poly condensation - Carother's equation – Linear polymers by poly condensation – Interfacial polymerization – crosslinked polymers by condensation – gel point- smart gel and smart polymer material – nano materials

Suggested Reading: graphine, carbon nanotubes, smart polymer Nano composites

MODULE 2: MOLECULAR WEIGHTS OF POLYMERS 09

Number average and weight average molecular weights – Degree of polymerization – molecular weight distribution – Polydispersity – Molecular weight determination- Different methods – Gel Permeation Chromatography - Renegade Distributions - Tromsdorff effect - size exclusion chromatography- MALDI mass spectrometry.

Suggested Reading: calculate molecular weight of the Polymer materials ,

MODULE 3: TRANSITIONS IN POLYMERS 09

First and second order transitions – Glass transition, Tg – multiple transitions in polymers – experimental study – significance of transition temperatures. Crystallinity in polymers – differential scanning calorimeter – factors affecting crystallization, crystal nucleation and growth – Relationship between Tg and Tm – Structure–Property relationship- PerkinElmer Analysis.

Suggested Reading: gaining knowledge about the concept of metastable state, simulation of self-assembling polymer blend using MATLAB© software

MODULE 4: SOLUTION PROPERTIES OF POLYMERS	09
Size and shape of the macromolecules – Solubility parameter – Ideal chain & Gaussian Chain– polymer/solvent interaction parameter – temperature – size and molecular weight. Solution properties of polymers. Importance of Rheology – Newtonian and Non-Newtonian flow behaviour – Polymer melts Rheology - Thermodynamics of Dilute Polymer Solutions **Suggested Reading:** Flory-Huggins Mean-Field Theory, Size Exclusion Chromatography and Confinement	
MODULE 5: POLYMER PROCESSING	**09**
Overview of Features of Single screw extruder –Tubular blown film process - Coextrusion.- Injection Moulding systems – Compression & Transfer Moulding - Blow Moulding – Rotational Moulding – Thermoforming – Vacuum forming - Fiber Spinning process –Structural Foam Moulding – Sandwich Moulding. Processing for Thermosets- Reaction Injection Moulding & Reinforced Reaction Injection Moulding. **Suggested Reading:** Create mould design using CAD/CAM Software Packages	

TEXT BOOKS	
1	R. Griskey “Polymer Process Engineering”, springer, 2012.
2	Richard A. Pethrick, “Polymer Products and chemical Process”, Chapman & Hall, New York, 2013.
REFERENCE BOOKS	
1	Joel R. Fried “polymer science and technology”, Prentice Hall; 3 edition, 2014
2	Sebastian Koltzenburg, “Polymer Chemistry”, 1st Edition, 2017
3	Hal F. Brinson, “ Polymer Engineering Science and Viscoelasticity” 2nd ed. 2014
4	Donald G. Baird, “ Polymer Processing”, Wiley; 2 edition 2014
5	A. Gandini “ Advancement in polymer Science”, Springer, 2013
6	R. R. Morrison, R. N. Boyd and S. K. Bhattacharjee, Organic Chemistry , Dorling Kindersley (India) Pvt. Ltd, New Delhi, 2011.
E BOOKS	
1	https://books.google.co.in/books?isbn=0123821797 - Alfred Rudin
2	https://books.google.co.in/books?isbn=1932078754 - Paul C. Painter
3	https://books.google.co.in/books?isbn=0299146944 - Robert Byron Bird
4	https://books.google.co.in/books?isbn=3527341315 - Stoyko Fakirov
5	https://books.google.co.in/books?isbn=0471811815 - Herman Francis Mark
MOOC	
1	https://www.edx.org/course/materials-science-engineering-misisx-mse1x
2	http://www.open.edu/openlearn/science-maths-technology/science/chemistry/introduction-polymers/content-section-0?active-tab=description-tab
3	http://nptel.ac.in/courses/113105028/
4	http://nptel.ac.in/courses/116102010/

COURSE TITLE	ADVANCED I.C. ENGINE			CREDITS	3
COURSE CODE	MEC4370	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Understand and compare the various cycle of operation under compression and spark ignition engine	1,2,5
2	Analyse the combustion chemistry under constant volume and pressure considerations with emphasizes on premixed and diffusive combustion.	1,3,5
3	Apply the concept of engine cycle simulation considering adiabatic flame temperature, heat release correlations and other thermodynamic models.	1,3,4,5
4	Understand the advances concepts of IC engine like LHR, surface ignition and stratified engine leading to better engine performance	1,2,4,12
5	Apply their knowledge on electronics parts used in SI and CI engine for lower emission and better performance.	1,3,5,12

Prerequisites : IC Engine and Steam turbine

MODULE 1: ENGINE CYCLE ANALYSIS **09**

Otto, Diesel, Dual, Stirling and Brayton cycles, Comparison of air standard, Fuel air and actual cycles, Simple problems on the engine cycles. Suggested Reading: Urp and Hrp analysis, Combustion chemistry

MODULE 2: COMBUSTION **09**

Combustion reactions and stoichiometry, heat of reaction, adiabatic flame temperature in constant pressure and constant volume systems, fuels for internal combustion engines and their properties, premixed and diffusion combustion as applicable to SI and CI engines, Suggested Reading: Concepts of burning rate and flame velocity, Fuel spray characteristics and combustion in diesel engines.

MODULE 3: COMBUSTION MODELLING **09**

Basic concepts of engine simulation, governing equations, simulation of various engine processes for SI and CI engines. Adiabatic flame temperature, Heat release calculations.

Suggested Reading: Thermodynamic and Fluid mechanic based models using Matlab©© .

MODULE 4: ADVANCES IN IC ENGINES **09**

LHR engines, Surface ignition concept, Stratified charge and lean burn engines, Performance and emission characteristics, Merits and demerits.

Suggested Reading: Concept of HCCI engine and multi fuel engines, Magnetic engine

MODULE 5: ELECTRONIC ENGINE **09**

Computer control of SI & CI engines for better performance and low emissions, closed loop control of engine parameters of fuel injection and ignition

Suggested Reading: Digital data acquisition system (DDAS), Interfacing of piezo-electric sensor and fuel monitoring sensor.

TEXT BOOKS	
1	John B Heywood, "Internal Combustion Engine Fundamentals", McGraw Hill Education, 1st Edition (Indian Edition) July 2017.
2	V Ganesan, "Internal Combustion Engines", McGraw-Hill Education; 4th Edition, July 2017.
3	V.Ganesan, "Computer Simulation of Spark-Ignition engine Processes", University Press, 1996.
REFERENCE BOOKS	
1	Kenneth W. Raglan and Kenneth M.Bryde. "Combustion Engineering", Second Edition, CRC Press – Taylor and Francis Group. New York, 2011.
2	Jerald A. Caton, "An Introduction to Thermodynamic Cycle Simulation for Internal Combustion Engines", John Wiley and Sons, 2016.
3	A J Martyr and M A Plint, "Engine Testing – Testing and Practice", Butterworth-Heinemann Publication, 2007.
E BOOKS	
1	https://books.google.co.in/books?id=UtxI5gXM1yQC&printsec=front cover&dq =IC+engine &hl=en&sa=X&ved=0ahUKEwiLuPjhl8jZAh VGNI8KHbNvB h8Q6AEIODAD# v=onepage &q=IC%20engine&f= false – R K Rajput
2	https://www.elsevier.com/books/engine-testing/martyr/978-0-7506-8439-2
3	https://books.google.co.in/books?id=u9FSAAAAMAAJ&q=IC+engine& dq=IC+engine& hl=en &sa =X&ved=0ahUKEwiLuPjhl8jZAhVGNI8KHb NvBh8Q6AEILTAB – John B Heywood
4	https://books.google.co.in/books?id=hfejAwAAQBAJ&printsec=front cover&dq= IC+engine&hl =en&sa=X&ved=0ahUKEwiLuPjhl8jZAh VGNI8KHb NvBh8Q6AEIK DAA#v=onepage &q =IC%20engine&f=false – V Ganesan
MOOC	
1	http://nptel.ac.in/courses/101104070/
2	http://nptel.ac.in/courses/101104014/
3	http://nptel.ac.in/courses/101106037/
4	http://nptel.ac.in/courses/112104033/

COURSE TITLE	CREEP AND FATIGUE BEHAVIOUR OF MATERIALS			CREDITS	3
COURSE CODE	MEC4371	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Explain the structure of materials ,their defects and the principles behind deformation	1,2,5
2	Explain the Creep and Fatigue behavior of the materials when subjected to their respective loads while in service	1,2,5
3	Calculate the Creep rupture data and its extrapolation, Fatigue life estimation and reasons for Macro fracto graphic Fatgue failures	1,3,4,5,10,12
4	Apply the principles and methods of Creep and Fatigue in the design stage of the product to avoid their failures	1,,2,3,4,5,9,12
5	Conduct Fracture and failure analysis	1,2,5,10,12

Prerequisites : Mechanical Metallurgy

MODULE 1: INTRODUCTION **9**

Strength of perfect crystals- Lattice resistance to dislocation movement, Elastic properties of dislocation Dislocation multiplication—Slip and Twinning in crystalline solid..

Suggested Reading: Lattice structure defects, Types of dislocations. Mechanical properties of metals

MODULE 2: HIGH TEMPERATURE DEFORMATION RESPONSE **9**

Creep of Solids-- Temperature stress—Strain rate relation—Deformation mechanism—Super plasticity deformation mechanism maps—Extrapolation procedure for Creep rupture Data—Materials for elevated temperature roles using MAT LAB Curve fitting Tool Box

Suggested Reading: Creep behaviour of Metals, Inferences from Creep curves

MODULE 3: CYCLIC STRESS AND STRAIN FATIGUE **9**

Macro fractography, fatigue failures-- cyclic stress and strain controlled fatigue- fatigue life estimation for Notched components—Crack initiation mechanisms using MAT LAB's Statistical Tool Box

Suggested Reading: S-N curves, Inferences from fatigue types, Design considerations

MODULE 4: FATIGUE CRACK PROPAGATION **9**

Stress and crack length correlations with FCP—Fracture modes in Fatigue—Microscopic fracture mechanisms – Crack growth behaviour at Δk extremes—Influences- Microstructural aspect of FCP in metal box Alloys using MATLAB©'s Data Acquisition Tool Box

. Suggested Reading: Types of Mode failures- Design considerations

MODULE 5: ANALYSIS OF ENGINEERING FAILURES **9**

Typical defects—Microscopic surface examination—Metallographic and Fracto graphic examination Component failure analysis—Fracture surface preservation—Cleaning and replication techniques and Image interpretation using Matlab©'s Image Acquisition Tool box

Suggested Reading: Fracture Mechanics and Failure Analysis

TEXT BOOKS	
1	Richard W. Hertzberg, Richard P. Vinci, Jason L. Hertzberg " Deformation and Fracture Mechanics of Engineering Materials" John Wiley and Sons,5th edition, 2012
2	Anderson T.L.: "Fracture Mechanics: Fundamentals and Applications" CRC Pres 4th edition, 2017
3	Jean Lemontre and Rodrigue Desmorat," Engineering Damage Mechanics: Ductile, Creep,Fatigue and Brittle Failures" Springer, 2010
REFERENCE BOOKS	
1	Courtney T.H." Mechanical Behaviour of Materials" Wave Land Press, 2005.
2	Hull &Bacon "Introduction to Dislocations" 5th edition, Elsevier Ltd, 2011
3	Michael E. Kassner "Fundamentals of Creep in Metals and Alloys"3rd edition, Elsevier, 2015
4	Norman E.Dowling, "Mechanical Behaviour of Materials" Pearson Publishing,4th edition 2013
E BOOKS	
1	https://www.amazon.in/Mechanical-Behavior-Matrial-Courtney…/ BOOGHVBHO
2	https://www.Wiley.com/../Dofrmation+and+Fracture+Mechanics+of+ EngineeringMaterials%2C+5th+Edition-10-
3	https//www.goodreads.com/book/../285369 Deformation_and_Fracture_Mechanics_ of_ Engineering_Materials
MOOC	
1	Edu.epfi.ch/course book/en/fracture-of-materials-MSE-424
2	https//www.edx.org/…/mechanical-behavior of materials-part-1-mifx-3-032-1
3	https://en.wikipedia.org/wik/creep_(deformation)

COURSE TITLE	PRODUCTION PLANNING AND CONTROL			CREDITS	3
COURSE CODE	MEC4372	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Understand the various functions of production	1,6,7,8,12
2	Know the various steps of industry planning	1,6,8,9,12
3	Learn the various components of controlling.	1,9,10,11,12
4	Learn the various components of controlling.	1,9,10,11,12
5	Know the recent trends like Manufacturing Requirement Planning (MRPII) and Enterprise Resource Planning (ERP).	1,9,10,11,12

Prerequisites : Nil

MODULE 1: PRODUCTION FUNCTIONS **9**

Functions of production control-Types of productions-Product development and design-Marketing aspect –Functional aspects-Operational aspect-Durability and dependability aspect-aesthetic aspect. -Economics of a new design, Method study, work measurement,

Self Study: Investments in physical capital, human capital and innovation drive productivity

MODULE 2: INDUSTRY PLANNING **9**

Product planning-Extending the original product information-Value analysis-Problems in lack of product planning-Process planning and routing-Pre requisite information needed for process planning-Steps in process planning, Material requirement planning.

Suggested Reading: Materials management function in a firm

MODULE 3: SCHEDULING **9**

Scheduling function-Master Scheduling-Scheduling rules- Gantt charts-Perpetual loading-Basic scheduling problems -Line of balance-Flow production scheduling-Batch production scheduling, Loading and -Product sequencing, - kanban–Dispatching-Progress reporting and expediting

Suggested Reading: Cycle-time analysis in batch processing environment

MODULE 4: CONTROL METHODS **9**

Production Control Systems-Production Control systems- Periodic batch control -Manufacturing lead time-Techniques for aligning completion times and due dates, Inventory control-Purpose of holding stock-Effect of demand on inventories-Ordering procedures. Two bin system-Determination of Economic order quantity and economic lot size-ABC analysis

Suggested Reading: Kaizen , long-term approach ,5 S program

MODULE 5: COMPUTER IN PRODUCTION PLANNING & CONTROL **9**

Introduction to Computer Integrated Production Planning systems-elements of Just In Time Systems-Fundamentals of MRPII, ERP.SAP

Suggested Reading: Business process reengineering in manufacturing industries

TEXT BOOKS	
1	David N. Burt, Sheila Petcavage, Richard Pinkerton ,"Proactive Purchasing in the Supply Chain: The Key to World-Class Procurement", McGraw Hill Professional 2011
2	Renna, Paolo,"Production and Manufacturing System Management" IGI Global, 2012
3	John Kenworthy "Planning and Control of Manufacturing Operations", Routledge, 2013
4	William Bolton," Production Technology: Processes, Materials and Planning" Elsevier, 2013
5	RiittaSmeds, J. Smeds,"Experimental Learning in Production Management" Springer, 2013
REFERENCE BOOKS	
1	Nick T. Thomopoulos, "Assembly Line Planning and Control", Springer Science & Business Media, 2013
2	Stefan Trzcielinski, WaldemarKarwowski ,"Advances in The Ergonomics in Manufacturing", AHFE Conference, 2014
3	Modrák, Vladimír "Handbook of Research on Design and Management of Lean Production Systems", IGI Global, 2014
4	HartmutStadtler, ChristophKilger, Herbert Meyr, "Supply Chain Management and Advanced Planning", Springer, 2014
5	Paul Schönsleben, "Integral Logistics Management", CRC Press, 2016
E BOOKS	
1	https://books.google.co.in/books?isbn=0071817247- Thomas E Vollmann
2	https://books.google.co.in/books?isbn=0071750320- F. Robert Jacobs
3	https://books.google.co.in/books?isbn=3642780636- Günter Fandel
4	https://books.google.co.in/books?isbn=3642516939 - Albert Lester
MOOC	
1	https://www.mooc-list.com/course/lean-production
2	http://nptel.ac.in/courses/112107143/
3	http://nptel.ac.in/courses/122106032/
4	http:// www.nptel.ac.in/courses/112102107/
5	http://nptel.ac.in/courses/110105067/
6	https://swayam.gov.in/

COURSE TITLE	NUMERICAL METHODS (Department of Aeronautical, Asp, Bio Tech, Chemical, EEE,EIE/MECH)			CREDITS	3
COURSE CODE	MAA4303	COURSE CATEGORY	DE	L-T-P-S	2 0 2 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Obtain successively better approximation to the roots of a real-valued function	1,2,4,12
2	Familiarize the process of approximating a given function	1,2,5
3	Understand numerical differentiation and integration	1,2,4,5
4	Solve initial value problems	1,2,4,5,12
5	Understand and solve a wave or heat equation	1,2,4,5,12

Prerequisites : Nil

MODULE 1: SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS (10L+2P)

Solution of algebraic and transcendental equations: Method of false position – Newton's method – Fixed point iteration method – Solution of linear system of Gaussian elimination and Gauss-Jordan methods – Iterative methods: Gauss Jacobi and Gauss – Seidel methods- Inverse of a matrix by Gauss-Jordan method. Eigenvalue of a matrix by power method.

Suggested Reading: System of equations

Lab: Solution of linear system problems

MODULE 2: INTERPOLATION AND APPROXIMATION (10L+2P)

Lagrangian Polynomials – Divided difference – Newton forward and backward difference method – Cubic Spline interpolation.

Suggested Reading: Relations and functions

Lab: Interpolation problems

MODULE 3: NUMERICAL DIFFERENTIATION AND INTEGRATION (10L+2P)

Derivatives from difference table – Divided difference and finite difference – Numerical integration by Trapezoidal and Simpson's 1/3 and 3/8 rules – Romberg's method – Two and three point Gaussian quadrature formula – Double integrals using trapezoidal and Simpson's rules.

Suggested Reading: Basic differentiation and integration

Lab: Numerical integration problems

MODULE 4: NUMERICAL SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS (10L+2P)

Single step Methods: Taylor Series method – Euler and Modified Euler method – Fourth order Runge-Kutta method for solving first and second order differential equations - Multistep method: Milne's and Adam's predictor and corrector methods.

Suggested Reading: Ordinary Differential Equations

Lab: Initial value problems

MODULE 5: BOUNDARY VALUE PROBLEMS (10L+2P)	
Finite difference solution for the second order ordinary differential equations. Finite difference solution for one dimensional heat equation by implicit and explicit methods – one dimensional wave equation and two dimensional Laplace and Poisson equations. Suggested Reading: Partial Differential Equations	
LAB/MINI PROJECT/FIELD WORK	
Theory with practical classes	
TEXT BOOKS	
1	Numerical Methods 3rd Edition by K. Gunavathi, P. Kandasamy, K. Thilagavathy, 2006
2	Gerald, C.F, and Wheatley, P.O, “Applied Numerical Analysis”, Sixth Edition, Pearson Education Asia, New Delhi, 2002.
3	Grewal. B.S., and Grewal. J.S., " Numerical methods in Engineering and Science", Khanna Publishers, New Delhi, 9th Edition, 2007.
4	Raj Kumar Bansal,Ashok Kumar Goel, Manoj Kumar Sharma, “MATLAB© and its Applications in Engineering”, Pearson Publication, Second Edition, 2016.
REFERENCE BOOKS	
1	Chapra. S.C., and Canale. R.P, "Numerical Methods for Engineers", 5th Edition, Tata McGraw Hill, New Delhi, 2007
2	Gerald. C.F., and Wheatley. P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi, 2006.
3	Jaan kiusalaas, Numerical methods with engineering with Python 3, January 2013 Edition, Cambridge Press
4	Dean G. Duffy., “Advanced Engineering Mathematics with MATLAB©”, CRC Press, Third Edition 2013.
E BOOKS	
1	http://nptel.ac.in/courses/112106061/Module_2/Lecture_2.2.pdf
2	http://www.nptel.ac.in/courses/122104018/node109.html
3	http://nptel.ac.in/courses/122107036/35
MOOC	
1	https://www.mooc-list.com/course/numerical-methods-engineers-saylororg

LIST OF DEPARTMENTAL ELECTIVES - SEMESTER VII

COURSE TITLE	DYNAMICS AND CONTROL			CREDITS	3
COURSE CODE	MEC4451	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Able to describe various input and output models of dynamic system.	1,2,3,4,5,10,12
2	Familiar with frequency domain descriptions and dynamic analysis	1,2,3,4,5,10,12
3	Evaluate the stability of systems using various methods	1,2,3,4,5,10,12
4	Design PID controller	1,2,3,4,5,10,12
5	Explain the concept of stability and effect of feedback control on sensitivity	1,2,3,4,5,10,12
6	Understand and apply the principles of control theory	1,2,3,4,5,10,12

Prerequisites : Mechanics of Machines

MODULE 1: LINEAR SYSTEMS THEORY **9**

Review of time domain analysis of linear systems dynamics - stability, performance measures and design process - state space and process models - example control systems.

System Representation in the s-domain: - free/ forced behaviour and the characteristic equation - system poles and zeros, relative and absolute stability, root loci - steady-state error and the final value theorem.

Suggested Reading: The Laplace transform and system transfer function,plot free/ forced behaviour using MATLAB©

MODULE 2: FREQUENCY RESPONSE OF LINEAR SYSTEMS **9**

Sinusoidal excitation and Fourier Series - forecasting gain and phase, the frequency response function - graphical representation of frequency response, Bode plots.

Suggested Reading: Sinusoidal Inputs and response plot, plot the frequency response using MATLAB©

MODULE 3: CLOSED-LOOP CONTROL SYSTEMS **9**

Open/closed loop transfer function definitions - performance measures in control system design control system design examples - PID control system definitions and characteristics.

Suggested Reading: models of mechanical system , Design PID controller using MATLAB©

MODULE 4: CONTROL SYSTEM STABILITY ANALYSIS **9**

Stability in the s-domain, the Root locus method - stability in the frequency domain, NY Quist criterion - performance measures in the frequency domain - gain and phase margins, closed loop frequency response.

Suggested Reading: sketching of polar plots,Nichols Plot,performance measures using MATLAB©

MODULE 5: DESIGN OF FEEDBACK CONTROL SYSTEMS	9
System compensation objectives and characteristics - lead-lag compensation, root locus and frequency response methods **Suggested Reading**: Gain and Phase Margins	
TEXT BOOKS	
1	N.S. Nise, Control System Engineering, 6th edition, Wiley & Sons, , 2012.
2	C. L. Phillips and R. D. Harbor, Feedback Control Systems, 5th Ed., Pearson Education India 2013.
3	Craig A Kluever Dynamic Systems: Modeling, Simulation, and Control Wiley & Sons, , 2015.
REFERENCE BOOKS	
1	Benjamin C. KuoFaridGolnaraghi Automatic Control System, 9 edition, Wiley Publication, 2014
2	K. Ogata, Modern Control Engineering, 5th Ed., Pearson Education India 2010.
E BOOKS	
1	https://books.google.co.in/books?id=Gq6T7Pqauk4C&lpg=PP1&dq=Control%20System%20Engineering&pg=PP1#v=onepage&q=Control% 20System%20Engineering&f=false
2	https://books.google.co.in/books?id=mvlQAAAAMAAJ&q=Dynamic+Systems&dq=Dynamic+Systems&hl=en&sa=X&ved=0ahUKEwjtxObctMjZAhUCTo8KHcmPB5EQ6AEIKzAB
MOOC	
1	https://www.edx.org/course/dynamics-and-control
2	http://nptel.ac.in/courses/111108066/
3	http://nptel.ac.in/courses/111104025/
4	http://nptel.ac.in/courses/108103007/

COURSE TITLE	MODAL ANALYSIS OF MECHANICAL SYSTEMS			CREDITS	3
COURSE CODE	MEC4452	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Understand the modal testing procedure and measurement methods of vibration parameters	1,2,12
2	Present the responses of properties of FRF data for SDOF & MDOF system.	1,,2,3,4,7
3	Understand the elements of the measurement scheme and construct the mounting arrangements for measurement of vibration parameters.	1,2,3,12
4	Present the modal parameters by using different methods for SDOF & MDOF system.	1,2,3,4,5,12
5	Develop/derive mathematical model for the system models in vibration.	1,2,3,5,7,12

Prerequisites : Mechanics of Machines

MODULE 1: OVERVIEW **12**

Introduction to Modal Testing – Applications of Modal Testing – Philosophy of Modal Testing – Summary of Theory – Summary of Measurement Methods – Summary of Analysis – Review of Test Procedure. Suggested Reading:Basic components of Measurement System, Nyquist plots

MODULE 2: THEORETICAL BASIS **12**

Introduction – Single Degree of Freedom (SDOF) System Theory – Presentation and Properties of FRF Data for SDOF System – Undamped Multi-degree of freedom (MDOF) system – Proportional Damping – Hysteretic Damping – General Case – Viscous Damping – General Case – Characteristics and presentation of MDOF FRF Data – Complete and incomplete models – Non-sinusoidal vibration and FRF Properties – Analysis of Weakly Nonlinear Structures.

Suggested Reading: Definitions of Frequency response functions, Frequency responses of Mass and stiffness elements.

MODULE 3: MOBILITY MEASUREMENT TECHNIQUES **12**

Introduction – Basic Measurement System – Structure preparation – Excitation of the Structure – Transducers and Amplifiers – Analyzers – Digital Signal Processing – Use of Different Excitation types – Calibration – Mass Cancellation – Rotational Mobility Measurement – Measurement on Non linear structures – Multi point excitation methods.

Suggested Reading: Elements of measurement chain, Various mounting arrangements used in exciter for measurement

MODULE 4: MODAL PARAMETER EXTRACTION METHODS **12**

Introduction – Preliminary checks of FRF Data – SDOF Modal Analysis-I – Peak-amplitude –
SDOF Modal Analysis-II – Circle Fit Method – SDOF Modal Analysis III – Inverse Method –
Residuals – MDOF curve-fitting procedures – MDOF curve fitting in the Time Domain – Global or Multi-Curve fitting – Non linear systems.

Suggested Reading: Properties of Modal Circle, Various terms in Modal series for FRF

MODULE 5: DERIVATION OF MATHEMATICAL MODELS	12
Introduction – Modal Models – Display of Modal Model – Response Models – Spatial Models – Mobility Skeletons and System Models. Methods for Structural modification- Applications. Suggested Reading: Mobility plot of Simple Mass-Spring-Mass system, Comparison of Measured and Predicted Mode Shapes and plotting.	
TEXT BOOKS	
1	D J Ewins, "Modal Testing Theory, Practice and application", 2nd edition, Research studies press Ltd., England, 2016
2	Rao, S.S., "Mechanical Vibrations", 6th Edition, Pearson Education Inc., Prentice Hall, 2014.
3	C. Sujatha, "Vibration and Acoustics: Measurement and Signal Analysis", Tata McGraw-Hill Education Private Limited, New Delhi, 2009.
REFERENCE BOOKS	
1	Graham Kelly. Scham's outline of Theory and Problems of Mechanical vibrations. Special Indian edition, Tata McGraw-Hill, 2012.
2	M. L. Munjal, Noise and Vibration Control, World Scientific Press: Singapore,2014.
3	A.R.Mohanty, "Machinery condition Monitoring: Principles and Practices", CRC Press, 2014.
E BOOKS	
1	https://drive.google.com/open?id=0B4SOTWiEAAOeMFowVzhSa2s0Rnc-William J.Bottega
2	https://drive.google.com/open?id=0B6pGoYzCs7PgMENHa2lOSEpreTQ – C.F.Beards
3	https://drive .google.com/open?id=0B7JWdKw_4Q07ZnZVYURuWTJnNTQ-SCHAUM
MOOC	
1	https://www.mooc-list.com/course/introduction-%C3%A0-la-m%C3%A9canique-des-non-linear systems vibration
2	https://courses.iitm.ac.in/course/info.php?id=1395
3	https://in.mathworks.com/support/learn-with-matlab-tutorials.html

COURSE TITLE	NEW PRODUCT DESIGN AND DEVELOPMENT			CREDITS	3
COURSE CODE	MEC4453	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Understand the basic product development process	1,2,5,10
2	Understand the concept development process	1,2,3,5,10
3	Apply the design process for product development	1,2,3,4,5,10
4	Analyze the feasibility of the proposed project	1,2,3,4,5,10
5	Understand the IPR related issues and patent registration	1,2,10

Prerequisites : Nil

MODULE 1: INTRODUCTION 9

Product Development, Organizations. Development Process, Product Planning, Identification of Customer Needs.

Suggested Reading: Establishing markets- market segments- relevance of market research

MODULE 2: CONCEPT DEVELOPMENT 9

Product and Target specification, various steps in concept generation, Brainstorming, Morphological analysis, Selection of concepts, EVAD (Design Evaluation) method, Principles of computer aided decision making.

Suggested Reading: Creative thinking –creativity and problem solving- creative thinking methods

MODULE 3: DESIGN PROCESS 9

Concept Testing, Response and Interpretation. Product Architecture, Platform planning, System level design issues. Embodiment design, Modelling.

MODULE 4: PLANNING FOR MANUFACTURE AND MANAGEMENT 9

Detail Design, Design Management, Project planning and control, Production design specification (PDS), Design review, Value analysis/engineering.

MODULE 5: INTELLECTUAL PROPERTY RIGHTS AND PROJECT ECONOMICS 9

Intellectual Property Rights, Write the description of the invention, Refine Claims, Pursue application. Economics and Management Accelerating Projects, Project Execution.

TEXT BOOKS

1	G. E. Dieter, “Engineering Design”, McGraw – Hill International, 2013.
2	Ken Hurst, “Engineering Design Principles”, Elsevier Science and Technology Books, 2014.

REFERENCE BOOKS

1	Karl T Ulrich, Steven D Eppinger, “Product design and development” New York, McGraw-Hill Education,2016
2	Kavin N Aotto, Kritine I Wood, “Product Design”, Prentice Hall Publications 2013

E BOOKS

1	https://books.google.co.in/books/about/Engineering_Design.html?id=wUgqAQAAMAAJ
2	https://books.google.co.in/books?isbn=8177588214
3	https://books.google.co.in/books?isbn=082477565
MOOC	
1	https://onlinecourses.nptel.ac.in/noc17_me16/preview
2	https://www.edx.org/course/product-design-delft-design-approach-delftx-dda691x-1

COURSE TITLE	**ADVANCED STRENGTH OF MATERIALS**			**CREDITS**	**3**
COURSE CODE	**MEC4454**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3 0 0 0**
CIA	**50%**			**ESE**	**50 %**
LEARNING LEVEL	**BTL-4**				

CO	**COURSE OUTCOMES**	**PO**
Upon successful completion of this course the student should be able to		
1	Understand the basic principles of structural elasticity, including statically determinate and indeterminate systems, and the factors which affect their strength and stiffness.	1,2
2	Demonstrate an understanding of the relationships between loads, member forces and deformations and material stresses and strains.	1,2
3	Possess the contemporary analytical, experimental and computational tools needed to solve the engineering problems.	1,2,3
4	Analyze and design structural members subjected to tension, Compression, torsion, bending and combined stresses using the fundamental concepts of stress, strain and elastic behaviour of materials.	1,2,3
5	Have acquired the independent judgment required to interpret the results of the engineering problems.	1,2,5
6	Be able to use these solutions to guide a corresponding design, manufacture, or failure analysis.	1,5,9
7	Be able to learn independently new solutions, principles and methods, read and understand professional articles on the subject.	1,4,12

Prerequisites : Strength of Material

MODULE 1: ELASTICITY **8**

Stress strain relations and general equations of elasticity in Cartesian, Polar and Spherical coordinates differential equations of equilibrium - Compatibility - boundary conditions - representation of 3 - dimensional stress of a tensor - Generalized Hooke's law - St. Venant's principle - plane strain - plane stress - Airy's stress function. Shear Center: Location of Shear center for various sections - shear flows. Unsymmetrical Bending: Stresses and deflections in beams subjected to unsymmetrical loading - Kern of a section.

Suggested Reading: Statically determinate – indeterminate, Stress on inclined planes under axial loading, bending of unsymmetrical beams - composite.

MODULE 2: CURVED FLEXURAL MEMBERS	8
Circumferential and radial stresses- deflections- curved beam with restrained ends-closed ring subjected to concentrated load and uniform load chain links and crane hooks. **Suggested Reading:** Instability – failure mode - Necking – tensile member – plastic buckling.	
MODULE 3: STRESSES IN FLAT PLATES	**8**
Stresses in circular and rectangular plates due to various types of loading and end conditions -- buckling of plates and stress concentrations **Suggested Reading:** plane stress – plane strain - Fracture – ductile specimen – brittle specimen.	
MODULE 4: TORISION OF NON - CIRCULAR SECTIONS	**8**
Torsion of rectangular cross sections-St. Venant's theory - Elastic membrane Analog:y-Prandtl's stress function-Torsional stresses in hollow thin-walled tubes. **Suggested Reading**: Torsion – rectangular shaft – thin walled shaft – Study on beams under torsion in MATLAB©.	
MODULE 5: STRESSES DUE TO ROTATION	**13**
Radial and tangential stresses in solid disc and ring of uniform, thickness and varying thickness-allowable speeds. Theory of Contact Stresses: Methods of computing contact stresses – Deflection of bodies in point and line Contact-Applications. **Suggested Reading:** Strain energy due to torsion.	

TEXT BOOKS	
1	JP. Den Hartog, "Advanced Strength of Materials", Dover/BSP Books, First Edition, 2016.
2	Stephen Timoshenko, "Theory of Elasticity", McGraw Hill Education, Third edition, 2017.
REFERENCE BOOKS	
1	Nash W.A, "Theory and problems in Strength of Materials", Schaum Outline Series, McGrawHill Book Co, New York, 2013.
2	Popov E.P, " Mechanics of Materials ", Pearson Education India; Second edition, 2015.
3	A. C. Ugural, Saul K. Fenster, "Advanced strength and applied elasticity" Prentice Hall, Fifth edition, 2012.
4	Beer F. P. and Johnston R, "Mechanics of Materials", McGraw-Hill Book Co, Seventh Edition, 2015.
5	S.S. Bhavikatti, "Advanced Strength of Materials", Vikas Publishing, Fouth edition, 2013.
6	Hibbeler,R.C, "Mechanics of materials" Pearson Education, 10th edition, 2016.
E BOOKS	
1	https://goo.gl/ArHdiY - Popov E.P
2	https://goo.gl/EgypX3 - Beer F. P. and Johnston R
3	https://goo.gl/VroJEj - R K Bansal
4	https://goo.gl/bqvlA8 - Rattan S S
MOOC	
1	http://nptel.ac.in/courses/112101095/
2	https://goo.gl/lCHuKR
3	http://nptel.ac.in/courses/112107147/
4	http://nptel.ac.in/courses/112107146/
5	http://nptel.ac.in/courses/112101095/
6	http://nptel.ac.in/courses/105105108/

COURSE TITLE	THERMAL TURBO MACHINES			CREDITS	3
COURSE CODE	MEC4455	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Understand the basics of thermal turbo machines, its governing equation along with basic terminologies and parameters used in this domain	1,2,12
2	Understand the basics of centrifugal compressor, blower and various diffuser used for energy transformation, its performance parameters	1,2,3,4,7
3	Understand the basics of an axial compressor and fan used for energy transformation, its theory and performance parameters	1,2,3,12
4	Understand the basics of an axial turbine, its theory along with losses and performance parameters	1,2,3,4,12
5	Understand the basics of radial flow turbines and various performance characteristics parameters	1,2,3,4,12
6	Understand the basics of wind turbine, various types and working of a horizontal wind turbine and performance parameters	1,2,3,4,7,12

Prerequisites : Fluid Mechanics and Machinery

MODULE 1: INTRODUCTION TO TURBO MACHINES **9**

Turbines, Pumps, Compressors, Fans and Blowers - Stages of Turbo machines - Energy transfer between fluid and rotor - Stage velocity triangles Thermal Turbo machines - Classification - General energy equation - Modified to turbo machines compression and expansion process - Velocity triangles - Work - T-S and H-S diagram, Total to Total and Total to Static efficiencies. Dimensional analysis - Non dimensional parameters of compressible flow Turbo machines - Similarity laws, applications and limitations.

Suggested Reading: Shape number, specific speed and its importance in turbo machines.

MODULE 2: CENTRIFUGAL FANS AND BLOWERS **9**

Definition, selection and classifications -Types of blading design-velocity triangles - Stage Parameters - Flow analysis in impeller blades - Design parameter- Volute and Diffusers - Efficiencies and Losses - Fan noises - Causes and remedial measures.

Centrifugal Compressors: - Constructional details - Stage velocity triangles -- Stage work - Stage pressure rise - Stage efficiency - Degree of reaction - Slip factor - H-S diagram - Efficiencies Performance characteristics.

Suggested Reading: Various types of diffusers used for centrifugal compressors and its present status; Plot the W-Q characteristics curve for the centrifugal blower at different mass flow rates using MATLAB©

MODULE 3: AXIAL FANS AND PROPELLERS **9**

Definition and classifications - Stage parameters - Types of fan stages-performance characteristics. Cascade of blades - Cascade tunnel - Blade geometry - Cascade variables - Energy transfer and loss in terms of lift and drag - Axial Flow Compressors: definition and classifications -

Constructional details - Stage velocity triangles - Stage work - Stage pressure rise - H-S diagram- Stage efficiencies and losses- Degree of reaction - Radial equilibrium-Surging and Stalling - Performance characteristics.

Suggested Reading: Twist in the blades; Plot the W-Q characteristics curve for the axial fan at different mass flow rates using MATLAB©

MODULE 4: AXIAL FLOW TURBINES 9

Construction details - 90^0 IFR turbine - Stage work - Stage Velocity triangles - Stage pressure rise - Impulse and reaction stage - Effect of degree of reaction - H-S diagram - Efficiencies and Losses Performance characteristics.

Suggested Reading: Degree of reaction for a case R = 0.50

MODULE 5: RADIAL FLOW TURBINES AND WIND TURBINES 9

Constructional details -- Stage velocity triangles - H-S diagram - Stage efficiencies and losses - Performance characteristics.

Wind turbines: definition and classifications - Constructional details -Horizontal axis wind turbine- Power developed - Axial thrust - Efficiency.

Suggested Reading: Vertical axis wind turbine, its different types and arrangement.; Plot the performance characteristics curve for a horizontal axis wind turbine at different wind speeds using MATLAB©

TEXT BOOKS

1	Erik Dick, Fundamentals of Turbomachines, Springer Science + Business Media, 2015.
2	S.L Dixon and C.A. Hall, Fluid Mechanics and Thermodynamics of Turbomachinery, Seventh Edition, Elsevier, 2015.
3	S.M. Yahya, Turbines, Compressors and Fans, Fourth Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2011.
4	A.R. Jha, Wind Turbine Technology, CRC Press, Taylors and Francis Group, 2011.
5	Seppo A. Korpela, Principles of Turbomachinery, Wiley, New Jersy, USA, 2011.

REFERENCE BOOKS

1	H. Cohen, G.F.C. Rogers, Paul Straznicky, H.I.H. Saravanamuttoo, Andrew Nix, Gas Turbine Theory, Prentice Education Limited, 2017
2	V. Ganesan, Gas Turbines, Third Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2010.
3	Erich Hau, Wind Turbines: Fundamentals, Technologies, Application, Economics, Third Translated Edition, Springer, London, 2013.

E BOOKS

1	https://books.google.co.in/books?id=0SEyBwAAQBAJ&printsec=frontcover&dq=turbo machine&hl=en&sa=X&ved=0ahUKEwi8tPeZqdzZAhXCRY8KHW9gAIIQ6AEINjAG #v=onepage&q=turbomachine&f=false --- Erik Dick
2	https://books.google.co.in/books?id=wZoTAAAAQBAJ&printsec=frontcover&dq=turbo machine+2010&hl=en&sa=X&ved=0ahUKEwij2fjcqtzZAhUBto8KHTrDA8oQ6AEIJDAD

	#v=onepage&q&f=false --- S.L Dixon and C.A. Hall
3	https://books.google.co.in/books?id=MpAl7kJPR1MC&printsec=frontcover&dq= turboma chine +2010&hl=en&sa=X&ved=0ahUKEwij2fjcqtzZAhUBto8KHTr DA8oQ6AEIEzAA #v=onepage&q&f=false -- S.M. Yahya
4	https://books.google.co.in/books?id=jX1vKWdUVYMC&printsec=frontcover& dq=turbo ma chine+2010&hl=en&sa=X&ved=0ahUKEwij2fjcqtzZAhUBto8KHTrDA8oQ6AEIHjAC #v=onepage&q&f=false --- V. Ganesan
MOOC	
1	http://nptel.ac.in/courses/101101058/
2	http://nptel.ac.in/courses/112105182/
3	http://nptel.ac.in/courses/112105206/
4	http://nptel.ac.in/courses/112107216/

COURSE TITLE	**POWDER METALLURGY**			**CREDITS**	**3**
COURSE CODE	**MEC4456**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3 0 0 0**
CIA	**50%**			**ESE**	**50 %**
LEARNING LEVEL	**BTL-4**				

CO	**COURSE OUTCOMES**	**PO**
Upon successful completion of this course the student should be able to		
1	Understand the various methods to manufacture the metal powders with various sizes and the methods to conditioning the powders.	1,3,4
2	Understand the various properties of metal powders and the testing methods for properties.	1,3,5
3	Understand the compaction stage of metal powder and the various methods involved in it.	1,2,4,5
4	Understand the sintering stage of metal powder and the various methods involved in it..	1,2,5
5	Understand the various applications for various metal powders. Able to identify new applications in different fields.	1,2,5,11,12

Prerequisites : Characterization of Materials

MODULE 1: POWDER MANUFACTURE AND CONDITIONING **12**

Mechanical methods Machine milling, ball milling, atomization, shotting- Chemical methods, condensation, thermal decomposition, carbonyl Reduction by gas-hydride, de-hydride process, electro deposition, precipitation from aqueous solution and fused salts, hydro metallurgical method. Physical methods: Electrolysis and atomisation processes, types of equipment, factors affecting these processes, examples of powders produced by these methods, applications, powder conditioning, heat treatment, blending and mixing, types of equipment, types of mixing and blending, Self-propagating high-temperature synthesis (SHS), sol-gel synthesis- Nano powder production methods

Suggested Reading: Powder Making from Vapour Phase, Reduction of Metal Compounds.

MODULE 2: CHARACTERISTICS AND TESTING OF METAL POWDERS	8
Sampling, chemical composition purity, surface contamination etc. Particle size and its measurement, Principle and procedure of sieve analysis, microscopic analysis: sedimentation, elutriation, permeability. Adsorption methods and resistivity methods: particle shape, classifications, microstructure. Apparent and tap density, green density, green strength, sintered compact density, porosity, shrinkage. **Suggested Reading:** Specific Surface Determination, Alloying of Powder, SEM Analysis of Powders.	
MODULE 3: POWDER COMPACTION	**7**
Pressure less compaction slips casting and slurry casting. pressure compaction- lubrication, single ended and double ended compaction, iso static pressing, powder rolling, forging and extrusion, explosive compaction. **Suggested Reading:** Injection Moulding, Forming without External Pressure, Methods to Produce Complicated Parts.	
MODULE 4: SINTERING	**8**
Stage of sintering, property changes, mechanisms of sintering, liquid phase sintering and infiltration, activated sintering, hot pressing and Hot Isostatic Pressing (HIP), vacuum sintering, sintering furnaces-batch and continuous-sintering atmosphere, Finishing operations – sizing, coining, repressing and heat treatment, special sintering processes- microwave sintering, Spark plasma sintering, Field assisted sintering, Reactive sintering, sintering of nano structured materials. **Suggested Reading**: Sintering in Multicomponent System, Activated Sintering, Sintering Furnaces.	
MODULE 5: APPLICATIONS	**10**
Major applications in Aerospace, Nuclear and Automobile industries- Bearing Materials-types, Self lubrication and other types, Methods of production, Properties, Applications. Sintered Friction Materials-Clutches, Brake linings, Tool Materials- Cemented carbides, Oxide ceramics, Cermets-Dispersion strengthened materials. **Suggested Reading:** Products from Hard Materials and Porous Materials, Products from Refractory Materials and Magnetic Materials.	

TEXT BOOKS	
1	P.C.Angelo and R.Subramanian.," Powder Metallurgy: Science, Technology and Application" Prentice Hall, Reprint 2013
2	AnishUpadhya and G S Upadhaya, " Powder Metallurgy: Science, Technology and Materials, Universities Press, 2011
REFERENCE BOOKS	
1	Sinha A. K., "Powder Metallurgy", DhanpatRai& Sons. New Delhi, 2005
2	KatsuyoshiKondoh, "Powder Metallurgy" 2012.
3	ASM Handbook. Vol. 7, "Powder Metallurgy", Metals Park, Ohio, USA, 2015.
4	Animesh Bose., "Advances in Particulate Materials", Elsevier Publisher, 2013.
5	Ramakrishnan. P., "Powder Metallurgy-Opportunities for Engineering Industries", Oxford and IBH Publishing Co., Pvt. Ltd, New Delhi, 2007.

6	Erhard Klar., "Powder Metallurgy Applications, Advantages and Limitations", American Society for Metals, Ohio, 2007.
E BOOKS	
1	https://books.google.co.in/books/about/POWDER_METALLURGY.html?id=7cmb7BgZtvIC – P. C. Angelo & R. Subramanian.
2	http://allaboutmetallurgy.com/wp/wp-content/uploads/2016/12/ Powder_Metallurgy.pdf - Kondoh
3	https://books.google.co.in/books/about/ASM_Handbook_Volume_7.html?id=epJUAAAAMAAJ – ASM Handbook
4	https://books.google.co.in/books/about/Iron_Powder_Metallurgy.html?id=W3r1BwAAQBAJ&redir_esc=y - Peter K Johnson.
MOOC	
1	http://nptel.ac.in/courses/112101005/downloads/Module_3_Lecture_6_final.pdf
2	http://nptel.ac.in/courses/112107144/12

COURSE TITLE	**RENEWABLE SOURCES OF ENERGY**			**CREDITS**	**3**
COURSE CODE	**MEC4457**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3 0 0 0**
CIA	**50%**			**ESE**	**50 %**
LEARNING LEVEL	**BTL-4**				

CO	**COURSE OUTCOMES**	**PO**
Upon successful completion of this course the student should be able to		
1	To know the energy demand of world, nation and available resources to fulfill the demand	1,2,5
2	To know about the exploration of solar energy resources and their effective tapping technologies	1,2,5
3	Effective utilization of available wind energy resources	1,2,4,5,10,12
4	Acquire the knowledge in bio energy system.	1,2,5,12
5	Acquire the knowledge of modern energy conversion technologies.	1,2,5,12

Prerequisites : Thermal Engineering

MODULE 1: - INTRODUCTION **09**

World Energy Use – Reserves of Energy Resources – Environmental Aspects of Energy Utilisation – Renewable Energy Scenario in Tamil nadu, India and around the World - Economics of renewable energy systems.

Suggested Reading: Potentials of renewable energy sources

MODULE 2: – SOLAR ENERGY **09**

Solar Radiation – Measurements of Solar Radiation - Flat Plate and Concentrating Collectors – Solar direct Thermal Applications – Solar thermal Power Generation - Fundamentals of Solar Photo Voltaic Conversion – Solar Cells – Solar PV Power Generation – Solar PV Applications.

Suggested Reading: Solar energy storage

MODULE 3: – WIND ENERGY	09
Wind Data and Energy Estimation – Types of Wind Energy Systems – Performance – Site Selection – Details of Wind Turbine Generator – Safety and Environmental Aspects Suggested Reading: Application of wind energy	
MODULE 4: – BIO - ENERGY	**09**
Biomass direct combustion – Biomass gasifiers – Biogas plants – Digesters – Ethanol production – Bio diesel – Cogeneration Suggested Reading: Application of biomass	
MODULE 5: – OTHER RENEWABLE ENERGY SOURCES	**09**
Tidal energy – Wave Energy – Open and Closed OTEC Cycles – Small Hydro-Geothermal Energy – Hydrogen and Storage - Fuel Cell Systems Hybrid Systems. Suggested Reading: Hybrid Systems.	

TEXT BOOKS	
1	Rai. G.D., "Non Conventional Energy Sources", Khanna Publishers, New Delhi, 2011.
2	Twidell, J.W. & Weir, A., "Renewable Energy Sources", EFN Spon Ltd., UK, 2006.
3	Sukhatme. S.P., "Solar Energy", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.
REFERENCE BOOKS	
1	Sukhatme. S.P., "Solar Energy", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.
2	Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 1996.
3	Tiwari. G.N., Solar Energy – "Fundamentals Design, Modelling & Applications", Narosa Publishing House, New Delhi, 2002.
4	Freris. L.L., "Wind Energy Conversion Systems", Prentice Hall, UK, 1990.
5	Johnson Gary, L. "Wind Energy Systems", Prentice Hall, New York, 1985
6	David M. Mousdale – "Introduction to Biofuels", CRC Press, Taylor & Francis Group, USA2010
E BOOKS	
1	https://books.google.co.in/books?id=Vps3P-S85o8C&printsec=copyright
2	https://books.google.com/books/.../Non_conventional_Energy_Sources_and_Util.htm...
MOOC	
1	Non-conventional Energy Sources and Utilization (Energy Engineering): For ... R. K. Rajput. S. Chand Pvt. Limited, 2012 - Power resources - 422 pages. Course: http://nptel.ac.in/courses/112105051/#wable sources

COURSE TITLE	LEAN MANUFACTURING			CREDITS	3
COURSE CODE	MEC4458	COURSE CATEGORY	DE	L-T-P-S	3 0 0 0
CIA	50%			ESE	50 %
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
Upon successful completion of this course the student should be able to		
1	Understand the concepts of lean manufacturing system.	1,9
2	Understand the various tools for lean manufacturing (LM).	1,3,5
3	Understand and apply various tools to implement LM system.	1,3,9,
4	Understand the principles of six sigma.	1,3,12
5	understand and learn from case studies of LM	1,3,5,12

Prerequisites : Nil

MODULE 1: INTRODUCTION TO LEAN MANUFACTURING **9**

Conventional Manufacturing versus Lean Manufacturing – Principles of Lean Manufacturing – Basic elements of lean manufacturing – Introduction to LM Tools.

Suggested Reading: Industry Examples

MODULE 2: CELLULAR MANUFACTURING, JIT, TPM **9**

Cellular Manufacturing – Types of Layout, Principles of Cell layout, Implementation. JIT – Principles of JIT and Implementation of Kanban. TPM – Pillars of TPM, Principles and implementation of TPM.

Suggested Reading: Toyota Production System (TPS)

MODULE 3: SET UP TIME REDUCTION, TQM, 5S, VSM **9**

Set up time reduction – Definition, philosophies and reduction approaches. TQM – Principles and implementation. 5S Principles and implementation - Value stream mapping - Procedure and principles.

Suggested Reading: TPS tools & techniques

MODULE 4: SIX SIGMA **9**

Six Sigma – Definition, statistical considerations, variability reduction, design of experiments – Six Sigma implementation.

Suggested Reading: Lean Manufacturing Company Application

MODULE 5: CASE STUDIES **9**

Various case studies of implementation of lean manufacturing at industries.

Suggested Reading: Toyota Production System (TPS) Company Application

TEXT BOOKS

1	Ronald G. Askin & Jeffrey B. Goldberg, “Design and Analysis of Lean Production Systems”, John Wiley & Sons, 2003.
2	Mikell P. Groover, “Automation, Production Systems and CIM”, Prentice Hall, 2008.
3	Rother M. and Shook J, “Learning to See: Value Stream Mapping to Add Value and Eliminate Muda”, Lean Enterprise Institute, Brookline, MA, 2003.
REFERENCE BOOKS	
1	James P. James P. W, “Lean Thinking: Banish Waste and Create Wealth in Your Corporation” Create Space Independent Publishing Platform, 2017.
2	Jamie Flinchbaugh, Andy Carlino, “The Hitchhiker's Guide to Lean: Lessons from the Road” Society of Manufacturing Engineers, 2006.
E BOOKS	
1	https://books.google.co.in/books?id=Vps3P-S85o8C&printsec=copyright
2	Learn to use condition-based maintenance in a Predictive Maintenance program in this onlinetraining course on Predictive Maintenance strategy development.
3	https://www.springer.com/in/book/9783662472149
MOOC	
1	This book presents the state-of-the-art in quality and reliability engineering from a product life-cycle standpoint. Topics in reliability include reliability models, life ... guides.lib.monash.edu/c.php?g=219722&p=1452921