PONDICHERRY UNIVERSITY

PUDUCHERRY – 605 014

REGULATIONS AND SYLLABUS IN

Bachelor of Technology (Mechanical Engineering)

2023-2024

FOR AFFILIATED COLLEGES

REGULATIONS

1. Conditions for Admission:

a) Candidates for admission to the first semester of the 8 semester B.Tech. degree programme should be required to have passed :

The Higher Secondary Examination of the (10+2) curriculum (Academic Stream) prescribed by the different State Boards/ Central Boards or any other examination equivalent there to with minimum of 45% marks (40% marks in case of candidates belonging to reserved category) in aggregate of subjects – Mathematics, Physics and any one of the following optional subjects: Chemistry / Biotechnology/ Computer Science / IT and equivalent/ Electronics/ Biology (Botany & Zoology) or Passed D.Voc Stream in the same or allied sector or an Examination of any University or Authority recognized by the Executive Council of the Pondicherry University as equivalent thereto.

b) Candidates for admission through Lateral entry into second year (third semester) of the 8 semester B.Tech. degree programme should be required to have passed :

Passed Minimum THREE years / TWO years (Lateral Entry) Diploma examination with at least 45% marks (40% marks in case of candidates belonging to reserved category) in ANY branch of Engineering and Technology.

OR

Passed B.Sc. Degree from a recognized University as defined by UGC, with at least 45% marks (40% marks in case of candidates belonging to reserved category) and passed 10+2 examination with Mathematics as a subject.

OR

Passed D.Voc. Stream in the same or allied sector.

(The Universities/colleges will offer suitable bridge courses such as Mathematics, Physics, Engineering drawing, etc., for the students coming from diverse backgrounds to achieve desired learning outcomes of the programme)

2. Age Limit :

As per applicable AICTE norms.

3. Duration of Programme:

The Bachelor of Technology degree programme shall extend over a period of 8 semesters spread over 4 academic years – two semesters constituting one academic year. The duration of each semester shall normally be 15 weeks excluding examinations.

4. Program Structure

The medium of instruction is English.

A student admitted to the B.Tech. programme in a particular branch of engineering will earn the degree in that branch by fulfilling all the requirements prescribed in the regulations during the course of study.

The student is also permitted to opt for earning an **Honors degree in the same discipline of Engineering or a Minor degree** in another discipline of engineering in addition to the degree in his own discipline of engineering. The student will be allowed to exercise this option at the end of first year based on his academic performance in the first year. The students admitted through lateral entry can exercise this option at the end of third semester, based on the GPA scored in the third semester examination.

The student opting for B.Tech. degree with **Honors or B.Tech. degree with Minor** is required to earn additional 20 credits starting from the third semester. The students admitted in the second year through lateral entry and opting for Honors / Minor degree will earn the additional 20 credits starting from the fourth semester.

5. Eligibility for the award of B.Tech. Degree:

No candidate shall be eligible for the award of the degree of Bachelor of Technology, unless he/she has undergone the course for a period of 8 semesters (4 academic years) / 6 semesters (3 academic years for Lateral Entry candidates) in the Faculty of Engineering and has passed the prescribed examinations in all the semesters. Details regarding the possible exit for a B.Tech. student – in line with one of the goals of the National Education Policy (NEP) 2020 are provided in section 13.

6. Branches of Study:

Branch I - Civil Engineering

Branch II – Mechanical Engineering

Branch III - Electronics & Communication Engineering

Branch IV - Computer Science & Engineering

Branch V – Electrical & Electronics Engineering

Branch VI – Chemical Engineering

Branch VII - Electronics & Instrumentation Engineering

Branch VIII – Information Technology

Branch IX - Instrumentation & Control Engineering

Branch X – Biomedical Engineering

Branch XI - Robotics and Automation

Branch XII – Food Technology

Branch XIII- CSE (Internet of Things & Cyber security including Block chain Technology)

Branch XIV – Artificial Intelligence and Machine Learning

Branch XV - Artificial Intelligence and Data Science

or any other branch of study as and when offered. The branch allocation shall be ordinarily done at the time of admission of the candidate to the first semester.

7. Course Structure and Subjects of Study:

Definition of Credit:

1 Hour Lecture (L) per week	1 Credit
1 Hour Tutorial (T) per week	1 Credit
2 Hours Practical (P) per week	1 Credit

Range of Credits: The total credits of all the branches for the four-year B. Tech. degree Programme shall be in the range of 160 to 172 (Minor variation is allowed as per AICTE guidelines). ″Minor Degree or Honors will cumulatively require additional 20 credits in the specified area in addition to the credits essential for obtaining the Under Graduate Degree in Major Discipline".

The subjects of study shall include theory, practical courses and project work/internships as given in the curriculum and shall be in accordance with the prescribed syllabus.

The curriculum of every programme will have courses that are categorized as follows:

(i) Humanities, Social Sciences and Management Courses (HSM)

(ii) Basic Science Courses (BSC)

(iii) Engineering Science Courses (ESC)

(iv) Professional Core Courses (PCC)

(v) Professional Elective Courses (PEC)

(vi) Open Elective Courses (OEC)

(vii) Professional Activity Courses (PAC)

(viii) Mandatory non-Credit Courses (MCC)

Each course will have either one or more of three components namely Lecture (L), Tutorial

(T) and Practice (P). Each course is assigned credits as detailed below:

(i) Theory courses will carry either 3 or 4 credits - 3 credits for courses with 3 lecture periods per week and 4 credits for courses with 3 lecture periods and 1 tutorial period per week.

(ii) All Elective courses including online courses will carry maximum 3 credits. The student can earn the credits towards the Open Elective Courses (OEC) by completing the online courses offered in NPTEL anytime between third and seventh semester on prior approval of the courses by the Academic Courses Committee of the Institute. Credits earned through the NPTEL courses will be confined to 2 or 3 credits and subject to a maximum of 9 credits during the entire programme of study.

(iii) Practical courses will normally carry either 1 or 1.5 credits – 1.5 credits for courses with 3 practice periods per week and 1 credit for courses with 2 practice periods per week.

(iv) Out of total credits required for successful completion of the degree, 14 to 22 credits can be assigned for Project work and/or Internship.

(v) Mandatory non-credit courses carry zero credit.

8. Examinations:

The theory and practical examinations shall comprise continuous internal assessment throughout the semester in all subjects as well as university examinations conducted by Pondicherry University at the end of the semester (November / December or April / May).

8.1. Evaluation Scheme

All Credit courses are evaluated for 100 marks comprising of Internal assessment and end-semester exam.

For Theory Course, the weightage of internal assessment is 40% and end semester examination is 60%

For Practical course, the weightage of internal assessment is 60% and end semester examination is 40%

For Project, the weightage of internal assessment is 60% and end semester examination is 40%

8.2. Internal Assessment (Theory)

Total Internal Assessment mark for a theory course is 40 marks. The breakup is as follows:

Criteria	Maximum Marks
a) Internal Assessment Tests	30
b) Percentage of Attendance	5
c) Assignment(s)	5
Total	**40**

Marks for Attendance is as follows:

Below 75%	0
75% - 80%	1
81% - 85%	2
86% - 90%	3
91% - 95%	4
96% - 100%	5

The Principal of the College/Institute schedules the Internal Assessment tests for all courses. All faculty members are expected to conduct this Internal Assessment tests for 1.30 hours duration and evaluate and required to upload the marks to the Controller of Examinations of University. Colleges are also requested to preserve the answer sheets of Internal Assessment tests until declaration of results by the University.

8.3. Internal Assessment (Practicals)

Faculty in-charge of Lab courses shall evaluate the practical course for 60 marks. The break up is as follows:

Criteria	Maximum Marks
a) Laboratory exercises and Record	30
c) Mid Semester exam (Average of 2 exams)	15
c) Internal Viva voce	5
d) Percentage of Attendance	10
Total	**60**

Marks for Attendance is as follows:

Below 75%	0
75% - 80%	2
81% - 85%	4
86% - 90%	6
91% - 95%	8
96% - 100%	10

8.4. Internal Assessment (Project)

The Project work carried out in the eighth semester shall be assessed as follows:

Criteria	Marks
a) Continuous assessment (Guide)	25
b) Project Evaluation Committee	35
Total	**60**

8.5 Requirement for appearing for University Examination

The Controller of Examinations (COE) of Pondicherry University schedules the End-Semester exams for all theory and practical courses based on the University academic calendar.

A detailed Exam Time Table shall be circulated to all Colleges at least 15 days before the start of exams. Question Papers shall be set externally based on BOS approved syllabus.

A candidate shall be permitted to appear for university examinations at the end of any semester only if:

i) He / She secures not less than 75% overall attendance arrived at by taking into account the total number of periods in all subjects put together offered by the institution for the semester under consideration.
(*Candidates who secure overall attendance greater than 60% and less than 75% have to pay a condonation fee as prescribed by University along with a medical certificate obtained from a medical officer not below the rank of Assistant Director*)

ii) He / She earns a progress certificate from the Head of the institution for having satisfactorily completed the course of study in all the subjects pertaining to that semester

iii) His / Her conduct is found to be satisfactory as certified by the Head of the institution.
A candidate who has satisfied the requirement (i) to (iii) shall be deemed to have satisfied the course requirements for the semester.

8.6 End Semester Exam Evaluation Pattern

Course	**Maximum marks**
a) Theory course (Sec A, Sec B and Sec C) Questions from all units of syllabus	60 marks
b) Practical course (Based on Lab exercises/Record/ Practicals/ /Viva)	40 marks

c) Internship /Project Work (Based on Seminar/Project Work/Project report/Presentation and viva voce)	40 marks

8.7 Consolidation of Marks and Passing Minimum

The Controller of Examinations of the University consolidates the Internal Assessment marks uploaded by the Colleges and marks secured by students in the end-semester examination.

A student shall be declared to have passed the examination in a subject of study only if he/she secures not less than **40% marks individually both in internal assessment and end-semester examination or an aggregate of 40%.**

A candidate who has been declared "Fail" in a particular subject may reappear for that subject during the subsequent semesters and secure pass marks. However, there is a provision for revaluation of failed or passed subjects provided he/she fulfills the following norms for revaluation.

a) Applications for revaluation should be filed within 15 days from the date of declaration of results or 7 days from the date of receipt of grade sheet whichever is earlier.
b) The candidate should have attended all the internal assessments conducted by the college as well as all the end semester examinations conducted by the University.
c) If a candidate has failed in more than two papers in the end semester examinations, his/her representation for revaluation will not be considered.
d) The request for revaluation must be made in the prescribed format duly recommended by the Head of the Institution along with the revaluation fee prescribed by the University.

A student shall be declared to have passed the examination in a subject of study only **if he/she secures not less than 40% marks in the end-semester examination and secures an overall aggregate of 40%.**

8.8. Arrear Exams

A student who failed to secure 40% marks in aggregate is declared as "Fail" and he is eligible to take up a supplementary examination by registering to the said course in the following semester. All other candidates who failed due to shortage of attendance and those seeking to improve the grade shall repeat the course.

8.9. Letter Grades and Calculation of CGPA

Total Marks Secured by a student in each course shall be converted into a letter grade. The following Table shows the seven letter grades and corresponding meaning and the grade points for the calculation of Cumulative Grade Point Average (CGPA).

Each course (Theory/Practical) is to be assigned 100 marks, irrespective of the number of credits, and the mapping of marks to grades may be done as per the following table:

Range of Marks	**Assigned Grade**	Grade Points
91-100	A^+	10
81-90	A	9
71-80	B^+	8
61-70	B	7
51-60	C^+	6
46-50	C	5
40-45	D	4
<40	F	0
Not Applicable	F^R (Fail due to shortage of attendance and therefore, to repeat the course)	0

Note: -F- denotes failure in the course; - F^R - denotes absent / detained as per AICTE norms.

After the results are declared, grade sheets will be issued to the students. The grade sheets will contain the following details:

a) The college in which the candidate has studied.
b) The list of courses enrolled during the semester and the grades scored.
c) The Grade Point Average (GPA) for the semester and the Cumulative Grade Point Average (CGPA) of all enrolled subjects from first semester onwards.

d) GPA is the ratio of sum of the products of the number of credits (C) of courses registered and the corresponding Grades Points (GP) scored in those courses, taken for all the courses and sum of the number of credits of all the courses.

$$\mathbf{GPA = \sum(C \times GP)/ \sum C}$$

CGPA will be calculated in a similar manner, considering all the courses enrolled from first semester. F^R grades are to be excluded for calculating GPA and CGPA.

e) The conversion of CGPA into percentage marks is as follows

$$\% \text{ Mark} = (\text{CGPA} - 0.5) \times 10$$

9. Procedure for completing the B.Tech. course:

A candidate can join/rejoin the course of study of any semester only at the time of its normal commencement and only if he/she has satisfied the course requirements for the previous semester and further has registered for the university examinations of the previous semester in all the subjects as well as all arrear subjects if any.

However, the entire B.Tech. course should be completed within 7 years (14 semesters) and six years (12 semesters) for students admitted under lateral entry.

10. Award of Class and Rank in B.Tech. degree:

i) A candidate who satisfies the course requirements for all semesters and who passes all the examinations prescribed for all the eight semesters (six semesters for lateral entry candidates) within a maximum period of 7 years (6 years for lateral entry candidates) reckoned from the commencement of the first semester to which the candidate was admitted shall be declared to have qualified for the award of B.Tech. degree.

ii) A candidate who qualifies for the award of the B.Tech. degree passing in all subjects pertaining to the semesters 3 to 8 in his/her first appearance within 6 consecutive semesters (3 academic years) and in addition secures a CGPA of 8.50 and above for the semesters 3 to 8 shall be declared to have passed the examination in **FIRST CLASS** with **DISTINCTION**.

iii) A candidate who qualifies for the award of the B.Tech. degree by passing in all subjects relating to semesters 3 to 8 within a maximum period of eight semesters after his/her commencement of study in the third semester and in addition secures CGPA not less than 6.5 shall declared to have passed the examination in **FIRST CLASS**.

iv) All other candidates who qualify for the award of B.Tech. degree shall be declared to have passed the examination in **SECOND CLASS**.

v) For the Award of University ranks and Gold Medal for each branch of study, the CGPA secured from the 1st to 8th semester alone should be considered and it is mandatory that the candidate should have passed all the subjects from the1st to 8th semester in the first attempt. Rank certificates would be issued to the first ten candidates in each branch of study.

11. Provisions for Honors/Minor degree along with B.Tech. degree:

1. B.Tech. with Honors Degree in the same Engineering discipline

a. The student shall be given an option to earn a Honors degree in the same discipline of engineering at the end of first year based on his academic performance in the first year.

b. A student is eligible to exercise this option if he has passed all the subjects offered in the first year in the first attempt itself and has earned a CGPA of not less than 7.5.

c. Honors degree in a particular discipline of engineering shall be offered for a batch of students if and only if a minimum of 5 eligible students opt for it.

d. The student is required to earn an additional 20 credits (over and above the prescribed maximum credits in the curriculum) starting from the third semester onwards to become eligible for the award of Honors degree. 20 credits shall be earned by the student by completing 5 additional courses of 4 credits each, one in each of the 5 semesters starting from the third to seventh semester. The syllabus of these 5 courses are framed so as to cover advanced topics in that discipline of engineering.

e. The students admitted in the second year through Lateral Entry Scheme will also be given a chance to opt for Honors degree. Eligibility to avail this option is CGPA of 7.5 and above with no arrears in the third Semester. The student will join the existing batch of students in the fourth semester and earn 16 credits by registering the prescribed courses offered up to the seventh semester. The respective BoS will decide on a suitable course in lieu of the course offered in the third semester to facilitate the student to earn the remaining 4 credits.

f. A student is eligible to get the Honors degree only on completing the programme in 'First Class with Distinction' class.

g. A student can exercise the option to withdraw from the Honors degree at any time after entry.

h. Details about the courses completed and credits earned for Honors degree will appear only in the 'Eighth Semester Grade Sheet' and 'Consolidated Grade Sheet'. These details will be listed under the heading 'Credits Earned for Honors degree'. In the case of students who have either withdrawn from Honors degree or become ineligible for Honors degree by not securing 'First Class with Distinction', the credits earned for the courses registered and successfully completed for Honors degree will be listed under the heading 'Additional Credits Earned'.

i. The CGPA will be calculated for all the courses credited by the students inclusive of major and honors courses

j. Nomenclature of Honors Degree is 'B.Tech.(Honors) in XXX ', where XXX is Discipline in which the student has enrolled.

2. B.Tech. with Minor degree in another Engineering discipline

a) The student shall be given an option to earn a minor degree in another discipline of engineering of his choice at the end of first year based on his academic performance in the first year.

b) A student is eligible to exercise this option if he has passed all the subjects offered in the first year in the first attempt itself and has earned a CGPA of not less than 7.5.

c) Minor degree in a particular discipline of engineering shall be offered for a batch of students if and only if a minimum of 5 eligible students opt for it.

d) The student is required to earn an additional 20 credits (over and above the prescribed maximum credits in the curriculum) starting from the third semester onwards to become eligible for the award of minor degree. 20 credits shall be earned by the student by completing 5 additional courses of 4 credits each, one in each of the 5 semesters starting from the third to seventh semester. The curricular content of these 5 courses are framed in such a way

that that these courses will essentially cover the core minimum knowledge required to be fulfilled for award of degree in the discipline of engineering in which the student chooses to earn the minor degree.

e) The students admitted in the second year through Lateral Entry Scheme will also be given a chance to opt for Minor degree. Students with a CGPA of 7.5 and with no arrears in the third semester are eligible to avail this option. The student will join the existing batch of students in the fourth semester and earn 16 credits by registering for prescribed courses offered up to seventh semester. The respective BoS will decide on a suitable course in lieu of the course offered in the third semester to facilitate the student to earn the remaining 4 credits.

f) A student can exercise the option to withdraw from the Minor degree at any time after entry.

g) Details about the courses completed and credits earned for Minor degree will appear only in the 'Eighth Semester Grade Sheet' and 'Consolidated Grade Sheet'. These details will be listed under the heading 'Credits Earned for Minor degree'. In the case of students who have withdrawn from Minor degree, the credits earned for the courses registered and successfully completed for Minor degree will be listed under the heading 'Additional Credits Earned'.

h) Nomenclature of Minor Degree is 'B.Tech. in XXX with Minor in YYY', where XXX is Discipline in which the student is enrolled and YYY is Discipline which the student has opted as Minor.

i) The CGPA will be calculated for all the courses credited by the students inclusive of major and minor courses.

12. Provision for withdrawal:

Based on the recommendation of the Head of the Institution, a candidate with valid reasons may be granted permission by the University to withdraw from writing the entire semester examination as one Unit. The withdrawal application shall be valid only if it is made earlier than the commencement of the last theory examination pertaining to that semester. Withdrawal shall be permitted only once during the entire course. A candidate who has withdrawn is also eligible to be awarded DISTINCTION provided he/she satisfies the other necessary conditions. But, they are not eligible to be awarded a rank.

13. Provisions for exit in B.Tech. course:

(For courses where AICTE specifies exit in the model curriculum)

The curriculum and the syllabus for all B.Tech programmes have been planned in compliance with the NEP guidelines proposed by AICTE. Accordingly, students joining B.Tech programmes shall have all benefits NEP offers in terms of exercising exit option during the course of study. Every B.Tech programme governed under this school board shall adopt the NEP guidelines, as and when proposed/amended by AICTE, and the following scheme will be applied for all such B.Tech programmes specified by AICTE.

NEP 2020 suggests that a student can exercise exits at multiple stages of the course of study. As per AICTE norms, a student can have two possible exits before the completion of the Full Engineering degree and may get a UG Diploma /Certificate or B.Sc. degree in the relevant discipline if he/she fulfils the following conditions: (Subject to change as per AICTE guidelines)

1. UG Diploma/Certificate in the relevant branch of study

A student should be able to get a UG Diploma if he/she completes:

a. 50% of the credits for B.Tech. (80-85 credits)

b. 50% of the program core courses

c. Students exiting the program after earning 50% credit requirements will be awarded a UG Diploma provided they secure an additional 6 credits through summer internships/apprenticeship of 2 months duration.

d. Students admitted through lateral entry cannot exercise the exit option as he will not be able to meet out the 50% Credits for B.Tech. degree.

2 B.Sc. in the relevant branch of study

A student should be able to get a B.Sc. degree if he/she completes:

(i) 75% of the credits for B.Tech. (minimum 120 credits) and at least 3 years in the program.

(ii) 100% of the core program courses.

(iii) Students exiting the program after earning 75% credit requirements will be awarded a B.Sc. provided they secure an additional 6 credits through 2 summer internships/apprenticeship for 2 months each.

(iv) With B.Sc. degree, the student is eligible for entry into programs which take B.Sc. degree as eligibility criteria.

2.1 Award of Class in B.Sc. degree

A candidate who satisfies the course requirements for all semesters and who passes all the examinations within a maximum period of 6 years (5 years for lateral entry candidates) reckoned from the commencement of the first semester to which the candidate was admitted shall be declared to have qualified for the award of B.Sc. degree in the relevant discipline.

i) A candidate who qualifies for the award of the B.Sc. degree passing in all subjects pertaining to semesters the 3 to 6 in his/her first appearance within 4 consecutive semesters (2 academic years) and in addition secures a CGPA of 8.50 and above for the semesters 3 to 6 shall be declared to have passed the examination in **FIRST CLASS** with **DISTINCTION**.

ii) A candidate who qualifies for the award of the B.Sc. degree by passing in all subjects relating to semesters 3 to 6 within a maximum period of six semesters after his/her commencement of study in the third semester and in addition secures CGPA not less than 6.5 shall declared to have passed the examination in **FIRST CLASS.**

iii) All other candidates who qualify for the award of B.Sc. degree shall be declared to have passed the examination in **SECOND CLASS**.

2. Re-entry to complete the program

A student exiting with B.Sc. should be entitled to re-enrol in the programme of the same Engineering discipline. Only students admitted to the B.Tech. programme and exercised an exit option are eligible for readmission to the B.Tech. programme under the same discipline. It is suggested that all credits will be transferred, if the student enrols back within a limited period (3 years) of exiting. In case a student enrols after that, then the decision on the transfer of credits should be based on the changes in the curriculum the student studied. A candidate after exit may rejoin the course only at the commencement of the semester at which he/she discontinued, provided he/she pays the prescribed fees to the University. The total period of completion of the B.Tech. course reckoned from the commencement of the first semester to which the candidate was admitted shall not in any case exceed 7 years, including of the period of discontinuance.

3. Completion Possibility in other Institutions

A student can earn B.Sc. in one institution (Engineering) and complete the degree program in another institution (same Engineering discipline only).

(Note: If these exit options are accepted for multiple B.Tech. programs, it is suggested that AICTE actively communicate these to the industry and other bodies, so they recognize these and accept them as bona-fide credentials for the purposes of recruitment and/or eligibility for admission to programs, appearing in competitive examinations, etc.)

13. Revision of Regulations and Curriculum:

The University may from time-to-time revise, amend or change the regulations of curriculum and syllabus as and when found necessary.

PONDICHERRY UNIVERSITY

BACHELOR OF TECHNOLOGY (Mechanical Engineering) for Affiliated Colleges

CURRICULUM AND SYLLABUS

SEMESTER WISE STRUCTURE

I Semester

S. No.	Subject Code	Subjects	Category	Periods			Credits	Marks		
				L	T	P		IA	UE	TM
Induction Program for 3 Weeks (Including UHV - I)										
Theory										
01	T101	Mathematics – I	BSC	4	1	0	04	40	60	100
02	T102	Engineering Chemistry	BSC	3	0	2	04	40	60	100
03	T103	Biology for Engineers	BSC	3	0	0	03	40	60	100
04	T104	Engineering Mechanics	ESC	3	1	0	04	40	60	100
Practical										
04	P101	Design Thinking	ESC	0	0	2	01	60	40	100
05	P102	Engineering Graphics & Design	ESC	1	0	4	03	60	40	100
06	P103	Programming for Problem Solving	ESC	2	0	3	04	60	40	100
07	P104	Idea Lab Workshop	ESC	2	0	4	-	-	-	-
Total				**15**	**1**	**15**	**23**	**340**	**360**	**700**

II Semester

S. No.	Subject Code	Subjects	Category	Periods			Credits	Marks		
				L	T	P		IA	UE	TM
Theory										
01	T105	Mathematics – II	BSC	3	1	0	04	40	60	100
02	T106	Basic Electrical and Electronics Engineering	ESC	3	0	2	04	40	60	100
03	T107	Engineering Physics	BSC	3	1	2	05	40	60	100
04	T108	Communicative English	HSMC	3	0	0	03	40	60	100
05	T109	Universal Human Values-2	HSMC	3	0	0	03	40	60	100
Practical										
07	P105	Digital Fabrication/ Workshop/ Manufacturing Practices.	ESC	0	0	3	2	60	40	100
08	P106	Sports and Yoga or NSS/NCC	MCC	2	-	-	-	-	-	-
Total				**18**	**1**	**6**	**21**	**260**	**340**	**600**

III Semester

S. No.	Subject Code	Subjects	Category	Periods			Credits	Marks		
				L	T	P		IA	UE	TM
Theory										
01	MAT31	Mathematics – III	BSC	3	1	0	04	40	60	100
02	MET31	Mechanics of Solids	PCC	3	1	0	04	40	60	100
03	MET32	Manufacturing Processes	PCC	3	0	0	03	40	60	100
04	MET33	Metallurgy & Material Science	PCC	3	0	0	03	40	60	100
05	MET34	Applied Thermodynamics	ESC	3	0	0	03	40	60	100
06	MET35	Environmental Science	MCC	3	0	0	-	-	-	-
Practical										
06	MEP31	Material Testing and Metallurgy Lab	PCC	0	0	2	01	60	40	100
07	MEP32	Computer Aided Machine Drawing Lab	PCC	0	0	3	02	60	40	100
Total				**18**	**2**	**5**	**20**	**320**	**380**	**700**

IV Semester

S. No.	Subject Code	Subjects	Category	Periods			Credits	Marks		
				L	T	P		IA	UE	TM
Theory										
01	MAT41	Probability, Statistics & Numerical Methods	BSC	3	1	0	04	40	60	100
02	MET41	Kinematics and Dynamics of Machinery	PCC	3	1	0	04	40	60	100
03	MET42	Thermal Engineering	PCC	3	1	0	04	40	60	100
04	MET43	Machining Processes	PCC	3	0	0	03	40	60	100
05	MET44	Fluid Mechanics and Machinery	PCC	3	0	0	03	40	60	100
Practical										
06	MEP41	Dynamics of Machines Lab	PCC	0	0	3	2	60	40	100
07	MEP42	Manufacturing Process Lab	PCC	0	0	3	2	60	40	100
08	MEP32	Fluid Mechanics and Machinery Lab	PCC	0	0	3	2	60	40	100
Total				**15**	**3**	**9**	**24**	**380**	**420**	**800**

V Semester

S. No.	Subject Code	Subjects	Category	Periods			Credits	Marks		
				L	T	P		IA	UE	TM
Theory										
01	MET51	Design of Machine Elements	PCC	3	1	0	04	40	60	100
02	MET52	Heat and Mass Transfer	PCC	3	1	0	04	40	60	100
03	MET53	Metrology and Mechanical Measurements	PCC	3	1	0	04	40	60	100
04	MET54	Mechatronics, Robotics & Control	PCC	3	0	0	03	40	60	100
05	MET55	Product Innovation & Entrepreneurship	ESC	3	0	0	03	40	60	100
Practical										
06	MEP51	Metrology and Mechanical Measurements Lab	PCC	0	0	3	2	60	40	100
07	MEP52	Thermal Engineering Lab	PCC	0	0	3	2	60	40	100
08	MEP53	Indian Constitution & Tradition	MCC	3	0	0	-	-	-	-
Total				**18**	**3**	**6**	**22**	**320**	**380**	**700**

VI Semester

S. No.	Subject Code	Subjects	Category	Periods			Credits	Marks		
				L	T	P		IA	UE	TM
Theory										
01	MET61	Design of Transmission System	PCC	3	1	0	04	40	60	100
02	MET62	Production & Operation Management	ESC	3	1	0	04	40	60	100
03	MET63	Manufacturing Automation	PCC	3	0	0	03	40	60	100
04	MET64	Computer Aided Design & Analysis	PCC	3	0	0	03	40	60	100
05	MET65	Industrial Psychology	HSMC	3	0	0	03	40	60	100
Practical										
06	MEP61	Modeling and Simulation Lab	PCC	0	0	3	2	60	40	100
07	MEP62	Computational Fluid Dynamics Lab	PCC	0	0	3	2	60	40	100
08	MEPW6	Engineering Project-1 (Literature Review)	PROJ	0	0	4	02	60	40	100
Total				**15**	**2**	**10**	**23**	**380**	**420**	**800**

VII Semester

S. No.	Subject Code	Subjects	Category	Periods			Credits	Marks		
				L	T	P		IA	UE	TM
Theory										
01		Professional Elective-1	PEC	3	0	0	03	40	60	100
02		Professional Elective-2	PEC	3	0	0	03	40	60	100
03		Open Elective-1	OEC	3	0	0	03	40	60	100
04		Open Elective-2	OEC	3	0	0	03	40	60	100
Practical										
05	MEPW7	Engineering Project-2 (Design & Analysis)	PROJ	0	0	8	04	60	40	100
06	MEP71	Seminar	PROJ	0	0	3	01	100	-	100
Total				**12**	**0**	**11**	**17**	**320**	**280**	**600**

VIII Semester

S. No.	Subject Code	Subjects	Category	Periods			Credits	Marks		
				L	T	P		IA	UE	TM
Theory										
01		Professional Elective-3	PEC	3	0	0	03	40	60	100
02		Open Elective-3	OEC	3	0	0	03	40	60	100
03		Professional Ethics	MCC	3	0	0	-	-	-	
Practical										
03	MEPW8	Engineering Project-3 (Prototype & Testing)	PROJ	0	0	16	08	60	40	100
Total				**9**	**0**	**16**	**14**	**140**	**160**	**300**

Professional Elective Courses (PEC) 7th /8thsem: Total **3** to be taken, based on Project topic and individual interest. Illustrative courses are listed here.

1. Refrigeration & Air Conditioning
2. Power Plant Engineering
3. Renewable Energy Engineering
4. Finite Element Analysis
5. Computational Fluid Dynamics
6. Design for Manufacturing & Assembly
7. Additive Manufacturing
8. Die, Mould and Tool Engineering
9. Automobile Engineering
10. Aerospace Engineering
11. Agricultural Engineering
12. Biomedical Engineering
13. Food Technology
14. Marine Engineering
15. Nuclear Engineering
16. Textile Engineering
17. Welding Technology
18. Industrial casting Technology
19. Hydraulics and pneumatics
20. Metal Forming Processes
21. Composite Materials
22. Bio Fuels
23. Organizational behavior and Industrial Engg
24. Total Quality Management
25. Lean Manufacturing
26. Entrepreneurship Development
27. Nano science and technology
28. Cryogenic Engineering
29. Advanced Manufacturing Technology
30. Fatigue, Fracture and Failure Analysis
31. Maintenance and Safety Engineering
32. Reverse Engineering and Rapid Prototyping
33. Design of Jigs, Fixtures and Press Tools
34. Non-Traditional Machining
35. Automotive Pollution and Control

Open Elective Courses (OEC) 7th /8thsem: Any **3** courses (from any department), based on individual interest and project.

Industry internship: Internship in industry, start-up or R&D lab in 2nd/3rd year summer is compulsory (audit). Longer internship for 6-monthy (**9** credits) or full-year including summer (**18** credits) can be takenin7th/8thsemester, **in lieu of** Engineering Project and Electives. The internship must be properly evaluated.

SYLLABUS

SEMESTER – I

T101 MATHEMATICS – I

Objectives

- *The course aims to enable students to comprehend the mathematical concepts of matrices, ordinary differential equations and multivariable calculus, for problem-solving in the engineering field.*

Unit I - Linear Algebra (Matrices) (12 Hrs)

Rank of a matrix, Consistency of a system of linear equations, Characteristic equation of a matrix, Eigen values and Eigen vectors – Properties of Eigen values and Eigen vectors, Cayley-Hamilton theorem (excluding proof) verification – Application (Finding Inverse and Power of a matrix), Diagonalization of matrix by orthogonal and similarity transformation, Quadratic form – Nature of Quadratic Form – Orthogonal reduction of quadratic form to canonical form.

Unit II – Ordinary Differential Equations (12 Hrs)

Differential Equations of First Order - Exact equations - Leibnitz's linear equations - Bernoulli's equation - Equations solvable for p - Clairaut's equation, Differential equations of Higher order - Linear differential equations of higher order with constant coefficients - Euler's linear equation of higher order with variable coefficients - Method of variation of parameters.

Unit III – Multivariable Calculus (Differentiation) (12 Hrs)

Partial differentiation – Partial derivatives of first order and higher order – Partial differentiation of implicit functions – Euler's theorem on homogeneous functions – Total derivative, Jacobian – Properties of Jacobian, Taylor's series for functions of two variables, Maxima and minima of functions of two variables.

Unit IV – Multivariable calculus (Multiple Integrals) (12 Hrs)

Double integration (Cartesian form and Polar form) – constant limits – variable limits – over the region R, change of variables in double integrals (Cartesian to polar), Application of double integral - Area by double integration, Change of Order of Integration, Triple Integration (Cartesian – Spherical and Cylindrical) – constant limits – variable limits – over the region R, Application of triple integral - Volume by triple integration.

Unit V – Multivariable Calculus (Vector Calculus) (12 Hrs)

Vector Differential Operator, Gradient – Properties, Directional derivative, Divergence and curl – Properties and relations, Solenoidal and Irrotational vector fields, Line integral and Surface integrals – Integral Theorems (excluding Proof) – Green's theorem – Stoke's theorem – Gauss divergence theorem

Text Books:

1. Veerarajan T., "Engineering Mathematics – I and II", Tata McGraw-Hill, New Delhi, 2014 and 2015.
2. Dr. M.K. Venkataraman, "Engineering Mathematics – Volume I and Volume II", The National Publishing Company, Chennai 2008.

Reference Books:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw-Hill, New Delhi, 2010.
3. Bali N.P and Manish Goyal., "A Text Book of Engineering Mathematics", Laxmi Publications(P) Ltd, 2011.
4. Erwin Kreyszig, Advanced Engineering Mathematics (9 th Ed), John Wiley & Sons, New Delhi, 2011

Online Courses/NPTEL/SWAYAM:

https://nptel.ac.in/courses/111106100

https://nptel.ac.in/courses/111104125

https://nptel.ac.in/courses/111105121

https://nptel.ac.in/courses/111107112

T102 ENGINEERING CHEMISTRY

Objectives

- *To know about the importance of Chemistry in Engineering domain*
- *To understand the chemistry background of industrial process*
- *To apply chemistry knowledge for Engineering disciplines*

UNIT -I **(9hours)**

Water- Hardness of water – units and calcium carbonate equivalent. Determination of hardness of water- EDTA method. Disadvantages of hard water-boiler scale and sludge, caustic embrittlement, priming & foaming and boiler corrosion. Water softening method – internal & external conditioning – lime-soda process, zeolite process and ion exchange process. Desalination – reverse osmosis & electrodialysis.

UNIT II **(9hours)**

Polymers- Classification, types of polymerization reactions – mechanism of radical, ionic and Ziegler-Natta polymerizations. Polymer properties – Chemical resistance, crystallinity and effect of temperature, Mn and Mw. Thermoplastics and thermosets. Preparation, properties and uses of PVC, TEFLON, Nylons, Bakelite, Polyurethane, rubber–vulcanization, synthetic rubber, BuNa-S,BuNa-N,Silicone and butyl rubber.
Conducting Polymers-classification and applications. Polymer composites–FRP– laminar composites. Moulding constituents of plastics, moulding techniques – compression, injection, transfer and extrusion moulding.

UNIT- III **(9hours)**

Electrochemical cells- Galvanic cell, single electrode potential, standard electrode potential, electromotive series. EMF of a cell and its measurement. Nernst equation. Electrolyte concentration cell. Reference electrodes - hydrogen, calomel, Ag/AgCl & glass electrodes. Batteries - primary and secondary cells, Leclanché cell, Lead acid storage cell, Ni-Cd battery & alkaline battery. Fuel cells – H_2-O_2 fuel cell.

UNIT -IV **(9hours)**

Corrosion and its control- Chemical & electrochemical corrosion-Galvanic, pitting, stress and concentration cell corrosion. Factors influencing corrosion-corrosion control methods - cathodic protection and corrosion inhibitors. Protective coating-types of protective Coatings-metallic coating-tinning and galvanizing, cladding, electroplating and anodizing.

UNIT-V **(9hours)**

Phase rule- Definition and derivation of phase rule. Application to one component system-water and sulphur systems. Thermal analysis, condensed phase rule. Two component systems – Pb - Ag, Cu-Ni and Mg-Zn systems.

Text books:

1. P.C. Jain and Monika Jain, Engineering Chemistry, Dhanpat Rai and Sons, New Delhi 15th Ed, 2010.

Reference Books:

1. S. S. Dara, A Textbook of Engineering Chemistry, 11th Ed, S. Chand & Co., Ltd. New Delhi,2008.
2. B.K.Sharma,EngineeringChemistry,3rdeditionKrishnaPrakashan Media (P) Ltd., Meerut,2001.
3. P.Kannanand A.RaviKrishnan"Engineering Chemistry"Hi-TechSri Krishna Publications, Chennai, 9th Ed,2009.
4. N.Krishnamurthy, P.Vallinayagam and D.Madhavan,Engineering Chemistry,2ndEd,PHILearningPVT.,LTD,NewDelhi,2008.

CHEMISTRY LAB (Lab -30hrs)

OBJECTIVES

- To gain a practical knowledge of Engineering chemistry in relevance to Industrial applications

LIST OF EXPERIMENTS (ANY 10 EXPERIMENTS)

1. Determination of dissolved oxygen in water.
2. Determination of total hardness of water by EDTA method.
3. Determination of carbonate and bicarbonate in water.
4. Estimation of chloride content in water.
5. Estimation of magnesium by EDTA.
6. Estimation of acetic acid in vinegar.
7. Estimation of ferrous by permanganometry.
8. Estimation of ferrous and ferric iron in a solution mixture by dichrometry.
9. Estimation of available chlorine in bleaching powder.
10. Estimation of copper in copper sulphate solution.
11. Estimation of calcium by permanganometry.
12. Estimation of iron by colorimetry.

DEMONSTRATION EXPERIMENTS (ANY TWO OF THE FOLLOWING)

1. Determination of COD of water sample.
2. Determination of lead by conductometry.
3. Percentage composition of sugar solution by viscometry.

T103 BIOLOGY FOR ENGINEERS

Objectives

- To convey that Biology is as important a scientific discipline as Mathematics, Physics and Chemistry
- To convey that classification per se is not what biology is all about. The underlying criterion, such as morphological, biochemical or ecological be highlighted.
- To convey that "Genetics is to biology what Newton's laws are to Physical Sciences" Mendel's laws, Concept of segregation and independent assortment
- How to analyses biological processes at the reductionistic level
- The fundamental principles of energy transactions are the same in physical and biological world.

UNIT-I **(9hours)**

Classification- (a)cellularity-Unicellular or multicellular (b)ultra structure prokaryotes or eukaryotes (c)Energy and Carbon-utilisation -Autotrophs, heterotrophs, lithotropes (d)Ammonia excretion–aminotelic, uricoteliec, ureotelic (e)Habitats- acquaticor terrestrial (f) Molecular taxonomy three major kingdoms of life.

UNIT-II **(9hours)**

Genetics-Mendel's laws, Concept of segregation &independent assortment. Concept of allele. Recessiveness, and dominance. Single gene disorders in humans–Sickle cell disease, Phenylketonuria.

UNIT-III **(9hours)**

Carbohydrates: Types, Structural & functional importance. Lipids: Classification - Simple, compound, & derived, Importance of lipid soluble vitamins. Amino acids – general structure, essential amino acids. Proteins - Levels of protein structure, structural & functional importance of proteins, Enzymes- Definition, Enzyme Activity & Units, Specific Activity, Specificity, Factors affecting enzyme activity. Nucleic acids: Types and importance.

UNIT-IV **(9hours)**

Metabolism-Introduction: Food chain & energy low. Definitions Anabolism Catabolism. Photosynthesis: Reaction and importance. Glycolysis & TCA cycle. ATP–the energy currency of cells.

UNIT-V **(9hours)**

Microbiology -Concept of single celled organisms. Concept of species & strains. Identification & classification of microorganisms. Virus–Definition, types, examples.

References

1.Biology: A global approach: Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M,L.; Wasserman, S.A.; Minorsky, P. V.;Jackson, R. B. Pearson Education Ltd

2.Outlines of Biochemistry, Conn, E.E; Stumpf, P.K; Bruening, G; Doi, R.H. John Wiley and Sons

3. Principles of Biochemistry (V Edition), By Nelson, D. L.; and Cox, M. M.W.H. Freeman and Company

4. Molecular Genetics (Second edition), Stent, G. S.; and Calender, R. W.H. Freeman and company, Distributed by Satish Kumar Jain for CBS Publisher

5. Microbiology, Prescott, L.M J.P. Harley and C.A. Klein 1995. 2nd edition Wm, C.Brown Publishers.

T104 ENGINEERING MECHANICS

Objectives

- *To understand the vector and scalar representation of forces and moments, static equilibrium of particles and rigid bodies in two dimensions.*
- *To comprehend the effect of friction on equilibrium*
- *To understand the laws of motion, the kinematics of motion and the interrelationship and to learn to write the dynamic equilibrium equation*
- *To emphasis the concepts through solved examples*

UNIT I – FUNDAMENTAL OF MECHANICS (9hours)

Basic Concepts Force System and Equilibrium, Definition of force, Moment and Couple, Principle of Transmissibility, Varignon's theorem, Resultant of force system – Concurrent and non-concurrent coplanar forces, Condition of static equilibrium for coplanar force system, stability of equilibrium, applications in solving the problems on static equilibrium of bodies.

UNIT II – PRACTICAL APPLICATION OF FORCE SYSTEM (9hours)

Structural member: Definition, degree of freedom, concept of free body diagrams, types of supports and reactions, types of loads, Analysis of trusses-method of joints, method of sections. Friction: Introduction, Static dry friction, simple contact friction problems, ladders, wedges.

UNIT III – PROPERTIES OF SURFACES (9hours)

Properties of sections – area, centroids of lines, areas and volumes, moment of inertia first moment of inertia, second moment of inertia and product of moment of inertia, polar moment of inertia, radius of gyration, mass moment of inertia.

UNIT IV – KINEMATICS AND KINETICS OF PARTICLES (9hours)

Equations of motion – Rectilinear motion, curve linear motion, relative motion, D'Alembert's principle, work-Energy equation – conservative forces and principle of conservation of energy, Impulse – momentum, Impact – Direct central impact and oblique central impact.

UNIT V – KINEMATICS AND KINETICS OF RIGID BODIES (9hours)

Plane motion, absolute motion, Relative motion, translating axes and rotating axes, work and energy, impulse and momentum

Text Books

1. Rajesekaran S and Sankara Subramanian., G., Engineering Mechanics, Vikas Publishing House Private Ltd., 2012.

Reference Books

1. Palanichamy, M.S. Nagan, S., Engineering Mechanics – Statics &Dynamics, Tata McGraw-Hill, 2011.
2. Beer, F.P and Johnson Jr. E.R, Vector Mechanics for Engineers, Vol. 1 Statics and Vol.2 Dynamics, McGraw – Hill International Edition, 1997.
3. Bhavikatti,S.S and K.G. Rajashekarappa, Engineering Mechanics, New Age International (p) Ltd, New Delhi, 2010.

P101 DESIGN THINKING LAB (30 hours)

Objective:

- To provide the new ways of creative thinking and learn the innovation cycle of Design Thinking process for developing innovative products which useful for a student in preparing for an engineering career.

UNIT-I

An Insight to Learning- Understanding the Learning Process, Kolb's Learning Styles, Assessing and Interpreting
Remembering Memory- Understanding the Memory process, Problems in retention, Memory enhancement techniques

UNIT-II

Emotions: Experience & Expression-Understanding Emotions: Experience & Expression, Assessing Empathy, Application with Peers
Basics of Design Thinking-Definition of Design Thinking, Need for Design Thinking, Objective of Design Thinking, Concepts & Brainstorming, Stages of Design Thinking Process (explain with examples) – Empathize, Define, Ideate, Prototype, Test.

Unit -III

Being Ingenious & Fixing Problem-Understanding Creative thinking process, Understanding Problem Solving, Testing Creative Problem Solving
Process of Product Design- Process of Engineering Product Design, Design Thinking Approach, Stages of Product Design, Examples of best product designs and functions, Assignment – Engineering Product Design

UNIT-IV

Prototyping & Testing-What is Prototype? Why Prototype? Rapid Prototype Development process, Testing, Sample Example, Test Group Marketing
Celebrating the Difference- Understanding Individual differences & Uniqueness, Group Discussion and Activities to encourage the understanding, acceptance and appreciation of Individual differences

UNIT-V

Design Thinking & Customer Centricity-Practical Examples of Customer Challenges, Use of Design Thinking to Enhance Customer Experience, Parameters of Product experience, Alignment of Customer Expectations with Product Design

Feedback, Re-Design & Re-Create- Feedback loop, Focus on User Experience, Address "ergonomic challenges, User focused design, rapid prototyping & testing, final product, Final Presentation – "Solving Practical Engineering Problem through Innovative Product Design & Creative Solution".

Text/Reference Books:

1. E. Balaguruswamy (2022), Developing Thinking Skills (The way to Success), Khanna Book, Publishing Company.

P102 ENGINEERING GRAPHICS & DESIGN (75 hours)

OBJECTIVES

- To convey the basics of engineering drawing
- To explain the importance of an engineering drawing
- To teach different methods of making the drawing
- To establish the importance of projects and developments mode in drawing that are used in real systems
- To explain the role of computer aided design_ AutoCAD
- To develop an intuitive understanding of underlying significance of using these drawings

UNIT I

Introduction to Standards for Engineering Drawing practice, Lettering, Line work and Dimensioning. Conic sections, Involutes, Spirals, Helix. Projection of Points, Lines and planes

UNIT II

Projection of Solids and Sections of solids.

UNIT III

Development of surfaces – Intersection of surfaces (Cylinder-Cylinder, cylinder-cone)

UNIT IV

Isometric projections and Orthographic projections

UNIT V

Computer Aided Drafting: Introduction to Computer Graphics and Drafting, Auto CAD, 2-D diagrams of simple geometries using Auto- CAD script.

Text Books:

1. K.R. Gopalakrishna and Sudhir Gopalakrishna, Engineering Graphics, Inzinc Publishers, 2007.

Reference Books:

2. N.D. Bhatt, Engineering Drawing, 49th edition, Chorotar Publishing House, 2006.
3. K. Venugopal, Engineering Drawing and Graphics + Auto CAD, 4th edition, New Age International Publication Ltd.,2004.
4. David I cook and Robert N Mc Dougal, Engineering Graphics and Design with computer applications, Holt – Sounders Int. Edn.1985.
5. JamesDBethuneandet.al., Modern Drafting, Prentice Hall Int.,1989.

P103 PROGRAMMING FOR PROBLEM SOLVING

Objectives:

- *To understand the problem-solving approaches.*
- *To learn the basic programming constructs in C program*
- *To articulate where computing strategies support in providing Python-based solutions to real world problems.*
- *To use C program data structures - lists, tuples, dictionaries.*
- *To do input/output with files FeelC program*

Course Contents:

Module I: Introduction to Programming; Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.)
Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudocode with examples.
From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code.

Module II: Arithmetic expressions and precedence.

Module III: Conditional Branching and Loops. Writing and evaluation of conditionals and consequent branching. Iteration and loops.

Module IV: Arrays, Arrays (1-D, 2-D), Character arrays and Strings.

Module V: Basic Algorithms, Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required).

Module VI: Function, Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference.

Module VII: Recursion, Recursion as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.

Module VIII: Structures, Defining structures and Array of Structures.

Module IX: Pointers, Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation).

Module X: File handling (only if time is available, otherwise should be done as part of the lab).

PRACTICALS:

1. Familiarization with programming environment
2. Simple computational problems using arithmetic expressions
3. Problems involving if-then-else structures
4. Iterative problems e.g., sum of series
5. 1D Array manipulation
6. Matrix problems, String operations
7. Simple functions
8. Programming for solving Numerical methods problems
9. Recursive functions
10. Pointers and structures
11. File operations

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. No	Experiment Nam	Experiment Link(s)
1.	Simple computational problems using arithmetic expressions.	http://ps-iiith.vlabs.ac.in/exp7/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
2.	Iterative problems e.g., sum of series.	http://ps-iiith.vlabs.ac.in/exp4/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
3.	1D Array manipulation	http://cse02-iiith.vlabs.ac.in/exp4/index.html
4.	Matrix problems, String operations.	http://ps-iiith.vlabs.ac.in/exp5/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
5.	Simple functions.	http://cse02-iiith.vlabs.ac.in/exp2/index.html
6.	Programming for solving Numerical methods problems.	http://ps-iiith.vlabs.ac.in/exp1/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%2
7.	Recursive functions.	http://ps-iiith.vlabs.ac.in/exp6/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab

TEXT/REFERENCE BOOKS:

1. AICTE's Prescribed Textbook: Programming for Problem Solving (ISBN: 978-93-91505-219)
2. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill.
3. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill.
4. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	INTRODUCTION TO PROGRAMMING IN C	PROF. SATYADEV NANDAKUMAR	IIT KANPUR
2	PROBLEM SOLVING THROUGH PROGRAMMING IN C	PROF. ANUPAM BASU	IIT KHARAGPUR

S. No.	Experiment Name	Experiment Link(s)
1.	Simple computational problems using arithmetic expressions.	http://ps-iiith.vlabs.ac.in/exp7/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
2.	Iterative problems e.g., sum of series.	http://ps-iiith.vlabs.ac.in/exp4/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
3.	1D Array manipulation.	http://cse02-iiith.vlabs.ac.in/exp4/index.html
4.	Matrix problems, String operations.	http://ps-iiith.vlabs.ac.in/exp5/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
5.	Simple functions.	http://cse02-iiith.vlabs.ac.in/exp2/index.html
6.	Programming for solving Numerical methods problems.	http://ps-iiith.vlabs.ac.in/exp1/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
7.	Recursive functions.	http://ps-iiith.vlabs.ac.in/exp6/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
8.	1D Array manipulation.	http://cse02-iiith.vlabs.ac.in/exp4/index.html
9.	Matrix problems, String operations.	http://ps-iiith.vlabs.ac.in/exp5/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
10.	Simple functions.	http://cse02-iiith.vlabs.ac.in/exp2/index.html
11.	Programming for solving Numerical methods problems.	http://ps-iiith.vlabs.ac.in/exp1/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
12.	Recursive functions.	http://ps-iiith.vlabs.ac.in/exp6/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab

COURSE OUTCOMES: The student will learn following through lectures:

- To formulate simple algorithms for arithmetic and logical problems.
- To translate the algorithms to programs (in C language).
- To test and execute the programs and correct syntax and logical errors.
- To implement conditional branching, iteration and recursion.
- To decompose a problem into functions and synthesize a complete program using divide and conquer approach.
- To use arrays, pointers and structures to formulate algorithms and programs.
- To apply programming to solve matrix addition and multiplication problems and searching and sorting problems.
- To apply programming to solve simple numerical method problems, namely rot finding of function, differentiation of function and simple integration.

The student will learn following through Practicals:

- To formulate the algorithms for simple problems.
- To translate given algorithms to a working and correct program.
- To be able to correct syntax errors as reported by the compilers.
- To be able to identify and correct logical errors encountered at run time.
- To be able to write iterative as well as recursive programs.
- To be able to represent data in arrays, strings and structures and manipulate them through a program.
- To be able to declare pointers of different types and use them in defining self-referential structures.
- To be able to create, read and write to and from simple text files.

P103 IDEA Lab Workshop

Objectives:

- *To learn all the skills associated with the tools and inventory associated with the IDEA Lab.*
- *Learn useful mechanical and electronic fabrication processes.*
- *Learn necessary skills to build useful and standalone system/ project with enclosures.*
- *Learn necessary skills to create print and electronic documentation for the system/project*

Course Contents:

Unit #	Topics	
1.	Electronic component familiarization, Understanding electronic system design flow. Schematic design and PCB layout and Gerber creation using EagleCAD. Documentation using Doxygen, Google Docs, Overleaf. Version control tools - GIT and GitHub. Basic 2D and 3D designing using CAD tools such as FreeCAD, Sketchup, Prusa Slicer, FlatCAM, Inkspace, OpenBSP and VeriCUT.	Introduction to basic hand tools - Tape measure, combination square, Vernier caliper, hammers, fasteners, wrenches, pliers, saws, tube cutter, chisels, vice and clamps, tapping and threading. Adhesives Introduction to Power tools: Power saws, band saw, jigsaw, angle grinder, belt sander, bench grinder, rotary tools. Various types of drill bits,
2.	Familiarization and use of basic measurement instruments - DSO including various triggering modes, DSO probes, DMM, LCR bridge, Signal and function generator. Logic analyzer and MSO. Bench power supply (with 4-wire output) Circuit prototyping using (a) breadboard, (b) Zero PCB (c) 'Manhattan' style and (d) custom PCB. Single, double and multilayer PCBs. Single and double-sided PCB prototype fabrication in the lab. Soldering using soldering iron/station. Soldering using a temperature controlled reflow oven. Automated circuit assembly and soldering using pick and place machines.	Mechanical cutting processes - 3-axis CNC routing, basic turning, milling, drilling and grinding operations, Laser cutting, Laser engraving etc. Basic welding and brazing and other joining techniques for assembly. Concept of Lab aboard a Box.

3.	Electronic circuit building blocks including common sensors. Arduino and Raspberry Pi programming and use. Digital Input and output. Measuring time and events. PWM. Serial communication. Analog input. Interrupts programming. Power Supply design (Linear and Switching types), Wireless power supply, USB PD, Solar panels, Battery types and charging	3D printing and prototyping technology – 3D printing using FDM, SLS and SLA. Basics of 3D scanning, point cloud data generation for reverse engineering. Prototyping using subtractive cutting processes. 2D and 3D Structures for prototype building using Laser cutter and CNC routers. Basics of IPR and patents; Accessing and utilizing patent information in IDEA Lab
4.	Discussion and implementation of a mini project	
5.	Documentation of the mini project (Report and video).	

Laboratory Activities:

S. No.	List of Lab activities and experiments
1.	Schematic and PCB layout design of a suitable circuit, fabrication and testing of the circuit.
2.	Machining of 3D geometry on soft material such as soft wood or modelling wax.
3.	3D scanning of computer mouse geometry surface. 3D printing of scanned geometry using FDM or SLA printer.
4.	2D profile cutting of press fit box/casing in acrylic (3 or 6 mm thickness)/cardboard, MDF (2 mm) board using laser cutter & engraver.
5.	2D profile cutting on plywood /MDF (6-12 mm) for press fit designs.
6.	Familiarity and use of welding equipment.
7.	Familiarity and use of normal and wood lathe.
8.	Embedded programming using Arduino and/or Raspberry Pi.
9.	Design and implementation of a capstone project involving embedded hardware, software and machined or 3D printed enclosure.

Reference Books:

S. No.	Title
1.	**AICTE's Prescribed Textbook: Workshop / Manufacturing Practices (with Lab Manual). ISBN: 978-9391505332**
2.	All-in-One Electronics Simplified, A.K. Maini; 2021. ISBN-13: 978-9386173393, Khanna Book Publishing Company, New Delhi.
3.	Simplified Q&A - Data Science with Artificial Intelligence, Machine Learning and Deep Learning, Rajiv Chopra, ISBN: 978-9355380821, Khanna Book Publishing Company, New Delhi.
4.	3D Printing & Design, Dr. Sabrie Soloman, ISBN: 978-9386173768, Khanna Book Publishing Company, New Delhi.
5.	The Big Book of Maker Skills: Tools & Techniques for Building Great Tech Projects. Chris Hackett. Weldon Owen; 2018. ISBN-13: 978-1681884325.
6.	The Total Inventors Manual (Popular Science): Transform Your Idea into a Top-Selling Product. Sean Michael Ragan (Author). Weldon Owen; 2017. ISBN-13: 978- 1681881584.
7.	Make: Tools: How They Work and How to Use Them. Platt, Charles. Shroff/Maker Media. 2018. ISBN-13: 978-9352137374
8.	The Art of Electronics. 3rd edition. Paul Horowitz and Winfield Hill. Cambridge University Press. ISBN: 9780521809269
9.	Practical Electronics for Inventors. 4th edition. Paul Sherz and Simon Monk. McGraw Hill. ISBN-13: 978-1259587542
10.	Encyclopedia of Electronic Components (Volume 1, 2 and 3). Charles Platt. Shroff Publishers. ISBN-13: 978-9352131945, 978-9352131952, 978-9352133703
11.	Building Scientific Apparatus. 4th edition. John H. Moore, Christopher C. Davis, Michael A. Coplan and Sandra C. Greer. Cambridge University Press. ISBN-13: 978-0521878586
12.	Programming Arduino: Getting Started with Sketches. 2nd edition. Simon Monk. McGraw Hill. ISBN-13: 978-1259641633
13.	Make Your Own PCBs with EAGLE: From Schematic Designs to Finished Boards. Simon Monk and Duncan Amos. McGraw Hill Education. ISBN-13: 978-1260019193.

14.	Pro GIT. 2nd edition. Scott Chacon and Ben Straub. A press. ISBN-13 : 978-1484200773
15.	Venuvinod, PK., MA. W., Rapid Prototyping – Laser Based and Other Technologies, Kluwer, 2004.
16	Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010
17.	Chapman W.A.J, "Workshop Technology", Volume I, II, III, CBS Publishers and distributors, 5th Edition,2002.

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SEMESTER – II

T105 MATHEMATICS-II

Objectives

- The course aims to equip students with the ability to formulate and solve partial differential equations, and apply Laplace and Fourier transforms within the engineering domain.

UNIT I **(12Hrs)**

PARTIAL DIFFERENTIAL EQUATIONS: Formation of partial differential equations, Solutions of standard types of first order partial differential equations, Lagrange's linear equation, Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNIT II **(12Hrs)**

LAPLACE TRANSFORM: Existence conditions, Transforms of elementary functions, Properties, Transform of unit step function and unit impulse function, Transforms of derivatives and integrals, Transforms of Periodic Functions, Initial and final value theorems.

UNIT III **(12Hrs)**

INVERSE LAPLACE TRANSFORM: Inverse Laplace Transforms – Properties, Convolution theorem, Application - Solution of ordinary differential equations with constant coefficients -Solution of simultaneous ordinary differential equations

UNIT IV **(12Hrs)**

FOURIER TRANSFORM: Fourier Integral theorem (statement only), Fourier transform and its inverse – Properties, Fourier sine and cosine transform - Properties, Convolution and Parseval's identity.

UNIT V **(12Hrs)**

FOURIER SERIES: Dirichlet's conditions; Expansion of periodic functions into Fourier series- Change of interval, Half-range Fourier series, Complex form of Fourier series, Root mean square value - Parseval's theorem on Fourier coefficients, Harmonic analysis.

Text Books:

1. Veerarajan T., “Transforms and Partial Differential Equations”, Tata McGraw-Hill, New Delhi, 2012.

Reference Books:

1. Grewal B.S., “Higher Engineering Mathematics”, Khanna Publishers, New Delhi, 43rd Edition, 2015.
2. Ramana B.V., “Higher Engineering Mathematics”, Tata McGraw-Hill, New Delhi, 2010.
3. Bali N.P and Manish Goyal., “A Text Book of Engineering Mathematics”, Laxmi Publications(P) Ltd, 2011.
4. Erwin Kreyszig, “Advanced Engineering Mathematics”, John Wiley & Sons, New Delhi, 9th Edition, 2011.

Online Courses/NPTEL/SWAYAM:

1. https://nptel.ac.in/courses/111106139
2. https://nptel.ac.in/courses/111101153
3. https://nptel.ac.in/courses/111107119

T106 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING

Objectives

- *To understand and gain basic knowledge about magnetic and electrical circuits, single phase and three phase power measurement and the operating principles of stationary and rotating machines*
- *To understand the basic operation, functions and applications of PN junction diode, transistor, logic gates and flip flops.*
- *To gain knowledge on various communication systems and network models and the use of ISDN*

UNIT -I **(9hours)**

DC Circuits: Definition of Voltage, Current, Power & Energy, circuit parameters, Ohm's law, Kirchoff's law & its applications – Simple Problems - Series & parallel connected circuits - star/delta conversion - Node and mesh methods of analysis of DC circuits.
DC Machines covering, working principle of DC machine as a generator and a motor; Types and constructional features; EMF equation of generator, DC motor working principle; Back EMF and its significance, Types of D.C. motors, characteristics and applications; Necessity of a starter for DC motor.

UNIT -II **(9 hours)**

AC Circuits: Concepts of AC circuits – rms value, average value, form and peak factors– Simple RL, RC, RLC series circuits and Problems – Concept of real and reactive power – Power factor - Introduction to three phase system - Power measurement by two wattmeter method.

UNIT -III **(9hours)**

Transformers covering, Principle of operation and construction of single phase transformers (core and shell types). EMF equation, losses, efficiency and voltage regulation; Synchronous Generators covering, Principle of operation; Types and constructional features; EMF equation; Three Phase Induction Motors covering; Concept of rotating magnetic field; Principle of operation, types and constructional features

UNIT -IV **(9hours)**

Electronic Circuits: Intrinsic semiconductors, Extrinsic semiconductors – P-type and N-type - V-I Characteristics of diode - Half-wave rectifier and Full-wave rectifier – with and without capacitor filter - Transistor –Bipolar Junction Transistor — CB, CE, CC Configurations and Characteristics - Transistor as an Amplifier - Principle and working of Hartley oscillator and RC phase shift oscillator - Construction and working of JFET & MOSFET.

UNIT-V **(9hours)**

Digital Electronics &Fundamentals Of Communication Theory: Boolean algebra – Reduction of Boolean expressions - De-Morgan's theorem – Logic gates -Implementation of Boolean expressions - Flip flops - RS, JK, T and D. Combinational logic - Half adder, Full adder and Subtractors, Sequential logic - Ripple counters and shift registers. Model.

Text Books:

1. Kothari D P and Nagrath I J, Basic Electrical Engineering, Tata McGraw Hill, 2009. (For Units I toIII)
2. Rajendra Prasad , "Fundamentals of Electronic Engineering", Cengage learning, New Delhi, first Edition, 2011 (For UnitIV)
3. Morris Mano, "Digital Design", PHI learning, Fourth Edition, 2008 (For UnitV)
4. Wayne Tomasi, "Electronic Communication Systems-Fundamentals Theory Advanced", Sixth Edition, Pearson Education, 2004.(For UnitVI)

Reference Books:

1. R.Muthusubramaniam, S.Salivahanan and K.A. Mureleedharan, Basic ElectricalElectronicsandComputerEngineering,TataMcGrawHill,2004.
2. J.B.Gupta, A Course in Electrical Power, Katson Publishing House, New Delhi,1993.
3. David.A Bell, "Electronic Devices and Circuits", PHI Learning Private Ltd, India Fourth Edition,2008.
4. Donald P Leach, Albert Paul Malvino and Goutam Saha, "digital Principles and Applications" 6th edition, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2008.
5. S.K. Sahdev, Fundamentals of Electrical Engineering and Electronics, Dhanpat Rai & Co,2013.
6. Jacob Millman and Christos C. Halkias, "Electronic Devices and Circuits" Tata McGraw Hill,2008.
7. R.L. Boylestad and L. Nashelsky, "Electronic Devices and Circuit Theory", PHI Learning Private Limited, Ninth edition,2008.
8. M.S.Sukhija and T.K. Nagsarkar, "Basic Electrical and Electronics Engineering", Oxford University Press,2012.

ELECTRICAL AND ELECTRONICS LABORATORY (30 HRS)

OBJECTIVES

An ability to design and conduct experiments on Transformers, AC and DC electrical machines for their performance analysis. Inverting / Non-Inverting Amplifier and Adder / Substractor using Op.Amps, Astable Multivibrator and Counter to analyze & interpret results.

LIST OF EXPERIMENTS:

1. OC and SC Test on Single Phase Transformer
2. Load Test on Single Phase Transformer
3. Load Test on 3 Phase Transformer
4. Load Test on Single Phase Induction Motor
5. Two Wattmeter Method of Power Measurement
6. Pre-determination of voltage regulation of 3 phase Alternator by EMF method
7. Inverting and Non-Inverting Amplifier Using 741 IC
8. Astable Multivibrator Using 555 IC
9. Counter Using 7490 IC
10. Adder / Substractor Using 741 IC

T107 ENGINEERING PHYSICS

Objectives:

- *To understand the concepts of physics and its significant contributions in the advancement of technology and invention of new products that dramatically transformed modern-day society.*
- *To expose the students to different areas of physics which have direct relevance and applications to different Engineering disciplines*
- *To understand the concepts and applications of Ultrasonics, optics and some optical devices, Laser and Fiber optics, Nuclear energy sources and wave mechanics*

UNIT -I **(12 hours)**

Acoustics & NDT- Ultrasonics – Ultrasonic Waves productions (piezoelectric & Magnetostriction method) - Detections (Acoustic Grating) NDT applications – Ultrasonic pulse echo Method - liquid penetrant Method

Acoustics - Factors affecting Acoustic of buildings (Reverberation, Loudness, Focusing, Echo, Echelon Effect and Resonance) and their Remedies – Sabine's formula for Reverberation Time – Doppler effect and its applications to Radars. (elementary ideas)

UNIT -II **(12 hours)**

Interference - Air wedge – Michelson's Interferometer - wavelength determination –Interference Filter – Antireflection Coatings

Diffraction - Diffraction Grating – Dispersive power of grating – Resolving power of grating & Prism

Polarization - Basic concepts of double refraction – Huygens Theory of Double Refraction – Quarter and Half Wave Plates – Specific Rotary Power – Laurent Half Shade Polarimeter.

UNIT III **(12 hours)**

Lasers - Principles of Laser – Spontaneous and Stimulated Emissions – Einstein's Coefficients – Population Inversion and Laser Action – types of Optical resonators(qualitative ideas) – Types of Lasers - NdYAG, CO_2 laser, GaAs Laser- applications of lasers

FiberOptics-PrincipleandPropagationoflightinopticalfiber–Numericalaperture and acceptance angle – Types of optical fibers (material, refractive index, mode) – applications to sensors and Fiber Optics Communication

UNIT- IV **(12 hours)**

Wave Mechanics-Matter Waves – de Broglie Wavelength – Uncertainty Principle – Schrodinger Wave Equation – Time Dependent – Time Independent – Application to Particle in a One Dimensional Potential Box – Quantum Mechanical Tunneling – Tunnel Diode.

UNIT-V **(12 hours)**

Nuclear Energy Source- General Properties of Nucleus (Size, Mass, Density, Charge) – Mass Defect – Binding Energy - Disintegration in fission – *Nuclear Reactor:* Materials Used in Nuclear Reactors. – PWR –BWR – FBTR. Nuclear fusion reactions for fusion reactors - D-D and D-T reactions, Basic principles of Nuclear fusion reactors.

Text Books:

1. V Rajendran, Engineering Physics, 2nd Edition TMH, New Delhi 2011 (For Units I to IVonly)
2. Arthur Beiser, Concepts of Modern Physics, 6th Edition, TMH, New Delhi reprinted 2008. (For Unit Vonly)

Reference Books:

1. Ajay Ghatak, Optics, 5th Edition TMH, New Delhi,2012.
2. K. Thyagarajan and Ajoy Ghatak, Laser Fundamentals and Applications, 2nd Edition, Springer2010.
3. R. Murugesan, Modern Physics, S. Chand & Co, New Delhi2006.
4. K.R.Nambiar, Laser, New Age International, New Delhi,2008.
5. Science of Engineering Materials, 2nd Edition, C.M. Srivastava and C. Srinivasan, New Age Int. (P) Ltd, New Delhi,1997.
6. Avadhanulu M N, Engineering Physics, Vol-1, S. Chand & Co,2009.

PHYSICS LABORATORY (30HOURS)

Objectives

- *To provide a practical understanding of some of the concepts learnt in the theory course on physics.*

List of Experiments (ANY 10 EXPERIMENTS)

1. Thermal conductivity – Lee's DISC
2. Thermal conductivity – radial flow
3. Spectrometer – Prism or Hollow prism
4. Spectrometer – Transmission grating
5. Spectrometer – Ordinary & Extraordinary rays
6. Newton's rings
7. Air – wedge
8. Half shade polarimeter – determination of specific rotatory power
9. Jolly's experiment – determination of α
10. Magnetism: i-h curve
11. Field along the axis of coil carrying current
12. Vibration magnetometer – calculation of magnetic moment & pole strength
13. Laser experiment: wavelength determination using transmission grating, reflection grating (vernier calipers) & particle size determination
14. Determination of optical absorption coefficient of materials using laser
15. Determination of numerical aperture of an optical fiber
16. Electrical conductivity of semiconductor – two probe / four probe method
17. Hall effect in semiconductor

T108 COMMUNICATIVE ENGLISH

Objectives

- *To provide learning environment to practice listening, speaking, reading and writing skills.*
- *To assist the students to carry on the tasks and activities through guided instructions and materials.*
- *To effectively integrate English language learning with employability skills and training.*
- *To provide hands-on experience through case-studies, mini-projects, group and individual presentations.*

UNIT -I **(9hours)**

Vocabulary Building-The concept of Word Formation-Root words from foreign languages and their use in English-Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives.-Synonyms, antonyms, and standard abbreviations.

UNIT-II **(9hours)**

Basic Writing Skills-Sentence Structures-Use of phrases and clauses in sentences-Importance of proper punctuation.
Creating coherence-Organizing principles of paragraphs in documents-Techniques for writing precisely

UNIT-III **(9hours)**

Identifying Common Errors in Writing-Subject-verb agreement-Noun-pronoun agreement-Misplaced modifiers-Articles-Prepositions-Redundancies-Clichés

UNIT- IV **(9hours)**

Nature and Style of sensible Writing-Describing Defining-Classifying, Providing examples or evidence-Writing introduction and conclusion.

UNIT -V **(9hours)**

Writing Practices-Comprehension-Précis Writing-Essay Writing-Oral Communication.

Text Books:

1. AICTE's Prescribed Textbook: English (with Lab Manual) ISBN: 978-93-91505-097
2. Effective Communication Skills. Kul Bhushan Kumar, Khanna Book Publishing, 2022.

Reference Books

1. Practical English Usage. Michael Swan. OUP. 1995.
2. Remedial English Grammar. F.T. Wood. Macmillan.2007
3. On Writing Well. William Zinsser. Harper Resource Book. 2001
4. Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
5. Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011.
6. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press.

T109 UNIVERSAL HUMAN VALUES-2

Objectives

- *To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.*
- *To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence.*
- *To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.*

UNIT -I **(9hours)**

Introduction to Value Education-Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education)-Understanding Value Education-Sharing about Oneself-Self-exploration as the Process for Value Education-Continuous Happiness and Prosperity – the Basic Human Aspirations-Exploring Human Consciousness-Happiness and Prosperity – Current Scenario-Method to Fulfill the Basic Human Aspirations-Exploring Natural Acceptance

UNIT- II **(9hours)**

Harmony in the Human Being-Understanding Human being as the Co-existence of the Self and the Body-Distinguishing between the Needs of the Self and the Body-Exploring the difference of Needs of Self and Body-The Body as an Instrument of the Self-Understanding Harmony in the Self-Exploring Sources of Imagination in the Self-Harmony of the Self with the Body-Programme to ensure self-regulation and Health-Exploring Harmony of Self with the Body.

UNIT -III **(9hours)**

Harmony in the Family and Society-Harmony in the Family – the Basic Unit of Human Interaction-'Trust' – the Foundational Value in Relationship-Exploring the Feeling of Trust-'Respect' – as the Right Evaluation-Exploring the Feeling of Respect-Other Feelings, Justice in Human-to-Human Relationship-Understanding Harmony in the Society-Vision for the Universal Human Order-Exploring Systems to fulfil Human Goal.

UNIT- IV **(9hours)**

Harmony in the Nature/Existence

Understanding Harmony in the Nature-Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature-Exploring the Four Orders of Nature-Realizing Existence as Co-existence at All Levels-The Holistic Perception of Harmony in Existence-Exploring Co-existence in Existence.

UNIT -V **(9hours)**

Implications of the Holistic Understanding – a Look at Professional Ethics-Natural Acceptance of Human Values-Definitiveness of (Ethical) Human Conduct-Exploring Ethical Human Conduct-A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order-Competence in Professional Ethics-Exploring Humanistic Models in Education-Holistic Technologies, Production Systems and Management Models-Typical Case Studies-Strategies for Transition towards Value-based Life and Profession-Exploring Steps of Transition towards Universal Human Order.

Textbook:

1. A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1
2. Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, RR Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53
3. Professional Ethics and Human Values, Premvir Kapoor, ISBN: 978-93-86173-652, Khanna Book Publishing Company, New Delhi, 2022.

Reference Books:

1. JeevanVidya: EkParichaya, A Nagaraj, JeevanVidyaPrakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj – Pandit Sunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

P106 DIGITAL FABRICATION/ WORKSHOP/ MANUFACTURING PRACTICES.

Objectives

- *To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering.*
- *To have a study and hands-on-exercise on plumbing and carpentry components.*
- *To have a practice on gas welding, foundry operations and fitting*
- *To have a study on measurement of electrical quantities, energy and resistance to earth.*
- *To have a practice on soldering.*

Module I: Manufacturing Methods-casting, forming, machining, joining, advanced manufacturing methods.

Module II: CNC machining, Additive manufacturing.

Module III: Fitting operations & power tools.

Module IV: Electrical & Electronics.

Module V: Carpentry.

Module VI: Plastic moulding, glass cutting.

Module VII: Metal casting.

Module VIII: Welding (arc welding & gas welding), brazing.

Practicals:

1. Machine shop
2. Fittingshop
3. Carpentry
4. Electrical &Electronics
5. Welding shop (Arc welding + Gaswelding)
6. Casting
7. Smithy
8. Plastic moulding& GlassCutting

Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.

Text/Reference Books:

1. AICTE's Prescribed Textbook: Workshop / Manufacturing Practices (with Lab Manual) ISBN:978-93-91505-332
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. KalpakjianS.AndStevenS.Schmid,"ManufacturingEngineeringandTechnology",4th edition, Pearson Education India Edition,2002.
4. Gowri P. Hariharan and A. Suresh Babu," Manufacturing Technology – I" Pearson Education, 2008.
5. Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998.
6. Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGraw Hill House,2017.

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. No.	Experiment Name	Experiment Link(s)
1	Welding shop (Arc welding + Gas welding).	http://mm-coep.vlabs.ac.in/LaserSpotWelding/Theory.html?domain=Mechanical%20Engineering&lab=Welcome%20to%20Micromachining%20laboratory
2	Casting	http://fab-coep.vlabs.ac.in/exp7/Theory.html?domain=Mechanical%20Engineering&lab=Welcome%20to%20FAB%20laboratory

P107 SPORTS AND YOGA

Objective:

- To make the students understand the importance of sound health and fitness principles as they relate to better health.
- To expose the students to a variety of physical and yogic activities aimed at stimulating their continued inquiry about Yoga, physical education, health and fitness.
- To create a safe, progressive, methodical and efficient activity based plan to enhance improvement and minimize risk of injury.
- Todevelopamongstudentsanappreciationofphysicalactivityasalifetimepursuitandameans to better health.

Module I: Introduction to Physical Education

- Meaning & definition of Physical Education
- Aims & Objectives of Physical Education
- Changing trends in Physical Education

Module II: Olympic Movement

- Ancient & Modern Olympics (Summer &Winter)
- Olympic Symbols, Ideals, Objectives & Values
- Awards and Honours in the field of Sports in India (Dronacharya Award, Arjuna Award, Dhayanch and Award, Rajiv Gandhi Khel Ratna Awardetc.)

Module III: Physical Fitness, Wellness & Lifestyle

- Meaning & Importance of Physical Fitness &Wellness
- Components of Physical fitness
- Components of Health-related fitness
- Components of wellness
- Preventing Health Threats through Lifestyle Change
- Concept of Positive Lifestyle

Module IV: Fundamentals of Anatomy & Physiology in Physical Education, Sports and Yoga

- Define Anatomy, Physiology & Its Importance
- Effect of exercise on the functioning of Various Body Systems. (Circulatory System, Respiratory System, Neuro-Muscular System etc.)

Module V: Kinesiology, Biomechanics & Sports

- Meaning & Importance of Kinesiology & Biomechanics in Physical Edu. &Sports
- Newton's Law of Motion & its application in sports.
- Friction and its effects in Sports.

Module VI: Postures

- Meaning and Concept of Postures.
- Causes of Bad Posture.
- Advantages & disadvantages of weight training.
- Concept & advantages of Correct Posture.
- Common Postural Deformities – Knock Knee; Flat Foot; Round Shoulders; Lordosis, Kyphosis, Bow Legs and Scoliosis.
- Corrective Measures for Postural Deformities

Module VII: Yoga

- Meaning & Importance of Yoga
- Elements of Yoga
- Introduction - Asanas, Pranayama, Meditation & YogicKriyas
- Yoga for concentration & related Asanas (Sukhasana; Tadasana; Padmasana & Shashankasana)
- Relaxation Techniques for improving concentration -Yog-nidra

Module VIII: Yoga & Lifestyle

- Asanas as preventive measures.
- Hypertension:Tadasana,Vajrasana,PavanMuktasana,ArdhaChakrasana, Bhujangasana,Sharasana.
- Obesity: Procedure, Benefits & contraindications for Vajrasana, Hastasana,Trikonasana, ArdhMatsyendrasana.
- Back Pain: Tadasana, ArdhMatsyendrasana, Vakrasana, Shalabhasana,Bhujangasana.
- Diabetes: Procedure, Benefits & contraindications for Bhujangasana, Paschimottasana, Pavan Muktasana, ArdhMatsyendrasana.
- Asthema: Procedure, Benefits & contraindications for Sukhasana,Chakrasana, Gomukhasana, Parvatasana, Bhujangasana, Paschimottasana,Matsyasana.

Module IX: Training and Planning in Sports

- Meaning of Training
- Warming up and limbering down
- Skill, Technique &Style
- Meaning and Objectives of Planning.
- Tournament – Knock-Out, League/Round Robin &Combination.

Module X: Psychology & Sports

- Definition & Importance of Psychology in Physical Edu. &Sports
- Define & Differentiate Between Growth &Development
- Adolescent Problems & Their Management
- Emotion: Concept, Type & Controlling of emotions
- Meaning, Concept & Types of Aggressions in Sports.
- Psychological benefits of exercise.
- Anxiety & Fear and its effects on Sports Performance.
- Motivation, its type &techniques.
- Understanding Stress & Coping Strategies.

Module XI: Doping

- Meaning and Concept of Doping
- Prohibited Substances &Methods
- Side Effects of Prohibited Substances

Module XII: Sports Medicine

- First Aid – Definition, Aims &Objectives.
- Sports injuries: Classification, Causes &Prevention.
- Management of Injuries: Soft Tissue Injuries and Bone & Joint Injuries

Module XIII: Sports / Games

Following subtopics related to any one Game/Sport of choice of student out of:

Athletics, Badminton, Basketball, Chess, Cricket, Kabaddi, Lawn Tennis, Swimming, Table Tennis, Volleyball, Yoga etc.

- History of the Game/Sport.
- Latest General Rules of the Game/Sport.
- Specifications of Play Fields and Related Sports Equipment.
- Important Tournaments and Venues.
- Sports Personalities.
- Proper Sports Gear and its Importance.

Text Books/References:

1. Modern Trends and Physical Education by Prof. AjmerSingh.
2. Light On Yoga by B.K.S.Iyengar.
3. Health and Physical Education – NCERT (11th and 12thClasse

SEMESTER – III

MAT31 MATHEMATICS – III

Objectives:

- To understand analytic functions, properties, harmonic conjugates, analytic function construction, standard conformal mapping, and bilinear transformations.
- To apply Cauchy's theorem, integral formulas, Taylor & Laurent series
- To solve one dimensional wave equations and one-dimensional heat flow equations using Fourier series solutions.
- To solve two dimensional steady-state heat flow equations using Fourier series solutions.
- To develop Z- transform techniques which will perform the analysis for discrete time systems.

Unit I – **Analytic Functions** **(12 Hrs)**

Analytic Functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates – Properties of Analytic Functions– Harmonic conjugates – Construction of analytic function – Standard Conformal mapping –Bilinear transformation.

Unit II – **Complex Integration** **(12 Hrs)**

Line integral – Cauchy's integral theorem – Cauchy's integral formula – Taylor's and Laurent's series – Singularities – Residues – Residue theorem – Application of residue theorem for evaluation of real integrals – Use of circular contour and semicircular contour.

Unit III – **Applications of PDEs (Wave Equation)** **(12 Hrs)**

Solution of PDE by Method of separation of variables – Classification of PDE – Fourier Series Solutions of one-dimensional wave equation.

Unit IV – **Applications of PDEs – II (Heat Equation)** **(12 Hrs)**

Fourier Series Solutions of one-dimensional equation of heat flow equation – Steady state solution of two-dimensional equation of heat flow equation. (Cartesian and Polar)

Unit V - Z – Transform **(12 Hrs)**

Z-transforms; Elementary properties; Convolution theorem; Inverse Z - transform (using partial fraction, convolution theorem and residues); Discrete time systems and Difference equations; Solution of difference equations using Z – transform.

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. Veerarajan T., "Engineering Mathematics", Tata McGraw-Hill, New Delhi, 2008.
   Ramana B.V., "Higher Engineering Mathematics", Tata McGraw-Hill, New Delhi, 2010.

REFERENCE BOOKS:

1. Bali N.P and Manish Goyal., "A Text Book of Engineering Mathematics", Laxmi Publications(P) LTD-2011.
2. Dr. M.K. Venkataraman, "Engineering Mathematics – Volume I and Volume II", The National Publishing Company, Madras 2001.

MET31 MECHANICS OF SOLIDS

Objectives:

- *The course is designed to introduce various behavior of structural components under different loading conditions.*
- *To understand the basic concepts of bending of beams and buckling of columns.*

UNIT – I **(12 Hours)**

Simple Stresses and Strain – Relation between three modulus and Poisson's ratio – Thermal Stress – Principal stress and Principal planes - Shear Force – Bending Moment – Cantilever and simply supported beams subjected to point loads and uniformly distributed loads.

UNIT – II **(12 Hours)**

Theory of simple bending-stress variation in beam cross Section; Normal and Shear stress in Beams – Beam of uniform strength for bending, combined direct and bending stresses.

UNIT – III **(12 Hours)**

Double integration method – moment area method – Introduction to strain energy method and Principle of virtual work.

UNIT – IV **(12 Hours)**

TorsionofcircularsolidandHollowshafts–ShaftsinSeriesandparallel–Combined bending and torsion -Application of Torsion in helical springs: Open and closed coil springs, Leaf Springs.

UNIT – V **(12 Hours)**

Euler's Equation – short and long column, Empirical formulae: Johnson – Rankine. Introduction to thin cylinder – Thick cylinder – Lame's Equation – Compound Cylinders – Interference fit.

Text Books:

1. RKBansal, Strength of Materials,4thEdition, Laxmi Publications, New Delhi, 2010
2. R.K.Rajput - Strength of Materials, S.Chand and Company Ltd., New Delhi, 2010**.**
3. Bhavikatti. S. S., Strength of Materials, Vikas Publishing House (P) Ltd., New Delhi, Second Edition,2008.

Reference Books:

1. U.G. Jindal - Strength of Materials, Galgotia Publication Pvt. Ltd., New Delhi, 1996.
2. Beer F, Jonston E R, DeWolf J, Mechanics of Materials, McGraw-Hill Publications,2005.

E-learning source:

1. **http://nptel.iitm.ac.in**

MET 32 MANUFACTURING PROCESSES

Objectives:

- *This course aims to impart the knowledge about various manufacturing processes. It deals with metal casting, metal forming and metal joining processes. After this course, a student will have a good exposure about the manufacturing processes and various operations and machinery. This also gives the recent trends in these processes also.*

UNIT – I **(09 Hours)**

Introduction to manufacturing processes – classification – steps involved in casting process – different types of casting – pattern and core making – materials, types and allowances – moulding tools and equipment - properties of moulding sand - casting defectsandremedies.

UNIT – II **(09 Hours)**

Types of welding processes – weldability - gas welding – oxy acetylene welding - Introduction to arc welding – types and equipment – resistance welding – types and applications - welding defects– Introduction to welding standards – welding of dissimilar metalsandnon-metals.

UNIT – III **(09 Hours)**

Classification of metal forming processes – Rolling, Forging, Extrusion, Drawing and other Sheet metal operations: terminology used, processes, machines and defects.

UNIT – IV **(09 Hours)**

Surface Finishing Processes: Surface Finish and Surface Roughness Honing – Lapping – Superfinishing – Abrasive Belt Finishing – Mass Finishing Processes – Polishing–Buffing. Grinding: Types of grinding–Types of Grinding machines–Size and specification of Grinding machines - Work Holding Devices – Grinding Operations - Grinding Fluids – Grinding Speed, Feed and Depth of Cut.

UNIT – V **(09 Hours)**

Plasticsandpolymers–structureofpolymers–additivesinplastics–thermoplastics and thermo setting plastics – manufacturing of plastic products – different moulding methods–forming or shaping methods – laminating methods – machining of plastics – joining plastics–industrial applications of plastics.

Note:Elementary treatment only for all the five units.

Text Books:

1. B.S.Nagendra Parashar &R.K.Mittal – Elements of Manufacturing Processes, Prentice Hall India Pvt. Ltd.,2003.
2. J.P.Kaushish – Manufacturing Processes, Prentice Hall India Pvt. Ltd.,2008.

Reference Books:

1. E.Paul De Garmo,J.T.Black and Ronald A.Kosher–Materials and Processes in Manufacturing, Prentice Hall India Pvt. Ltd.,2008.
2. Roy A.Lindberg - Processes and Materials of Manufacture, Prentice Hall India Pvt. Ltd.,2002.
3. S.K.Hajra Choudry - Workshop Technology, Vol. - I, & II, Media Promoters and Publishers Pvt. Ltd.,2009.
4. www.Myebookslibrary.com/workshop technology - by - hajra choudry-vol.1-pdf-download.pdf.

MET33 METALLURGY & MATERIAL SCIENCE

Objectives:

- *To acquaint students with the basic concepts and properties of Material Science.*
- *To impart a fundamental knowledge of Ferrous & Non Ferrous Metal Processing*
- *To help them to home in on the right material when they design some components.*
- *To familiarize students with the various kinds of testing done on the metals.*
- *To develop futuristic insight into Metals.*

UNIT – I **(09 Hours)**

Crystal structures – Solid Solutions – Types – Metallography – Metallurgical microscopes – specimen preparation- Cooling curves – Allotropy concept.

UNIT – II **(09 Hours)**

Construction and interpretation of binary phase diagrams – Types – Eutectic, Eutectoid, Petitectic and Peritectoid systems – Iron Carbon equilibrium diagrams – classification of steels and alloy steels – types, manufacture, properties and applications of cast irons.

UNIT – III **(09 Hours)**

Heat treatment of steel: Critical temperature on heating and cooling, effects of residual stresses – Annealing, normalizing, hardening, Hardenability tests, tempering-construction and interpretation of TTT diagram – Martensitic transformation – Sub zero treatment – Surface hardening processes.

UNIT – IV **(09 Hours)**

Non ferrous metals and alloys: Copper, Aluminium, Nickel, Zinc and Lead based alloys – concept and applications of metal matrix composites. Mechanical properties of materials – Testing of materials: Tensile, compression, torsion, hardness (micro & macro) and impacttesting.

UNIT – V **(09 Hours)**

Plastic deformation, Slip and twinning – Hot, cold and warm working – recovery and recrystallization concepts. Introduction to fracture mechanics – Types – ductile to brittle transition–Creepand Fatigue failures–Testing.

Text Books:

1. Raghavan V, Physical Metallurgy – Principles and Practice, Prentice Hall India Pvt. Ltd., New Delhi,2006
2. S.H.Avner, Introduction to Physical Metallurgy, Tata-McGraw Hill Publishing Co., New Delhi,2000.
3. G.E.Dieter, Mechanical Metallurgy, McGraw Hill Publishing Co., New York, 1988.

Reference Books:

1. Donald R. Askeland, The Science and Engineering of Materials, Chapman and Hall,1990.
2. Raghavan V, Materials Science and Engineering, Prentice Hall India Pvt. Ltd.,New Delhi,2007
3. Budinski and Budinski, Engineering Materials – Properties and Selection, Prentice Hall India Pvt. Ltd.,2005.

MET34 APPLIED THERMODYNAMICS

Objectives:

- *To familiarize the students with the fundamentals of thermodynamics so that a basis can be provided for the design of thermal machines*

UNIT – I **(09 Hours)**

Ideal and Real gases: Laws of perfect gases – Boyle's law – Charle's law – Gay Lussac law – Joule's law – Avogadro's law – state equation of gases – specific heat of gases. VanderWalls equation, Redlich Kwong equation, Dieterici equation, compressibility charts.Gas mixtures: Mole fraction, mass fraction – calculation of mixture properties.

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UNIT – II **(09 Hours)**

Energy and Entropy: I law of thermodynamics – energy balance of closed and open systems. Steady and unsteady flow systems. II Law of thermodynamics – Entropy generation principle, its application, entropy balance of closed and open systems.

UNIT – III **(09 Hours)**

Formation of steam and its thermodynamic properties, p-v, p-T, T-v, T-s, h-s diagrams. P-v-T surface. Use of Steam Table and Mollier Chart. Determination of dryness fraction. Application of I and II law for pure substances. Ideal and actual Rankine cycles, Cycle Improvement Methods – Reheat and Regenerative cycles, Binary and Combined cycles.

UNIT – IV **(09 Hours)**

General thermodynamic property relations: Maxwell equations – Tds equations – property relations of gases – Clausius-Clapeyron equation – Joule-Thomson coefficient – Gibbs phase rule – equilibrium condition.

UNIT – V **(09 Hours)**

Psychrometric properties, Psychrometric charts. Property calculations of air vapour mixtures by using chart and expressions. Psychrometric process – adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing. Simple Applications.

Text Books:

1. P.K. Nag, Engineering Thermodynamics, Tata McGraw Hill Publishing Co. Ltd., New Delhi,2008.
2. Y. Cengel and M. Boles, Thermodynamics – An Engineering Approach, Tata McGraw Hill, 7th Edition,2010.

Reference Books :

1. C.P.Arora,Thermodynamics,TataMcGrawHillPublishingCo.Ltd.,NewDelhi, 2003.
2. Rathakrishnan E, Fundamentals of Engineering Thermodynamics, 2nd Edition, PHI Learning Pvt. Ltd., New Delhi,2008.

E-learning source:

www.nptel.ac.in

MET35 ENVIRONMENTAL SCIENCE
(Audit course – No credit)

Objectives:

- *The course is designed to help students understand the environment and natural resources available, design rainwater harvesting systems and methods for recycling and reusing domestic water, create models for resource and energy management, environmental management systems, impact, lifecycle and human health risk assessment, various environment laws, policies and acts.*

UNIT – I **(09 Hours)**

Water resources- Water Cycle, Distribution, Groundwater flow, Demand for water, Water pollution- causes CO1 and effects, Water Act (1974), Rainwater Harvesting-Methodology, components, design of rainwater harvesting system for a single house (as per IS:15797-2008) Domestic waste water- Definition, Characteristics, Recycling and Reuse of domestic waste water.

UNIT – II **(09 Hours)**

Air Pollution- definition, classification, causes, Sources, effects and control measures, Air Act(1981) Solid Waste management – Causes- effects and control measures of Urban and industrial waste, Waste management initiatives in India for human well-being.

UNIT – III **(09 Hours)**

Renewable and non-renewable energy resources- use of alternating energy sources – Energy management. Green Buildings- Definition, Importance, building envelope, Problems in existing buildings, Energy use in Buildings, Greenhouse gas emissions and indoor air pollution, green construction materials, Green building assessment system, Case study.

UNIT – IV **(09 Hours)**

Environmental Management Systems; ISO14000 series; Environmental auditing: Environmental Impact Assessment; Life cycle assessment; Human health risk assessment.

UNIT – V **(09 Hours)**

Environmental Law and Policy – Objectives; Polluter pays principle, Precautionary principle; The Water and Air Acts with amendments; The Environment (Protection) Act (EPA) 1986; National Green Tribunal Act, 2010; National Environment Policy; Principles of International Law and International treaties.

Text Books

1. P.Yugananth, R.Kumaravelan, Environmental Science and Engineering, Scitech Publications (Inida) P.Ltd., Delhi, 2017.
2. John Pichtel, Waste Management Practices: Municipal, Hazardous and Industrial, CRC Press,2014.
3. V.S.K.V.Harish, Arunkumar, Green Building Energy Simulation and Modeling, Elsevier Science & Technology,2018

Reference Books

1. Anubha Kaushik and C.P.Kaushik, Environmental Science and Engineering, New Age International (P) Ltd., New Delhi, 2010.
2. S.S.Dara, A text book of Environmental Chemistry and Pollution Control, S.Chand and Company Ltd., New Delhi, 2014.
3. IS:15797:2008, Roof Top Rainwater Harvesting-Guidelines, BIS, New Delhi
4. Energy Conservation Building Code, 2017, Bureau of Energy Efficiency, Ministry of Power, Government of India.
5. G.D RAI Renewable energy sources

MEP31 MATERIAL TESTING AND METALLURGY LABORATORY

(30 Hours)

Objectives:

- *To train the students in performing basic metal characterization studies and in measuring physical properties of materials relevant to mechanical engineering using various machines and equipments.*

LIST OF EXPERIMENTS:

MATERIALS TESTING LABORATORY

1. Tension test
2. Compression test
3. Impact test – Izod test
4. Brinell Hardness test
5. Rockwell Hardness test
6. Ductility test: Sheet metals (Al, GI and MS)
7. Impact test – Charpy test

METALLURGY LABORATORY

1. Study of Metallurgical microscope
2. Preparation of a Specimen for microscopic examination
3. Identification of the Metal1
4. Identification of the Metal2
5. Identification of the Metal3
6. Study of Heat Treatment Processes on metals
7. Study of various Quenching mediums
8. Hardening of Steel
9. Normalizing of Steel
10. Annealing of Steel
11. Jominy end quenching test

MEP32 COMPUTER AIDED MACHINE DRAWING LABORATORY

(45 Hours)

Objectives:

- *To expose the students to CAD/CAE software in the design and drawing of machine components.*
- *Create 2-D Sketches*
- *To draw various permanent and temporary joints*
- *To be able to understand and find mistakes in the diagrams drawn by draughtsman*
- *Create assembly models of simple machine (minimum 5components)*

I	Draw the orthographic views for the given simple 3D blocks using AutoCAD screen icons--Minimum two exercises
II	Draw the orthographic views for the given simple 3D blocks using AutoCAD script file - Minimum two exercises
III	Draw the isometric view for the objects given in orthographic views. Minimum two exercises
IV	Preparation of Drawings for Parts and Assembly of the following by using Drafting software.
V	Gear coupling, spring loaded safety valve, lever safety valve, blow-off cock, cast iron flange joint, hydraulic joint, feed check valve, foot step bearing, ball valve, stuffing box- minimum 5 exercises
VI	Preparation of Production Drawings with tolerances limits and fits using Drafting software. -- Minimum one exercise

Important Note

Submission of all above assignments may be made in electronic format (preferably in single CD/DVD for all batches/students) and may be reviewed by external examiner at the time of Practical Examination.

References:

1. Ajeet Singh, Machine Drawing Includes Auto CAD, Tata McGraw-Hill Publishing Company, New Delhi, 5th Reprint,2011.
2. Bhatt.N.D.andPanchal.V.M.“MachineDrawing”,CharotarPublishingHouse, 38th Edition,2003.
3. Sham Tikoo,“AutoCAD2002withApplications”,TataMcGraw-HillPublishing Company, New Delhi,2002.
4. Goutam Pohit, Goutam Ghosh, Machine drawing with AutoCAD, Pearson Education, 1st Ed.,2005.
5. K.L.Narayana, P.Kannaiah, K.Venkata Reddy, Machine drawing, New Age International, 3rd Ed.,2006.

SEMESTER – IV

MAT41 PROBABILITY, STATISTICS AND NUMERICAL METHODS

Objectives:

- To understand and apply concepts related to discrete and continuous random variables, including important distributions.
- To apply large sample tests, conduct chi-square tests for goodness of fit and independence of attributes, and perform one-way and two-way classifications.
- To solve linear systems using iterative and direct methods, and apply the power method to find dominant eigen values and eigen vectors.
- To utilize numerical methods for solving ordinary differential equations.
- To apply numerical techniques for solving partial differential equations.

Unit I - Probability and Random Variables (12 Hrs)

Probability – The axioms of probability – Conditional probability – Baye's theorem - Discrete and continuous random variables – Moment generating functions – Binomial distribution – Poisson distribution – Geometric distribution – Uniform distribution – Exponential distribution – Normal distribution.

Unit II – Testing of Hypothesis and Design of Experiments (12 Hrs)

Large sample test for single proportion **–** difference of proportions **–** Tests for single mean **–** difference of means **–** difference of standard deviations **–** Test for ratio of variances – Chi – square test for goodness of fit and independence of attributes, one way and two way classifications.

Unit III – Solution of Linear System and Numerical Integration (12 Hrs)

Gaussian elimination and Gauss – Jordan methods – LU – decomposition methods – Crout's method – Jacobi and Gauss – Seidel iterative methods – sufficient conditions for convergence – Power method to find the dominant eigen value and eigen vector and Integration By Trapezoidal and Simpson's Rules.

Unit IV – Numerical Solution of Ordinary Differential Equations (12 Hrs)

Euler's method – Euler's modified method – Taylor's method and Runge – Kutta method for simultaneous equations and 2nd order equations – Stability analysis of single step methods – Multistep methods – Milne's and Adams' methods.

Unit V – Numerical Solution of Partial Differential Equations (12 Hrs)

Numerical solution of Laplace equation and Poisson equation by Liebmann's method– solution of one dimensional heat flow equation – Bender – Schmidt recurrence relation – Crank – Nicolson method – Solution of one – dimensional wave equation.

Text Books

1. Johnson, R.A., Miller, I and Freund J., “Miller and Freund’s Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences”, Cengage Learning, New Delhi, 8th Edition, 2014.
3. Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum’s Outlines on Probability and Statistics ", Tata McGraw Hill Edition, 2004.
4. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., “Probability and Statistics for Engineers and Scientists", 8th Edition, Pearson Education, Asia, 2007.

Reference Books

1. David Kincaid and Ward Cheney, “Numerical Analysis”, 3rd edition, American Mathematics Society, (Indian Edition) – 2010.
2. Gerald C.F., and Wheatley P.O., “Applied Numerical Analysis”, Addison-Wesley Publishing Company, 1994.
3. Jain, M.K., Iyengar, S.R. and Jain, R.K., “Numerical Methods for Scientific and Engineering Computation”, New Age international, 2003.
4. Grewal. B.S. and Grewal. J.S., “Numerical Methods in Engineering and Science ", 10th Edition, Khanna Publishers, New Delhi, 2015.
5. Burden, R.L and Faires, J.D, "Numerical Analysis”, 9th Edition, Cengage Learning, 2016.

MET41KINEMATICS AND DYNAMICS OF MACHINES

Objectives:

- *To understand the kinematics and rigid-body dynamics of kinematically driven machine components.*
- *To understand the motion of linked mechanisms in terms of the displacement, velocity and acceleration at any point in a rigid link*
- *To be able to design linkage mechanisms and cam systems to generate specified output motion*
- *To understand the kinematics of gear trains.*

Unit I: Mechanisms (12 Hours)

Definition and types of joints; Lower and higher pairs; Classification of mechanisms based on function and constraints; Common mechanisms such as slider crank and 4-bar mechanisms and their inversions; Quick return mechanism, Straight line generators, rocker mechanisms, universal joints, steering mechanisms, etc.
Degree of freedom and Grübler's formula; Grashof's rule and rotatability limits; Mechanical advantage; Transmission angle; Limit positions.

Unit II: Kinematic Analysis of Simple Mechanisms (12 Hours)

Displacement, velocity, and acceleration analysis; Velocity analysis using instantaneous centers; Position, velocity and acceleration analysis using loop closure equations; Coincident points; Coriolis component of acceleration.

Unit III: Static & Dynamic Force analysis of Simple Mechanisms (12 Hours)

Two & three force members; Force & moment equilibrium; inertial forces; Equations of motion for force-bar and slider-crank mechanisms.

Unit IV: Cams and Followers (12 Hours)

Classification and terminology; Displacement, velocity, acceleration and jerk diagrams; Uniform velocity, parabolic, simple harmonic and cycloidal motions; Derivatives of follower motions; Circular and tangent cams; Pressure angle and undercutting; Graphical and analytical disc cam profile synthesis for roller and flat face followers.

Unit V: Gears (12 Hours)

Involute and cycloidal profiles; gear parameters; Fundamental law of gearing and conjugate action; Spur gear contact ratio and interference; Helical, bevel, worm, rack & pinion gears; Epicyclic and regular gear train kinematics; Force analysis of spur, helical, bevel and worm gearing.

Computer-aided simulation of simple mechanisms.

Text /Reference Books:

1. Thomas Bevan, "Theory of Machines," CBS Publishers & Distributors, 2005.
2. W. L. Cleghorn, "Mechanisms of Machines," Oxford University Press, 2005.
3. R. L. Norton, "Kinematics and Dynamics of Machinery," Tata McGraw Hill, 2009.
4. A.Ghosh and A.K. Mallick, "Theory of Mechanisms and Machines," Affiliated East-West Pvt. Ltd, New Delhi, 1988.

Online Resources:

1. https://nptel.ac.in/courses/112105268

MET42 THERMAL ENGINEERING

Objectives:

- *Study of IC engines and propulsion system*
- *Study of combustion in IC engines*
- *Understanding of emission, its impact on environment and control*
- *Study of compressible fluid flow*

UNIT – I **(12 Hours)**

Classification of IC engines – petrol and diesel engines; two stroke and four stroke engines – scavenging in two stroke engines - port and valve timing diagram - fuel supply system in SI and CI engines - ignition system and its types – cooling system and its types – lubrication system and its types - lubricants - governing of IC engines– engine operating characteristics – power – cruising – idle and low engine speed – high engine speed – cold start - performance characteristics – heat balance test for IC engines.

UNIT – II **(12 Hours)**

Fuels: liquid and gaseous fuel and their characteristics –desirable properties of fuels for SI and CI engines–flashpoint, fire point, calorific value, Combustion process in IC engines – Flame propagation, normal and abnormal combustion, delay period, knocking and detonation, knocking rate of fuel, cetane number, octane number, supercharging and turbo charging – combustion chamber and types. Engine emission -formation of nitrogen oxides, carbon monoxide, hydrocarbon and particulates- emission standards.

UNIT – III **(12 Hours)**

Basic principles – stagnation properties – sonic velocity – Mach number – and mach waves – Isentropic flow through variable area - Mach number variation – stagnation and critical states – area ratio as a function of Mach number, mass flow rate, flow through nozzles and diffusers.

UNIT – IV **(12 Hours)**

Normal shocks – development of a shock wave, governing equations, Mach number after the shock, pressure and temperature across the shock. Obliques hocks–Nature of flow through Oblique shock waves, fundamental relations and equations, flow in constant area ducts with friction, flow in constant area ducts with heat transfer – multidimensional flows.

UNIT –V **(12 Hours)**

Principle of jet propulsion – air craft jet engines – jet engine cycle – turbojet – turbofan– turboprop–turbofanengines-engineperformance–thrustandefficiency, thrust power, propulsion power, propulsion efficiency and thermal efficiency–engine- aircraft matching. Rocket engines – introduction – space missions.

Text Books:

1. Collin R. Ferguson–Internal Combustion Engines-Applied Thermo sciences, Wiley,2004.
2. Yahya S.M., Fundamentals of Compressible Flow, New Age International, New Delhi, 2012.
3. Hill P. and Peterson C., Mechanics and Thermodynamics of Propulsion, Pearson Education,2012.

Reference Books:

1. Willard W. Pulkrabek– Internal Combustion Engines, Prentice Hall of India, 2002.
2. J.B. Heywood– Internal Combustion Engines – fundamentals, McGraw Hill, 1988.
3. Cambel, A.B. and Jennings, 'Gas dynamics and Compressible Flow", Tata McGraw Hill,1958.
4. V. Ganesan – Internal Combustion Engines, Tata McGraw Hill,1999.

Web Resources:

1. https://www.coursera.org/course/introthermodynamics
2. http://nptel.ac.in/courses/112104033

MET43 MACHINING PROCESSES

Objectives:

- *To understand the concept and basic mechanics of metal cutting, working of standard machine tools such as lathe, shaping and allied machines, milling, drilling and allied machines, grinding and allied machines and cutting tools.*

UNIT – I: TURNING OPERATIONS (09 Hours)

Lathe–Types, Designation, Work holding devices–Cutting Speed, Feed and Depth of Cut, MRR - Operations, Machining Time.

UNIT – II: DRILLING AND ALLIED OPERATIONS (09 Hours)

Drilling Machines - Types, Operations, Machining Time - Boring, Reaming and Tapping (Definition of operations only)

UNIT – III: BASIC MACHINING OPERATIONS (09 Hours)

Shaper, Types, Shaping Operations, Planner, Types, Planning Operation, Slotting Machine Operations.

UNIT – IV: ADVANCED MACHINING OPERATIONS (09 Hours)

Milling Machine, Types, Milling Process, Milling Operations, MRR, Machining Time. Introduction to unconventional machining – EDM, ECM, ECG, AJM and USM.

UNIT – V: CUTTING TOOLS/FLUIDS (09 Hours)

Tool Materials, Nomenclature and Geometry of Cutting Tools, Tool wear Mechanisms, Tool Life – Tool Life Criteria. Cutting Fluids - Categories, Desirable Properties, Selection of Cutting Fluids.

Text/Reference Books:

1. B.S.NagendraParashar,R.K.Mittal."ElementsofManufacturingProcesses"- Prentice - Hall of India Pvt. Ltd; New Delhi –1,2012.
2. R.K.Singal, Mridul Singal, Rishi Singal. "Fundamentals of Machining and MachineTools"-I.K.InternationalPublishingHomePvt.Ltd;NewDelhi,2008.
3. Roy.A.Lindberg, "Process and Materials of Manufacture", Prentice Hall India Pvt. Ltd,2002.
4. www.egr.msu.edu/pkwon/me478/operations.pdf

MET45 FLUID MECHANICS AND MACHINERY

Objectives:

- The properties of fluids and concept of control volume are studied
- To understand the importance of dimensional analysis
- The applications of the conservation laws to flow through pipes are studied.
- To understand the importance of various types of flow in turbines.
- To understand the importance of various types of flow in pumps.

UNIT I FLUID PROPERTIES AND FLOW CHARACTERISTICS (09 Hours)

Units and dimensions- Properties of fluids- mass density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapor pressure, surface tension and capillarity. Flow characteristics – concept of control volume - application of continuity equation, energy equation and momentum equation.

UNIT II FLOW THROUGH CIRCULAR CONDUITS (09 Hours)

Hydraulic and energy gradient - Laminar flow through circular conduits and circular annuli- Boundary layer concepts – types of boundary layer thickness – Darcy Weisbach equation – friction factor- Moody diagram- commercial pipes- minor losses – Flow through pipes in series and parallel.

UNIT III DIMENSIONAL ANALYSIS (09 Hours)

Need for dimensional analysis – methods of dimensional analysis – Similitude –types of similitude - Dimensionless parameters- application of dimensionless parameters – Model analysis.

UNIT IV PUMPS (09 Hours)

Impact of jets - Euler's equation - Theory of roto-dynamic machines – various efficiencies– velocity components at entry and exit of the rotor- velocity triangles - Centrifugal pumps– working principle - work done by the impeller - performance curves - Reciprocating pump- working principle – Rotary pumps –classification.

UNIT V TURBINES (09 Hours)

Classification of turbines – heads and efficiencies – velocity triangles. Axial, radial and mixed flow turbines. Pelton wheel, Francis turbine and Kaplan turbines- working principles - work done by water on the runner – draft tube. Specific speed - unit quantities – performance curves for turbines – governing of turbines.

TEXT BOOK:

1. Modi P.N. and Seth, S.M. "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi 2013.

REFERENCES:

1. Graebel. W.P, "Engineering Fluid Mechanics", Taylor & Francis, Indian Reprint, 2011
2. Kumar K. L., "Engineering Fluid Mechanics", Eurasia Publishing House(p) Ltd., New Delhi 2016
3. Robert W.Fox, Alan T. McDonald, Philip J.Pritchard, “Fluid Mechanics and Machinery”, 2011.
4. Streeter, V. L. and Wylie E. B., "Fluid Mechanics", McGraw Hill Publishing Co. 2010

MEP41 DYNAMICS OF MACHINES LAB (45 Hours)

Objectives:

- *To teach the students principle of working of various governor.*
- *To teach the students about various mechanisms working and demonstration.*
- *To teach the students the different modes of balancing*
- *To teach the students, various modes of vibration.*

SUGGESTED LIST OF EXPERIMENTS

1. Demonstration of four bar inversion mechanism
2. Natural frequency of single mass, single helical spring system.
3. Natural frequency of combination of springs–springs in parallel, springs in series
4. Natural frequency of undamped Torsional single rotor, double rotor system. Effect of inertia (I) and stiffness (k).
5. Determination of radius of gyration of a given compound pendulum
6. Determination of radius of gyration, moment of inertia–bifilar suspension method – trifilar suspension method
7. Damping coefficient of Torsional single rotor system–Effect of depth of immersion in oil and damping ratio
8. Resonance frequency of equivalent spring mass system–undamped and damped condition

a) To plot amplitude Vs frequency graph for different damping.

9. Determination of characteristic curves of Watt, Porter, Proell and spring loaded governors.
10. Static and Dynamic balancing.
11. Whirling of shafts/ determination of critical speed with and without Rotors.
12. Gyroscopic couple verification.
13. Journal bearing–pressure distribution of different loads at different Speeds.
14. Cam motion analysis.
15. Generation of involute gear profile.
16. Tracing of coupler curves.
17. Determination of error in straight line drawn by watt chain mechanism.

MEP42 MANUFACTURING PROCESS LABORATORY (45 Hours)

Objectives:

- *To provide an understanding of advanced manufacturing methods.*
- *To get an idea of the dimensional& form accuracy of products*

LIST OF EXPERIMENTS:

LATHE:
Plain turning and facing
Step turning, grooving, chamfering and knurling
Taper turning and external thread cutting using lathe
SHAPING MACHINE:
Cube shaping

MILLING MACHINE
Contour milling using vertical milling machine

GEAR CUTTING:
Spur gear cutting in Hobbing machine

GRINDING MACHINE:
Cylindrical grinding

CNC MACHINE:
CNC part programming
3D PRINTING
Designing and Printing of Machine Elements

MEP43 FLUID MECHANICS AND MACHINERY LABORATORY (45 Hours)

Objectives:

- *To identify safe operating practices and requirements for laboratory experiments.*
- *To design and conduct an experiment as well as to analyze and interpret data.*
- *To cover the elements of fluid mechanics in fluid flow systems.*
- *To cover a range of experimental techniques aiming to provide students with a general knowledge and understanding of the subject fluid mechanics and machinery, including recommendations for further studies.*

UNIT I: FLOW VISUALIZATION AND MEASUREMENT

Flow visualization -Heleshaw, Reynolds experiment, verification of Bernoulli's theorem, solid body rotation, calibration of flow measuring instruments – venturimeter, orificemeter and rotometer.

UNIT II: PUMPS

Determination of performance characteristics of pumps – centrifugal pumps, submersible pumps, turbine pumps and positive displacement pumps – reciprocating and gear pumps.

UNIT III: TURBINES

Determination of performance characteristics of turbines – reaction turbines and impulse turbines.

List of experiments:

1. Determination of the coefficient of discharge of given Orificemeter.
2. Determination of the coefficient of discharge of given Venturimeter.
3. Calculation of the rate of flow using Rotameter.
4. Visualizing the flow structures through various models.
5. Proving Bernoulli's theorem.
6. Conductingexperimentsanddrawingthecharacteristicscurvesofcentrifugal pump.
7. Conducting experiments and drawing the characteristics curves of submersible pump.
8. Conducting experiments and drawing the characteristics curves of jet pump.
9. Conducting experiments and drawing the characteristics curves of pump in series and parallel.
10. Conducting experiments and drawing the characteristics curves of reciprocating pump.
11. Conducting experiments and drawing the characteristics curves of Gear pump.
12. Conducting experiments and drawing the characteristics curves of Pelton wheel.
13. Conducting experiments and drawing the characteristics curves of Francis turbine.
14. Conducting experiments and drawing the characteristics curves of Kaplan turbine.
15. Conducting experiments and drawing the characteristics curves of hydraulic ram.

Text Books:

1. CWR, Hydraulics LaboratoryManual,2004
2. N. Kumarasamy, Fluid Mechanics and Machinery laboratory manual, Charotar Publishing House Pvt. Ltd.2008.

Reference Books:

1. S K Agrawal, Fluid Mechanics and Machinery, Tata McGraw-Hill Education, 2001
2. Subramanya, Fluid Mechanics and Hydraulic Machines, Tata McGraw-Hill Education,2011.
3. S C Gupta, Fluid Mechanics and Hydraulic Machines, Pearson Education India,2006.

Web Reference:

1. http://en.wikipedia.org
2. http://www.engineeringtoolbox.com

SEMESTER –V

MET51 DESIGN OF MACHINE ELEMENTS

Objectives:

- *To teach students how to apply the concepts of stress analysis, theories of failure and material science to analyze, design and/or select commonly used machine components.*
- *To illustrate to students the variety of mechanical components available and emphasize the need to continue learning.*
- *To teach students how to apply mechanical engineering design theory to identify and quantify machine elements in the design of commonly used mechanical systems.*
- *To teach students how to apply computer based techniques in the analysis, design and/or selection of machine components.*

UNIT – I **(12hours)**

Fundamentals of machine design - Design philosophy- Engineering Materials- Brief overviewofdesignandManufacturing–PrincipalStresses-FailureTheories-Design of Welded Joints-Types–Strength–Eccentric Loaded welded joints–Welded joints subjected to fluctuating load.

UNIT – II **(12hours)**

Strength and Stability Criteria, Design of Power Screws. Threaded Joints – Bolted Joints under fluctuating load, Combined Stresses, and eccentric loading.

UNIT – III **(12hours)**

Design of Couplings – Design of Rigid and flange Couplings – Types of Clutches and Design of Clutches. Types of Brakes–Design of Brakes.

UNIT – IV **(12hours)**

Introduction to Design of Helical Springs-Design of Helical Springs for Variable Load- Design of Leaf Springs- Design of Pipe Joints – Cotter and Knuckle joints.

UNIT – V **(12hours)**

Design of Shafts under static load: members subjected to Eccentric loading – stresses in curved beams. Design of Shafts under Fluctuating Load: Design for Finite and Infinite life – Soderberg and Goodman equations – combined stresses.

Text books:

1. V.B. Bhandari -Design of Machine Elements, Tata McGraw Hill publishing Co.,2010.
2. Sharma and Purohit, Design of Machine Elements, PHI,2009.
3. Ganesh Babu, K. and Srithar, K., Design of Machine Elements, McGraw Hill Education (India) Pvt. Ltd., Noida,2009

Reference books:

1. J.Shigley,MechanicalEngineeringDesign,McGrawHillInternationalEdition, 2011.
2. Abdul Mubech, Machine Design, III Edition, Khanna Publishers,1998.
3. Sadhu Singh, Machine Design, III Edition, Khanna Publishers,2001.

E-learning sources:

1. www.nptel.iitm.ac.in
2. www.shellbuckling.com

MET52 HEAT AND MASS TRANSFER

Objectives:

- *To convey the basics of the heat transfer principles.*
- *To establish the relationship of these principles to thermal system behaviour.*
- *To develop methodologies for predicting the system behaviour.*
- *To explain the role of exact solutions in the heat and boundary layer equations, numerical solution methods, heat transfer with phase change and design of heat exchangers.*
- *To develop an intuitive understanding of underlying physical mechanism and a mastery of solving practical problems in real world.*

UNIT – I **(12hours)**

Heat Transfer by Conduction: Concept of heat conduction–Law of heat conduction– heat conduction equations; solution for steady state conduction; conduction with heat sources; extended surfaces – transient heat conduction, solution using Heisler's charts – measurement of thermal conductivity – effects of temperature on thermal conductivity –electrical analogy.

UNIT – II **(12hours)**

Heat Transfer by Convection and with Phase Change: Convection – forced convection, external flow, laminar and turbulent flow over flat plate, cylinder and sphere – internal flow, laminar and turbulent flow through circular tubes – free convection, laminar flow over plates and tubes. **Condensation** – concept of condensation – types - Nusselt's theory – heat transfer during condensation. **Boiling** – pool boiling; regimes – nucleate boiling, film boiling, critical heat flux – flow boiling, pattern, heat flux.

UNIT – III **(12hours)**

Heat Transfer by Radiation: Nature of thermal radiation-concept of black body, Stefan-Boltzman law, Kirchoff's law, intensity of radiation - radiative heat exchange betweensurfaces–shapefactors–conceptofgreybodyradiationbetweensurfaces separated by non-absorbing medium-electrical analogy.

UNIT – IV **(12hours)**

Double pipe heat exchangers, parallel and counter flows – Log Mean Temperature Difference (LMTD) – multi pass heat exchangers, analysis using correction factors – heat exchanger effectiveness – effectiveness expressed in terms of NTU for different configurations – effectiveness Vs NTU charts.

UNIT – V **(12hours)**

Similarity between phenomena of heat transfer and mass transfer – diffusion mass transfer, Fick's Law of diffusion, species conservation equation-initial and boundary conditions, steady state molecular diffusion-diffusive mass transfer and convective mass transfer– momentum, heat and mass transfer analogies, convective mass transfer correlations, evaporation of water into air.

Text books:

1. F.P.Incropera and D.P.Dewitt, Fundamentals of Heat and Mass Transfer, IV Edition, John Wiley &Sons,2000.
2. J.P.Holman, Heat Transfer, X Edition,Mc Graw Hill Book Company,NY, 2009.

Reference books:

1. A.Bejan, Heat Transfer, John Wiley & Sons,1993,
2. M.N.Ozisik, Heat Transfer: A Basic Approach, McGraw Hill Book Company, New York, 1985.
3. R.C.Sachdeva, Fundamentals of Engineering Heat and Mass Transfer, Wiley Eastern Ltd.,1997.

Web Reference:

1. http://nptel.iitm.ac.in/courses/Webcourse-c**on**tents/

MET53 METROLOGY AND MECHANICAL MEASUREMENTS

Objectives:

- *To understand the proper use and maintenance of important instruments, such as Vernier callipers, autocollimators, slip gauges, and pyrometers*
- *To identify the techniques for the quality assurance of the products and the optimality of the process in terms of resources and time management.*

UNIT I: Measurement Purpose and Parameters, (12hours)

Measurement Principles: Parameters–geometry (straightness, flatness, roundness, etc.), displacement, force, speed, torque, flow, level, pressure, temperature, acceleration, etc.; Definitions: Accuracy, precision, range, resolution, uncertainly and error sources; Regression analysis. Structure and examples of measurement systems; Calibration principles; Linear and angular measurements; Comparators; Gauge design; Interferometry.

UNIT II: Limits, Fit and Tolerances: (12hours)

Definitions; Tolerance zone and grades, Hole and shaft system, Geometric tolerances, Tylor's principle of gauging, Design of tolerances for various applications; Tolerance analysis in manufacturing and assembly; Role of metrology in Design of Manufacturing.

UNIT III: Mechanical Measurements and Equipment: (12hours)

Dimensional metrology– Vernier, micrometers, LVDT; Form metrology– form tester, surface profiler, CMM, 3D scanning; Surface metrology optical microscopes, Laser scanning microscopes, electron microscopy (SEM/TEM),x- ray microscopy, Raman spectroscopy; Tool wear, work piece quality and process metrology. Measurement of temperature, thermal conductivity and diffusivity; Flow obstruction methods; Magnetic flow meters.

UNIT IV: Electrical Measurements and Instruments: (12hours)

Signal generators and analysis; Wave analyzer; Spectrum analyzer; Frequency counters– measurement errors, extending the frequency range; Transducers – types, strain gages, displacement transducers; Digital data acquisition system- interfacing transducers to electronics control and measuring system; Instrumentation amplifier; Isolation amplifier; Computer- controlled test systems.

UNIT V: Design of Experiments and Statistical Analysis: (12hours)

DOE techniques; Taguchi orthogonal arrays; Data acquisition, signal processing and conditioning; Error of a system of ideal elements; Error probability density function of a system of non-ideal elements; Error reduction techniques; Quality control and assurance in industry.

Text Books

1. E.O Doebelin and Dhanesh Manik, “Measurement Systems”, McGraw Hill,2017
2. Bewoor& Kulkarni, “Metrology & Measurement” Tata McGraw Hill,2009.
3. D. James, and S, Meadow, “Geometric Dimensioning and Tolerancing”, Marcel Dekker,1995

Reference Books:

1. Madhav S. Phadke, Quality Engineering using Robust Design, Prentice Hall,1989

Web Resources:

1. Mechanical Measurements and Metrology by Prof. S P Venkateshan (IIT Madras), NPTEL Course (Link:https://nptel.ac.in/courses/112/106/112106138/).
2. Principles of Mechanical Measurement by Prof. Dipankar N Basu (IIT Guwahati), NPTEL Course (Link:https://nptel.ac.in/courses/112/103/112103261/).

MET54 MECHATRONICS, ROBOTICS &CONTROL

Objectives:

- *Model and analyze mechatronic systems for an engineering application*
- *Identify sensors, transducers and actuators to monitor and control a process or product.*
- *Develop PLC programs for an engineering application.*
- *Evaluate the performance of mechatronic systems.*

Unit I: Introduction: Electro-mechanical systems; Typical applications; Examples – automobiles, home appliances, medical instruments, etc. **(09hours)**

Unit II: Sensors and Actuators: Transduction principles; Sensitivity, accuracy, range, resolution, noise sources; Sensors for common engineering measurements – proximity, force, velocity, temperature, etc.; Signal processing and conditioning; Selection of sensors. **Actuators:** Pneumatic and hydraulic actuators; Electric motors including DC, AC, BLDC, servo and stepper motors; Solenoids and relays; Active materials – piezoelectric and shape memory alloys. **(09hours)**

Unit III: Machine Controls: Microprocessors and their architecture; Memory and peripheral interfacing; Programming; Microcontrollers; Programmable Logic Controllers; PLC principle and operation; Analog and digital input/output modules; Memory module; Timers, internal relays, counters and data handling; Industrial automation systems; Basic PLC programming; Industry kits (Arduino, Raspberry Pi, etc.). **(09hours)**

Unit IV: Robotics: Robot configurations: serial and parallel; Denavit – Hartenberg parameters; Manipulators kinematics; Rotation matrix, Homogenous transformation matrix; Direct and inverse Kinematics for robot position and orientation; Workspace estimation and path planning; Robot vision; Motion tracking; Robot programming and control; Industrial robots - Pick and place robots, sorting, assembly, welding, inspection, etc. **(09hours)**

Unit V: Control Theory and Systems, Computational Tools: Basic control concepts; Feedback; Open and closed loop control; Concept of block diagrams; P, PI and PID controllers; Tuning the gain of controllers; System models, transfer functions, system response, frequency response; Root Locus method and Bode plots. **Computational Tools**: Demonstration and projects using simulation software (e.g., Matlab, Scilab, ROBODK) for control systems and robotics. **(09hours)**

Text Books:

1. W. Bolton, “Mechatronics,” Addison Wesley Longman, 2010.
2. J. J. Craig, Introduction to Robotics Mechanics and Control, Addison Wesley, 1999.
3. G.K. McMillan, “Process/Industrial Instruments and Controls Handbook,” McGraw-Hill, 1999.

Reference Book:

1. S. Mukherjee, “Essentials of Robotics Process Automation”, Khanna Book Publishing, 2021

Web Resources:

1. https://nptel.ac.in/courses/107/106/107106090/
2. https://nptel.ac.in/courses/112/101/112101098/
3. https://nptel.ac.in/courses/112/107/112107289/
4. https://nptel.ac.in/courses/112/104/112104298/

MET55 PRODUCT INNOVATION & ENTREPRENEURSHIP

Objective:

To expose aspiring student entrepreneurs to various elements of a technology venture starting from market need identification to innovative solution development and its commercialization through business planning and start-up company incubation.

UNIT-I

Entrepreneurship: Role of entrepreneurship in economic development; Entrepreneurial mindset, motivation and competencies; Market pull and technology push factors; New product development lifecycle; Technology readiness levels; Product-market fit validation; Commercialization pathways; Business vision & leadership; Team composition & management. **(09hours)**

UNIT-II

Product Innovation: Opportunity scanning, market survey, need identification and problem definition; Creative design thinking for concept generation; Detailed design & prototyping; Functionality & manufacturability; Bill of materials & components supply chain; Manufacturing & assembly plan; Product testing & quality assurance; Intellectual property rights management. **(09hours)**

UNIT-III

Marketing & Finance: Market segmentation & market sizing; Customer persona & value proposition; Marketing (Go-to-market) strategy; Distribution channels and sales network; Funding requirement (based on stage); Source of funding for startup ventures; Financial projections and accounting; Startup to scale up financing. **(09hours)**

UNIT-IV

Venture Creation: Sustainable business options & pathways; Business model & business canvas; Startup team & business partners; Startup ecosystem and stakeholders; Technology business incubators & parks; Proposal pitching & agreements; Startup company incorporation; Social impact & responsibility. **(09hours)**

UNIT-V

Course Project: Need identification, innovative solution, business plan, go-to-market strategy. **(09hours)**

Text Books:

1. Bill Aulet, “Technology Entrepreneurship”, 4th ed., Tata McGraw Hill,2014.
2. Peter F. Drucker, “Innovation and Entrepreneurship”, 1st ed., Harper Business,2006.

Reference Books:

1. Chelat Bhuvana chandran, Innovation, Khanna Book Publishing,2022.
2. Byers, Dorf, and Nelson, Technology Ventures: From Ideas to Enterprise, McGraw Hill,2010
3. Steve Blank, “The Startup Owner's Manual”
4. T.V. Rao, “Entrepreneurship - A South Asian Perspective”

Web Resources:

1.https://onlinecourses.nptel.ac.in/noc22_ge03/preview

MEP51 METROLOGY AND MECHANICAL MEASUREMENT LAB (45 hours)

Objectives:

- *To get the practical knowledge in metrology and mechanical measurement techniques.*
- *To get hand-on experience on handling different measurement instruments and metrology devices.*

LIST OF EXPERIMENTS

1. Calibration of Micrometer.
2. Measurement of taper using SineBar.
3. Calibration of Plain Plug Gauge.
4. Straightness and Flatness Measurement using Autocollimator.
5. Surface Roughness Measurement (Taly surf method)
6. Inspection of Screw Threads (Effective Diameter).
7. Calibration of Inclined Tube Manometer.
8. Measurement of Pressure using Strain Gauges.
9. Determination of the Time Constant of Thermocouples.
10. Measurement of Force using Transducers.
11. Measurement of Strain using Strain Gauges.
12. Study of Displacement using LVDT and RVDT.
13. Vibration Measurement using Accelerometer.
14. Measurement of speed using stroboscope
15. Inspection of gear tooth profile using profile projectors
16. Tool Maker Microscope (inspection of screws)
17. Inspection of internal and external surfaces (C MM)

MEP52 THERMAL ENGINEERING LAB (45 hours)

Objectives:

- To make the students to understand the different properties of fuels like flash point, fire point, viscosity, calorific value etc and the principle of measurement.
- To teach the students principle of working of air compressors and blowers
- To teach the students the different modes of heat transfer like natural convection, forced convection and the use of fins
- To teach the students the composition of exhaust gases and their analysis using Orsat apparatus
- To teach the students the principle of parallel flow and counter flow heat exchangers.

LIST OF EXPERIMENTS

(A) Determination of Kinematic Viscosity using Redwood viscometer
(B) Determination of flash and fire point using Cleavel and apparatus

1. Determination of calorific value of solid fuel using bomb calorimeter
2. Determination of calorific value of gaseous fuel using Junker's gas calorimeter
3. Performance test on reciprocating air compressor
4. Performance test on centrifugal air blower
5. Determination of thermal resistance and conductivity of a composite wall
6. Determinationofheattransfercoefficientforheattransferfromcylindrical surface by natural convection
7. Determinationofheattransfercoefficientforheattransferfromcylindrical surface by forced convection
8. Performance of parallel flow/counter flow heat exchanger
9. Valve and port timing diagrams of 4-stroke and 2-stroke IC engines
10. Performance test on single cylinder 4- stroke petrol engine.
11. Performance test on multi-cylinder 4- stroke petrol engine
12. Performance test on single cylinder 4- stroke diesel engine
13. Performance test on multi-cylinder 4- stroke diesel engine
14. Performance test on cooling tower.
15. Performance test on refrigeration system.
16. Performance test on air-conditioning system.

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MEP53 INDIAN CONSTITUTION & TRADITION
(Audit course – No credit)

Objectives:

- *To make the students to understand the essence and significance of the constitution*
- *To teach the students about fundamental duties and rights and the structure & functions of legislature, executive and judiciary*
- *To make the students understand the functioning of state governments and union territories*
- *To make the students understand the centre-state relations and functioning of constitutional bodies*
- *To facilitate the students with the concepts of Indian tradition knowledge and to make them understand the Importance of roots of knowledge system.*

UNIT-I Introduction of Indian Constitution, State, Rights and Duties (09hours)

The Making of Indian Constitution - The Constituent Assembly - Sources of Indian Constitution - Preamble and the Supreme Court's Judgments on Preamble. State and Union Territories – Citizenship - Fundamental Rights - Directive Principles of State Policy - Fundamental Duties.

UNIT-II Union Government (09hours)

Union Government - The Powers and Functions of the President, Vice–President, Council of Ministers, Prime Minister, Judiciary, Supreme Court - Judicial Review - Judicial Activism- Public Interest Litigation - Power and Functions of the Parliament - Budget Power and Functions of Parliament, Speaker of Lok Sabha.

UNIT-III State Governments (09hours)

State Governments – Governor - State Council of Ministers - Chief Minister- Legislative Assembly- High Courts - Union Territories - Panchayati Raj Institutions - 73th and 74th Constitutional Amendment - Gram Panchayats - Block Panchayats - Municipalities.

UNIT-IV Union- State Relations, Constitutional Bodies (09hours)

Centre – State Relations - Public Service - Election Commission - NITI Ayog, Emergency Powers of the President- Constitution Amendment Procedure- Right to Information Act - Right to Education. Major Constitutional Amendments and their impact on Indian Political System.

UNIT-V Introduction to traditional knowledge (09hours)

Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK), characteristics, traditional knowledge vis-à-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge vis-à-vis formal knowledge

Text Books:

1. M.V.Pylee, “Introduction to the Constitution of India”,4th Edition, Vikas publication,2005.
2. Durga Das Basu (DD Basu), “Introduction to the constitution of India”, (Student Edition),19th edition,Prentice-Hall EEE, 2008.
3. Traditional Knowledge System in India, by Amit Jha, 2009.
4. Traditional Knowledge System and Technology in India by Basanta Kumar Mohanta and Vipin Kumar Singh, Pratibha Prakashan 2012.

References:

1. Austin, Granville. The Indian Constitution: Cornerstone of a Nation. Oxford University Press, 1999.
2. Basu, Durga Das, et al. Introduction to the Constitution of India. 20th ed., Thoroughly Rev, Lexis Nexis Butterworths
3. Wadhwa Nagpur, 2008.
4. Choudhry, Sujit, et al., editors. The Oxford Handbook of the Indian Constitution. Oxford University Press, 2016.
5. Bakshi, Parvinrai Mulwantrai, and Subhash C. Kashyap, The Constitution of India (Universal Law Publishing, 2016)
6. Bhargava, Rajeev, ‘Politics and Ethics of the Indian Constitution’, 2009
7. Rajeev Bhargava - ‘The Promise of India’s Secular Democracy’, 2010
8. Chakrabarty, Bidyut, India’s Constitutional Identity: Ideological Beliefs and Preferences (Routledge, 2019)
9. Jayal, Niraja Gopal, and Pratap Bhanu Mehta, The Oxford Companion to Politics in India, Oxford University Press,
10. 2010
11. Kashyap, Subhash C., Our Constitution: An Introduction to India’s Constitution and Constitutional Law (NBT India,
12. 1994)
13. Kashyap, Subhash C. Our Parliament: An Introduction to the Parliament of India. Revised edition, National Book
14. Trust, India, 2011.
15. Subhash C. Kashyap Our Constitution Paperback –. (NBT India, 2012).
16. Laxmikanth, M. "INDIANPOLITY". McGraw-Hill Education "Constitution of India". Ministry of Law and Justice, Govt. of India.
17. Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002 2. "Knowledge Traditions and Practices of India" Kapil Kapoor, Michel Danino

Web resources:

1. http://nptel.ac.in/courses/121106003/

SEMESTER –VI

MET61 DESIGN OF TRANSMISSION SYSTEMS

Objectives

- *To study about various mechanical transmissions systems and design of bearings, chains and ropes.*
- *To have a better understanding of gears and design of spur gears, helical gears, herring bone gears, straight and spiral bevel gears, worm gears and skew gears.*
- *To design the gear box, speed reducers, speed diagrams and stepped pulley.*

UNIT – I **(12hours)**

Theory of hydrodynamic bearing –design of journal bearing – heat dissipation – elementary ideas of hydrostatic bearings – bearing materials and lubricants. Rollingcontactbearings– loadcapacityandlife–selectionofrollingcontactbearings for radial and axial loads.

UNIT – II **(12hours)**

Belt drives – types – selection and design of flat and V-belts Chain drives – roller chains – polygonal effect – sprocket wheels – silent chain.

UNIT – III **(12hours)**

Advantage of gear drives over other drives, nomenclature, failures of gear tooth, design of gears – based on bending and wears criteria – based on Lewis and Buckingham equation

UNIT – IV **(12hours)**

Bevel gears - nomenclature, design of gears – based on bending and wear criteria– based on Lewis and Buckingham equation, worm and worm wheel – nomenclature – design procedure.

UNIT – V **(12hours)**

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. Speed reducer – design of speed reducer using spur and helical gears.

Text books:

1. T.J.Prabhu, Design of transmission elements, Madras book house, Chennai, 1997.
2. T.J.Prabhu, Fundamentals of machine design, Madras book house, Chennai, 1997.

Reference Books:

1. J.E.Shigley, Mechanical engineering design, I metric edition, McGraw Hill International Edition, 2011.
2. S.K.Basu, Design of machine tools, Oxford & IBH., 1990.
3. Sadhu singh, Machine design, Khanna publishers, 2001.
4. R.B.Gupta, Auto Design, Satya prakashan, 1990.

E-learning sources:

1. www.nptel.iitm.ac.in

MET62 PRODUCTION & OPERATIONS MANAGEMENT

Objectives:

- *To provide knowledge on machines and related tools for manufacturing various components.*
- *To understand the relationship between process and system in manufacturing domain.*
- *To identify the techniques for the quality assurance of the products and the optimality of the process in terms of resources and time management*

UNIT – I: INTRODUCTION (12hours)

Scope of production management. Production system and resources (machines, tooling, etc.); Types of production (batch, flow and unit), Roles of line supervisors and production managers.

UNIT – II: Project Management (12hours)

Project life cycle: concept phase (RFQ, Quotations, Proposals), Project initiations, DPR preparation (project value, business case development and feasibility study); Project planning (obtaining resources, acquiring financing and procuring required materials); Project team, producing quality outputs, handling risk, acceptance criteria; Project execution (allocation of resources, scheduling, building deliverables); Project Monitoring and control: Project networks, progress review (physical and financial), CPM and PERT, critical path, re-scheduling; Project closure: acceptance of project deliverable; Analytics: Performance, capability aggregation, cost benefit analysis, variability analysis, Output-outcome analysis, project documentation, best practices, and depository.

UNIT – III: Production Planning and Control (12hours)

Production planning, Process planning, Resource planning, demand-utility mapping (production capability index, forecasting models, aggregate production planning, materials requirement planning); Inventory Management: Economic order Quantity, discount models, stochastic inventory models, practical inventory control models, JIT; Supply chain and management.

UNIT – IV: Factory Management (12hours)

Factory layout: line balancing, material flow and handling, Lean and green manufacturing, Human resource management, Training need analysis, Advantage and opportunities for Digitalization, Advanced factory systems: TQM; Important acts, regularities and safety norms, Reliability assessment of processes, Block chain, Energy management, Efficiency & throughput, Overall equipment effectiveness. Process capability, lean manufacturing.

UNIT – V: Operation Management **(12hours)**

Linear programming, objective function and constraints, graphical method, Simplex and duplex algorithms, transportation assignment; Simple queuing theory models; Traveling Salesman problem; Network models: shortest route, minimal spanning tree, maximum flow model.

Text /Reference Books:

1. L.J. Krajewski and L.P Ritzmen, Operations Management: Strategy and Analysis, Pearson, 2010.
2. R.B. Chase, F.R. Jacobs and N.J. Aquilano, Operations Management for Competitive Advantage, Tata McGraw Hill,2011.
3. W. J. Hopp and M. L. Spearman, Factory Physics: Foundations of Manufacturing Management, McGraw Hill International Edition,2008.
4. Mahadevan. B., Operations Management: Theory and Practice, Pearson, 2015.
5. Taha H. A., Operations Research, 6th Edition, PHI India, 2003.
6. M.P. Poonia, Total Quality Management, Khanna Publishing House, 2022.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc20_mg06/preview

MET63 MANUFACTURING AUTOMATION

Objectives:

- *To understand the importance of automation in the of field machine tool based manufacturing*
- *To get the knowledge of various elements of manufacturing automation – CAD/CAM, sensors, pneumatics, hydraulics and CNC*
- *To understand the basics of product design and the role of manufacturing automation*

UNIT – I **(09 hours)**

Introduction: Definition; Reasons for automating; Strategies; Types of automation; Numerical control (NC, CNC, DNC); Introduction to CNC programming and computer-aided process planning. **Machine and Process Automation**: CNC machines, Automated flow lines (types, selection); Work part transport and transfer mechanisms; Feedback systems and control; Modular and reconfigurable machines, adaptive machine controls.

UNIT – II **(09 hours)**

Automated Assembly Systems: Historical developments; Choice of assembly methods; Design for automated assembly; Transfer systems; Vibratory and non-vibratory feeders; Feed tracks, part orienting and placing mechanisms. **Factory Automation:** Lean manufacturing, Automation scalability (fixed, programmable, flexible and reconfigurable); Design and analysis of automated flow lines; Average production time, production rate, line efficiency; Analysis of transfer lines without storage; Partial and full automation.

UNIT – III **(09 hours)**

Automation Tools and Techniques: Mechanical, electro-mechanical, pneumatic and hydraulic systems; Sensors integration; Process monitoring, data analysis and control using actuators; Robots (pick, place, assembly, welding, painting, etc.); Automatic Guided Vehicles; Automated inspection and measurement (CMM and 3D Scanning); Machine vision, AI and machine learning; Human- machine interfaces; Examples and case studies.

UNIT – IV **(09 hours)**

Advanced Automation Trends: Digital, inclusive, smart and distributed manufacturing; Industry 4.0; Digital transformations in shop-floors (CIM to Smart factory; Intelligent machines to Smart Machines; Factory automation to Distributed automation; Human sense to system sensed).

UNIT – V **(09 hours)**

Examples and Case Studies: Pick and place robots, testing and sorting based systems, etc; Orientation of parts: in-bowl and out-of-bowl tooling's; Manufacturing equipment embedded with digital data and driven by adoptive controls; Manufacturing automation with autonomous decisions taken by computers based on the realistic process/machines (production conditions) data acquired from the resources.

Text Books:

1. M. P. Groover, Automation, Production Systems and Computer-integrated Manufacturing, Prentice Hall,2018.
2. S. Kalpakjian and S. R. Schmid, Manufacturing – Engineering and Technology,Pearson.

Reference Books:

1. Yoram Koren, Computer Control of Manufacturing Systems, McGraw Hill,2005
2. CAD/CAM Principles and Applications, P.N. Rao, Tata McGraw Hill,2010.

Online Resources:

1. https://nptel.ac.in/courses/112/104/112104289/
2. https://nptel.ac.in/courses/112/103/112103293/
3. https://nptel.ac.in/courses/112/103/112103174/

MET64 COMPUTER AIDED DESIGN AND ANALYSIS

Objectives:

- *To provide an overview of how computers are being used in mechanical component design*
- *Student will get ability to use standards for model transformation.*
- *Students will able to understand the geometric construction*
- *To get idea about standard proper data base to develop an expert system.*
- *Students will able to understand the modeling and analysis software*

UNIT-I **(09 hours)**

Design process - Morphology of design, Types of design models, Application of design models, concurrent Engineering – CAD system architecture. CAD Hardware: workstation – CPU, mass storage, input devices (keyboard, light pen, thumb wheel joy stick, mouse, digitizer etc.,) and output devices (printers, plotters) Display Devices

UNIT-II **(09 hours)**

Bresenham's line and circle algorithms. Transformation in Graphics: co-ordinate system used in Graphics and windowing and view port transformations, Clipping , hidden line elimination, 2D transformations – rotation, scaling, translation, mirror, reflection and shear – homogeneous transformations, 3D Transformation – orthographic and Perspective Projections

UNIT-III **(09 hours)**

Classification of Geometric Modelling – Wire frame, Surface and Solid Modelling, applications – representation of curves and surfaces – Parametric form – Design of curved shapes- Cubic spline – Bezier curve – B-spline – Design of Surfaces - features of Surface Modelling Package – Solid Primitives, CSG, Brep and description of other modelling techniques like Pure primitive instancing, cell decomposition, spatial occupancy enumeration, Boolean Operations (join, cut, intersection), Creating 3D objects from 2D profiles (extrusion, revolving etc.)

UNIT-IV **(09 hours)**

Standards for computer graphics (GKS) and Data exchange standards – IGES, STEP. Data structures for Entity storage – Data structures for interactive modelling- Relational databases introduction to SQL language. Role of OOPS in CAD.

UNIT-V **(09 hours)**

Design information system an overview of modelling and analysis software like PRO-E, CATIA, IDEAS, SOLID EDGE, ANSYS, HYPERMESH etc.

Text Books:

1. Chris Mcmahon and Jimmie Browne - CAD/CAM – Principle Practice and Manufacturing Management, 2nd Edition, Addison Wesley England, 2000.
2. Sadhu Singh - Computer Aided Design and Manufacturing, II Edition, Khanna Publishers, New Delhi, 2008.

Reference Books:

1. P.Radhakrishnan et al - CAD/CAM/CIM, New Age International P Ltd., New Delhi, 2006.
2. M.P.Groover and E.W.Zimmers - CAD/CAM; Computer Aided Design and Manufacturing, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2006.
3. Ibrahim Zeid - CAD/CAM Theory and Practice, Tata McGraw Hill PublishingCo. Ltd., New Delhi, 2005.

MET65 INDUSTRIAL PSYCHOLOGY

Objectives:

- *To understand the origins of Industrial Psychology and what Industrial Psychologists do.*
- *To Increase awareness of important psychometric properties of personnel and psychological testing materials and their applications.*
- *To develop skills for designing and developing human/employee relationship with industry.*
- *To impart relevant skills and knowledge for independent learning of other subjects that requires such skills and knowledge.*
- *To understand the concepts of consumer psychology and Consumer decision making process.*

UNIT I - Introduction: Nature, Scope and Problems of Industrial Psychology, Historical Development psychology in Organizations, Scientific Management, Principles, Experiments Conducted for the Application, of Principles. Critical Analysis of the Principles. Individual Differences and their Evaluation. Hawthorne; studies and Implications. **(09 hours)**

UNIT II - Psychological Testing: Approaches, Validity, Advantages and Limitations in Industry. Attitude: Need, Importance, Measurement Techniques used to improve Attitude in industry. Morale: Determinants, measurement Methods of improving morale. Job satisfaction: Meaning. Definition, Theories of job satisfaction: Maslow's Hierarchy, Vroom's Theory, Herzberg's Theory, Stogdill's Theory, and Methods to improve Job Satisfaction. **(09 hours)**

UNIT III - Industrial Conflicts: Industrial Absenteeism; its Causes and Control. Labour Turnover: Relationship between Turnover and Job Complexity. Industrial Fatigue: Definition, Nature, Measurements, production Curve, Mitigation Measures. Industrial Accident: Causes, Accident Proneness: Approaches, critical Evaluation: Reduction and Prevention. **(09 hours)**

UNIT IV - Human Engineering: Importance, Development, Problems Stress and Mental Health of Employees: Causes, Reduction and Measures. **(09 hours)**

UNIT V - Consumer Psychology: Consumer Psychology Factors. Self-Image, Culture. Consumer Decision Making Process: Cognitive, Economic, Passive, Emotional Model.

(09hours)

Text Books:

1. M.L Blum & J.C. Naylor. "Industrial Psychology" (Its Theoretical & Social Foundations) CBS, 2004.
2. P.K. Ghosh & M.B. Ghorpade, "Industrial Psychology" Himalaya Publications, revised edition. 2016.
3. J.B. Miner, "Industrial-Organisation Psychology- Tata McGraw Hill, 2008.

Reference Books:

1. Matthew Ward, Georges Grinstein and Daniel Kelm "Interactive Data Visualization Foundations, Techniques, Application", 2010.
2. Robert Spence "Information visualization - Design for interaction". Pearson Education, 2007.

MEP61 MODELLING & SIMULATION LABORATORY (45 hours)

Objectives:

- *To give exposure to students about computer aided design and modeling & analysis software*

PART – A

COMPUTER AIDED DESIGN OF MACHINE COMPONENTS

1. Design and drafting of the following components using TK SOLVER/ FORTRAN / C or C++/ Matlab
2. Transmission shafts,
3. Journal bearings,
4. Flange couplings etc.

PART-B:

I. 3D MODELLING

1. Introduction to 3-D modeling– sketcher, part design, assembly and drafting workbenches.
2. Generation of various 3D Models through Protrusion, revolve, shell sweep.
3. Feature based and Boolean based modeling surfaces.
4. Assembly modeling of components having a minimum of six machine elements. [Minimum of two exercises in part modeling and one exercise in assembly]

II. FE Analysis:

1. Using any of the general purpose FEA software packages solve for
2. Force and stress analysis in trusses
3. SF and BMD diagrams for different types of beams with different loading and boundary conditions.
4. Stress concentration study on plate with central hole
5. Thermal stress and heat transfer analysis of a simple plate.

Note: In university practical examination, students have to answer one question each from Part A and Part B.

MEP62 COMPUTATIONAL FLUID DYNAMICS LABORATORY (45 hours)

Objectives:

- *Introduce the students to the science of computational fluid dynamics and heat transfer*
- *Familiarity with pre and post processing steps in CFD study*
- *Using physics based simulation for computer aided design and engineering*
- *Grid generation and boundary conditions for complex geometry*
- *Understandingthemultiphysicalsimulationapproachforphenomenaunder investigation*
- *Design Optimization using CFD*

Geometry and Grid Generation - SaloME Solver - OpenFOAM
Analysis of Results - Para View

1. 2D and 3D structured grid generation – flat plates, aerofoil
2. 3D unstructured grid generation – pipe, external aerodynamics
3. Incompressible internal laminar flows
4. Incompressible external laminar flows
5. Incompressible internal turbulent flows
6. Incompressible external turbulent flows
7. Forced Convection flows
8. Buoyancy driven flows
9. Multiphase flows – Capillary driven
10. Compressible flows
11. Non-Newtonian and Biological flows
12. Fluid Structure Interaction

Reference Books:

1. OpenFOAM 2.3.0 User Manual,2014.
2. Salome 7.4.0 User Manual,2014.
3. ParaView 4.2.0 User Manual,2014.

Web Resources:

1. https://www.coursera.org/course/spobuildaerodynamics
2. http://nptel.ac.in/courses/101106045
3. http://ocw.mit.edu/courses/aeronautics-and-astronautics/16-100-aerodynamics-fall-2005

MEPW6 ENGINEERING PROJECT-1 (Literature Review) (60 hours)

Objectives:

This course is aimed to provide more weightage for project work. The project work could be done in the form of a summer project or internship in the industry or even a minor practical project in the college. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

SEMESTER – VII

PROFESSIONAL ELECTIVE-1
PROFESSIONAL ELECTIVE-2
OPEN ELECTIVE-1
OPEN ELECTIVE-2

MEPW7 ENGINEERING PROJECT-2 (DESIGN & ANALYSIS)

Objective:

This course is aimed to provide more weightage for project work. The project work could be done in the form of a summer project or internship in the industry or even a minor practical project in the college. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

MEP71 SEMINAR

Each one of the students will be assigned a Seminar Topic in the current and frontier areas. The student has to conduct a detailed study/survey on the assigned topic and prepare a report. The student will make an oral presentation followed by a brief question and answer session. The Seminar (presentation and report) will be evaluated by an internal assessment committee for a total of 100 marks.

SEMESTER – VIII

PROFESSIONAL ELECTIVE-3
OPEN ELECTIVE-3

MEPW8 ENGINEERING PROJECT-3 (PROTOTYPE & TESTING)

Objective:

It is intended to start the project work early in the seventh semester and carry out both design and fabrication of a mechanical device whose working can be demonstrated. The design is expected to be completed in the seventh semester and the fabrication and demonstration will be carried out in the eighth semester.

PROFESSIONAL ETHICS

(Audit course – No credit)

The course should cover the following topics by way of Seminars, Expert Lectures and assignments:

1. Engineering Ethics – Moral issues, Ethical theories and their uses
2. Engineering as Experimentation – Code of Ethics
3. Engineer's responsibility for safety
4. Responsibilities and rights
5. Global issues of engineering ethics

References:

1. Charles D.Fleddermann, "Engineering Ethics", Prentice Hall, New Mexico, 1999
2. Mike W.Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi,2003
3. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003
4. World Community Service Centre, "Value Education", Vethathiri publications, Erode,2011

PROFESSIONAL ELECTIVE COURSES (PEC)

7^{th} /8^{th} SEM

PROFESSIONAL ELECTIVE COURSES (PEC) 7TH /8TH SEM

MEE1 REFRIGERATION, AIR CONDITIONING & CRYOGENICS ENGG

Objectives:

- *To expose to different methods of refrigeration*
- *To disseminate the operation of various types of refrigeration systems*
- *To build up an intuitive understanding of operation of air-conditioning systems*
- *To develop ability to estimate capacity of any air-conditioner*
- *To understand the basics of cryogenics and operation of* cryogenic systems

UNIT - I: REFRIGERATION (09 hours)

Basics of refrigeration – Methods of refrigeration: ice refrigeration, evaporative refrigeration, expansion cooling, throttling – Unit of refrigeration – vapour compression refrigeration system- p-h and T-s diagrams- deviations from theoretical cycle – sub-cooling and super heating- effects of condenser and evaporator pressure on COP- Refrigerants: primary and secondary refrigerants –Properties of refrigerants- Selection of refrigerants-Nomenclature-ODP&GWP

UNIT II OTHER REFRIGERATIONSYSTEMS (09 hours)

Vapour absorption refrigeration system- Working pairs of absorption refrigeration system – vapour jet refrigeration system, thermoelectric refrigeration system, Air refrigeration system, vortex tube refrigeration, pulse tube refrigeration and adiabatic demagnetization cooling

UNIT - III: PSYCHROMETRY AND AIR-CONDITIONING (09 hours)

Psychrometry and psychrometric properties – Psychrometric Chart- Psychrometric relations: Dalton's law of partial pressures – Wet bulb temperature and measurement- Adiabatic saturation temperature – Psychrometric processes – Air-conditioning systems: summer air-conditioning and winter air-conditioning – Requirement for comfort air-conditioning – Factors governing human comfort –Comfort chart.

UNIT - IV: COOLING LOAD AND DESIGN OF AIR-CONDITIONING SYSTEMS (09 hours)

Sources of heat load – Conduction load – Sun load – Load from occupants – Equipment load – Infiltration air-load – Load from moisture gain – Fresh air load – ASHRAEstandards– Calculationofloadonair-conditioningsystem–Methodsofair- conditioning system: Centralized air-conditioning system, unitary air-conditioning system and direct air-conditioning system – Air-conditioning devices and equipment: air cleaners, air filters, humidifiers, dehumidifiers, fans and blowers – cooling towers.

UNIT -V: CRYOGENICS LIQUEFACTION AND REFRIGERATION SYSTEMS (09 hours)

Introduction to cryogenics–Applications involving cryogenic engineering–Cryogenic fluids and properties – Production of low temperature: Joule-Thomson effect – Inversion curve – Adiabatic expansion – Cryogenic liquefaction systems: Linde- Hampson system, pre-cooled Linde - Hampson system Linde dual pressure system, Claude system, pre cooled Claude system, Kapitza system, Heyland tsystem, Collin's helium-liquefaction system and Simon helium-liquefaction system. Joule - Thomson refrigeration system – Cascade Joule -Thomson refrigeration system – Expansion - engine refrigeration system – Cold gas refrigeration system – Philips refrigerator – Solvay refrigerator – A. D. Little refrigerator – Vuilleumier refrigerator.

Reference books:

1. Arora, C. P., Refrigeration and Air conditioning, Tata McGraw Hill Publishing Co. Ltd., New Delhi,2000
2. Stoecker, W.F.and Jones,J.W.,Refrigeration and Air conditioning, McGraw Hill Book Publishing Co. Ltd., New York,1995
3. ASHRAE Equipment Handbook, The American Society of Heating, Refrigerating and Air-conditioning Engineers Inc., Atlanta, Georgia,2001
4. Randall Barron, Cryogenic Systems, McGraw Hill Book Publishing Co. Ltd., New York, 1966
5. Tim merhaus, K. D. and Flynn, T. M., Cryogenic Process Engineering, Plenum Press, New York,1989

MEE2 POWER PLANT ENGINEERING

Objectives:

- *Introduce the students to fundamentals of power generation using fossil fuels namely coal, gas and liquid*
- *Familiarizing with the power generation terminology and performance figures*
- *Power plant equipment for fuel handling, steam generation, feed water, combustion air and flue gas*
- *Emission control through equipment and process modification*
- *Estimation of power costs through the Economics involved in power plant construction and operation*

UNIT – I **(09hours)**

Power Scenario in India- Vapour power cycles - Rankine Cycle- Reheat cycle – Regenerative cycle – Reheat – regenerative cycle. Binary vapour cycle. Steam generators–modern high pressure generators-Accessories: Boiler Feed Pump, feed water heaters / economiser, air-pre heaters, Super heaters,

UNIT – II **(09hours)**

Air handling system: forced draught fans, primary and secondary air system for solid fuels – flue gas path; method of producing draught: natural, induced draughts – induced draught fans – flue gas treatment for pollution: particulate emissions and pollutants - cyclone separator, electro-static precipitator – chimney – calculation of chimneyheight-Bottomashhandlingsystem.Coolingtowers,Feedwatertreatment: de mineralised water, treatment processes: mechanical, chemical processes – Duration – fuel handling system: solid fuels – pulverized fuels, liquid and gaseous fuels –supply system.

UNIT – III **(09hours)**

steam nozzles – flow through nozzles – nozzle efficiency – Effect of super heating – supersaturated (or) metastable expansion of steam in a nozzle – steam turbines – classification – turbine blading - velocity diagrams – Compounding of impulse turbine Reaction turbine-Blade pro files of impulse and reaction turbines

UNIT – IV **(09hours)**

External combustion engines - Gas turbine plant cycle – classification – simple cycle– regenerative cycle – reheat cycle – regenerative – reheat cycle – inter-cooling. Combined cycles - Steam and gas turbine Power plants – cycle analysis - Nuclear fuels – coolants – moderators – radiation shield – Nuclear reactor - terminology: different types – Nuclear Power Plant Layout – Fuel requirements – Safety - Waste disposal – comparison with coal fired plant.

UNIT –V **(09hours)**

Fluctuating loads – terms and definitions, load curves, effect of variable load, methods to meet variable load – peak load plants: demand, requirements and load analysis. Power plant economics: Terminology - growth rates – capital costs – operating costs – system power cost – Estimation of power costs –CWIP, AFUDC, Escalation, Taxes, selection of type of generation and equipment, economic analysis of performance and operating characteristics, method so tariff for electrical energy.

Text Books:

1. W. Culp, Principles of Energy Conversion, Tata McGraw Hill, 2000.
2. P. K. Nag, Power Plant Engineering, Tata McGraw Hill, 2000.

Reference Books:

1. Frederick T. Morse, Power Plant Engineering, Affiliated East-west Press Ltd., 1953.
2. William A.Vapert, Power Station Engineering and Economy, Tata McGraw Hill, 1972.
3. M.D.Burghardt,EngineeringThermodynamicswithApplications,HarperRow, 1986
4. El Wakil MM, Power Plant Technology, McGraw-hill Publications,2002
5. P. K .Nag, Power Plant Engineering, Tata McGraw Hill, 2000.

Web Resources:

1. https://www.coursera.org/course/nuclearscience
2. http://nptel.ac.in/courses/103106101
3. http://ocw.mit.edu/courses/nuclear-engineering/22-312-engineering-of-nuclear-reactors-fall-2007

MEE 3 RENEWABLE ENERGY ENGINEERING

Objectives:

- *To impart knowledge on the following Topics ·*
- *Awareness about renewable Energy Sources and technologies.*
- *Adequate inputs on a variety of issues in harnessing renewable Energy.*
- *Recognize the current and possible future role of renewable energy sources.*

UNIT – I INTRODUCTION TO ENERGY STUDIES (09 hours)

Introduction, Energy science and Technology, Forms of Energy, Importance of Energy Consumption as Measure of Prosperity, Per Capita Energy Consumption, Roles and responsibility of Ministry of New and Renewable Energy Sources, Needs of renewable energy, Classification of Energy Resources, Conventional Energy Resources , Non-Conventional Energy Resources, World Energy Scenario, Indian Energy Scenario.

UNIT – II (09 hours)

Biomass energy- Introduction, Photosynthesis process, Biomass fuels, Biomass energy conversion technologies and applications, Urban waste to Energy Conversion, Biomass Gasification, Types and application of gasifier, Biomass to Ethanol Production, Biogas production from waste biomass, Types of biogas plants, Factors affecting biogas generation, Energy plantation, Environmental impacts and benefits, Future role of biomass, Biomass programs in India.

UNIT – III (09 hours)

Solar energy- Introduction, Solar Radiation, Sun path diagram, Basic Sun-Earth Angles, Solar Radiation Geometry and its relation, Measurement of Solar Radiation on horizontal and tilted surfaces, Principle of Conversion of Solar Radiation into Heat, Collectors, Collector efficiency, Selective surfaces, Solar Water Heating system, Solar Cookers, Solar driers, Solar Still, Solar Furnaces, Solar Greenhouse. Solar Photo voltaic, Solar Cell fundamentals, Characteristics, Classification, Construction of module, panel and array. Solar PV Systems (stand-alone and grid connected), Solar PV Applications. Government schemes and policies.

UNIT – IV (09 hours)

Wind Energy- Introduction, History of Wind Energy, Wind Energy Scenario of World and India. Basic principles of Wind Energy Conversion Systems (WECS), Types and Classification of WECS, Parts of WECS, Power, torque and speed characteristics, Electrical Power Output and Capacity Factor of WECS, Stand alone, grid connected and hybrid applications of WECS, Economics of wind energy utilization, Site selection criteria, Wind farm, Wind rose diagram.

UNIT – V **(09 hours)**

Hydropower: Introduction, Capacity and Potential, Small hydro, Environmental and social impacts. Tidal Energy: Introduction, Capacity and Potential, Principle of Tidal Power, Components of Tidal Power Plant, Classification of Tidal Power Plants. Ocean Thermal Energy: Introduction, Ocean Thermal Energy Conversion (OTEC), Principle of OTEC system, Methods of OTEC power generation. Geothermal Energy: Introduction, Capacity and Potential, Resources of geothermal energy.

Text Books:

1. Sukhatme. S.P., Solar Energy, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.
2. B. H. Khan, Non-Conventional Energy Resources, , The McGraw Hill
3. Twidell, J.W. & Weir, A. Renewable Energy Sources, EFN Spon Ltd., UK, 2006.
4. S. P. Sukhatme and J.K. Nayak, Solar Energy – Principles of Thermal Collection and Storage, Tata McGraw-Hill, New Delhi.
5. Garg, Prakash, Solar Energy, Fundamentals and Applications, Tata McGraw Hill.

References

1. Tiwari. G.N., Solar Energy–"Fundamentals Design, Modeling & Applications", Narosa Publishing House, New Delhi, 2002.
2. Freris. L.L., "Wind Energy Conversion Systems", Prentice Hall, UK, 1990.
3. Frank Krieth & John F Kreider , Principles of Solar Energy, John Wiley, New York

MEE 4 FINITE ELEMENT ANALYSIS

Objectives:

- *Teach students about variational method and weighted residue method.*
- *Illustratestudentsaboutelementshapefunctionsandnumericalintegration.*
- *Teach about a one dimensional FEA for second order and fourth order ODE.*
- *Teach about a two dimensional structural FEA for second order ODE.*
- *Teach about a two dimensional steady state heat transfer FEA for second order ODE.*

UNIT – I **(09 hours)**

Basic Concept of FEM, discretisation, comparison with finite difference method, advantages and disadvantages, history of development, application. Variational and Weighted Residual Formation : Boundary value problems, approximated methods of solution, review of variational calculus, geometric and natural boundary condition, method of Weighted residuals, Rayleigh Ritz and Galerk in methods of finite element formulations and convergence criteria, weak formulation - simple problems.

UNIT – II **(09 hours)**

Classification of C0, C1 continuous problems-Parameter functions, its properties- completeness and compatibility condition, One-dimensional elements, Global coordinates, Two-dimensional elements, three noded triangular elements and four noded quadrilateral elements. Natural co-ordinate systems –Lagrangian Interpolation Polynomials- Serendipity Formulation- Difference between Super parametric, Sub parametric and Iso parametric Elements, Iso paramatric Elements Formulation, length coordinates – 1Dbarelements, C0 continuous shape function, beam elements, C1 continuous shape function - 2D Triangular elements, Rectangular elements. – Area coordinates- Numerical integration – simple Problems using Gauss quadrature Technique.

UNIT – III **(09 hours)**

One dimensional second order equations, discretisation of domain into elements, derivation of element equations, assembly of element equation, imposition of boundary conditions, solution of equations - post processing, extension of fourth order equations and their solutions – examples from solid mechanics, heat transfer.

UNIT – IV **(09 hours)**

Basic Boundary Value Problems in 2 Dimensions – Introduction to Theory of Elasticity-Plane Stress – Plain Strain and Axisymmetric Formulation – Principle of virtual work – Weak Formulation – triangular, Quadrilateral elements - Element matrices using energy approach.-Simpleproblemsusingthreenodedtriangularelementsonly-Frontal Solution Method –Static condensation.

UNIT – V **(09 hours)**

Green-Gauss Theorem-Element equation formulation – Variational calculus approach- Galerk in approach-General Two-Dimensional Heat Conduction – Axisymmetric Heat conduction - Triangular, Quadrilateral elements-Simple problems using three noded triangular elements (generalized approaches only). Finite Element Analysis Software : Pre- and Post –Processors - General Requirements, Method of FE model generation- Graphical Output facilities – FEA software Packages, Recent trends – Error estimates and Adaptive Meshing.

Content beyond syllabus:

1. verifying the 1D, 2D thermal/structural problems using any FEA software package
2. Discussion about non-linear problems.

Text books:

1. FrankL. Stasa, Applied Finite Element Analysis for Engineers, CBS International, Edition, 1985.
2. J.N. Reddy, An Introduction to Finite Element Method, Mc Graw Hill International Edition, 2005.

Reference books:

1. Cook Robert Devisetal, Concepts and Application of finite Element Analysis, Wiley John & Sons,2002.
2. S.S. Rao, Finite Element Method in Engineering, Butterworth-Heinemann, 2005.
3. G.Buchaman, Schaum's Outline of finite Element Analysis, McGrawHill,1994

Web Reference:

1. http://nptel.iitm.ac.in/video.php?subjectId=112104115
2. http://solidmechanics.org/FEA.htm#Matlab

MEE 5 COMPUTATIONAL FLUID DYNAMICS

Objectives:

- *To study about the fundamentals of Fluid Flow.*
- *To know about various types of discretization.*
- *To study Finite difference methods (FDM), Finite element method (FEM), Finite volume method (FVM).*
- *To study the different types of grid generation.*
- *To study specialized techniques.*

UNIT – I INTRODUCTION (09 hours)

Basics of Computational Fluid Dynamics (CFD) – One dimensional computation: Finite difference methods (FDM) – Finite element method (FEM) – Finite volume method (FVM) – boundary conditions for FDM, FEM, and FVM. Governing equations: Classification of partial differential equations (PDE) – Navier- Stokes system of equations – boundary conditions.

UNIT – II FDM (09 hours)

Finite difference methods – Derivation of Finite Difference equation – Simple method- General method Higher order derivatives – Multi Dimensional Finite Difference Formulas – Mixes derivatives – Solution methods – Incompressible viscous flows - Artificial compressibility method – Pressure correction method. – Compressible viscous flows - Euler equations and Potential equations.

UNIT – III FEM (09 hours)

Finite element methods – Formulation – Finite element interpolation functions – Linear problems – Non-linear problems – Incompressible viscous flows – Compressible viscous flows – Finite volume methods through finite difference methods – Formulations of finite volume equations: Burgers' equations – Incompressible and compressible flows.

UNIT – IV GRID GENERATION (09 hours)

Structured grid generation: Algebraic methods – PDE mapping methods – Surface grid generation – Multi block structured grid generation. Unstructured grid generation: Delaunay-Voronoi methods (DVM) – Advancing front methods (AFM) – Combined DVM and AFM – Three dimensional applications. Adaptive methods: Structured and unstructured adaptive methods.

UNIT – V SPECIALIZED TECHNIQUES (09 hours)

Computing techniques: Domain decomposition methods – Multi grain methods – Parallel processing. Applications of CFD: Turbulence – combustion – acoustics – Heat transfer – Multiphase flows – Electromagnetic flows.

Text books:

1. Anderson, D.A., Tan nehill, J.C. and Pletcher, R.H.,- Computational Fluid Mechanics and
   Heat Transfer, Hemisphere Publishing Corporation, New York, 2011
2. Wendt, J.F.(Ed.), Verlag - Computational Fluid Dynamics–An Introduction, Springer,2012
3. Zienkiewicz, O.C .and & Morgan, K,-Finite Element and Approximation, John WileySons,2000..

Reference books

1. Reddy,J. N., - An Introduction to Finite Element Method, Mc GrawHill Book Co.,2005.
2. Gunz burger, M.D.,-Finite Element Method for Viscous Incompressible Flows, Academic Press Inc., New York,2005.

Web reference:

1. www.**cfd-online**.com https://twitter.com/**cfdonline** www.**cfd**.com.au/www.flow3d.com/home/resources/**cfd**https://eurobank.**cfdonline**trader .com/ www.**cfd**-software.org/www.**researchgate**.net/
2. **nptel.ac.in/ nptel**.iitk.ac.in/

MEE 6 DESIGN FOR MANUFACTURING AND ASSEMBLY

Objectives:

- *Select of material, manufacturing process and mechanism for a product.*
- *Design a component by considering the form design and machining.*
- *Design a component by considering machining process.*
- *Design a component based on casting considerations*
- *Design a eco-friendly product*

UNIT I INTRODUCTION:

General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances Geometric tolerances - Assembly limits -Datum features **(09hours)**

UNIT II FACTORS INFLUENCING FORM DESIGN:

Working principle, Material, Manufacture, Design- Possible solutions - Materials choice - Influence of materials on form design - form design of welded members, forgings and castings. **(09hours)**

UNIT III COMPONENT DESIGN - MACHINING CONSIDERATION:

Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area-simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability - Design for accessibility - Design for assembly – surface orientation- error free assembly **(09hours)**

UNIT IV COMPONENT DESIGN - CASTING CONSIDERATION:

Redesign of castings based on parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - Modifying the design - group technology - Computer Applications for DFMA **(09hours)**

UNIT V DESIGN FOR THE ENVIRONMENT:

Introduction – Environmental objectives – Global issues – Regional and local issues – Basic DFE methods – Design guide lines – Example application – Lifecycle assessment – Basic method – AT&T's environmentally responsible product assessment - Weighted sum assessment method – Lifecycle assessment method – Techniques to reduce environmental impact – Design to minimize material usage – Design for disassembly – Design for recyclability – Design for remanufacture – Design for energy efficiency – Design to regulation and standards **(09hours)**

TEXT BOOKS:

1. Geoffrey Dewhurst, Peter| Knight, Winston A. Boothroyd, “Product Design for Manufacture and Assembly (Manufacturing Engineering and Materials Processing)" CRC Press; Third edition, 14 Dec 2010.
2. Harry peck, "Design for Manufacture”, Pitman, 1973
3. Robert Matousek “Engineering Design” Springer; 1963

REFERENCES:

4. James Bralla, "Design for Manufacture handbook", McGraw hill, 1999.
5. O. Molloy and E.A. Warman "Design for Manufacturing and Assembly : Concepts, architectures and implementation", Springer, November 2012
6. Joseph Fiksel, "Design for the Environment", McGraw-Hill Professional; 2 edition, 2011

MEE 7 ADDITIVE MANUFACTURING

Objectives:

- *Identify the product design and development concept related with RPT*
- *Explain the functions and facilities involved in selective laser sintering*
- *Discuss the principle of fusion deposition modeling*
- *Explain the operation of laminated object manufacturing*
- *Understand and explain rapid tooling and RP software*

UNIT I INTRODUCTION:

Introduction: Need for time compression in product development, Product development – conceptual design – development – detail design – prototype – tooling. **(09hours)**

UNIT II STEREOLITHOGRAPHY SYSTEMS:

Principle, Process parameters, Process details, Data preparation, Data files and Machine details, Applications. Selective Laser Sintering - Types of machines, Principle of operation, Process parameters, Data preparation for SLS, Applications **(09hours)**

UNIT III FUSION DEPOSITION MODELING:

Principle, Process parameters, Path generation, Applications. Solid Ground Curing: Principle of operation, Machine details, Applications **(09hours)**

UNIT IV LAMINATED OBJECT MANUFACTURING:

Principle of operation, LOM materials, Process details, Applications. Concept Modelers - Principle, Thermo jet printer, Sander's model market, 3-D printer, Genisys Xs printer, JP system 5, Object Quadra System. Laser Engineered Net Shaping (Lens) – principle –applications **(09hours)**

UNIT V RAPID TOOLING AND SOFTWARE FOR RAPID PROTOTYPING:

Indirect Rapid Tooling - Silicone rubber tooling, Aluminum filled epoxy tooling, Spray metal tooling, etc. Direct Rapid Tooling - Direct AIM, Quick cast process, Copper polyamide, Rapid Tool, DMILS, Pro Metal, Sand casting tooling, Laminate tooling, soft tooling vs hard tooling. STL files, Overview of Solid view, Magics, mimics, magics communicator. Application of Rapid prototyping in Medical field **(09hours)**

TEXT BOOKS:

1. Pham. D. T. & Dimov. S. S., "Rapid Manufacturing", Verlag, London, 2001.
2. Fabrication Techniques for 3D MEMS", Wiley-Blackwell, 29 Jan 2001

REFERENCES:

1. Paul. F. Jacobs, "Stereo lithography and other RP & M Technologies", SME, NY, 1996.
2. Vijay K. Varadan, Xiaoning Jiang, V. V. Varadan, "Micro stereo lithography"
3. Terry Wohlers, "Wohlers Report 2006", Wohlers Associates, 2006

MEE 8 DIE, MOULD AND TOOL ENGINEERING

Objectives:

- *To understand the concepts of basic design of die and its process.*
- *To understand manufacturing techniques, such as Die, Moulding and design of machining tools.*
- *To understand the necessity, role in modern industries, working principles, constructional details and performance characteristics of Die, Moulding and tool design processes.*

UNIT-I

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. **(09hours)**

UNIT-II

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 –Sand Casting defects – Inspection methods. **(09hours)**

UNIT-III

Moulding of Thermoplastics – Working principles and typical applications of - Injection moulding – Plunger and screw machines – Compression moulding, Transfer moulding - Typical industrial applications – Introduction to Blow moulding – Rotational moulding – Film blowing – Extrusion - Thermoforming - Bonding of Thermoplastics. **(09hours)**

UNIT-IV

General principles of Machine Tool Design-Parameters defining working motions of a machine tool- Machine tool drives- mechanical and hydraulic transmission and its elements- engineering design process applied to machine tools. **(09hours)**

UNIT-V

Design of machine tool structures – design criteria for machine tool structures – materials for machine tool structures- design of beds, columns, housings, bases and tables, cross rails, arms, saddles and carriages, rams. **(09hours)**

Text Books

1. Hajra Choudhury S.K. and Hajra Choudhury A.K., "Element of Manufacturing Technology Vol. I", Media Publications, 2009.
2. Kalpakjian S., "Manufacturing Engineering and Technology", Pearson Education India Edition, 2006. Mehta NK - Machine Tool Design & Numerical Control, Tata McGraw Hill publisher New Delhi 2009

References

1. CMTI - Machine Tool Design Handbook, Tata McGraw Hill publisher New Delhi 2009
2. Basu SK & Pal DK - Design of Machine Tools, India Book House Pvt Ltd, New Delhi 2009
3. Yoram Koren & Joseph Ben-Uri - Numerical Control of Machine Tools, Khanna publishers, Delhi, 2005

MEE 9 AUTOMOBILE ENGINEERING

Objectives:

- *To explain the construction features of chassis systems.*
- *To analyze the various layouts by applying principles of mobility mechanics.*
- *To analyze the different configurations of IC engines by the principles of engine kinematics.*
- *To explain the transmission system of automobile*
- *To explain the Electrical system of automobile*

UNIT I

Classificationofvehicles–drives-generallayout.Engine-DieselandPetrolengines for automobiles - two stroke and four stroke engines - comparison of performance - factors affecting choice - power requirements of an automobile - rolling, wind and gradient resultant-factors affecting resistance and power requirement**.** **(09hours)**

UNIT – II

Power transmission system - requirement of transmission system – clutches - plate clutches – semi automatic & automatic clutches - Gear box: manual shift four speed and positive speed gear boxes - synchromesh devices -fluid transmission - fluid flywheel and torque converter-automatic transmission - drive line - differential, conventional and non-slip types –drive axle. **(09hours)**

UNIT – III

Suspension system – requirements - rigid axle and independent suspension - types of suspension - leaf spring - coil spring - torsion rod and air suspension - shock absorbers. Front axle : types – front wheel geometry - conditions for true rolling. Steering geometry - Ackerman and Davis steering - steering linkages - steering gear box-power and power assisted steering. Wheel alignment - Tyres: materials and types static and rolling properties of pneumatic tyres. **(09hours)**

UNIT – IV

Braking system-hydraulic braking systems-drum type and disc type brakes-power and power assisted brakes - factors affecting brake performance - tests on brakes - skid and skid prevention. Chassis - types of bodies - chassis frame - integral body – vehicle stability. **(09hours)**

UNIT – V

Battery: types - Chemical reaction – charging - battery rating - battery life - battery testing. Starting motor: constructional features and operation - series wound motor - drive arrangements: types, Ignition: types - ignition coil - contact breaker –distributor-firing order - spark plug. Generator - constructional features of D.C. generator and Alternator – Rectifier - Generator regulation - Automotive lighting - Electronics in automobile. **(09hours)**

Text Books:

1. W.H.Crouse, Automotive Mechanics, Tata McGraw Hill Publishing Co., 1995.
2. V.L.Maleev, Internal Combustion Engines, McGraw Hill, 1987.

Reference Books:

1. Newton Steeds & Garret, The Motor Vehicle.
2. Joseph Heitner, Automotive Mechanics, CBS Publishers & Distributors,1987.
3. R.B. Gupta, Automobile Engineering, Satya Prakashan, New Delhi,1997.
4. R.B. Gupta., Auto Design, Satya Prakashan, New Delhi,1995.

MEE 10 AEROSPACE ENGINEERING

Objectives:

- *To understand the basic principles of aerodynamics and aircraft performance.*
- *To analyze and evaluate different aircraft structures and materials.*
- *To comprehend the functioning of propulsion systems used in aerospace vehicles.*
- *Can gain knowledge of space systems, including satellites and launch vehicles.*

UNIT-I

Introduction to Aerospace Engineering- Definition and scope of aerospace engineering - Historical overview of aerospace advancements- Current trends and challenges in the aerospace industry (09hours)

UNIT-II

Aerodynamics- Properties of fluids and gas laws-Bernoulli's principle and its applications-Airfoils and wings- Lift, drag, and aircraft performance (09hours)

UNIT-III

Aircraft Structures- Structural components of an aircraft- Types of materials used in aerospace structures-Stress and strain analysis-Failure modes and safety considerations (09hours)

UNIT-IV

Propulsion Systems- Overview of different propulsion systems (jet engines, rocket engines)-Thermodynamics of propulsion- Engine performance parameters-Propulsion system selection criteria (09hours)

UNIT-V

Introduction to Space Systems-Basics of space exploration-Overview of satellites and their applications-Launch vehicles and space propulsion (09hours)

Textbooks

1. Fundamentals of Aerospace Engineering: (Beginner's Guide) by Francisco Gallardo Lopez
2. Fundamentals of Aerospace Engineering: An Introductory Course to Aeronautical Engineering by Manuel Soler

References

1. Introduction to Aircraft Performance, Selection and Design by Francis J Hale
2. Fundamentals of Aerospace Engineering : An Introductory Course to Aeronautical Engineering by Manuel Soler

MEE 11 AGRICULTURAL ENGINEERING

Objectives:

- *To develop a comprehensive understanding of advanced topics in agricultural engineering.*
- *To explore emerging technologies and trends in agricultural engineering.*
- *To analyze and evaluate advanced machinery and equipment used in agriculture.*
- *To assess the impact of agricultural engineering on sustainable farming practices.*
- *To enhance problem-solving and critical thinking skills in the context of agricultural engineering.*

UNIT-I

Farm Machinery Management- Machinery selection, operation, and maintenance-Energy use in agricultural machinery-Machinery safety and regulations-Economic analysis and optimization of machinery use (09hours)

UNIT-II

Post-Harvest Engineering-Principles of post-harvest handling and storage-Drying and preservation techniques for agricultural products-Design and management of post-harvest facilities-Quality assessment and value-added processing (09hours)

UNIT-III

Irrigation and Drainage Systems-Principles of irrigation and drainage engineering-Design and operation of irrigation systems-Water management and conservation strategies-Drainage systems and environmental considerations (09hours)

UNIT-IV

Renewable Energy in Agriculture-Solar energy applications in agriculture-Wind energy systems for farm operations-Biomass and bio energy technologies-Energy-efficient practices in agricultural operations (09hours)

UNITV

Agricultural Automation and Robotics- Automation in agricultural processes- Robotics for field operations and crop monitoring-Sensor technologies and data analysis- Autonomous vehicles and drones in agriculture (09hours)

Text books

1. Principles of Agricultural Engineering (Vol.-1) by A.M. Michael T.P. Ojha
2. Agricultural Engineering And Feeding The Future by Anne Rooney
3. Fundamentals Of Agriculture (Vol. 1-2) by R.L. Arya

References

1. Farm Machinery an Approach by S.C.Jain
2. Principles of Farm Machinery by KEPNER R.A.

Web references

1. https://nptel.ac.in/courses/126105009

MEE 12 BIOMEDICAL ENGINEERING

Objectives:

- *To provides an introduction to the field of Biomedical Engineering, covering the fundamental principles and applications of biomedical engineering techniques and technologies.*
- *To familiarize students with the interdisciplinary nature of biomedical engineering and its role in healthcare.*

UNIT-I

Introduction to Biomedical Engineering-Definition and scope of Biomedical Engineering-Historical overview of the field-Interdisciplinary nature of Biomedical Engineering
Human Anatomy and Physiology-Overview of human organ systems-Basic concepts in physiology relevant to biomedical engineering (09hours)

UNIT-II

Medical Imaging - Principles of medical imaging techniques (X-ray, CT, MRI, ultrasound, etc.) - Image acquisition, processing, and analysis (09hours)

UNIT-III

Biomechanics-Introduction to biomechanics and its relevance in healthcare-Analysis of forces and mechanics in biological systems-Applications in prosthetics, orthopedics, and rehabilitation Biomaterials-Introduction to biomaterials and their properties-Biocompatibility and tissue engineering-Applications of biomaterials in medical devices and implants (09hours)

UNIT-IV

Biosensors and Bioinstrumentation-Principles of biosensors and bioinstrumentation-Sensors and transducers for medical applications-Measurement techniques in biomedical engineering (09hours)

UNIT-V

Medical Device Design and Development- Design process and regulatory considerations-Human factors engineering and usability testing Ethical and Regulatory Issues in Biomedical Engineering-Ethical considerations in healthcare technology (09hours)

Text books

1. Biomedical Engineering by Metin Akay
2. Biomedical Engineering and Design Handbook by Myer Kutz

References

1. Encyclopedia of Biomaterials and Biomedical Engineering by Gary L. Bowlin
2. Encyclopedia of Medical Devices and Instrumentation by John G. Webster.

Web references

1. https://onlinecourses.nptel.ac.in/noc21_bt30/preview
2. https://onlinecourses.nptel.ac.in/noc21_bt50/preview

MEE 13 FOOD TECHNOLOGY

Objectives:

- *To provides an introduction to the field of food technology, principles followed in food preservation and processing.*
- *To familiarize students with the interdisciplinary nature of Food technology and its role in mechanical engineering*

UNIT-I

Introduction to food technology-Food processing technology – definition, need, scope, scenario and status of food processing at national and global level. Fruits and vegetables –changes during cooking – effect of acid and alkali on cooking. Deterioration factors and their control– enzymatic, chemical, physical and biological causes and types of food spoilage.

(09hours)

UNIT-II

Principles and methods of food preservation by temperature: Thermal processing– pasteurization, sterilization, blanching and canning process. General consideration in establishing commercial fruits and vegetable cannery unit. Preservation by use of low temperature – principles and procedures involved – equipment required. (09hours)

UNIT-III

Technical methods of reducing food deterioration - principles and procedure in reduction of moisture-rying and dehydration, method sand types of driers. Reduction of moisture by concentration–principles and equipments required. Preservation by chemical reagents and osmosis. Preservation by irradiation - principle, methods and equipment required – advantages and disadvantages. (09hours)

UNIT-IV

Food additives - classification and role of preservatives, antioxidants, chelating agents, flour improvers, artificial sweeteners, flavours, colours, stabilizers, emulsifiers, firming agent, leavening and clarifying agent. Food fortification and enrichment-application in foods. Food Laws and Standards. (09hours)

UNIT-V

Preservation by fermentation - principle, methods and equipment required. Principles of hurdle technology –shelf stable foods. Non thermal preservation technology – pulse electric field, ultraviolet and ionizing radiation, high pressure processing and microwave processing.

(09hours)

Textbook

1. Srivastava, R.P. and Sanjeev Kumar. 2002. Fruit and Vegetable Preservation: Principles and Practices. International Book Distributing Company.
2. Norman W. Desroiser. 1977. Elements of Food Technology. AVI Publishing Company.
3. Kalia, M. and Sood, S. (2010). Food Preservation and Processing. Revised Edition, Kalyani Publishers, New Delhi.

References:

4. Jood, S. and Khetar paul, N. (2002). Food Preservation. Geeta Somani Agrotech Publishing Academy, Udaipur.
5. Srilakshmi, B. 2018. Food Science. New Age International (P) Limited Publishers, New Delhi.
6. Journal of Food Science and Technology

MEE 14 MARINE ENGINEERING

Objectives:

- *To impart knowledge in basic concept of marine engineering.*
- *To grasp the concepts of working of engines, ventilation, air-conditioning, refrigeration and about boilers.*

UNIT-I

Marine Diesel Engines – Low speed and medium speed engines – Auxiliary engines – Scavenging and supercharging systems – Starting and reversing gear – Maintenance – Autom ation – Hazards in engine room. (9hours)

UNIT-II

Marine Turbines – Steam turbine Classification based on impulse and reaction principles – Fl ow thro' blade passages and design – Losses and performance- Compounding, velocity triangles- Starting and Maintenance procedures. Marine gas turbines –Practical cycles and shaft arrangements-Power turbine – Applications. (9hours)

UNIT-III

arine Refrigeration Cycles Compressors, Condensers, Evaporators and thermostatic valves – S pace coolers – Maintenance and Auxiliary equipment. (9hours)

UNIT-IV

Marine Airconditioning cooling, Heating, Humidication process Types of Air conditioning s ystems Ducting controls.Ventilation Requirements and provision Insulation protection of m aterials and maintenance. (9hours)

UNIT-V

Marine Boilers – Composite and water tube boilers –Waste heat boilers Arrangement of boiler room – Feed water treatment for Marine boilers –feed supply systems and control. (9hours)

Text Books:

1. Marine Power plant Engineering - Akimov.P
2. Marine I.C Engines-A.B Kane
3. Principles and practice of Marine Diesel Engines – D.K Sanyal

References

1. Refrigeration and air conditioning, P.L. Ballaney
2. Marine Steam Boilers, Milton J.H.

MEE 15 NUCLEAR ENGINEERING

Objectives:

- *To study Radioactivity concept with Mechanical Applications.*
- *To understand the concept of Nuclear reaction.*
- *To study the Neutron flux and Diffusion theory.*
- *To understand the principle of Thermal reactors.*
- *To understand the concept of Thermal design of reactor.*

UNIT – I

Radioactivity – nuclear reactions – binding energy – neutron interaction – cross sections – fission – power from fission – fission chain reactions – criticality – conversion and breeding – nuclear fuel performance. (9hours)

UNIT – II

Nuclear power reactors – nuclear fuel cycles – fuel enrichment – fuel assembly –fuel reprocessing – decommissioning of power plants – radioactive waste disposal and its management. (9hours)

UNIT – III

Neutron flux – diffusion theory applicaions – ficks law – solution to diffusion equation for point source – plannar source and bare slab – diffusion length – energy loss in scattering collisions– moderators. (9hours)

UNIT – IV

One group reactor equation – one group criticality equation – thermal reactors – criticality calculations – homogeneous and heterogeneous reactors – reactor kinetics and safety – prompt neutron life time – reactor with and without delayed neutrons – prompt criticality – control rods– principles of nuclear reactor safety. (9 hours)

UNIT – V

Heat generation in reactors – thermal constraints – heat transfer to coolants – thermal design of reactor. (9hours)

Reference books:

1. Lamarsh,J.R., Introduction to Nuclear Engineering, Addison-Wesley, New York,1983.
2. Marshall,W., Nuclear Power Technology -Vol.I,II&III, Clarendon Press, Oxford,1985.
3. Samuel Glasstone, Principle of Nuclear Reactor Engineering, Van No strand Reinhold Co., NewYork,1963.
4. Culp, Archie W., Principles of Energy Conversion ,McGrawHillBookCo.,1991

Web reference:

1. en.wikipedia.org/wiki/**Nuclear_engineering**web.mit.edu/nse/
2. www.iitk.ac.in/netwww.nuc.berkeley.edu/www.engr.utk.edu/**nuclear**www.ne.ncsu.edu
3. www.engr.wisc.edu/ep/ep-research-priorities-**nuclear-engineering**.htmlwww.sciencebuddies.org
4. www.ans.org/StudyGuide
5. **nuclear**.mst.edu/
6. www.bls.gov/ooh/architecture-and-**engineering**/**nuclear-engineers**.htmwww.journals.elsevier.com/**nuclear-engineering**-and-design/ www3.imperial.ac.uk/**nuclearengineering**/courses/msc www.nuceng.ufl.edu/
7. www.ans.org/StudyGuide
8. www.**nptel**.ac.in/courses

MEE 16 TEXTILE ENGINEERING

Objectives:

- *To understand the basic concepts and terminology used in textile engineering.*
- *To describe the properties and characteristics of different textile fibers.*
- *To identify various yarn structures and their properties.*
- *To explain the principles and techniques involved in textile manufacturing processes.*

UNIT-I

Introduction to Textile Engineering-Definition and scope of textile engineering-Historical development of the textile industry-Overview of the textile value chain. Textile Fibers-Classification of fibers (natural, synthetic, and regenerated)-Fiber properties (physical, chemical, and mechanical) (9hours)

UNIT-II

Yarn Formation- Yarn manufacturing methods (spinning, twisting, and filament production)-Types of spinning systems (ring spinning, rotor spinning, and others)-Yarn properties and characteristics Fabric Structures-Weaving, knitting, and nonwoven fabric structures-Fabric geometry and terminology (9hours)

UNIT-III

Textile Manufacturing Processes-Preparatory processes (winding, warping, and sizing)-Weaving, knitting, and nonwoven manufacturing techniques-Dyeing and printing methods-Finishing processes (bleaching, dyeing, and coating). (9hours)

UNIT-IV

Textile Testing and Quality Control-Testing methods for fiber, yarn, and fabric properties-Physical and chemical testing techniques-Quality control measures in textile production-Standards and regulations in textile testing. (9hours)

UNIT-V

Emerging Trends in Textile Engineering-Sustainable textile engineering practices-Nanotechnology applications in textiles - Smart textiles and wearable technology-Advanced manufacturing techniques in textiles. (9hours)

Text books

1. Textbook of Fabric Science: Fundamentals to Finishing by Seema Sekhri
2. Principles of Textile Testing by Booth J.E.
3. Textile Yarns: Technology, Structure, and Applications by B.C. Goswami and J.G. Martindale

Reference

1. Textiles – A Handbook for Designers Rev by Marypaul Yates
2. Handbook of Textile Design by Wilson, J
3. Textiles: Fiber to Fabric by Bernard P. Corbman

E Learning Resources :

1. **https://archive.nptel.ac.in/courses/116/102/116102029/**

MEE 17 WELDING TECHNOLOGY

Objectives:

- *To impart knowledge on basic concepts and process mechanisms of welding Processes.*
- *To understand the metallurgical concepts and applications welding process.*

UNIT – I

Introduction to different types of welding – Welding Symbols – Weld Joint selection – Preparation of weld Joints – Welding Metallurgy – Structure of Welded metals. Gas Welding Theory of ionization of Gas Welding Systems – Ferrous and Non – Ferrous Welding, Gas Cutting–Safety Precautions–Applications. (09hours)

UNIT – II

Arc Welding : Introduction – Electrodes , Transfer of Metal from electrode- Power Supplies , Operation - Carbon Arc Welding, Metal Arc Welding, Gas Shield Arc Welding and Submerged Arc Welding Process – Arc Cutting Process – Applications. (09hours)

UNIT – III

Plasma Arc welding – Electro gas and Electro slag Welding – Solid State Bonding. Electron Beam Welding – Laser Welding – Thermit Welding – Metal Flame Spraying. Introduction to Under water Welding - Applications. (09hours)

UNIT – IV

Resistance Welding: Types, Process, Applications. Welding of Plastics: Ultrasonic – Friction – Hot plate – Hot gas – High Frequency Welding of Plastics, Welding of plastic Pipes and other Applications. (09hours)

UNIT – V

Testing of Welds: Introduction to Testing and Inspection of Welds – Destructive and Non Destructive Tests – Advantages and Limitations. Distortion in welds – Prevention. (09hours)

Text Books:

1. Little, Principles of Welding Technology, Tata McGraw Hill, 1985.
2. Parmer R.S., Welding Engineering and Technology, KhannaPublishers,2002

Reference Books:

1. P.T. Hould Croft, Welding Process Technology, Cambridge University Press, 1983.
2. L.Carl Love, Welding Procedures and Applications, Prentice Hall Inc., 1993.
3. M.N. Watson, Joining Plastics in Production, Welding Institute, Cambridge, 1990.
4. ASM Handbook vol.6, welding Brazing & Soldering,2003

MEE 18 INDUSTRIAL CASTING TECHNOLOGY

Objectives:

- *To acquaint the student interested in the production of metal castings, with the essential techniques required for the production of castings in ferrous/non-ferrous metals and plastics, from basic pattern making to moulding and metal pouring.*
- *To understand the factors affecting the casting process as a production method, and how to improve the products quality and reduce production cost.*

UNIT- I

Patterns and Moulding Sands: Introduction to casting - pattern making – requirements, pattern materials, machines and tools for pattern making – pattern allowances - metal and consumable type of patterns-life expectancy, storage and repair of patterns - mouldings and sand conditioning – testing of mouldings and scores – types of cores - core sands and core making - machine moulding. (9hours)

UNIT- II

Melting equipment for foundries – crucible furnace – open hearth furnace – air furnace – rotary furnace – cupola furnace – electric furnaces – refractories for melting units - metallurgical characteristics of cast metals – Solidification of metals. (9hours)

UNIT- III

Gating and Risering of castings–gating systems–different types of gates– calculation of gating system dimensions – risering of castings-open and blind risers- design and positioning of risers – directional solidification – methods to achieve directional solidification-form design of castings. (9 hours)

UNIT- IV

Moulding Processes : special sand moulding processes - Permanent mould casting – Pressure die casting – Low pressure die casting – Squeeze casting – Centrifugal casting – continuous casting – Electro slag casting – Vacuum moulding process - plastic moulding processes : compression moulding, transfer moulding, injection moulding, extrusion and blow moulding. (9hours)

UNIT-V

Cleaning and inspection – Fettling and repair of castings - Heat treatment of castings, Defects in castings, Inspection and testing of castings – Pollution control in foundries – Plant layout for foundries –Areas of mechanization. (9hours)

Text Books :

1. P.L. Jain, Principles of Foundry Technology, Tata McGraw Hill, 5th Edition,2009.
2. O.P. Khanna, Foundry Technology, Dhanpat Rai Publications,2011
3. Sero be Kalpa kjian and Steven R.Schmid, Manufacturing Engineering &Technology, Pearson Education Asia, 7th Edition, 2013 (For Plastic Moulding Processes only)

Reference Books :

1. Richard W.Heineetal .-Principles of Metal Casting, TataM cGraw Hill Edition, 2013.
2. T.V. Ramana Rao, Metal Casting: Principles and Practice, New Age International, 2010.

Web references

1. www.nptel.ac.in
2. Peter Beeley, Foundry Technology, Elsevier, Second Edition,2001.
3. John Campbell, Complete Casting Handbook: Metal Casting Processes, Metallurgy, Techniques and Design, Elsevier, 1st Edition,2011.

MEE 19 HYDRAULICS AND PNEUMATICS

Objectives:

- *To provide student with knowledge on the application of fluid power in process, construction and manufacturing Industries.*
- *To provide students with an understanding of the fluids and components utilized in modern industrial fluid power system.*
- *To develop a measurable degree of competence in the design, construction and operation of fluid power circuits.*
- *Understand how PLCs are interfaced and used to control pneumatic systems.*

UNIT I INTRODUCTION:

Need for Automation, Hydraulic, pneumatic – Properties of hydraulic fluids – General types of fluids – Applications of Pascal's Law- Properties of air Kinetic theory of gases – Boyle's Law - Laminar and Turbulent flow – Reynold's number Selection criteria. (09hours)

UNIT II FLUID POWER GENERATING / UTILIZING ELEMENTS:

Hydraulic pumps and motor gears, vane, piston pumps and motors -motors-selection and specification- pump performance – Variable displacement pumps. Drive characteristics – Compressors – Filter, Regulator, Lubricator Unit – Air control valves -Linear actuator – Single acting, Double acting special cylinders like tandeem, Rodless, Telescopic, Cushioning mechanism, Construction of double acting cylinder, Limited rotation motor, mounting details, power packs – construction. Reservoir, accumulators – standard circuit symbols. (09hours)

UNIT III CONTROL AND REGULATION ELEMENTS:

Direction flow and pressure control valves- Directional control valve – 3/2 way valve – 4/2 way valve – 5/2 way valve . Shuttle valve – check valve. Pressure control valve – Simple and compound relief valve, pressure reducing valve, sequence valve, counter balance valve. Flow control valve Fixed and adjustable. Methods of actuation, electro hydraulic servo valves - Different types- characteristics and performance. (09hours)

UNIT IV HYDRAULIC PNEUMATIC CIRCUIT DESIGN:

Regenerative circuit, Pump unloading circuit, Counter balance valve application circuit , sequence valve application circuit, Speed control circuits, synchronizing circuit, Accumulator circuits, hydro-pneumatic circuits, Fail safe circuit, Sequential circuit design for simple applications using cascade method, step counter method. (09hours)

UNIT V RELAY, PLC & SCADA:

Relay logic - Electrical control of pneumatic and hydraulic circuits-use of relays, Ladder logic-Ladder diagram using internal relay, timers, and counters. Programmable logic control of Hydraulics Pneumatics circuits, PLC wiring diagram for various circuits. SCADA-Pneumatic control applications in machine tool and other mechanical fields – Maintenance

(09hours)

TEXT BOOK

1. Anthony Esposito, Fluid Power with Applications, Prentice-Hall, March 17, 2016.
2. Andrew Parr, Hydraulics and Pneumatics: A technician's and engineer's guide [Kindle Edition].
3. W.Bolton, Mechatronics, Electronic control systems in Mechanical and Electrical Engineering Pearson Education, 2011.

REFERENCES

1. James L. Johnson **"Introduction to Fluid Power**" Delmar Thomson Learning Publishers 2003.CMTI Handbook .
2. Peter croser, Frankabel, **Pneumatics, Basic level** ,Festo Manual, Edition 10/2002. https://nptel.ac.in/courses/112105046/

MEE 20 METAL FORMING PROCESSES

Objectives:

- *To impart knowledge on plasticity, surface treatment for forming of various types of metal forming process.*
- *To understand the basic concepts of metal forming techniques and to develop force calculation in metal forming process.*

UNIT – I

Classification of forming processes – flow curves and their significance in forming – Effect of temperature, speed and metallurgical structure on forming processes – Effect of friction on forming processes. Basic concepts of yield criteria – types. (9 hours)

UNIT – II

Classifications of forging processes - Forging equipment – forging die design procedure for simple products – forging defects – determination of forging load – concept of P/M forging– Applications. (9hours)

UNIT – III

Rolling mills – Estimation of rolling load and power – rolling defects – Applications. Direct extrusion equipment – hydrostatic extrusion-extrusion of tubes – Determination of extrusion stress-extrusion defects–Applications. (9hours)

UNIT – IV

Drawing of rods, wires and tubes - Determination of drawing loads through conical dies, sheet metal forming: Shearing, blanking, bending, punching, piercing, stretch forming, deep drawing, rubber pad forming–Applications. (9hours)

UNIT – V

High rate energy forming processes: Introduction - Effect on mechanical properties and microstructures–Explosive forming, Electro hydraulic forming–Electromagnetic forming, Water hammer forming. (9hours)

Text Books:

1. Dieter, Mechanical Metallurgy, Mc Graw-Publishing Co., NewYork, 2002.
2. P.C. Sharma, Production Engineering, S.Chand &Co. NewDelhi, 2008.
3. Serope Kalpakjian, Steven R Schmid, “Manufacturing Process for Engineering Materials” Pearson Education, 4th Edition,2003.

Reference Books:

1. G.W.Rowe, An Introduction to the Principles of Metal Working", Edward, Arnold Publications,1973.
2. Gyril Donaldson, Tool Design, Tata McGraw Hill Publishing Co. Ltd.,1989.
3. Altan T., Metal forming – Fundamentals and applications – American Society of Metals, Metals park,2003.

E-learning source:

1. **www.nptel.ac.in**
2. **www.sciencedirect.com**

MEE 21 COMPOSITE MATERIALS

Objectives:

- *To learn the fundamental knowledge on composites materials and their unique properties.*
- *To be able to fabricate fiber reinforced, polymer composite products using a variety of processes and to know how variables affect the processing and product performance.*
- *To be able to use rework and repair methods common to the fabrication of composite products.*
- *Tobeabletosynthesisanewadvancedcompositeindigenouslybyindividual student.*
- *To acquire knowledge on latest green composites.*

UNIT - I

Definition – Need – General Characteristics , Matrices – Polymer, Metal, Carbon and Ceramic Matrices, Reinforcement – Types – fibers, whiskers and particles, Reinforcement materials, Selection, advantages and limitations. (9hours)

UNIT - II

Polymer Matrix Composites – Matrix Resins – Thermosetting resins, Thermoplastic resins, Polyacryl ethers(PAE),Thermoplastic Polyimides (TPI), Polyacrylene Sulfide, Molecularly ordered liquid Crystals (MOLC), Polyblends Alloys, Fibers and Laminar Composites.(9hours)

UNIT - III

Metal Matrix Composites – Matrix selection, Reinforcement and reinforcement selection, Matrix reinforcement interface, Interaction zone, Interface bond strength. (9 hours)

UNIT - IV

Polymer Matrix Production Methods – Bag Moulding, Compression Moulding, Pultrusion, Filament Winding, Metal Matrix Composites - Fabrication methods – Solid State Techniques and Liquid State Techniques. (9hours)

UNIT - V

Micro mechanics and macro mechanics of composites, monotonic strength and fracture, Fatigue and Creep , Applications of composites, Green composites and Nano composites.

(9hours)

Reference books:

1. Krishan Chawla,K.- Composite Materials: Science and Engineering, Springer,2001.
2. F.L .Mathews and Rawlings, R.D. - Composite Materials - Engineering and Science, CRC Press,2002.
3. Sanjay K.Mazumdar - Composites Manufacturing: Materials, Product and Process Engineering, CRC Press,2002.

E-learning source:

1. **www.nptel.ac.in**
2. **www.sciencedirect.com**

MEE 22 BIO FUELS

Objectives:

The course provides an understanding of the processes for converting biomass to fuels by various approaches. In addition, develops potential to evaluate technical and economical feasibility & sustainability of energy production from biomass.

UNIT I

Biomass Energy Potential: Indian and global scenario, Life Cycle Analysis, Sustainability Criteria of Bio fuels and Biomass Thermo-chemical conversions Thermal Decomposition Mechanisms of Bio-Renewable: Direct Combustion, Technology of Biomass gasification, Pyrolysis , Hydrothermal Liquefaction of Bio-renewable Feed stocks, Direct Liquefaction Chemical Conversion Hydrolysis and hydrogenation, Solvent extraction of hydrocarbons, Solvolysis of wood, Chemicals from biomass (09hours)

UNIT II

Bio- Energy Systems Biomass Gasifiers: Principle, Design of Bio mass Gasifiers, updraft gasifier, downdraft gasifier, zero carbon biomass gasification plants, applications for cooking, electricity generation, Gasifier Engines, Operation of spark ignition and compression ignition engine with wood gas, methanol, ethanol and biogas, Biomass integrated gasification/combined cycles systems. (09hours)

UNIT III

Bio-ethanol Bio-ethanol feed stocks, Fuel Properties of ethanol, Ethanol from Biomass, Bio-ethanol production by fermentation of Carbohydrates (09hours)

UNIT IV

Bio-diesel Production methods of Bio-diesel: Fuel quality, standards and Properties, Availability of Raw materials for bio-diesel, Applications, Bio-diesel potential in India (09hours)

UNIT V

Energy from Algae Cultivation, Photo-bioreactors, Harvesting, Sewage and Waste water growth conditions, algae biomass, algal meal/cake, Integration of CO2 emitting industries for growth of Algae, Other applications of Algae: food, pigment etc (09hours)

Textbooks

1. Bio-fuels: biotechnology, chemistry, and sustainable development by DM Mousdale, CRC Press.
2. Renewable Energy by B Sorensen, Academic press, New York.

References

1. Renewable energy: Power for a sustainable future by G Boyle (Ed), Oxford, GROUP.

MEE 23 ORGANIZATIONAL BEHAVIORS AND INDUSTRIAL ENGG

Objectives:

- *To equip the students with the tools necessary to understanding the dynamics of individual and group behavior for efficient and effective utilization of human resources in the organizations.*
- *to help the students to be able to understand and analyze the individual needs, feelings, aspirations*
- *To develop skills needed to plan for the implementation of change in an organization; •identify and develop effective motivational and leadership skills.*

UNIT-I INTRODUCTION :

Concept of Organizational Behavior (OB): Management roles, skills and activities: Disciplines that contribute to OB; Opportunities for OB (Globalization, Indian workforce diversity, customer service, innovation and change, networked organizations, work-life balance, people skills, positive work environment, ethies) (09hours)

UNIT-II INDIVIDUAL BEHAVIOUR:

1. Learning, attitude and Job satisfaction: Concept of learning, conditioning, shaping and reinforcement. Concept of attitude, components, behavior and attitude. Job satisfaction: causation; impact of satisfied employees on workplace.

Motivation : Concept; Theories (Hierarchy of needs, X and Y, Two factor, McClelland, Goal setting, Self-efficacy, Equity theory); Job characteristics model; Redesigning job and work arrangements; Employee involvement; Flexible benefits, Personality and Values : Concept of personality; Myers-Briggs Type Indicator (MBTI); Big Five model. Relevance of values; Indian values; Linking personality and values to the workplace (person-job fit, person-organization fit) (09hours)

UNIT-III GROUP BEHAVIOUR :

1. Groups and Work Teams : Concept : Five Stage model of group development; Group think and shift ; Indian perspective on group norms. Group and teams; Types of teams; Creating team players from individuals bulding and team based work(TBW) 2. Leadership : Concept; Trait theories; Behavioral theories (Ohio and Michigan studies); Contingency theories (Fiedler, Hersey and Blanchard, Path-Goal); Authentic leadership; Mentoring, self-leadership, online leadership: Inspirational Approaches (transformational, charismatic): Comparison of Indian leadership styles with other countries. Exercises, games and role plays may be conducted to develop team and leadership skills. (09hours)

UNIT-IV ORGANISATIONAL CULTURE AND STRUCTURE :

Concept of culture; Impact (functions and liability); Creating and sustaining culture: Employees and culture: Creating positive and ethical cultures, Concept of structure, Prevalent organizational designs: New design options. (09hours)

UNIT-V ORGANISATIONAL CHANGE, CONFLICT AND POWER:

Forces of change; Planned change; Resistance; Approaches (Lewin's model, Organisational development); Learning organization; Organisational change in Indian businesses. Concept of conflict; Traditional view and interactionists view of conflict; Conflict process; Functional/ Dysfunctional. Introduction to power and politics. (09hours)

Textbook

1. Organizational Behaviour by Stephen P. Robbinsa
2. Classics of Organizational Behavior by Walter E. Natemeyer

Reference books

1. Organizational Behavior by Cary L. Cooper (Editor); Stewart R.
2. The SAGE Encyclopedia of Industrial and Organizational Psychology by Steven G. Rogelberg

MEE 24 TOTAL QUALITY MANAGEMENT

Objectives:

To introduce students with the TQM concepts, techniques and various process analysis tools, international standards, and expose students to organizational TQM implementation techniques and continuous quality improvement.

Unit I :
Introduction to TQM – Strategies concepts and objectives – Total quality model – TQM as applied to Indian Industries – Quality circle concepts – concepts, objectives and functions of quality circles – Benefits of the organization – Training of quality Circle members– Implementation. (9hours)

Unit II :
Tools and Techniques – The seven management tools - Technique for analyzing a quality process – Statistical process Control (9 hours)

Unit III :
Cost of quality – Taguchi's quality loss function – House keeping concepts for industries, tool room, production shop – processing industries. (9 hours)

Unit IV :
Quality based product and process Design – Design for reliability – Design for maintainability – Quality Function Deployment (QFD) – QFD and Quality Assurance – QFD Principles, Concepts and applications – case studies. (9 hours)

Unit V :
Introduction to SQC concepts- KAIZEN Concepts – Kaizen by TQC – POKA YOKE - IS 9000-QS9000,14000 concepts- certification system – 9001 to 9004 systems – procedures, audits and reviews – Lean manufacturing systems- Toyota production concepts-case studies.
(9hours)

Text Books :

1. Dale H. Besterfiled, et al. - Total Quality Management, Pearson Education Asia, 3rd Edition,2006.
2. P.N. Mukherjee – Total Quality Management, Prentice Hall of India Ltd., New Delhi, 2006.
3. James R Evans and William M Lindsay – Quality Control and Management, Centage Learning India Pvt. Ltd., New Delhi,2008.

Reference Books :

1. S.M. Sundara Raja - Total Quality Management, Tata Mc Graw Hill, 1998.
2. Patrick. J.Sweeney (Editor)-TQM for Engineering, Quality Resources, New York, 1993.
3. John Bank-The Essence of Total Quality Management, Prentice Hall of India, 1998.
4. James I Bossert- Quality Function Deployment, ASQC Quality Press, Wisconsin,1994.
5. Kanishka Bedi–Quality Management, Oxford UniversityPress,8th Impression, 2011.
6. Poornima M Charantimath – Total Quality Management, First Indian Print, 2003.

E Learning Resources :

1. www.nptel.ac.in

MEE 25 LEAN MANUFCATURING

Objectives:

- *To study the various tools of Lean Manufacturing like JIT, KANBAN etc.*
- *To apply the above tools to implement LM system in an organization*.

UNIT I

Introduction To Lean Manufacturing -Conventional Manufacturing versus Lean Manufacturing – Principles of Lean Manufacturing – Basic elements of lean manufacturing – Introduction to LM Tools. (09hours)

UNIT II

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. (09hours)

UNIT III

Set up time reduction – Definition, philosophies and reduction approaches. TQM – Principles and implementation. 5S Principles and implementation - Value stream mapping – Procedure and principles. (09hours)

UNIT IV

Six Sigma – Definition, statistical considerations, variability reduction, design of experiments – Six Sigma implementation (09hours)

UNIT V

Various case studies of implementation of lean manufacturing at industries. (09hours)

Text books

1. Design and Analysis of Lean Production Systems, Ronald G. Askin & Jeffrey B. Goldberg, John Wiley & Sons, 2003.
2. Mikell P. Groover (2002) Automation, Production Systems and CIM.

Reference

1. Rother M. and Shook J, 1999 Learning to See: Value Stream Mapping to Add Value and Eliminate Muda‘ , Lean Enterprise Institute, Brookline, MA.

MEE 26 ENTREPRENEURSHIP DEVELOPMENT

Objectives:

- *This course will introduce the many aspects required to create a successful new venture.*
- *The life cycle of a start-up company from the points of view of inventors, engineers or investors includes issues of planning, dealing with legal and tax issues, financial opportunities at different stages, and sources of technical assistance..*

UNIT I

Indian Industrial Environment – competence; Opportunities and Challenges, entrepreneurship and Economic growth, Small Scale Industry in India, Objectives, linkages among small, medium and heavy industries and forms enterprises. (09hours)

UNIT II

Identification and characteristics of Entrepreneurs, Emergence of First generation entrepreneurs, environmental influence and women entrepreneurs. Conception and evaluation of ideas, their sources and decision making, Choice of Technology – Collaborative interaction for Technology development. (09hours)

UNIT III

Project formulation, Analysis of marked demand, Demand supply gap, Financial and Profitability analysis and Technical analysis. Project financing in India**.** (09hours)

UNIT IV

Project Management during construction phase, project organization, project planning and control using CPM-PERT techniques. Human aspects of project management. Assessment of tax burden. (09hours)

UNIT V

Behavioral aspects of entrepreneurs: Personality – determinants, attributes and models, leadership concepts and models. Values and attitudes. Motivation aspects, change behaviour. Time Management: Various approaches of time management, their strengths and weaknesses. The urgency addiction and the time management matrix. (09hours)

Text Books:

1. Vasant Desai, Dynamics of Entrepreneurial Development and Management, Himalaya Publishing House, 1997.
2. Prasanna Chandra, Project – Planning, Analysis, Selection, Implementation and Review, Tata Mc Graw Hill Publishing Company Ltd., 1995.

References

1. B.Badhai, Entrepreneurship for Engineers, Dhanpath rai & Co., Delhi, 2001.
2. Stephen R. Covey and A.Roger Merril, First Things First, Simon and Schuster, 2002.
3. Robert D. Hisrich and Michael P.Peters, Entreneurship, Tata Mc Graw Hill ed., 2002.

MEE 27 NANO SCIENCE AND TECHNOLOGY

Objectives:

- *To equip graduates with the broad range of the skills required to flourish in the rapidly developing field of nano technology.*
- *To study on various nano-materials, principal fabrication approaches and nano-scale characterization tools.*
- *To create a strong research focus among the under graduate students to take up state-of-the-art research.*
- *To develop the student's ability to create and devise realistic industrial nano devices.*

UNIT – I

Elements of Nano science and Nanotechnology - Fundamentals and overview of nano science –Nano revolution of the 20th century, Properties at nano scale (optical, electronic and magnetic). Theory, definitions and scaling. (09hours)

UNIT – II

Properties of Nano materials - Metal and Semiconductor Nano materials, Bucky balls and Carbon Nanotubes, Nano structures - Electronic Structure of Nano particles- Nano structured Materials- Zero dimensional, one-dimensional and two dimensional nanostructures. (09hours)

UNIT – III

Synthesis of Nano materials - Synthesis of bulk nano-structured materials –sol gel processing –Mechanical alloying and mechanical milling- Inert gas condensation technique, Nanolithography, CVD, chemical synthesis, Wet Deposition techniques, Self-assembly. (09hours)

UNIT – IV

Characterization - Scanning Electron Microscopy (SEM), Scanning Probe Microscopy (SPM), TEM and EDAX analysis, X-ray diffraction, Fluorescence Microscopy and Imaging, STM - AFM and their application in nanotechnology. (09hours)

UNIT – V

Applications of Nanotechnology - Nano Devices and Sensors-Nano fabrication and machining- Nano coatings- Nanotechnology in Health Care, Solar cells - Thin film Si solar cells, Fuel Cells. (09hours)

Text books:

1. Guozhong Cao - Nanostructures and Nano materials, synthesis, properties and applications, Imperial College Press,2004.
2. Pradeep, T - NANO: The Essential, Understanding Nano science and Nanotechnology, Tata McGraw-Hill Publishing Company Limited,2007.

Reference books

1. Charles Poole, P. Jr. - Introduction to Nanotechnology, John Willey & Sons, 2003.
2. Nabok, A. - Organic and Inorganic Nanostructures, Artech House,2005
   Dupas, C. Houdy, P. Lahmani, M - Nanoscience: Nanotechnologies and Nanophysics, Springer-Verlag Berlin Heidelberg

MEE 28 CRYOGENIC ENGINEERING

Objectives:

- *To understand the material properties at cryogenic temperatures, various cycles related to cryogenics and gas separation*
- *To study the working Cryo coolers, Stirling Cycle Refrigerators, G.M. Cryo coolers, Pulse Tube Refrigerators, Regenerators used in Cryogenic Refrigerators, Magnetic Refrigerators and other equipments related to cryogenics*
- *To learn the mathematical treatment related to design and selection of cryogenic insulation and heat exchangers*

UNIT I

Cryogenic Systems: Properties of Cryogenic fluids, Material properties at Cryogenic Temperatures. Carnot Liquefaction Cycle, F.O.M. and Yield of Liquefaction Cycles. Inversion Curve - Joule Thomson Effect. (09hours)

UNIT II

Liquefaction Cycles: Linde Hampson Cycle, Precooled Linde Hampson Cycle, Claudes cycle, Collins Cycle, Dual Pressure Cycle, Helium Refrigerated Hydrogen Liquefaction Systems. Critical components in Lique faction Systems, Introduction to air separation. (09hours)

UNIT III

Cryogenic Refrigerators: J.T. Cryocoolers, Stirling Cycle Refrigerators,G.M. Cryocoolers, Pulse Tube Refrigerators, Regenerators used in Cryogenic Refrigerators, Magnetic Refrigerators ; Storage and transfer of Cryogenic liquids, Design of storage vessels. (09hours)

UNIT IV

Cryogenic Insulation, Multi layer insulation, Vacuum insulation etc. Applications: Applications of Cryogenic in Space Programmes, Superconductivity, Cryo Metallurgy, Medical applications. (09hours)

UNIT V

Cryogenic heat transfer Applications, Material Properties at cryogenic temperatures, specific heats and thermal conductivity of solid, liquid and gases, Cryogenic insulations, gas-filled and evacuated powders and fibrous materials, microsphere and multi-layer insulations. ; Heat Exchanger: Cryogenic heat exchanger types and design. (09hours)

Reference Books/Material:

1. K. D. Timmerhaus and T.M. Flynn, Cryogenic Process Engineering, Plenum Press, 1989 :
2. R. F. Barron, Cryogenic Systems, McGraw Hill, 1985
3. R.B. Scott, Cryogenic Engineering, Van Nostrand and Co., 1962
4. H. Weinstock, Cryogenic Technology, 1969 5. R.W. Vance, Cryogenic Technology, John Wiley & Sons, Inc., New York, London.

MEE 29 ADVANCED MANUFACTURING TECHNOLOGY

Objectives:

- *To introduce the development of Additive Manufacturing (AM), various business opportunities and applications*
- *To familiarize various software tools, processes and techniques to create physical objects that satisfy product development / prototyping requirements, using AM.*
- *To be acquainted with vat polymerization and material extrusion processes.*
- *To be familiar with powder bed fusion and direct energy deposition*.

UNIT –I

Introduction: Overview – Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping- Rapid Tooling – Rapid Manufacturing – Additive Manufacturing. AM Process Chain- Classification – Benefits. Applications: Building Printing-Bio Printing- Food Printing-Printing Electronics. Business Opportunities and Future Directions - Intellectual Property. (09hours)

UNIT –II

Vat Polymerization And Material Extrusion- Photo polymerization: Stereolithography Apparatus (SLA)- Materials -Process -Advantages- Limitations- Applications. Digital Light Processing (DLP) - Materials – Process - Advantages - Applications. Extrusion Based System: Fused Deposition Modeling (FDM)- Process-Materials - Applications and Limitations. (09hours)

UNIT –III

Powder Bed Fusion: Selective Laser Sintering (SLS): Process – Powder Fusion Mechanism – Process Parameters – Typical Materials and Application. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Materials – Process - Advantages and Applications. Beam Deposition Process: Laser Engineered Net Shaping (LENS)- Process -Material Delivery - Process Parameters -Materials -Benefits -Applications. (09hours)

UNIT –IV

Introduction - Need for non-traditional machining processes - Classification of non-traditional machining processes - Applications, advantages and limitations of non-traditional machining processes - Abrasive jet machining, Abrasive water jet machining, Ultrasonic machining their principles, equipment, effect of process parameters, applications, advantages and limitations. (09hours)

UNIT –V

Nano Film Coating Processes-Physical vapor deposition- EB-PVD, sputter disposition- DC-RF techniques, chemical vapor deposition-spray pyrolysis, coating techniques-spin coating, analysis techniques-various thermal analysis techniques. (09hours)

TEXT BOOKS:

1. Andreas Gebhardt and Jan-Steffen Hötter "Additive Manufacturing: 3D Printing for Prototyping and Manufacturing", Hanser publications, United States, 2015, ISBN: 978-1-56990-582-1.
2. Ian Gibson, David W. Rosen and Brent Stucker "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", 2nd edition, Springer., United States, 2015, ISBN-13: 978-1493921126.
3. Adithan. M., "Unconventional Machining Processes", Atlantic, New Delhi, India, 2009. ISBN 13: 9788126910458
4. Anand Pandey, "Modern Machining Processes", Ane Books Pvt. Ltd., New Delhi, India, 2019.

REFERENCES:

1. Amit Bandyopadhyay and Susmita Bose, "Additive Manufacturing", 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590.
2. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing", Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.
3. Benedict, G.F., "Non-traditional Manufacturing Processes", Marcel Dekker Inc., New York 1987. ISBN-13: 978-0824773526.
4. Carl Sommer, "Non-Traditional Machining Handbook", Advance Publishing., United States, 2000, ISBN-13: 978-1575373256.

MEE 30 FATIGUE, FRACTURE AND FAILURE ANALYSIS

Objectives:

After completion of this course, students should have been understood causes of fracture and failure on the basis of fracture mechanics.

UNIT I

The geometry of stress and strain, elastic deformation, plastic and elasto-plastic deformation - limit analysis. (09hours)

UNIT II

Two dimensional elastic fields – Analytical solutions yielding near a crack front – Irwin's approximation - plastic zone size – Dugdaale model – J integral and its relation to crack opening displacement. (09hours)

UNIT III

Griffith analysis – Linear Fracture Mechanics-Crack Opening displacement – Dynamic energy balance – crack arrest. (09hours)

UNIT IV

Empirical Relation describing crack growth by fatigue – Life calculations for a given load amplitude – effects of changing the load spectrum – Effects of Environment. (09hours)

UNIT V

Examples of crack-growth Analysis for cyclic loading - leak before break – crack Initiation under large scale yielding – Thickness as a Design parameter – crack instability in Thermal or Residual – stress fields. (09hours)

TEXT BOOK:

1. Norman E. Dowling," Mechanical Behavior of Materials", 2nd Edition, Prentice-Hall 1999.

REFERENCES:

2. David Broek,"Elementary Engineering Fracture Mechanics", Fifthoff and Noerdhoff International Publisher, 1978.

Reference books

1. Kare Hellan,"Introduction of Fracture Mechanics", McGraw-Hill Book Company, 1985.
2. Preshant Kumar, "Elements of Fracture Mechanics", Wheeler Publishing, 1999.
3. Suresh, S.," Fatigue of Materials", Cambridge University Press, 2 nd edition, 1998.
4. Ashok Saxena," Nonlinear Fracture Mechanics for Engineers", CRC Press, 1998
5. Schive, Jaap, "Fatigue of Structures and Materials", Kluwer Academic Publishers, 2001.

MEE 31 MAINTENANCE AND SAFETY ENGINEERING

Objectives:

- *Focused study on the issues of maintenance, reliability and safety of technical systems*
- *Fault finding and diagnostics in engineering industry*
- *Knowledge of lubricants and lubrication systems*
- *Understand maintenance requirements of plant and equipment with increased sophistication and complexity.*

UNIT – I

Objectives of maintenance - types of maintenance – Breakdown, preventive and predictive maintenance - Repair cycle - Repair Complexity, Lubrication system – Lubricants - inspection. Maintenance of Mechanical transmission systems - align machinery – static and dynamic balancing - process plants – air conditioning – water purification –environmental control.

(9 hours)

UNIT – II

Predictive Maintenance - vibration analysis data and noise as maintenance tool – wear debris analysis-Condition monitoring concepts applied to industries–diagnose faults – overhaul – testing and measurement using approved procedures - Total Productive Maintenance (TPM) - Economics of Maintenance- Computer aided maintenance–modern practice–modern manufacturing aspects. (9 hours)

UNIT – III

Reliability : Definition, concept of reliability based design, failure rate, MTTF, MTBF, failure pattern, system reliability: Series, Parallel and Mixed configurations - Availability and Maintainability concepts- Applications – electro, proportional and servo hydraulic components –shutdown machinery–isolation–dismantle–inspect– NDT-assembly–fans–pumps –valves–bearings–static–dynamic seals. (9 hours)

UNIT – IV

Safety and productivity - causes of accidents in industries – accident reporting and investigation - measuring safety performance - Safety organizations and functions - Factories act and rules - Manufacture, Storage and Import of Hazardous Chemical rules-Explosive act-Gas cylinder rules–Electricity act. (9 hours)

UNIT – V

Safety Codes and Standards – Air Quality – indoor - outdoor – safe drinking water - General Safety considerations in Material Handling equipments - Machine Shop machineries-pressure vessels and pressurized pipelines – IBR - welding equipments- operation and inspection of extinguishers – prevention and spread of fire – emergencyexitfacilities-NFPAStandards–ISO14000. (9 hours)

Text Books:

1. P.Gopalakrishnan and A. K. Banerji - Maintenance and Spare Parts Management, PHI Learning Pvt. Ltd., New Delhi,2013.
2. Patrick D. T. O'Connor – Practical Reliability Engineering, Wiley,2008.
3. B. S. Dhillon – Engineering Safety – Fundamental Techniques and Applications, World Scientific,2003.

Reference Books:

1. R.C.Mishra and K.Pathak, Maintenance Engineering and Management, PHI Learning Pvt. Ltd., New Delhi,2012.
2. H.P.Garg, Industrial Maintenance, S.Chand& Co Ltd., New Delhi,1990.
3. Birolini, Reliability Engineering, Springer,2014.
4. RollandP.Blake-IndustrialSafety,PrenticeHallofIndiaPvt.Ltd.,NewDelhi, 1973.

Web Resources:

1. https://www.coursera.org/course/
2. http://nptel.ac.in/courses/112106177
3. http://ocw.mit.edu/courses/nuclear-engineering/22-091-nuclear-reactor-safety-spring-2008/

MEE 32 REVERSE ENGINEERING & RAPID PROTOTYPING

Objectives:

- *To understand the fundamentals of methods and techniques to support engineering design processes, by focusing on the opportunities provided by Reverse Engineering and Rapid Prototyping.*
- *To achieve a global understanding of product development processes.*
- *To design phases and the circumstances in which Reverse Engineering and Rapid Prototyping are the most advantageous*

UNIT-I

Introduction to New Product Development. Tasks of detailed design, new frontiers of Computer-Aided Design tools. (09 hours)

UNIT-II

Reverse Engineering -Objectives and common application fields. Existing technologies. Contact systems. Non-contact systems. Manipulation of acquired data. Practical experiences. (09 hours)

UNIT-III

Introduction to the Basic Principles of Additive Manufacturing. Design for Additive Manufacturing. (09 hours)

UNIT-IV

Rapid Prototyping technologies- polymers with a particular focus on Stereolithography (SLA) and Fused Deposition Modelling (FDM). For metals. For other materials. Practical experiences. (09 hours)

UNIT-V

Employment of Reverse Engineering and Rapid Prototyping technologies in different industrial fields with an outlook on the South Tyrolean industrial fabric. (09 hours)

Text Books :

1. Eldad Eilam's Reversing: Secrets of reverse engineering.
2. Hacking the Xbox: An Introduction to Reverse Engineering.
3. The IDA Pro Book: The Un official Guide to the World's Most Popular Dis assembler.

References

1. The Art of Memory Forensics: Detecting Malware and Threats in Windows, Linux, and Mac Memory.
2. Practical Malware Analysis: The Hands-On Guide to Dissecting Malicious Software.
3. The Root kit Arsenal : Escape and Evasion in the Dark Corners of the System 2nd Edition.
4. Practical Reverse Engineering: x86, x64, ARM, Windows Kernel, Reversing Tools, and obfuscation.

MEE 33 DESIGN OF JIGS, FIXTURES AND PRESS TOOLS

Objectives:

- *To understand the functions and design principles of Jigs, fixtures and press tools*
- *To gain proficiency in the development of required views of the final design.*

UNIT I

Objectives of tool design- Function and advantages of Jigs and fixtures – Basic elements – principles of location – Locating methods and devices – Redundant Location – Principles of clamping – Mechanical actuation – pneumatic and hydraulic actuation Standard parts – Drill bushes and Jig buttons – Tolerances and materials used. (09 hours)

UNIT II

JIGS AND FIXTURES Design and development of jigs and fixtures for given component- Types of Jigs – Post, Turnover, Channel, latch, box, pot, angular post jigs – Indexing jigs – General principles of milling, Lathe, boring, broaching and grinding fixtures – Assembly, Inspection and Welding fixtures-Modular fixturing systems- Quick change fixtures. (09 hours)

UNIT III

Press Working Terminologies - operations – Types of presses – press accessories – Computation of press capacity – Strip layout – Material Utilization – Shearing action – Clearances – Press Work Materials – Center of pressure- Design of various elements of dies – Die Block – Punch holder, Die set, guide plates – Stops – Strippers – Pilots – Selection of Standard parts – Design and preparation of four standard views of simple blanking, piercing, compound and progressive dies. (09 hours)

UNIT IV

Difference between bending and drawing – Blank development for above operations – Types of Bending dies – Press capacity – Spring back – knockouts – direct and indirect – pressure pads – Ejectors – Variables affecting Metal flow in drawing operations – draw die inserts – draw beads ironing – Design and development of bending, forming, drawing, reverse redrawing and combination dies – Blank development for axisymmetric, rectangular and elliptic parts – Single and double action dies. (09 hours)

UNIT V

Bulging, Swaging, Embossing, coining, curling, hole flanging, shaving and sizing, assembly, fine Blanking dies – recent trends in tool design- computer Aids for sheet metal forming Analysis – basic introduction - tooling for numerically controlled machines- setup reduction for work holding – Single minute exchange of dies – Poka Yoke. (09 hours)

TEXT BOOKS:

1. Joshi, P.H. “Jigs and Fixtures”, Second Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2004. 2. Joshi P.H “Press tools - Design and Construction”, wheels publishing, 1996

REFERENCES:

1. Venkataraman. K., “Design of Jigs Fixtures & Press Tools”, Tata McGraw Hill, New Delhi, 2005.
2. Donaldson, Lecain and Goold “Tool Design”, 3rd Edition, Tata McGraw Hill, 2000.
3. Kempster, “Jigs and Fixture Design”, Third Edition, Hoddes and Stoughton, 1974.
4. Hoffman “Jigs and Fixture Design”, Thomson Delmar Learning, Singapore, 2004.
5. ASTME Fundamentals of Tool Design Prentice Hall of India.
6. Design Data Hand Book, PSG College of Technology, Coimbatore

MEE 34 NON TRADITIONAL MACHINING

Objectives:

To learn various concepts related to modern machining processes & their applications

UNIT-I

Introduction: Needs for nontraditional machining processes, classification and comparative analysis (09 hours)

UNIT-II

Abrasive jet machining: Fundamental principle, application process parameters, MRR models. Water jet machining: Fundamental principle, application process parameters Chemical machining: Principle of operation, etch ants and mask ants, photochemical process, equipment, applications. (09 hours)

UNIT-III

Analysis of material removal: Electrochemical machining: Process principle Dynamics of ECM Process, tool design, applications. Ultrasonic machining: Physical principles Physical principles of USM, Process parameters, Transducers types materials and design (09 hours)

UNIT-IV

Horn design: Shaws model of MRR, other applications of Ultrasonic machining Electrical discharge machining: Operating principles of EDM, process parameters and their effects, flashing, wire EDM process, applications. (09 hours)

UNIT-V

Lasing process: Types of lasers (Gas and solid state), lasing mediums, laser material processing-cutting, drilling, surface treatment, special applications. (09 hours)

Text books

1. Modern Machining Processes by P.C. Pandey& H.S. Shan, Tata McGraw Hill.
2. Advanced Machining Processes by Vijay K. Jain, Allied Publishers.
3. Nontraditional Manufacturing Processes by G.F. Benedict, Marcel Dekker Inc., NY.

References

1. Advanced Methods of Machining by Mc Geough, Chapman and Hall, London.
2. New Technology by A. Bhattacharya, Institute of Engineers, India.
3. Material & Processes in Manufacturing by Paul De Garmo, J.T. Black and Ronald A. Kohser,
4. Advanced Machining Processes By Hassan Abdel-Gawad El-Hofy Tata McGraw Hill, ISBN 0071453342 / 9780071453349 PHI

MEE 35 AUTOMOTIVE POLLUTION AND CONTROL

Objectives:

- *To present a problem oriented in depth knowledge of automobile pollution and control.*
- *To address the underlying concepts and methods behind automobile pollution and control.*

UNIT-I

Introduction -Vehicle population assessment in metropolitan cities and contribution to pollution, effects on human health and environment, global warming, types of emission, transient operational effects on pollution, noise vibration and harshness (NVH). (09hours)

UNIT-II

Pollutant Formation in Engines -Pollutant formation in SI Engine, mechanism of HC, CO and NO in SI engine, exhaust emission and factors affecting the emission, evaporative emission, crankcase emission, lead emission CI engine emissions: formation of smoke, factors affecting the smoke formation, diesel odour, unburned hydrocarbons, carbon monoxide, oxides of nitrogen, smog and comparison of diesel and petrol emissions. Two stroke engine pollution. (09hours)

UNIT-III

Control of Emissions from Engines -Design strategies to control emission from engines, effect of design and operating parameters on emission concentrations, modification in the engine design, modifying the fuel used, exhaust gas treatment devices, crankcase emission control, evaporative emission control, exhaust emission control, air injection system, second generation air injection system, spark timing emission control system, thermal reactor package, catalytic convertor package, NOx emission control, control of smoke, odour control, and pollution from gas turbine and its control. (09hours)

UNIT-IV

Noise Pollution from Automobiles -Noise, Vibration And Harshness, Sources of Noise, Measurement of Noise-Engine combustion noise, Inlet and Exhaust Noise, Traffic Noise, Vehicle Body Noise-control of noise, control devices and noise proof materials (09hours)

UNIT-V

Measurement Techniques Emission Standards and Test Procedure NDIR,FID, Chemiluminescent analyzers, Gas Chromatograph, smoke meters, emission standards, driving cycles–USA, Japan, Euro and India. Test procedures–ECE, FTP Tests. SHED Test-chassis dynamometers, dilution tunnels. (09hours)

Textbooks

1. Paul Degobert–Automobiles and Pollution–SAE International ISBN-1-56091-563-3, 1991. Ganesan, V-“Internal Combustion Engines”-Tata McGraw-Hill Co.-2003.
2. Beranek.L.L. “ Noise Reduction”, McGraw Hill Book co., Inc, New York, 1993.

Reference books

1. SAE Transactions-“Vehicle Emission”-1982 (3 volumes).
2. Obert.E.F.-“Internal Combustion Engines”-1988
3. Marco Nute-“ Emissions from two stroke engines, SAE Publication–1998.
4. Internal combustion engine by domkundwar.

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