B.E. (Mechanical Engineering)

2015 Regulations, Curriculum & Syllabi

BANNARI AMMAN INSTITUTE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University, Chennai
Approved by AICTE - Accredited by NBA New Delhi, NAAC with 'A' Grade and ISO 9001:2008 Certified)

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REGULATIONS 2015 (CHOICE BASED CREDIT SYSTEM) (Common to all B.E./B.Tech. Degree Programmes)

Regulation 2015 has been prepared in accordance with the guidelines given by the University Grants Commission, All India Council for Technical Education and affiliating University incorporating the features of the Choice Based Credit System (CBCS). The Regulation 2015 is applicable to the candidates admitted to the Bachelor of Engineering (B.E.) / Bachelor of Technology (B.Tech.) Degree Programmes of the Institution in the academic year 2015-2016 for Regular admission (Academic year 2016-2017 for Lateral Entry) and subsequently.

The regulations hereunder are subjected to amendments as may be decided by the Academic Council of the Institution from time to time. Any or all such amendments will be effective from such date and to such batches of students (including those already in the middle of the programme) as may be decided by the Academic Council.

1. ADMISSION

Candidate, seeking admission to the B.E./B.Tech. Programme, shall satisfy the conditions of admission prescribed by the Directorate of Technical Education and Anna University, Chennai as given below.

1.1 Regular Admission

Candidates, for admission to the first semester of the eight semesters B.E./B.Tech. Degree Programmes, shall be required to have passed:

- Higher Secondary Examination (10 +2) of Curriculum (Regular Academic Stream) prescribed by the Government of Tamil Nadu with Mathematics, Physics, and Chemistry as three of the four subjects of the study prescribed under Part-III or any other examinations of any Board or University or authority accepted by the Syndicate of the University / Directorate of Technical Education (DoTE), Chennai as equivalent thereto.

(or)

- Should have passed Higher Secondary Examination of Vocational Stream (Engineering/Technology), prescribed by the Government of Tamil Nadu.

1.2 Lateral Entry Admission

1.2.1 The candidates who possess Diploma in Engineering / Technology awarded by the State Board of Technical Education and Training, Tamil Nadu or its equivalent are eligible to apply for Lateral Entry admission to the third semester of B.E. / B.Tech. Programmes in the branch of study as per the eligibility criteria prescribed by the Directorate of Technical Education from time to time.

(or)

1.2.2 The candidates who possess the Bachelor Degree in Science (B.Sc.) (10+2+3 stream) with Mathematics as a subject in B.Sc. is eligible to apply for Lateral Entry admission to the third semester of B.E./B.Tech. Programmes, as per the eligibility criteria prescribed by the Directorate of Technical Education from time to time. Such candidates shall undergo two additional Engineering subject(s) one each in third and fourth semesters, as bridge courses.

2. PROGRAMMES OFFERED

A candidate may be offered admission to any one of the programmes offered by the Institution for the candidates specified in Clause 1.1 and as per the eligibility criteria of DoTE for the candidates under Clause 1.2 from the list given below:

B. E. Programmes

i. Aeronautical Engineering
ii. Agricultural Engineering
iii. Automobile Engineering
iv. Civil Engineering
v. Computer Science and Engineering
vi. Electrical and Electronics Engineering
vii. Electronics and Communication Engineering
viii. Electronics and Instrumentation Engineering
ix. Mechanical Engineering
x. Mechatronics

B. Tech. Programmes

i. Biotechnology
ii. Fashion Technology
iii. Information Technology
iv. Textile Technology
v. Food Technology

3. STRUCTURE OF THE PROGRAMME

3.1 Every programme shall have a distinct curriculum with syllabi consisting of theory, laboratory, mini-project, life-skills and personality development courses, as prescribed by the respective Boards of Studies, broadly categorized under:

(i) **Basic Science** courses including Mathematics, Physics, Chemistry and further specialization in these subjects

(ii) **Basic Engineering c**ourses including Engineering Graphics, Workshop Practices, Basics of Electrical, Electronics, Civil, Mechanical Engineering, Engineering Mechanics and Computer Programming.

(iii) **Humanities and Social Science c**ourses including Language Courses, Management Courses, Life Skills and Professional Ethics.

(iv) **Professional Courses** include Discipline Core Courses, Professional Electives, Core Electives and Open Electives.

(v) **Employability Enhancement Courses (EEC)** include Project Work and /or Internship, Seminar, Industrial /Practical Training, Value Added and Certificate Courses.

The assortment of different courses shall be designed that the student, at the end of the programme, would be able to be trained not only in his / her relevant professional field but also as a socially mindful human being.

The medium of instruction is English for all the Courses, Examinations, Seminar Presentation, Projects and any other courses that a student registers for.

3.2 Each course is normally assigned a certain number of credits, with 1 credit per lecture period per week, 1 credit for 2 periods of tutorial, 1 credit for 2 periods of laboratory courses, and 1 credit for 2 periods of seminar/project work per week.

3.3 A Diagnostic Test will be administered to all the B.E. / B.Tech. students after the admission to assess the proficiency in English and based on the score they will be brought under two streams namely, Stream A and Stream B. Students under Stream A will study **Communicative English I** and Stream B will study **Basic English I** under Language Elective I in the First Semester. In the Second Semester, Stream A will be further divided into two categories based on their English language proficiency assessed in the Continuous Assessment, while the upper segment can enroll and study **German / Japanese / French / Chinese / Hindi** and the remaining students of that Stream will study **Communicative English II**. The students under Stream B will study **Basic English II** or may opt for **Communicative English II** based on the assessment carried out at the end of the semester I.

3.4 Every student shall be required to opt for **Nine** electives from the list of electives. Students can opt for the electives (Core / Professional / Open Elective) from any branch of B.E/B.Tech. Programmes, besides his / her own discipline courses, during V to VIII Semesters, if he/she satisfies the prerequisite for that particular course.

3.5 However, out of nine electives, every student shall be required to opt for, a minimum of three electives as open electives from the list of open electives of the branch / branches other than his / her branch of specialisation. There shall be no pre-requisite course(s) for such open electives.

3.6 Students can also opt for **one-credit courses** of 15 to 20 hour duration, which will be offered by the experts from the industry on specialised topics. Students can opt for such **one-credit courses** during the semesters I to VII as and when these courses are offered. A student will also be permitted to register the **one-credit courses** offered by other Departments, provided the student has fulfilled the necessary pre-requisites or the courses that may not require any pre-requisites. Under no circumstances, the same one credit course shall be repeated in subsequent semesters in any Department / Centre and a maximum batch size for a given course shall not exceed 40. In the case of disciplines with multiple divisions (intake more than 60) different course(s) shall be offered to other batch(es) of students.

On successful completion of one credit courses, Credits will be indicated in the Grade Sheet, but will not be considered for computing the Cumulative Grade Point Average (CGPA). However, if a student wishes to avail the exemption from any one of the Electives (other than open elective) of the Semester VIII, he / she can do so by exercising his / her option in writing to the respective Head of the Department during the beginning of the VIII Semester, following the equivalence norm, that **one regular elective (**in the **VIII Semester)** is equivalent to **three one-credit courses** completed by the student during the previous semesters, IV to VII. Details of the one credit courses offered by the department shall be forwarded to the Office of the Controller of Examinations. However one credit courses completed during I to III semesters shall be maintained in the Grade sheet as “Additional credits earned” (not considered for the computation of GPA/CGPA).

3.7 Fast Track System shall enable students to undergo a semester-long Internship or Special Training during Semester VIII. A student who secures a minimum CGPA of 8.50 in Semester IV with no current arrears, as on that date and maintains the CGPA of 8.50 till VI Semester without any arrears shall be eligible to opt for Fast Track System and such student is required to complete three elective courses satisfactorily, while completion of Semester VII, as additional Credits during the semesters V to VII.

3.8 Every student shall be required to carry out a Project Work in the Department / Industry or by exercising Fast track during VIII Semester in consultation with the Faculty Guide and submit the project report, in the prescribed format, at the end of the VIII Semester for the valuation.

3.9 A student can register for Self-Study Elective(s) over and above the electives from any branch of Engineering / Technology at the rate of one per semester starting from V semester onwards provided he/she maintains a Cumulative Grade Point Average (CGPA) of 8.50 or above till the previous semesters with no current arrears. Credits will be indicated for such courses in the grade sheets (additional credits) but will not be considered for computing the CGPA.

3.10 A Student may be permitted to credit online courses with the approval of the Departmental Consultative Committee constituted by the Head of the Department, subject to a maximum of three credits. Such students may be exempted from attending the classes, if such course(s) are offered in the semester. Summary of such on-line courses, taken by the students, along with the offering agency shall be presented to the Academic Council for information and further suggestions. However, those students need to obtain certification from the agency / agencies offering the course, to become eligible for writing or seeking exemption (core elective course) from the End Semester Examination. In case of credits earned through online mode, from the other Institute / University, the credits may also be transferred directly after due approval from the Departmental Consultative

Committee and the Office of the Controller of Examinations. A student can get exemption for a maximum of 3 credits during the entire programme (in lieu of Discipline elective or Open elective).

4. VALUE ADDED COURSES / ADD-ON COURSES

A Student can opt for the Value Added Courses / Add-on Courses offered by the various Department / Centres for which the batch size will not exceed 40 per course from Semester II to VII. Head of the Department / Centre shall submit the list of such courses, duly approved / ratified by the Academic Council, to the Controller of Examinations to administer the examination process. A separate Certificate will be issued on successful completion of the course by the Office of the Controller of Examinations.

5. DURATION OF THE PROGRAMME

5.1 A regular student (admitted after 10+2) or equivalent is normally expected to satisfactorily fulfil the requirements for award of the degree B.E. / B.Tech. within four academic years (8 semesters) from the date of admission but in any case not more than 7 years (14 Semesters); lateral entry students shall fulfil such requirements within three academic years (6 semesters) from the date of admission but in any case not more than six years (12 Semesters) leading to the award of Degree of Bachelor of Engineering (B.E.) / Bachelor of Technology (B.Tech.) of Anna University, Chennai.

5.2 The total period for completion of the programme from the commencement of the semester, to which the student was admitted, shall not exceed the maximum period (Clause 5.1), regardless to the break-of-study (vide Clause 15) or period of prevention in order.

5.3 Each semester shall consist of minimum 90 working days or 450 periods of 60 minutes each or equivalent. Head of the Department shall ensure that every faculty member teaches the subject / course as prescribed in the approved curriculum and syllabi.

5.4 Special Theory / Practical Sessions may be conducted for students who require additional inputs over and above the number of periods normally specified

(Remedial Classes), as decided by the Head of the Department, within the specified duration of the Semester / Programme.

6. COURSE ENROLLMENT AND REGISTRATION

6.1 Each student, on admission shall be assigned to a Faculty Advisor (vide Clause 8) who shall advise / counsel the student about the details of the academic programme and the choice of course(s) considering the student's academic background and career objectives.

6.2 Every student shall enroll for the courses of the succeeding semester, in the current semester. However, the student shall confirm the enrollment by registering for the courses within the first five working days after the commencement of the semester concerned.

6.3 After registering for a course, a student shall attend the classes, satisfy the attendance requirements, earn Continuous Assessment marks and appear for the End Semester Examinations.

6.3.1 Each student, on admission to the programme, shall register for **all the courses prescribed in the curriculum in** the **first Semester of study (III Semester** for students admitted under **lateral entry stream).**

6.3.2 The enrollment for all the courses of the Semester II will commence 10 working days prior to the last working day of Semester I. The student shall confirm the enrollment by registering for the courses within the first five working days after the commencement of the Semester II. In the case, if a student fails to register in the course(s), he/ she may be permitted to register the same, as specified in the Clause 6.5, in the subsequent semesters or when it is offered.

6.3.3 The enrollment for the courses of the Semesters III to VIII will commence 10 working days prior to the last working day of the preceding semester. The student shall enroll for the courses with the guidance of the student's Faculty Advisor. If a student wishes, the student may drop or add courses (vide Clause 6.4) within **five** working days after the commencement of the semester concerned and complete the registration process duly authorized by the Faculty Advisor.

6.4 Flexibility to Add or Drop courses

6.4.1 A student has to earn the total number of credits specified in the Curriculum of the respective Programme of study in order to be eligible to obtain the degree. However, if a student wishes, the student is permitted to earn more than the total number of credits prescribed in the curriculum by opting for one- credit courses, self study electives or additional courses.

6.4.2 From the III to VIII semesters (from IV to VIII Semesters in case of lateral entry students), the student has the option of registering for additional courses or dropping existing courses. Total number of credits of such courses cannot exceed 6 in a given Semester. However the maximum number of credits that a student can register in a particular semester shall not exceed 30 credits (regardless to the reappearance credits). In such cases, the attendance requirement as stated Clause 7 is mandatory.

6.4.3 The minimum number of credits that a student can register in a particular semester shall not be less than 18 credits (except VII / VIII semester).

6.4.4 The student shall register for the project work in the VIII semester only.

6.5 Reappearance Registration

6.5.1 If a student fails in a theory course, the student shall do reappearance registration (Examination) for that course in the subsequent semesters or when it is offered next.

6.5.2 On registration, a student may attend the classes for the reappearance registration courses, if the student wishes, and the attendance requirement (vide Clause 7) is not compulsory for such courses.

6.5.3 However, if a student wishes to improve his/ her continuous assessment, in the second attempt during reappearance, shall satisfy the Clause 6.5.5 and appear for continuous assessment as given for that particular course.

6.5.4 If the theory course, in which the student has failed, is either a professional elective or an open elective, the student may register for the same or any other professional elective or open elective course, respectively in the subsequent semesters. However, the change of elective courses is permitted only once.

6.5.5 In this case (Clause 6.5.4), the student shall attend the classes, satisfy the attendance requirements (vide Clause 7), earn Continuous Assessment marks and appear for the End Semester Examination.

6.5.6 The student who fails in any Laboratory Course/ Project work / Seminar or any other EEC courses (Specified in Clause 3.1) shall register for the same in the subsequent semesters or when offered next, and **repeat** the course as per Clause 6.5.5.

6.5.7 If a student is prevented from writing the end semester examination of a course or several courses due to lack of attendance, the student has to register for that / those course(s) again, when offered next, attend the classes and fulfill the requirements as per Clause 6.5.5 & 6.5.6. If the course, in which the student has 'lack of attendance', is a Core Elective or an Open Elective, the student may register for the same or any other Core Elective or Open Elective course(s) respectively in the subsequent semesters and appear in the examination as per Clause 6.5.5.

7. REQUIREMENTS FOR APPEARING FOR THE END SEMESTER EXAMINATION OF A COURSE

A student who has fulfilled the following conditions (vide Clause 7.1 and 7.2) shall be deemed to have satisfied the attendance requirements for appearing for End Semester Examination of a particular course.

7.1 Every student is expected to attend all the periods and earn 100% attendance. However, a student shall secure not less than 80% attendance (Physical presence) course wise taking into account the number of periods required for that course as specified in the curriculum.

7.2 If a student, secures attendance between 70% and 79% in any course(s) in the current semester due to medical reasons (prolonged hospitalization / accident / specific illness) or participation in Institution/ University/ State/ National/ International level extra and co-curricular activities, with prior permission from the Head of the Department, shall be permitted to appear for the current semester examinations subject to the condition that the student shall submit the medical certificate / participation certificate attested by the Head of the Department (along with Condonation form). Such certificates along with the condonation forms shall be forwarded to the Controller of Examinations for verification and permission to attend the examinations. However during the entire programme of study, a student can avail such Condonation in any two semesters only (regardless the number of courses).

7.3 A student shall normally be permitted to appear for End Semester Examination of the course(s) if the student has satisfied the attendance requirements (vide Clause 7.1 – 7.2) and has registered for examination in those courses of that semester by paying the prescribed fee.

7.4 Students who do not satisfy Clause 7.1 and 7.2 and who secure less than 70% attendance in a course will not be permitted to write the End-Semester Examination of that course. The student has to register and repeat this course in the subsequent semesters or when it is offered next (vide Clause 6.5).

7.5 In the case of reappearance registration for a course (vide Clause 6.5), the student has to register for examination in that course by paying the prescribed fee.

7.6 A student who has already appeared for a course in a semester and passed the examination is not entitled to reappear in the same course for improvement of grades.

8. FACULTY ADVISOR

To help the students in planning their courses of study and for general advice on the academic programme, the Head of the Department will attach a certain number of students to a Faculty member of the Department who shall function as Faculty Advisor for those students. The Faculty Advisor shall advise and guide the students in registering of courses, reappearance of courses, monitor their attendance and progress and counsel them periodically. If necessary, the Faculty Advisor may also discuss with or inform the parents about the progress / performance of the students concerned.

9. COMMITTEES

9.1 Common Course Committee

9.1.1 A theory course handled by more than one faculty including the discipline with multiple divisions (greater than or equal to 2) shall have a “Common Course Committee” comprising of all members of faculty teaching that course with one of the members as the Course Coordinator, nominated by the Head of the Institution (Head of the Department in the case of multiple divisions of a discipline) and student representatives (one per specialization or division) registered for that course in the current semester.

First meeting of the Common Course Committee shall be held within fifteen days from the date of commencement of the semester. Two subsequent meetings in a semester may be held at suitable intervals. During these meetings, the student members shall meaningfully interact and express their opinions and suggestions of all the students to improve the effectiveness of the teaching-learning process. It is the responsibility of the student representatives to convey the proceedings of these meetings to all the students.

9.1.2 In addition, Common Course Committee (without the student representatives) shall meet to ensure uniform evaluation through the common question papers during Continuous Assessment and End Semester Examinations.

9.2 Class Committee Meeting

For all the courses taught, prescribed in the curriculum, Class Committee meeting shall be convened thrice in a semester (first meeting within 15 days from the commencement of the semester and other two meetings at equal interval after the first meeting) comprising members of the faculty handling all the courses and two student representatives from the class.

One of the members of the faculty (preferably not handling any courses to that class), nominated by the Head of the Department, shall coordinate the activities of the Committee. During these meetings, the student members shall meaningfully interact and express their opinions and suggestions of all the students to improve the effectiveness of the teaching-learning process. It is the responsibility of the student representatives to convey the proceedings of these meetings to all other students.

10. SYSTEM OF EXAMINATION

10.1 Performance in each course of study shall be evaluated based on (i) Continuous Assessment throughout the semester and (ii) End Semester examination at the end of the semester for the regular courses or as given in the Clause 16. However, the final examination in the case of one credit courses / certificate / value added courses may be conducted, as and when the course is completed, through the office of the Controller of Examinations.

10.2 Each course, both theory and practical including project work, shall be evaluated as per the Scheme of Assessment given in Clause 16.

10.3 The End Semester Examinations shall normally be conducted after satisfying the Clause 5.2. Supplementary Examinations may also be conducted, at such times, for the benefit of the students as decided by the Controller of Examinations.

10.4 For the End Semester examinations, both theory and practical courses including project work, the internal and external examiners (from Academia or Industry) shall be appointed by the Controller of Examinations as per the guidelines given by the Examination and Evaluation Board of the Institute.

11. PASSING REQUIREMENTS AND PROVISIONS

11.1 A student who secures not less than 50% of total marks prescribed for a course, vide Clause 16, comprising a minimum of 50% of the marks prescribed for the End Semester Examination, shall be declared to have passed the course successfully and earned the prescribed credits for that course, applicable for all registered courses.

11.1.1 If a student fails to secure a pass in a particular course, i.e., failing to obtain minimum marks, as stated above, it is mandatory that he/she shall register and reappear for the examination in that course in the subsequent semester(s) whenever the examinations are conducted for that course, till he / she secures a 'Pass'.

11.1.2 Continuous Assessment (CA) marks obtained by the student in the first appearance shall be retained and considered valid for one subsequent attempt, except Clause 6.5.4, 6.5.5, 6.5.6 and 6.5.7. However, from the third attempt onwards, the student shall be declared to have passed the course if he/she secures a minimum of 6 Grade Points (B Grade) in the course prescribed during the End Semester Examinations.

11.2 The minimum number of total credits to be earned by a student to qualify for the award of Degree in the various branches of study as prescribed by the respective Boards of Studies is given below:

Branch of Study	Minimum Credits	
	Regular Admission	**Lateral Entry**
B.E. Programmes		
Aeronautical Engineering	178	134
Agricultural Engineering	177	133
Automobile Engineering	179	134
Civil Engineering	176	131
Computer Science and Engineering	176	131
Electrical and Electronics Engineering	176	132
Electronics and Communication Engineering	177	132
Electronics and Instrumentation Engineering	177	133
Mechanical Engineering	179	135
Mechatronics	177	133
B.Tech. Programmes		
Biotechnology	175	131
Fashion Technology	176	132
Information Technology	176	131
Textile Technology	175	131
Food Technology	175	131

11.2.1 Student Migration and Credit Transfer: Normalization of the Credits will be carried out in consultation with the Board of Studies of the programme concerned and approved by the Head of Institution, if a student migrates from other institutions to Bannari Amman Institution of Technology or rejoins from previous regulation to this regulation.

11.3 A student shall be declared to have qualified for award of B.E/B.Tech. Degree if he/she successfully completes the course requirements (vide Clause 7, 10 and 11) and passed all the prescribed courses of study of the respective programme (listed in Clause 2), within the duration specified in Clause 5.1.

12. ASSESSMENT AND AWARD OF LETTER GRADES

12.1 The assessment shall be based on the performance in the End Semester Examinations and / or Continuous Assessment, carrying marks as specified in Clause 16. Letter Grades (based on Credit Point and Grade Point) are awarded to the students based on the performance in the evaluation process.

12.2 Credit Point is the product of Grade Point and number credits for a course and Grade Point is a numerical weight allotted to each letter grade on a 10-point scale (as specified in the Clause 12.3), while the Letter Grade is an index of the performance of a student in a said course.

12.3 The performance of a student will be reported using Letter Grades, each carrying certain points as detailed below:

Range of Total Marks (as specified in Clause 16) / Specific Reason	Grade Points	Letter Grade
91 to 100	10	O (Outstanding)
81 to 90	9	A + (Excellent)
71 to 80	8	A (Very Good)
61 to 70	7	B + (Good)
50 to 60	6	B (Above average)
0 to 49	0	RA (Reappearance Registration)
Incomplete	0	I
Withdrawal	0	W
Absent	0	AB
Shortage of Attendance	0	SA

‘RA’ ---Reappearance registration is required for that particular course

‘I’ --- Continuous evaluation is required for that particular course in the subsequent examinations.

‘SA’ --- shortage of attendance (Clause 7) and hence prevented from writing end semester examination.

12.4 After completion of the evaluation process, Grade Point Average (GPA), and the Cumulative Grade Point Average (CGPA) is calculated using the formula:

$$GPA/CGPA = \frac{\sum_1^n C_i * g_i}{\sum_1^n C_i}$$

where

C_i : Credit allotted to the course.

g_i : Grade Point secured corresponding to the course.

n : number of courses successfully cleared during the particular semester in the case of GPA and all the semesters, under consideration, in the case CGPA.

12.5 A student who does not appear for the End Semester Examinations in a course, after registering for the same, shall be deemed to have appeared for that examination for the purpose of classification (Subject to Clause 14 and 15).

12.6 For the non credit courses Grades shall be indicated as given in the Clause 16 and shall not be counted for the computation of GPA/CGPA.

12.7 **Photocopy / Revaluation:** A student, who seeks the re-valuation of the answer script is directed to apply for the photocopy of his/her semester examination answer paper(s) in the theory course(s), within 2 working days from the declaration of results in the prescribed format to the Controller of Examinations through the Head of the Department. On receiving the photocopy, the student can consult with a competent member of faculty and seek the opinion for revaluation. Based on the recommendations, the student can register for the revaluation through proper application to the Controller of Examinations. The Controller of Examinations shall arrange for the revaluation and declare the results. Revaluation is not permitted to the courses other than theory courses. In the case of theory courses with laboratory component, a student can seek revaluation for the theory component only, following the procedure stated above.

13. CLASSIFICATION OF THE DEGREE AWARDED

For the purpose of the 'Award of Degree', the duration of completion of the programme shall be the total duration taken by a student for completing first time registration of all the required courses and satisfying Clause 11, regardless to the period of Break-of-study as per Clause 15 and satisfy any one of the conditions required as given below.

13.1 **First Class with Distinction**: A student who qualifies for the award of the Degree having passed all the courses of study of all the Eight Semesters (six semesters for lateral entry students) at the first opportunity, after the commencement of his / her study and securing a CGPA not less than 8.50 (vide clause 12.3) shall be declared to have passed with **First Class with Distinction**.

13.2 **First Class**: A student who qualifies for the award of the Degree having passed all the courses of study of all the eight semesters (six semesters for lateral entry students) after the commencement of his / her study and securing a CGPA not less than 6.50 shall be declared to have passed with **First Class** (not exceeded the total duration as specified in the Clause 5).

13.3 **Second Class**: All other students who qualify for the award of the Degree shall be declared to have passed in **Second Class.**

13.4 Course Completion Certificate shall be given to a student, provided he / she should have registered all the courses and also registered for the examinations in those courses (subject to Clause 6.0 and 7.0).

14. WITHDRAWAL FROM THE EXAMINATION

14.1 A student may, for valid reasons, be granted permission by the Head of the Department to withdraw from appearing in the examination in any course(s) only once during the entire duration of the degree programme.

14.2 Withdrawal application shall be valid only, if the student is eligible to write the examination as per Clause 7 and, if such request for withdrawal is made prior to the submission of the Continuous Assessment marks of the course(s) with the recommendations from the Head of the Department.

14.3 Withdrawal shall not be considered as an appearance in the examination for the eligibility of a student for First Class with Distinction or First Class.

15. AUTHORIZED BREAK OF STUDY FROM A PROGRAMME

15.1 A student is permitted to go on break of study for a maximum period of one year either as two breaks of one semester each or a single break of one year.

15.2 A student is normally not permitted to break the period of study temporarily. However, if a student happens to discontinue the programme temporarily during the middle of programme of study, for reasons such as personal accident or hospitalization due to ill health or in need of health care, he/she shall apply to the Head of the Institution in advance, in any case, not later than the last date for registering for the semester examination, through the Head of the Department stating the reasons for the break-of-study (for one academic semester or 6 months, whichever is earlier). However, a student detained for want of minimum attendance requirement as per Clause 7 shall not be considered as permitted 'Break of Study' and Clause 15.3 is not applicable for such case.

15.3 The student is permitted to rejoin the programme after the break shall be governed by the rules and regulations of DoTE and the Curriculum and Regulations in force at the time of rejoining, subject to the Clause 11.2.1.

15.4 Authorized break of study will be counted towards the duration specified for passing all the courses (vide Clause 5.1 and 5.2) and for the purpose of classification of Degree (vide Clause 13).

15.5 The total period for completion of the programme reckoned from the commencement of the first semester to which the student is admitted shall not exceed the maximum period specified in Clause 5.1, irrespective of the period of break of study in order that he / she may be eligible, for the award of the degree (vide Clause 13).

15.6 In case of valid reasons (as stated in Clause 15.2) extended break-of-study may be granted by the Head of the Institution for a period not more than one year (total duration or two semesters whichever is earlier) in addition to the earlier authorized break of study.

15.7 If a student does not report back to the Institute, even after the extended Break of Study, the name of the student shall be deleted permanently from the college enrollment. Such students are not entitled to seek readmission under any circumstances.

16. SCHEME OF ASSESSMENT

Courses offered under B.E. / B.Tech. Programmes are assessed as given below:

		Marks
I	**THEORY COURSES**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	Test I (15)	
	Test II (15)	
	Open book test (10)	
	Library - Seminars / Assignments (Two) (10)	
	End Semester Examination	**50**
	Total Marks	**100**

II	**THEORY COURSES WITH LAB COMPONENT**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	Test I (10)	
	Test II (10)	
	Conduct of Experiment	
	Preparation(5)	
	Experiment and Results (5)	
	Record Note[#]	
	Final Lab Examination (20)	
	End Semester Examination (QP pattern as per (I))	**50**
	Total Marks	**100**

III	**LABORATORY COURSES**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	Conduct of Experiment	
	i. Preparation (5)	
	ii. Experiment and Results (10)	
	iii. Record / Observation[#] *(5)*	
	Test – Cycle I (15)	
	Test – Cycle II (15)	
	End Semester Examination	
	Experiments & Results (40)	**50**
	Viva Voce – (10)	
	Total Marks	**100**

[#] *Reports / Record Note / Integrated Lab Manual to be retained for 1 year for Academic Audit, by respective Department*

IV	**TECHNICAL SEMINAR**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	Presentation I (25)	
	Presentation II (25)	
	End Semester Examination	
	Report# (20) *Presentation (20)* *Viva voce (10)*	**50**
	Total Marks	**100**
V	**PROJECT**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	Review I	
	Literature survey (10)	
	Problem Identification (5)	
	Methodology (10)	
	Review II	
	Continuation in Methodology (10)	
	Results / Progress (15)	
	End Semester Examination	
	Report# (20) *Presentation (20)* *Viva voce (10)*	**50**
	Total Marks	**100**
VI	**LANGUAGE ELECTIVE**	**Marks**
	(CONTINUOUS ASSESSMENT ONLY)	
	Test 1	
	Listening (10) *Speaking (5)* *Reading (5)* *Writing (5)*	**25**
	Test 2	
	Listening (10) *Speaking (5)* *Reading (5)* *Writing (5)*	**25**
	Oral Exam	**50**
	Total Marks	**100**

Reports / Record Note / Integrated Lab Manual to be retained for 1 year for Academic Audit, by respective Department

VII	**ONE-CREDIT COURSE**	**Marks**
	Test	**30**
	Quiz	**20**
	Final Examination	**50**
	Total Marks	**100**
VIII	**MINI-PROJECT**	**Marks**
	(CONTINUOUS ASSESSMENT ONLY)	
	Review I	**25**
	Review II	**25**
	Project Evaluation	
	Report (25)[#]	**50**
	Presentation&Viva Voce (25)	
	Total Marks	**100**
IX	**LIFE SKILLS**	**Marks**
	(CONTINUOUS ASSESSMENT ONLY)	
	Test I	**25**
	Test II	**25**
	Final Examination	**50**
	Total Marks	**100**
	Grades (Excellent / Good / Satisfactory/Not Satisfactory)	
X	**VALUE ADDED / CERTIFICATE COURSES**	**Marks**
	(CONTINUOUS ASSESSMENT ONLY)	
	Test I	**25**
	Test II	**25**
	Final Evaluation / Test	**50**
	Total Marks	**100**
	Grades (Excellent / Good / Satisfactory / Not Satisfactory)	
XI	**ENGINEERING GRAPHICS**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	Class work (based on attendance) (5)	
	Assignments (Minimum 8 Assignments) (20)	
	Model Examination (25)	
	End Semester Examination	**50**
	Total Marks	**100**

[#] *Reports / Record Note / Integrated Lab Manual to be retained for 1 year for Academic Audit, by respective Department*

Optional Test: *A student becomes eligible to appear for the one optional test conducted after the Periodical Test II, only under the following circumstances: (i) absent for Test I or Test II or both on account of medical reasons (hospitalization / accident / specific illness), or (ii) participation in the College / University / State / National / International level Sports events with prior permission from the Head of the Institution and (iii) on satisfying the conditions (i) or (ii), the student should have registered for the Optional Test, through the concerned member of faculty who handles the course or through the respective Head of the Department, submitted to the Controller of Examinations. Such Optional Tests are not conducted for the courses under the categories III, IV, V, VI, VII, VIII, IX, X and XI listed above.*

17. FIELD / INDUSTRIAL VISIT / INTERNSHIP

Heads of Departments, in order to provide the experiential learning to the students, shall take efforts to arrange at least two industrial visits / field visits in a semester. The students may also undergo in-plant training / internship during summer / winter vacation between III and VII semesters.

18. PERSONALITY AND CHARACTER DEVELOPMENT

Every student shall be required to undergo a minimum of 40 hours of Personality Development Programmes viz, NSS / NCC / YRC / YOGA / Sports and Games / Technical and Non-technical Club activities during the first year, failing which he/she shall not be permitted to appear for the End Semester examinations of semester II and there onwards. Such students are permitted to appear for the End Semester examinations of semester II and there onwards only after completing satisfactorily the requirements.

The attendance of the personality and character development courses / events shall be maintained on the regular basis by the concerned First Year Co-ordinators and made available in the Office of the Controller of Examinations before the commencement of Semester examinations of Semester I or Semester II.

19. DISCIPLINE

A student is expected to follow the rules and regulations laid down by the Institute and the affiliating University, as published from time to time. Any violations, if any, shall be treated as per the procedures stated thereof.

If a student indulges in malpractice in any of the End Semester / Continuous Assessments, he / she shall be liable for punitive action as prescribed by the Institution / University from time to time.

20. REVISION OF REGULATIONS, CURRICULUM AND SYLLABI

The Institution reserves the right to revise/amend/change the Regulations, Curriculum, Syllabi, Scheme of Examinations and date of implementation and to introduce Additional Electives, Open Electives, One Credit Courses and Value Added Courses through the Academic Council.

The Question Paper pattern (Theory Examination) for UG Programme is given below:

PART A

Objective Type Questions: 20	**(20X1 = 20 Marks)**	**20**

PART B

Short Answer Questions: 10	**(10X2 = 20 Marks)**	**20**

PART C

Long Answer Questions: 5	**(5X12 = 60 Marks)**	**60**

	Total	**100**

Program Educational Objectives (PEOs)

After graduation, the Graduates of Mechanical Engineering will be able to

PEO I	Become familiar with applications of Science, Technology, Engineering and Mathematics in day-to-day life and present their ideas with good communication and aptitude.
PEO II	Design and develop products / processes with appropriate research and provide solutions to the requirements of industry and society.
PEO III	Be innovative, develop the quest for entrepreneurship or pursue higher education, be ethical in profession, and create healthy environment.

Program Outcomes

a) **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b) **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c) **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d) **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e) **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f) **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g) **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h) **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i) **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j) **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k) **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l) **Life-long Learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

m) Design, analyse and evaluate the performance of mechanical systems.

n) Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

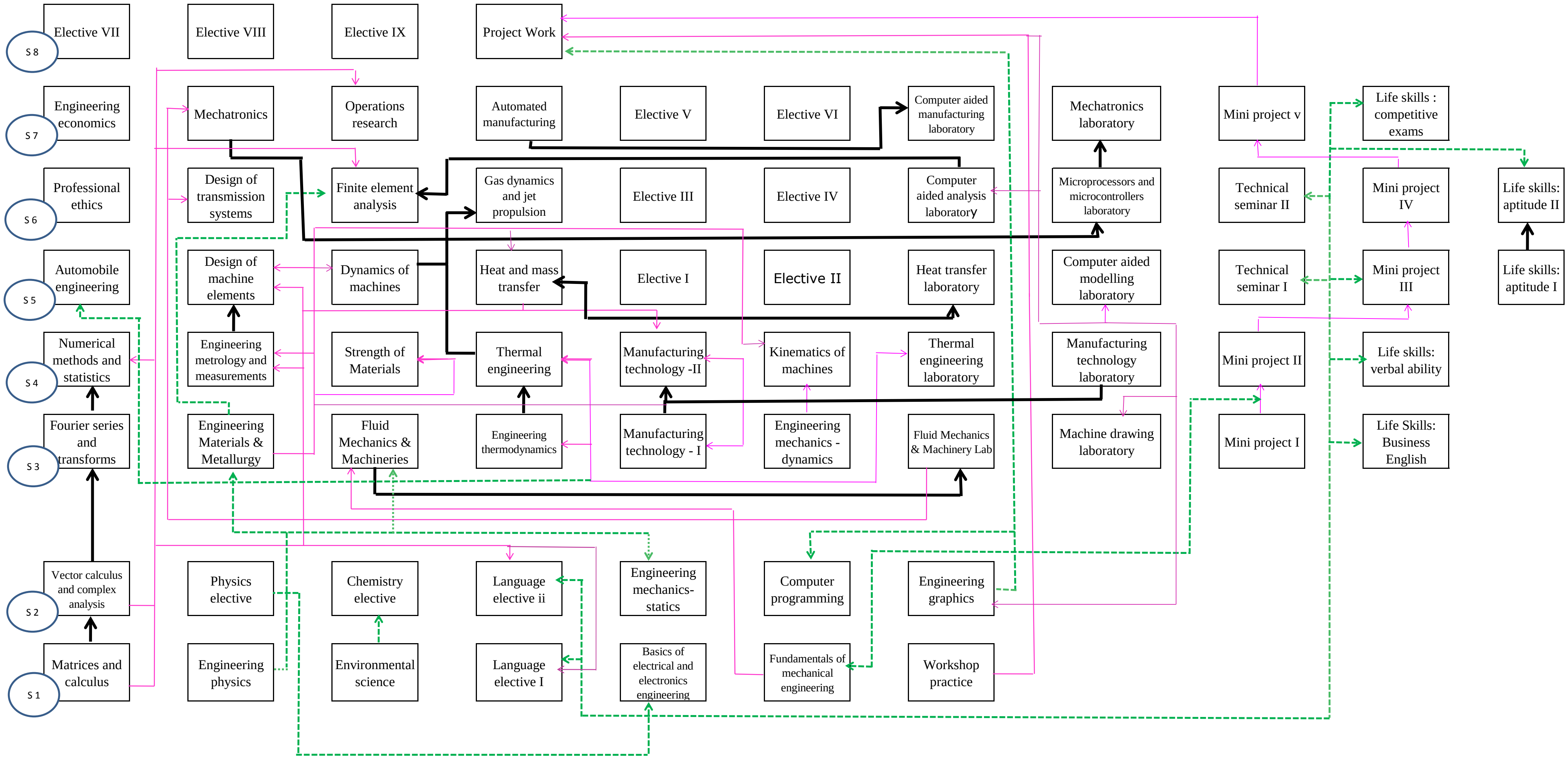
o) Address all the fluid flow and energy transfer related problems of mechanical systems.

Correlation of PEOs with POs and PSOs

POs	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
PEO I	3	2	2	2	1	2	2	1	2	3	2	2	3	3	3
PEO II	3	3	3	3	3	3	3	2	2	2	2	2	3	2	2
PEO III	2	3	3	3	3	3	3	3	2	2	2	2	3	3	3

DEPARTMENT OF MECHANICAL ENGINEERING
CURRICULAM DESIGN & INTERLINKING OF COURSES

360 º FLEXIBLE LEARNING FRAME WORK



B.E. MECHANICAL ENGINEERING
Minimum Credits to be Earned :179

FIRST SEMESTER

Code No.	Course	Objectives & Outcomes		L	T	P	C	Maximum Marks			Category
		PEOs	POs					CA	ES	Total	
15MA101	MATRICES AND CALCULUS*	I,II,III	a,b	3	2	0	4	50	50	100	BS
15PH102	ENGINEERING PHYSICS*	I,II,III	a,b	2	0	2	3	50	50	100	BS
15CH103	ENVIRONMENTAL SCIENCE*	I,II,III	a,b,c,f,g	2	0	2	3	50	50	100	HSS
	LANGUAGE ELECTIVE I#	-	-	-	-	-	3	100	-	100	HSS
15GE105	BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING$^{\Delta}$	I,II,III	a,b,d	2	0	2	3	50	50	100	ES
15ME106	FUNDAMENTALS OF MECHANICAL ENGINEERING	I,II,III	a	2	0	2	3	50	50	100	ES
15GE107	WORKSHOP PRACTICE$^{\Omega}$	I,II,III	a,e,i,k,n	0	0	2	1	50	50	100	ES
Total				**11**	**2**	**10**	**20**	**400**	**300**	**700**	**-**

SECOND SEMESTER

Code No.	Course	Objectives & Outcomes		L	T	P	C	Maximum Marks			Category
		PEOs	POs					CA	ES	Total	
15MA201	VECTOR CALCULUS AND COMPLEX ANALYSIS*	I,II,III	a,b	3	2	0	4	50	50	100	BS
	PHYSICS ELECTIVE*	-	-	-	-	-	4	50	50	100	BS
	CHEMISTRY ELECTIVE*	-	-	-	-	-	4	50	50	100	BS
	LANGUAGE ELECTIVE II#	-	-	-	-	-	3	100	-	100	HSS
15ME205	ENGINEERING MECHANICS-STATICS	I,II,III	a,b,m	2	0	2	3	50	50	100	ES
15GE206	COMPUTER PROGRAMMING$^{\Psi}$	I,II,III	a,b,c,e	3	0	2	4	50	50	100	ES
15GE207	ENGINEERING GRAPHICS$^{\lambda}$	I,II,III	a,f,h,j,l,m	0	0	4	2	50	50	100	ES
Total				**8**	**0**	**8**	**24**	**400**	**300**	**700**	**-**

* Common to all branches of B.E./B.Tech
# Common to all branches of B.E./B.Tech (Continuous Assessment)
$^{\Delta}$ Common to AE,AG,AU,CE,ME,MTRS, BT,TT,FD (I Semester) and to CSE,FT,IT (II Semester)
$^{\Omega}$ Common to AE, AG,AU,ME,MTRS, BT,FT,TT ,FD (I Semester) and to CE,CSE,ECE,EEE,EIE,IT (II Semester)
$^{\Psi}$ Common to CE (I Semester) and to AE,AG,AU, ME,MTRS, BT,FT,TT,FD (II Semester)
$^{\lambda}$ Common to CE,CSE,ECE,EEE,EIE,IT (I Semester) and to AE, AG,AU,ME,MTRS, BT,FT,TT, FD (II Semester)

Code No.	Course	Objectives & Outcomes		L	T	P	C	Maximum Marks			Category
THIRD SEMESTER											
Code No.	**Course**	**PEOs**	**POs**	**L**	**T**	**P**	**C**	**CA**	**ES**	**Total**	**Category**
15MA301	FOURIER SERIES AND TRANSFORMS[α]	I,II,III	a,b	3	2	0	4	50	50	100	BS
15ME302	ENGINEERING MATERIALS AND METALLURGY[∇]	I,II,III	a,b,l,n	2	0	2	3	50	50	100	ES
15ME303	FLUID MECHANICS AND MACHINERY[∇]	I,II,III	a,b,d,f,g,o	3	2	0	4	50	50	100	ES
15ME304	ENGINEERING THERMODYNAMICS[∇]	I,II,III	a,b,d,f,g,o	3	2	0	4	50	50	100	ES
15ME305	MANUFACTURING TECHNOLOGY - I	I,II,III	a,b,i,j,l,n	2	0	2	3	50	50	100	PC
15ME306	ENGINEERING MECHANICS - DYNAMICS	I,II,III	a,b,f,l,m	2	2	0	3	50	50	100	ES
15ME307	FLUID MECHANICS AND MACHINERY LABORATORY	I,II,III	a,b,d,j	0	0	2	1	50	50	100	ES
15ME308	MACHINE DRAWING LABORATORY	I,II,III	a,f,j,l,m	0	0	2	1	50	50	100	PC
15ME309	MINI PROJECT I	I,II,III	a,b,c,d,e,f,g, h,i,j,k,l	0	0	2	1	100	-	100	EEC
15GE310	LIFE SKILLS: BUSINESS ENGLISH[Φ]	I,III	j	0	0	2	-	100	-	100	EEC
Total				**17**	**6**	**10**	**24**	**600**	**400**	**1000**	**-**
FOURTH SEMESTER											
Code No.	**Course**	**PEOs**	**POs**	**L**	**T**	**P**	**C**	**CA**	**ES**	**Total**	**Category**
15MA401	NUMERICAL METHODS AND STATISTICS[β]	I,II,III	a	2	2	0	3	50	50	100	BS
15ME402	ENGINEERING METROLOGY AND MEASUREMENTS[∇]	I,II,III	a,e,l,n	2	0	2	3	50	50	100	PC
15ME403	STRENGTH OF MATERIALS[∇]	I,II,III	a,b,c,l,m	2	2	2	4	50	50	100	PC
15ME404	THERMAL ENGINEERING	I,II,III	a,b,c,e,g,o	3	2	0	4	50	50	100	PC
15ME405	MANUFACTURING TECHNOLOGY -II	I,II,III	a,b,g,l,n	3	0	0	3	50	50	100	PC
15ME406	KINEMATICS OF MACHINES	I,II,III	a,b,l,m	3	2	0	4	50	50	100	PC
15ME407	THERMAL ENGINEERING LABORATORY	I,II,III	a,b,c,e,i,l,o	0	0	2	1	50	50	100	PC
15ME408	MANUFACTURING TECHNOLOGY LABORATORY	I,II,III	a,i,j,l,n	0	0	2	1	50	50	100	PC
15ME409	MINI PROJECT II	I,II,III	a,b,c,d,e,f,g, h,i,j,k,l	0	0	2	1	100	-	100	EEC
15GE410	LIFE SKILLS: VERBAL ABILITY[Φ]	I,III	j	0	0	2	-	100	-	100	EEC
Total				**15**	**8**	**12**	**24**	**600**	**400**	**1000**	**-**

[α] Common to all branches of B.E./B.Tech. except CSE
[∇] Common to AU and ME
[Φ] Common to all branches of B.E./B.Tech (Non-Credit Course)
[β] Common to AG,AU,ME,MTRS,EEE,EIE,BT,TT,FT,FD

FIFTH SEMESTER

Code No.	Course	Objectives & Outcomes		L	T	P	C	Maximum Marks			Category
		PEOs	POs					CA	ES	Total	
15ME501	AUTOMOBILE ENGINEERING	I,II,III	e,f,g,l,o	2	0	2	3	50	50	100	PC
15ME502	DESIGN OF MACHINE ELEMENTS	I,II,III	a,b,l,m	3	2	0	4	50	50	100	PC
15ME503	DYNAMICS OF MACHINES	I,II,III	a,b,l,m	2	0	2	3	50	50	100	PC
15ME504	HEAT AND MASS TRANSFER	I,II,III	a,b,e,g	3	2	0	4	50	50	100	PC
	ELECTIVE I	-	-	-	-	-	3	50	50	100	PE
	ELECTIVE II	-	-	-	-	-	3	50	50	100	PE
15ME507	HEAT TRANSFER LABORATORY	I,II,III	a,b,e,i,l,o	0	0	2	1	50	50	100	PC
15ME508	COMPUTER AIDED MODELLING LABORATORY	I,II,III	a,e,j,l,m	0	0	2	1	50	50	100	PC
15ME509	TECHNICAL SEMINAR I	I,II,III	b,e,f,j,l	0	0	2	1	50	50	100	EEC
15ME510	MINI PROJECT III	I,II,III	a,b,c,d,e,f,g,h,i,j,k,l	0	0	2	1	100	-	100	EEC
15GE511	LIFE SKILLS: APTITUDE I $^{\Phi}$	-	-	0	0	2	-	100	-	100	EEC
Total				**10**	**4**	**14**	**24**	**650**	**450**	**1100**	**-**

SIXTH SEMESTER

Code No.	Course	Objectives & Outcomes		L	T	P	C	Maximum Marks			
		PEOs	POs					CA	ES	Total	Category
15GE601	PROFESSIONAL ETHICS $^{+}$	I,II,III	f,g,h,i,j,k	2	0	0	2	50	50	100	HSS
15ME602	DESIGN OF TRANSMISSION SYSTEMS	I,II,III	a,b,c,l,m	3	2	0	4	50	50	100	PC
15ME603	FINITE ELEMENT ANALYSIS $^{\nabla}$	I,II,III	a,b,c,l,m	3	2	0	4	50	50	100	PC
15ME604	GAS DYNAMICS AND JET PROPULSION	I,II,III	a,b,f,o	2	2	0	3	50	50	100	PC
	ELECTIVE III	-	-	-	-	-	3	50	50	100	PE
	ELECTIVE IV	-	-	-	-	-	3	50	50	100	PE
15ME607	COMPUTER AIDED ANALYSIS LABORATORY	I,II,III	a,b,d,e,l,m	0	0	2	1	50	50	100	PC
15ME608	MICROPROCESSORS AND MICROCONTROLLERS LABORATORY	I,II,III	a,d,e	1	0	2	2	50	50	100	ES
15ME609	TECHNICAL SEMINAR II	I,II,III	b,e,f,h,i,j,l	0	0	2	1	50	50	100	EEC
15ME610	MINI PROJECT IV	I,II,III	a,b,c,d,e,f,g,h,i,j,k,l	0	0	2	1	100	-	100	EEC
15GE611	LIFE SKILLS: APTITUDE II $^{\Phi}$	-	-	0	0	2	-	100	-	100	EEC
Total				**11**	**6**	**10**	**24**	**650**	**450**	**1100**	**-**

$^{\Phi}$ Common to all branches of B.E./B.Tech (Non-Credit Course)
$^{+}$ Common to AE, AU, CE, ME,MTRS, BT,FT,TT, FD (VI Semester) and to CSE,ECE,EEE,EIE,IT (VII Semester)
$^{\nabla}$ Common to AU and ME

SEVENTH SEMESTER											
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**	Maximum Marks			
		PEOs	**POs**					**CA**	**ES**	**Total**	**Category**
15GE701	ENGINEERING ECONOMICS[$]	II,III	f,g,k,l	3	0	0	3	50	50	100	HSS
15ME702	MECHATRONICS	I,II,III	a,b,c,l,m	3	0	0	3	50	50	100	PC
15ME703	OPERATIONS RESEARCH	I,II,III	a,b,c,e,n	2	2	0	3	50	50	100	PC
15ME704	AUTOMATED MANUFACTURING	I,II,III	a,e,l,n	3	0	0	3	50	50	100	PC
	ELECTIVE V	-	-	-	-	-	3	50	50	100	PE
	ELECTIVE VI	-	-	-	-	-	3	50	50	100	PE
15ME707	COMPUTER AIDED MANUFACTURING LABORATORY	I,II,III	a,e,i,j,l,n	0	0	2	1	50	50	100	PC
15ME708	MECHATRONICS LABORATORY	I,II,III	a,b,c,e,l,m	0	0	2	1	50	50	100	PC
15ME709	MINI PROJECT V	I,II,III	a,b,c,d,e,f,g,h,i,j,k,l	0	0	2	1	100	-	100	EEC
15GE710	LIFE SKILLS : COMPETITIVE EXAMS[Φ]	-	-	0	0	2	-	100	-	100	EEC
Total				**11**	**2**	**8**	**21**	**600**	**400**	**1000**	**-**

EIGHT SEMESTER											
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**	Maximum Marks			
		PEOs	**POs**					**CA**	**ES**	**Total**	**Category**
	ELECTIVE VII	-	-	-	-	-	3	50	50	100	PE
	ELECTIVE VIII	-	-	-	-	-	3	50	50	100	PE
	ELECTIVE IX	-	-	-	-	-	3	50	50	100	PE
15ME804	PROJECT WORK	I,II,III	a,b,c,d,e,f,g,h,i,j,k,l	-	-	-	9	50	50	100	EEC
Total				**-**	**-**	**-**	**18**	**200**	**200**	**400**	**-**

[$] Common to CSE,ECE,EEE,EIE,IT (VI Semester) and to AE, AG,AU,CE,ME,MTRS,BT,FT,TT, FD (VII Semester)
[Φ] Common to all branches of B.E./B.Tech (Non-Credit Course)

Electives							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
LANGUAGE ELECTIVES							
15LE101	BASIC ENGLISH I	I	j	3	0	0	3
15LE102	COMMUNICATIVE ENGLISH I	I	j	3	0	0	3
15LE201	BASIC ENGLISH II	I	j	3	0	0	3
15LE202	COMMUNICATIVE ENGLISH II	I	j	3	0	0	3
15LC203	CHINESE	I	j	3	0	0	3
15LF203	FRENCH	I	j	3	0	0	3
15LG203	GERMAN	I	j	3	0	0	3
15LH203	HINDI	I	j	3	0	0	3
15LJ203	JAPANESE	I	j	3	0	0	3
PHYSICS ELECTIVES							
15PH201	PHYSICS OF MATERIALS	I,II,III	a,b,i	3	0	2	4
15PH202	APPLIED PHYSICS	I,II,III	a,b,i	3	0	2	4
15PH203	MATERIALS SCIENCE	I,II,III	a	3	0	2	4
15PH204	PHYSICS OF ENGINEERING MATERIALS	I,II,III	a	3	0	2	4
15PH205	SOLID STATE PHYSICS	I,II,III	a	3	0	2	4
CHEMISTRY ELECTIVES							
15CH201	ENGINEERING CHEMISTRY	I,II,III	a,b,d	3	0	2	4
15CH202	APPLIED CHEMISTRY	I,II,III	a,b,d	3	0	2	4
DISCIPLINE ELECTIVES							
15ME001	COMPUTER AIDED DESIGN	I,II,III	a,b,m	3	0	0	3
15ME002	APPLIED HYDRAULICS AND PNEUMATICS	I,II,III	a,b,c,l,m	3	0	0	3
15ME003	DESIGN OF JIGS, FIXTURES AND PRESS TOOLS	I,II,III	a,b,c,f,l,m	3	0	0	3
15ME004	NON - TRADITIONAL MACHINING PROCESSES	I,II,III	a,b,e,g,l,n	3	0	0	3
15ME005	WELDING TECHNOLOGY	I,II,III	a,b,c,d,e,f,g,k,l,n	3	0	0	3
15ME006	MECHANICAL BEHAVIOUR OF MATERIALS	I,II,III	a,c,e,f,m	3	0	0	3
15ME007	PROCESS PLANNING AND COST ESTIMATION	I,II,III	a,b,c,h,i,k,l,m,n	3	0	0	3
15ME008	INTERNAL COMBUSTION ENGINES	I,II,III	a,c,g,l,o	3	0	0	3
15ME009	REFRIGERATION AND AIR-CONDITIONING	I,II,III	a,b,e,g,l,o	3	0	0	3
15ME010	TOTAL QUALITY MANAGEMENT	I,II,III	a,b,c,e,f,g,h,i,j,k,m,n	3	0	0	3

15ME011	COMPOSITE MATERIALS AND MECHANICS	I,II,III	a,b,l,n	3	0	0	3
15ME012	STATISTICAL QUALITY CONTROL AND RELIABILITY ENGINEERING	I,II,III	a,b,c,e,m,n	3	0	0	3
15ME013	MECHANICAL VIBRATIONS	I,II,III	a,b,e,l,m	3	0	0	3
15ME014	FLEXIBLE MANUFACTURING SYSTEMS	I,II,III	a,b,e,l,n	3	0	0	3
15ME015	COMPUTER INTEGRATED MANUFACTURING	I,II,III	a,b,c,e,n	3	0	0	3
15ME016	ADVANCED CASTING AND FORMING PROCESSES	I,II,III	a,b,c,l,n	3	0	0	3
15ME017	INDUSTRIAL SAFETY ENGINEERING	I,II,III	a,b,c,e,f,g,h,i,j,n	3	0	0	3
15ME018	INDUSTRIAL ROBOTICS	I,II,III	a,b,l,m	3	0	0	3
15ME019	ADDITIVE MANUFACTURING	I,II,III	a,b,c,e,l,n	3	0	0	3
15ME020	NON - DESTRUCTIVE TESTING	I,II,III	a,b,c,l,n	3	0	0	3
15ME021	RENEWABLE ENERGY SOURCES	I,II,III	a,b,g,h,o	3	0	0	3
15ME022	CRYOGENIC ENGINEERING	I,II,III	a,b,c,l,m	3	0	0	3
15ME023	ENGINEERING TRIBOLOGY	I,II,III	a,b,g,k,l,m	3	0	0	3
15ME024	POWER PLANT ENGINEERING	I,II,III	a,b,c,f,g,k,o	3	0	0	3
15ME025	OPTIMIZATION TECHNIQUES	I,II,III	a,b,c,e,l,m	3	0	0	3
15ME026	DESIGN FOR MANUFACTURE AND ASSEMBLY	I,II,III	a,b,c,e,l,m	3	0	0	3
15ME027	INDUSTRIAL ENGINEERING	I,II,III	a,b,c,n	3	0	0	3
15ME028	INDUSTRIAL MAINTENANCE ENGINEERING	I,II,III	a,b,c,e,f,g,n	3	0	0	3
15ME029	COMPUTATIONAL FLUID DYNAMICS	I,II,III	a,b,c,d,e,m,n,o	3	0	0	3
15ME030	**FUELS AND COMBUSTION**	I,II,III	a,b,g,o	3	0	0	3
ENTREPRENEURSHIP ELECTIVES							
15GE001	ENTREPRENEURSHIP DEVELOPMENT I	I,II,III	b,c,d,e,f,k	3	0	0	3
15GE002	ENTREPRENEURSHIP DEVELOPMENT II	I,II,III	b,c,h,i,j,k	3	0	0	3
PHYSICAL SCIENCE ELECTIVES							
15GE0P1	NANOMATERIALS SCIENCE	I,II,III	a,b	3	0	0	3
15GE0P2	SEMICONDUCTOR PHYSICS & DEVICES	I,II,III	a,b	3	0	0	3
15GE0P3	APPLIED LASER SCIENCE	I,II,III	a,b	3	0	0	3
15GE0C1	CORROSION SCIENCE	I,II,III	a,b,g	3	0	0	3
15GE0C2	ENERGY STORING DEVICES AND FUEL CELLS	I,II,III	a,b,d	3	0	0	3
15GE0C3	POLYMER CHEMISTRY AND PROCESSING	I,II,III	a,b,c	3	0	0	3
OPEN ELECTIVES							
15ME0YA	**INDUSTRIAL PROCESS ENGINEERING**	II, III	a,b,c,n	3	0	0	3
15ME0YB	SAFETY ENGINEERING	II, III	a,b,c,e, f, g, h,i,n	3	0	0	3

15ME0YC	MAINTENANCE ENGINEERING	II, III	a,b,c,e, f, g	3	0	0	3
15ME0YD	BASICS OF NON-DESTRUCTIVE TESTING	I, II, III	a,e,g,j,n	3	0	0	3
15ME0YE	RAPID PROTOTYPING	I, II, III	a,b,e,l,m,n	3	0	0	3
ONE CREDIT COURSES							
15ME0XA	GEOMETRIC DIMENSIONING AND TOLERANCING			-	-	-	1
15ME0XB	LEAN MANUFACTURING			-	-	-	1
15ME0XC	PIPING ENGINEERING			-	-	-	1
15ME0XD	PROBLEM SOLVING TECHNIQUES			-	-	-	1
15ME0XE	AUTOMOTIVE EXHAUST SYSTEM			-	-	-	1
15ME0XF	CONTINUOUS IMPROVEMENT			-	-	-	1
15ME0XG	INDIAN PATENT LAW			-	-	-	1
15ME0XH	RAILWAY TRACK TECHNOLOGY			-	-	-	1
15ME0XI	GLASS ENGINEERING			-	-	-	1
15ME0XJ	PLASTICS – DESIGN, PROCESSING, TOOLING, ASSEMBLY AND TESTING			-	-	-	1
15ME0XK	5S-INTRODUCTION AND IMPLEMENTATION			-	-	-	1
15ME0XL	ENERGY AUDITING AND INSTRUMENTS			-	-	-	1
ADDITIONAL ONE CREDIT COURSES (I to III Semesters)							
15GE0XA	HEALTH & FITNESS			-	-	-	1
15GE0XB	FOUNDATION COURSE IN COMMUNITY RADIO TECHNOLOGY			-	-	-	1
15GE0XC	VEDIC MATHEMATICS			-	-	-	1
15GE0XD	INTRODUCTION TO ALGORITHMS			-	-	-	1
15GE0XE	ETYMOLOGY			-	-	-	1
15GE0XF	HINDUSTANI MUSIC			-	-	-	1
15GE0XG	CONCEPT, METHODOLOGY AND APPLICATIONS OF VERMICOMPOSTING			-	-	-	1
15GE0XH	AGRICULTURE FOR ENGINEERS			-	-	-	1
15GE0XI	INTRODUCTION TO DATA ANALYSIS USING SOFTWARE			-	-	-	1
15GE0XJ	ANALYSIS USING PIVOT TABLE			-	-	-	1
15GE0XL	INTERVIEW SKILLS			-	-	-	1
15GE0XN	JOURNALISM AND MASS COMMUNICATION			-	-	-	1
15GE0XO	VISUAL MEDIA AND FILM MAKING			-	-	-	1
15GE0XP	YOGA FOR HUMAN EXCELLENCE			-	-	-	1
15GE0XQ	CARNATIC MUSIC			-	-	-	1
15GE0XR	GENERAL PSYCOLOGY			-	-	-	1
15GE0XS	NEURO BEHAVIOURAL SCIENCE			-	-	-	1
15GE0XT	INNOVATION AND ENTREPRENEURSHIP			-	-	-	1

VALUE ADDED COURSES	
15MEV01	INTRODUCTION TO RISK ANALYSIS
15MEV02	MODELING USING CATIA V5
15MEV03	MODELING IN SOLID WORKS
15MEV04	CORE JAVA PROGRAMMING
15MEV05	FUNDAMENTALS OF VALUE ENGINEERING
15MEV06	TOOL DESIGN AND MANUFACTURING
15MEV07	CNC PROGRAMMING AND OPERATIONS
15MEV08	WELDING INSPECTION & TESTING
15MEV09	PUMP INSPECTION AND TESTING
15MEV10	PRODUCT LIFE CYCLE MANAGEMENT
15MEV11	SHEET METAL TOOLS - DESIGN AND MANUFACTURING PROCESS
15MEV12	3D VIA COMPOSER

BRIDGE COURSES	
15MEB01	ENGINEERING MECHANICS-STATICS
15MEB02	ENGINEERING GRAPHICS

SUMMARY OF CREDIT DISTRIBUTION

S.No	CATEGORY	CREDITS PER SEMESTER								TOTAL CREDIT	CREDITS in %	Range of Total Credits	
		I	II	III	IV	V	VI	VII	VIII			Min	Max
1	BS	7	12	4	3					26	15	15%	20%
2	ES	7	9	15			2			33	18	15%	20%
3	HSS	6	3				2	3		14	08	5%	10%
4	PC			4	20	16	12	11		63	35	30%	40%
5	PE					6	6	6	9	27	15	10%	15%
6	EEC			1	1	2	2	1	9	16	09	10%	15%
Total		20	24	24	24	24	24	21	18	179	100	-	-

BS - Basic Sciences
ES - Engineering Sciences
HSS - Humanities and Social Sciences
PC - Professional Core
PE - Professional Elective
EEC - Employability Enhancement Course
CA - Continuous Assessment
ES - End Semester Examination

15MA101 MATRICES AND CALCULUS 3 2 0 4

Course Objectives

- Interpret the introductory concepts of Matrices and Calculus, which will enable them to model and analyze physical phenomena involving continuous changes of variables
- Summarize and apply the methodologies involved in solving problems related to fundamental principles of Matrices and Calculus.
- Develop enough confidence to identify and model mathematical patterns in real world and offer appropriate solutions, using the skills learned in their interactive and supporting environment.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Analyze the characteristics of a linear system with eigen values and vectors.
2. Identify and model the real time problem using first order linear differential equations.
3. Recognize and solve the higher order ordinary differential equations.
4. Characterize the functions and get the solutions of the same.
5. Evaluate the functions to get the surface area and volume using multiple integral.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1														
2	1	2													
3	1														
4	1	2													
5	3														

UNIT I **9 Hours**

MATRICES

Eigen Values and Eigen Vectors of a real matrix - Properties of Eigen Values-Stretching of elastic membranes. Cayley - Hamilton Theorem - Quadratic form: Reduction of a quadratic form to a canonical form.

UNIT II **8 Hours**

ORDINARY DIFFERENTIAL EQUATIONS OF FIRST ORDER

Leibnitz's Equations - Modelling and solutions using Newtons law of cooling of bodies - solutions to R-L and R-C electric circuits.

UNIT III **11 Hours**

ORDINARY DIFFERENTIAL EQUATIONS OF HIGHER ORDER

Linear differential equations of second and higher order with constant coefficients. Linear differential equations of higher order with variable coefficients: Cauchys linear differential equation - Method of variation of parameters for second order differential equations.

UNIT IV **9 Hours**

MULTIVARIABLE CALCULUS

Functions of Two Variables and their solutions- Total Differential - Derivative of implicit functions- Jacobians Unconstrained maxima and minima.

UNIT V **8 Hours**

MULTIPLE INTEGRALS

Double integration with constant and variable limits-Region of integration -Change the order of integration -Area as double integral in cartesian coordinates. Triple integral in Cartesian coordinates.

FOR FURTHER READING

Applications of mass spring system in ordinary differential equations of higher order

Total: 75 Hours

Reference(s)

1. C. Ray Wylie and C Louis Barrett, Advanced Engineering Mathematics, Sixth Edition, Tata McGraw-Hill Publishing Company Ltd, 2003.
2. Erwin Kreyszig , Advanced Engineering Mathematics, Tenth Edition, Wiley India Private Limited,New Delhi 2015.
3. Peter V. O Neil , Advanced Engineering Mathematics, Seventh Edition , Cengage Learning India Private Limited, 2012.
4. B.S. Grewal, Higher Engineering Mathematics, Forty Third Edition, Khanna Publications , New Delhi 2014.
5. Glyn James, Advanced Engineering Mathematics, Third Edition,Wiley India, 2014.
6. T.Veerarajan, Engineering mathematics for First Year,Tata McGraw-Hill Publishing company Limited, New Delhi, 2014.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2					6					6			6											20
2	2					2				4					4				6						18
3		2			2						6			6					6						22
4		2					6				8				6										22
5	2						4			6									6						18
																								Total	100

Assessment Questions

Remember

1. Define spectral values of a matrix.
2. State Cayley - Hamilton theorem.
3. List out five natures of a quadratic form.
4. Reproduce the solution for the first order linear differential equation $\frac{dy}{dx} + Py = Q$

5. State Newton's Law of cooling in ordinary differential equation.
6. Define Jacobian in three dimensions.
7. State Wronskian determinant.
8. List two sufficient conditions for extreme of a function $z = f(x, y)\ at\ (a, b)$.
9. Define Jacobian of $u\ and\ v$ with respect to $x\ and\ y$.
10. Recall any two properties of Jacobians.

Understand

1. Identify whether there exists a square matrix without eigenvalues. Give reason.
2. Indicate the matrix which has real eigenvalues and real eigenvectors.
3. Identify in which cases can we expect orthogonal eigenvectors.
4. Compare second and higher order ordinary differential equation.
5. A condenser of capacity C discharged through an inductance L and resistance R in series and the charge q at the time t satisfies the equation L$\frac{d^2q}{dt^2}$+R$\frac{dq}{dt}+\frac{q}{c}$=0.given that L=0.25 henries,R=250 ohms,C=2×10^{-6} farads,and that when t=0,charge q is 0.002 coulombs and the current $\frac{dq}{dt}$=0,obtain the value of q in terms of t.
6. Represent the area bounded by the parabolas y^2=4-x and y^2=4-4x as a double integral.
7. Formulate Leibnitz's equation where R=100 ohms L=0.05 henry E=100 Cos300t volts.
8. A condenser of capacity C discharged through an inductance L and resistance R in series and the charge q at the time t satisfies the equation L$\frac{d^2q}{dt^2}$+R$\frac{dq}{dt}+\frac{q}{c}$=0.the circuit consists of an inductor of 1H,a resistor of 12Ω,capacitor of 0.01 F,and a generator having voltage given by E(t)=24 sin10t.find the charge q and the current I at time t,if q=0 and i=0 at t=0 where i=$\frac{dq}{dt}$.
9. Formulate the area between the curves y^2=4x and x^2=4y.
10. Indicate and change the order of integration for $\int_0^1\int_{x^2}^{2-x} xydydx$

Apply

1. Carry-out the three engineering applications of eigen value of a matrix.
2. Find the Eigen values and Eigen vectors of the matrix A = $\begin{pmatrix} 11 & -4 & -7 \\ 7 & -2 & -5 \\ 10 & -4 & -6 \end{pmatrix}$ and hence find the

   Eigen values of A^2, 5A and A^{-1} using properties.
3. Use Cayley Hamilton theorem to find inverse of A =$\begin{pmatrix} 1 & 3 & 7 \\ 4 & 2 & 3 \\ 1 & 2 & 1 \end{pmatrix}$.
4. Find the points of the function $f(x, y) = x^2y + xy^2 - axy$ where f is a maximum or minimum.
5. A body originally at 80^0C cools down to 60^0C in 20 minutes, the temperature of the air being 40^0C. what will be the temperature of the body after 40 minutes from the original?

6. If the temperature of a cake is 300^0F when it leaves the oven and is 200^0F 10 minutes later, when will it be practically equal to the room temperature of 60^0F, say, when will it be 61^0F? Use Newton's law of cooling.
7. In an L-C-R circuit, the change q on a plate of a condenser is given by L $\frac{d^2q}{dt^2}$ +R $\frac{dq}{dt}$ $\frac{q}{c}$ =Esinpt, where i= $\frac{dq}{dt}$ .the circuit is tuned to resonance so that p^2=1/LC. If initially the current I and the charge q be zero. Showthat, for small values of R/L, the current in the circuit at time t is given by (Et/2L) sinpt.
8. Construct the solution for the equation $(D^3 - D)y = xe^x$
9. Use the method of variation of parameters to solve $(D^2+4)y = \cot 2x$.
10. Construct the equation $x^2y'' + xy' = x$ into a linear differential equation with constant coefficients.

Analyze

1. Justify whether the matrix B = $\begin{pmatrix} \cos\theta & \sin\theta & 0 \\ -\sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{pmatrix}$ is orthogonal or not?
2. Suppose that in winter the day time temperature in a certain office building is maintained at 70°F, The heating is shut off at 10 P.M. and turned on again at 6 A.M. On a certain day the temperature inside the building at 2 A.M. was found to be 65°F. The outside temperature was 50°F at 10 P.M. and had dropped to 40°F by 6 A.M. Find the temperature inside the building when the heat was turned on at 6 A.M.?
3. Experiment show that the radioactive substance decomposes at a rate proportional to the amount present. Starting with 2grms at time t=0 find the amount available at a later time.
4. Differentiate RL and RC electric circuit.
5. Transform the equation $x^2y'' + xy' = x$ into a linear differential equation with constant coefficients.
6. If the voltage in the RC circuit is E = E_0 cos ωt, find the charge and the current at time t.
7. Solve $(x^2D^2-2xD+2)y = (3x^2-6x+6)e^x$, y(1) = 2 +3e, $y'(1)$ =3e
8. In a circuit the resistance is 12Ω and the inductance is 4 H. The battery gives a constant voltage of 60 V and the switch is closed when t = 0, so the current starts with I(0) = 0. (a) Find I(t) (b) Find what happens to the current after a long time justify the current after 1 s.
9. If $g(x,y)=\psi(u,v)$ where $u = x^2 - y^2$, $v = 2xy$ prove that $\frac{\partial^2 g}{\partial x^2} + \frac{\partial^2 g}{\partial y^2} = 4(x^2+y^2)\left(\frac{\partial^2\psi}{\partial u^2} + \frac{\partial^2\psi}{\partial v^2}\right)$
10. Solve $\int_0^a \int_0^{\sqrt{a^2-x^2}} \int_0^{\sqrt{a^2-x^2-y^2}} xdxdydz$.

Evaluate

1. Use Cayley-Hamilton theorem to find the value of $A^8 - 5A^7 + 7A^6 - 3A^5 + A^4 - 5A^3 + 8A^2 - 2A + I$ if the matrix A = $\begin{pmatrix} 2 & 1 & 1 \\ 0 & 1 & 0 \\ 1 & 1 & 2 \end{pmatrix}$.
2. Determine the nature, index, rank and signature by reducing the quadratic form $2x^2+2y^2+2z^2+2yz$ to canonical form by an orthogonal transformation.
3. Determine the value of y from the equation $\frac{dy}{dx} = \frac{x^2+y^2+1}{2xy}$.
4. Determine the solution of y of the equation $\sqrt{1-y^2}dx = (sin^{-1}x - x)dy$.
5. Determine the value of y from the equation $\frac{dy}{dx} - \frac{\tan y}{1+x} = (1+x)\, e^x \sec y$.
6. Determine the complete solution for y from the equation $\frac{d^2y}{dx^2} + \frac{1}{x}\frac{dy}{dx} = \frac{12\log x}{x^2}$.
7. Determine the complete solution for y of $(x^2D^2 - xD + 4)y = x^2 \sin(\log x)$.
8. Determine the solution of the initial value problem $y'' + y' - 6y$ =0 with the initial conditions y(0)=10 and $y'(0)$ =0.
9. Evaluate $\iiint (x^2 + y^2 + z^2)\, dxdydz$ taken over the region of space defined by $x^2 + y^2 \le 1$ and $0 \le x \le 1$.
10. Evaluate $\int_0^a \int_y^a \frac{x}{x^2+y^2} dxdy$ by changing into polar coordinates.

15PH102 ENGINEERING PHYSICS 2 0 2 3

Course Objectives

- To impart knowledge in properties of matter, crystallography and ultrasonics
- To understand the applications of lasers and fiber optics
- To implement the principles of quantum physics in the respective engineering fields

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Analyze the concept of properties of matter and apply the same for practical applications
2. Identify the suitable laser source for fiber optic communication applications
3. Analyze the properties of ultrasonic waves and apply the same for day today applications
4. classify the different types of crystal structures and analyze their properties
5. Apply the Schrodinger wave equation to illustrate the motion of quantum particles

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2													
2	1	2													
3	2	1													
4	1	1													
5	1	1													

UNIT I **8 Hours**

PROPERTIES OF MATTER

Elasticity: elastic and plastic materials - Hooke's law - elastic behavior of a material -stress -strain diagram- factors affecting elasticity. Three moduli of elasticity- Poisson's ratio-torsional pendulum-twisting couple on a cylinder. Young's modulus- uniform bending -non- uniform bending. Viscosity: coefficient of viscosity -streamline and turbulent flow -experimental determination of viscosity of a liquid -Poiseuille's method.

UNIT II **6 Hours**

APPLIED OPTICS

Interference: air wedge- theory- uses- testing of flat surfaces- thickness of a thin wire. Laser: introduction- principle of laser- characteristics of laser- types: CO2 laser -semiconductor laser (homo junction). Fiber optics: principle of light transmission through fiber- expression for acceptance angle and numerical aperture- types of optical fibers (refractive index profile and mode)- fiber optic communication system (block diagram only).

UNIT III **5 Hours**

ULTRASONICS

Ultrasonics: introduction- properties of ultrasonic waves-generation of ultrasonic waves- magnetostriction- piezo electric methods- detection of ultrasonic waves. Determination of velocity of ultrasonic waves (acoustic grating). Applications of ultrasonic waves: SONAR- measurement of velocity of blood flow -study of movement of internal organs.

UNIT IV **5 Hours**

SOLID STATE PHYSICS

Crystal Physics: lattice -unit cell -crystal systems- Bravais lattices- Miller indices- 'd' spacing in cubic lattice- calculation of number of atoms per unit cell, atomic radius, coordination number and packing density for SC, BCC, FCC and HCP structures- X-ray diffraction: Laue's method - powder crystal method.

UNIT V **6 Hours**

QUANTUM MECHANICS

Quantum Physics: development of quantum theory- de Broglie wavelength -Schrodinger's wave equation- time dependent and time independent wave equations- physical significance. Application: particle in a box (1d)- degenerate and non-degenerate states. Photoelectric effect: quantum theory of light work function- problems.

FOR FURTHER READING

Neutrions - expanding universe

2 Hours

INTRODUCTION

Exposure to Engineering Physics Laboratory and precautionary measures

4 Hours

EXPERIMENT 1

Determine the moment of inertia of the disc and calculate the rigidity modulus of a given wire using torsion pendulum (symmetrical masses method).

4 Hours

EXPERIMENT 2

Find the elevation of the given wooden beam at the midpoint by loading at the ends and hence calculate the Youngs modulus of the material.

4 Hours

EXPERIMENT 3

Find the depression at the midpoint of the given wooden beam for 50g, 100 g, 150 g, 200 g and 250 g subjected to non-uniform bending and determine the Youngs modulus of the material of the beam.

4 Hours

EXPERIMENT 4

Determine the coefficient of viscosity of the given liquid by Poiseulles method.

4 Hours

EXPERIMENT 5

Form the interference fringes from the air wedge setup and calculate the thickness of the given wire.

4 Hours

EXPERIMENT 6

By applying the principle of diffraction, determine the wavelength of given laser and the average particle size of lycopodium powder using laser source.

4 Hours

EXPERIMENT 7

Determine the
(i) wavelength of ultrasonics in a liquid medium,
(ii) velocity of ultrasonic waves in the given liquid
(iii) compressibility of the given liquid using ultrasonic interferometer.

Total: 60 Hours

Reference(s)

1. D. S. Mathur, Elements of Properties of Matter, 5th edition, S Chand & Company Ltd., New Delhi, 2012.
2. Charles Kittel, Introduction to Solid State Physics, 8th edition, Wiley India Pvt. Ltd., New Delhi, 2012.
3. Arthur Beiser, Shobhit Mahajan and S Rai Choudhury, Concepts of Modern Physics, 6th Edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2010.
4. B. K. Pandey and S. Chaturvedi, Engineering Physics, 1st edition, Cengage Learning India Pvt. Ltd., New Delhi, 2012.
5. Halliday and Resnick, Fundamentals of Physics, John Wiley and Sons, Inc, 2011.
6. Ian Morison, Introduction to Astronomy and Cosmology, John Wiley and Sons, Ltd., 2013.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2	2				4	2				6				4				4						24
2		2				2	6			2	4			4											20
3		4				4	2			4				2				2							18
4	2	2				4					6			2				2							18
5	2	2				4	4			4					4										20
																								Total	100

Assessment Questions

Remember

1. Reproduce Hooke's law
2. Name the three types of moduli of elasticity
3. List the two applications of air wedge
4. Recall the two conditions required for achieving total internal reflection
5. Define magnetostriction effect
6. Recognize the four applications of ultrasonics in medical field
7. Write the Bragg's condition necessary for obtaining X-ray diffraction in crystals
8. Retrieve the seven types of crystal system
9. Recall four physical significance of wave function
10. Define photoelectric effect

Understand

1. Explain the procedure adopted for determining the Young's modulus of the given material by non-uniform bending method

2. Illustrate the effect of temperature on elasticity of a material
3. Classify the fiber optics based on refractive index profile
4. Indicate the role of optical resonators in the production of laser
5. Compare the merits of magnetostriction and piezo-electric oscillators
6. Summarize the four applications of ultrasonic waves in day-today life
7. Identify the closely packed cubic crystal structure with an example
8. Compare Laue method and powder crystal method used in X-ray diffraction
9. Infer the significance of photoelectric effect
10. Represent the two assumptions involved in solving the Schrödinger time dependent wave equation

Apply

1. Show that when a cylinder is twisted the torsional couple depends on torsional rigidity
2. Using torsional pendulum, explain the rigidity modulus of the wire
3. Design an experimental setup used for determining the thickness of a thin material
4. A silica optical fiber has a core refractive index of 1.50 and a cladding refractive index of 1.47. Find the numerical aperture for the fiber.
5. Construct the piezo electric oscillator circuit and explain the generation of ultrasonic waves
6. Find the depth of submerged submarine if an ultrasonic wave is received after 0.33 s from the time of transmission.(given v=1400 m/s)
7. Show that the axial ratio for an ideal HCP structure is 1.633
8. Sketch the planes having Miller indices (100) and (111).
9. Assess the various energy levels of an electron enclosed in a one dimensional potential well of finite width ‘a’
10. Compute the relation between de Broglie wavelength and velocity of a particle

Analyse

1. Differentiate uniform bending from non-uniform bending
2. Straight lined fringes are formed only in flat glass plates. Justify.
3. Conclude that the thickness of thin wire is influenced by band width of a material
4. Outline the merits and demerits of magnetostriction oscillator method.
5. Five fold symmetry is not possible in crystal structures. Justify your answer.
6. Compare the degenerate state with non-degenerate state

Evaluate

1. Determine the viscosity of a given liquid using Poiseuille’s method (Given: water, burette, stop clock, capillary tube, stand and travelling microscope)
2. When ultrasonic waves are passed through liquids, cavitations are produced. Criticize the statement
3. Check the packing factor for a simple cubic structure is 0.52

15CH103 ENVIRONMENTAL SCIENCE 2 0 2 3

Course Objectives

- Realize the interdisciplinary and holistic nature of the environment
- Understand how natural resources and environment affect the quality of life and stimulate the quest for sustainable development
- Recognize the socio-economic, political and ethical issues in environmental science

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Assess the importance of interdisciplinary nature of environment studies, uses and exploitation of natural resources.
2. Analyze the different types of ecosystems and biodiversity, its values and also role of professionals in protecting the environment from degradation.
3. Identify the existing environmental challenges related to pollution and its management.
4. Select suitable strategies for sustainable management of components of environmental.
5. Correlate the impacts of population and human activities on environment.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3		2												
2		2													
3			3				1								
4			2			3	1								
5			2			1	3								

UNIT I **6 Hours**

NATURAL RESOURCES

Forest resources: Use - over exploitation - deforestation - case studies. Water resources: Use - over utilization of surface and ground water - conflicts over water. Mineral resources: Use - exploitation - environmental effects of extracting and using mineral resources - case studies. Food resources: Effects of modern agriculture - fertilizer-pesticide problems (eutrophication, blue baby syndrome, biomagnification) - water logging - salinity - case studies. Energy resources: renewable(solar, wind, tidal, geothermal and hydroelectric power) - non renewable energy sources

UNIT II **6 Hours**

ECOSYSTEMS AND BIODIVERSITY

Concept of an ecosystem: Structure and function of an ecosystem - producers - consumers - decomposers - food chains - food webs and ecological pyramids - Types of ecosystem: Introduction - characteristic features: forest ecosystem - desert ecosystem - ecological succession. Biodiversity - value of biodiversity - threats to biodiversity - endangered and endemic species - Conservation of biodiversity: In-situ and ex-situ conservation of biodiversity - field study

UNIT III **6 Hours**

ENVIRONMENTAL POLLUTION

Pollution: Definition - causes - effects - control measures of air pollution - water pollution : (Sewage water treatment by activated sludge and trickling filter process) - marine pollution - thermal pollution - noise pollution. Disaster management: causes - effects - control measures of floods - earthquake - cyclone - landslides

UNIT IV **7 Hours**

SOCIAL ISSUES AND ENVIRONMENT

Sustainable development : Definition - Unsustainable to sustainable development - urban problems related to energy. Environmental ethics - issues and possible solutions - solid waste management - causes - effects - 3R Principles (landfills, incineration, composting). Water conservation - rain water harvesting - watershed management. Climate change - global warming - acid rain - ozone layer depletion. Environment protection act: Air (Prevention and control of pollution) act - wildlife protection act

UNIT V **5 Hours**

HUMAN POPULATION AND ENVIRONMENT

Human population: Population growth - characteristics - variation among nations - population explosion - women and child welfare programmes - value education - HIV / AIDS. Role of information technology in environment and human health - occupational safety and health administration (OSHA)

FOR FURTHER READING

Human rights:E - waste and biomedical waste -Identification of adulterants in food materials

1 **2 Hours**

EXPERIMENT 1

General instructions to students for handling the reagents and safety precautions.

2 **4 Hours**

EXPERIMENT 2

Estimation of dissolved oxygen in a water sample/sewage by Winklers method

3 **4 Hours**

EXPERIMENT 3

Estimation of chloride content in water by argentometric method

4 Hours

EXPERIMENT 4
Estimation of calcium in lime by complexometric method

5 **4 Hours**
EXPERIMENT 5
Estimation of chromium in leather tannery effluents

6 **4 Hours**
EXPERIMENT 6
Determination of percentage purity of washing soda

7 **4 Hours**
EXPERIMENT 7
Estimation of heavy metals in the given solution by EDTA method

8 **4 Hours**
EXPERIMENT 8
Determination of Prussian blue dye concentration by spectrophotometer

Total: 60 Hours

Reference(s)

1. Anubha Kaushik, C.P. Kaushik, Environmental Science and Engineering , 4th Multi Colour Edtion, New Age International Publishers, New Delhi, 2014
2. A. Ravikrishnan, Environmental Science and Engineering, 5th revised Edition, Sri Krishna Hitech Publishing company (P) Ltd, Chennai, 2010
3. T. G. Jr. Miller, S. Spoolman, New Environmental Science, 14th Edition, Wadsworth Publishing Co, New Delhi, 2014
4. E. Bharucha, Textbook of Environmental studies, second Edition, Universities Press Pvt. Ltd., New Delhi, 2013
5. A. K. De, Environmental Chemistry, 7th Edition , New age international publishers, New Delhi, 2014

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	3	3			4	5				1			1	3											20
2	4	1			5	7							1	2											20
3	3				4	6	2		1	1			1	1				1							20
4	1	2			3	8	1			4			2	4											25
5	1	2			2	5				1			1	2				1							15
																								Total	100

Assessment Questions
Remember

1. Define the term bio-magnification.
2. Name any four major gases responsible for air pollution.
3. Recall four gases responsible for greenhouse effect.
4. State environmental ethics.

5. List any two impacts of water pollution.
6. Mention the two objectives of value education.
7. List any four consequences of air pollution on human health.
8. Recall any two endangered and endemic species of India.
9. List any two disadvantages of nuclear energy production.

Understand

1. Summarize the structural and functional attributes of an ecosystem.
2. With the help of neat flow chart explain waste water treatment process using activated sludge process.
3. Explain the modern method of rain water harvesting technique diagrammatically and discuss the various strategies adopted for water conservation.
4. Summarize the abstracts of Wildlife (protection) Act, 1972.
5. Indicate the three consequences of noise pollution.
6. Classify the ecosystems on the basis of energy sources
7. Infer two types of photochemical reactions involved in formation and destruction of ozone in the stratosphere.
8. Explain how the impacts of natural disasters can be minimized on human communities with on representative example.
9. Summarize four major effects caused on forests and tribal people due to big dam construction.
10. Infer the any two conflicts over water, confining to our nation.
11. Identify three major threats to Indian biodiversity
12. Relate the concept of food chain and food web with tropic level and mention their three significances.

Apply

1. Identify any seven impacts caused if ground water is used enormously.
2. Select the proper disaster management techiques that can be implemented to manage. a) Earthquake b) Floods
3. Summarize the concept age-structure pyramids as a tool to achieve stabilized population in our nation.
4. Predict the significances of child welfare programmes in India.
5. Implement the 3R approach to manage solid waste.
6. Assess the four adverse effects of solid waste.
7. Assess how climate change affects human health.

Analyse

1. Differentiate between confined and unconfined aquifers.
2. Distinguish between critical and strategic minerals with two examples for each.
3. Outline variations in population growth among nations with necessary diagram.
4. “Day by day our atmosphere gets prone to serious effects” and “deterioration of environment affects human health”. Justify these two statements.
5. Compare the major two advantages and limitations of major greenhouse pollutant CO2.

Evaluate

1. Choose any one suitable method to minimize the impact of acid rain on environment.
2. Determine the doubling time of population, if annual growth rate of a nation is 25 years.

15GE105 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING

2 0 2 3

Course Objectives

- To understand the basic concepts of electric circuits and magnetic circuits.
- To illustrate the construction and operation of various electrical machines and semiconductor devices.
- To Learn the fundamentals of communication systems.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Apply the fundamental laws to electric circuits and compute the different alternating quantities.
2. Apply the laws of magnetism for the operation of DC motor.
3. Examine the construction and working principle of different AC machines
4. Analyze the different speed control methods of DC motors and special machines.
5. Analyze the performance characteristics and applications of semiconductor devices.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2		1											
2	1	2		1											
3	1	1													
4	1	2													
5	1	2		1											

UNIT I **7 Hours**

ELECTRIC CIRCUITS

Definition of Voltage, Current, Electromotive force, Resistance, Power & Energy, Ohms law and Kirchoffs Law & its applications - Series and Parallel circuits - Voltage division and Current division techniques - Generation of alternating emf - RMS value, average value, peak factor and form factor- Definition of real, reactive and apparent power.

UNIT II **5 Hours**

DC MACHINES

Introduction of magnetic circuits - Law of Electromagnetic induction, Flemings Right & Left hand rule- Types of induced emf - Definition of Self and Mutual Inductance - DC Motor- Contruction - Working Principle- Applications.

UNIT III **6 Hours**

AC MACHINES

Single Phase Transformer - Alternator - Three phase induction motor - Single phase induction motor - Contruction - Working Principle - Applications.

UNIT IV **5 Hours**

ELECTRICAL DRIVES

Speed control of dc shunt motor and series motor - Armature voltage control - Flux control - Construction and operation of DC servo motor - Construction and operation of DC servo motor stepper motor.

UNIT V **7 Hours**

ELECTRON DEVICES AND COMMUNICATION

Characteristics of PN Junction diode and Zener diode - Half wave and Full wave Rectifiers - Bipolar Junction Transistor - Operation of NPN and PNP transistors - Logic gates - Introduction to communication systems.

FOR FURTHER READING

Voltage Regulator - Stepper motor - Energy meter - SMPS, Satellite and Optical communication.

1 **4 Hours**

EXPERIMENT 1

Analyze the VI characteristics of a fixed resistor and a lamp by varying its temperature.

2 **4 Hours**

EXPERIMENT 2

Apply the voltage division and current division techniques for series and parallel connections of lamp loads.

3 **4 Hours**

EXPERIMENT 3

Understand the concept of electromagnetic induction using copper coil.

4 **4 Hours**

EXPERIMENT 4

Understand the construction and working principle of DC machines.

5 **6 Hours**

EXPERIMENT 5

Determine the VI Characteristics of PN Junction diode and plot the input and output wave shapes of a half wave rectifier.

6 **4 Hours**

EXPERIMENT 6

Realize the working of transistor as an electronic switch through experiments.

7 **4 Hours**

EXPERIMENT 7

Lighting applications using logic gates principle.

Total: 60 Hours

Reference(s)

1. T. K. Nagsarkar and M. S. Sukhija, Basic of Electrical Engineering, Oxford University Press, 2011.
2. Smarjith Ghosh, Fundamentals of Electrical and Electronics Engineering, Prentice Hall (India) Pvt. Ltd., 2010
3. A. Sudhakar, Shyammohan S Palli, Circuits and Networks Analysis and Synthesis, Tata McGraw Hill, 2010
4. R. S. Sedha, A Textbook of Applied Electronics, S.Chand & Company Ltd, 2013
5. Muthusubramanian & Salivahanan, Basic Electrical and Electronics Engineering and Communication Engineering, Seventh Edition, Tata MCGraw Hill Education Private Limited, 2011

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2					2	2			2			2				2			2		2		4	20
2		3									2	2		2					2	2			2	5	20
3			3				2				2			6				2		2		3			20
4				2				2		2		2			4		3		2				3		20
5			2				2			2				3				3	3		2			3	20
																								Total	100

Assessment Questions

Remember

1. State kirchoff’s current law.
2. State Ohm’s law.
3. State kirchoff’s voltage law.
4. State Faraday’s law of electromagnetic induction.
5. Define reluctance.
6. Define magnetic flux.
7. State the operating principle of a transformer.
8. State the operating principle of DC motor
9. State Fleming’s Left hand rule.
10. State Fleming’s right hand rule.
11. Label the V-I characteristics of zener diode.
12. Reproduce the block diagram of communication system
13. List the applications of DC motors.

Understand

1. Give the properties of flux lines.
2. Compare series and parallel circuits.
3. Classify the magnetic circuits.
4. Explain the concepts of self and mutually induced emf.
5. Interpret the laws of electromagnetic induction.
6. Illustrate the working principle of a transformer.
7. Illustrate the construction and working principle of three phase induction motor.
8. Summarise the characteristics of PN junction diode in forward and reverse biasing.
9. Explain the operation of PNP and NPN transistor.

10. Illustrate the input and output characteristics of transistor CE configuration.
11. Summarize the truth table for logic gates.

Apply

1. Three resistors are connected in series across a 12V battery. The first resistance has a value of 2 ohm, second has a voltage drop of 4V and third has power dissipation of 12 W. Calculate the value of the current in the circuit.
2. A 25 ohm resistor is connected in parallel with a 50 ohm resistor. The current in 50 ohm resistor is 8A. What is the value of third resistance to be added in parallel to make the total line current as 15A.
3. The self inductance of a coil of 500turns is 0.25H. If 60% of the flux is linked with a second coil of 10500 turns. Calculate a) the mutual inductance between the two coils and b) emf induced in the second coil when current in the first coil changes at the rate of 100A/sec.
4. An air cored toroidal coil has 480 turns, a mean length of 30cm and a cross-sectional area of 5 cm2.Calculate a)the inductance i\of the coil and b) the average induced emf, if a current of 4 A is reversed in 60 milliseconds
5. Show the applications of DC motors.
6. Demonstrate the full wave bridge rectifier.
7. Demonstrate the speed control of DC shunt motor.
8. Demonstrate the speed control of DC series motor.
9. Demonstrate the speed control of DC series motor.
10. Find the average and RMS value of EMF of half wave rectifier.

Analyse

1. Outline the voltage, current and power in a resistor supplied with an alternating voltage.
2. Resolve the expression for RMS, average value, peak and form factor of sinusoidal voltage
3. Organize the expressions for self inductance and mutual inductance.
4. Diffentiate electric and magnetic circuit.
5. Differentiate the squirrel cage induction motor and slip ring induction motor.
6. Differentiate step up and step down transformer.
7. Outline the characteristics of zener doide.
8. Demonstrate the characteristics of PNP transistor.
9. Resolve the expression of ripple factor, efficiency of full wave bridge rectifier.
10. Justify, why domestic appliances connected in parallel.
11. Resolve the expression of ripple factor, efficiency of half wave bridge rectifier.
12. Derive the expression for self and mutual inductance.
13. Derive the expression for form factor of half and full wave rectifier.

15ME106 FUNDAMENTALS OF MECHANICAL ENGINEERING 2 0 2 3

Course Objectives

- To make the students practice various fundamental and derived units to manipulate length, time, mass, temperature and derived concepts from the fundamental quantities.
- To make the students familiar with various forces and its conversions, material properties and geometric properties through demonstrations.
- To make the students capable for understanding the energy in various forms (except nuclear energy) and make them capable of converting energy in one form to another form.
- To familiarize students with all commonly used mechanical elements along with its applications.
- To expose students with conventional manufacturing techniques along with their application for enabling them to start doing mechanical projects from the second semester.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

Course Outcomes (COs)

1. Use the instruments to measure any fundamental quantities such as length, time, mass, temperature
2. Measure force, fluid and material related parameters and convert the measured values from instruments into any system of units.
3. Convert energy in one form into another form by understanding conservation of mass energy principle.
4. Identify any commonly known mechanical component along with its application and its working principle
5. Identify any conventional manufacturing process and understand their limits and capabilities

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2														
2	2														
3	2														
4	2														
5	2														

UNIT I **7 Hours**

ENGINEERING MEASUREMENTS

Basic Concepts : Length using scale, sine rule and cosine rule, radians, calculation of surface area and volume of standard objects, time zones, period and frequency, linear velocity, linear acceleration, volume flow rate, angular velocity, angular acceleration, mass, density, specific volume, specific gravity, mass flow rate, momentum, conservation of mass and energy, temperature, heat, conduction, convection, radiation, insulation, thermal expansion, specific heat, calorific value, self-ignition temperature, cryogenic temperature, latent heat, evaporation, condensation. Demonstration, measurement and experiments: Length, surface area and volume of standard objects, periods and frequency, linear velocity, linear acceleration, volume flow rate, angular velocity, mass, density, momentum, conservation of mass and energy, temperature, heat, conduction, convection, radiation, insulation, thermal expansion, specific heat, calorific value, self-ignition temperature, latent heat.

UNIT II **7 Hours**

ENGINEERING MEASUREMENTS II

Basic Concepts : Newton's Laws, Force, Centripetal Force, Work, Energy, Power, Pressure load area relation, Stress and its types, Atmospheric Pressure, Types of fluids, Elasticity, Plasticity, Fluid Pressure head Velocity head relation, Surface tension, Archimedes, Principle, Pascal's Law, Force Displacement Relations, Speed and Torque relations, Siphon, Compressibility, Hardness, Brittleness, Toughness, Ductility, Moment, First moment of Area, Second moment of Area. Demonstration, measurement and experiments: Newton's laws, force, centripetal force, power, pressure, pressure load area relation, stress and its types (tension, compression and shear), atmospheric pressure, fluid pressure head and velocity head relation, elasticity, plasticity, types of fluid, surface tension, viscosity, Archimedes principle, Pascal law, siphon, compressibility, hardness, brittleness, toughness, ductility, moment, first moment of area, second moment of area.

UNIT III **6 Hours**

ENERGY CONVERSION

Basic Concepts : Kinetic energy in linear and rotary form, potential energy in head and pressure form, energy stored in springs, elastic energy, mechanical energy, thermal energy, chemical energy, magnetic energy, law of conservation of energy, conversion of kinetic energy to potential energy vice versa, mechanical energy in various forms to thermal energy, chemical energy to mechanical energy, fluid energy to mechanical energy vice versa, damping, electrical energy to mechanical energy vice versa, electrical energy to thermal energy, efficiency, flywheel energy storage, thermal energy storage, transmission of energy in pressure form, thermal form, kinetic energy form. Demonstration, measurement and experiments: Conversion of linear kinetic, rotary kinetic, potential in pressure head, spring , elastic, thermal, chemical into other forms, law of conservation of energy, energy storage in flywheel and thermal form, transmission of energy in pressure, thermal and kinetic form.

UNIT IV **5 Hours**

MECHANICAL ELEMENTS

Basic Concepts, Demonstration, measurement and experiments: Bearings - ball bearing, roller bearing, thrust bearing, linear bearing, tapper roller bearing, journal / bush bearing, needle bearing, spherical roller bearings, bearing blocks, one way bearings-Gears - spur, helical, herringbone, internal ring, face, hypoid, straight bevel, spiral bevel, screw, worm gears, rack and pinion, sprockets, ratchet and Paul, gear trains, sun planet gears-Couplings - rigid coupling - sleeve, flange, clamp couplings. Flexible coupling - Oldham, belt, universal, jaw and fluid couplings. Torque limiter -Belt drives - flat belt, v belt, timing belt drives. Chain drives, cable drives, chain block-Conveyers - roller conveyer, belt conveyer, vertical conveyer, pneumatic conveyer, chain conveyer, screw conveyer-Shafts, keys, spline shafts-Cam and followers - plate cam, wedge / translating cam, barrel cam, face cam, Globoidal cam, Geneva mechanism-Springs - tension spring, compression spring, coil spring, torsion spring, leaf spring, gas spring-Fasteners - screws, bolts, nuts and their specifications in mm and inch scale-Tools - double end spanners, box spanners, Allen keys and standards.

UNIT V **5 Hours**

MANUFACTURING PROCESSES

Basic Concepts, Demonstration, measurement and experiments: Turning, facing, drilling, internal and external thread cutting, boring, grooving, tapper turning in lathe. Milling using end milling cutters. drilling using universal drilling machine -sheet metal spinning, deep drawing, forging of clay models, making water tank using FRP, sheet metal work-arc welding, brazing, riveting -investment casting, sand casting, injection molding, vacuum molding, blow molding -powder coating.

FOR FURTHER READING

Triangulation, projectile motion in trebuchet, water hammer, water bug, air suspension, MR fluid, five axis milling.

1 **2 Hours**

EXPERIMENT 1

Measure the size, area and volume of given object.

2 **2 Hours**

EXPERIMENT 2

Measure the natural period, natural frequency and maximum velocity of an oscillating pendulum.

3 **4 Hours**

EXPERIMENT 3

Measure the volume and mass low rate of water through a given pipe

4 **2 Hours**

EXPERIMENT 4

Measure the mass, weight and density of given material or fluid.

5 **2 Hours**

EXPERIMENT 5

Demonstrate the conservation of energy in a colliding object and name all the energy conversions

6 **2 Hours**

EXPERIMENT 6

Design a setup to prevent heat loss from a given hot object through conduction, convection and radiation

7 **4 Hours**

EXPERIMENT 7

Find the calorific value, specific heat and self-ignition temperature of a given fuel.

8 **4 Hours**

EXPERIMENT 8

Demonstrate an experimental setup to prove Archimedes Principle.

9 **2 Hours**

EXPERIMENT 9

Design an experimental setup to prove Pascal Law.

10 **2 Hours**

EXPERIMENT 10

Identify the given materials based on their mechanical properties such as hardness, brittleness and Toughness.

11 **2 Hours**

EXPERIMENT 11

Design an experimental setup to convert mechanical energy in rotation form to any other form.

12 **2 Hours**

EXPERIMENT 12

Design an experimental setup to convert potential energy into mechanical rotation.

Total: 60 Hours

Reference(s)

1. David Halliday, Robert Resnick, Jearl Walker, Principles of Physics, 10th Edition International Student Version, John Wiley & Sons, 2014.
2. Moaveni, Saeed, Engineering fundamentals: an introduction to engineering, Cengage Learning, 2015.
3. Wickert, Jonathan, and Kemper Lewis, An introduction to mechanical engineering, Cengage learning, 2012
4. Serway, Raymond, and John Jewett. Physics for scientists and engineers with modern physics, Cengage learning, 2013.
5. Roger Timing, Engineering Fundamentals, Newnes, 2002.
6. C. F. Geraldand P. O. Wheatley, Applied Numerical Analysis, Pearson Education 2003.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	10					5				10															25
2		10				10				5															25
3		10				10																			20
4	5				5					5															15
5		5				10																			15
																								Total	100

Assessment Questions

Remember

1. What is the thermal conductivity of Steel?
2. What are the specific heat of water?
3. What is the atmospheric pressure in water column, mercury column, coconut oil column?
4. Define ductility.
5. What are the types of screws?
6. What are the types of bolts?
7. What is FRP?
8. Name any four bearings with their specific applications
9. Name two examples for storing energy in mechanical form.

Understand

1. Why should a metal expand when heated?
2. What is the relation between density of an object and its heat?
3. How to demonstrate self ignition temperature?
4. How a thermo flask works?
5. What are all the stresses involved in bending a square rod?
6. Why should velocity head increase when the pressure head decreased in a pipe flow?
7. How is leverage works?
8. Why cant fluid moved flow low head to higher head using siphon principle?

9. Why pneumatic machine is called as air compressor but hydraulic machine is called as pump?
10. Why train tracks are made in "I" section?
11. Why timing belts are called as timing belt?

Apply

1. Explore the size of your classroom, the seating arrangement, the location of the chalkboard with respect to the class room's main entrance, dimensions of the ceiling fan, sizes of the windows, sizes of door, size of window grill rod, White paint coated surface area, volume of the podium and the area of black board. Prepare a brief report by measuring using standard measuring tape. Specify all the answers in SI and U.S. Customary units.
2. Determine how many chalk pieces can be made from one tone of raw material? And what will be the change in number if you want to make chalk pieces 1.5 times larger than present size?
3. Determine the base area of a Iron Box and suggest a fastest way to calculate the area.
4. Estimate the frontal area of the car shown in the accompanying drawing.
5. Investigate what the typical range of pressure is in the following applications: a bicycle tire, Home water line and the maximum pressure developed by your lungs.
6. Lift a mass of 10 kg using a mass of 5 kg using Pascal's Law.
7. Calculate the pressure exerted by water on a scuba diver who is swimming at a depth of 50 ft below the water surface.
8. Do you think there is relationship between a person's height, weight, and foot size? if so, verify your answer. Designers often learn from their natural surrounding; do the bigger animals have bigger feet?

15GE107 WORKSHOP PRACTICE 0 0 2 1

Course Objectives

- To provide hands on training for fabrication of components using carpentry, sheet metal and welding equipment / tools.
- To gain the skills for making fitting joints and household pipe line connections using suitable tools.
- To develop the skills for preparing the green sand mould and to make simple household electrical connection
- To provide hands on training for dismantling and assembling of petrol engines, gear box and pumps.
- To develop the skills for making wood/sheet metal models using suitable tools

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
n. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Fabricate simple components using carpentry, sheet metal and welding equipment/tools
2. Make fitting joints and household pipe line connections using suitable tools.
3. Prepare green sand mould and make simple household electrical connections using suitable tools
4. Dismantle and assemble petrol engines, gear box and pumps.
5. Make simple models using wood and sheet metal.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2				2				2		1			2	
2	2				2				2		1			2	
3	2				2						1			2	
4	2				2				2		1			2	
5	2				2				2		1			2	

1 **2 Hours**

EXPERIMENT 1

Forming of simple object in sheet metal using suitable tools (Example: Dust Pan / Soap Box)

2 **4 Hours**

EXPERIMENT 2

Fabrication of a simple component using thin and thick plates. (Example: Book rack)

3 **2 Hours**

EXPERIMENT 3

Making a simple component using carpentry power tools. (Example: Pen stand/Tool box/ Letter box.

4 **2 Hours**

EXPERIMENT 4

Prepare a "V" (or) Half round (or) Square joint from the given mild Steel flat.

5 **4 Hours**

EXPERIMENT 5

Construct a household pipe line connections using pipes, Tee joint, Four way joint, elbow, union, bend,Gate way and Taps (or) Construct a pipe connections of house application centrifugal pump using pipes,bend, gate valve, flanges and foot valve.

6 **4 Hours**

EXPERIMENT 6

Prepare a green sand mould using solid pattern/split pattern.

7 **4 Hours**

EXPERIMENT 7

Construct a domestic electrical wire connections using indicator, one way switch with calling bell, two way switch with lamp, one way switch with fan regulator and one way switch with socket.

8 **4 Hours**

EXPERIMENT 8

Dismantling and assembly of Centrifugal Monoblock / Gear Pump / Gear box.

9 **2 Hours**

EXPERIMENT 9

Dismantling and assembly of two stroke and four stroke petrol engine.

10 **2 Hours**

EXPERIMENT 10

Mini Project (Fabrication of Small Components).

Total: 30 Hours

15MA201 VECTOR CALCULUS AND COMPLEX ANALYSIS 3 2 0 4

Course Objectives

- Implement the Complex Analysis, an elegant method in the study of heat flow, fluid dynamics and electrostatics.
- Summarize and apply the methodologies involved in solving problems related to fundamental principles of Calculus viz: Differentiation, Integration and Vectors.
- Develop enough confidence to identify and model mathematical patterns in real world and offer appropriate solutions, using the skills learned in their interactive and supporting environment.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Determine & apply the important quantities associated with vector fields such as the divergence, curl and scalar potential.
2. Apply the theoretical aspects of vector integral calculus in their core areas.
3. Recognize the differentiation properties of vectors.
4. Identify the complex functions and their mapping in certain complex planes.
5. Use the concepts of integration to complex functions in certain regions.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1														
2	1	2													
3	1														
4	1	2													
5	3														

UNIT I **10 Hours**

VECTOR CALCULUS

Gradient -Divergence -Curl - Directional derivative- Solenoidal -Irrotational vector fields -Line Integral -Surface integrals.

UNIT II **9 Hours**

INTEGRAL THEOREMS OF VECTOR CALCULUS

Green's theorem in a plane- Stoke's Theorem- Gauss divergence theorem- Applications involving cubes and parallelepiped.

UNIT III **8 Hours**

ANALYTIC FUNCTIONS

Analytic Functions- Necessary and Sufficient conditions of Analytic Function- Properties of Analytic function - Determination of Analytic Function using Milne Thompson method -Applications to the problems of Potential Flow.

UNIT IV **8 Hours**

MAPPING OF COMPLEX FUNCTIONS

Physical interpretation of mapping- Application of transformation: translation, rotation, magnification and inversion of multi valued functions - Linear fractional Transformation (Bilinear transformation).

UNIT V **10 Hours**

INTEGRATION OF COMPLEX FUNCTIONS

Cauchy's Fundamental Theorem - Cauchy's Integral Formula - Taylor's and Laurent's series- Classification of Singularities - Cauchy's Residue Theorem.

FOR FURTHER READING

Applications to Electrostatic and Fluid Flow.

Total: 75 Hours

Reference(s)

1. C. Ray Wylie and C. Louis Barrett, Advanced Engineering Mathematics, Tata McGraw-HillPublishing Company Ltd, 2003
2. Erwin Kreyszig , Advanced Engineering Mathematics, Tenth Edition, Wiley India Private Limited,New Delhi 2015
3. J. A. Brown and R. V. Churchill, Complex Variables and Applications , Sixth Edition, McGraw Hill,New Delhi, 1996
4. B. S. Grewal, Higher Engineering Mathematics, Forty third Edition, Khanna Publications , New Delhi 2014
5. Peter V. O. Neil, Advanced Engineering Mathematics, Seventh Edition ,Cengage Learning India Private Limited, 2012
6. Glyn James, Advanced Engineering Mathematics, Third Edition,Wiley India,2007

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2					6					8			4			2								22
2	2					4				4					4				6						20
3		2									10								6						18
4	2						4				6				6										18
5	2						4			6				4					6						22
																								Total	100

Assessment Questions

Remember

1. Define gradient of a vector.
2. Define irrotational of a vector.
3. State Green's theorem.

4. State Gauss divergence theorem.
5. Check whether the function is f(z)=z^3 analytic.
6. List the necessary condition for a function f(z) to be analytic.
7. Define bilinear transformation.
8. State the condition for the transformation w = f(z) to be conformal at a point.
9. State the formula for finding the residue of a double pole.
10. State Cauchy's integral formula.

Understand

1. If $\vec{F} = x^2\,\vec{i} + xy^2\,\vec{j}$ evaluate the line integral $\int \vec{F}.\vec{dr}$ from (0,0) to (1,1) along the path y=x.
2. Identify the unit normal vector to the surface $x^2 + xy + z^2 = 4$ at the point (1,-1, 2).
3. Identify the value of $\nabla x \nabla \Phi$.(F), using Stoke's theorem.
4. Formulate the area of a circle of radius a using Green's theorem.
5. Illustrate the two properties of analytic function.
6. Represent the analyticity of the function w = sin z.
7. Identify fixed points of the transformation w = z^2 .
8. Identify the image of the triangular region in the z plane bounded by the lines x= 0, y = 0, and x+ y= 1 under the transformation w = 2z.
9. Infer $\int_c \frac{dz}{(z-3)^2}$ where c is the circle $|z| = 1$.
10. Identify the residues of the function $f(z) = \frac{4}{z^3(z-2)}$ at its simple pole.

Apply

1. Find $\int_c \overline{F}.dr$ where $\overline{F} = (2y+3)i + xzj + (yz - x)k$ along the line joining the points (0,0,0) to(2,1,1).
2. If $\vec{F} = 3xy\,\vec{i} - y^2\,\vec{j}$, find $\int_C \vec{F}\cdot d\vec{r}$ where C is the curve in the xy-plane y=$2x^2$ from (0,0) to (1,0)
3. Apply Green's theorem in the plane to Compute $\int_c (3x^2 - 8y^2)dx + (4y - 6xy)dy$ where C is the boundary of the region defined by x=0, y=0 and x+y=1.
4. Using Gauss divergence theorem,Compute $\iint_s \vec{F}\cdot\hat{n}ds \; where\, \vec{F} = 4xz\vec{i} - y^2\vec{j} + yz\vec{k}$ and S is the surface of the cube bounded by x=0, y=0, z=0, x=1, y=1, z=1.
5. If ω=φ+iψ represent the complex potential for an electric field and $\psi = x^2 - y^2 + \frac{x}{x^2 + y^2}$, find the function φ.
6. If $u = \log(x^2 + y^2)$, find v and f (z) such that f (z) =u+iv is analytic.
7. Find bilinear transformation which maps the points I,-1,I of the z plane into the points 0,1,∞ of the w plane respectively.

8. Find the image of the circle $|z-1|=1$ in the complex plane under the transformation w = $\frac{1}{z}$.

9. Find Taylor's series f(z) = cos z about z = $\frac{\pi}{3}$.

10. Find the nature of singularity $z\, e^{\left(\frac{1}{z}\right)^2}$.

Analyze.

1. Conclude $div\, grad(r^n)=\nabla^2(r^n)=n(n+1)r^{n-2}$.
2. Demonstrate the irrotational vector and solenoidal vector with an example.
3. Justify stokes's theorem for $\overline{F}=-yi+2yzj+y^2k,$ where S is the upper half of the sphere $x^2+y^2+z^2=1$.
4. Justify Gauss divergence theorem for $\vec{F}=x^2\vec{i}+y^2\vec{j}+z^2\vec{k}$ where S is the surface of the cuboid formed by the planes x= 0, x= a, y = 0, y = b, z = 0 and z = c.
5. The complex potential f(z)=z^2 describes a flow with constant equipotential lines and streamlines, Determine the velocity vector.
6. Show that the function $u=x^3+x^2-3xy^2+2xy-y^2$ is harmonic and find the corresponding analytic function.
7. Find the image of the rectangle whose vertices are (0,0), (1,0), (1,2), (0,2) by means of linear transformation w = (1+i)z+2-i. Also compare the images.
8. Generate $f(z)=\frac{z}{(z-1)(z-3)}$ as Laurent's series valid in the regions: $1<|z|<3$ and $0<|z-1|<2$
9. Use Cauchy's integral formula Compute $\int_C \frac{e^z\, dz}{(z+2)\,(z+1)^2}$ where C is the circle $|z|=3$.
10. Find $\int_C \frac{z+4}{z^2+2z+5}dz$ where C is $|z+1+i|=2$.

Evaluate

1. Determine $\iint_s (xdydz+2ydzdx+3zdxdy)$, where s is the closed surface of the sphere $x^2+y^2+z^2=a^2$
2. Prove that $curl(curl\vec{F})=grad(div\vec{F})-\nabla^2\vec{F}$.
3. Check Stokes theorem for $\vec{F}=(x^2+y^2)\vec{i}-2xy\vec{j}$ taken around the rectangle bounded by x=±a,y=0 y=b.
4. Check Green's theorem in the plane to determine $\int_c (3x^2-8y^2)dx+(4y-6xy)dy$ where c is the boundary of the region defined by $(i)\, x=0, y=0, x+y=1 (ii)\, y=\sqrt{x}\ and\ y=x^2$.

5. Determine the analytic function f (z) = P + iQ, if Q = $\frac{\sin x \sinh y}{\cos 2x + \cosh 2y}$, if f(0) = 1.

6. Determine f (z) and the conjugate harmonic v such that w = u + i v is an analytic function of z given that u = $e^{x^2-y^2} \cos 2xy$.

7. Determine the image of the infinite strip $\frac{1}{4} \le y \le \frac{1}{2}$ under the transformation w = $\frac{1}{z}$

8. Determine the Laurent's series expansion $f(z) = \frac{z-1}{(z+2)(z+3)}$ *for* $2 < |z| < 3$.

9. Determine $\int_C \frac{z+4}{z^2+2z+5} dz$ where C is $|z+1+i| = 2$

10. Using Cauchy's integral formula determine $\int_C \frac{e^z dz}{(z+2)(z+1)^2}$ where C is |Z| =1.

15ME205 ENGINEERING MECHANICS-STATICS 2 0 2 3

Course Objectives

- To familiarise basic concepts and force systems in a real world environment.
- To provide knowledge on statics of particles in space with moment.
- To impart knowledge on equilibrium of rigid bodies.
- To study the moment of surfaces and solids.
- To learn the concepts of static friction.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
m. Design, analyse and evaluate the performance of mechanical systems

Course Outcomes (COs)

1. Draw a free body diagrams for given real world systems to compose and resolve forces involved.
2. Compute the moment created by the applied forces with reference to any centre/axis in 2D & 3D space.
3. Estimate the appropriate support system for the given force system by considering the force generated by various reactions.
4. Identify the location of the centroid, centre of gravity for a geometrical body and calculate the moment of inertia for 2D sections.
5. Compute the effect and resultant forces generated by the frictional forces involved in given systems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1											2		
2	2	1											2		
3	2	1											2		
4	2	1											2	-	
5	2	1											2		

UNIT I **5 Hours**

BASIC CONCEPTS AND FORCE SYSTEM

Introduction to mechanics - idealization of mechanics - laws of mechanics - principle of transmissibility - vector - addition, subtraction and product. Force- types - system of forces - resultant forces - composition of forces - resolution of force-free body diagram for real world systems.

UNIT II **6 Hours**

STATICS OF PARTICLES AND FORCE SYSTEM

Equilibrium of particle in space, moment of couple-equilibrant Moment about point and specific axis-moment at couple- simplification of force and couple systems.

UNIT III **7 Hours**

STATICS OF RIGID BODIES

Equilibrium of rigid bodies in two and three dimensions - beams - types of loads, supports and their reactions Two and three force members-Static determinacy.

UNIT IV **7 Hours**

PROPERTIES OF SURFACES AND SOLIDS

Determination of centroid of areas, volumes and mass - Pappus and Guldinus theorems - moment of inertia of plane and areas Parallel axis theorem radius of gyration of area- product of inertia- mass moment of inertia.

UNIT V **5 Hours**

FRICTION

Introduction - mechanism of friction-types -laws of friction - friction on horizontal and inclined planes, ladder and wedge friction - rolling resistance.

FOR FURTHER READING

Moment of Inertia of flywheel - Internal force of a member - Equilibrium of rigid bodies in three dimensions: Ball and socket joint.

1 **2 Hours**

EXPERIMENT 1

Experimental verification of Parallelogram law.

2 **4 Hours**

EXPERIMENT 2

Experimental verification of Lamis Theorem.

3 **2 Hours**

EXPERIMENT 3

Experimental analysis of forces in equilibrium using pulley arrangement.

4 **4 Hours**

EXPERIMENT 4

Experimental demonstration of principle of moments using bell crank lever apparatus.

5 **4 Hours**

EXPERIMENT 5

Experimental study of equilibrium of forces in three concurrent co-planer systems.

6 **2 Hours**

EXPERIMENT 6

Experimental analysis of the reaction forces of a simply supported beam and compare with analytical results.

7 **2 Hours**

EXPERIMENT 7

Determination of centroid of laminas

8 **4 Hours**

EXPERIMENT 8

Determination of moment of inertia of plane area

9 **4 Hours**

EXPERIMENT 9

Determination of Coefficient of Friction between two surfaces

10 **2 Hours**

EXPERIMENT 10

Demonstration of tipping and sliding

Total: 60 Hours

Reference(s)

1. F.P. Beer, and Jr. E.R Johnston, Vector Mechanics for Engineers - Statics and Dynamics, Tata McGraw-Hill Publishing Company, New Delhi, 2007.
2. N.H.Dubey, Engineering Mechanics- Statics and Dynamics, Tata McGraw-Hill Publishing Company, New Delhi, 2013.
3. Irving H. Shames, Engineering Mechanics - Statics and Dynamics, Pearson Education Asia Pvt. Ltd., 2006.
4. R.C.Hibbeller, Engineering Mechanics: Combined Statics & Dynamics, Prentice Hall, 2009.
5. D. P. Sharma, Engineering Mechanics, Dorling Kindersley (India) Pvt. Ltd., New Delhi, 2010.
6. S. Rajasekaran and G. Sankara subramanian, Fundamentals of Engineering Mechanics, Vikas Publishing House Pvt. Ltd., New Delhi, 2005.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	8				12																				20
2	2	2			2	2				12															20
3	2	2				4												12							20
4	4				4					12															20
5	4				4													12							20
																								Total	100

Assessment Questions

Remember

1. State Parallelogram law of forces.
2. Define force system
3. State Lamis theorem.

4. What are all the various equilibrium conditions available?
5. State laws of friction.
6. Mention the various types of loads.
7. Define Polar Moment of Inertia.
8. State perpendicular axis theorem.
9. Define Varignon's Theorem.
10. What does the term centroid refer to?

Understand

1. Difference between mass and weight.
2. What are the factors influencing the frictional force?
3. Why sliding friction is less than static friction? Justify.
4. Which kind of support has maximum reactions and what are they?
5. Give an example for a moment and a couple.
6. Which theorem helps to determine resultant of a parallel coplanar system of forces?
7. When will the centroid and centre of gravity will be same?
8. Compare Principal M.I and M.I.
9. How will you identify whether the given system is under equilibrium or not?
10. At what situation Lami's theorem cannot be applicable.

Apply/Evaluate

1. Given the applied forces, frictional coefficient and weight of a block resting on a rough plane, how to check the equilibrium condition of the block?
2. A non-coplanar parallel system of forces is acting on a structure. How to reduce it to a force-couple system?

15GE206 COMPUTER PROGRAMMING 3 0 2 4

Course Objectives

- To learn the basics of computer organisation.
- To study the basics of C primitives, operators and expressions.
- To understand the different primitive and user defined data types.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Develop solutions using problem solving techniques and number system conversions
2. Develop programs using operators, type conversion and input-output functions
3. Apply decision making and looping statements in writing C programs
4. Apply the concepts of arrays and strings in developing C programs
5. Design applications using structures and functions in C

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	3													
2	1	2			3										
3	1	3			3										
4	1	3			3										
5	1	2	3		3										

UNIT I **8 Hours**

INTRODUCTION TO COMPUTERS

Introduction to computers - Characteristics of Computers - Evolution of Computers - Computer Generations - Basic Computer Organization - Number System - Problem Solving Techniques - Features of a Good Programming Language.

UNIT II **9 Hours**

INTRODUCTION TO C PROGRAMMING

Overview of C-Structure of C program-Keywords-Constants- Variables-Data types-Type conversion Operators and Expressions: Arithmetic-Relational-Logical-Assignment- Increment and Decrement-Conditional-Bitwise -Precedence of operators-Managing I/O operations-Formatted I/O-Unformatted I/O.

UNIT III **10 Hours**

CONTROL STATEMENTS

Decision Making and Branching: simple if statement-if else statement-nesting of if else Statement-Switch Statement.Decision Making and Looping: while statement-do while statement-for statement-Nested for statement Jump Statements: goto-break-continue-return statement

UNIT IV **9 Hours**

ARRAYS AND STRINGS

Arrays: Introduction, one dimensional array, declaration - Initialization of one dimensional array, two-dimensional arrays, initializing two dimensional arrays, multi dimensional arrays. Strings: Declaring and initializing string variables- Reading strings from terminal - writing string to screen - String handling functions.

UNIT V **9 Hours**

STRUCTURES AND FUNCTIONS

Structures and Unions: Introduction-defining a structure- declaring structure variables-accessing structure members- structure initialization-Unions-Enumerated data type
User Defined Functions: Elements of user defined functions -Definition of functions-return values and their types- function calls-function declaration-categories of function -call by value and call by reference-recursion-Preprocessor directives and macros.

FOR FURTHER READING

Creating and manipulating document using word - Mail merge - Creating spread sheet with charts and formula using excel - developing power point presentation with Animations - C graphics using built in functions

1 **3 Hours**

EXPERIMENT 1

Write a C program to perform arithmetic operations on integers and floating point numbers.

2 **3 Hours**

EXPERIMENT 2

Write a C program to implement ternary operator and relational operators.

3 **3 Hours**

EXPERIMENT 3

Write a C program to find the greatest of three numbers using if-else statement.

4 **3 Hours**

EXPERIMENT 4

Write a C program to display the roots of a quadratic equation with their types using switch case.

5 **3 Hours**

EXPERIMENT 5

Write a C program to generate pyramid of numbers using for loop.

6 **4 Hours**

EXPERIMENT 6

Write a C program to perform Matrix Multiplication

7 **3 Hours**

EXPERIMENT 7

Write a C program to check whether the given string is Palindrome or not.

8 **4 Hours**

EXPERIMENT 8

Write a C program to find the factorial of given number.

9 **4 Hours**

EXPERIMENT 9

Design a structure to hold the following details of a student. Read the details of a student and display them in the following format Student

details: rollno, name, branch, year, section, cgpa.

****

NAME:

ROLL NO:

BRANCH:

YEAR:

SECTION:

CGPA:

Total: 75 Hours

Reference(s)

1. Pradeep K. Sinha, Priti Sinha, Computer Fundamentals, BPB publications, 2008
2. Ashok. N. Kamthane, Computer Programming, Second Edition, Pearson Education, 2012
3. E.Balagurusamy, Programming in ANSI C, Tata McGraw-Hill, 2012
4. Herbert Schildt, C -The complete Reference, Tata McGraw-Hill, 2013
5. Byron Gottfried, Programming with C, Schaum's Outlines, Tata Mcgraw-Hill, 2013

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	6	4				4					6														20
2	6					2					12														20
3	2				2		4				6		6												20
4	6				2		4		4		4														20
5	4				2		2				2						6				4				20
																								Total	100

Assessment Questions

Remember

1. List the characteristics of a computer.

2. List the features of a good programming language.
3. Define a constant.
4. Define associativity.
5. List the three looping statments in C.
6. State the use of switch case statement.
7. Recall arrays.
8. Recall strings.
9. Define a structure.
10. Define a union.

Understand

1. Explain the generations of computers.
2. Exemplify the problem solving techniques.
3. Illustrate the structure of a C program with an example.
4. Summarise the operators in C.
5. Exemplify the decision making statements in C.
6. Classify the looping statements in C.
7. Classify the types of arrays in C.
8. Summarize the string handling functions in C.
9. Exemplify the process of defining a structure.
10. Explain the components of a function.

Apply

1. Predict the reason for calling C as a structured programming language.
2. Demonstrate the concept of number conversions.
3. Execute a C program to find th roots of a quadratic equation.
4. Implement a C program to use the bitwise operators.
5. Implement a C program to generate fibonacci series.
6. Implement a C program to check whethr a number i prime or not.
7. Implement a C program to perform matrix multiplication.
8. Implment a C program to check whether a string is a palindrome or not.
9. Implement a C program to find the size of a union.
10. Implement a C program to swap two numbers using call by value and call by reference.

Analyse

1. Compare structure and union in C.
2. Organize the basic computer organization.
3. Differentiate == and = operators.
4. Differentiate rak and continue statements.

Evaluate

1. Check the value of th expression c=(x*y+(z/x)) with x=10,y=20,z=30.
2. Determine the sum of n numbers using functions.
3. Determine the vowels using switch case statement.
4. Determine the vowels using switch case statement.
5. Differentiate the use of strcpy() and strncpy() functions.

Create

1. Generate a structure to store the following details: Rollno, Name, Mark1, Mark2, Mark3, Total, Average, Result and Class. Write a program to read Rollno, name and 3 subject marks. Find out the total, resultÂ and class as follows:
   a) Total is the addition of 3 subject marks.
   b) Result is "Pass" if all subject marks are greater than or equal to 50 else "Fail".
   c) Class will be awarded for students who have cleared 3 subjects
   i. Class "Distinction" if average >=75
   ii. Class "First" if average lies between 60 to 74 (both inclusive)
   iii. Class "Second" if average lies between 50 & 59 (both inclusive)
   d) Repeat the above program to manipulate 10 students' details and sort the structures as per rank obtained by them.

2. Derive a CÂ program that determines whether a given integer is odd or even and displays the number and description on the same line.

15GE207 ENGINEERING GRAPHICS 0 0 4 2

Course Objectives

- To learn conventions and use of drawing tools in making engineering drawings.
- To draw orthographic projections of points, line and solids.
- To draw the section of solids and development of surfaces of the given objects.
- To draw the isometric projections and perspective projections of the given solids.
- To introduce CAD software to draw simple two dimensional drawings.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Design, analyse and evaluate the performance of mechanical systems

Course Outcomes (COs)

1. Recognize the conventions and apply dimensioning concepts while drafting simple objects.
2. Draw the orthographic projection of points, line, and solids.
3. Draw the section of solid drawings and development of surfaces of the given objects.
4. Draw the isometric and perspective projection of the given objects.
5. Draw the simple two dimensional drawings using computer aided drawing tool.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1					1		1		2		1	1		
2	2					2		2		2		1	1		
3	2					2		2		2		1	1		
4	2					3		3		3		2	1		
5															

UNIT 1 **12 Hours**

CONVENTIONS AND BASIC DRAWINGS

Importance - conventions - ISO and BIS - drawing tools and drawing sheets - lettering, numbering, dimensioning, lines and Symbols-Conic sections - types constructions -ellipse, parabola and hyperbola - eccentricity and parallelogram method.

UNIT 2 **14 Hours**

ORTHOGRAPHIC PROJECTIONS

Principles - first and third angle projections - Points - first angle projection of points, straight lines - parallel, perpendicular and inclined to one reference plane, solid - cylinders, pyramids, prisms and cones.

UNIT 3 **12 Hours**

SECTION OF SOLIDS AND DEVELOPMENT OF SURFACE

Section of solids - simple illustrations. Development of surfaces - cylinders, pyramids, prisms, cones and simple truncated objects.

UNIT 4 **12 Hours**

ISOMETRIC AND PERSPECTIVE PROJECTIONS

Importance - orthographic to isometric projection - simple and truncated solids- perspective projections of simple solids.

UNIT 5 **10 Hours**

INTRODUCTION TO COMPUTER AIDED DRAWING (NOT FOR END SEMESTER EXAMINATION)

Basics commands of AutoCAD - two dimensional drawing, editing, layering and dimensioning - coordinate Systems -Drawing practice - orthographic views of simple solids using AutoCAD.

Total: 60 Hours

Reference(s)

1. K Venugpoal, Engineering Drawing and Graphics, Third edition, New Age International, 2005.
2. Basant Agrawal, Mechanical drawing, Tata McGraw-Hill Education, 2008.
3. Engineering Drawing Practice for Schools & Colleges, BUREAU OF INDIAN STANDARDS-SP46, 2008.
4. N. D. Bhatt and V. M. Panchal, Engineering Drawing, Charotar Publishing House Pvt. Limited, 2008.
5. K.V.Natarajan, A Text Book of Engineering Graphics, Dhanalakshmi Publishers, 2013.
6. George Omura, Brian C. Benton, Mastering AutoCAD 2015 and AutoCAD LT 2015: Autodesk Official Press, Wiley Publisher, 2015.

15MA301 FOURIER SERIES AND TRANSFORMS 3 2 0 4

Course Objectives

- Understand the concepts of Fourier series, Transforms and Boundary Conditions, which will enable them to model and analyze the physical phenomena
- Implement the Fourier analysis, an elegant method in the study of heat flow, fluid mechanics and electromagnetic fields.
- Summarize and apply the mathematical aspects that contribute to the solution of one dimensional wave equation
- Develop enough confidence to identify and model mathematical patterns in real world and offer appropriate solutions, using the skills learned in their interactive and supporting environment.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Recognize the periodicity of a function and formulate the same as a combination of sine and cosine using Fourier series.
2. Formulate a function in frequency domain whenever the function is defined in time domain.
3. Apply the Fourier transform, which converts the time function into a sum of sine waves of different frequencies, each of which represents a frequency component.
4. Classify a partial differential equation and able to solve them.
5. Use the Z-transform to convert a discrete-time signal, which is a sequence of real or complex numbers, into a complex frequency domain representation.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1														
2	1	2													
3	1														
4	1	3													
5	1														

UNIT I **9 Hours**

FOURIER SERIES

Dirichlet's conditions - General Fourier series - Odd and even functions - Half range cosine and sine series - Root mean square value.

UNIT II **13 Hours**

LAPLACE TRANSFORM

Laplace Transform- Existence Condition -Transforms of Standard Functions - Unit step function, Unit impulse function- Properties- Transforms of Derivatives and Integrals - Initial and Final Value Theorems - Laplace transform of Periodic Functions - Inverse Laplace transforms.

UNIT III **8 Hours**

FOURIER TRANSFORM

Fourier Integral Theorem- Fourier Transform and Inverse Fourier Transform- Sine and Cosine Transforms - Properties - Transforms of Simple Functions - Convolution Theorem - Parseval's Identity

UNIT IV **8 Hours**

APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS

Classification of Second Order Quasi Linear Partial Differential Equations - Fourier Series Solutions of One Dimensional Wave Equation - One Dimensional Heat Equation - Steady State Solution of Two-Dimensional Heat Equation - Fourier Series Solutions in Cartesian Coordinates.

UNIT V **7 Hours**

Z -TRANSFORM

Z-Transform - Elementary Properties - Inverse Z-Transform - Convolution Method- Partial fraction method - Solution of Difference Equations using Z-Transform.

FOR FURTHER READING

Solutions of one dimensional wave equation and heat equations using Laplace transforms method.

Total: 75 Hours

Reference(s)

1. Larry.C.Andrews and Bhimsen.K.Shivamoggi, Integral Transforms for Engineers, First Edition, PHI Learning, New Delhi, 2007
2. Ian.N.Sneddan, The Use of Integral Transforms, Second Edition, McGraw Hill companies, 1972.
3. E. Kreyszig, Advanced Engineering Mathematics, Eighth Edition, John Wiley and Sons, Inc, Singapore, 2008.
4. Peter V. O. Neil,Advanced Engineering Mathematics, Seventh Edition, Cenage Learning India Private Ltd, 2012.
5. B.S. Grewal, Higher Engineering Mathematics, Fortieth Edition, Khanna Publications, New Delhi 2007.
6. C. Ray Wylie and C. Louis Barrett,Advanced Engineering Mathematics, Tata McGraw-Hill Publishing Company Ltd, 2003.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2					2					6				6				6						22
2	2					6				6					6				6						26
3		2					2				6							6							16
4		2					6				6				6										20
5	2						2			6									6						16
																								Total	100

Assessment Questions

Remember

1. State the Dirichlet's Conditions.
2. Define even and odd function graphically.
3. List out the complex Fourier transform pair.
4. State convolution theorem in Fourier transforms.
5. Label the condition for the existence of Laplace Transform.
6. Reproduce L (t sin at).
7. State the final value theorem for Laplace Transform.
8. Label the inverse Laplace Transform of $1/(s^2+w^2)^2$.
9. Recognize $z\{f(n+1)\}$ *in terms of* $\overline{f}(z)$.
10. Recall the Z – Transform of $\cos\left(\frac{n\pi}{2}\right)$.

Understand

1. Infer the half-range cosine series for the function $f(x) = x, 0 < x < \pi$.
2. Interpret the Fourier series of period 2 for the function $f(x) = \begin{cases} \pi x & 0 \le x \le 1 \\ \pi(2-x) & 1 \le x \le 2 \end{cases}$
3. Identify the Fourier transform of $f(x) = \begin{cases} 1-|x| & for\ |x| \le 1 \\ 0 & for\ |x| > 1 \end{cases}$. Hence evaluate $\int_0^\infty \left(\frac{\sin x}{x}\right)^2 dx$ and $\int_0^\infty \left(\frac{\sin x}{x}\right)^4 dx$.
4. Illustrate the Fourier Sine and Cosine transform of e^{-ax} and evaluate $\int_0^\infty \frac{dx}{(a^2+x^2)}$.
5. Exemplify $\int_0^t \sin u \cos(t-u)\,du$ using Laplace Transform .
6. Indicate the inverse Laplace transform of $\frac{z}{(z-1)(z-2)(z-3)}$ by the method of partial fraction.
7. Use convolution theorem to find the inverse Laplace transform of $\frac{8z^2}{(2z-1)(4z+1)}$.
8. Classify the possible solutions of one dimensional wave equation.
9. Formulate $z\{nf(t)\} = -z\frac{dF}{dz}(z)$.
10. Summarize Z-transform.

Apply

1. Execute the function $f(x) = |\cos x|$ *in* $(-\pi, \pi)$ to represent as a Fourier series of periodicity 2π.
2. A taut string of length L is fastened at both ends. The midpoint of the string is taken to a height of b and then released from rest in this position. Find the displacement of the string at any time t.
3. Find the Fourier transform of $f(x) = \begin{cases} a-|x| & for\ |x| \le a \\ 0 & for\ |x| > a \end{cases}$. Hence evaluate $\int_0^\infty \left(\frac{\sin x}{x}\right)^2 dx$ and $\int_0^\infty \left(\frac{\sin x}{x}\right)^4 dx$.
4. Find the Fourier transform of $f(x) = \begin{cases} 1, & for\ |x| < a \\ 0, & for\ |x| > a \end{cases}$ hence evaluate $\int_0^\infty \frac{\sin x}{x} dx$ and $\int_0^\infty \left(\frac{\sin^2 x}{x^2}\right) dx$
5. Verify the initial and final value theorem for the function $1 + e^{-2t}$.

6. Find $L\left(\frac{\cos 2t-\cos 3t}{t}\right)$

7. Using Convolution theorem find the inverse Laplace transform of $\frac{1}{s^2\left(s^2+25\right)}$.

8. Find $L^{-1}\left(\frac{p^2-p+2}{p(p+2)(p-3)}\right)$ using Partial fraction method.

9. Using Convolution theorem evaluate $z^{-1}\left(\frac{z^2}{(z-1)(z-3)}\right)$.

10. Solve the differential equation
$y(n+3)-3y(n+1)+2y(n)=0$ *given that* $y(0)=4,\ y(1)=0$ *and* $y(2)=8$.

Analyze

1. Organize the sine series for $f(x)=\begin{cases} x \ \ in \ \ 0<x<l/2 \\ l-x \ \ in \ \ l/2<x<l \end{cases}$ in the interval $(0,l)$.

2. A tightly stretched string of length 'ℓ' fastened at both ends. The mid-point of the string taken to a height 'b' and show that the displacement at any time 't' is given by
$y(x,t)=-\frac{8b}{\pi^2}\left[\frac{1}{1^2}\sin\left(\frac{\pi x}{\ell}\right)\cos\left(\frac{\pi at}{\ell}\right)-\frac{1}{3^3}\sin\left(\frac{3\pi x}{\ell}\right)\cos\left(\frac{3\pi at}{\ell}\right)+........\right]$.

3. Organize the Fourier transform of f(x) given by $f(x)=\begin{cases} a^2-x^2 & for\ |x|\le a \\ 0 & for\ |x|\ge a \end{cases}$. Hence evaluate
$\int_0^\infty\left[\frac{\sin t-t\cos t}{t^3}\right]dt=\frac{\pi}{4}$.

4. Integrate $\int_0^\infty \frac{dx}{\left(x^2+a^2\right)\left(x^2+b^2\right)}$ using transform method.

5. Organize the Fourier sine and cosine transform of $f(x)=\begin{cases} x, & 0<x<1 \\ 2-x, & 1<x<2 \\ 0, & x>2 \end{cases}$.

6. Prove that the Laplace Transform of the triangular wave of period 2π defined by
f (t) = $\begin{cases} t & , 0\le t\le \pi \\ 2\pi-t & , \pi<t<2\pi \end{cases}$ is $\frac{1}{s^2}\tan h\left(\frac{\pi s}{2}\right)$.

7. Organize the inverse Laplace transform of $\frac{s+2}{s^2-4s+13}$ using partial fraction.

8. Solve using Laplace Transforms $\frac{d^2y}{dt^2}+4\frac{dy}{dt}+4y=te^{-t}$; $y(0)=0;\ y'(0)=-1$.

9. Find $z^{-1}\left(\frac{z^2}{(z+2)(z^2+4)}\right)$ by the method of partial fraction.

10. Using Z – Transform solve $y(n)+3y(n-1)-4y(n-2)=0,\ n\ge 2$ *given that* $y(0)=3$ *and* $y(1)=-2$.

Evaluate

1. Determine the Fourier series of the function f(x) of Period 2π given by $f(x)=\begin{cases}1+\dfrac{2x}{\pi} & in \quad -\pi\le x\le 0\\ 1-\dfrac{2x}{\pi} & in \quad 0\le x\le \pi\end{cases}$

2. A string is stretched between two fixed points at a distance 2ℓ apart and the points of the string are given initial velocities 'u' where $u=\begin{cases}\dfrac{cx}{\ell}, & in\ 0<x<\ell\\ \dfrac{c}{\ell}(2\ell-x) & in\ \ell<x<2\ell\end{cases}$ x being the distance from one end point. Find the displacement of the string at any subsequent time.

3. Use transforms method to evaluate $\int_0^\infty \dfrac{dx}{(x^2+1)(x^2+4)}$

4. Determine the Fourier cosine transform of $e^{-a^2x^2}$. Hence prove $e^{-\frac{x^2}{2}}$ is a self-reciprocal.

5. Choose the Laplace transform of the function f(t) with period $\frac{2\pi}{\omega}$, where

   f(t) = $\begin{Bmatrix}\sin\omega t & , for\ 0<t<\pi/\omega\\ 0 & , for\ \pi/\omega<t<2\pi/\omega\end{Bmatrix}$

6. Using Laplace transform evaluate $\int_0^\infty te^{-3t}\sin 2t\ dt$

7. Using Convolution theorem find the inverse Laplace transform of $\dfrac{1}{s^2\left(s^2+25\right)}$.

8. Solve using Laplace transforms $\dfrac{d^2y}{dt^2}+4\dfrac{dy}{dt}+4y=te^{-t}$; $y(0)=0;\ y'(0)=-1$.

9. Solve the equation $y_{n+2}-7y_{n+1}+12y_n=2^n$, *given that* $y_0=y_1=0$.

10. Evaluate inverse Z-transform of $\dfrac{z}{(z-1)(z-2)(z-3)}$ by the method of partial fraction.

15ME302 ENGINEERING MATERIALS AND METALLURGY

2 0 2 3

Course Objectives

- To provide knowledge on physical metallurgy of metals through the study of phase diagrams.
- To study the properties and applications of various metals and alloys used in engineering industries.
- To expose various heat treatment processes of steels.
- To study the properties and applications of polymers and ceramics.
- To impart knowledge on mechanical properties evaluation and testing methods of engineering materials.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
n. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Explain the phase diagrams of different engineering materials.
2. Recognize the properties and applications of various metals and alloys.
3. Identify appropriate heat treatment processes for the given applications.
4. Apply various nonmetals, its manufacturing techniques and various applications.
5. Test the mechanical properties of the given materials for real-time applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2										2		2	
2	2	2												2	
3	2	2										2		2	
4	2	2												2	
5	3	2										2		2	

UNIT I **6 Hours**

PHASE DIAGRAMS AND CONSTITUTION OF ALLOYS

Alloys, Solid solutions - Phase diagram, phase rule, lever rule, Binary phase diagram -Isomorphous, eutectic, peritectic, eutectoid reactions - Iron-Carbon phase diagram - Metallography, microstructure.

UNIT II **6 Hours**

ENGINEERING METALS AND ALLOYS

Classification of Engineering materials - Ferrous metals -Plain carbon steel (low, medium and high carbon steels), microstructure/composition, properties, applications - Alloy steels, effect of alloying additions on steels - stainless steels, High Strength Low Alloy Steels (HSLA), maraging, tool steels - Cast iron - grey, white, malleable, spheroidal graphite cast iron, microstructure, properties, applications - Non-ferrous metals - Nickel, Copper, Titanium, Aluminium, Magnesium, Zinc alloys, properties and applications - Bearing materials

UNIT III **7 Hours**

HEAT TREATMENT OF STEELS

Purpose of heat treatment - Annealing (stress relief, recrystallization, spheroidizing) -Normalizing - Hardening and Tempering, Isothermal transformation diagrams (T-T-T diagrams), Cooling curves superimposed on T-T-T diagrams (martensite and bainite phase formation) -Hardenability, Jominy end quench test, Case hardening processes, carburizing, nitriding, carbontiriding, cyaniding, flame hardening, induction hardening

UNIT IV **5 Hours**

INTRODUCTION TO POLYMERS AND ENGINEERING CERAMICS

Polymers - Plastics and elastomers - Thermoplasts and thermosets, properties and applications (polyethylene, polypropylene, polyurethane, polystyrene, poly vinylchloride, polymethyl methacrylate, polyethylene terapthalate, polycarbonate, polyamide, acrylonitrile butadiene styrene, polyamide, polyamideimide, polypropyleneoxide, polypropylene sulphide, polyetheretherketone, polytetrafluroethylene, urea formaldehyde, phenol formaldehyde, polyester, nylon, epoxy) - Rubber and its types - Types of Ceramics and applications

UNIT V **6 Hours**

MECHANICAL PROPERTIES AND MATERIALS TESTING

Elastic and plastic deformation, slip and twinning - Tensile test, stress-strain behavior of ductile and brittle materials - Stress-strain behaviour of elastomers - Viscoelasticity - Compression test - Hardness and testing methods -Impact test - Fatigue test, Stress vs number of cycles (S-N) curve, endurance limit, factors affecting fatigue - Creep test, creep curves -Types of fracture - Fracture toughness - Three crack propagation modes

FOR FURTHER READING

Review on Super alloys, Shape memory alloys, Composite Materials, Case studies in Metallurgical failure analysis

2 Hours

EXPERIMENT 1

Study of parts and functions of a metallurgical microscope

4 Hours

EXPERIMENT 2

Methodology for preparation of specimen for metallographic examination/analysis.

2 Hours

EXPERIMENT 3

Methodology for observation of Microstructure - grain size and secondary phase

4 Hours

EXPERIMENT 4
Preparation of plain carbon steel sample and microstructural observation.

4 Hours

EXPERIMENT 5
Preparation of stainless steel sample and microstructural observation.

2 Hours

EXPERIMENT 6
Preparation of cast iron sample and microstructural observation.

2 Hours

EXPERIMENT 7
Preparation of non-ferrous metal samples (Al/Mg/Ni) and microstructural observation.

4 Hours

EXPERIMENT 8
Study of hardenability of steel using Jominy end quench test.

2 Hours

EXPERIMENT 9
Dry sliding wear analysis of a given sample (aluminum/mild steel).

4 Hours

EXPERIMENT 10
Study the influence of structure (crystal structure/grain structure) of metallic materials on the tensile properties using universal tensile testing machine.

Total: 60 Hours

Reference(s)

1. William D Callister Jr., Materials Science and Engineering: An Introduction, 7th Edition, John Wiley & Sons Inc., New York, 2007.
2. G. E.Dieter, Mechanical Metallurgy, McGraw Hill, 2007.
3. V. Raghavan, Materials Science and Engineering, Prentice Hall of India, Delhi, 2009.
4. William Smith and Javed Hashemi, Foundations of Materials Science and Engineering, 5th Edition, McGraw Hill, New York, 2009.
5. G. Murray, C. White and W. Weise, Introduction to Engineering Materials, 2nd Edition, Chemical Rubber Company (CRC) Press, Taylor & Francis Group, Florida, 2007.
6. C.P.Sharma, Engineering Materials-Properties and Applications of Metals and Alloys, Prentice Hall of India, New Delhi, 2004.

7. **Assessment Pattern**

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	10					10																			20
2	8	5				7																			20
3	6					10								4											20
4	8	4				4								4											20
5		4				10					3			3											20
																								Total	100

Assessment Questions
Remember
1. Define solid solution.
2. Define polymer.
3. State the objective behind the heat treatment of steels.
4. What is polymerization?
5. What are the 2 basic components in a composite?
6. Define Hooke's law of elastic limit.
7. Define elastic and plastic deformation.
8. What causes fatigue failure?
9. Draw a completely reversed stress cycle.
10. What is the effect of silicon as an alloying element in steel?

Understand
1. Identify the reactions that occur in an iron-iron carbide phase diagram.
2. Why the solubility of carbon is more in austenite?
3. Identify the significance of C-curve during heat treatment of steels?
4. Why are nickel alloys used in aircraft engines?
5. Why aluminium, magnesium and PMC are proposed to replace cast iron and steel in automobile and aircraft industries?
6. Why is stainless steel 'stainless'?
7. Interpret the strain-strain curve of an elastomer and a thermosetting plastic.
8. Compare the stress-strain behavior of brittle and ductile materials using a stress-strain curve.
9. Compare slip and twinning.
10. Distinguish between hardness and hardenability.

Apply
1. An aluminium test piece has a gauge length of 40 mm. The test piece is strained in tension, so that the gauge length becomes 47 mm. Find the strain.
2. (a) A steel rod of 6 mm in diameter is under the action of a tensile force of 400 N. Calculate the tensile stress in the rod. If the rod's length is 40 mm and is extended elastically to 42.3 mm. What is the strain experienced by the rod? Find the elastic modulus of the rod at 400 N.
   (b) With further loading, it was observed that the tensile force increased to 650 N and the material fractured at the extension of 57.5 mm. Find the ultimate tensile strength and the strain to fracture of the material.
3. A steel wire of 0.5 mm^2 cross-sectional area and 10 meters long is extended elastically 1.68 mm by a force of 17.24 N. Calculate the modulus of elasticity.
4. If the elastic modulus of pure titanium is 100 GPa. Find the theoretical strength of the material.

Analyse
1. Identify, why low carbon steel in the normalized condition is stronger than the same steel in the annealed condition?
2. If discontinuous fibres are used in a composite, identify, how rule of mixtures can be used to explain their behaviour?
3. Using suitable figures of structure and mechanical property, distinguish between thermoset, thermoplastic and elastomer.
4. Identify how creep-fatigue interaction occurs in steam generators or nuclear reactor pipelines where no external fatigue loads are involved.
5. Compare the structures, properties and applications of grey cast iron and white cast iron.
6. Justify why metals like lead and tin creep at room temperatures.

15ME303 FLUID MECHANICS AND MACHINERY 3 2 0 4

Course Objectives

- To study the fluid laws, properties and measurements.
- To expose various fluid flow measuring devices and calculate the flow losses in pipes.
- To learn the concept of boundary layer theory over bodies and perform dimensional analysis.
- To impart knowledge on various types of hydraulic turbines and performance curves.
- To gain knowledge on working principles and performance analysis of fluid pumps.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
o. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Estimate the flow properties and pressure head using fundamental laws of fluid mechanics.
2. Evaluate the discharge and loss of energy in flow through pipes.
3. Illustrate the impact of boundary layer over bodies and model the fluid structures using Reynolds and Froudes Model law.
4. Analyze the performance of hydraulic turbine for a given application.
5. Analyze the performance of hydraulic pumps for a given application.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2													
2	3	2													
3	3	2				2									
4	2	3		1			1								3
5	2	3		1											

UNIT I **7 Hours**

INTRODUCTION TO FLUID AND FLUID MOTION

Fluid- Fluid mechanics -Laws of Fluid Mechanics-Properties of fluid and its application-Types of fluid Types of fluid flow-Measurement of pressure-U-tube and differential manometer- Measurement of velocity using Discharge Actual discharge-Flow pattern-law of conservation of Mass, Energy, Momentum -continuity equation.

UNIT II **11 Hours**

FLUID DYNAMICS AND FLUID FLOW OVER CONDUITS

Forces acting on a fluid element- Eulers and Bernoulli theorem Application in internal and external flows measuring instruments - Momentum equation applications for bend in pipes Major losses and Minor losses in pipes using standard charts and tables pipes in series and pipes in parallel. Identification of laminar and turbulent flow in closed conduits, flow in circular pipe - Darcy Weisbach equation.

UNIT III **9 Hours**

EXTERNAL FLOW OVER BODIES AND DIMENSIONAL ANALYSIS

Fluid flow over Bodies: Boundary layer theory-Boundary layer development on a flat plate -Lift and drag of an aero foil. Need for dimensional analysis dimensional analysis using Buckingham pi theorem - Similitude types of similitude - Dimensionless parameters- application of dimensionless parameters Model analysis through Reynolds and Froudes Model law.

UNIT IV **9 Hours**

HYDRAULIC TURBINES

Definition of turbine Classification -Types of head and efficiencies of turbine-Impulse turbine - Reaction turbine-Francis turbine, Kaplan turbine - working principles and velocity triangle- Work done by water on the runner Specific speed - unit quantities performance curves.

UNIT V **9 Hours**

HYDRAULIC PUMPS

Definition -Centrifugal pump Classification Construction working principle and velocity Triangle Definition of heads-Losses and efficiencies-Multistage Centrifugal pump-Specific speed Priming and cavitation effects of centrifugal pump. Reciprocating pump Classification Working Principle Coefficient of discharge and slip-Indicator diagram (Descriptive treatment only).

FOR FURTHER READING

Case study simple experiments /analyzing the properties of fluid Analyzing the torcelli equation by a simple experiment

Total: 75 Hours

Reference(s)

1. R.K.Bansal, A Textbook of Fluid Mechanics and Machinery, Laxmi Publications (P) Ltd., New Delhi, Revised Ninth edition, 2014.
2. Victor L. Streeter, K.W. Bedford and Wylie E. Benjamin , Fluid Mechanics, Tata McGraw Hill Publishing Company Pvt Ltd., New York, Revised Ninth Edition 1997.
3. Bruce R Munson , Donald F Young, Theodore H Okiishi and Wade W. Huebsch, Fundamentals of Fluid Mechanics, John Wiley & Sons, Sixth edition 2009.
4. Pijush K Kundu and Ira M Cohen, Fluid Machines, Academic Press, Burlington, United states of america, 2010.
5. Yunus Cengel and John Cimbala, Fluid Mechanics Fundamentals and Application, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi 2009.
6. Robert and W Fox, Introduction to Fluid Machines, John Wiley Eastern Pvt. Ltd., New Delhi, 6th edition ,2006.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	
1	4				2	2			6										6						20
2		2			4	2												12							20
3	2						2				12								2		2				20
4	2					2			12									4							20
5		2			2														12			4			20
																								Total	100

Assessment Questions

Remember

1. Define density.
2. State law of conservation of mass.
3. State the criteria for laminar flow.
4. Define viscosity.
5. What is meant by Newtonian fluid?
6. What are the assumptions made in Bernoulli’s equation?
7. Define Reynolds number.
8. State the law of conservation of momentum.
9. Sketch velocity distribution curve for laminar flow occur in a pipe.
10. State the advantages of dimensional analysis.
11. Define webbers number.
12. Sketch the velocity triangle for an impulse turbine.

Understand

1. How does the viscosity of an incompressible fluid vary with temperature?
2. Classify the different types of fluids.
3. Compare the steady and unsteady flow.
4. Differentiate Newtonian and Non-Newtonian fluid.
5. Why specific gravity of a fluid is related to density?
6. If the specific gravity is greater than 1, what will be effect if a piece of wood is placed inside the oil contained in a vessel?
7. Differenciate pump and turbine.
8. Classify the turbine based on head and specific speed.
9. Compare and contrast the Francis and Kaplan turbine.
10. Why the Kaplan turbine are utilized for low head and high discharge?

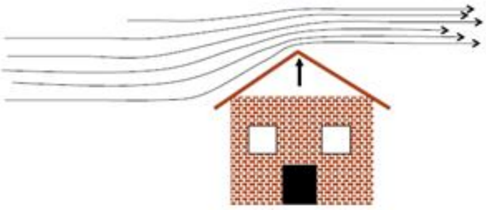
Apply

1. Choose the type of fluid for measuring pressure by a u-tube manometer.
2. Predict the type of flow occurs when a fluid is pumped from the well to the reservoir and then passes through a pipe?
3. “A Bullet is piercing out from the riffle with certain velocity"–Discuss it type of flow.
4. How does rain water tends to form like droplets in a leaf on tree?
5. How does water beads up into small drops on flower petals?
6. When does the compressible fluid tend to act as an incompressible fluid?

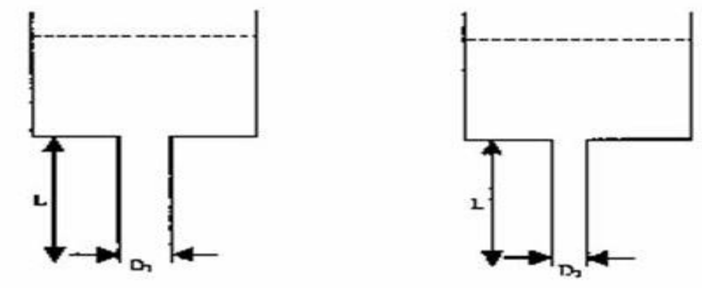
Evaluate

1. Anything to do with specific Gravity.
2. Functional differences between an elbow joint and a Bend Joint with both have 900 shift of axis.

3. In a storm houses lose its roof? –Refer Picture. Explain.



4. The efficiency η of geometrically similar fans depends upon mass density of air ρ , its viscosity μ , speed of fan N , diameter of blades D , and discharge Q , Perform Dimensional analysis.
5. A geometrically similar model of an air duct is built to 1/25 scale and tested with water which is 50 times more viscous and 800 times denser than air. When tested under dynamically similar conditions, the pressure drop is 200 kPa in the model. Find the corresponding pressure drop in the full scale prototype and express in cm of water.
6. A 0.15 m diameter journal runs in a bearing 0.3m.the lubricant used has a specific gravity of 0.855 and a kinematic viscosity 1.81 stokes. The radial clearance may be assumed to be uniform and equal to 0. 05m. What will be the torque to overcome viscous resistance of lubricant?
7. Select the type of vanes in a centrifugal pump utilized for an industrial practice.
8. Two pipes 1 and 2 each of 10cm diameter branch off from a point A in pipeline and rejoin at B. Pipe 1 is 300 m long and pipe 2 is 500m long. The total head at A is 30m. A short pipe 8cm diameter is fitted at B and the flow is discharged into atmosphere through it. Assume friction factor =0.02 for both the pipes what will be the discharge of pipe 1?
9. Two identical reservoirs, open at the top are drained through pipes attached to the bottom of the tanks as shown below. Two drain pipes of same length, but of different diameters (D1>D2). Assume the flow to be steady and laminar in both drain pipes, if the volumetric flow rate in the larger pipe is 16 times of that in the smaller pipe, find the ratio of D1/D2.



Create

1. Fabricate a 1:10 model of a real fan and prove the model similarity.
2. Make a positive displacement pump and prove its efficiency and measure the maximum pressure developed by it.

15ME304 ENGINEERING THERMODYNAMICS 3 2 0 4

Course Objectives

- To study the fundamentals of thermodynamics and zeroth law.
- To provide the knowledge on first law of thermodynamics.
- To impart the knowledge on second law of thermodynamics and entropy.
- To study the thermodynamic properties of pure substances and its phase change processes
- To learn about gas power cycles and properties of gas mixtures.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
o. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Exemplify the basic concepts and zeroth law of thermodynamics.
2. Apply the first law of thermodynamics to closed and open systems.
3. Solve the problems related to cycles and cyclic devices using second law of thermodynamics.
4. Determine the thermodynamic properties of pure substances and its phase change processes.
5. Evaluate the air standard performance of heat engines and properties of gas mixtures.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3													
2	2	3					1								
3	2	2					2								3
4	2	3		1			2								
5	2	3		1		2	3								2

UNIT I **8 Hours**

INTRODUCTION AND ZEROTH LAW OF THERMODYNAMICS

Macroscopic and Microscopic approaches, Definitions and concepts- heat, work, thermodynamic equilibrium, system and types, surroundings, Properties- intensive and extensive properties, Path and point functions, Energy- macroscopic and microscopic modes of energy, Thermodynamic processes and cycle, State postulate, Zeroth law of thermodynamics- temperature scale, perfect gas scale.

UNIT II **10 Hours**

FIRST LAW OF THERMODYNAMICS

First law of thermodynamics, I law for Closed systems - constant pressure process, constant volume process, constant temperature process, adiabatic process, polytropic process, throttling process. I law for open systems -Steady state flow processes, Steady flow energy equation (SFEE), Application of SFEE-turbines and compressors, nozzles and diffusers, throttling valves, heat exchangers

UNIT III **8 Hours**

SECOND LAW OF THERMODYNAMICS

Limitations of I law of thermodynamics, Second law of thermodynamics- Kelvin - Planck and Clausius statements, Heat Engine, heat pump and refrigerator, Reversibility and irreversibility- irreversible and reversible processes, Carnot's principles, Carnot cycle, Carnot engine, Thermodynamic temperature scale, Clausius inequality, Entropy- principle of entropy increase, Availability & irreversibility

UNIT IV **9 Hours**

PROPERTIES OF PURE SUBSTANCES

Thermodynamic properties of fluids. Pure substance-phases - Phase change processes, Property diagrams - pressure-volume (P-v), pressure-temperature (P-T), temperature volume (T-v), temperature-entropy (T-s) and enthalpy-entropy (h-s) diagrams. Steam tables - Problems on flow and non-flow processes. Ideal gas - equation of state, Van derWaals equation and compressibility chart.

UNIT V **10 Hours**

GAS MIXTURES AND GAS POWER CYCLES

Thermodynamics of ideal gas mixture- mixture of ideal gas, mixture of perfect gases, Dalton's law of partial pressure, Amagat's law, Thermodynamics properties, Psychrometric properties and processes - Psychrometric chart. Air standard cycles Otto, Diesel and Dual Calculation of mean effective pressure and air standard efficiency.

FOR FURTHER READING

Thermodynamic property relations- Maxwell relations, TDS equations, The Clapeyron equation, Joule-Thompson expansion.

Total: 75 Hours

Reference(s)

1. Y. Cengel and Boles, Thermodynamics - An Engineering Approach, Tata McGraw Hill Publishing Company Pvt. Ltd, New Delhi,2003.
2. R.K. Rajput, Engineering Thermodynamics, Laxmi Publications Pvt.Ltd., New Delhi,2011.
3. R.S.Khurmi, Steam table with Psychometric chart,S.Chand Publications, New Delhi,2009.
4. J.P.Holman, Thermodynamics, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi,2002.
5. P.K.Nag, Engineering Thermodynamics, Tata McGraw-Hill, New Delhi, 2007.
6. C.P.Arora, Thermodynamics, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi,2003.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	4				2	2					8			4											20
2	2				4	2					8			4											20
3	2				4	2					8			4											20
4	2				4	2					8			4											20
5	2				4	2					8			4											20
																								Total	100

Assessment Questions

Remember

1. Define the term entropy.
2. Define enthalpy.
3. What is a heat engine?
4. Define internal energy.
5. State the terms path, process, cycle in thermodynamics.
6. Define Coefficient of Performance.
7. State Clausius statement of second law of thermodynamics.
8. State Kelvin-plank statement of second law of thermodynamics.
9. Define volumetric efficiency.
10. State Dalton’s law of partial pressure.
11. Define Dry bulb temperature.
12. Define Relative humidity.

Understand

1. Identify a steady flow system and indicate the expressions.
2. Justify the limitations for first law of thermodynamics.
3. How the vapour power cycle suited for three phase flow? Give some examples.
4. Why we apply Maxwell relations?
5. What is the effect of cut-off ratio in the efficiency of a Diesel cycle?
6. Differentiate 2-stroke and 4-stroke engines based on construction.
7. Compare dry bulb and wet bulb temperature.
8. Prove that for an isolated system, there is no change in internal energy.
9. Differentiate homogeneous and heterogeneous system.
10. Compare flow and non-flow processes.

Apply

1. A rigid tank containing $0.4m^3$ of air at 400 kPa and 30°C is connected by a valve to a piston cylinder device with zero clearance. The mass of the piston is such that a pressure of 200 kPa is required to raise the piston. The valve is opened slightly and air is allowed to flow into the cylinder until the pressure of the tank drops to 200kPa.During this process, heat is exchanged with the surrounding such that the entire air remains at 30ºC at all times. Determine the heat transfer for this process.
2. A Carnot heat engine receives heat from a reservoir at 1173 K at a rate of 800 kJ/min and reject the waste heat to the ambient air at 300 K. the entire work output of the heat engine is used to drive a refrigerator that removes heat from the refrigerated space at 268 K and transfers it to the same ambient air at 300 K. Determine the maximum rate of the heat removal from the refrigerated space and the total rate of heat rejection to the ambient air.
3. One kg of steam is contained in an elastic Baloon of spherical shape which supports an internal pressure proportional to its diameter. The initial condition of steam is saturated vapour at 110ºC heat is transferred to steam until pressure reaches 200kPa. Determine: Final temperature and Heat transferred. Take Cps = 2.25 kJ/kg.K

4. 0.45 kg of CO and 1 kg of air is contained in a vessel of volume 0.4 m3 at 15ºC. Air has 23.3% of Oxygen and 76.7% of nitregen by mass. Calculate the partial pressure of each constituents and total pressure in the vessel. Molar masses of CO, Oxygen and nitregen are 28, 32 and 28 kg/k mol. The dry and the wet bulb temperatures of atmospheric air at 1 atm (101.325 kPa) pressure.
5. The dry and the wet bulb temperatures of atmospheric air at 1 atm (101.325 kPa) pressure are measured with a sling psychrometer and determined to be 25ºC and 15°C respectively. Determine the specific humidity the relative humidity the enthalpy per unit mass of the dry air, and the masses of dry air and water vapour in the room.

Analyse

1. Analyse clausius inequality with its p-V diagram.
2. Prove that the difference in specific heat capacities equal to Cp-Cv = R and Cp-Cv = TVβ2 / kT.
3. Relate the terms enthalpy, entropy, internal energy for a thermodynamic system.
4. Analyse the relation between heat and work transfer for a flow and non-flow process.

15ME305 MANUFACTURING TECHNOLOGY - I 2 0 2 3

Course Objectives

- To study the sand casting and special casting processes sand casting processes and practice mould preparation
- To learn various metal joining processes and gain welding skills.
- To provide the knowledge on various bulk deformation processes and its applications.
- To expose knowledge on sheet metal forming processes and special forming processes and to make small sheet metal parts.
- To learn about the various plastics moulding and forming processes and to make simple plastic part.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
n. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Understand sand casting and special casting processes and produce castings.
2. Select the suitable metal joining process for the given materials and its applications.
3. Select the suitable bulk deformation processes for the given materials and its applications.
4. Understand the sheet metal and special forming processes and prepare simple sheet metal components.
5. Identify the suitable moulding and forming processes of plastics for the given applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2							1	1		2		2	
2	2	2							1	1		1		2	
3	2	2										1		2	
4	2	2							1			1		2	
5	2	2							1	1		1		2	

UNIT I **7 Hours**

CASTING PROCESSES

Introduction to production processes and its classifications - Pattern - Types, Materials and Allowances. Moulding sand - Types, Properties and Testing. Moulding machines and its types. Melting furnaces - Cupola and Induction. Fettling and cleaning. Sand casting defects. Special casting processes - Shell moulding, Die casting, Centrifugal casting and Investment casting

UNIT II **7 Hours**

METAL JOINING PROCESSES

Introduction to welding processes and its classifications - Principle of Gas welding and its flames - Principle of arc welding - Electrodes, Fluxes and filler materials. Principle of Resistance welding - Spot, butt and seam. Principle of Gas metal arc welding, Submerged arc welding, Tungsten Inert Gas welding, Plasma arc welding, Thermit welding, Electron beam welding and Friction welding - Weld defects - Brazing and soldering

UNIT III **6 Hours**

BULK DEFORMATION PROCESSES

Introduction - Hot and cold working of metals - Forging processes - Open and close die forging, Forging equipment and operations. Rolling - Types of Rolling mills, shape rolling operations, Tube piercing and Defects. Principle of Extrusion and its types. Principle of rod and wire drawing.

UNIT IV **5 Hours**

SHEET METAL FORMING AND SPECIAL FORMING PROCESSES

Introduction - Shearing, bending and drawing operations - Stretch forming operations - Principle of special forming processes - Hydro forming, Rubber pad forming, Metal spinning, Explosive forming, Magnetic pulse forming, Peen forming and Super plastic forming.

UNIT V **6 Hours**

MOULDING AND FORMING OF PLASTICS

Introduction to plastics - Moulding of Thermoplastics - Principle and applications of Injection moulding and its types, Blow moulding, Rotational moulding, Thermoforming and Extrusion. Moulding of Thermosets -Principle and applications of Compression moulding and Transfer moulding - Bonding of Thermoplastics - Fusion and solvent methods `

FOR FURTHER READING

Automation in moulding - Underwater welding - Sequence of operations for producing a fan blade - Production of thermoplastic film, Inspection methods

1 **3 Hours**

EXPERIMENT 1

To prepare a mould using split pattern in sand casting process

2 **3 Hours**

EXPERIMENT 2

To demonstrate the various patterns used in sand casting

3 **3 Hours**

EXPERIMENT 3

To prepare a core using core box

4 **3 Hours**

EXPERIMENT 4

To produce a lap/butt joint using gas welding

5 **3 Hours**

EXPERIMENT 5

To join two SS plates using TIG welding

6 **3 Hours**

EXPERIMENT 6

To join two MS plates using MIG welding

7 **2 Hours**

EXPERIMENT 7

To make a V bending using hydraulic press

8 **3 Hours**

EXPERIMENT 8

To make a simple component using metal spinning

9 **3 Hours**

EXPERIMENT 9

To make a simple thermoplastic component using injection molding

10 **2 Hours**

EXPERIMENT 10

To make a simple component using compression molding

11 **1 Hours**

EXPERIMENT 11

To join thermoplastic component using solvent method.

Total: 60 Hours

Reference(s)

1. P. N. Rao, Manufacturing Technology vol. I, Tata McGraw-Hill Publishing Company Private Limited, New Delhi, 2010.
2. Serope Kalpakjian, Steven R. Schmid, Manufacturing Engineering and Technology,Pearson Education Limited,New Delhi, 2013.
3. J. P. Kaushish, Manufacturing Processes, Prentice Hall of India Learning Private Limited, New Delhi, 2013.
4. P.C. Sharma, Manufacturing Technology - I, S Chand and Company Private Limited,New Delhi,2010.
5. S K Hajra Choudhury, Elements of Workshop Technology - Vol. I, Media Promoters & Publishers Private Limited, Mumbai,2013
6. http://nptel.ac.in/courses/112107144/1

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	5					3					12														20
2	5				3	12																			20
3	4				4	12																			20
4	4				4	12																			20
5	4					4					12														20
																								Total	100

Assessment Questions
Remember

1. Define casting.
2. List any four types of patterns.
3. Define core print.
4. State any three types of resistance welding.
5. List any four rolling defects.
6. Define recrystallization.
7. What do you mean by hot working and cold working?
8. What is meant by spring back effect?
9. List any two advantages of hydro forming process.
10. What is meant by rotational molding?
11. A wax pattern is used in
    a) investment casting
    b) sand casting
    c) die casting
    d) shell casting
12. Which of the following material is used for making shell moulding pattern
    a) aluminum
    b) wax
    c) slurry
    d) cast iron
13. Investment casting is used to
    a) jewelleries & decorative items
    b) Automobile items
    c) Machine body items
    d) Cooking utensils
14. Metal moulds are used in
    a) Sand casting
    b) Shell casting
    c) Die casting
    d) Investment casting
15. Drag is defined as
    a) lower part of the moulding flask
    b) upper part of the moulding flask
    c) intermediate part of the moulding flask
    d) channel in the parting line

Understand

1. Why is pattern allowance to be given?
2. Why the tungsten is preferred material for non-consumable electrodes?

3. How does the pressure welding differ from fusion welding?
4. Differentiate soldering and brazing.
5. Differentiate open and closed die forging.
6. How does press forging differ from drop forging?
7. How to use rolling process for producing threads?
8. Compare blanking and punching.
9. What are the possible methods to overcome spring back effect?
10. Compare thermoplastics and thermo-set plastics.
11. Refractory slurry is used in
    a) investment casting
    b) sand casting
    c) die casting
    d) shell casting
12. Big components are produced by
    a) investment casting
    b) sand casting
    c) die casting
    d) shell casting
13. Cores are not used to produce hollow profile in
    a) Machine moulding
    b) True centrifugal casting
    c) Semi centrifugal casting
    d) Shell moulding
14. The best method for producing cast iron pipes is
    a) Sand casting
    b) Shell casting
    c) Die casting
    d) Centrifugal casting
15. In centrifugal casting the impurities are
    a) uniformly distributed
    b) forced towards the outer surface
    c) collected at the centre
    d) all of the above

Apply

1. Select suitable methods, tools and procedures to make cylindrical component with a hole.
2. Select and apply a suitable welding process for producing boiler shell.
3. Select suitable manufacturing methods to make seamless.
4. How the SS chairs with multiple holes can be produced?
5. Apply a suitable thermo plastic moulding process for producing the water bottle.

15ME306 ENGINEERING MECHANICS - DYNAMICS

2 2 0 3

Course Objectives

- Determine the solution for the problems related to kinematics of particles.
- Evaluate the relation existing among force, mass and acceleration of particles.
- Calculate forces associated with work, energy, impulse and momentum.
- Analyze the geometric motion of rigid bodies.
- Apply the concepts of rigid body kinetics to solve engineering problems.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Determine the solution for the problems related to kinematics of particles.
2. Determine the relation existing among force, mass and acceleration of particles.
3. Calculate forces associated with work, energy, impulse and momentum.
4. Apply the concepts of rigid body kinematics to solve engineering problems.
5. Apply the concepts of rigid body kinetics to solve engineering problems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2										2	3		
2	3	2										1	2		
3	3	2				3						2	3		
4	3	2										1	2		
5	2	2										2	3		

UNIT I **6 Hours**

KINEMATICS OF PARTICLES

Introduction to dynamics - Rectilinear motion - displacement, velocity and acceleration - Equations of motion - Curvilinear motion - angular displacement, velocity and acceleration. Types of coordinates system - rectangular, tangential and normal, radial and transverse.

UNIT II **6 Hours**

KINETICS OF PARTICLES I: FORCE, MASS AND ACCELERATION

Introduction to kinetics - Newton's second law of motion - Equations of motion - Problems on rectangular coordinates, normal and tangential components, cylindrical coordinates - Dynamic equilibrium - D'Alembert's principle - equation of motion for a system of particles.

UNIT III **6 Hours**

KINETICS OF PARTICLES II: WORK ENERGY AND IMPULSE MOMENTUM

Principle of work - conservative and non-conservative forces. Principle of energy - potential energy, kinetic energy, conservation of energy. Principles of Impulse and Momentum - principle of conservation of linear momentum. Impact - direct, central, non-central, oblique - coefficient of restitution.

UNIT IV **6 Hours**

PLANE KINEMATICS OF RIGID BODIES

Introduction to planar kinematics - Types of motion - Rectilinear and curvilinear Translation motion, Rotational motion about a fixed axis, General plane motion - Absolute and relative velocity - Instantaneous centre of rotation and acceleration.

UNIT V **6 Hours**

PLANAR KINETICS OF RIGID BODIES

Introduction to 2-D kinetics - Force and Acceleration - General equations of motion. Principle of work and Energy - work done by a couple, spring - principle of conservation of energy. Principle of impulse and momentum - linear momentum.

FOR FURTHER READING

Kinetics of particles - system of particles. Kinetics of rigid bodies - principle of conservation of momentum.

Total: 60 Hours

Reference(s)

1. Beer, Johnston, Mazurek, Cornwells and Sanghi, Vector Mechanics for Engineers: Statics, Dynamics, 10th Edition, Tata McGraw Hill - Noida, Uttar Pradesh, 2013.
2. N.H.Dubey, Engineering Mechanics - Statics and Dynamics, 1st Edition, McGraw-Hill Education India Private Ltd., New Delhi, 2012.
3. R.C.Hibbeler, Engineering Mechanics: Dynamics, 13th Edition, Prentice Hall, 2012.
4. J.L.Meriam and L.G.Kraige, Engineering Mechanics: Dynamics, 7th Edition, Wiley India Private Limited, 2013.
5. Irving H. Shames, Engineering Mechanics - Statics and Dynamics, 4th Edition, Pearson India, 2011.
6. www.nptel.iitm.ac.in/video.php?subjectId=122104015.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	3					5				6	6														20
2		3				4				4	8														19
3		3				5				3	10														21
4	3					4				6	6														19
5	3					5				5	8														21
																								Total	100

Assessment Questions
Remember

1. Define dynamics.
2. Define kinematics.
3. What is a force?
4. Define system of forces.
5. State D'Alembert's principle.
6. State Newton's three laws.
7. Define 'equilibrium'.
8. State the law of conservation of momentum.
9. What is general plane motion?
10. What are the techniques used in kinetics of rigid bodies?
11. Define coriolis acceleration.

Understand

1. Differentiate between the motion and rest of the body.
2. Contrast acceleration and retardation.
3. Compute the equations of motion if a body is subjected to force of gravity.
4. Interpret horizontal range.
5. Why a force cannot do any work in a direction perpendicular to it?
6. Infer principle of conservation of momentum.
7. Select a situation where conservation of momentum principle can be applied.
8. Why principle of conservation of energy cannot be applied to frictional force?
9. Interpret eccentric impact?
10. Contrast velocity of approach and velocity of separation.

Apply

1. A body is moving with a velocity of 3m/sec. after five seconds the velocity of the body becomes 13 m/sec. find the acceleration of the body.
2. The brakes of the train reduce its speed from 60 to 20 kms/ hr while it runs 200m. Assuming that these exists constant retarding force, find (a) how much further the train will run before coming to rest and (b) how long will it take?
3. Two trains are starting at different time from the same station. Assume that first train always moves with velocity less than that of second train and the acceleration pattern for both trains is different during start, motion and stop of the trains. Enumerate the approach of finding the distance at which second train overtake the first train.
4. How to determine the velocity and direction of two bodies having an oblique central impact after the impact is over?
5. A stone is dropped from the top of the tower. The stone reaches the ground in 10s. Determine the height of tower and the velocity of stone, when it reaches the ground.
6. An automobile weighing 2000kg is driven down a 5° incline at a speed of 90 km/h when the brakes are applied, causing a constant total braking force (applied by the road on tires) of 7.5 kN. Determine the time required for the auton=mobile to come to stop.
7. A pendulum is drawn aside so that the hob is raised vertically through 12 cm from its mean position and let go. Find the velocity when it crosses the mean position
8. A ball of 30 kg mass moving with a velocity of 4 m/s strikes directly on another ball of mass 15 kg moving in the opposite direction with a velocity of 12 m/s. if the coefficient of restitution is equal to 5/6, then determine the velocity of each ball after impact.
9. A 60 kg homogeneous cylinder 1000 mm in diameter accelerates from rest to a speed of 120 rev/min in just one revolution. Determine the torque which is needed to keep this speed. Also find the power required.
10. The radius of gyration of a flywheel, which weights 6kN, is 50cm. if the flywheel starts from rest and attains a speed of 200 rpm in 2 minutes, determine the average torque exerted on the flywheel.

15ME307 FLUID MECHANICS AND MACHINERY LABORATORY

0 0 2 1

Course Objectives

- To demonstrate the principles of fluid mechanics.
- To measure the energy losses in a pipe flow.
- To perform characteristic study on impulse, reaction and axial flow turbines.
- To perform characteristic study on positive displacement pumps.
- To perform characteristic study on non-positive displacement pumps.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Examine the fluid flow and coefficient of discharge in fluid flow devices.
2. Measure the major and minor losses associated in a pipe flow.
3. Interpret the characteristic study on impulse, reaction and axial flow turbine.
4. Evaluate the performance of positive displacement pumps.
5. Evaluate the performance of non-positive displacement pumps

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2								1					
2	3	2								1					
3	3	2		1						1					
4	3	2		1						1					
5	3	2		1						1					

1 **3 Hours**

EXPERIMENT 1

Experimental verification of Bernoullis theorem in a pipe flow and visualize the flow using Reynolds apparatus.

2 **4 Hours**

EXPERIMENT 2

Measurement of flow rate using venturimeter and orificemeter and calculate the coefficient of discharge.

3 **2 Hours**

EXPERIMENT 3

Determination of loss of head in different pipes (major loss) and fittings (minor loss) for various flow rates.

4 **2 Hours**

EXPERIMENT 4

Performance test on tangiantial flow impulse (Pelton wheel) turbine against constant head.

5 **2 Hours**

EXPERIMENT 5

Performance test on Francis turbine against constant head.

6 **4 Hours**

EXPERIMENT 6

Performance test on reaction (Kaplan) turbine.

7 **3 Hours**

EXPERIMENT 7

Performance characteristics of a reciprocating pump.

8 **3 Hours**

EXPERIMENT 8

Performance characteristics of a gear pump.

9 **4 Hours**

EXPERIMENT 9

Performance test on centrifugal pump.

10 **3 Hours**

EXPERIMENT 10

Performance test on submersible pump.

Total: 30 Hours

15ME308 MACHINE DRAWING LABORATORY 0 0 2 1

Course Objectives

- Use limits, fits and tolerances in real world problems.
- Apply different sectional views in drawings.
- Recognize the drawing notations of standard machine elements.
- Draw the assembly drawing.
- Draw the detailed drawing of given components.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Use limits, fits and tolerances in real world problems.
2. Sketch the sectional views of simple elements.
3. Select and draw the standard mechanical elements like bolt,nut,screw etc.
4. Select the assembly drawing of automobile components.
5. Sketch the detailed drawing of automobile components.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2					2						3			
2	2											2			
3	2					2				2			2		
4	2									3					
5	2									3					

UNIT 1 5 Hours

LIMITS, FITS AND TOLERANCES

Limit System- Tolerance, Limits, Deviation, Actual Deviation, Upper Deviation, Lower Deviation, Allowance, Basic Size, Design Size, Actual Size. Fits- Types, Tolerances of Form and Position- Form and Position Variation, Geometrical Tolerance, Tolerance Zone, Indicating Geometrical Tolerances. Indication of Surface Roughness, Standard Abbreviations and Symbols used in industries.

UNIT 2 **5 Hours**

SECTIONAL VIEWS

Sections- Hatching of Sections, Cutting Planes, Revolved or Removed Section, Sectional Views- Full Section, Half Sections and Auxiliary Sections- Conventional Representation-One-view, Two-view and three view Drawings.

UNIT 3 **5 Hours**

INTRODUCTION TO MACHINE ELEMENT DRAWINGS

Drawing standards and Designation of Bolts, nuts, screws, keys, pins, Rivets, Welded Joints- Dimensioning of Welds, Belt Driven Pulleys, Chain and Gears Drives.

UNIT 4 **8 Hours**

ASSEMBLY DRAWINGS AND SECTIONAL VIEWS

Preparation of manual parts drawing and assembled sectional views from orthographic part drawings, Automobile components - stuffing box, Machine Tool Parts plummer block, Joints knuckle joints, Couplings Protected type flanged coupling, Bearings swivel bearing, Preparation of Bill of materials and tolerance data sheet.

UNIT 5 **7 Hours**

REAL PRODUCTS TO MACHINE DRAWING CONVERSION

Preparation of manual parts drawing and assembled sectional views from real time products- Internal combustion engine parts, connecting rod, couplings - universal coupling, machine tool parts - tailstock, Automobile components screw jack, stuffing box - Commercial products - Preparation of Bill of materials and tolerance data sheet.

Total: 30 Hours

Reference(s)

1. N.D. Bhatt, Machine Drawing, Charotar Publishing House Pvt. Ltd., 2014
2. P.S.Gill, A Textbook of Machine Drawing, Katson books, 2013
3. R.K.Dhawan, A Textbook of Machine Drawing,S.Chand,2012
4. K.C. John, Textbook of Machine Drawing, PHI Learning Pvt. Ltd.,2009

15ME309 MINI PROJECT I 0 0 2 1

Course Objectives

- To develop skills to formulate a technical project.
- To give guidance on the various tasks of the project and standard procedures.
- To teach use of new tools, algorithms and techniques required to carry out the projects.
- To give guidance on the various procedures for validation of the product and analyse the cost effectiveness.
- To provide guidelines to prepare technical report of the project.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Formulate a real world problem, identify the requirement and develop the design solutions.
2. Identify technical ideas, strategies and methodologies.
3. Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis the cost effectiveness.
5. Prepare report and present oral demonstrations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1		3	2			2	1								
2	2	2	1	3		2					2	2			
3			3	2	2			2			2	2			
4		1		2	3	1	2	2							
5									3	3		2			

Total: 30 Hours

15GE310 LIFE SKILLS: BUSINESS ENGLISH 0 0 2 0

Course Objectives

- To acquire command in both the receptive skills (Listening and Reading)and the productive skills(Writing and Speaking) of English language
- Employ various types of sentences in business correspondence
- To acquire language skills needed for B2 level of the CEFR/ Common European Framework of Reference for Languages

Programme Outcomes (POs)

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

Course Outcomes (COs)

1. Listen to business conversations and understand specific information and overall idea
2. Read and understand business texts
3. Write coherent business letters, e-mails and reports using appropriate sentence structures and cohesive devices
4. Communicate orally in business situations using necessary verbal and non verbal devices
5. Appear for the Business English Certificate (BEC)Vantage level examination conducted by Cambridge Assessment English

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1										2					
2										2					
3										2					
4										2					
5										2					

15 Hours

UNIT I
LISTENING AND READING

Listening for writing short answers - filling gaps in Listening for writing short answers - filling gaps in sentences - identifying topic, context and function - identify different functions of language in business situations - identify prompts -identify paraphrases of required information
Scanning - reading for gist - understanding sentence structure - error identification - identify paraphrases - cohesive words and phrases - understand the importance of analysing the distractors - identify grammatical and semantic relationships

15 Hours

UNIT II
WRITING AND SPEAKING

Business Emails - notes - memos to colleagues or friends - Giving instructions - explaining a development - asking for comments - requesting information - agreeing to requests - explaining -

apologising - reassuring - complaining - describing - summarising - recommending - persuading
Turn-taking - sustaining interaction - initiating - responding - giving personal information - Talking about present circumstances, past experiences and future plans - expressing opinion - speculating - organising a larger unit of discourse - giving information - expressing and justifying opinions - speculating - comparing and contrasting - agreeing and disagreeing

Total: 30 Hours

Reference(s)

1. Whitehead, Russell and Michael Black. Pass Cambridge BEC Vantage Self-Study Practice Tests with Key, Heinle,a part of Cengage Learning, Delhi, 2003.

15MA401 NUMERICAL METHODS AND STATISTICS 2 2 0 3

Course Objectives

- By enrolling and studying this course the students will be able to understand the methods to solve polynomial equations and Implement the mathematical ideas for interpolation numerically
- Summarize and apply the methodologies involved in solving problems related to ordinary and partial differential equations
- Apply the concepts testing of hypothesis in their core areas
- Develop enough confidence to identify and model mathematical patterns in real world and offer appropriate solutions, using the skills learned in their interactive and supporting environment

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

Course Outcomes (COs)

1. Classify the equations into algebraic, transcendental or simultaneous and apply the techniques to solve them numerically
2. Demonstrate and obtain the differentiation and integration of functions using the numerical techniques
3. Obtain the solutions of all types of differential equations, numerically.
4. Apply basic statistical inference techniques, including confidence intervals, hypothesis testing to science/engineering problems.
5. Design an experiment for an appropriate situation using ANOVA technique.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1														
2	2														
3	3														
4	3														
5	3														

UNIT I **6 Hours**

SOLUTION OF EQUATIONS

Solution of algebraic and transcendental equations: Newton- Raphson method - Solution of system of linear equations: Gauss elimination method - Inverse of a matrix: Gauss-Jordan method- Eigen values of a matrix by Power method.

UNIT II **5 Hours**

INTERPOLATION, DIFFERENTIATIONAND INTEGRATION

Interpolation: Newton's forward and backward interpolation formulae - Numerical differentiation: Newton's forward and backward interpolation formulae.

Numerical integration: Trapezoidal rule- Simpson's rules for single integrals- Two point Gaussian quadrature formula.

UNIT III **7 Hours**

SOLUTIONS OF DIFFERENTIAL EQUATIONS

Solution of first order ordinary differential equations: Fourth order Runge- Kutta method - Solution of partial differential equations: Elliptic equations: Poissons equation- Parabolic equations by Crank Nicholson method- Hyperbolic equations by explicit finite difference method.

UNIT IV **6 Hours**

TESTING OF HYPOTHESIS

Sampling distributions- Large sample test: Tests for mean- Small sample tests: Tests for mean (t test), F- test- Chi-square test for Goodness of fit and Independence of attributes

UNIT V **6 Hours**

DESIGN OF EXPERIMENTS

Completely randomized design - Randomized block design - Latin square design.

FOR FURTHER READING

Collection of data and use the testing of hypothesis to analyze the characteristics of the data.

Total: 60 Hours

Reference(s)

1. 1.Grewal B. S, Numerical Methods in Engineering and Science with Programms in C & C++, Ninth Edition, Khanna Publications, 2010.
2. 2.Sankara Rao. K, Numerical Methods for Scientists and Engineers, Third Edition, PHI Learning Private Limited, New Delhi, 2009.
3. 3.Gerald C. F and Wheatley P.O, Applied Numerical Analysis, Seventh Edition, Pearson Education, New Delhi, 2004.
4. 4.Johnson R.A, Miller and FreundÃƒÂ¢??s Probability and Statistics for Engineers, Seventh Edition, Prentice Hall of India, New Delhi, 2005.
5. 5.Walpole R.E, Myers R.H, Myers R.S.L and Ye K, Probability and Statistics for Engineers and Scientists, Seventh Edition, Pearsons Education, Delhi, 2002.
6. Burden R. L and Douglas Faires J, Numerical Analysis Theory and Applications, CengageLearning, Ninth Edition, 2005.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2					6					8			4			2								22
2		2									12								6						20
3	2					2				4					4				6						18
4	2						4			6				4					6						22
5		2					4				6				6										18
																								Total	100

Assessment Questions

Remember

1. Define Algebraic and Transcendental equations.

2. Recall the order and condition of convergence of Newton-Raphson method.
3. Recognize the derivatives of Newton‘s Forward and Backward Interpolation formula.
4. List the conditions for applying Simpson‘s rule.
5. Reproduce the formula of Fourth order Runge – Kutta method.
6. Label the procedure used in Liebmann’s process.
7. Define the region of acceptance.
8. Label the types of errors in the hypothesis testing.
9. Recall the difference between CRD and RBD.
10. Label the uses of Latin Square Design.

Understand

1. Indicate the order and condition of convergence of Newton‘s method.
2. Infer the working rule in Gaussian elimination method.
3. Interpret y’ (2) from the following:

X :	0	1	2	3	4
Y:	6.9897	7.4036	7.7815	8.1281	8.4510

4. Interpret the value of $\int_1^5 \log x\, dx$, using Trapezoidal rule.
5. Using Runge – Kutta method of fourth order, find y(0.2) given that $y' = x + y\ ,\ y(0) = 1$
6. Exemplify the working rule for solving a boundary value problems using finite difference method.
7. Sample of 900 members is found to have a mean of 3.4 cms. Can it be regarded as a simple Sample from a large population with mean 3.2 cms and SD 2.3 cms..
8. Narrate the properties and the advantages of $\chi^2 - test.$
9. Classify three basic principles of experimental design.
10. Indicate the applications of RBD and CRD.

Apply

1. Find the inverse of the following matrix using Gauss Jordan method

$$\begin{pmatrix} 1 & 0 & -2 \\ 3 & 4 & 8 \\ -1 & 0 & 5 \end{pmatrix}$$

2. Find the solution by Gaussian elimination method:
   6x + 3y +12z = 36; 8x -3y +2z = 20; 4x +11y –z =33.
3. The table given below reveals the velocity V of a body during the time ‘t‘ specified. Find its acceleration at t = 1.1:

t:	1.0	1.1	1.2	1.3	1.4
v:	43.1	47.7	52.1	56.4	60.8

4. Using 11 ordinates calculate the value of $\int_0^\pi \sin xdx$ by Trapezoidal rule and Simpson’s 1/3 rule. Compare the results with the exact answer.
5. Construct $y_{tt} = y_{xx}$ up to t = 0.5 with spacing 0.1 subject to y(0,t) = 0, y(1,t) = 0, $y_t(x,0) = 0$ and y(x,0) =10 + x (1-x).
6. Use Runge-kutta method, find y(0.01) from dy/dx= - x, y(0)=1.
7. Two independent samples of sizes 8 and 7 contained the following values :
   Sample I: 19 17 15 21 16 18 16 14
   Sample II: 15 14 15 19 15 18 16
   Is the difference between the sample means significant?

8. Apply Gauss two point formula to evaluate $\int_0^1 \frac{dx}{1+x^2}$

9. Use χ^2 - test of goodness of fit,to test the normality of the following distribution.

x:	125	135	145	155	165	175	185	195	205	Total
f :	1	1	14	22	25	19	13	3	2	100

10. Compute y (0.2) given $\frac{dy}{dx} + y + x\,y^2 = 0$, y(0) = 1 by taking h = 0.1 using Runge – Kutta method of fourth order.

Analyze / Evaluate

1. Organize to find the dominant Eigen value and the corresponding Eigen vector of the matrix
$$A = \begin{bmatrix} 1 & 6 & 1 \\ 1 & 2 & 0 \\ 0 & 0 & 3 \end{bmatrix}$$
2. Determine the solution using Newton-Raphson method, cos x – x e^x = 0.
3. Use Newton's forward interpolation formula to find x when y = 20

X :	1	2	3	4
Y:	1	8	27	64.

4. From the following data, find y' at x = 43:

X:	40	50	60	70	80	90
Y:	184	204	226	250	276	304

5. Solve the equation $\nabla^2 u = -10(x^2 + y^2 + 10)$ over the square with sides x = 0 =y, x = 3 = y with u=0 on the boundary and mesh length 1.
6. Evaluate y(0.2) and y(0.4) from $y' = \frac{y^2 - x^2}{y^2 + x^2}$ given that y(0) = 1 by Runge – Kutta method of fourth order.
7. A survey of 320 families with five children each revealed the following distribution,

No. of boys	:	0	1	2	3	4	5
No. of girls	:	5	4	3	2	1	0
No. of families	:	12	40	88	110	56	14

Is this result consistent with the hypothesis that male and female are equally probable?
8. Test whether the example having the values 63,63, 64, 65, 66, 69, 70, 70 and 71 has been chosen from a population with mean 65 at 5% LOS.
9. A farmer applied 3 types of fertilizers on 4 separate plots. The figure on yield per acre is tabulated below:

Fertilizers	Yield			
	A	B	C	D
Nitrogen	6	4	8	6
Potash	7	6	6	9
Phosphates	8	5	10	9
Total	21	15	24	24

Find out if the plots are materially different in fertility, as also, if the three fertilizers make any material difference yields.
10. In a Latin square experiment given below are the yields in quintals per acre on the paddy crop carried out for testing the effect of four fertilizers A, B, C and D. Analyze the data for variances.

A 18	C 21	D 25	B 11
D 22	B 12	A 15	C 19
B 15	A 20	C 23	D 24
C 22	D 21	B 10	A 17

15ME402 ENGINEERING METROLOGY AND MEASUREMENTS 2 0 2 3

Course Objectives

- To study the concepts of measurement and characteristics of instruments.
- To learn the procedure for various linear and angular measurements.
- To provide knowledge on measurement of gear and thread terminologies using suitable instruments.
- To study the use of laser and advances in metrology for linear geometric dimensions.
- To expose the measuring procedure to measure the mechanical parameters using suitable instruments

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
n. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Explain the basic concept of measurement and characteristics of measuring instruments
2. Practice the appropiriate linear and angular dimensions using recision measuring instruments
3. Examine the major terminologies for the gear, screw thread and roundness measurement
4. Apply the advanced techniques in metrology to calculate the geometric dimensions.
5. Explain the suitable type of instrument used to measure the mechanical parameters

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2				1							1		1	
2	2				1							1		2	
3	2				1							1		2	
4	1				2							1		2	
5	2				2							1		2	

UNIT I **4 Hours**

CONCEPT OF MEASUREMENT

Introduction: Definition, Objectives, Elements of Measuring System, Accuracy and Precision - Units and Standards - Characteristics of measuring instrument: Sensitivity, Stability, Interchangeability, Range of accuracy, Readability, Reliability, Backlash, Repeatability and Reproducibility - Calibration - Errors in Measurement: Static and dynamic errors - Care of Measuring Instruments.

UNIT II **6 Hours**

LINEAR AND ANGULAR MEASUREMENTS

Linear Measurements: Vernier Caliper, Vernier Height and Depth Gauges, Micrometer and depth micrometer, Slip gauge, limit gauge and its classification - Comparator: Mechanical, Pneumatic and Electrical types - Angular Measurements: Bevel protractor, Sine bar, Angle Decker, Autocollimator.

UNIT III **8 Hours**

FORM MEASUREMENT

Thread Measurement: Terminologies, Errors - External Thread Measurement: Pitch Gauge, Tool Maker's microscope, Floating Carriage micrometer with One, Two and Three wires - Internal Thread Measurement: Taper Parallels and Rollers method.
Gear Measurement: Terminologies, Errors, Gear Tooth Vernier caliper, Profile Projector, Base pitch measuring instrument, David Brown Tangent Comparator, Involutes tester, Parkinson Gear Tester - External and Internal Radius measurements - Roundness measurement: Circumferential confining gauge, Assessment using V block and Rotating centres.

UNIT IV **6 Hours**

LASER AND ADVANCES IN METROLOGY

Interferometer: NPL Flatness, Laser, Michelson - Computer Aided Inspection - Digital Devices - Machine Vision System - Coordinate Measuring Machine: Basic concept, Types, Constructional features, Probes, Accessories - Surface Roughness Measurement - Straightness Measurement - Squareness Measurement - Machine Tool Metrology.

UNIT V **6 Hours**

MEASUREMENT OF MECHANICAL PARAMETERS

Measurement of Force - Principle, analytical balance, platform balance, proving ring. Torque - Prony brake, hydraulic dynamometer. Measurement of Power: Linear and Rotational - Pressure Measurement: Principle, use of elastic members, Bridgeman gauge, Mcleod gauge, Pirani gauge - Temperature Measurement: bimetallic strip, thermocouples, metal resistance thermometer, pyrometers.

FOR FURTHER READING

Angle measurement of V-groove - Checking of angle of taper hole - Tool Maker's microscope for Gear Measurement - Thread measurement using Profile Projector - Industrial expansion thermometers.

1 **4 Hours**

EXPERIMENT 1

Comparing the accuracy of vernier caliper, vernier height gauge and micrometer to check the various dimensions of a given specimen.

2 **2 Hours**

EXPERIMENT 2

Checking the dimensional limits of ten similar components using mechanical comparator.

3 **4 Hours**

EXPERIMENT 3

Measurement of taper angle of a given specimen by direct and indirect method.

4 **4 Hours**

EXPERIMENT 4
Measurement of screw thread specifications by direct and indirect method.

5 **2 Hours**

EXPERIMENT 5
Measurement of gear tooth specifications by using Gear tooth vernier calliper / Tool maker microscope / Profile projector / Parkinson gear rolling tester.

6 **4 Hours**

EXPERIMENT 6
Differentiate the work piece by its surface roughness value.

7 **4 Hours**

EXPERIMENT 7
Measurement of dimensions of a given specimen using Coordinate measuring machine.

8 **2 Hours**

EXPERIMENT 8
Measurement of Straightness of a given job by using Autocollimator and Interferometer.

9 **2 Hours**

EXPERIMENT 9
Machine tool alignment test on Lathe / Milling machine / Drilling machine.

10 **2 Hours**

EXPERIMENT 10
Temperature measurement by using Bimetallic strip / Thermocouples / Pyrometer.

Total: 60 Hours

Reference(s)

1. Bewoor, Vinay Kulkarni, Metrology & Measurement, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2009.
2. Alan S. Morris, The Essence of Measurement, Prentice Hall of India, New Delhi,2001
3. R. K. Jain, Engineering Metrology, Khanna Publishers, New Delhi, 2009.
4. A. K. Jayal, Instrumentation and Mechanical Measurements, Galgotia Publications, New Delhi 2000.
5. T. G. Beckwith, N. Lewis Buck, Mechanical Measurements, Addison Wesley, New Delhi 2008.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	5				10																				15
2		5				5	5			10															25
3		5				5	5			10															25
4		5	5			5				5															20
5		5				5				5															15
																								Total	100

Assessment Questions

Remember

1. Define Repeatability.
2. List the importance of Grade 0 and Grade 1 slip gauges.
3. List any four applications of bevel protractor.
4. List any four alignment tests to be conducted in a lathe.
5. List any four methods of gear tooth thickness measurement.
6. List any four the advantages of digital devices when compare to ordinary devices.
7. State any four applications of sine bar.
8. Define the terms ‘Torque’ and ‘Power’.
9. Define precision.

Understand

1. Compare Accuracy and Precision with suitable example.
2. Compare the vernier caliper and micrometer based on its advantages and limitations.
3. How to inspect the drilling machine?
4. Classify Coordinate Measuring Machine based on its measuring head movements.
5. Illustrate the surface finish requirement on a technical drawing?
6. Interpret in the checking of diameter of a bore by using precision steel balls?
7. How to calibrate a vernier caliper?
8. How to check the performance characteristics of centre lathe?
9. How to use dial indicator?
10. How to measure a taper plug gauge using rollers, slip gauges and micrometer?

Apply

1. Predict the reason for sine bar recommendation for measuring angle less than 45°.
2. Explain the computation angle of tapered shaft by using Sine Bar.
3. Explain the selection procedure of a suitable nut for a bolt by using Tool Makers’ Microscope and pitch gauge.
4. In mass production, is it possible to check the profile and size of parts simultaneously. How?
5. Execute the temperature measurement of flame from the gas stove.
6. Implement the procedure to check the pressure inside the vacuum system.
7. Assess the centre alignment of four jaw chuck with the lathe centre.
8. Execute surface finish test on lathe bed and compare the results with its supplier specification.

15ME403 STRENGTH OF MATERIALS 2 2 2 4

Course Objectives

- To study and estimate the mechanical properties of materials and its deformations under different loading conditions through experiments.
- To learn two dimensional stress systems and stresses in thin cylinders and spherical shells.
- To gain knowledge on shear force and bending stress distribution in different beams under various loads.
- To impart knowledge on finding slope and deflection of beams and buckling of columns for various boundary conditions.
- To learn the deformation of shaft under torsion and deflection of closed helical springs.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Evaluate the stresses and strains in a regular and composite structures subjected to axial loads.
2. Examine the stresses in two dimensional systems and thin cylinders.
3. Examine the shear force, bending moment and shear stress of various beams under different loading conditions
4. Evaluate the slope and deflection of beams and buckling loads of columns with different boundary conditions.
5. Examine the stresses induced in shaft and closed coil helical springs subjected to torsion.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	1	3									1	1		
2	2	2	2									1	2		
3	3	1	2									2	2		
4	3	1	2									3	1		
5	2	1	2									2	1		

UNIT I **6 Hours**

STRESS, STRAIN AND DEFORMATION OF SOLIDS

Introduction to material properties. Stresses and strains due to axial force, shear force, impact force and thermal effect-stepped and composite bars-uniformly varying cross section. Stress-strain curve for ductile and brittle materials-Hooke-law-Factor of safety Poisson-ratio. Elastic constants and their relationship.

UNIT II **6 Hours**

ANALYSIS OF STRESSES IN TWO DIMENSIONS

State of stresses at a point-Normal and shear stresses on inclined planes-Principal planes and stresses-Plane of maximum shear stress-Mohr's-circle for bi-axial stress with shear stress. Hoop and longitudinal stresses in thin cylindrical and spherical shells-Changes in dimensions and volume.

UNIT III **6 Hours**

LOADS AND STRESSES IN BEAMS

Types of beams-Supports and Loads, Shear force and Bending Moment in beams, Cantilever, simply supported and overhanging beams-Point of contra flexure. Theory of simple bending-bending and shear stress-stress variation along the length and section of the beam, Section modulus.

UNIT IV **6 Hours**

DEFLECTION OF BEAMS AND COLUMNS

Slope and Deflection of cantilever, simply supported and overhanging beams- Double integration method and Macaulay's method. Columns-types-Equivalent length Euler and Rankine formulae-Slenderness.

UNIT V **6 Hours**

TORSION IN SHAFT AND HELICAL SPRING

Analysis of torsion of circular solid and hollow shafts-stepped shaft-compound shaft-Shear stress distribution, angle of twist and torsional stiffness. Closed coil helical spring-stresses and deflection under axial load-Maximum shear stress in spring section including Wahl's Factor problems, applications.

FOR FURTHER READING

Fatigue, shear flow, shear center, thick wall pressure vessels and bending of curved beams. Open coil spring-stresses and deflection.

1 **2 Hours**

EXPERIMENT 1

Find the hardness of the material using Rockwell hardness tester.

2 **2 Hours**

EXPERIMENT 2

Calculate the hardness of the material using Brinell hardness tester.

3 **2 Hours**

EXPERIMENT 3

Calculate the hardness of the material using Vickers hardness tester.

4 **4 Hours**

EXPERIMENT 4

Experimental analysis of an axial bar under tension to obtain the stress strain curve and the strength.

5 **4 Hours**

EXPERIMENT 5

Determine the Young-modulus and stiffness of a metal beam through load deflection curve.

6 **2 Hours**

EXPERIMENT 6

Experimentally calculate the compressive strength of the materials.

7 **4 Hours**

EXPERIMENT 7

Calculate the strains through thin cylinder test set up.

8 **2 Hours**

EXPERIMENT 8

Experimentally calculate the strain energy of a material subjected to impact loading.

9 **4 Hours**

EXPERIMENT 9

Determination of spring constant through load vs deflection curve.

10 **4 Hours**

EXPERIMENT 10

Experimental analysis of a bar under torsion to obtain stiffness and angle of twist.

Total: 90 Hours

Reference(s)

1. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India Learning Pvt. Ltd, New Delhi, 2010.
2. S.S.Rattan, Strength of Materials, Tata McGraw Hill, Delhi, Second Edition, 2011.
3. D. K. Singh, Mechanics of Solids, Pearson Education New Delhi, 2006.
4. W.A. Nash, Theory and problems in Strength of Materials, Schaum Outline Series, McGraw-Hill Book Co., New York,1995.
5. F. P. Beer and R. Johnston, Mechanics of Materials, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi, Third edition,2002.
6. B. K. Sarkar, Strength of Materials, Tata McGraw Hill Publishing Company Pvt. Ltd, New Delhi, Second Reprint, 2007.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	8				10					8															26
2	2	2			4	2				4	6														20
3	2	2				4				10															18
4	4				4					4	6														18
5	4				4					6	4														18
																								Total	100

Assessment Questions

Remember

1. Define Stress and strain.
2. State Hook's law.
3. Define factor of safety.
4. State the range of Poisson's ratio value for ductile material.

5. Define resilience.
6. List out the types of beams.
7. What are the types of supports used in beams?
8. Define slenderness ratio.
9. State the assumptions made in simple bending.
10. Define stiffness of the spring.
11. List the assumptions made in simple torsion.
12. Define section Modulus.

Understand

1. Differentiate true stress and engineering stress.
2. How do you find the value of Young's Modulus using stress – strain diagram?
3. Differentiate shear stress and shear strain.
4. Distinguish pressure and stress.
5. Differentiate Ultimate and Yield strength of material with respect to applied load.
6. Why do cylindrical pressure vessels have hemispherical ends?
7. Differentiate simple and compound stress.
8. Compare the strength beams which have rectangular and I shape cross sections.
9. How do you reduce the stress induced in the cantilever beam where the load value remains same?
10. What are the conditions to be met for neutral axis to pass through the centroid of a beam?
11. A steel shaft is required to transmit 75 kW power at 100 r.p.m. and the maximum twisting moment is 30% greater than the mean. Find the diameter of the steel shaft if the maximum stress is 70 N/mm². Also determine the angle of twist in a length of 3 m of the shaft. Assume the modulus of rigidity for steel as 90 kN/mm².

Apply

1. A rod of diameter 30 mm and length 400 mm was found to elongate 0.35 mm when it was subjected to a load of 65 kN. Compute the modulus of elasticity of the material of this rod.
2. Two vertical rods one of steel and other of copper are each rigidly fixed at the top and 600 mm apart. Diameters and lengths of the rods are 25 mm and 5 m respectively. A cross bar fixed to the rods at the lower end carries a load of 7 kN such that the cross bar remains horizontal even after loading. Find the steps in each rod and the position of the load on the cross bar. Assume the modulus of elasticity for steel and copper as 200 kN/mm² and 100 kN/mm² respectively.
3. A cast iron pipe 300 mm internal diameter, metal thickness 15 mm, is supported at two points 6 m apart. Find the maximum bending stress in the metal of the pipe when it is running full of water. Assume the specific weight of cast iron and water as 72 kN/m³ and 10 kN/m³ respectively.
4. A helical spring, in which the mean diameter of the coils is 12 times the wire diameter, is to be designed to absorb 300 J energy with an extension of 150 mm. The maximum shear stress is not to exceed 140N/mm². Determine the mean diameter of the spring, diameter of the wire which forms the spring and the number of turns. Assume the modulus of rigidity of the material of the spring as 80 kN/mm².
5. A beam of length 6 m is simply supported at the ends and carries two point loads of 48 kN and 40 kN at a distance of 1 m and 3 m respectively from the left support. Compute the slope and deflection under each load. Assume EI = 17000 kN–m².
6. A hollow cast iron strut 150 mm outer and 100 mm in diameter and 8 m long, one end pin jointed and other end is fixed, is subjected to an axial compressive load. Taking factor of safety as 5 and Rankine's constants 550 N/mm² and 1/1600, calculate the safe load.

15ME404 THERMAL ENGINEERING 3 2 0 4

Course Objectives

- To learn the concept of Brayton cycle and Rankine cycle.
- To study the components, systems and performance of internal combustion engines
- To provide knowledge on steam nozzles and steam turbines.
- To impart knowledge on working principles and performance of air compressors.
- To study the working principle and applications of refrigeration and air conditioning systems.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
o. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Understand the applications of Brayton cycle and Rankine cycle.
2. Recognize the components and compute the performance of internal combustion engines.
3. Resolve the problems involving steam nozzles and steam turbines.
4. Understand the classification, working and performance of air compressors.
5. Estimate the cooling load and select suitable refrigeration and air conditioning system.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	2		2		1								
2	2	3					1								3
3	2	3	2				1								
4	2	3	2				2								3
5	2	3	2		2		2								3

UNIT I **9 Hours**

POWER PLANT CYCLES

Gas turbine power plant cycle, Brayton cycle, expression for efficiency, work ratio. Modifications of Brayton cycle with intercooler, reheater and regenerator. Steam power plant cycle - Rankine cycle, modifications with reheater and regenerator. Problem solving using Mollier chart.

UNIT II **9 Hours**

INTERNAL COMBUSTION ENGINES

Internal combustion engines - Classification - Components and functions - Comparison. Valve timing diagram and port timing diagram - Fuel supply systems - Ignition Systems Lubrication system and cooling system. Performance calculation, Heat balance sheet preparation- Air-fuel ratio calculation-Knocking and detonation.

UNIT III **9 Hours**

STEAM NOZZLES AND TURBINES

Flow of steam through nozzles-Shapes of nozzles, effect of friction, critical pressure ratio, supersaturated flow. Impulse and reaction principles- Compounding of Turbines - velocity diagrams for simple and multistage turbines- Speed regulations- Governors.

UNIT IV **9 Hours**

AIR COMPRESSOR

Classification and working principle-Work of compression with and without clearance, volumetric efficiency, Isothermal efficiency and isentropic efficiency of reciprocating air compressors. Multistage air compressor and inter cooling, Work of multistage air compressor. Rotary compressors-Centrifugal, vane and roots blowers.

UNIT V **9 Hours**

REFRIGERATION AND AIR-CONDITIONING

Vapour compression refrigeration cycle Effect of superheat, sub cooling of refrigerant, performance calculations. Working principle of vapour absorption system- Ammonia, water, Lithium bromide water systems (Elementary treatment only), comparison between vapour compression and absorption systems. Cooling load calculations, Concept of RSHF, GSHF, ESHF, Air conditioning systems.

FOR FURTHER READING

Introduction to Super charger and turbo charger - Twin charging, Two-speed and two-stage superchargers. Emissions in an IC engine - Exhaust gas analysis, pollution control norms.

Total: 75 Hours

Reference(s)

1. Kothandaraman.C.P., Domkundwar.S. and A.V.Domkundwar., A course in Thermal Engineering, Dhanpat Rai & Sons, Fifth edition, 2002.
2. C. P. Kothandaraman, Steam Tables, New Age International Private limited, 2007.
3. R. S. Khurmi & J. K. Gupta, Refrigeration Tables with Chart, S Chand & Company Limited, New Delhi, 2008.
4. Yunus A. Cengel, Michael A. Boles, Thermodynamics An Engineering Approach, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2008.
5. Mahesh M. Rathore, Thermal Engineering, Tata McGraw - Hill Education Private Limited, New Delhi, 2011.
6. J. P. Holman, Thermodynamics, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2007.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2	2			2	4				8															18
2	2	2			2	2				8				2											18
3	4				2	2				12															20
4	4				4					12															20
5	4				4					8			8												24
																								Total	100

Assessment Questions

Remember

1. Define thermodynamic cycle.
2. List out the assumptions made for the analysis of thermodynamic air cycles.
3. Define compression and expansion ratio.
4. What is meant by highest useful compression ratio?
5. State the limitations of simple carburetor.
6. List the various types of nozzles and their function?
7. What is supersaturated flow?
8. What is meant by free air delivered?
9. List the function of throttling valve.
10. Define sub-cooling.

Understand

1. When will be the gas turbine cycle efficiency reaches maximum?
2. Compare two stroke and four stroke engines.
3. Why diesel engines are more efficient than petrol engines?
4. Why the actual cycle efficiency is much lower than the air-standard cycle efficiency?
5. Why a choke is used in carburetor and what is meant by automatic chocking?
6. Why clearance is necessary in reciprocating compressor?
7. Compare reciprocating and rotary compressor.
8. What is the effect of clearance volume on the power required and work done in a reciprocating air compressor?
9. How does the actual vapour compression cycle differ from that of the ideal cycle?
10. Which thermodynamic cycle is used in air conditioning of air planes using air as refrigerant?

Apply

1. Air enters the compressor of an air-standard Brayton cycle at 100kPa, 300K with a volumetric flow ratio of $5m^3/s$. The compressor pressure ratio is 10. The turbine inlet temperature is 1400K. Determine (a) thermal efficiency of the cycle, (b) back work ratio, (c) net power developed in kW.
2. A nozzle is to be designed to expand steam at the rate of 0.10 kg/s from 500kPa, 210°C to 100kPa. Neglect inlet velocity of steam. For a nozzle efficiency of 0.9, determine the exit area of the nozzle.
3. In a single-stage, single-row impulse turbine, the steam is entering at a velocity of 1200m/s with a nozzle angle of 20° and leaving the blade in the axial direction. The ratio of blade velocity to whirl velocity of steam is 0.6. Sketch the velocity diagram and calculate (a) Blade velocity (b) Work done per kg of steam.

Analyse

1. How do you convert a cooler of a refrigerator as a freezer?
2. Refrigeration engineers usually presume that if a R12 car air conditioner compressor is operated with R134a, its cooling capacity would fall by about 10%. Examine this assumption by a realistic vapour compression cycle analysis.

3. Find the percentage saving in work input by compressing air in two stages from 1 bar to 7 bar instead of one stage. Assume a compression index of 1.35 in both the cases and optimum pressure and complete intercooling in a two-stage compressor.
4. High compression ratios not used in spark-ignition engines, why?
5. Why the compounding is necessary for turbines?
6. When the multistage compressors are preferred? State the reason.

15ME405 MANUFACTURING TECHNOLOGY -II 3 0 0 3

Course Objectives

- To learn the metal cutting theory and calculate the forces involved in it.
- To study construction, working and operations of centre, semi-automatic and automatic lathes.
- To provide the knowledge on construction, working of milling and gear cutting machines.
- To impart knowledge on construction, working and operations of reciprocating, drilling and boring machines.
- To provide knowledge on construction, working of broaching, grinding and few fine finishing processes.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
n. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Apply the metal cutting theory, calculate the various cutting forces, application of cutting tools and cutting fluids.
2. Select the suitable type of lathe machine for machining operations and explain its working.
3. Explain the working of milling and gear cutting machine and identify the suitable machines based on the applications.
4. Choose the suitable reciprocating machine and explain its working.
5. Illustrate the working of broaching, grinding & fine finishing processes and identify the suitable finishing process based on the application.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2					1					1		2	
2	2	2										1		2	
3	2	2										1		2	
4	2	2										1			
5	2	2										1		3	

UNIT I **10 Hours**

METAL CUTTING THEORY

Introduction - Orthogonal, Oblique Cutting and types of chip formation. Mechanisms of metal cutting - Shear plane, Stress, Strain and cutting forces. Merchants Circle - Deriving the forces, calculations. Cutting tool - Properties, materials, wear, single point tool nomenclature, tool life and its calculations. cutting fluids - Types and its properties.

UNIT II **10 Hours**

LATHE, SEMI AUTOMATS AND AUTOMATS

Introduction - Types- Centre Lathe - Construction, specification, operations. Mechanisms - Head stock driven using all geared type and thread cutting. Work holding devices - Centres, chucks, carrier with catch plate and face plates. Calculation of machining time - Capstan and turret lathes - Introduction, turret indexing and bar feeding mechanism. Automats - single spindle, multi spindle and their types.

UNIT III **8 Hours**

MILLING MACHINE AND GEAR CUTTING MACHINES

Milling - Introduction, types, up milling, down milling, operations, and nomenclature of plain milling cutter. Indexing - simple and differential indexing methods. Gear cutting-gear milling, gear shaper and gear hobbing machine.

UNIT IV **10 Hours**

RECIPROCATING MACHINES, DRILLING AND BORING MACHINES

Shaper, Planer and Slotter - Introduction, types, specification and quick return mechanisms. Drilling - Introduction, types, construction of universal drilling machine, specification, types of drills and nomenclature of twist drill. Introduction to horizontal boring machine.

UNIT V **7 Hours**

BROACHING AND FINISHING PROCESSES

Broaching - Introduction, types and tool nomenclature. Finishing processes - Grinding -Introduction, types, grinding wheel- specification, selection, glazing, loading, dressing and truing. Fine finishing processes - Honing, lapping, polishing, buffing and super finishing.

FOR FURTHER READING

Select proper Machines and list the sequence of operations to produce the components - External threaded shafts with key way, Hexagonal bolt and Hexagonal nut.

Total: 45 Hours

Reference(s)

1. J. P. Kaushish, Manufacturing Processes, Prentice Hall India Learning Private Limited., New Delhi, 2013.
2. Serope Kalpakjian and Steven R Schmid, Manufacturing Engineering and Technology, Pearson Education Limited., New Delhi, 2013.
3. P. N. Rao, Manufacturing Technology- Metal Cutting and Machine Tools, Tata McGraw Hill Publishing Company Private Limited., New Delhi, 2013
4. S. K. Hajra Choudhury, Elements of Workshop Technology. Vol. II, Media Promoters & Publishers Private Limited., Mumbai, 2013.
5. P.C Sharma, Manufacturing Technology - II, S.Chand & Company Limited. New Delhi, 2012.
6. http://nptel.ac.in/courses/112105126/1

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	4					4					12														20
2	4					4								12											20
3	6					14																			20
4	6					14																			20
5	6					14																			20
																								Total	100

Assessment Questions
Remember
1. Define tool life.
2. List any six machining operations performed in a capstan lathe.
3. Define drilling.
4. List any four cutting fluids.
5. What is meant by structure of a grinding wheel?
6. State any two advantages of finishing processes.
7. List any two abrasive materials used in grinding wheel.
8. List any four types of gears.
9. State any two main purposes of gears.
10. Define indexing.
11. List any four milling operations.

Understand
1. Differentiate between orthogonal and oblique cutting.
2. Why the tool material is harder than work piece material?
3. Compare turret and capstan lathe.
4. Why up milling is preferable in milling operation?
5. Compare tapping and reaming operation.
6. Compare the grain sizes of abrasive particles used in grinding and honing processes.
7. Differentiate between gear forming and generating processes.
8. How the grinding machines are classified?
9. Compare automatic lathe with semi-automatic lathe.
10. Why milling machine is better than shaping machine for producing flat surfaces?
11. How to specify the hob cutter?

Apply
1. During turning using HSS tool, the tool life was found to be 25 min, give your suggestion to improve the tool life for the same cutting velocity.
2. Choose suitable machines to produce flat surface in smaller and bigger components.
3. Identify the suitable machine tool to produce 2 module, 30 teeth, 20 degree pressure angle Gear and justify your selection.
4. Select the machines and list the sequence of operations to produce lathe dead centre.
5. Select the grinding wheel for grinding hard material with high tensile strength and justify your selection.

Analyse

1. Compare engine lathe with capstan lathe and analyze the reason for high production rate in capstan lathe.
2. Compare lapping operation with surface grinding and analyze the reason for high surface finish in lapping operation.
3. Analyze the various manufacturing processes to produce 2.5 module, 30 teeth, 20 degree pressure angle spur gear and select the suitable process to produce 100 gears per shift.

15ME406 KINEMATICS OF MACHINES 3 2 0 4

Course Objectives

- To impart the knowledge on the concept of simple mechanisms.
- To provide knowledge on kinematic analysis of simple mechanisms.
- To study and construct the cam profile for the various types of follower motion.
- To learn the kinematics terminologies of spur gear and calculate speed ratio of various types of gear train.
- To introduce the concept of friction drives in kinematic of machines.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. c
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Identify the simple mechanisms based on given application.
2. Find velocity and acceleration of simple mechanisms.
3. Construct the cam profile for different types of follower motion.
4. Identify the kinematic terminologies of spur gear and calculate speed ratio of various types of gear train.
5. Estimate the amount of power transmitted by friction drive.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2											1			
2	2	1										2	1		
3	1	2											3		
4	3	2										3	2		
5	2	2										1	2		

UNIT I **9 Hours**

FUNDAMENTALS OF MECHANISMS

Basic Terminology - Kinematic link, Pair, joints, Structure, Machine, Degree of freedom, Grubler & Kutzbach Criterion - Inversions of four bar mechanism, Mechanical advantage - Transmission Angle , Inversion of single slider and double slider crank mechanisms. Common Mechanisms - Straight line mechanism, Dwell mechanism.

UNIT II **9 Hours**

KINEMATIC ANALYSIS OF MECHANISMS

Relative velocity of kinematic link, Rubbing Velocity of kinematic pair, Construction of velocity and acceleration diagram by graphical method (Relative Velocity Method), Four bar mechanism, slider crank mechanisms and complex mechanism.

UNIT III **9 Hours**

CAM AND FOLLOWER MECHANISMS

Introduction - Terminology, Classifications, Types of follower motion - Uniform velocity Motion, Simple Harmonic Motion, Uniform Acceleration and Retardation Motion and Cycloidal Motion- Construction of cam profile - Knife edge follower, Roller and flat faced follower.

UNIT IV **9 Hours**

GEAR AND GEAR TRAIN

Gears - Terminology, Law of gearing, Length of path of contact, Length of arc of contact, contact ratio- Interference and undercutting. Gear trains- Speed ratio, train value. Simple gear train, compound gear train, Epicyclic gear train- speed calculation by tabular method.

UNIT V **9 Hours**

UNIT V FRICTION DRIVES

Introduction-Friction clutch, types -single plate, Multi plate and cone clutch. Flat Belt Drives Velocity, slip, creep and Centrifugal effect of belt, length of open and cross belt drives, Maximum power transmitted, ratio of driving tension in flat belt drives - V Belt drives.

FOR FURTHER READING

Intermittent motion mechanisms - calculation of velocity and acceleration of two and four wheel vehicle. Cam mechanism in milling machine - Automotive transmission gear trains - Gear train in ships and aero planes - Application Ropes and chain drives.

Total: 75 Hours

Reference(s)

1. S. S. Rattan, Theory of Machines, Tata McGraw Hill Publishing Company Pvt. Ltd, New Delhi, 2014.
2. J. J. Uicker, G. R. Pennock and J. E. Shigley, Theory of Machines and Mechanisms, Oxford University Press, New York, 2011.
3. Ballaney P L, Theory of Machines and Mechanisms, Khanna Publishers, New Delhi, 2005.
4. Sadhu Singh, Theory of Machines, Pearson Education, Second Edition, 2012.
5. Rao J S and Dukkipati, Mechanism and Machine Theory, Wiley- Eastern Ltd., New Delhi, 2006.
6. Beven T, Theory of Machines, Third Edition, CBS Publishers and Distributors, New Delhi, 2010.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1		5				10				5															20
2	5					5								10											20
3					5					5													10		20
4		5				5												10							20
5		5							5									10							20
																								Total	100

Assessment Questions

Remember

1. Define kinematic link.
2. Define Inversion of Mechanism.
3. What is lower and higher pair?
4. List the types of constrained motion.
5. What is locked chain?
6. List the types of Joints in a Chain.
7. What is the use of idler pulley in the belt drive?
8. State Grashof's law for four bar mechanism.
9. Give an example of straight line generators.
10. Define tangential component of an acceleration.
11. List the types of gear trains.
12. What is meant by lift and stroke of the follower?

Understand

1. What are the differences between Machine and Structure?
2. How does Sliding Pair differ from turning and rolling pairs?
3. How does helical gear differ from bevel gearing?
4. How the power is transmitted in bevel and worm gear drive?
5. Which type of profile generally used in gear? Give reason.
6. Discuss length of path of contact and length of arc of contact in gear systems.
7. How to find the velocity ratio of epicyclic gear train?
8. What are the factors affecting the amount of power transmission in belt drive?
9. State the disadvantages of V belt drive over flat belt drive.
10. What is the condition to draw the tangential component for an input link?

Apply

1. Sketch & describe working of bicycle free wheel sprocket mechanism.
2. Describe how indexing mechanism is used to divide the periphery of a circular piece into a number of equal parts.
3. In a simple steam engine the length of the crank and the connecting rod are 100 mm and 400 mm respectively. The weight of the connecting rod is 50kg and its centre of mass is 220mm from the cross head centre. The radius of the gyration about the centre of mass is 120 mm. If the engine speed is 300rpm, determine for the position when the crank has turned 45° from the inner dead centre, (i) the velocity and acceleration of the centre of the mass of the connecting rod (ii) The kinetic energy of the rod

Analyse

1. An epicyclic gear consist of a pinion a wheel of 40 teeth and an annulus with 84 internal teeth concentric with a wheel. The pinion gear with the wheel and the annulus. The arm that carries the axis of the pinion rotates at 100 rpm. If the annulus is fixed, find the speed of the wheel; if wheel is fixed, also find the speed of the annulus.
2. An open belt drive is required to transmit 10 KW of power from a motor running at 600 rpm. Diameter of the driving pulley is 250mm. the speed of the driven pulley is 220 rpm. The belt is 12 mm thick and has a mass density of 0.001 g/mm^3. Safe stress in the belt is not to exceed 2.5 N/mm^2. The two shafts are 1.25 m apart. The co efficient of friction is 0.25. Determine the width of the belt.

15ME407 THERMAL ENGINEERING LABORATORY

0 0 2 1

Course Objectives

- To learn the port timing and valve timing diagram of internal combustion engines.
- To impart the knowledge on flash point, fire point, calorific value and viscosity of the fuel sample.
- To study the performance, retardation and emission characteristics of internal combustion engines.
- To provide the knowledge on working of two stage reciprocating air compressor.
- To study the performance of refrigeration and air conditioning systems.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
o. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Draw the port timing and valve timing diagram of two stroke and four stroke internal combustion engines.
2. Measure the flash point, fire point, calorific value, viscosity and calculate the performance with emission characteristics of IC engines.
3. Evaluate the performance of IC engine on retardation.
4. Evaluate the performance of two stage reciprocating air compressor.
5. Calculate the COP of refrigeration and air conditioning systems

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2						1						2
2	3	3			2										2
3	3	3	2		2				1						2
4	3	3													2
5	3		2									3			2

1 **4 Hours**

EXPERIMENT 1

Experimental study on port timing and valve timing diagram of IC engines.

2 **6 Hours**

EXPERIMENT 2

Measure the flash point, fire point, calorific value and viscosity of the given oil sample.

3 **2 Hours**

EXPERIMENT 3

Experimental study of performance test on 4-Stroke Petrol engine.

4 **4 Hours**

EXPERIMENT 4

Experimental study of performance and emission characteristics on 4-Stroke diesel engine.

5 **2 Hours**

EXPERIMENT 5

Heat balance test on 4-Stroke diesel engine.

6 **2 Hours**

EXPERIMENT 6

Morse test on multi-cylinder petrol engine.

7 **2 Hours**

EXPERIMENT 7

Retardation test on 4-Stroke diesel engine.

8 **2 Hours**

EXPERIMENT 8

Experimental study on performance of two stage reciprocating air compressor.

9 **2 Hours**

EXPERIMENT 9

Experimental study on determination of Coefficient of Performance of refrigeration system.

10 **4 Hours**

EXPERIMENT 10

Experimental study on determination of Coefficient of Performance of Air-conditioning system.

Total: 30 Hours

15ME408 MANUFACTURING TECHNOLOGY LABORATORY

0 0 2 1

Course Objectives

- To learn the basic machining operations using lathe machine.
- To know the grinding machine operations.
- To provide training on machining operations through milling, gear hobbing and slotting.
- To develop skill on drilling operations.
- To develop skill for making a product using various machining operations.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
n. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Produce components as per the given drawing using lathe machine.
2. perform surface finish operation using grinding machines.
3. Make components using milling, gear hobbing and slotting machines.
4. Perform operations using drilling machines.
5. Make a product using machining operations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2								1	1				2	
2	2								1	1				2	
3	2								1	1				2	
4	2								1	1				2	
5	2								1	1		2		2	

1 **6 Hours**

EXPERIMENT 1

Exercise on turning, threading, taper turning and boring.

2 **6 Hours**

EXPERIMENT 2

Exercise on surface grinding, cylindrical grinding and internal grinding.

3 **6 Hours**

EXPERIMENT 3

Exercise on milling, gear hobbing and Slotting.

4 **6 Hours**

EXPERIMENT 4

Exercise on drilling, tapping and reaming.

5 **6 Hours**

EXPERIMENT 5

To make one of the following product: gear box/direct indexing/pump/press tool/progressive die/screw jack/single cavity mould.

Total: 30 Hours

15ME409 MINI PROJECT II 0 0 2 1

Course Objectives

- To develop skills to formulate a technical project.
- To give guidance on the various tasks of the project and standard procedures.
- To teach use of new tools, algorithms and techniques required to carry out the projects.
- To give guidance on the various procedures for validation of the product and analyse the cost effectiveness.
- To provide guidelines to prepare technical report of the project.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Formulate a real world problem, identify the requirement and develop the design solutions.
2. Identify technical ideas, strategies and methodologies.
3. Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis the cost effectiveness.
5. Prepare report and present oral demonstrations

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1		3	2			2	1								
2	2	2	1	3		2					2	2			
3			3	2	2			2			2	2			
4		1		2	3	1	2	2							
5									3	3		2			

Total: 30 Hours

15GE410 LIFE SKILLS: VERBAL ABILITY 0 0 2 0

Course Objectives

- Read and understand business passages
- Employ various types of sentences in Business Correspondence
- Equip students with strategies for vocabulary development

Programme Outcomes (POs)

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

Course Outcomes (COs)

1. Read and understand business related articles
2. Identify errors in the given sentences
3. Attempt vocabulary related questions in competitive exams
4. Write coherent business letters, e-mails, reports and proposals
5. Write instructions and descriptions related to business contexts

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1										2					
2										2					
3										2					
4										2					
5										2					

15 Hours

UNIT 1

Synonyms - Antonyms - Word groups - Verbal analogies - Etymology - Critical Reasoning - Cloze Test - One Word Substitutes - Idioms and Phrases - Text and Paragraph Completion

15 Hours

UNIT 2

Sentence formation - Paragraph formation- Change of voice - Change of Speech - Reading Comprehension - Sentence Equivalence - Jumbled Sentences - Spotting Errors - Homophones - Homonyms - Commonly Mispronounced/Misspelt Words

Total: 30 Hours

Reference(s)

1. Raymond Murphy. ENGLISH GRAMMAR IN USE - A SELF-STUDY REFERENCE AND PRACTICE BOOK FOR INTERMEDIATE LEARNERS OF ENGLISH.IVed. United Kingdom: Cambridge University Press. 2012.
2. Lewis, Norman. WORD POWER MADE EASY. Goyal Saab Publisher, 2011.
3. BARON'S THE OFFICIAL GUIDE FOR NEW GMAT REVIEW 2015. New Jersey : John Wiley & Sons, Inc.

15ME501 AUTOMOBILE ENGINEERING **2 0 2 3**

Course Objectives

- To impart knowledge on the constructional details and principle of operation of various automobile components.
- To provide knowledge on the working of fuel supply system in various automobiles.
- To learn the function of various components in transmission and drive lines of a vehicle.
- To study the concept and working of steering, brakes and suspension systems in automobile.
- To impart knowledge on electrical and electronic systems of automobiles.

Programme Outcomes (POs)

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
o. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Demonstrate the operating principles and constructional details of various automobile components.
2. Classify two main types of fuel supply systems and explain its working.
3. Explain the function of components in transmission and drive lines of a vehicle.
4. Identify and explain the types of steering system, suspension system and braking system.
5. Interpret the functioning of electrical and electronic systems in automobiles

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1						2						2			1
2						2	2					2			1
3						2						2			1
4						2						2			1
5					2	2	2					2			1

UNIT I **6 Hours**

VEHICLE STRUCTURE AND ENGINES

Types of Automobiles - vehicle construction, chassis, frame and body. Engines Supercharger, turbo chargers, engine emission control by 3 Way catalytic controller.Alternative energy resources Liquefied petroleum gas, Bio Diesel.

UNIT II **6 Hours**

FUEL SUPPLY SYSTEMS

Spark ignition engine Carburetor-Types simple carburettor, solex carburettor, carter carburetor. Electronic fuel injection system, mono-point and multi Point injection systems.Compression iginition engine-Inline fuel injection system, Common rail direct fuel injection system.

UNIT III **6 Hours**

TRANSMISSION AND DRIVE LINES

Clutch types single plate clutch, multi plate clutch.Gearbox synchromesh gear box, sliding mesh gear box, constant mesh gear box. Fluid flywheel, torque convertors, propeller shaft, slip joint, universal Joints,differential and rear axle hotchkiss drive and torque tube drive.

UNIT IV **6 Hours**

STEERING, BRAKES AND SUSPENSION

Wheels and Tyres Construction. Steering geometry and types of steering gearbox rack and pinion steering gear, recirculating ball type gear and Power steering construction and working principle. Suspension systems types rear suspension and front suspension. Braking systems-types disc brake, drum brake, hydraulic brake and air brake.

UNIT V **6 Hours**

ELECTRICAL AND ELECTRONIC SYSTEMS

Electrical systems, battery types, construction and working principle of lead acid battery. Generator, starting motor and drives. lighting, ignition (Battery, Magneto Coil and Electronic type), regulators, cut outs. Common rail direct fuel injection system.Different electronic control unit used in the engine management, block diagram of the engine management system.

FOR FURTHER READING

Case Study : To assemble and dismantle of advanced engines and automobile components.

1 **3 Hours**

EXPERIMENT 1

Dismantling and study of Multi-cylinder Petrol Engine

2 **3 Hours**

EXPERIMENT 2

Assembling of Multi-cylinder Petrol Engine

3 **3 Hours**

EXPERIMENT 3

Dismantling and study of Multi-cylinder Diesel Engine

4 **3 Hours**

EXPERIMENT 4

Assembling of Multi-cylinder Diesel Engine

5 **3 Hours**

EXPERIMENT 5

Study of petrol engine fuel system

6 **3 Hours**

EXPERIMENT 6
Study of diesel engine fuel system

7 **2 Hours**
EXPERIMENT 7
Study and measurement of light and heavy commercial Vehicle Frame

8 **2 Hours**
EXPERIMENT 8
Study, dismantling and assembling of front and rear Axles

9 **2 Hours**
EXPERIMENT 9
Study, dismantling and assembling of differential Unit.

10 **2 Hours**
EXPERIMENT 10
Study, dismantling and assembling of Clutch

11 **2 Hours**
EXPERIMENT 11
Study, dismantling and assembling of Gear Box

12 **2 Hours**
EXPERIMENT 12
Study , dismantling and assembling of steering system

Total: 60 Hours

Reference(s)

1. Kirpal Singh, Automobile Engineering Volume.1 and 2, Standard Publishers, New Delhi,2009.
2. Crouse and Anglin, Automotive Mechanism, Tata McGraw Hill Publishing Company Private Limited, New Delhi, 2003.
3. Newton, Steeds and Garet, Motor vehicles, Butterworth Publishers, 2000.
4. S. Srinivasan, Automotive Mechanics, Tata McGraw Hill Publishing Company Private Limited, New Delhi, 2003.
5. Joseph Heitner, Automotive Mechanics, East-West Press, 2006.
6. H. M. Sethi, Automobile Technology, Tata McGraw Hill Publishing Company Private Limited, New Delhi, 2007.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	8				12																				20
2	2	2			2	4				10															20
3	2				8					10															20
4	4				4					12															20
5		4			10					6															20
																								Total	100

Assessment Questions

Remember

1. What is a circlip? Where it is used?
2. What is a dip stick?
3. What is the voltage of the batteries generally used in the automotive ignition systems?
4. What are the two basic approaches to decrease pollution from automobiles?
5. Define 'light-off temperature' of a catalytic converter.
6. What is an over drive?
7. Define whirling of shafts.
8. Define 'offset' with reference to automobile wheels.
9. What are 'primary 'and 'secondary' brakes?
10. List main parts of an anti-lock braking system.
11. What is a radial engine?
12. What is meant by rotational moulding?

Understand

1. How are the materials chosen for chassis frames and body?
2. How does the feed pump gets drive?
3. How is the seizing of piston caused?
4. Why are the baffle plates provided in the fuel tank?
5. Why is an automobile tyre usually black in colour?
6. Which material is generally used for brake drums? why?
7. Why do we provide gear box in a vehicle?
8. Where is the contact breaker located on the engine?
9. Why asbestos being phased out as material for clutch facings?
10. Compare plug-in-hybrids with conventional hybrids.

Apply

1. An automobile clutch has a clutch plate of 160mm inside and 240mm outside diameters. Six springs in the clutch provide a total force of 4.8 kN , when the clutch is new and each spring is compressed 5mm. The maximum torque developed by the automobile engine is 250Nm . Determine (i) factor of safety for the new clutch and (ii) the amount of wear of the clutch facing that will take place before the clutch starts slipping. Assume coefficient of friction for the facing is 0.3.
2. Two shafts, whose axes are inclined at 20 are connected by means of a Hooke's joint at 20. The driving shaft rotates uniformly at 500 r.p.m .What are the maximum and the minimum velocities of the driven shaft?
3. A car with a database 2.45m has pivot centres 1.1m. the track distance between tyrecentre lines is 1.2m.if the angle of lock is 30°and tyre width 100mm.determine the minimum radius of the outer turning circle.
4. A car using drum brake has wheel cylinder pistons of 50mm diameter at the front and 25 mm diameter at the back. The master cylinder piston is of 40mm diameter. The leverage of brake pedal linkage is 4.if the driver applies a force of 100N at the pedal, calculate braking force on each axle. Determine also the distance through which the pedal should be pressed so as to move the wheel cylinder pistons through 1 mm.

15ME502 DESIGN OF MACHINE ELEMENTS 3 2 0 4

Course Objectives

- To learn the design procedure of machine elements subjected to simple and variable loads.
- To study the design procedure of shafts and couplings.
- To provide knowledge on the design of bolted and welded joints.
- To provide knowledge on the design of helical, leaf and torsional springs subjected to constant and variable loads.
- To study the selection procedure of sliding and rolling contact bearings.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Design machine elements subjected to simple and variable loads.
2. Design shaft and couplings for various engineering applications.
3. Design bolted and welded joints subjected to static load.
4. Design helical, leaf and torsional springs subjected to constant and variable loads.
5. Select suitable bearings for axial and radial loading conditions from manufacturers' catalogue.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2										1	2		
2	1	2										1	2		
3	2	2										1	2		
4	3	2										1	2		
5	3	2										1	2		

UNIT I **10 Hours**

STEADY AND VARIABLE STRESSES

Introduction to the design process - Design of straight and curved beams - C -frame and Crane hook. Stress concentration - Design for variable loading - Soderberg, Goodman, Gerber methods and combined stresses - Theories of failure.

UNIT II **10 Hours**

DESIGN OF SHAFTS AND COUPLINGS

Design of shafts based on strength, rigidity and critical speed. Design of rigid flange coupling - Design of flexible coupling.

UNIT III **9 Hours**

DESIGN OF JOINTS

Design of bolted joints - stresses due to static loading, eccentrically loading. Design of welded joints - Butt and Fillet welded Joints - Strength of parallel and traverse fillet welded Joints - Eccentrically loaded joints.

UNIT IV **8 Hours**

DESIGN OF SPRINGS

Types, End connections and design parameters. Design of helical springs - Circular and noncircular wire - Concentric springs. Design of leaf and torsional springs under constant and varying loads - Wahl's stress factor.

UNIT V **8 Hours**

DESIGN OF BEARINGS

Types and selection criteria - Design of journal bearings - Design of rolling contact bearing Ball and roller bearing.

FOR FURTHER READING

Case study on Design of shock absorbing coupling - Design of advanced bearings.

Total: 75 Hours

Reference(s)

1. V. B. Bhandari, Design of Machine Elements, Tata McGraw-Hill Publishing Company Pvt. Ltd., New Delhi, 2010.
2. Faculty of Mechanical Engineering, PSG College of Technology, Design Data Book, M/s.Kalai kathir Achchagam, 2013.
3. J. E. Shigley and C. R. Mischke, Mechanical Engineering Design, Tata McGraw-Hill Publishing Company Pvt. Ltd., New Delhi, 2011.
4. R. C. Juvinall and K. M. Marshek, Fundamentals of Machine Component Design, John Wiley & Sons, New Delhi, 2011.
5. R. L. Norton, Design of Machinery, Tata McGraw-Hill Publishing Company Pvt. Ltd., New Delhi, 2004.
6. M. F. Spoutts, T. E. Shoup and I. E. Hornberger, Design of Machine Elements Pearson Education, 2006.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2	3				5				5	5				5										25
2	2	3									5				5										15
3	2	3				5					5				5										20
4	2	3				5					5				5										20
5	2	3				5					5				5										20
																								Total	100

Assessment Questions

Remember

1. What is an Engineering design?
2. Define the terms load, stress and strain.
3. Define the term Equivalent torsional moment.
4. What do you understand by the nominal size and basic size?
5. What is threaded joint?
6. What is surge in spring?
7. List any two practical applications of coil spring.
8. Define the term nip.
9. List any four applications of sliding contact bearing.
10. What is meant by thin film lubrication?

Understand

1. How hole basis system is differing from shaft basis system?
2. Predict the effect of stress concentration in design process.
3. Identify any two applications of hollow shaft.
4. In what way hollow shaft is better than solid shaft?
5. How locking of threads obtained in castle nut?
6. Predict the type of stress induced in eccentrically loaded joint.
7. State Wahl's stress factor.
8. Classify springs according to their shapes.
9. Why ball and roller bearings are called as ant frictional bearings?

Apply

1. A reciprocating steam engine connecting rod is subjected to a maximum load of 65 kN. Find the diameter of the connecting rod at its thinnest part, if the permissible tensile stress is 35MPa.
2. The crankpin of an engine sustains a maximum load of 35 kN due to steam pressure. If the allowable bearing pressure is 7 MPa, find the dimensions of the pin. Assume the length of the pin equal to 1.2 times the diameter of the pin.
3. A bar of 2 m length, 20 mm breadth and 15 mm thickness is subjected to a tensile load of 30 kN. Find the final volume of the bar, if the Poisson's ratio is 0.25 and Young's modulus is 200 GPa.
4. A motor car shaft consists of a steel tube 30 mm internal diameter and 4 mm thick. The engine develops 10 kW at 2000 r.p.m. Find the maximum shear stress in the tube when the power is transmitted through a 4 : 1 gearing.
5. A shaft 80 mm diameter transmits power at maximum shear stress of 63 MPa. Find the length of a 20 mm wide key required to mount a pulley on the shaft so that the stress in the key does not exceed 42 MPa.
6. Design a bushed-pin type flexible coupling for connecting a motor shaft to a pump shaft for the following service conditions: Power to be transmitted = 40 kW; speed of the motor shaft = 1000 r.p.m.; diameter of the motor shaft = 50 mm; diameter of the pump shaft = 45 mm.
7. An engine cylinder is 300 mm in diameter and the steam pressure is 0.7 MPa. If the cylinder head is held by 12 studs, find the size. Assume safe tensile stress as 28 MPa.
8. The free end of a torsional spring deflects through 90° when subjected to a torque of 4 N-m. The spring index is 6. Determine the coil wire diameter and number of turns with the following data:
   Modulus of rigidity = 80 GPa; Modulus of elasticity = 200 GPa; Allowable stress = 500 MPa.
9. The main bearing of a steam engine is 100 mm in diameter and 175 mm long. The bearing supports aload of 28 kN at 250 r.p.m. If the ratio of the diametric clearance to the diameter is 0.001 and the absolute viscosity of the lubricating oil is 0.015 kg/m-s, find: 1. The coefficient of friction; and 2.The heat generated at the bearing due to friction.

10. A ball bearing subjected to a radial load of 5 kN is expected to have a life of 8000 hours at 1450 r.p.m.with a reliability of 99%. Calculate the dynamic load capacity of the bearing so that it can be selected from the manufacturer's catalogue based on a reliability of 90%.

Analyse

1. A cast iron pulley transmits 20 KW at 300 RPM. The diameter of pulley is 550 mm and has four straight arms of elliptical cross section in which major axis is twice the minor axis. Find the dimensions of the arm, if the allowable bending stress is 15 MPa.
2. Find the minimum size of a hole that can be punched in a 20 mm thick mild steel plate having an ultimate shear strength of 300 MPa. The maximum permissible compressive stress in the punch material is 1200 MPa.
3. Find the diameter of a shaft to transmit twisting moments varying from 800 Nm to 1600Nm. The ultimate tensile strength for the material is 600MPa, and yield stress is 400MPa. Assume the stress concentration factor=1.2; surface finish factor =0.8 and size factor =0.85.
4. A ball bearing subjected to a radial load of 5 kN is expected to have a life of 8000 hours at 1450 r.p.m. with a reliability of 99%. Calculate the dynamic load capacity of the bearing so that it can be selected from the manufacturer's catalogue based on a reliability of 90%.

Evaluate

1. In a single degree damped vibrating system, a suspended mass of 8 kg makes 30 oscillations in 18 sec. the amplitude decreases to 0.25 of the initial value after 5 oscillation determine the stiffness of the spring, Logarithmic decrement, damping factor, damping co efficient.

15ME503 DYNAMICS OF MACHINES 2 0 2 3

Course Objectives

- To impart knowledge in dynamic analysis of simple mechanism and design of flywheel.
- To provide knowledge on balancing of rotating and reciprocating masses.
- To study the working principle of governor and gyroscope.
- To learn the concept of free and forced vibration.
- To learn the concept of transverse and torsional vibration.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Perform dynamic analysis of simple mechanism and design of flywheel.
2. Estimate the balancing mass for rotating and reciprocating masses by using the force and couple polygon.
3. Compute the range of speed for governor and gyroscopic effect of ship and aero plane
4. Evaluate the natural frequency of single degrees of freedom system subjected to free and forced vibration.
5. Calculate the natural frequency of transverse and torsional vibration of single, two and three rotors system.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2											2		
2	2	2										1	2		
3	3	2											2		
4	2	2										1	2		
5	1	2										1	2		

UNIT I **6 Hours**

DYNAMIC FORCE ANALYSIS OF MECHANISMS

Principle of superposition, Condition for dynamic analysis, Dynamic analysis of four bar & slider crank mechanism - Engine force analysis. Turning moment diagram for steam & IC Engine. Energy stored in flywheel, Dimension of flywheel rim, Flywheel in punching press.

UNIT II **6 Hours**

BALANCING

Introduction - Static balancing and dynamic balancing, Balancing of Rotating mass several masses in same and different plane. Balancing of reciprocating mass Swaying couple, Tractive force, Hammer Blow. Balancing of coupled locomotives.

UNIT III **6 Hours**

GOVERNOR AND GYROSCOPE

Governor Terminology, Working principle, Types - Watt, Porter and Proell governor, Characteristics of Governor-sensitiveness, Hunting, Ichoronisn, Stability. Gyroscope- Gyroscopic effect, gyroscopic couple, gyroscopic effect on aero planes and naval ships.

UNIT IV **6 Hours**

FUNDAMENTAL OF VIBRATION

Introduction-Terminology, Classification, elements of vibration, free undamped vibration, Free Damped vibration (Viscus Damping) - Damping ratio and logarithmic decrement. Force damped vibration - Magnification factor. Vibration isolation and transmissibility.

UNIT V **6 Hours**

TRANSVERSE AND TORSIONAL VIBRATION

Transverse vibration of shafts and beams Shaft carrying several loads, whirling of shafts. Torsional vibration- effect of inertia on torsional vibration-Torsionally equivalent Shaft, single rotor, two rotor and three rotor system.

FOR FURTHER READING

Turning moment balancing of W, V8, V12 engine, Instruments for dynamic measurements, vibration and noise standards, Mutifilar systems.

1 **3 Hours**

EXPERIMENT 1

Kinematic analysis of simple mechanism using CAD software.

2 **3 Hours**

EXPERIMENT 2

Determine the characteristics and effort of watt, Porter and Proell Governors.

3 **2 Hours**

EXPERIMENT 3

Exercise on Balancing of reciprocating masses in slider crank mechanism.

4 **2 Hours**

EXPERIMENT 4

Exercise on Balancing of four rotating masses placed on different plane.

5 **2 Hours**

EXPERIMENT 5

Analyze the gyroscopic effect using Gyroscope and verify its laws.

6

EXPERIMENT 6 **2 Hours**
Determination of critical speed of shaft with concentrated loads by Whirling of shaft

7 **2 Hours**
EXPERIMENT 7
Determine the moment of inertia of object by bifilar suspension

8 **2 Hours**
EXPERIMENT 8
Kinematic analysis of cam model, Epicyclic gear train and worm wheel model.

9 **4 Hours**
EXPERIMENT 9
Determination of natural frequency of single degree of freedom system and two rotor system.

10 **4 Hours**
EXPERIMENT 10
Determine the frequency of forced vibration using electro dynamic shaker.

11 **4 Hours**
EXPERIMENT 11
Determine the performance of suspension system by quarter car model.

Total: 60 Hours

Reference(s)

1. S. S. Rattan, Theory of Machines, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2014.
2. John J Uichker and Joesph E. Shigley, Theory of Machines and Mechanism, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2005.
3. Ashok G Ambekar, Mechanism and Machine Theory, Prentice Hall of India, New Delhi, 2009.
4. R. L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2005.
5. Sadhu Singh, Theory of Machines, Prentice Hall of India, New Delhi, 2007.
6. R. L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw Hill Publishing Company Pvt. Ltd, New Delhi, 2005.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	5					10				5															20
2		5				5								10											20
3		5				10				5															20
4						5				5								10							20
5			5			5										10									20
																								Total	100

Assessment Questions

Remember

1. State D Alembert's principle.
2. Define inertia force' and 'inertia torque.
3. What are the methods of finding the crank effort in a reciprocating single acting, single cylinder petrol engine?
4. Define Maximum fluctuation of speed.
5. Define Period of vibration.
6. What is critical speed of a shaft?
7. List the types of vibration.
8. What is the controlling force in centrifugal governor?
9. What is hunting of governor?
10. What are the different cases of balancing?
11. State the necessary conditions of dynamic balancing.

Understand

1. Compare piston effort, crank effort and crank pin effort.
2. Justify the condition of acceleration of the link comes to zero.
3. How the turning moment diagram for a single cylinder differ from double acting steam engine?
4. What is the effect of friction on the functioning of a Porter governor?
5. How does a Porter governor differ from that of Watt governor?
6. How dynamically equivalent system can be used to determine the direction of inertia force?
7. In an automobile, what is the gyroscopic torque when the vehicle makes a left turn?
8. What is the effect of the gyroscopic couple on the reaction of the four wheels of a vehicle negotiating a curve?
9. What is the effect of the gyroscopic couple on a two wheeled vehicle when taking a turn?
10. What is the couple applied to the disc causing precession when a disc is spinning with anAngular velocity about the axis of spin?

Apply

1. Compute the velocity of the piston, when the crank is at the inner dead centre, in a horizontal reciprocating steam engine?
2. Implement the essential condition of placing the two masses, so that the system becomes dynamically equivalent.
3. A horizontal steam engine running at 240 r.p.m. has a bore of 300 mm and stroke 600 mm. The connecting rod is 1.05 m long and the mass of reciprocating parts is 60 kg. When the crank is 600 past its inner dead centre, the steam on the cover side of the piston is 1.125MPa while that on the crank side is 0.125 MPa. Neglecting the area of the piston rod, determine: 1. the force in the piston rod; and 2. the turning moment on the crankshaft.
4. A machine has to carry out punching operation at the rate of 10 holes per minute. It does 6 kN-m of work per mm^2 of the sheared area in cutting 25 mm diameter holes in 20 mm thick plates. A flywheel is fitted to the machine shaft which is driven by a constant torque. The fluctuation of speed is between 180 and 200 r.p.m. The actual punching takes 1.5 seconds. The frictional losses are equivalent to 1/6 of the work done during punching. Find: 1. Power required driving the punching machine, and 2. Mass of the flywheel, if the radius of gyration of the wheel is 0.5 m

Analyse

1. The inertia of the connecting rod can be replaced by two masses concentrated at two points and connected rigidly together. How to determine the two masses so that it is dynamically equivalent to the connecting rod?
2. How the velocity and acceleration of the single slider crank chain determined analytically?
3. A Porter governor has all four arms 200 mm long. The upper arms are pivoted on the axis of rotation and the lower arms are attached to a sleeve at a distance of 25 mm from the axis. Each ball has a mass of 2 kg and the mass of the load on the sleeve is 20 kg. If the radius of rotation of the balls at a speed of 250 r.p.m. is 100 mm, find the speed of the governor after the sleeve has lifted 50 mm. Also determine the effort and power of the governor.

Evaluate

1. In a single degree damped vibrating system, a suspended mass of 8 kg makes 30 oscillations in 18 sec. the amplitude decreases to 0.25 of the initial value after 5 oscillation determine the stiffness of the spring, Logarithmic decrement, damping factor, damping co efficient.

15ME504 HEAT AND MASS TRANSFER 3 2 0 4

Course Objectives

- To impart the knowledge of conduction heat transfer mechanisms.
- To provide the knowledge on the principles of free and forced convection.
- To study the performance of various types of heat exchange.
- To impart the knowledge on black body radiation and grey body radiation.
- To learn about diffusion and convective mass transfer.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Apply the heat conduction equation to compute the rate of heat transfer in simple and composite systems
2. Assess the convection phenomena and select appropriate correlation to determine the rate of heat transfer in free and forced convection
3. Compare the thermal performance of various types of heat exchangers using LMTD and NTU approach
4. Determine the rate of radiation heat transfer in black and grey bodies.
5. Find the mass transfer rate in diffusion and convective mass transfer applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3			1										
2	2	3			1										
3	2	3			1		2								
4	3	2			1										
5	3	1			1		2								

UNIT I **11 Hours**

CONDUCTION

Basic concepts - Mechanism of Heat transfer. Conduction - Fourier's Law, General differential equation in Cartesian and cylindrical coordinates, one dimensional steady state heat conduction, conduction through plane wall, cylinders and spherical systems. Composite Systems. Extended surfaces Use of Heisler chart.

UNIT II **10 Hours**

CONVECTION

Basic Concepts - Heat transfer coefficients, boundary layer concept. Types of convection - Forced convection, dimensional analysis, non-dimensional numbers, external flow, flow over plates, cylinders and spheres, internal flow, laminar and turbulent flow, combined laminar and turbulent. Free convection - Dimensional analysis, flow over vertical plate, horizontal plate.

UNIT III **9 Hours**

PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS

Modes of boiling - Nusselt's theory of condensation, types of condensation - correlations in boiling and condensation. Heat exchangers - Types, heat exchanger analysis, fouling factor, LMTD (Logarithmic mean temperature difference) and Effectiveness - NTU (number of transfer units) Method - Overall Heat Transfer Coefficient.

UNIT IV **8 Hours**

RADIATION

Laws of Radiation- Stefan-Boltzmann Law, Kirchhoff's Law - Black body radiation - Grey body radiation - Shape factor algebra - Electrical analogy - Radiation shields.

UNIT V **7 Hours**

MASS TRANSFER

Basic concepts - Diffusion mass transfer - Fick's law of diffusion, Steady state molecular diffusion. Convective mass transfer, momentum, heat and mass transfer analogy, convective mass transfer correlations.

FOR FURTHER READING

Numerical methods in heat conduction - Finite difference formulation of differential equation, two dimensional steady state heat conduction.

Total: 75 Hours

Reference(s)

1. R. C. Sachdeva, Fundamentals of Engineering Heat and Mass Transfer, New Age International private limited, New Delhi, 2010.
2. Yunus A.Cengel, Heat and Mass Transfer: a Practical Approach, Tata McGraw Hill publishing Company private limited, New Delhi, 2007.
3. J. P. Holman, Heat Transfer, Tata McGraw Hill publishing Company private limited, New Delhi, 2009.
4. C. P. Kothandaraman and S. Subramanyan, Fundamentals of Heat and Mass Transfer, New Age International private limited, New Delhi, 2014.
5. Frank P. Incropera, Fundamentals of Heat and Mass Transfer, John Wiley, New Delhi, 2007.
6. R. K. Rajput, Heat and Mass Transfer, S Chand and Company, New Delhi, 2009.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	
1	2					2			8									8							20
2	2					2								8				8							20
3	6					6								8											20
4		2				4			6					8											20
5	2					6			6									6							20
																								Total	100

Assessment Questions

Remember

1. State Fourier's law and write the equation.
2. What is conduction?
3. State Newton's law of cooling or convection law.
4. Define overall heat transfer co-efficient.
5. State the application of fins.
6. What are the factors affecting the thermal conductivity?
7. Define Emissive power.
8. State Stefan-Boltzmann law.
9. What is meant by film-wise condensation and drop-wise condensation?
10. What are the modes of mass transfer?
11. Define Schmidt number.

Understand

1. How conduction resistance of solids is affected by its thermal conductivity?
2. How conduction heat transfer differs from convection heat transfer?
3. Contrast Natural and forced convection.
4. How convection resistance at a surface is affected by the convection co-efficient?
5. Why surface emissivity is significant in radiation heat transfer?
6. What is the physical basis for existence of a critical insulation radius? How do the thermal conductivity and the convection coefficient affect its value?
7. How is the thermal energy of material affected by the absorption of incident radiation?
8. How does the velocity boundary layer thickness vary with distance from the leading edge for laminar flow?
9. What physical features distinguish turbulent flow from laminar flow?

Apply

1. Consider a 3 m high, 5 m wide and 0.3 m thick wall whose thermal conductivity is k = 0.9 W/m°C. On a certain day, the temperatures of the inner and the outer surfaces of the wall are measured to be 16°C and 2°C, respectively. Determine the rate of heat loss through the wall on that day.
2. A 3 m high and 5 m wide wall consists of long 16 cm x 22 cm cross section horizontal bricks (k = 0.72 W/m°C) separated by 3 cm thick plaster layers (k = 0.22 W/m °C). There are also 2 cm thick plaster layers on each side of the brick and a 3 cm thick rigid foam (k = 0.026 W/m°C) on the inner side of the wall. The indoor and outdoor temperatures are 20°C and -10°C, and the convection heat transfer coefficients on the inner and outer sides are $h1$ = 10 W/m²°C and $h2$ = 25 W/m°C, respectively. Assuming one-dimensional heat transfer and disregarding radiation, determine the rate of heat transfer through the wall.
3. A 3 m internal diameter spherical tank made of 2cm thick stainless steel (k =15 W/m °C) is used to store ice water at $T1$ = 0°C. The tank is located in a room whose temperature is $T2$ = 22°C. The walls of the room are also at 22°C. The outer surface of the tank is black and heat transfer between the outer surface of the tank and the surroundings is by natural convection and radiation. The convection heat transfer coefficients at the inner and the outer surfaces of the tank are $h1$ = 80 W/m²°C and $h2$ = 10 W/m² °C, respectively. Determine (a) the rate of

heat transfer to the iced water in the tank and (*b*) the amount of ice at 0°C that melts during a 24hour period.

4. Steam in the condenser of a power plant is to be condensed at a temperature of 30°C with cooling water from a nearby lake, which enters the tubes of the condenser at 14°C and leaves at 22°C. The surface area of the tubes is 45 m^2 and the overall heat transfer coefficient is 2100 $W/m^2°C$. Determine the mass flow rate of the cooling water needed and the rate of condensation of the steam in the condenser.
5. A counter-flow double-pipe heat exchanger is to heat water from 20°C to 80°C at a rate of 1.2 kg/s. The heating is to be accomplished by geothermal water available at 160°C at a mass flow rate of 2 kg/s. The inner tube is thin-walled and has a diameter of 1.5 cm. If the overall heat transfer coefficient of the heat exchanger is 640 $W/m^2°C$, determine the length of the heat exchanger required to achieve the desired heating.

Analyse

1. A long pipe of 0.6 m outside diameter is buried in earth with axis at a depth of 1.8 m. The surface temperature of pipe and earth are 95ºC and 25ºC respectively. Calculate the heat loss from the pipe per unit length. The conductivity of earth is 0.51W/mK
2. A vertical pipe 80 mm diameter and 2 m height is maintained at a constant temperature of 120ºC. The pipe is surrounded by still atmospheric air at 30ºC. Find heat loss by natural convection.
3. Two large plates are maintained at a temperature of 900 K and 500 K respectively. Each plate has area of 6 m^2. Compare the net heat exchange between the plates for the following cases.(i) Both plates are black (ii) Plates have an emissivity of 0.5
4. A counter flow double pipe heat exchanger using super-heated steam is used to heat water at the rate of 10500 kg/hr. The steam enters the heat exchanger at 180ºC and leaves at 130ºC. The inlet and exit temperature of water are 30ºC and 80ºC respectively. If the overall heat transfer coefficient from steam to water is 814 W/m^2K, calculate the heat transfer area. What would be the increase in area if the fluid flow were parallel?
5. If a cube of sugar is placed in a cup of coffee, what is the driving potential for dispersion of the sugar in the coffee? What is the physical mechanism responsible for dispersion if the coffee is stagnant? What is the physical mechanism if the coffee is stirred?

Evaluate

1. Air at 25ºC flows past a flat plate at 2.5 m/s. the plate measures 600 mm X 300 mm and is maintained at a uniform temperature at 95ºC. Calculate the heat loss from the plate, if the air flows parallel to the 600 mm side. How this heat loss would be affected if the flow of air is made parallel to the 300 mm side.
2. The filament of a 75 W light bulb may be considered as a black body radiating into a black enclosure at 70ºC. The filament diameter is 0.10 mm and length is 5 cm considering the radiation, determine the filament temperature.
3. Water flows at the rate of 65 kg/min through a double pipe counter flow heat exchanger. Water is heated from 50ºC to75ºC by an oil flowing through the tube. The specific heat of the oil is 1.780 kJ/kgK. The oil enters at 115ºC and leaves at 70ºC.the overall heat transfer co-efficient is 340 W/m^2K. Evaluate the heat exchanger area and rate of heat transfer.
4. A pan of 40 mm deep, is filled with water to a level of 20 mm and is exposed to dry air at 300ºC. Calculate the time required for all the water to evaporate. Take, mass diffusivity as 0.25X10-4 m^2/s.

15ME507 HEAT TRANSFER LABORATORY 0 0 2 1

Course Objectives

- To impart the knowledge on steady and unsteady heat transfer.
- To demonstrate the principles of free and forced convection.
- To provide the knowledge on performance of heat exchangers.
- To provide knowledge on black body radiation and grey body radiation.
- To study the pressure drop in a fluidized bed.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
o. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Find the thermal conductivity of metals, liquids and insulating materials.
2. Assess the parameters associated with free and forced convection.
3. Compute the performance of various types of heat exchanger.
4. Check the Stefan Boltzmann constant and emissivity of a radiating body.
5. Determine the pressure drop in a fluidized bed.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3							1			2			2
2	2	3			1				1			3			2
3	2	3			1				1			3			2
4	2	3							1			2			2
5	2	3							1			2			2

1 **4 Hours**

EXPERIMENT 1
Determination of thermal conductivity of powdered and packed insulating material.

2 **4 Hours**

EXPERIMENT 2
Determination of thermal conductivity of metal rod and guarded hot plate.

3 **4 Hours**
EXPERIMENT 3
Determination of thermal conductivity of liquids and composite material.

4 **2 Hours**
EXPERIMENT 4
Determination of heat transfer co-efficient by unsteady heat transfer.

5 **2 Hours**
EXPERIMENT 5
Determination of heat transfer co-efficient by natural convection.

6 **2 Hours**
EXPERIMENT 6
Determination of heat transfer co-efficient by forced convection.

7 **2 Hours**
EXPERIMENT 7
Determination of heat transfer co-efficient in a parallel and counter flow heat exchanger.

8 **2 Hours**
EXPERIMENT 8
Determination of overall heat transfer co-efficient for a plate type heat exchanger.

9 **2 Hours**
EXPERIMENT 9
Determination of overall heat transfer for film wise and drop wise condensation.

10 **2 Hours**
EXPERIMENT 10
Determination of Stefan-Boltzmann constant.

11 **2 Hours**
EXPERIMENT 11
Determination of emissivity using emissivity apparatus.

12 **2 Hours**
EXPERIMENT 12
Determination of pressure drop in a fluidized bed.

Total: 30 Hours

15ME508 COMPUTER AIDED MODELLING LABORATORY

0 0 2 1

Course Objectives

- To provide knowledge and skills to draw orthographic projections of simple components using geometric modelling software.
- To impart knowledge for creating three dimensional assembly models of few automotive and machine components using CAD Software.
- To provide knowledge on generating 3D assembly models of few machine elements using CAD software.
- To provide knowledge on three dimensional model of simple mechanism and animation using CAD software.
- To expose the knowledge to prepare the technical documents for the given components using software.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Sketch the orthographic projections of simple components using geometric modelling software.
2. Construct three dimensional assembly models of few automotive and machine components using CAD Software.
3. Construct the three dimensional assembly models of machine elements using CAD software.
4. Create the animation of simple mechanisms using CAD software.
5. Prepare the technical documents for the given components using software.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2				3					1		3	3		
2	2				3					1		3	3		
3	1				3					1		3	3		
4	1				3					1		3	3		
5	2				3					2		3	3		

2 Hours

EXPERIMENT 1
Create an orthographic view of machine components from the given isometric drawings.

2 **4 Hours**

EXPERIMENT 2
Construct a three dimensional assembly model of bearing.

3 **4 Hours**

EXPERIMENT 3
Generate a three dimensional shaft and coupling assembly model by considering tolerance in each Component.

4 **4 Hours**

EXPERIMENT 4
Create a three dimensional assembly model of Piston and Connecting Rod.

5 **4 Hours**

EXPERIMENT 5
Build a three dimensional assembly model of power drive system.

6 **4 Hours**

EXPERIMENT 6
Create a three dimensional assembly model of two wheeler suspension system.

7 **2 Hours**

EXPERIMENT 7
Construct a three dimensional assembly model of control valve.

8 **2 Hours**

EXPERIMENT 8
Generate a three dimensional assembly model of Jig/fixture.

9 **2 Hours**

EXPERIMENT 9
Create a three dimensional assembly model of simple mechanism and animate its working using modeling software.

10 **2 Hours**

EXPERIMENT 10
Prepare technical documents for an I.C. Engine Assembly by using 3D Via software.

Total: 30 Hours

Reference(s)

1. Creo Parametric 2.0 for Engineers and Designers, Prof Sham Tickoo, Prabhakar Singh
2. Geometric Modelling: Theoretical and Computational Basis towards Advanced CAD Applications, Fumihiko Kimura

15ME509 TECHNICAL SEMINAR I 0 0 2 1

Course Objectives

- To develop self-learning skills of utilizing various technical resources to make a technical presentation.
- To promote the technical presentation and communication skills.
- To impart the knowledge on intonation, word and sentence stress for improving communicative competence, identifying and overcoming problem sounds.
- To promote the ability for Interacting and sharing attitude.
- To engarauge the commitment-attitude to complete tasks.

Programme Outcomes (POs)

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Refer and utilize various technical resources available from multiple fields
2. Improve the technical presentation and communication skills
3. Analyze the importance of intonation, word and sentence stress for improving communicative competence, identifying and overcoming problem sounds.
4. Interact and share their technical knowledge to enhance the leadership skills
5. Prepare report and present oral demonstrations

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1		2				2									
2					1					2		2			
3										3		3			
4		2				2				2		1			
5										2		2			

Total: 30 Hours

15ME510 MINI PROJECT III 0 0 2 1

Course Objectives

- To develop skills to formulate a technical project.
- To give guidance on the various tasks of the project and standard procedures.
- To teach use of new tools, algorithms and techniques required to carry out the projects.
- To give guidance on the various procedures for validation of the product and analyse the cost effectiveness.
- To provide guidelines to prepare technical report of the project.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Formulate a real world problem, identify the requirement and develop the design solutions.
2. Identify technical ideas, strategies and methodologies.
3. Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis the cost-effectiveness.
5. Prepare report and present oral demonstrations

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1		3	2			2	1								
2	2	2	1	3		2					2	2			
3			3	2	2			2			2	2			
4		1		2	3	1	2	2							
5									3	3		2			

Total:30 Hours

15GE511 LIFE SKILLS: APTITUDE I 0 0 2 0

Course Objectives

- To expose the undergraduate students to such methods and practices that help, develop and nurture qualities such as character, effective communication, aptitude and holding ethical values.

Course Outcomes (COs)

1. Distinguish the pattern of coding and decoding.
2. Demonstrate various principles involved in solving mathematical problems and thereby reducing the time taken for performing job functions
3. Evaluate critically the real life situations by resorting and analyzing analytical reasoning of key issues and factors
4. Calculate the percentages and averages

UNIT 1 **3 Hours**

CODING AND DECODING

Introduction - Description of Coding method - Coding patterns - Concepts of Coding and Decoding - Problems involving Coding and Decoding methods

UNIT 2 **3 Hours**

SEQUENCE AND SERIES

Introduction - Sequences of real numbers - Number and Alphabet series - Description of Number and Alphabet series - Analogy - Odd man out- Power series

UNIT 3 **3 Hours**

DATA SUFFICIENCY

Introduction to Data Sufficiency - Overview of the wide variety of Data Sufficiency problems - Basic introduction on how to determine what information is sufficient to solve a given problem - Common pitfalls to avoid

UNIT 4 **3 Hours**

DIRECTION

Introduction to Direction - sense test - Overview of the wide variety of Direction problems -Direction - Plotting diagrams

UNIT 5 **3 Hours**

PROBLEM ON AGES

Introduction- basic concept - usage of percentage and averages- applications

UNIT 6 **3 Hours**

ANALYTICAL REASONING

Introduction - basic concept - non verbal analytical reasoning - arrangements

UNIT 7 **3 Hours**

BLOOD RELATION

Introduction - Basic concept - Kinds of relation - Tree diagram - Relations

UNIT 8 **3 Hours**

BLOOD RELATION

Introduction -Basic concept - Kinds of relation - Tree diagram - Relations

UNIT 9 **3 Hours**

VISUAL REASONING

Introduction - Basic concepts - Odd man out - Next series - Mirror image and water image

UNIT 10 **3 Hours**

SIMPLIFICATIONS

Introduction - Basic concepts - Arithmetic operations -Equation solving methods - Puzzles

Total: 30 Hours

Reference(s)

1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, Tata McGraw-Hill Publishing Company Ltd, 2012
2. Arun Sharma, How to prepare for Data Interpretation for the CAT, First Edition, Tata McGraw-Hill Publishing Company Ltd, 2012.
3. Dr.R S Aggarwal, Quantitative Aptitude, Seventh Revised Edition, S.Chand Publishing Company Ltd, 2013.
4. Edgar Thorpe , Course In Mental Ability And Quantitative Aptitude For Competitive Examinations, Third Edition, Tata McGraw-Hill Publishing Company Ltd, 2013.
5. Arun Sharma, How to prepare for Quantitative Aptitude for the CAT, Fifth Edition, Tata McGraw-Hill Publishing Company Ltd, 2013

15GE601 PROFESSIONAL ETHICS 2 0 0 2

Course Objectives

- To understand Human values, ethical theory, codes of ethics, work place responsibilities, rights, engineering experimentation, global issues and contemporary ethical issues.
- To understand personal ethics, legal ethics, cultural associated ethics and engineers responsibility

Programme Outcomes (POs)

f. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Course Outcomes (COs)

1. Explain the human values.
2. Implement the importance of ethics and professionalism.
3. Illustrate the effect of social exprementation.
4. Identify the work place responsiblities and uphold right issues.
5. Construct duties pertaining to global issues.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1						2		3			1				
2						2		3	1						
3						2	2	3		1					
4								3			1				
5							3	3		2					

UNIT I **6 Hours**

HUMAN VALUES

Morals and Ethics - Honesty - Integrity - Values - Work Ethic - Civic Virtue - Respect for Others - Living Peacefully - Caring and Sharing - Self-Confidence - Courage - Co-operation - Commitment - Empathy.

UNIT II **6 Hours**

ENGINEERING ETHICS AND PROFESSIONALISM

Scope of 'Engineering Ethics'- Variety of moral issues - Types of inquiry - Accepting and sharing responsibility - Ethical dilemmas - Moral autonomy - Kohlberg's and Gilligan's theory - Consensus and controversy - Profession and Professionalism - Models of Professional Roles - Right action theories - Senses of corporate responsibility - Codes of ethics: Importance - justification - limitation - Abuse - Sample codes NSPE - IEEE - Institution of Engineers (India).

UNIT III **6 Hours**

ENGINEERING AS SOCIAL EXPERIMENTATION

Engineering as experimentation - Engineers as responsible experimenters - Balanced outlook on law - Cautious optimism - Safety and risk - Assessing and reducing risk - Safe exits - The Challenger case study - Bhopal Gas Tragedy - The Three Mile Island and Chernobyl.

UNIT IV **6 Hours**

WORKPLACE RESPONSIBILITIES AND RIGHTS

Fundamental Rights - Responsibilities and Duties of Indian Citizens - Teamwork - Ethical corporate climate - Collegiality and loyalty - Managing conflict - Respect for authority - Collective bargaining - Confidentiality - Conflicts of interest - Occupational crime - Professional rights - Employee rights.

UNIT V **6 Hours**

GLOBAL ISSUES

Multinational corporations: Technology transfer and appropriate technology - International rights - promoting morally just measures - Environmental ethics: Engineering, ecology - economics - Human and sentient centred - and bio and eco centric ethics - Computer ethics and internet - Engineers as managers - Consulting engineers - Engineers as expert witnesses and advisors - Moral leadership.

FOR FURTHER READING

The Challenger case study - Bhopal Gas Tragedy - The Three Mile Island and Chernobyl case studies - Fundamental Rights, Responsibilities and Duties of Indian Citizens -Sample code of ethics like IETE, ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management.

Total: 30 Hours

Reference(s)

1. Mike W Martin and Roland Schinzinger, Ethics in Engineering, 4th edition, Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi, 2014.
2. M Govindarajan, S Natarajan and V S Senthil Kumar, Engineering Ethics, PHI Learning Private Ltd, New Delhi, 2012.
3. R S Naagarazan, A text book on professional ethics and human values, New age international (P) limited, New Delhi,2006.
4. Charles D Fleddermann, Engineering Ethics, Pearson Education/ Prentice Hall of India, New Jersey, 2004.
5. Charles E Harris, Michael S Protchard and Michael J Rabins, Engineering Ethics - Concepts and Cases, Wadsworth Thompson Learning, United States, 2005.
6. http://www.slideworld.org/slidestag.aspx/human-values-and- Professional-ethics

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	5	5				5					5														20
2		5			5						5										5				20
3		5					10				5														20
4	5									5											5	5			20
5	5					5				5					5										20
																								Total	100

Assessment Questions
Remember

1. Define Human Values.
2. What are Morals and Values?
3. What do you mean by Civic virtue and Respect for others?
4. Write the various meanings of ï¿½??Spirituality?
5. List four different types of Virtues.
6. Mention different Human values.
7. What is meant by moral autonomy?
8. Classify the types of inquiry
9. What are the steps needed in confronting moral dilemmas?
10. List the levels of moral development suggested by Kohlberg
11. What do you understand by self-interest and ethical egoism?
12. What are the steps needed in confronting moral dilemmas?
13. What are the three virtues of religion?
14. What are the professional responsibilities?

Understand

1. Which are the practical skills that will help to produce effective independent thought about moral issues?
2. Why does engineering have to be viewed as an experimental process?
3. Why isn‘t engineering possible to follow a random selection in product design?
4. Why is the code of ethics important for engineers in their profession?
5. What does the Balanced Outlook on Law stress in directing engineering practice?
6. Are the engineers responsible to educate the public for safe operation of the equipment? How?
7. What kind of responsibility should the engineer have to avoid mistakes that may lead to accident due to the design of their product?
8. What is the use of knowledge of risk acceptance to engineers?
9. Why is Environmental Ethics so important to create environmental awareness to the general public?
10. Why do the engineers refuse to do war works sometimes?

Apply

1. How does the consideration of engineering as a social experimentation help to keep a sense of autonomous participation is a person’s work?
2. How does the code of ethics provide discipline among the engineers?
3. Exemplify the space shuttle Challenger case accident?
4. How does the manufacturer understand the risk in a product catalog or manual?
5. How does the knowledge of uncertainties in design help the engineers to access the risk of a product?
6. How can the quantifiable losses in social welfare resulting from a fatality be estimated? Give some examples.
7. How does the engineer act to safeguard the public from risk?

15ME602 DESIGN OF TRANSMISSION SYSTEMS 3 2 0 4

Course Objectives

- To study the design procedure of belt and rope drives.
- To learn the design procedure of spur and helical gear drives.
- To learn the design procedure of bevel and worm gear drives.
- To study the design procedure of multi stage gear box.
- To familiarize the students for design of I.C engine components.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Design of belt and rope drives
2. Design of spur and helical gear drives.
3. Design of bevel and worm gear drives.
4. Draw the kinematic and ray diagrams for multi stage gear boxes.
5. Design of Ratchet & Pawl, Geneva mechanisms and I.C. Engine Components.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	3									1	2		
2	3	2	3									1	2		
3	3	2	3									1	2		
4	3	2	3									2	2		
5	3	2	3									1	2		

UNIT I **9 Hours**

DESIGN OF FLEXIBLE ELEMENTS

Need for power transmission - Types and classification of transmission systems, Applications, Limitations. Belt drives - Types, materials and construction, Selection of flat and V-belts from manufacturer's catalogue. Wire Ropes- Construction, Rope lay, Stresses in wire rope, Failure of ropes.

UNIT II **9 Hours**

DESIGN OF SPUR AND HELICAL GEARS

Spur and Helical gears- Introduction, Gear design, Force analysis, Tooth stresses - Beam strength calculation - Failure in gears.

UNIT III **9 Hours**

DESIGN OF BEVEL AND WORM GEARS

Bevel Gear- Introduction, Types, Geometry, Angle relations, Basic dimensions, Force analysis. Worm Gear -Introduction, Types, Geometry, Basic dimensions - Forces on worm and worm wheel - Mode of failures - Efficiency - Heat removal calculations.

UNIT IV **9 Hours**

DESIGN OF GEAR BOXES

Gear Box - Geometric progression - Standard step ratio - Ray diagram - Kinematics layout. Design of multi stage gear boxes, Calculation of number of teeth and overlapping speed.

UNIT V **9 Hours**

DESIGN OF MECHANISMS AND I.C. ENGINE MACHINE COMPONENTS

Design of Ratchet & pawl mechanism and Geneva mechanism. Design of I.C engines components such as piston, connecting rod and crank shaft.

FOR FURTHER READING

Factors influencing the choice of selection of belt and gear drives -Design of multi speed gear box for machine tool applications.

Total: 75 Hours

Reference(s)

1. V. B. Bhandari, Design of Machine Elements, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi, 2010.
2. R. L. Norton, Design of Machinery, Fifth Edition, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2011.
3. B. J. Hamrock, B. Jacobson and S. R. Schmid, Fundamentals of Machine Elements, Third Edition, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2014.
4. T. J. Prabhu, Design of Transmission Elements, Mani Offset, Chennai, 2008.
5. S. G. Kulkarni, Machine Design, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2010.
6. http://nptel.iitm.ac.in/courses/Webcourse-contents/

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2	2				2				2	8				4										20
2	2	2				4					8				4										20
3		2				2					4								12						20
4	2	2				4					8				4										20
5	2	2				2				2	12														20
																								Total	100

Assessment Questions

Remember

1. State the Law of Belting.
2. What is meant by ply of belt?
3. What is gear drive?
4. State the Law of gearing
5. What is a helical gear?
6. Label the three advantages of helical gears.
7. State three advantages of Herringbone gear.
8. Define the following terms: (a) Cone distance, (b) Face angle.
9. List three applications of gear box.
10. Define preferred number.
11. What is the function of a clutch?

Understand

1. During the selection of a belt drive, what are factors considered?
2. Why tight-side of the belt should be at the bottom side of the pulley?
3. In what ways wire ropes are superior to fibre ropes?
4. What are the possible ways by which a chain drive may fail?
5. What is interference in gears? How can you overcome it?
6. What is the effect of increase in pressure angle in gears?
7. Why dedendum value is more than addendum value?
8. Why pinion is made harder than gear?
9. Why multi-start worm is more efficient than the single start one?
10. Why a service factor is used for calculating the design capacity of a clutch?
11. Why is heat dissipation necessary in clutches?

Apply

1. At what occasions nonmetallic gears are employed.
2. What preliminary design considerations should be, adopted, when selecting gear drive?
3. Why in automobiles braking action when travelling in reverse is not as effective as when moving forward?

Analyse

1. Design a layout of a 9 speed gear box for a machine tool. The minimum and maximum speeds are 100 and 900 rpm. Power is 5 kW from 1200 rpm induction motor.
2. Design a spur gear pair to transmit 1.5 kW at 1440 rpm from an electric motor to an air compressor running at 720 rpm. Material to be used is Cast Iron grade 25 for both pinion and wheel. Gear is to work 8 hours per day, six days a week and for 3 years.
3. Design a pair of helical gears to transmit 10 kW at 1000 rpm of the pinion reduction ratio of 5 is required. Assume suitable materials and other data.
4. Design a 9 speed gear box for the following data:
   Minimum speed: 100 rpm, Step ratio: 1.25. The input is from a 4 kW, 1400 rpm motor. Draw the speed diagram and indicate the number of teeth on each gear in a kinematic diagram.
5. Design a crushing machine is to be run at 560 rpm. Design a suitable drive to transmit 15 kW from a motor at 1200 rpm. Minimum centre distance is 1.5 m.

Evaluate

1. A 7.5 kW electric motor running at 1400 rpm is used to drive the input shaft of the gearbox of a special purpose machine. Design a suitable roller chain to connect the motor shaft to the gearbox shaft to give an exact speed ratio of 10 to 1. Assume the minimum centre distance between driver and driven shafts as 600 mm.
2. A motor shaft rotating at 1500 rpm has to transmit 15kW to a low speed shaft with a speed reduction of 3:1. Assume starting torque to be 25% higher than the running torque. The teeth are 200 involutes with 25 teeth on the pinion. Assume both the gears are made of same material and life of gear is 10000 hours. Design a spur gear drive to suit the above conditions and check for compressive and bending stresses and plastic deformations.

15ME603 FINITE ELEMENT ANALYSIS 3 2 0 4

Course Objectives

- To impart basic knowledge in finite element method.
- To provide knowledge in 1D elements.
- To provide knowledge in 2D elements.
- To study heat conduction problems using finite element method.
- To provide knowledge on higher order and iso parametric elements.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply the numerical methods to formulate the simple finite element problems.
2. Apply one dimensional finite element method to solve bar, beam and truss type problems.
3. Apply finite element method for plane stress, plane strain and axisymmetric conditions.
4. Determine temperature distribution of one and two dimensional heat transfer problems using one and two dimensional finite elements.
5. Apply the numerical methods to formulate the higher order and isoperimetric problems.

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	3									2	2		
2	3	2	3									2	2		
3	3	2	3									2	2		
4	3	2	3									2	2		
5	3	2	3									2	2		

UNIT I **10 Hours**

INTRODUCTION

Relevance and scope of finite element methods - strain vs displacement relations - stresses and equilibrium - natural and essential boundary conditions - Rayleigh Ritz - Galerkin method- FEM procedure - Discretisation of domain-element shapes, types, size, location and numbers.

UNIT II **10 Hours**

ONE-DIMENSIONAL (1D) ELEMENTS

Coordinate system types-global, local and natural. shape function of 1D bar element -Finite element formulation - stiffness matrix, load vector, boundry condition and assembly of global equation-1D bar element and two node truss element- problems in 2D truss. Introduction to beam element.

UNIT III **8 Hours**

TWO-DIMENSIONAL (2D) ELEMENTS

Shape function for linear triangular element-Finite element formulation- Constant Strain Triangular (CST) element -plane stress, plane strain - axisymmetric elements - problems.

UNIT IV **9 Hours**

HEAT TRANSFER APPLICATIONS

Shape function for 1D and 2D triangular element heat conduction - stiffness matrix, load vector and assembly of global equation for 1D and 2D triangular element heat conduction, heat generation with convective boundary conditions for linear element.

UNIT V **8 Hours**

HIGHER ORDER AND ISOPARAMETRIC ELEMENT

Selection of order of polynomial-linear, simplex, complex and multiplex elements. Mesh refinement methods and convergence requirements. Iso, Sub and Super parametric element. Shape functions for a 2-D four nodded and eight nodded Isoparametric rectangular element using natural coordinate system - problems. Gaussian quadrature method-problems.

FOR FURTHER READING

Construct the FEA steps for the structural and thermal analysis of machine elements.

Total: 75 Hours

Reference(s)

1. S. S. Rao, Finite Element Method in Engineering, Elsevier India, 2005.
2. David V. Hutton, Fundamentals of Finite Element Analysis, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi,2005.
3. Robert D. Cook, s. David , Malkucs Michael E. Plesha, Concepts and Applications of Finite Element Analysis, John Wiley, New Delhi,2007.
4. T. R. Chandrupatla and A. D. Belegundu, Introduction to Finite Elements Engineering, Pearson Education, New Delhi, 2002.
5. S. S. Bhavikati, Finite Element Analysis, New Age International Publishers, 2015.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	4		4		4		6				8														26
2	2	2			4	2				4	6														20
3	2	2				4				4	6														18
4	4				4					4	6														18
5	4				4					6	4														18
																								Total	100

Assessment Questions

Remember

1. What is weighted residual method?
2. What is an Eigen value problem?
3. State the principle of minimum potential energy.
4. What is meant by Discretization of the domain?
5. What are the three major categories of problem in FEM?
6. What is global Coordinate system?
7. What is aspect ratio?
8. What is stiffness matrix?
9. Define CST element with diagram.
10. Define simplex element.
11. Define shape function.

Understand

1. What is the difference between Propagation and Steady state problem?
2. Compare FEM with other methods.
3. What do you understand by element connectivity?
4. How do you built a finite element model?
5. Differentiate Beam element and Truss element.
6. What the Numerical integration is used in FEM?
7. How will you select the order of the polynomial ?
8. How will you draw a Pascal's triangle and tetrahedron for arranging 2-D and 3-D polynomial Function?
9. Differentiate h-method and p-method of mesh refinement.
10. In Steady state and Propagation there exist ______solution but in Eigen value problem there is no _________ solution.

Apply

1. Elucidate the step by step procedure for solving a static structural problem in FEM for the axially loaded stepped bar.
2. Find the approximate deflection of a simply supported beam under a uniformly distributed load pusing Rayleigh-Ritz method.
3. When you will apply the Pascal's triangle and tetrahedron and for what?
4. The cross section of a bar of length 10cm is rectangular in section of width 3cm and depth 1 cm. The bar is subjected to forced convection over its length due to flow of fluid at temperature of 25°C. The convection coefficient is 5 W/cm²°C. Compute the thermal load vector due to convection.
5. Derive stiffness matrix for a one dimensional bar subjected to both distributed load and point loads. (Note: Differential equation should be formed and then apply basic Galerkin method on differential equation to form element stiffness matrix.)
6. Derive stiffness matrix for a one dimensional bar subjected to both distributed load and point loads. (Note: Differential equation should be formed and then apply basic Galerkin method on differential equation to form element stiffness matrix.)
7. Derive the element stiffness matrix and element force matrices for a one dimensional line element.

15ME604 GAS DYNAMICS AND JET PROPULSION 2 2 0 3

Course Objectives

- Understand the fundamental principles of compressible flow.
- Resolve the problems on isentropic flow through variable area ducts, Fanno flow and Rayleigh flow.
- Understand the effect of flow properties on normal shock.
- Apply the basic gas dynamics theories for aircraft Propulsion systems.
- Describe the working of solid propellant and liquid propellant rocket engines

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
o. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Illustrate the fundamental principles of compressible flow.
2. Resolve the problems on isentropic flow through variable area ducts, Fanno flow and Rayleigh flow.
3. Interpret the effect of flow properties on normal shock.
4. Explain the basic gas dynamics theories for aircraft propulsion systems.
5. Demonstrate the working of solid propellant and liquid propellant rocket engines

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3													3
2	2	3				2									2
3	2	3				2									2
4	2	3				2									2
5	2	3													2

UNIT I **6 Hours**

COMPRESSIBLE FLOW FUNDAMENTALS

Introduction to compressible flow - Integral and differential forms of conservation equations, velocity of sound, Mach number, various regimes of flow, wave propagation, Mach cone and Mach angle-Stagnation state - stagnation enthalpy, stagnation temperature, stagnation pressure and stagnation density - critical state - reference velocities, reference Mach number. Effect of Mach number on compressibility.

UNIT II **6 Hours**

FLOW THROUGH VARIABLE AREA DUCTS

Isentropic flow through variable area ducts - effect of area change on flow parameters, area ratio as a function of Mach number, impulse function, mass flow rate equations, chocking flow, effect of back pressure on performance of convergent and De lavel nozzle.

UNIT III **6 Hours**

FLOW THROUGH CONSTANT AREA DUCTS

Flow in constant area ducts with friction (Fanno flow) Governing equations, fanno curves and Fanno flow equations, variation of flow properties, variation of Mach number with duct length. Flow in constant area ducts with simple stagnation temperature change (Rayleigh Flow) - Governing equations,Rayleigh line and Rayleigh flow equation, variation of flow properties, maximum heat transfer in Rayleigh flow.

UNIT IV **6 Hours**

FLOW WITH NORMAL SHOCK

Governing equations - variation of flow properties like static pressure, static temperature, density, stagnation pressure and entropy across the normal shock - Prandtl equation - Rankine Hugonoit equation. Impossibility of shock in subsonic flows, flow in convergent and divergent nozzle with normal shock - normal shock in Fanno and Rayleigh flows.

UNIT V **6 Hours**

AIRCRAFT AND ROCKET PROPULSION

Aircraft propulsion - types of jet engines, energy flow through jet engines. Performance of turbo jet engines - thrust, thrust power, propulsive and overall efficiencies - thrust augmentation in turbo jet engine. Ram jet, Scram jet and Pulse jet engines. Rocket Propulsion - Classification of rocket engines. Propellants - solid, liquid and hybrid propellants, rocket engines thrust equation, effective jet velocity,specific impulse. Rocket engine performance.

FOR FURTHER READING

Case Study : Advanced Aircraft Engines, select Fuel for Air-craft engines

Total: 60 Hours

Reference(s)

1. Patrick H. Oosthuizen and William E. Carscallen, Introduction to Compressible Fluid Flow, 2nd edition, CRC Press, Taylor & Francis Group, Florida, 2013.
2. Robert D. Zucker, Fundamentals of Gas Dynamics, 2nd edition, John Wiley & Sons Inc., New York, 2002.
3. H.I.H. Saravanamuttoo, G.F.C. Rogers, H. Cohen and P.V. Straznicky, Gas Turbine Theory, 6th edition, Pearson Education, 2009.
4. George P. Sutton and Oscar Biblarz, Rocket Propulsion Elements, 8th edition, John Wiley & Sons Inc., New York, 2010.
5. S. M. Yahya, Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion, 4th edition, New Age International private Limited, 2014.
6. E. Rathakrishnan, Gas Dynamics, 5th edition, PHI Learning Private Limited, 2013.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2	4				2					12														20
2		2				2									8				8						20
3		2				2									8				8						20
4		2				2									8				8						20
5	1	1					12								6										20
																								Total	100

Assessment Questions

Remember

1. Define Compressibility.
2. Give the expression for T/To and T/T* for isentropic flow through variable area in terms of Mach number.
3. Define strength of shock wave.
4. List out any two merits of ram jet engine.
5. List out the applications of supersonic diffuser and give two examples.
6. List out the assumptions used in the analysis of Rayleigh flow process.
7. State the expression for dA/A as a function of Mach number.
8. Define MACH Number.

Understand

1. How gas dynamics differs from fluid dynamics?
2. Draw the Mach cone and identify its salient features.
3. Distinguish between Jet and Rocket propulsion.
4. Which causes the shock in isentropic flow through nozzle.
5. When does the maximum mass flow occur for an isentropic flow with variable area?
6. Draw the variation of Mach number along the length of a convergent divergent duct when it acts as a (a) Nozzle (b) Diffuser (c) Venturi.
7. Classify the rocket engines based on the source of energy employed.
8. Sketch the effect of disturbance in still air as it moves from rest to supersonic velocity for the following Mach numbers: M = 0, M = 0.5, M = 1.0, M = 2. Explain in detail about the observed phenomena.
9. What do you understand by chocking in Rayleigh flow?
10. With a neat sketch explain the working of a turbo-pump feed system used in a liquid propellant rocket.

Apply

1. Air at 200º C static temperature moves 125 m/ sec velocity. Find stagnation property.
2. Nitrogen (molecular Wt. =12 and γ = 1.4) at stagnation temperature of – 13 º C and moving at 75 m / sec. Find mach number and maximum sonic velocity.
3. The wave front caused by firing a bullet gave a Mach angle of 35°. Find the velocity of the bullet if the static temperature of atmosphere is 276K
4. What is the effect of Mach number on compressibility? Derive the relation between pressure coefficient and Mach number. Calculate the percentage deviation due to the assumption of incompressibility when the Mach number is 0.2, 0.4, 0.6, 0.8 and 1.0 for γ = 1.4.
5. What is meant by velocity of sound? Derive the expression for velocity of sound.
6. From fundamentals derive the momentum equation in integral form.
7. Derive the integral form of continuity equation starting from the fundamental physical principle.
8. From fundamentals derive the energy equation in integral form.
9. Illustrate the effect of back pressure on performance of convergent nozzle.
10. Analyze the effect of area ratio on pressure and temperature in a variable area duct.

11. Derive an expression for area ratio A/A* in terms of Mach number for an isentropic flow of a perfect gas.
12. Analyze the effect of area ratio on mach number in a variable area duct.
13. Discuss the effect of flow properties in Fanno flow.
14. Show the the downstream Mach number of a normal shock approaches a minimum value as the upstream Mach number increases towards infinity.
15. Why shock waves cannot be formed in subsonic flow? Analyze.

Analyse

1. Air flows through a convergent nozzle with inlet stagnation pressure of 1 MPa . For the exit pressure of 500 kPa , find the exit mach number.
2. Air (γ=1.4, R=287.43 J/kgK) enters a straight axisymmetric duct at 300 K, 3.45 bar and 150 m/s and leaves at 277 K, 2.058 bar and 260 m/s. The area of cross section at entry is 500 cm^2. Assuming adiabatic flow, determine a) Stagnation temperature b) Maximum velocity c) Mass flow rate and d) Area of cross-section at exit.
3. A circular duct passes 8.25 Kg / s of air at an exit Mach number of 0.5. The entry pressure and temperature are 345 KPa and 380 °C respectively and the coefficient of friction 0.005. If the Mach number at entry is 0.15, determine, a) The diameter of the duct b) Length of the duct, c) Pressure and temperature at exit and c) Stagnation pressure loss
4. Air at pressure 3 bar, temperature 288 K and Mach number 1.5 is brought to sonic velocity in a frictionless constant area duct through which heat transfer can occur. Determine a) final pressure and temperature, heat added during the process b) What will be the Mach number, pressure and temperature of air if this heat is exhaust from the air?
5. The velocity of a normal shock wave moving into stagnant air (p=1.0 bar, t=17°C) is 500 m/s . If the area of cross- section of the duct is constant determine (a) pressure (b) temperature (c) velocity of air (d) stagnation temperature and (e) the mach number imparted upstream of the wave front.
6. A rocket flies at 10,080 Kmph with an effective exhaust jet velocity of 1400m/s and propellant flow rate of 5.0Kg/s. If the heat of reaction of the propellants is 6500KJ/Kg of the propel at mixture determine; a) Propulsion efficiency and propulsion power b) Engine output and thermal efficiency and c) Overall efficiency.
7. The ratio of the exit to entry area in a subsonic diffuser is 4.0 .The Mach number of a jet of air approaching the diffuser at p0=1.013 bar, T =290 K is 2.2 .There is a standing normal shock wave just outside the diffuser entry. The flow in the diffuser is isentropic. Determine at the exit of the diffuser, Mach number, temperature and pressure.
8. Air is kept in a tank at a pressure of 700 kPa and a temperature of 15°C. If the air is allowed to issue out of the duct in one dimensional isentropic flow, what is the maximum possible flow per unit flow, what is the maximum possible flow per unit area. What is the flow per unit area at the exit of the nozzle where pressure is 500 kPa.
9. A stream of air flows in a duct of 100 mm diameter at the rate of 1 kg/s. The stagnation temperature is 37°C. At one section of the duct the static temperature is 10°C. Calculate the mach number, velocity and stagnation pressure at this section.

15ME607 COMPUTER AIDED ANALYSIS LABORATORY **0 0 2 1**

Course Objectives

- To introduce knowledge on the FEA software as a tool for truss and beam analysis
- To provide knowledge on applications having plane stress, plane strain and axisymetric conditions using FEA software.
- To impart knowledge in dynamic analysis using FEA software.
- To learn about temperature distribution for heat conduction using FEA software.
- To impart knowledge on coupled field analysis using FEA software.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Analysis of trusses and beams using FEA software.
2. Apply plane stress, plane strain and axisymetric conditions using FEA software.
3. Dynamic analysis of simple structure using FEA software.
4. Find temperature distribution for heat conduction using FEA software.
5. Thermo-mechanical analysis of simple structure using FEA software.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	3		2	1							1	3		
2	1	3		2	1							2	3		
3	1	3		2	2							3	3		
4	1	3		3	1							3	3		
5	1	3		2	1							2	3		

1 **2 Hours**

EXPERIMENT 1

Structural analysis of simple and composite trusses.

2 **4 Hours**

EXPERIMENT 2

Structural analysis of cantilever beam, simply supported beam and fixed beam under different boundary conditions.

3 **2 Hours**

EXPERIMENT 3

Stress analysis of a simple machine element.

4 **2 Hours**

EXPERIMENT 4

Stress analysis under plane strain condition.

5 **2 Hours**

EXPERIMENT 5

Stress analysis of pressure vessel subjected to an internal pressure.

6 **4 Hours**

EXPERIMENT 6

Dynamic analysis of a rotating shaft subjected to twisting moment.

7 **4 Hours**

EXPERIMENT 7

Modal analysis of Cantilever, Simply supported and Fixed beams under different boundary conditions.

8 **4 Hours**

EXPERIMENT 8

Harmonic analysis of Cantilever, Simply supported and Fixed beams under different boundary conditions.

9 **2 Hours**

EXPERIMENT 9

Heat transfer analysis of 2D and 3D components under different boundary conditions.

10 **4 Hours**

EXPERIMENT 10

Coupled field analysis.

Total: 30 Hours

Reference(s)

1. Finite Element Analysis using Ansys 11.0, PHI Learning Pvt. Ltd, 2010.
2. Finite Element Analysis Theory and Applications with Ansys, Saeed Moaveni, Pearson Education, 2014.

15ME608 MICROPROCESSORS AND MICROCONTROLLERS LABORATORY

1 0 2 2

Course Objectives

- To acquire basic knowledge about Microprocessors and Microcontrollers.
- To study the architectures of microprocessor
- To study the architectures of microcontroller.
- To impart the programming skills on 8085 and 8051 microprocessors.
- To understand the Programming analyzing concept of various peripheral interfacing with 8085.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Identify the various types of microprocessors and microcontrollers.
2. Explain the fundamental concepts of the microprocessor.
3. Explain and use the basic concepts of the microcontroller.
4. Develop the logical programmes using 8085 and 8051 microprocessors.
5. Analyse the various peripheral interfacing with 8085.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1			2	1										
2	1			2	1										
3	1			2	1										
4	1			3	1							3			
5	1			2	1										

UNIT I **3 Hours**

8085 CPU

8085 Architecture - Instruction set - Addressing modes -Timing diagrams - Assembly language programming - Counters - Time Delays - Interrupts - Memory interfacing - Interfacing, I/O devices

UNIT II **3 Hours**

PERIPHERALS INTERFACING

Interfacing Serial I/O (8251)- parallel I/O (8255) -Keyboard and Display controller (8279) - ADC/DAC interfacing - Inter Integrated Circuits interfacing (I2C Standard)- Bus: RS232C-RS485-GPIB

UNIT III **3 Hours**

8086 CPU

Intel 8086 Internal Architecture - 8086 Addressing modes- Instruction set- 8086 Assembly language Programming-Interrupts.

UNIT IV **3 Hours**

8051 MICROCONTROLLER

8051 Micro-controller Hardware- I/O Pins, Ports And Circuits- External Memory -Counters And Timers-Serial Data I/O- Interrupts-Interfacing to External Memory And 8255.

UNIT V **3 Hours**

8051 PROGRAMMING AND APPLICATIONS

8051 Instruction Set - Addressing Modes - Assembly Language Programming - I/O Port Programming -Timer And Counter Programming - Serial Communication - Interrupt Programming - 8051 Interfacing: Lcd, Adc, Sensors, Stepper Motors, Keyboard And Dac.

1 **4 Hours**

EXPERIMENT 1

Programs for 8/16 bit Arithmetic operations (Using 8085).

2 **2 Hours**

EXPERIMENT 2

Programs for String manipulation operations (Using 8086).

3 **2 Hours**

EXPERIMENT 3

Programs for Digital clock and Stop watch (Using 8086).

4 **4 Hours**

EXPERIMENT 4

Performance Characteristics of single phase Induction motor

5 **4 Hours**

EXPERIMENT 5

Interfacing and Programming 8279, 8259, and 8253.

6 **2 Hours**

EXPERIMENT 6

Interfacing ADC and DAC.

7 **2 Hours**

EXPERIMENT 7

Interfacing and Programming 8279, 8259, and 8253.

8 **2 Hours**

EXPERIMENT 8

Interfacing and Programming of Stepper Motor and DC Motor Speed control.

9 **2 Hours**

EXPERIMENT 9

8 bit multiplication/division using 8085 instructions

10 **2 Hours**

EXPERIMENT 10

Programming using Arithmetic, Logical and Bit Manipulation instructions of 8051 microcontroller.

11 **2 Hours**

EXPERIMENT 11

Programming and verifying Timer, Interrupts and UART operations in 8031 microcontroller.

12 **2 Hours**

EXPERIMENT 12

Communication between 8051 Microcontroller kit and PC.
-Design oriented experiment
-Application oriented experiment

Total: 45 Hours

Reference(s)

1. Ramesh S. Gaonkar, Microprocessor Architecture, Programming and application with 8085, Penram International Publishing, New Delhi, 2000.
2. John Uffenbeck, The 80x86 Family, Design, Programming and Interfacing, Pearson Education, New Delhi, 2002.
3. Mohammed Ali Mazidi and Janice Gillispie Mazidi, The 8051 Microcontroller and Embedded Systems, Pearson Education Asia, New Delhi, 2003.
4. A. K. Ray and K. M. Burchandi, Intel Microprocessors Architecture Programming and Interfacing, McGraw Hill International Edition, New Delhi, 2000.
5. Kenneth J. Ayala, The 8051 Microcontroller Architecture Programming and Application, Penram International Publishers (India), New Delhi, 1996.
6. M. Rafi Quazzaman, Microprocessors Theory and Applications, Intel and Motorola, Prentice Hall of India, New Delhi, 2003.

15ME609 TECHNICAL SEMINAR II 0 0 2 1

Course Objectives

- To develop self-learning skills of utilizing various technical resources to make a technical presentation
- To promote the technical presentation and communication skills.
- To impart the knowledge on intonation, word and sentence stress for improving communicative competence, identifying and overcoming problem sounds.
- To promote the ability for Interacting and sharing attitude.
- To engarauge the commitment-attitude to complete tasks.

Programme Outcomes (POs)

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

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

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

Course Outcomes (COs)

1. Refer and utilize various technical resources available from multiple fields
2. Improve the technical presentation and communication skills
3. Analyze the importance of intonation, word and sentence stress for improving communicative competence, identifying and overcoming problem sounds.
4. Interact and share their technical knowledge to enhance the leadership skills
5. Prepare report and present oral demonstrations

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1		2				2									
2					1			3	3	2		2			
3										3		1			
4		2				2		1	2	2		1			
5								2	2	2		2			

Total: 30 Hours

15ME610 MINI PROJECT IV 0 0 2 1

Course Objectives

- To develop skills to formulate a technical project.
- To give guidance on the various tasks of the project and standard procedures.
- To teach use of new tools, algorithms and techniques required to carry out the projects.
- To give guidance on the various procedures for validation of the product and analyse the cost effectiveness
- To provide guidelines to prepare technical report of the project.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Formulate a real world problem, identify the requirement and develop the design solutions.
2. Identify technical ideas, strategies and methodologies.
3. Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis the cost-effectiveness.
5. Prepare report and present oral demonstrations

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1		3	2			2	1								
2	2	2	1	3		2					2	2			
3			3	2	2			2			2	2			
4		1		2	3	1	2	2							
5									3	3		2			

Total: 30 Hours

15GE611 LIFE SKILLS: APTITUDE II 0 0 2 0

Course Objectives

- The undergraduate students to such methods and practices that help, develop and nurture qualities such as character, effective communication, aptitude and holding ethical values

Course Outcomes (COs)

1. Perform arithmetical operations with complex numbers
2. Explain the meanings of a relation defined on a set, an equivalent relation and a partition of a set
3. Calculate percentages in real life contexts , find any percentage of a given whole using their knowledge of fraction multiplication and increase / decrease a given whole by a percentage
4. Demonstrate the situations like motion in as straight line,Boats and Streams, Trains, Races and clocks
5. Evaluate the Counting techniques, Permutation and Combination, Recursion and generating functions

3 Hours

UNIT 1
NUMBER SYSTEMS

Introduction - definition- classification on Numbers -power cycles and remainders - short cut process - concept of highest common factor - concept of least common multiple - divisibility - number of zeros in an expression

3 Hours

UNIT 2
PERCENTAGES

Introduction - definition and Utility of percentage - importance of base/denominator for percentage calculations - concept of percentage values through additions - fraction to percentage conversion table

3 Hours

UNIT 3
AVERAGES

Introduction - average of different groups - addition or removal of items and change in average-replacement of some of the items

3 Hours

UNIT 4
RATIO, PROPORTIONS AND VARIATION

Introduction- Ratio- properties-dividing a given number in the given ratio - comparison of ratios - proportions - useful results on proportion- continued proportion - relation among the quantities more than two – variation

3 Hours

UNIT 5
PROFIT AND LOSS
Gain/Loss and percentage gain or percentage loss-multiplying equivalents to find sale price - relation among cost price, sale price, gain/loss and percentage gain or percentage loss - an article sold at two different selling price - two different articles sold at same selling price - percentage gain or percentage loss on selling price - percentage gain or percentage loss on whole property

3 Hours

UNIT 6
TIME AND WORK
Introduction - Basic concepts -Concepts on working with different efficiency - Pipes and Cisterns - Work Equivalence (Man Days) -Alternative approach

3 Hours

UNIT 7
TIME, SPEED AND DISTANCE
Definition - Basics of Time, Speed and Distance - Relative speed - Problems based on Trains? Problems based on Boats and Streams -Problems based on Races - time taken with two difference modes of transport - time and distance between two moving bodies

3 Hours

UNIT 8
PERMUTATION AND COMBINATION
Definition - Fundamental rules - Theorems on Permutation - Theorems on Combination

3 Hours

UNIT 9
PROBABILITY
Concept and importance of probability - underlying factors for Real- Life estimation of probability - Basic facts about probability - some important consideration while defining event.

3 Hours

UNIT 10
MIXTURES AND ALLIGATION
Definition - alligation rule - mean value (cost price) of the mixture - some typical situations where allegation can be used.

Total: 30 Hours

Reference(s)

1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, Tata McGraw-Hill Publishing Company Ltd, 2012
2. Arun Sharma, How to prepare for Data Interpretation for the CAT, First Edition, Tata McGraw-Hill Publishing Company Ltd, 2012
3. Dr.R S Aggarwal, Quantitative Aptitude, Seventh Revised Edition, S.Chand Publishing Company Ltd, 2013.
4. Edgar Thorpe , Course In Mental Ability And Quantitative Aptitude For Competitive Examinations, Third Edition, Tata McGraw-Hill Publishing Company Ltd, 2013
5. Arun Sharma, How to prepare for Quantitative Aptitude for the CAT, Fifth Edition, Tata McGraw-Hill Publishing Company Ltd, 2013

15GE701 ENGINEERING ECONOMICS 3 0 0 3

Course Objectives

- To introduce the concepts of micro, macro economic systems and business decisions in organizations.
- To acquire knowledge on laws of demand & supply and methods of forecasting the demand
- To emphasis the systematic evaluation of the costs, breakeven point for return on economics and diseconomies
- To acquaint in pricing methods, payback and competition in modern market structure
- To obtain knowledge on macro economics, various taxes and financial accounting procedures

Programme Outcomes (POs)

f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Explain the micro economic environment for creating a favourable business environment.
2. Make use of the major concepts and techniques of engineering economic analysis in real time applications.
3. Compare the cost of multiple projects by using the methods learned, and make a quantitative decision between alternate facilities and/or systems.
4. Apply the appropriate engineering economics analysis method(s) for problem solving: present worth, annual cost, rate-of-return, payback, break-even, benefit-cost ratio.
5. Examine and evaluate the issues in macro-economic analysis.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1						2	2								
2											3	2			
3						2	2				2	2			
4						2	2				3	2			
5						2	2				2	2			

UNIT I **9 Hours**

INTRODUCTION

Introduction to Micro and Macro economics - Kinds of Economic Systems - Production Possibility Frontier - Opportunity Cost - Objective of Organizations - Kinds of Organization.

UNIT II **9 Hours**

DEMAND AND SUPPLY

Functions of Demand and Supply - Law of diminishing Marginal Utility - Law of Demand and Supply - Elasticity of Demand - Demand Forecasting Methods - Indifference curve.

UNIT III **9 Hours**

PRODUCTION AND COST

Production Function - Returns to Scale - Law of Variable Proportion - Cost and Revenue concepts and Cost Curves - Revenue curves - Economies and Dis-economies of scale - Break Even point.

UNIT IV **9 Hours**

MARKET STRUCTURE

Market Structure - Perfect Competition - Monopoly - Monopolistic - Oligopoly - Components of Pricing - Methods of Pricing - Capital Budgeting IRR - ARR - NPV - Return on Investment - Payback Period.

UNIT V **9 Hours**

INTRODUCTION TO MACRO ECONOMICS AND FINANCIAL ACCOUNTING

National Income - Calculation Methods - Problems - Inflation - Deflation - Business Cycle - Taxes - Direct and Indirect Taxes - Fiscal and monetary policies.

FOR FURTHER READING

Nature and characteristics of Indian Economy - Role and functions of Central bank - LPG - GATT - WTO.

Total: 45 Hours

Reference(s)

1. A Ramachandra Aryasri and V V Ramana Murthy, Engineering Economics and Financial Accounting, Tata McGraw Hill Publishing Company Limited, New Delhi, 2006.
2. V L Samuel Paul and G S Gupta,Managerial Economics Concepts and Cases, Tata McGraw Hill Publishing Company Limited, New Delhi, 1981.
3. R Kesavan, C Elanchezhian and T Sunder Selwyn, Engineering Economics and Financial Accounting, Laxmi Publication (P) Ltd, New Delhi, 2005.
4. S N Maheswari, Financial and Management Accounting, Sultan Chand
5. V L Samuel Paul and G S Gupta, Managerial Economics-Concepts and Cases

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2					2					8			6											18
2		2					2			8					6				4						22
3			2			2				8								4							16
4	2						2		8						6				4						22
5		2				2				8				6				4							22
																								Total	100

Assessment Questions

Remember

1. Define Economics
2. What is opportunity cost?

3. List the types of Demand.
4. State the law of Demand.
5. Define Elasticity of Demand.
6. State the different degrees of elasticity of Demand?
7. List the factors determining Elasticity of Demand?
8. State the Law Of Diminishing Marginal Utility.
9. Define Replacement Cost and Historic Cost
10. Define Monopoly.
11. Define Oligopoly
12. Name the two types of Oligopoly.
13. List the objectives of Pricing?
14. Define Accounting
15. Define inflation

Understand

1. Explain the nature and scope of Economics.
2. List and explain the focus areas of Managerial economics.
3. Give reasons why mangers aim to maximize sales even at the cost of a lower profit.
4. Explain the nature of Demand.
5. What are the assumptions made when talking about the Law of Diminishing Marginal Utility?
6. Explain the characteristics of the Indifference Curve with examples
7. Can Demand Forecasting principles be applied to Services? Substantiate your answer with an example
8. What are the characteristic features of an oligopoly industry?
9. What causes Oligopoly?
10. Explain the types and features of Cost Based Pricing.
11. Explain the types and features of Demand Based Pricing.
12. Under what conditions does a company go in for Cross Subsidization pricing?
13. What is the role of the Central bank in controlling inflation?

Apply

1. Explain decisions based on the degree of certainty of the outcome with examples.
2. Give examples of products falling under the various kinds of competition, and the reasons they are able to survive in the market.
3. Give six examples of products that fall under Monopolistic Competitive pricing.
4. Give six examples of products that fall under Oligopolistic pricing
5. Pick any six Consumer Items and based on your knowledge of the markets, explain the pricing method that you think is most likely to have been followed for each of these items.

Analyse

1. Differentiate between Macro and Micro economics
2. Differentiate between Extension and Increase in Demand.
3. Distinguish between Cost and Price
4. Compare the merits and demerits of the Deductive Method and the Inductive Method of Investigation
5. The per-capita income of farmers in the country has to be raised by 20% this year to prevent their migration to cities. Discuss this statement from the point of view of Positive and Normative Economics.
6. Decision making improves with age and experience- Discuss.

7. Do a survey of the automotive (only cars) industry and analyze the reasons and timing for discounts offered from the point of view of elasticity of demand
8. How would you modify a sealed bid pricing system to take care of different technical approaches by different bidders for a project for which bids are called for, given that the cost varies depending on the technical approach?

Create

1. Create a matrix consolidating the definitions of the word ï¿½??Economics as defined by the leading Economists in the prescribed textbook. Using this define economics the way you understand it, in less than 50 words.
2. Study the price of a commodity over a period of one year and explain the possible reasons for the fluctuations from an economist‘s point of view
3. You are in a job which is paying you adequately. You are called for an interview for a job that double your salary. Unfortunately you miss the only train that will take you in time for the interview. How will you justify the cost of taking a flight considering the cost concepts you have learnt.?
4. Due to cancellation of an export order, you are stuck with a huge stock of jeans of international quality. Device a pricing strategy for disposing this stock without incurring a loss, considering that it is a very competitive market.

15ME702 MECHATRONICS 3 0 0 3

Course Objectives

- To introduce the concept and working of sensors used in mechatronic system.
- To study different types of actuators used in mechatronic system.
- To provide knowledge on feedback mechanism for improving the reliability of mechatronic system.
- To impart knowledge on working of microcontroller in mechatronic systems
- To learn the Programmable Logic Controller (PLC) used in mechatronic systems.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Select the different types of sensor for various mechatronics applications.
2. Identify suitable actuator used in mechatronic system.
3. Design a feedback controller for mechatronics system.
4. Develop a controller using the microcontroller for mechatronic system.
5. Write a program for PLC used in mechatronic systems

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3														
2	3	1													
3	2	2	1									2	2		
4	2		2									2	2		
5	3		2									2	2		

UNIT I **8 Hours**

SENSORS

Components of mechatronics system, Sensor - terminology and Mathematical equation - Potentiometer, Linear Variable differential transformer, strain gauge, Piezoelectric sensor, Optical encoder, Hall effect sensor, Thermistor, Thermo-couple, Light sensor.

UNIT II **10 Hours**

ACTUATOR

Terminology, mathematical equation of Mechanical Actuation system - cam, gear, belt & chain, Ball screw, Mechanical aspects of motor selection. Pneumatic & hydraulic Actuation system. Electrical actuation system -relay & solenoid, working & control of Brush & brushless DC motor, working & control of Stepper & servo motor.

UNIT III **11 Hours**

FEEDBACK CONTROL

Transfer Function, Mathematical Modeling of Mechanical & Electrical system, Electrical analogy, Electro-mechanical system, First order system, second order system, Proportional control, derivative control, Integral control, PID control, Controller tuning, Concept of stability.

UNIT IV **9 Hours**

MICROCONTROLLER

Architecture of 8051- I/O Pins, Ports and Circuits, memory, counter, Timer, Interrupt, Instruction set-Moving data, Logical ,arithmetic operation, Jump & call instruction, LCD & Keyboard Interfacing. Examples -Windscreen wiper motion, Car engine management

UNIT V **7 Hours**

PROGRAMMABLE LOGIC CONTROLLER

Basic Structure - Input / Output Processing - Programming - Mnemonics - Timers, Internal relays and counters - Shift Registers - Master and Jump Controls - Data Handling - Analogue Input / Output - Selection of PLC. Examples -Pick and place robot. Car park barrier system.

FOR FURTHER READING

Hardware in the loop Simulation, Rapid prototyping, Stepper motor interfacing with micro-controller. Optical isolation of PLC circuit.

Total: 45 Hours

Reference(s)

1. W. Bolton, Mechatronics, Pearson Education, New Delhi, 2012.
2. Godfrey Onwubolu, Mechatronics: Principles and Applications Butterworth-Heinemann Ltd, 2005.
3. Nitaigour Premchand Mahalik, Mechatronics : Principles, Concepts and Applications, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2008
4. Krishna Kant, Microprocessors & Microcontrollers, Prentice Hall of India, 2007.
5. K. P. Ramachandran, G. K. Vijayaraghavan, and M. S. Bala-Sundram, Mechatronics: Integrated Mechanical Electronic Systems, Wiley India Pvt. Ltd., New Delhi 2008.
6. http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT-roorkee/industrialengineering/index.htm

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	8																					12			20
2		4				12			4																20
3							12			2					6										20
4		6								12					2							6			26
5		12				2																			14
																								Total	100

Assessment Questions

Remember

1. What are the basic elements of a measurement system?
2. Define sensor.
3. Define the terms accuracy & precision.
4. What is hysteresis?
5. State the dynamic characteristics of simplified measuring system.
6. Define mechatronics.
7. What is meant by cylinder sequencing?
8. List the factors to be considered when selecting the belt drives.
9. State the objectives of DCVs.
10. What are the factors to be considered for selecting solenoids?
11. List down the different types of timers.
12. State two methods of Input / Output processing.

Understand

1. How the mechatronics used in industries?
2. Distinguish between accuracy and sensitivity of a transducer.
3. Compare the touch & proximity sensor.
4. Discuss how velocity is measured by using electromagnetic transducers.
5. Differentiate inductive sensors and capacitive sensors.
6. Why sequential valves are necessary in pneumatic system?
7. Distinguish between pressure relief valve and pressure reducing valve.
8. How do you compare the operation of brushless DC motor with the operation of a stepper motor?
9. Why differential controllers are combined with other modes of controllers for practical application?
10. How does a simple weighing scale work using traditional mechanical system?

Apply

1. Identify and explain the various elements that might be present in a control system involving a thermostatically controlled electric heater.
2. Compare and contrast the control system for the domestic central heating system involving a bimetallic thermostat and that involving a microprocessor.
3. Suggest a sensor that could be used, as part of a control system, to determine the difference in levels between liquids in two containers. The output is to provide an electrical signal for the control system.
4. Derive differential equations for a permanent magnet D.C. motor.
5. Derive an expression for a Hydraulic – mechanical systems.
   Automatic Camera
   Automatic Car park system

15ME703 OPERATIONS RESEARCH 2 2 0 3

Course Objectives

- To impart knowledge on the basics of linear programming techniques.
- To understand the transportation and assignment models.
- To provide knowledge on network models and project management.
- To learn the concept of queuing model and problems associated in it.
- To familiarize the sequencing and replacement models.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
n. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Formulate and select the suitable method to solve the linear programming problem.
2. Solve the different transportation and assignment based models.
3. Draw the network models and solve it.
4. Select the suitable queuing model and solve the given applications.
5. Find the total elapsed time and optimum replacement policy.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	1		3									2	
2	2	2	1		3									2	
3	2	2	1		3									2	
4	2	3	2		2									2	
5	2	2	2		2									2	

UNIT I **8 Hours**

LINEAR PROGRAMMING

Operations Research - Introduction, Scope, Objectives, Phases and its limitations. Linear Programming Problem(LPP) Formulation, Graphical method, Simplex method. Artificial variable techniques - Big-M method and two-phase method.

UNIT II **5 Hours**

TRANSPORTATION AND ASSIGNMENT MODEL

Transportation - Introduction, Initial basic feasible solutions - Northwest corner rule, Least cost method and Vogel's approximation method. Optimality test using MODI method. Assignment - Introduction and Hungarian method for optimal solution. Travelling salesman problem.

UNIT III **7 Hours**

NETWORK MODELS AND PROJECT MANAGEMENT

Network models - Introduction, Rules for construction and errors. Shortest route - Dijkstra's algorithm, Minimal spanning tree - Kruskal's algorithm, Maximum flow models. Project management - CPM and PERT networks.

UNIT IV **5 Hours**

QUEUING MODELS

Queueing model - Introduction , elements, Kendall's Notation, parameters, Single Server and multi-server models, Poisson input, Exponential service, Constant rate service, Finite and Infinite population.

UNIT V **5 Hours**

SEQUENCING AND REPLACEMENT MODEL

Sequencing Problem - Introduction, Types - n jobs with 2 machines and n jobs with 3 machines. Replacement Models - Introduction, Types, Replacement of items that deteriorate with time, Value of money changing with time and not changing with time, Optimum replacement policy - Individual and Group replacement policy.

FOR FURTHER READING

Application of queuing models in banking sector, Formulate LPP for transporting goods from factory to customers. Software packages such as LINDO, LINGO and TORA

Total: 60 Hours

Reference(s)

1. Frederick S. Hiller, Gerald J. Liberman, Operations Research Concepts and Cases, 8th edition, Tata McGraw-Hill Publishing Company Private Limited, 2010
2. Prem Kumar Gupta, D. S. Hira, Introduction to Operations Research, S.Chand and Co, 2004
3. R. Panneerselvam, Operations Research, second edition, Prentice Hall of India, 2010
4. Hamdy A. Taha, Operation Research - An Introduction, Pearson Publications, 2010
5. K. Levy Ferdinand, D. Wiest Jerome, A Management Guide To PERT/CPM, With GERT /PDM/DCPM and Other Networks, 7th Edition, PHI Learning Private Limited, 2009
6. Wagner,Operations Research,Prentice Hall of India,2000

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	4					4					12														20
2	4					4									12										20
3	4					4					12														20
4	4					4					12														20
5	4					4									12										20
																								Total	100

Assessment Questions

Remember

1. Define feasible solution.
2. What do you mean by unbounded solution?
3. What do you mean by transportation problem?
4. Define a project.
5. Define a dummy activity
6. What are the three common errors in the constructing of network?
7. What is meant by critical path?
8. List some basic characteristics of queuing system.
9. Define sequencing.
10. Define the term operations research.
11. What are the main characteristics of OR?
12. When do you use dummy activity in the network?

Understand

1. In what aspect the slack variable differs from surplus variable?
2. How do you check the degeneracy in transportation?
3. How do you solve the unbalanced assignment problem?
4. Compare the transportation with assignment.
5. Distinguish between PERT and CPM.
6. How do you solve the three machine problem?
7. Why the replacement is necessary?
8. Distinguish between deterministic and probabilistic model.
9. Compare group replacement and individual replacement

Apply

1. Which type of network model is applied in construction industry?
2. Which type of queuing model is applied in petrol bunk?
3. The cost of a new machine is Rs.3000/-, the maximum cost during 10th year is given by Rs.200 (n-1). n=1, 2…. n-12. The interest rate per year is 0.04, after how many years it will be economical to replace it by a new one.
4. We have five jobs each of which must go through the machines A, B and in the order ABC. Determine the sequence that will minimize the total elapsed time.

Job	1	2	3	4	5
M/C A	5	7	6	9	5
M/C B	2	1	4	5	3
M/C C	3	7	5	6	7

Analyse

1. Select the appropriate optimization techniques for solving the transportation problem and justify it.
2. An automobile manufacturer makes automobiles and trucks in a factory that is divided into two shops. Shop A, which perform the basic assembly operation must work 5 man days on each truck but only 2 man days on each automobile. Shop B, which perform finishing operation must work 3 man days for each truck (or) automobile that it produces. Because of men and machine limitation shop A has 180 man days per week available while shop B has 135 man days per week. If the manufacturer makes a profit of Rs. 300 on each truck and Rs. 200 on each automobile, how many of each should he produce to maximize his profit?
3. A library wants to improve its service facilities in terms of the waiting time of its borrowers. The library has 2 counters at present and borrowers arrive according to Poisson's distribution with an arrival rate 1 in every 6 minutes and service time follows exponential distribution with a mean of 10 minutes. The library has relaxed its membership rules and substantial increase in the number of borrowers is expected. Find the number of additional counters to be

provided if the arrival rate is expected to be twice the present value and the average waiting time of the borrowers must be limited to half the present value.

4. Ships arrive at a port at the rate of 1 in every 4 hours with exponential distribution of inter arrival times. The time a ship occupies a berth for unloading has exponential distribution with an average of 10 hours. If the average delay of ships waiting for berths is to be kept below 14 hours, how many berths should be provided at the port?
5. Book binder has one printing press, one binding machine and the manuscripts of a number of different books. The time (hrs) requires to perform the printing and blocking operations for each book are shown below. We wish to determine the order in which books should be processed, in order to minimize the total time required to turn out all books.

Books	1	2	3	4	5	6
Printing	30	120	50	20	90	110
Binding	80	100	90	60	30	10

15ME704 AUTOMATED MANUFACTURING 3 0 0 3

Course Objectives

- To impart the knowledge on construction and working of Computer Numerical Control (CNC) Machines, maintenance and retrofitting of CNC machines.
- To provide knowledge on interfacing, communication and control of CNC drives.
- To introduce programming of CNC turning center
- To provide exhaustive skill on programming of CNC machining center
- To educate the concept, applications and emerging trends in Additive Manufacturing (AM) technologies

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
n. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Explain the construction,working and maintenance of CNC machine tools.
2. Assess the interfacing drives, feedback devices used in CNC machine tools using programmable logic control (PLC) and other peripherals
3. Select the suitable tools, work holding devices and write the programs for CNC turning center.
4. Formulate the programs to manufacture prismatic components using CNC machining centers for popular controller.
5. Explain the various technologies of AM and select the appropriate method to manufacture the prototype.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2											1		2	
2	2											1		2	
3	2				2							1		2	
4	2				2							1		2	
5	2				2							1		2	

UNIT I **11 Hours**

CONSTRUCTION OF CNC AND MOTION CONTROL

Evolution of CNC Technology - CNC machine -Concept, classification, features and applications - Constructional features and applications - Linear motion and Recirculating ball bearings - CNC controller and Interpolator -Maintenance and retrofitting .

UNIT II **10 Hours**

DRIVES AND CONTROL

Spindle and feed drives - Sensors -Position, Encoders, Proximity, Limit switch -Interfacing system -Microcontroller and PLC based -Introduction to Graphical User interface -Communication protocol -RS232, RS 485, USB, Ethernet -PLC -Ladder diagram -Peripherals -Timer, Counter, Encoder interface, Human Machine Interface

UNIT III **8 Hours**

PROGRAMMING OF CNC LATHE

Coordinate system - structure of a part program -G & M Codes -Programming for FANUC and SIEMENS controller -Single pass and canned cycle -Turning, facing and threading -Multi-pass canned cycle -Rough and Finish turning, facing, pattern repeating, grooving, threading, drilling, boring, peck drilling, high speed drilling cycle -Subprogram and Macro programming -Tool length and nose radius compensation - offset -Tool, work and coordinate -Insert -Materials, Classification, Nomenclature and Selection -Tool and Work holding devices -Automatic tool changer -Turret and drum type -Tool holder nomenclature and selection -CNC part programming using CAD/CAM software and interfacing with CNC machines

UNIT IV **8 Hours**

PROGRAMMING OF CNC MACHINING CENTRE

Coordinate system - G & M Codes for machining centre - Programming for FANUC and SIEMENS controller -Machining cycles - Linear and circular interpolation, Contouring, rectangular and circular pocketing, drilling, peck drilling, high speed drilling, Back boring, counter boring and tapping cycle -Cutter diameter compensation -Nomenclature of multi-point cutting tool and tool holder -Tool and work holding devices -Automatic Pallet changer

UNIT V **8 Hours**

ADDITIVE MANUFACTURING

Introduction to additive manufacturing - Applications of AM in Automotive, Aerospace, Business, Consumer Electronics, Die & Mould, Jewellery and Medical industries -Generic process chain -Classification -Components, Working principle, Materials processed and Applications -Stereolithography (SLA), Fusion Deposition Modelling (FDM), 3D Printing (3DP), Selective Laser Sintering (SLS), Electron Beam Additive Manufacturing (EBAM)

FOR FURTHER READING

Five Axis CNC machines - User defined cycles - Rapid Manufacturing.

Total: 45 Hours

Reference(s)

1. HMT, Mechatronics, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2005.
2. P. M. Agrawal and V. J. Patel, CNC Fundamentals and Programming, Charotar Publishing House Pvt. Ltd., 2014.
3. P. Radhakrishnan, Computer Numerical Control Machines, New Central Book Agency, 2004.
4. G. E. Thyer, Computer Control of Machine Tools, Butterworth-Heinemann Ltd, 1991.
5. Mikell P. Groover, Automation, Production System and Computer Integrated Manufacturing, Prentice Hall of India, New Delhi, 2008
6. Chua Chee Kai, Leong Kah Fai and Lim Chu Sing, Rapid Prototyping: Principles and Applications, World Scientific Publishing Company, Singapore, 2010.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	
1	4				4	8			4																20
2	2	2			2	2				12															20
3	2	2				8				8															20
4		2				8			2	4	4														20
5		4				12				4															20
																								Total	100

Assessment Questions

Remember

1. Define CNC.
2. Depict the recirculating ball screw.
3. List the application of G and M codes.
4. State the principle of rotary encoders.
5. State the limitations of absolute encoders.
6. Define canned cycle.
7. List the machining cycle available for CNC machining centre.
8. Define photopolymerisation.
9. List the different R P formats.

Understand

1. Estimate the various items needed before starting programming in a CNC machine.
2. Predict why linear tooling is preferred in some CNC Chuckers.
3. Differentiate between point-to-point control and continuous path control.
4. Illustrate how the pre-load of a ball screw is done.
5. Indicate importance of interfacing feed and spindle drives.
6. Identify the functions and role of automatic tool changers.
7. Compare CNC lathe with machining centre.
8. Summarize the process of generating stl file.
9. Compare FDM with SLA.
10. Select the process to develop prototypes for casting industry and justify the selection.

Apply

1. Show the functions and applications of computer numerical control in machine tools.
2. Choose the suitable slide way for the CNC tool/work piece movement.
3. Find the process parameter which affect the surface finish, dimensional accuracy of parts in FDM process.
4. Construct the layout of CNC applied to wood carving machines.
5. Assess the need of tool compensation in CNC lathe and Machining centre.
6. Consider the manufacture of metal implants using AM technology. Aside from the AM process, what other processing is likely to be needed in order to make a final part that can be implanted inside the body?

15ME707 COMPUTER AIDED MANUFACTURING LABORATORY

0 0 2 1

Course Objectives

- To provide knowledge on modelling and creating tool path of machine components using computer aided manufacturing softwares.
- To impart part programming knowledge on CNC lathe.
- To expose part programming knowledge on CNC milling machine.
- To study the working of wire cut EDM for cutting various shapes.
- To impart knowledge on developing the prototype by additive manufacturing process.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
n. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Formulate the tool path for circular and prismatic parts using machining programs.
2. Creat the part program for the machining component using CNC lathe.
3. Creat the part program for the machining component using CNC milling.
4. Demonstrate the the wire cut EDM for producing intricate shapes.
5. Demonstrate the component using additive manufacturing process.

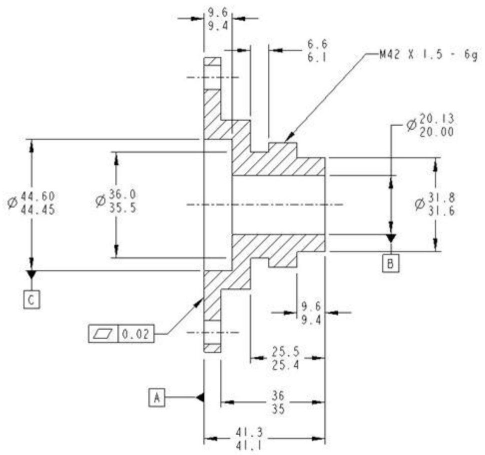
Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2				2				1	1		1		2	
2	2				2				1	1		1		2	
3	2				2				1	1		1		2	
4	2				2				1	1		1		2	
5	2				2				1	1		1		2	

1 **4 Hours**

EXPERIMENT 1

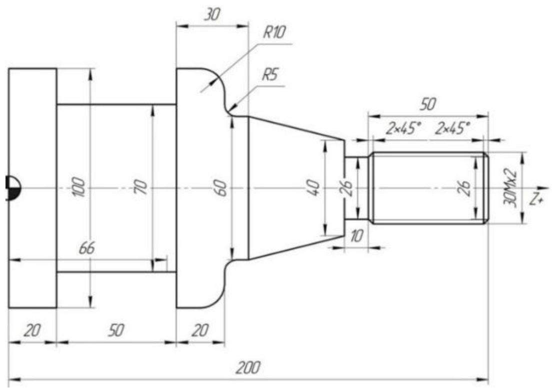
To make a protected type fanged coupling to transmit the power from dia20mm shaft.



2 **4 Hours**

EXPERIMENT 2

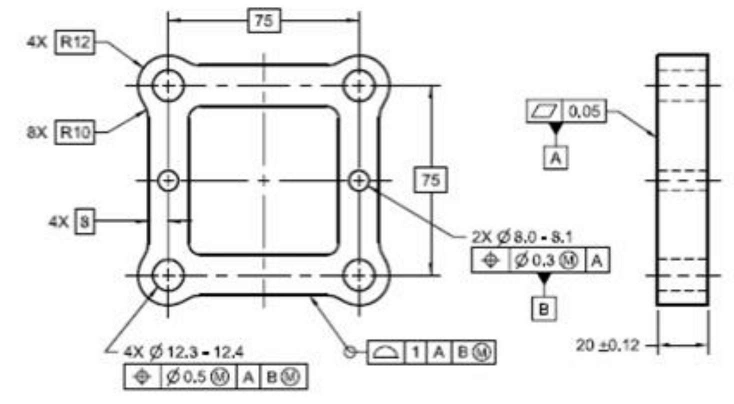
To manufacture a following component as shown below.



3 **4 Hours**

EXPERIMENT 3

To fabricate a stand as shown in figure.



4

4 Hours

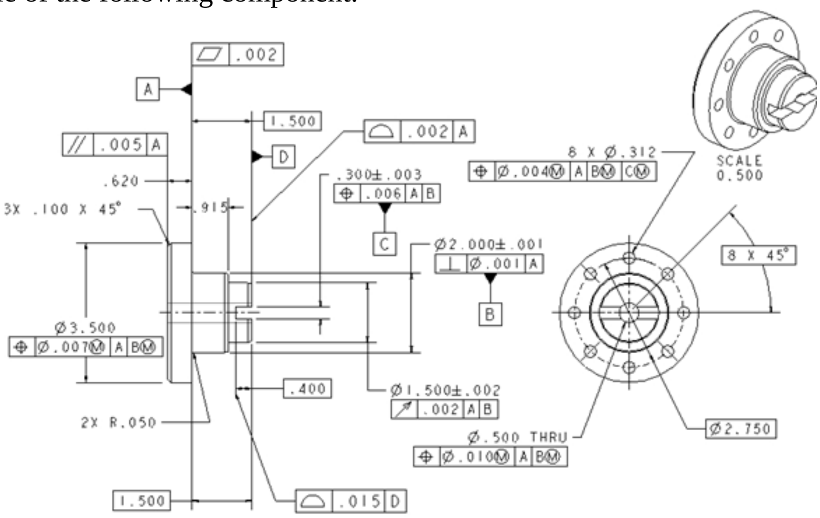
EXPERIMENT 4

To machine a logo of Bannari amman Institute of Technology.

5 **4 Hours**

EXPERIMENT 5

To make a profile of the following component.



6 **4 Hours**

EXPERIMENT 6

To make an injection molding die for simple part using CNC milling and EDM/wire cut EDM machine

7 **4 Hours**

EXPERIMENT 7

Exercise on reverse engineering of pump impeller using 3D scanner and printer

8 **2 Hours**

EXPERIMENT 8

Redesign and make an extruder assembly of a 3D printer to hold three filaments using design for additive manufacturing principles.

Total: 30 Hours

15ME708 MECHATRONICS LABORATORY 0 0 2 1

Course Objectives

- To impart knowledge on modeling and simulation of mechatronics system.
- To provide knowledge on design of fluid power circuit in mechatronic system.
- To understand the working of microcontroller and PLC in mechatronic systems through experiments.
- To expose knowledge on force, acceleration and displacement measurements.
- To gain the knowledge for controlling the position, velocity and force in mechatronics system.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Develop mathematical model of mechatronics system.
2. Simulate fluid power circuit using Simulation software.
3. Develop mechatronics system using microcontroller & PLC.
4. Measure the force, acceleration and displacement of a system using microcontroller program.
5. Control the position, velocity and force of mechatronics system.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	1			2							2	2		
2	1	2			2							2	2		
3	1		3		2							3	3		
4	1		2		2							2			
5	1	2	3		1							2	2		

1 **4 Hours**

EXPERIMENT 1

Modeling and simulation of mechatronics system using MATLAB.

2 **4 Hours**

EXPERIMENT 2

Modeling and design of PID controller for Mechatronics system.

3 **2 Hours**

EXPERIMENT 3

Study and simulation of various hydraulic and pneumatic components using FLUIDSIM software.

4 **2 Hours**

EXPERIMENT 4

Design and testing of fluid power circuits for automatic opening and closing for doors and to control its velocity and direction.

5 **4 Hours**

EXPERIMENT 5

Position and speed control of DC Motor using Microcontroller Board.

6 **4 Hours**

EXPERIMENT 6

Speed control of Stepper Motor using Microcontroller Interface Board.

7 **4 Hours**

EXPERIMENT 7

Measurement of force, acceleration and displacement using Virtual instrumentation.

8 **2 Hours**

EXPERIMENT 8

Design of Programmable logic Controller based timer controller for multiple pneumatic cylinder Sequencing in assembly operations.

9 **2 Hours**

EXPERIMENT 9

Position and velocity control of pick and place robot arm for loading and unloading Application using Robot Programming language.

10 **2 Hours**

EXPERIMENT 10

Measurement and control of temperature of an application using Virtual instrumentation.

Total: 30 Hours

Reference(s)

1. W. Bolton, Mechatronics, Pearson Education, New Delhi, 2012.
2. Godfrey Onwubolu, Mechatronics: Principles and Applications Butterworth-Heinemann Ltd, 2005.
3. Nitaigour Premchand Mahalik, Mechatronics : Principles, Concepts and Applications, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2008
4. Krishna Kant, Microprocessors & Microcontrollers, Prentice Hall of India, 2007.

5. K. P. Ramachandran, G. K. Vijayaraghavan, and M. S. Bala-Sundram, Mechatronics: Integrated Mechanical Electronic Systems, Wiley India Pvt. Ltd., New Delhi 2008.

15ME709 MINI PROJECT V 0 0 2 1

Course Objectives

- To develop skills to formulate a technical project.
- To give guidance on the various tasks of the project and standard procedures.
- To teach use of new tools, algorithms and techniques required to carry out the projects.
- To give guidance on the various procedures for validation of the product and analyse the cost effectiveness.
- To provide guidelines to prepare technical report of the project.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

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

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

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

k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

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

Course Outcomes (COs)

1. Formulate a real world problem, identify the requirement and develop the design solutions.
2. Identify technical ideas, strategies and methodologies.
3. Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis the cost effectiveness.
5. Prepare technical report and oral presentations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1		3	2			2	1								
2	2	2	1	3		2					2	2			
3			3	2	2			2			2	2			
4		1		2	3	1	2	2							
5									3	3		2			

Total: 30 Hours

15GE710 LIFE SKILLS : COMPETITIVE EXAMS 0 0 2 0

Course Objectives

- Understand the concepts of applied mechanics, Theory of Machines and Design.
- Understand the concepts of Fluid Mechanics and Thermal Engineering.
- Understand the concepts of Materials, Manufacturing and Industrial Engineering.

Course Outcomes (COs)

1. Solve the problems related to applied mechanics, Theory of Machines and Design concepts
2. Solve the problems related to Fluid Mechanics and Thermal Engineering
3. Explain the the concepts of Materials, Manufacturing and Industrial Engineering.

10 Hours

UNIT 1

Engineering Mechanics-Statics and Dynamics, Mechanics of Materials- deflection of beams, testing of materials, Theory of Machines- Kinematics and Dynamics, Vibrations, Machine Design- design of machine elements, shafts, gears, rolling and sliding contact bearings, brakes and clutches, springs.

10 Hours

UNIT 2

Fluid Mechanics, Thermodynamics, Heat-Transfer-conduction, convection and radiation, Power Engineering: Air and gas compressors, I.C. Engines, refrigeration, air-conditioning, Turbomachinery.

10 Hours

UNIT 3

Engineering Materials, Casting, Forming and Joining Processes, Machining and Machine Tool Operations, Metrology and Inspection, Computer Integrated Manufacturing, Production Planning and Control, Inventory Control, Operations Research.

Total: 30 Hours

Reference(s)

1. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India Learning Pvt. Ltd, New Delhi, 2010
2. Y. Cengel and Boles, Thermodynamics - An Engineering Approach, Tata McGraw Hill Publishing Company Pvt. Ltd, New Delhi,2003.
3. R.K. Bansal, A Textbook of Fluid Mechanics and Machinery, Laxmi Publications Ltd., New Delhi, Revised Ninth edition, 2014.
4. V. B. Bhandari, Design of Machine Elements, Tata McGraw-Hill Publishing Company Pvt. Ltd., New Delhi, 2010.
5. Beer, Johnston, Mazurek, Cornwells and Sanghi, Vector Mechanics for Engineers: Statics, Dynamics, 10th Edition, Tata McGraw Hill - Noida, Uttar Pradesh, 2013
6. Behrouz A.Forouzan, Data Communication and Networking, 5th Edition, Tata McGraw-Hill, 2014.

15ME804 PROJECT WORK 0 0 0 9

Course Objectives

- To develop skills to formulate a technical project.
- To give guidance on the various tasks of the project and standard procedures.
- To teach use of new tools, algorithms and techniques required to carry out the projects.
- To give guidance on the various procedures for validation of the product and analyse the cost effectiveness.
- To provide guidelines to prepare technical report of the project.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Formulate a real world problem, identify the requirement and develop the design solutions.
2. Identify technical ideas, strategies and methodologies.
3. Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis the cost effectiveness.
5. Prepare technical report and oral presentations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1		3	2			2	1								
2	2	2	1	3		2					2	2			
3			3	2	2			2			2	2			
4		1		2	3	1	2	2							
5									3	3		2			

15LE101 BASIC ENGLISH I 3 0 0 3

Course Objectives

- To teach students basic English vocabulary and tenses
- To offer practice on various conversation patterns
- To improve spelling and pronunciation by offering rigorous practice and exercises

Programme Outcomes (POs)

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

Course Outcomes (COs)

1. Students will be able to: Form sentences using basic grammar and vocabulary in English
2. Involve in basic day-to-day conversation
3. Express opinions, agree & disagree on topics of general interest
4. Listen and understand Indian English audio clippings
5. Understand reading comprehension passages and answer related questions

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1										1					
2										3					
3										3					
4										2					
5										2					

Unit I **7.5 Hours**

Module	Vocabulary/ Grammar	Skills Sets	Skill Sets
1	Basic words- 12 most used words in English, usage and pronunciation	Starting a conversation and talking about what one does	Sentence construction bolstered by mother tongue
2	Basic words- 20 often used words, usage and pronunciation	Analysing an action plan	Creating and presenting one’s own action plan
3	Basic words with a focus on spelling	Discriminative listening	Informal conversation
4	Basic words- 10 oft used words, usage and pronunciation	Content listening and Intonation	Reading comprehension
5	Unit Test I		

Unit II **7.5 Hours**

Module	Vocabulary/ Grammar	Skills Sets	Skill Sets
6	Basic words + greetings to be used at different times of the day	Formal conversation	Intonation to be used in formal address
7	Last 28 of the 100 most used words	Informal conversation between equals	Reading practice and peer learning
8	Using the 14 target words to form bigger words	Informal dialogues using contracted forms	Guided speaking- talking to peers using contracted forms
9	Palindromes, greetings- good luck, festivals	Placing a word within its context- culling out meaning	Offering congratulations
10	Unit Test II		

Unit III **7.5 Hours**

Module	Vocabulary/ Grammar	Skills Sets	Skill Sets
11	Homophones	Formal and informal methods of self-introduction	Let's Talk is a group activity that gives them some important pointers of speech
12	Homophone partners, matching words with their meanings	Contracted forms of the – be verbs, 've and 's	Translating English sentences to Tamil
13	Briefcase words- finding smaller words from a big word	Formal and informal ways of introducing others	Team work- speaking activity involving group work, soft skills
14	Compound words and pronunciation pointers	Giving personal details about oneself	Using the lexicon
15	Unit Test III		

Unit IV **7.5 Hours**

Module	Vocabulary/ Grammar	Skills Sets	Skill Sets
16	Proper and common nouns	Asking for personal information and details	Pronunciation pointers- an informal introduction to the IPA
17	Pronouns	Telephone skills and etiquette	Reading aloud and comprehension
18	Abstract and common nouns	Dealing with a wrong number	Reading practice and comprehension
19	Group names of animals, adjectives	Taking and leaving messages on the telephone	Pronunciation pointers
20	Unit Test IV		

Unit V **7.5 Hours**

Module	Vocabulary/ Grammar	Skills Sets	Skill Sets
21	Determiners	Interrupting a conversation politely- formal and informal	Pair work reading comprehension
22	Conjugation of the verb ‘to be’- positive and negative forms	Thanking and responding to thanks	Comprehension questions that test scanning, skimming and deep reading
23	Am/is/are questions	Giving instructions and seeking clarifications	Small group activity that develops dialogue writing
24	Present continuous tense-form and usage	Making inquiries on the telephone	Finishing sentences with appropriate verbs
25	Unit Test V		

Unit VI **7.5 Hours**

Module	Vocabulary/ Grammar	Skills Sets	Skill Sets
26	Words with silent ‘b’ Present continuous questions	Calling for help in an emergency	Dialogue writing
27	Words with silent ‘c’ Simple present tense- form and usage	Making requests and responding to them politely	Identifying elements of grammar in text extract
28	Simple present tense- rules	Describing people	Guided writing
29	Words with silent ‘g’ Questions in the simple present tense	Describing places	Filling in the blanks with correct markers of tense
30	Unit Test VI		

Total: 45 Hours

Reference(s)

1. 1. Basic English Module, L&L Education Resources, Chennai, 2011.

15LE102 COMMUNICATIVE ENGLISH I 3 0 0 3

Course Objectives

- To communicate effectively in social scenario
- To enhance the ability of reading, summarising and paraphrasing information
- To develop the techniques of writing through appropriate use of grammar and vocabulary

Programme Outcomes (POs)

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

Course Outcomes (COs)

1. Listen and comprehend different spoken discourses
2. Communicate ideas in English fluently during personal / official conversations
3. Use grammar and vocabulary required at CEFR B1 level in spoken and written discourses
4. Read and understand general & technical text
5. Involve in formal written communication using appropriate mechanics of writing

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1										2					
2										3					
3										1					
4										2					
5										3					

UNIT I **9 Hours**

GRAMMAR

Content words- Structural words - Subject - Verbs and verb phrase - Subject - Verb agreement - Tenses - Active voice and passive voice - Sentence types (declarative, imperative, exclamatory & interrogative) - Framing questions - Comparative adjective

UNIT II **9 Hours**

LISTENING

Listening for specific information: Short conversations / monologues - Gap filling - Telephone conversations - Note-taking - Listening for gist / interviews - Listening to songs and completing the lyrics - Clear individual sounds - Word stress - Telephone etiquette

UNIT III **9 Hours**

READING

Prediction - Skimming for gist - Scanning for specific information - Understanding text and sentence structure

9 Hours

UNIT IV

WRITING

Short documents: E-mail - memo - note - message- notice -advertisement -Short reports / proposals -Principles of writing a good paragraph: Unity, cohesion and coherence -Identifying the topic sentence and controlling ideas - Paragraph writing (descriptive, narrative, expository & persuasive).

UNIT V **9 Hours**

SPEAKING

Self-introduction -Giving personal and factual information - Talking about present circumstances, past experiences and future plans - Mini-presentation - Expressing opinions and justifying opinions - Agreement / disagreement - Likes and dislikes - Speculation - Tongue twisters.

FOR FURTHER READING

Novel Reading -Book Review

Total: 45 Hours

Reference(s)

1. Murphy, Raymond. English Grammar in Use - A Self-Study Reference and Practice Book For Intermediate Learners Of English .IVed. United Kingdom: Cambridge University Press. 2012.
2. 2.Seely, John. Oxford Guide to Effective Writing and Speaking. Indian edition. New Delhi: Oxford University Press. 2005.
3. 3. Anderson, Kenneth. Study Speaking: A Course in Spoken English for Academic Purposes. United Kingdom: Cambridge University Press. 2004.

15LE201 BASIC ENGLISH II 3 0 0 3

Course Objectives

- To focus on natural acquisition of rudimentary structures in English language through ample listening, reading and writing inputs
- To concentrate on speaking and conversation skills with a view to increase fluency in speaking
- To enhance the ability of correct pronunciation and spelling

Programme Outcomes (POs)

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

Course Outcomes (COs)

1. The students will be able to: Express themselves clearly in English to individuals / groups without hesitation
2. Comprehend simple day-to-day formal/ informal conversations
3. Use various forms of tenses in speaking and writing
4. Read and understand paragraphs on simple topics
5. Write coherent paragraphs / reports / letters on familiar topics

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1										3					
2										2					
3										1					
4										2					
5										3					

Unit I **7.5 Hours**

Module	Vocabulary/ Grammar	Skills Sets	Skill Sets
31	Difference between Present Continuous and Simple Present tense.	Calling for help in an emergency	Reporting an event- journalistic style
32	Verbs ‘have’ and ‘have got’	Describing animals	Asking for and giving directions
33	Simple Past Tense	Inviting people, accepting and declining invitations	Self- enquiry and offering one’s opinion on a given topic.
34	Spelling rules & table of Irregular Verbs	Refusing an invitation	Reading and practicing pre-written dialogues

35	Unit Test I		

Unit II **7.5 Hours**

Module	Vocabulary/ Grammar	Skills Sets	Skill Sets
36	Questions and the negative form of the simple past tense	Apologizing and responding to an apology	(Reading) conversation practice
37	Asking questions in the simple past tense	Reading comprehension	Seeking, granting and refusing permission
38	Past continuous tense	Paying compliments and responding to them	Pair work: writing dialogues and presenting them
39	Difference between simple past and past continuous- when and where to use each	Describing daily routines	Reading and comprehension skills
40	Unit Test II		

Unit III **7.5 Hours**

Module	Vocabulary/ Grammar	Skills Sets	Skill Sets
41	Simple future tense	Talking about the weather	Making plans- applying grammar theory to written work
42	Simple future tense- more aspects, possessive pronouns	Talking about possessions	Opening up and expressing one's emotions
43	Future continuous tense	Talking about current activities	Listening comprehension
44	Revision of future tense- simple and continuous forms, prepositions used with time and date	Asking for the time and date	Discussion- analyzing and debating a given topic
45	Unit Test III		

Unit IV **7.5 Hours**

Module	Vocabulary/ Grammar	Skills Sets	Skill Sets
46	Articles a/an	Writing, speaking and presentation skills	Transcribing dictation
47	Singular- Plural (usage of a/an)	Reading practice- independent and	Comprehension –logical analysis, process analysis and

		shared reading	subjective expression
48	Countable and uncountable nouns- a/an and some	Listening comprehension	Vocabulary: using context tools to decipher meaning
49	Articles- the	Sequencing sentences in a paragraph	Listening to a poem being recited, answer questions on it and practice reciting the same
50	Unit Test IV		

Unit V **7.5 Hours**

Module	Vocabulary/ Grammar	Skills Sets	Skill Sets
51	Articles- the: usage and avoidance	Speaking: sharing stories about family, village/town, childhood, etc. 10 students	Listening: comprehend and follow multiple step instructions read out by the teacher
52	Articles- the: usage and avoidance with like and hate	Speaking: sharing stories about family, village/town, childhood, etc. 10 students	Reading: make inferences from the story about the plot, setting and characters
53	Articles- the: usage and avoidance with names of places	Speaking: sharing stories about family, village/town, childhood, etc. 10 students	Comprehension passage
54	This/ that/ these and those	Writing a notice- announcement	Speaking: Debate
55	Unit Test V		

Unit VI **7.5 Hours**

Module	Vocabulary/ Grammar	Skills Sets	Skill Sets
56	One and ones	Collaborative learning- problem solving	Writing short answers to questions based on reading
57	Capitalization and punctuation	Controlled writing	Listen to a story and respond to its main elements
58	Syntax and sentence construction- rearrange jumbled sentences	Guided writing	Listen to a poem and discuss its elements
59	Cloze	Free writing	Frame simple yet purposeful questions about a given passage
60	Unit Test VI		

Total: 45 Hours

Reference(s)

1. Basic English Module, L&L Education Resources, Chennai, 2011.

15LE202 COMMUNICATIVE ENGLISH II 3 0 0 3

Course Objectives

- To acquire skills for using English language effectively in workplace
- To prepare students for taking BEC Vantage level examination
- To enhance the communicative ability from Intermediate to Upper Intermediate level
- To enhance the communicative ability from Intermediate to Upper Intermediate level

Programme Outcomes (POs)

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

Course Outcomes (COs)

1. The students will be able to: Express themselves orally while interacting with individuals or groups in formal occasions
2. Listen and comprehend business conversations
3. Read and understand business correspondences and company literature
4. The students will be able to use language structures and vocabulary that is required at CEFR B2 level
5. Communicate effectively through formal and informal written business correspondences

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1										3					
2										2					
3										2					
4										1					
5										3					

UNIT I **9 Hours**

GRAMMAR AND VOCABULARY

Simple, compound and complex sentences - Direct and indirect speech - Conditionals - Business vocabulary - Collocations -Discourse markers

UNIT II **9 Hours**

LISTENING

Listening to identify topic, content, function - Sentence stress - Rhythm - Intonation

UNIT III **9 Hours**
READING
Reading graphs and charts - Skimming and scanning texts - Job advertisements - Read business articles for specific information - Understanding the structure of a text - Error identification

UNIT IV **9 Hours**
WRITING
Formal and Informal English - Longer Documents: writing individual paragraphs to longer text, Business Correspondence, Reports and Proposals - Transcoding

UNIT V **9 Hours**
SPEAKING
Collaborative task - Turn taking (initiating and responding appropriately) - Negotiating - Exchanging information - Language Functions: suggesting - comparing and contrasting - expressing - Finding out facts, attitudes and opinions - Commonly mispronounced words

FOR FURTHER READING
Reading Novels (The Monk Who Sold His Ferrari by Robin Sharma; Three Mistakes of my Life by Chetan Bhagat; The Fountainhead by Ayn Rand)

Total: 45 Hours

Reference(s)

1. 1.Guy Book- Hart, BEC Vantage Cambridge Business Benchmark, Upper-Intermediate Cambridge University Press, 2006.
2. 2.Eric H. Glendinning and Beverly Holmstrom, Study Reading: A Course in Reading for Academic Purposes. United Kingdom: Cambridge University Press, 2004.

15LC203 CHINESE 3 0 0 3

Course Objectives

- To help students acquire the basics of Chinese language.
- To teach the student show to converse in Chinese in various situations.
- To teach Chinese cultural facets and social etiquettes to the students.

Programme Outcomes (POs)

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

Course Outcomes (COs)

1. Identify Initials and Finals of Chinese Alphabet.
2. Recognise four different tones in a spoken Chinese sentence.
3. Read Mandarin Chinese through Pinyin.
4. Form sentences using basic Chinese vocabulary.
5. Listen and understand basic Chinese conversation

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1										1					
2										2					
3										2					
4										3					
5										2					

UNIT I **9 Hours**

Nǐ hǎo - 你 好

Xuéhuì wènhòu de jīběn biǎodá yòngyǔ - 学会问候的基本表达用语 ; Xuéhuì jièshào zìjǐ de xìngmíng, guójí - 学会介绍自己的姓名，国际 ; Xuéhuì hànyǔ pīnyīn de shèngmǔ - 学会汉语拼音的圣母 ; yùnmǔ hé shēngdiào - 韵母和声调 ; Pīn dú hé shēngdiào liànxí - 拼 读 和 声调 练习

UNIT II **9 Hours**

Xiànzài jǐ diǎn - 现在 几 点

Xuéhuì shíjiān, rìqí de biǎodá - 学会时间，日期的表达 ; Rèshēn - 热身 ; Shēngcí - 生词 ; Jùzi - 句子 ; Huìhuà - 会话 ;Huódòng - 活动 ; Kàn tú wánchéng huìhuà - 看 图 完成 会话 ; Xué cíyǔ shuō shíjiān ; Tìhuàn liànxí - 替换练习Dú yī dú ránhòu lián xiàn - 读一读然后连线 ; Bǎ xiàmiàn de cí àn zhèngquè de shùnxù páiliè chéngjù - 把下面的词 按 正确的 顺序排列成句

UNIT III **9 Hours**

Nà jiàn máoyī zěnme mài? - 那件毛衣 怎么卖 ?

Xúnwèn jiàqián jí qián de biǎodá - 询问价钱及钱的表达 ; Tǎojiàhuánjià - 讨价还 价 ; Tíchū duì suǒ mǎi dōngxī dàxiǎo, yánsè děng děng jùtǐ yāoqiú - 提出 对所买 东西大小， 颜色 等等具体要求 ;

Shēngcí Huódòng - 活动 ; Kàn tú wánchéng huìhuà - 看 图 完成 会话 ; Xué cíyǔ shuō shíjiān ;Dú yī dú ránhòu lián xiàn - 读一读然后连线 ;Tīng lùyīn xuǎnzé zhèngquè dá'àn - 听 录音选择正确答 案 ; Bǔchōng cíyǔ biǎo - 补充词语表

UNIT IV **9 Hours**

Xuéhuì xúnwèn jiātíng qíngkuàng, zhíyè hé niánlíng - 学会询问家庭情况， 职业和年龄

Xuéhuì diǎn cài tí yāoqiú jiézhàng - 学会点菜 提要求结账 ; Shēngcí - 生词 ; Jùzi - 句子 ; Huìhuà - 会话 ;Huódòng - 活动 ; Kàn tú wánchéng huìhuà - 看 图 完成 会话 ; Xué cíyǔ shuō shíjiān ;Dú yī dú ránhòu lián xiàn - 读一读然后连线 ;Tīng lùyīn xuǎnzé zhèngquè dá'àn - 听 录音选择正确答 案 ; Bǔchōng cíyǔ biǎo - 补充词语表Juésè bànyǎn - 角色 扮演 ; Tīng lùyīn pànduàn duì cuò - 听录音判断对错

UNIT V **9 Hours**

Nǐ zài nǎ'er gōngzuò - 你 在 哪儿 工作

Xuéhuì xúnwèn jiātíng qíngkuàng, zhíyè hé niánlíng - 学会询问家庭情况， 职业和年龄 Shēngcí - 生词 ; Jùzi - 句子 ; Huìhuà - 会话 ; Huódòng - 活动 ; Kàn tú wánchéng huìhuà - 看 图 完成 会话 ;Tīng lùyīn xuǎnzé zhèngquè dá'àn - 听 录音选择正确答 案 ; Bǔchōng cíyǔ biǎo - 补充词语表 - Tīng lùyīn xuǎnzé zhèngquè dá'àn - 听 录音选择正确答 案 ; Bǔchōng cíyǔ biǎo - 补充词语表

Total: 45 Hours

Reference(s)

1. TiyanHanyuShenghuoPian "Experiencing Chinese" Ying Yu Ban Di 1 Ban. Beijing: Higher Education Press: Gaodengjiaohuchu ban she. 2011
2. 1.Mandarine Day - Hancel Don : Chinese learning Software 2.My Chinese Classroom - David J. White
3. www.chinesexp.com.cn www.yiwen.com.cn

3 0 0 3

15LF203 FRENCH

Course Objectives

- To help students acquire familiarity in the French alphabet & basic vocabulary
- To teach the students to use French in simple day-to-day conversations
- To prepare the students for French examination (level A1)

Programme Outcomes (POs)

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

Course Outcomes (COs)

1. Listen and comprehend individual sounds of French and simple day-to-day conversations.
2. Apply basic sounds and words in simple sentences for communication
3. Read and understand short passages on familiar topics.
4. Frame basic sentence structures while writing.
5. Recognize and apply basic grammar and appropriate vocabulary in completing language tasks.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1										2					
2										3					
3										2					
4										3					
5										1					

UNIT I **6 Hours**

Alphabet Français (alphabets) - Les Accents Français (the accents in French) - aigu - grave - circonflexe - tréma cédille - écrire son nom dans le français (spellingone-sname in French) - Les noms de jours de la semaine (Days of the week)

UNIT II **6 Hours**

Les noms de mois de l'année (Months) - Numéro 1 à 100 (Numbers 1 to 100) GRAMMAIRE: Conjugaison

UNIT III **10 Hours**

Moyens de transport (Transport) - Noms de Professions (Professions) - Noms d'endroits communs (Places) - Nationalités (Nationalities) ECOUTER : (Listening)
Écouter l- alphabet associéà des prénoms français - Écouter et répondre PARLER (Speaking)Présntation - même /Présentez- Vous (Introducingoneself)LIRE :Lireles phrases simples

UNIT IV **12 Hours**

Pronoms (Pronouns) - Noms communs masculins et de femme (Common masculine and Femininenouns) - Verbes communs (Common verbs) COUTER :couter et crier les prnoms - Observer les dessins et couter les dialogues LIRE : Lire les profils d'utilisateurs d'interlingua (alter ego)PARLER :Parler de sa ville - Parler de sa profession

UNIT V **11 Hours**

Narration de son nom et l'endroit où on vit - Son âge et date de naissance - Numéro de téléphone et'dresse - Narration du temps - La France en Europe PARLER :Conversation entre deux amis - Jouer la scène ÉCOUTER :Ecouter les conversations (CD alter ego)ÉCRIRE :Écrireune carte postale

Total: 45 Hours

Reference(s)

1. Alter ego+ Niveau a1 ,Catherine Hugot,, HACHETTE LIVRE 2012.
2. Cahier alter ego+.
3. Grammaire Progressive du Français, CLE international, 2010.
4. Collins Easy Learning French Verbs& Practice, Harpercollins, 2012.
5. Barron's Learn French, 3rd edition.
6. FrançaisLinguaphone, Linguaphone Institute Ltd., London, 2000. FrançaisI.Harrisonburg: The Rosetta Stone: Fairfield Language Technologies, 2001.

15LG203 GERMAN 3 0 0 3

Course Objectives

- To help students acquire the basics of German language.
- To teach them how to converse in German in day-to-day situations.
- To teach them how to converse in German in day-to-day situations

Programme Outcomes (POs)

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

Course Outcomes (COs)

1. Listen and identify individual sounds of German and simple day-to-day conversations.
2. Speak simple sentences using basic sounds and words.
3. Read and understand short passages on familiar topics.
4. Apply basic sentence structures while writing.
5. Apply basic grammar and appropriate vocabulary in completing language tasks.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1										2					
2										3					
3										2					
4										3					
5										1					

6 Hours

UNIT I

Introduction to German language: Alphabets - Numbers -Greetings - country - nationalities - Working with Dictionary.

6 Hours

UNIT II

Nouns - Pronouns - definite and indefinite article - Speaking about oneself - Listening to CD supplied with the books, paying special attention to pronunciation.

11 Hours

UNIT III

Regular verbs - Conjugation - Irregular verbs - Time - Negation - adjectives - family - profession - Introduction to types of sentences.

12 Hours

UNIT IV

Question words - Types of Questions - Nominative - Accusative and dative case - framing basic questions and answers -Writing short notes and letter- reading the news boards, directions.

10 Hours

UNIT V

Imperative case - Possessive articles - propositions - modal auxiliaries - Basic dialogue and group conversation -ordering in restaurants.

Total: 45 Hours

Reference(s)

1. Continuum International Publishing Group Ltd. London / New York, 1992. Eckhard, Christine. Whittle, Black & Ruth. Cassel Language Guides - German.
2. Rusch, Paul. Netzwerk A1. Deutsch AlsFremdsprache. Goyal Publishers & Distributers Pvt. Ltd. New Delhi, 2015.
3. Langenscheidt Universal German Dictionary: German-English, English-German. Goyal Publishers & Distributers Pvt. Ltd., New Delhi, 2009.
4. Grundkurs Deutsch A Short Modern German Grammar Workbook and Glossary. Verlag Fur Deutsch.Munichen, 2007.
5. Grundkurs. Deutsch Lehrbuch. Hueber. Munichen, 2007.

15LH203 HINDI 3 0 0 3

Course Objectives

- To help students acquire the basics of Hindi language
- To teach them how to converse in Hindi in day-to-day situations
- To help students acquire the ability to understand a simple technical text in Hindi

Programme Outcomes (POs)

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

Course Outcomes (COs)

1. Read and identify Hindi letters, words and simple sentences.
2. Construct simple sentences and use appropriate vocabulary during day-to-day oral communication.
3. Identify basic sounds of Hindi language and understand simple conversations on familiar topics.
4. Write common words and sentences.
5. Comprehend elementary level grammar of Hindi.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1										2					
2										3					
3										2					
4										3					
5										1					

UNIT I **9 Hours**

HINDI ALPHABET

Introduction - Vowels - Consonants - Plosives - Fricatives - Nasal sounds - Vowel Signs - Chandra Bindu & Visarg -Table of Alphabet -Vocabulary.

UNIT II **9 Hours**

NOUNS IN HINDI

Genders (Masculine & Feminine Nouns ending in a ,e,i,o, u,)- Masculine & Feminine - Reading Exercises.

UNIT III **9 Hours**

PRONOUNS AND TENSES

Categories of Pronouns - Personal Pronouns - Second person (you & honorific) - Definite & Indefinite pronouns - Relative pronouns - Present tense - Past tense - Future tense -Assertive & Negative Sentences - Interrogative Sentences.

UNIT IV **9 Hours**

CLASSIFIED VOCABULARY

Parts of body - Relatives - Spices- Eatables- Fruit & Vegetables - Clothes - Directions-Seasons - Professions.

UNIT V **9 Hours**

SPEAKING

Model Sentences - Speaking practice for various occasions.

Total: 45 Hours

Text Book(s)

1. B. R. Kishore, Self Hindi Teacher for Non-Hindi Speaking People, Vee Kumar Publications (P) Ltd., New Delhi, 2009.

Reference(s)

1. Syed, PrayojanMulak Hindi, RahamathullahVaniPrakasan, New Delhi, 2002.
2. Ramdev, VyakaranPradeep, SaraswathiPrakasan, Varanasi, 2004.

15LJ203 JAPANESE 3 0 0 3

Course Objectives

- To help students learn Japanese alphabet.
- To teach students how to use the basic Japanese sentences in day-to-day conversation.
- To make students familiar with the Japanese cultural facets and social etiquettes.

Programme Outcomes (POs)

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

Course Outcomes (COs)

1. Recognise and write Japanese alphabet.
2. Speak using basic sounds of the Japanese language.
3. Apply appropriate vocabulary needed for simple conversation in Japanese language.
4. Apply appropriate grammar to write and speak in Japanese language.
5. Comprehend the conversation and give correct meaning.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1										2					
2										2					
3										2					
4										2					
5										2					

9 Hours

UNIT 1

Introduction to Japanese - Japanese script - Pronunciation of Japanese(Hiragana) - Long vowels - Pronunciation of in,tsu,ga - Letters combined with ya,yu,yo - Daily Greetings and Expressions - Numerals. N1 wa N2 des - N1 wa N2 ja arimasen - S ka - N1mo - N1 no N2 - .san - Kanji - Technical Japanese Vocabulary (25 Numbers) - Phonetic and semantic resemblances between Tamil and Japanese.

9 Hours

UNIT 2

Introduction - Kore - Sore - are - Kono N1 - Sono N1 - ano N1 - so des - so ja arimasen - S1 ka - S2 ka - N1 no N1 - so des ka ' koko - soko - asoko - kochira - sochira - achira - N1 wa N2 (Place) des - dhoko- N1 no N2 - Kanji-10 - ima-.ji-fun des - Introduction of verb - V mas - V masen - V mashitha - V masen deshitha - N1(Time) ne V - N1 kara N2 des - N1 tho N2 / S ne Kanji-10 - Technical Japanese Vocabulary (25 Numbers) - Dictionary Usage.

9 Hours

UNIT 3

- N1(Place) ye ikimas - ki mas - kayerimasu - Dhoko ye mo ikimasen - ikimasendheshitha - N1(vehicle) de ikimasu - kimasu - kayerimasu - N1(Personal or Animal) tho V ithsu - S yo. - N1 wo V (Transitive) - N1 wo shimus - Nani wo shimasu ka - Nan & Nani - N1(Place) de V - V masen ka - V masho - Oo.

Kanji-10 , N1(tool - means) de V - Word / Sentence wa go nan des ka - N1(Person) ne agemus - N1(Person) ne moraimus - mo V shimashitha - , Kanji-10 - Japanese Typewriting using JWPCE Software, Technical Japanese Vocabulary (25 Numbers).

9 Hours

UNIT 4

Introduction to Adjectives - N1wanaadj des. N1 wa ii adj des - naadjna N1 - ii adj ii N1 - Thothemo - amari - N1 wadho des ka - N1 wadhonna N2 des ka - S1 ka S2 - dhore - N1 gaarimasu - wakarimasu - N1 ga suki masu - N1 gakiraimasu - jozu des - hetha des - dhonna N1 - Usages of yoku - dhaithai - thakusan - sukoshi - amari - zenzen - S1 kara S2 - dhoshithe, N1 gaarimasu - imasu - N1(Place) ne N2 gaarimasu - iimasu - N1 wa N2(Place) ne arimasu - iimasu - N1(Person,Place,or Thing) no N2 (Position) - N1 ya N2, Kanji-10 - Japanese Dictionary usage using JWPCE Software, Technical Japanese Vocabulary (25 Numbers).

9 Hours

UNIT 5

Saying Numbers , Counter Suffixes , Usages of Quantifiers -Interrogatives - Dhonokurai - gurai - Quantifier-(Period) ne -.kai V - Quantifier dhake / N1 dhake Kanji - Past tense of Noun sentences and na Adjective sentences - Past tense of ii-adj sentences - N1 wa N2 yoriadj des - N1 tho N2 tho Dhochiragaadj des ka and its answering method - N1 [no naka] de {nani/dhoko/dhare/ithsu} ga ichiban adj des ka - answering -N1 gahoshi des - V1 mas form dhake mas - N1 (Place) ye V masu form ne ikimasu/kimasu/kayerimasu - N1 ne V/N1 wo V - Dhokoka - Nanika - gojumo - Technical Japanese Vocabulary (25 Numbers)

Total: 45 Hours

Text Book(s)

1. Japanese for Everyone: Elementary Main Textbook1-1, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.
2. Japanese for Everyone: Elementary Main Textbook 1-2, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.

Reference(s)

1. Software 1. Nihongo Shogo-1 2. Nihongo Shogo-2 3. JWPCE Software 3. JWPCE Software
2. 1. www.japaneselifestyle.com 2. www.learn-japanese.info/ 3. www.kanjisite.com/ 4. www.learn-hiragana-katakana.com/typing-hiragana-characters/

15PH201 PHYSICS OF MATERIALS 3 0 2 4

Course Objectives

- To understand the physical properties of conductors, semiconductors and superconductors
- To recognize the basic principles of interaction of light with matter and working of optical devices
- To classify the types of dielectric, magnetic materials and polarization mechanisms with their properties

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Analyze the properties of conductors and superconductors for different applications
2. Apply the concepts and types of semiconductors for solar cell applications
3. Discuss the types, properties and applications of dielectric materials
4. Explain the properties of optical materials, working mechanism of LEDs and LCDs
5. Classify the magnetic materials with their properties and apply in the data storage devices

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1							2						
2	2	1							2						
3	2	1													
4	2	1													
5	2	1							2						

UNIT I **9 Hours**

CONDUCTING AND SUPERCONDUCTING MATERIALS

Electrical and thermal conductivity of metals - Wiedemann Franz law - band theory of metals - density of states. Superconductors: properties - types - High Tc superconductors- applications.

UNIT II **10 Hours**

SEMICONDUCTORS

Elemental and compound semiconductors - intrinsic semiconductors: carrier concentration - electrical conductivity- band gap. Extrinsic semiconductors: carrier concentration - variation of Fermi level. Hall effect: theory and experimental determination -applications:Solar cells

UNIT III **9 Hours**

DIELECTRIC MATERIALS

Types of polarization: electronic, ionic, orientation and space charge polarization mechanisms - Langevin-Debye equation - frequency and temperature effects on polarization - dielectric strength and loss -dielectric breakdown mechanisms - active dielectric materials: pizo, pyro and ferroelectricity - applications.

UNIT IV **9 Hours**

OPTICAL MATERIALS

Interaction of light with materials - optical absorption - transmission - Luminescence in solids - Fluorescence and Phosphorescence - Optical band gap - LED ,LCD.

UNIT V **8 Hours**

MAGNETIC MATERIALS

Classification and properties - domain theory - hard and soft magnetic materials - anti-ferro and ferri magnetic materials - applications: magnetic recording and memories.

FOR FURTHER READING

Photonic crystals - LIFI

2 Hours

INTRODUCTION

Exposure to Engineering Physics Laboratory and precautionary measures

4 Hours

EXPERIMENT 1

Using Lees disc apparatus, determine the coefficient of thermal conductivity of a bad conductor.

4 Hours

EXPERIMENT 2

Find the band gap value of the given semiconductor diode. Based on the band gap value, identify the given semiconductor.

4 Hours

EXPERIMENT 3

With the aid of travelling microscope, find the refractive index of a transparent solid and liquid material.

4 Hours

EXPERIMENT 4

Determine the wavelength of polychromatic source in the visible region using spectrometer.

4 Hours

EXPERIMENT 5

Based on Hall effect, calculate the charge carrier density of a given semiconductor and identify the nature of the semiconductor.

4 Hours

EXPERIMENT 6

Draw the B-H curve of a ferromagnetic material subjected to external magnetic field and hence identify the nature of the material.

4 Hours

EXPERIMENT 7

Determine the V-I characteristics of a solar cell.

Total: 75 Hours

Reference(s)

1. Saxena, Gupta, Saxena, Mandal, Solid State Physics, Pragati Prakashan Educational Publishers, 13th revised edition, Meerut, India, 2013.
2. M.N. Avadhanulu and P.G. Kshirsagar, A Text Book of Engineering Physics, S. Chand & Company Ltd., New Delhi, 2011.
3. S. O. Pillai, Solid State Physics, New Age International Publications, New Delhi, 2010.
4. M.A. Wahab, N.K. Mehta, Solid state physics-structure and properties of materials, Narosa publishing house Pvt. Ltd, 6th edition, 2010.
5. Semiconductor Physics and Devices, Donald A. Neamen , Mc Graw-Hill, 2011.
6. P.K. Palanisamy, Materials Science, Scitech Publications India Pvt. Ltd, 2014.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2	4	2		1	4	2		1	2			1	1											20
2	2		2		2		4		5	3			4												22
3	1	2	1		3	4			3	4			2												20
4	2	2			2	5			2	5			2												20
5	1	3			3	2	3		3	1			2												18
																								Total	100

Assessment Questions

Remember

1. State Meissner effect
2. List six properties of superconducting materials
3. Define photovoltaic effect
4. List the six common applications of dielectric materials
5. Retrieve optical absorption in metals
6. Reproduce the principle of LCD in display devices
7. Recall the term hysteresis in ferromagnetic materials
8. List four applications of magnetic materials
9. Recognize the need of optical band gap in differentiating the materials
10. Reproduce five applications of hard magnetic materials in day to day life

Understand

1. Explain the principle, construction and working of LED
2. Classify the three types of materials based on band gap energy
3. Interpret the working mechanism and characteristics of a solar cell
4. Illustrate Hall effect experiment used to find the concentration of charge carriers in n- type semiconductors and hence explain the necessary theory
5. Summarize the various dielectric breakdown mechanisms observed in dielectric materials
6. Infer the principle involved in working of magnetic levitation

7. Classify the two types of luminescence in solids with appropriate energy level diagrams
8. Subsume the four types of polarization mechanisms involved in dielectric materials
9. Illustrate the V-I characteristics of a solar cell
10. Extrapolate the Clausius Mosotti equation for the dielectric material which is subjected to external electric field

Apply

1. Free electron density of aluminum is 18.10x1028 m-3. Calculate its Fermi energy at 0K. Planck’s constant and mass of free electron are 6.62x10-34 Js and 9.1x10-31 Kg
2. Compute the relation between Remanence and Coercivity
3. Demonstrate the domain theory of ferromagnetism
4. Derive the expressions for electrical and thermal conductivity of metals and hence compute the Wiedemann Frantz law
5. Compute the carrier concentration in intrinsic and extrinsic semiconductors
6. Calculate the number of free electrons per unit volume in a metal in terms of Fermi energy
7. Assess the Magnetic levitation and SQUIDS in day to day life
8. Show the importance of dielectric breakdown mechanisms in dielectrics
9. Implement the applications of dielectric materials in real world problems
10. Compute the relation between polarization vector (P) and electric field (E)

Analyse

1. Differentiate Phosphorescence and Fluorescence
2. Can we increase the orientation polarization with increase in temperature? Justify
3. Justify the principle, construction, working, advantages and disadvantages of LCD
4. Compare hard and soft magnetic materials
5. Differentiate the ferromagnetic and anti-ferromagnetic materials with examples
6. Compare dia, para and ferromagnetic materials
7. Distinguish between polarization and polarizability
8. Differentiate elemental and compound semiconductors
9. Compare type I and type II superconductors
10. Compare LED and LCD

15PH202 APPLIED PHYSICS 3 0 2 4

Course Objectives

- To understand conducting, semiconducting, dielectric and magnetic properties of materials and exemplify their applications
- To analyze the basic concepts of thermodynamics and heat transfer with illustrations
- To gain knowledge about acoustical standards of buildings

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Analyze the physical properties of conducting and semiconducting materials
2. Discuss the physical properties of dielectric and magnetic materials with their applications
3. Apply the thermodynamic processes and laws to compute the efficiency of heat engines
4. Compare the different heat transfer modes with real time applications of conduction
5. Explain the characteristics of music and select proper sound absorbing materials for good acoustic of buildings

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1							2						
2	2	1							2						
3	2	1													
4	2	1													
5	2	1							2						

UNIT I **11 Hours**

CONDUCTORS AND SEMICONDUCTORS

Conductors: Classical free electron theory - electrical and thermal conductivity- Wiedemann - Franz law - merits and demerits of classical free electron theory - band theory - density of states. Semiconductors: Elemental and compound semiconductors - intrinsic semiconductors -Fermi level and electrical conductivity - band gap energy - extrinsic semiconductors - n-type and p-type semiconductors: variation of Fermi level with temperature (qualitative) - Hall effect - applications.

UNIT II **9 Hours**

DIELECTRIC AND MAGNETIC MATERIALS

Dielectrics: Fundamental terminologies - electronic and ionic polarizations - orientation polarization mechanism (qualitative) - space charge polarization - Langevin -Debye equation - dielectric loss - applications of dielectric and insulating materials.

Magnetic Materials: Properties of dia, para and ferromagnetic materials - domain theory of ferromagnetism - hysteresis curve - hard and soft magnetic materials - applications

UNIT III **9 Hours**

THERMODYNAMICS

Zeroth law of thermodynamics - Heat - equilibrium and quasistatic process - path functions - comparison between heat and work - internal energy - first law of thermodynamics - isothermal and adiabatic process - work done - reversible and irreversible process - second law of thermodynamics - entropy - enthalpy - Carnot ideal engine and its efficiency - Carnot's theorem-actual heat engine: Diesel engine and its efficiency

UNIT IV **9 Hours**

HEAT TRANSFER

Modes of heat transfer - thermal conductivity - heat capacity and diffusivity - rectilinear flow of heat - conduction through bodies in series and parallel - determination of thermal conductivity: good conductor: Searle's method - bad conductor: Lee's disc method - applications of heat transfer: formation of ice in ponds - conductivity of earth's crust and age of earth - practical applications

UNIT V **7 Hours**

ACOUSTICS

Classification of sound based on frequency - characteristics of audible sound - reverberation time: Sabine's formula - determination of absorption coefficient - Erying's formula (qualitative). Sound insulation - sound absorbing materials - factors affecting the acoustics of building - remedies

FOR FURTHER READING

Nanomaterials and its applications

2 Hours

INTRODUCTION

Exposure to Engineering Physics Laboratory and precautionary measures

4 Hours

EXPERIMENT 1

Using Lees disc apparatus, determine the coefficient of thermal conductivity of a bad conductor.

4 Hours

EXPERIMENT 2

Find the band gap value of the given semiconductor diode. Based on the band gap value, identify the given semiconductor.

4 Hours

EXPERIMENT 3

With the aid of traveling microscope, find the refractive index of a transparent solid and liquid material

4 Hours

EXPERIMENT 4

Determine the wavelength of polychromatic source in the visible region using spectrometer

4 Hours

EXPERIMENT 5

Based on Hall effect, calculate the charge carrier density of a given semiconductor and identify the nature of the semiconductor.

4 Hours

EXPERIMENT 6

Draw the B-H curve of a ferromagnetic material subjected to external magnetic field and hence identify the nature of the material.

4 Hours

EXPERIMENT 7

Determine the V-I characteristics of a solar cell.

Total: 75 Hours

Reference(s)

1. William D. Callister, Materials Science and Engineering an Introduction, John Wiley and Sons,Inc, 2010
2. BrijLal, N. Subrahmanyam and P. S. Hemne, Heat, Thermodynamics & Statistical Physics, S. Chand & Company Ltd., New Delhi, 2012
3. Saxena, Gupta, Saxena, Mandal, Solid State Physics, Pragati Prakashan Educational Publishers, 13threvised edition, Meerut, India, 2013
4. P.K. Mittal, Applied Physics, I.K. International Publishing House Pvt. Ltd, 2008
5. Donald A. Neamen, Semiconductor Physics and Devices,McGraw-Hill, 2011

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	3	4				3				4	4			2					4						24
2	2	2				4	2			2	4			4											20
3	2	4				4	2			4	2			2											20
4	2	2				4	2			2	4			4											20
5	2	2				2	2			4					4										16
																								Total	100

Assessment Questions

Remember

1. State Ohm's law.
2. Define drift velocity.
3. List the two drawbacks of classical free electron theory.
4. State Wiedemann-Franz law.
5. Mention the practical unit used for electron's magnetic moment.
6. Recall the term hysteresis in ferromagnetic materials.
7. List the four uses of magnetic materials.
8. State Zeroth law of thermodynamics.
9. State the Kelvin's statement of second law of thermodynamics.
10. Name the three modes of heat transfer.
11. State Echelon effect.

Understand

1. Illustrate the significance of Fermi energy.

2. Why indirect gap semiconductors are preferred in fabricating transistors?
3. Classify the types of magnetic materials.
4. Outline the term retentivity and coercivity.
5. Compare dia, para and ferro magnetic materials.
6. Point out the ideal conditions required for diesel cycle.
7. Sketch the isothermal and adiabatic processes in P-V diagram.
8. Is it possible for a practical engine to have 100% efficiency? Justify.
9. Ice kept in saw dust or wrapper in a blanket will not melt. Why?
10. Classify the types of sound waves.
11. Explain the three characteristics of musical sound.

Apply

1. The average energy of a conduction electron in copper at 300 K is 4.23 eV. Calculate the Fermi energy of copper at 300 K.
2. Determine the carrier concentration of *p*-type semiconductor whose hall coefficient is 3.6610-4 m3/C.
3. Compute the efficiency of Carnot's engine operating between the temperatures 3270C and 270C.
4. Point out practical applications of heat conduction.
5. Compute the efficiency of Carnot's engine working the steam point and the ice point.
6. Assess the reason for the formation ice on pond surface.
7. The intensity of sound produced by thunder is 0.1 Wm-2.Calculate the intensity level in decibels.
8. Calculate Sabine's mathematical relation for reverberation time of the hall.
9. Compute the minimum wavelength of audible sound at zero degree centigrade.

Analyse

1. Distinguish between relaxation time and collision time.
2. Differentiate between electrical and thermal conductivity.
3. List the various applications of soft and hard magnetic materials for day to day life.
4. Analysis the six properties of hard and soft magnetic materials.
5. If the system and surrounding are in thermal equilibrium, is it necessary they are in same state? Comment the statement.
6. Differentiate isothermal and adiabatic process.
7. Entropy remains constant in an adiabatic process. Justify the statement.
8. Compare Carnot's cycle and diesel cycle.
9. Distinguish between loudness and intensity of sound.
10. Compare reverberation and echo.
11. How do you maintain optimum reverberation in a hall? Justify.

Evaluate

1. The mean free collision time of copper at 300 K is equal to 2X 10^{-14} s. Determine its electrical conductivity.
2. A silicon plate of thickness 1mm, breadth 10 mm and length 100mm is placed in a magnetic field of 0.5 wb/m^2 acting perpendicular to its thickness. If 10^{-2} A current flows along its length, determine the Hall voltage developed if the Hall coefficient is 3.66 X 10^{-4} m^3 / Coulomb

15PH203 MATERIALS SCIENCE 3 0 2 4

Course Objectives

- To explain the properties of conducting, semiconducting and dielectric materials
- To impart fundamental knowledge in optical materials
- To understand the nature and applications of different magnetic materials

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

Course Outcomes (COs)

1. distinguish electrical properties of different kinds of conducting materials
2. identify the different types of semiconductors and its applications
3. categorize the various polarization mechanisms in dielectrics
4. choose the suitable material for the construction of display devices
5. select appropriate magnetic materials for magnetic storage devices

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3														
2	2														
3	1														
4	1														
5	1														

UNIT I **8 Hours**

ELECTRICAL PROPERTIES OF METALS

Quantum free electron theory: Fermi-Dirac distribution function - Fermi energy and its variation with temperature - density of energy states - calculation of density of electrons and fermi energy at 0K - mean energy of electrons at 0K - problems.

UNIT II **10 Hours**

SEMICONDUCTING MATERIALS

Introduction - elemental and compound semiconductors - intrinsic semiconductors: expressions for number of electrons and holes - determination of carrier concentration and position of Fermi energy - electrical conductivity - band gap energy determination - carrier concentration in extrinsic semiconductors. Hall effect: theory and experimental determination - uses - problems.

UNIT III **9 Hours**

DIELECTRICS

Introduction - fundamental definitions in dielectrics - expressions for electronic and ionic polarizations - orientation polarization (qualitative) - space charge polarization - Langevin - Debye equation - frequency and temperature effects on polarization - internal field - expression for internal field (cubic structure) - Clausius-Mosotti equation and its importance - applications of dielectric materials - problems.

UNIT IV **9 Hours**

OPTICAL MATERIALS

Introduction - optical absorption in metals, semiconductors and insulators. Fluorescence and phosphorescence. Light emitting diode: principle, construction, working and applications. Liquid crystal display: general properties - dynamic scattering display - twisted nematic display - applications - comparison between LED and LCD. Blue ray disc - principle - working.

UNIT V **9 Hours**

MAGNETIC MATERIALS

Introduction - orbital and spin magnetic moments - Bohr magneton - basic definitions - classification of magnetic materials - domain theory of ferromagnetism - process of domain magnetization - explanation of hysteresis curve based on domain theory - hard and soft magnetic materials.

FOR FURTHER READING

Optical data storage and Giant magnetoresistance

2 Hours

INTRODUCTION

Exposure to Engineering Physics Laboratory and precautionary measures

4 Hours

EXPERIMENT 1

Using Lees disc apparatus, determine the coefficient of thermal conductivity of a bad conductor.

4 Hours

EXPERIMENT 2

Find the band gap value of the given semiconductor diode. Based on the band gap value, identify the given semiconductor.

4 Hours

EXPERIMENT 3

With the aid of traveling microscope, find the refractive index of a transparent solid and liquid material.

4 Hours

EXPERIMENT 4

Determine the wavelength of polychromatic source in the visible region using spectrometer.

4 Hours

EXPERIMENT 5

Based on Hall effect, calculate the charge carrier density of a given semiconductor and identify the nature of the semiconductor.

4 Hours

EXPERIMENT 6

Draw the B-H curve of a ferromagnetic material subjected to external magnetic field and hence identify the nature of the material.

4 Hours

EXPERIMENT 7

Determine the V-I characteristics of a solar cell.

Total: 75 Hours

Reference(s)

1. William D. Callister, Materials Science and Engineering an Introduction, John Wiley and Sons, Inc, 2010.
2. S.O. Pillai, Solid State Physics, New Age International Publications, New Delhi, 2014.
3. M.N. Avadhanulu and P.G. Kshirsagar, A Text Book of Engineering Physics, S. Chand & Company Ltd., New Delhi, 2011.
4. P.K. Palanisamy, Physics For Engineers, Scitech Publications (India) Pvt. Ltd., Chennai, 2010.
5. V. Raghavan, Materials Science and Engineering, Prentice Hall of India, New Delhi, 2010.
6. R.K.Gaur and S.L.Gupta, Engineering Physics, Dhanpat Rai publications, New Delhi, 2010.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2	5	2		1	5	2		1																18
2	2		2		2	3	2		5		2		4												22
3	1	2	1		3	3			3	5			2												20
4	2	3			3	3			2	5			2												20
5	1	3			3	2	5		3	1			2												20
																								Total	100

Assessment Questions

Remember

1. Define density of electron energy states in metals.
2. Recall Fermi energy.
3. State Hall Effect.
4. List out the four advantages of semiconductors.
5. Define dielectric constant
6. Recall electric polarization.
7. Define Fluorescence.
8. Recognize hard and soft magnetic materials.
9. State the working principle of LED.
10. Define Bohr magnetron.

Understand

1. Classify three types of free electron theory
2. Represent the variation of Fermi level with temperature
3. Explain Clausius-Mosotti relation.
4. Compare element and compound type semiconductors.
5. Illustrate the variation of Fermi level with temperature in n-type semiconductors.
6. Distinguish between a dielectric and insulator.
7. Mention the technique to increase the emission time in phosphorescence.
8. Exemplify hysteresis on the basis of domain theory of ferromagnetism.
9. Identify four examples for hard magnetic materials.
10. Identify four properties of ferromagnetic materials.

Apply

1. Compute the Fermi direc function for energy kT above the Fermi energy.
2. Asses the Fermi-Dirac distribution function.

3. Energy level of p-type and n-type semiconductors and justify the results
4. Compute the carrier concentration of intrinsic semiconductors
5. Explain the principle, construction and working of Hall Effect
6. Show that electronic and ionic polarizabilities are independent of temperature.
7. Calculate the polarization of an atom above value five.
8. Differentiate the dia, para and ferromagnetic materials.
9. Compute the B-H Hysteresis curve on the basis of domain theory.

Analyse

1. Discriminate drift velocity and thermal velocity of an electron
2. Difference between p-type and n-type semiconductors.
3. Obtain the expression for concentration of charge carriers in p-type semiconductor.
4. In practical dielectrics, the current does not exactly lead the voltage by 90?. Justify.
5. Local field is the space and time average of the electric field acting on a particular molecule Justify the result.
6. Justify the special features of magnetic blue ray disks.
7. Analyze the role of energies in the domain growth.
8. Explain the roll of activators in optical materials
9. Describe the working of twisted pneumatic display device.
10. Compare LED and LCD.

15PH204 PHYSICS OF ENGINEERING MATERIALS 3 0 2 4

Course Objectives

- To familiarize with the physical properties of materials
- To gain practical applications of modern spectroscopy and microscopy techniques
- To understand the preparation of bio and nanomaterials

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

Course Outcomes (COs)

1. identify the electrical and thermal properties of conducting and semiconducting materials
2. analyze the various polarization mechanisms in dielectrics
3. choose specific materials for optical and magnetic data storage devices
4. investigate the specimen with the aid of suitable spectroscopic techniques
5. realize the methods adopted for preparing nano materials

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3														
2	2														
3	1														
4	3														
5	2														

UNIT I **10 Hours**

CONDUCTING AND SEMICONDUCTING PROPERTIES

Quantum free electron theory - Fermi-Dirac distribution function - effect of temperature on Fermi function - density of energy states - calculation of density of electrons and Fermi energy at 0 K. Intrinsic semiconductors: expressions for density of electrons and holes - intrinsic carrier concentration - band gap energy. Extrinsic semiconductors: carrier concentration in n-type and p-type semiconductors - variation of Fermi level with temperature and impurity concentration - problems.

UNIT II **9 Hours**

DIELECTRIC PROPERTIES

Introduction: fundamental definitions in dielectrics - types of polarization - expressions for electronic and ionic polarization mechanisms - orientation polarization (qualitative) - Langevin-Debye equation - frequency and temperature effects on polarization - dielectric loss - dielectric breakdown mechanisms - active dielectric materials - applications of dielectric materials - problems.

UNIT III **10 Hours**

OPTICAL AND MAGNETIC PROPERTIES

Optical properties: introduction - light interaction with solids - atomic and electronic interactions - optical properties of metals, semiconductors and insulators - reflection - refraction - absorption - transmission - luminescence and photoconductivity. Magnetic properties: introduction - origin of magnetic moment - properties of dia, para and ferro magnetic materials - domain theory and hysteresis effect - hard and soft magnetic materials - problems.

UNIT IV **8 Hours**

SPECTROSCOPY AND MICROSCOPY TECHNIQUES

Introduction: different types of spectroscopy techniques - basic principle of FTIR spectroscopy and X-ray Photoelectron Spectroscopy (XPS). Basic principle and working mechanisms of Scanning Electron Microscope (SEM) - Transmission Electron Microscope (TEM) - Atomic Force Microscope (AFM).

UNIT V **8 Hours**

BIO AND NANO MATERIALS

Biomaterials: classification of biomaterials - development of biomaterials - applications. Nanomaterials: properties - synthesis of nanomaterials - top-down approach: ball milling technique - bottom-up approach: Chemical Vapour Deposition (CVD) - uses of nanomaterials. Carbon nanotubes: properties and applications.

FOR FURTHER READING

Health and environmental impacts

2 Hours

INTRODUCTION

Exposure to Engineering Physics Laboratory and precautionary measures

4 Hours

EXPERIMENT 1

Using Lees disc apparatus, determine the coefficient of thermal conductivity of a bad conductor.

4 Hours

EXPERIMENT 2

Find the band gap value of the given semiconductor diode. Based on the band gap value, identify the given semiconductor.

4 Hours

EXPERIMENT 3

With the aid of traveling microscope, find the refractive index of a transparent solid and liquid material.

4 Hours

EXPERIMENT 4

Determine the wavelength of polychromatic source in the visible region using spectrometer.

4 Hours

EXPERIMENT 5

Based on Hall effect, calculate the charge carrier density of a given semiconductor and identify the nature of the semiconductor.

4 Hours

EXPERIMENT 6

Draw the B-H curve of a ferromagnetic material subjected to external magnetic field and hence identify the nature of the material.

4 Hours

EXPERIMENT 7

Determine the V-I characteristics of a solar cell.

Total: 75 Hours

Reference(s)

1. William D. Callister, Materials Science and Engineering An Introduction, John Wiley and Sons, Inc, 2010.
2. Halliday and Resnick, Fundamentals of Physics, John Wiley and Sons, Inc, 2011.
3. Jacob Milliman, Christos Halkias, Satyabrata JIT, Electronic Devices and Circuits, McGraw Hill Education (India) Private Limited, New Delhi, 2014.
4. S. O. Pillai, Solid State Physics, New Age International Publications, New Delhi, 2010.
5. Subbiah Pillai, Nanobiotechnology, MJP Publishers, 2010.
6. Yang Leng, Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, Wiley-VCH, 2013.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	1	4	2		2	5	2		2	2			1	1											22
2	2		2		2		2		5	3			4												20
3	2		2		3	3	2		3	3			2	2											22
4	1	2	1		3	3			3	3			2												18
5	2	2			3	2	3		2				2	2											18
																								Total	100

Assessment Questions

Remember

1. Recall the merits of quantum free electron theory over classical free electron theory
2. Define carrier concentration
3. Recall Fermi energy
4. List the four types of polarization mechanisms.
5. Recognize polar and non-polar molecules
6. Define Bohr magneton
7. Recall coercivity and retentivity
8. Point out the four salient features of biomaterials
9. Define bioactive materials
10. State the working principle of FTIR spectroscopy

Understand

1. Classify three types of materials based on bandgap energy
2. Explain fermi-distribution function and effect of temperature on Fermi function
3. Represent the variation of Fermi level with temperature
4. Explain intrinsic and thermal breakdown mechanisms
5. Infer the importance of Fermi level in a semiconductor
6. Illustrate the phenomenon of B-H hysteresis on the basis of domain theory
7. Classify four types of biomaterials

8. Represent the scanning electron microscope to determine the grain size of the nanomaterials
9. Explain the principle, construction and working of Scanning electron microscope
10. Explain the principle and working mechanism of X – ray photoelectron spectroscopy (XPS)

Apply

1. Find the variation of Fermi level with temperature and impurity concentration in n-type semiconductors
2. Show that electronic and ionic polarizabilities are independent of temperature
3. Show that the position of Fermi level is exactly at the midpoint of forbidden energy gap in intrinsic semiconductor
4. Compute the relationship between polarizability and electric flux density.
5. Assess the properties of dia, para and ferromagnetic materials
6. Show that top down method is inferior to bottom up method
7. Construct B-H Hysteresis curve on the basis of domain theory
8. Design the principle, construction and working of chemical vapour deposition.
9. Show that the electronic polarizability is directly propotional to the volume of an atom
10. Compute the expression for carrier concentration in intrinsic semiconductors

Analyse

1. Extrinsic semiconductors possess high electrical conductivity than intrinsic semiconductors. Justify
2. Silver is the best conductor of electricity. But gold is used in high-end electronic connectors. Justify.
3. Identify the role of impurity concentration in the variation of Fermi level in the case of p-type semiconductors.
4. Compare polar dielectrics with non-polar dielectrics.
5. Analyse the features of hard and soft magnetic materials.
6. Compare the six properties of dia, para and ferro magnetic materials
7. Differentiate top down approach from bottom up approach.
8. Select the four important features of TEM
9. Justify the electronic polarizability of Argon is much greater than that of Helium.
10. Intrinsic semiconductors are insulators at 0K. Justify.

15PH205 SOLID STATE PHYSICS 3 0 2 4

Course Objectives

- To explain the properties of conducting, semiconducting and dielectric materials
- To understand the working mechanism of junction diodes
- To impart knowledge in optical and magnetic materials

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

Course Outcomes (COs)

1. identify different types of emission of electrons and significance of Fermi function
2. explore the carrier concentration and its variation with temperature of different semiconducting materials
3. analyze the I-V characteristics of a junction diode
4. investigate the various polarization mechanisms in dielectrics
5. select appropriate optical and magnetic materials for data storage devices

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3														
2	2														
3	1														
4	2														
5	1														

UNIT I **10 Hours**

EMISSION PROPERTIES AND QUANTUM THEORY OF SOLIDS

Emission of electrons: types thermionic emission-principle- Richardson equation- secondary emission- principle- work function- Fermi-Dirac distribution function and its temperature dependence significance of Fermi energy- density of energy states- calculation of density of electrons and Fermi energy at 0K- average energy of electrons at 0K problems.

UNIT II **9 Hours**

SEMICONDUCTOR PHYSICS

Intrinsic semiconductors: the law of mass action - expressions for density of electrons and holes - determination of carrier concentration - band gap energy. Extrinsic semiconductors: carrier concentration in p-type and n-type semiconductors. Hall effect: theory - experimental determination of Hall voltage - applications - problems.

UNIT III **9 Hours**

JUNCTION DIODE CHARACTERISTICS

Introduction - pn junction diode - volt-ampere characteristics - diode current equation - static and dynamic resistances - space charge - diffusion capacitance - junction diode switching times. Diode circuit with DC voltage source. Applications: full wave rectifier - capacitor filters - clamper circuits.

UNIT IV **9 Hours**

DIELECTRICS

Introduction: fundamental definitions in dielectrics - expressions for electronic and ionic polarizations - orientation polarization (qualitative) - space charge polarization - Langevin Debye equation - frequency and temperature effects on polarization - expression for internal field (cubic structure) - Clausius-Mosotti equation - dielectric loss - applications of dielectrics - problems.

UNIT V **8 Hours**

OPTOELECTRONICS AND MAGNETIC MATERIALS

Principle, working and characteristics of LED and LCD - blue ray disc. Magnetic materials: basic definitions - properties of dia, para and ferro magnetic materials - explanation of hysteresis curve based on domain theory - hard and soft magnetic materials. Magnetic storage device: principle - working - giant magnetoresistance.

FOR FURTHER READING

Motion of an electron in uniform and non-uniform magnetic fields - electric and magnetic fields in a crossed configuration.

2 Hours

INTRODUCTION

Exposure to Engineering Physics Laboratory and precautionary measures

4 Hours

EXPERIMENT 1

Using Lees disc apparatus, determine the coefficient of thermal conductivity of a bad conductor.

4 Hours

EXPERIMENT 2

Find the band gap value of the given semiconductor diode. Based on the band gap value, identify the given semiconductor.

4 Hours

EXPERIMENT 3

With the aid of traveling microscope, find the refractive index of a transparent solid and liquid material.

4 Hours

EXPERIMENT 4

Determine the wavelength of polychromatic source in the visible region using spectrometer.

4 Hours

EXPERIMENT 5

Based on Hall effect, calculate the charge carrier density of a given semiconductor and identify the nature of the semiconductor.

4 Hours

EXPERIMENT 6

Draw the B-H curve of a ferromagnetic material subjected to external magnetic field and hence identify the nature of the material.

4 Hours

EXPERIMENT 7

Determine the V-I characteristics of a solar cell.

Total: 75 Hours

Reference(s)

1. Jacob Millman, Christos Halkias and Satyabrata JIT, Electronic Devices and Circuits, McGraw Hill Education (India) Private Limited, New Delhi, 2014.
2. William D. Callister, Materials Science and Engineering an Introduction, John Wiley and sons, Inc, 2010.
3. Halliday and Resnick, Fundamentals of Physics, John Wiley and Sons, Inc, 2011.
4. R. S. Sedha, A textbook of Applied Electronics, S. Chand & Company Ltd., New Delhi, 2010.
5. S. O. Pillai, Solid State Physics, New Age International Publications, New Delhi, 2010
6. M. N. Avadhanulu and P.G. Kshirsagar, A Text Book of Engineering Physics, S. Chand & Company Ltd., New Delhi, 2011.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	1	2	2		2	4	2		2	5			2												22
2	2	2			2		3		2	3					6										20
3	2		1		3		2		5				2	2				3							20
4	2	2	2		2	3			2	5			2												20
5	2	2			3	2	2		2				5												18
																								Total	100

Assessment Questions

Remember

1. Recall the Richardson equation.
2. Define dynamic resistance.
3. State the law of mass action.
4. Define Hall Effect.
5. List the three practical applications of p-n junction diode.
6. List the three practical applications of p-n junction diode.
7. List the four types of polarizations in dielectrics
8. Reproduce the expressions for electronic and ionic polarization.
9. State the working principle of LED.
10. Define retentivity and coercivity.

Understand

1. Explain the variation of Fermi-Dirac distribution function with temperature.
2. Indicate the importance of Fermi level.
3. Indicate the reason for preferring extrinsic semiconductors over intrinsic semiconductors.
4. Represent four applications of Hall Effect.
5. Represent the switching action of a diode.
6. Interpret the relation between polarization and polarisability in dielectrics.
7. All the dielectrics are insulators but all the insulators are not dielectrics. Illustrate with examples.
8. Interpret the relation between the dielectric constant and electric susceptibility.
9. Explain the phenomenon of electroluminescence in LED.
10. Summarize the working principle of giant magnetoresistance.

Apply

1. Find the expression for density of electrons and Fermi energy at 0 K.
2. Using the Fermi function, compute the temperature at which there is 1% probability that an electron in a solid will have energy 0.5 eV above EF of 5 eV.
3. Explain how phosphorous atoms donate electrons to the conduction band.
4. Apply the law of mass action to determine the carrier concentration of intrinsic semiconductors.
5. Construct a circuit using p-n junction diode and execute its V-I characteristics.
6. Construct a diode circuit with DC voltage source and demonstrate its working conditions.
7. Show that electronic polarizability is independent of temperature.
8. Explain frequency dependence of dielectrics with a neat sketch.
9. Apply the domain theory to the hysteresis effect observed in ferromagnetic materials.
10. Compute the wavelength of light emitted by an LED with band gap energy of 1.8 eV.

Analyse

1. The average energy of electrons at 0 K depends on Fermi level. Justify.
2. Differentiate p-type and n-type semiconductors.
3. Outline the working principle of full wave bridge rectifier.
4. At optical frequencies the total polarization is less. Justify.
5. Outline the causes for dielectric loss in dielectric materials.
6. Analyze the magnetic behavior of dia, para and ferromagnetic materials.
7. Compare the properties of LED and LCD.
8. Outline the difference between hard and soft magnetic materials.

Evaluate

1. Evaluate the resistance value using V-I characteristics of a p-n junction diode.
2. Evaluate the value of Fermi distribution function for an energy kT above the Fermi energy at that temperature and comment on the answer.

15CH201 ENGINEERING CHEMISTRY 3 0 2 4

Course Objectives

- Recall the terminologies of electrochemistry and explain the function of batteries and fuel cells with its electrochemical reactions
- understand the fundamentals of corrosion, its types and polymers with its applications
- choose appropriate instrumentation technique for interpreting analytical data

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. construct an electrochemical cell and measure its potential using selected reference electrode
2. identify the electrodes, electrolyte and cell reactions in batteries, fuel cells and infer the selection criteria for commercial battery systems with respect to commercial applications
3. Analyze the type of corrosion, factors influencing rate of corrosion on metals and identify suitable corrosion control method
4. differentiate polymers based on its source, properties and applications
5. Select suitable analytical method for the estimation of alkali and alkaline earth metals in aqueous media

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3													
2	2														
3	3	2		1											
4	2	2													
5	3	3		1											

UNIT I **10 Hours**

INTRODUCTION TO ELECTROCHEMISTRY

Types of electrodes - electrode potential - salt bridge - cell reaction - cell representation - silver-silver chloride electrode - calomel electrode - determination of single electrode potential - electrochemical series and its importance. Ion-selective electrode: glass electrode - measurement of pH using glass electrode. Concentration cells (electrode and electrolyte). Potentiometry - potentiometric titrations (redox titration). difference between electrochemical and electrolytic cells

UNIT II **9 Hours**

ENERGY STORAGE DEVICES

Batteries - characteristics of battery - types of batteries. construction, working and applications: Primary (alkaline) and secondary (lead-acid and nickel-cadmium) - Modern batteries (zinc air battery and lithium batteries) - precautions for battery maintenance. Comparison with conventional galvanic cells. Fuel cells - Types of fuel cells: solid polymer electrolyte fuel cell - solid oxide fuel cells - microbial fuel cell. Hydrogen-oxygen fuel cell - construction, working, advantages and limitations

UNIT III **8 Hours**

CORROSION SCIENCE

Corrosion: definition - types of corrosion: chemical and electrochemical corrosion - Pilling-Bedworth ratio - types of oxide layer (stable, unstable, volatile and porous) - hydrogen evolution and oxygen absorption mechanism for electrochemical corrosion - mechanism for rusting of iron. Types of electrochemical corrosion: Galvanic corrosion - differential aeration corrosion (pitting, waterline and pipeline). Galvanic series - applications. Factors influencing corrosion: nature of metal and environment. Corrosion control methods: sacrificial anode method - impressed current cathodic protection method - electroplating - electroless plating

UNIT IV **10 Hours**

POLYMERS AND ITS PROCESSING

Advantages of polymers over metals. Monomers - polymers - polymerization - functionality - degree of polymerization - classification of polymers based on source and applications - Molecular weight determination. Types of polymerization: addition, condensation and copolymerization - mechanism of free radical polymerization. Preparation, properties and applications of thermosetting (epoxy resin and bakelite) and thermoplastics (polyvinyl chloride and polytetrafluoroethylene). Compounding of plastics - injection and extrusion moulding methods

UNIT V **8 Hours**

INSTRUMENTATION TECHNIQUES FOR CHEMICAL ANALYSIS

Beer - Lamberts law. Principle, instrumentation (block diagram only) and applications: UV-visible spectroscopy - Atomic absorption spectroscopy - Colorimetry (estimation of a transition metal) - Flame photometry (estimation of an alkali metal)

FOR FURTHER READING

Nobel prize winners in chemistry over past 5 years

1 **2 Hours**

EXPERIMENT 1

Preparation of N/10 oxalic acid and M/10 sodium carbonate solution.

2 **4 Hours**

EXPERIMENT 2

Determination of strength of hydrochloric acid present in the given solution by pH measurement.

3 **4 Hours**

EXPERIMENT 3

Determination of strength of HCl by conductometric titration.

4 **4 Hours**

EXPERIMENT 4

Conductometric titration of mixture of acids (Hydrochloric acid and acetic acid).

5 **4 Hours**

EXPERIMENT 5

Estimation of iron in the given sample by potentiometric method using saturated calomel electrode.

6 **4 Hours**

EXPERIMENT 6

Measurement of rate of corrosion on zinc/mild steel in aerated neutral/acidic/alkaline solution by weight loss method.

7 **4 Hours**

EXPERIMENT 7

Determination of molecular weight of polyvinyl alcohol using Ostwald viscometer.

8 **4 Hours**

EXPERIMENT 8

Estimation of iron (thiocyanate method) in the given solution by spectrophotometric method.

Total: 75 Hours

Reference(s)

1. M. Munjal and S.M. Gupta, Wiley Engineering Chemistry, Second edition, Wiley India Pvt. Ltd, New Delhi, 2013.
2. A. Pahari and B.Chauhan, Engineering Chemistry, Infinity Science press LLC, New Delhi, 2010.
3. P.H. Rieger, Electrochemistry, Springer, Netherland, Second Edition (Reprint) 2012.
4. Fred W. Billmeyer JR, Textbook of polymer science, John Wiley & sons, Third edition, 2008.
5. Willard Merritt and Dean Settle, Instrumental methods of analysis, CBS publishers, Seventh edition, 2012.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	1	1	1		3	4	2			4	4				1			2							23
2	1	1	1		4	4	3		1	2				1	2										20
3	1	1	1		2	2	1			2	2			2	1			1				1			17
4	5	3	2		3	1	1		1				1	2	2		1	1							23
5	1					3					3				7			2				1			17
																								Total	100

Assessment Questions

Remember

1. List any four significances of EMF series.
2. Define the term single electrode potential.
3. Recall the four advantages of H2-O2 fuel cell.
4. Define the term functionality of a monomer.
5. State Pilling-Bedworth rule.
6. Name two monomers used for the preparation of epoxy resin.
7. Label the parts and charge carried by electrodes in electrochemical and electrolytic cells.
8. List any two significances of monomer functionality.
9. State Beer - Lamberts law.

10. Define concentration cell.

Understand

1. Classify two types of polymers based on source.
2. Compare electrochemical cell and electrolytic cell with suitable diagrams.
3. Illustrate the mechanism involved in electrochemical corrosion.
4. Explain the principle and five components of UV-visible spectrophotometer.
5. Outline the mechanism for the synthesis of –(CF2-CF2)n– polymer.
6. Identify any two analytical methods to estimate sodium present in aqueous media.
7. Illustrate the injection molding process with a necessary explanation and two advantages.
8. Indicate any two importance of salt bridge in an electrochemical cell.
9. Ilustrate the route to synthesis epoxy resin from its two monomers.
10. Summarize any four advantages of polymers over metals in everyday life.

Apply

1. Calculate the single electrode potential value zinc half-cell dipped in a 0.01M ZnSO4 solution at 25°C? E° Zn/Zn 2+ = 0.763 V, R=8.314 JK -1 Mol -1 , F= 96500 Coulombs.
2. Identify two advantages of degree of polymerization.
3. Find the concentration of given solution using spectrophotometer, if %T, bath length and molar adsorption coefficient are 18, 1 cm and 6000 L/mol. cm.
4. Derive an equation for determination pH of unknown solution using glass electrode.
5. Elaborate any six applications of electrochemical series.
6. Select and explain suitable potentiometric titration to estimate the amount of ferrous ion in the given solution.
7. Discuss the construction and working of electrolyte concentration cell with suitable example.
8. Assess the significance of functionality of monomer in the properties and structure of polymer.

Analyse

1. Outline any two methods for preventing chemical and electrochemical corrosion.
2. Compare the advantages and limitations of electro and electroless plating of nickel.
3. The statement “prevention is better than cure” is not suitable for corrosion science and engineering-Justify your answer.
4. Differentiate addition and condensation polymers based on its synthesis.
5. Arrange the following polymers based on the increasing order of resistance towards chemical
   1. poly(ethylene) 2. Starch 3.Baklite 4.Teflon

Evaluate

1. Calculate the electrode potential of zinc metal if EMF of the cell is 1.10 V (Sat. Calomel electrode was used for complete cell formation.
2. Electrode potentials of A and B are E 0 A/A+ = +0.76 V and E 0 B/B+ = -0.34 V respectively. Choose the appropriate anode half-cell and cathode half-cell by giving the cell representation
3. Find out the degree of polymerization for a low density polytetrafluoroethylene with a molecular weight of 10002 amu. (Atomic weights of F=18.9; C=12)
4. The standard reduction potentials of metals Ag, Fe, Cu and Zn are +0.80v,-0.44v, +0.34v and -0.76v respectively. Arrange the metals in the increasing order of their ability to undergo corrosion.

Create

1. A ship hull in ocean is safe against corrosion under any circumstance - Give reason.
2. Derive the probable reason and possible solution for the following:
   i. Stainless steel should not be used to build ship hull.
   ii. Small anodic area results in intense corrosion.
   iii. Metal under water drop undergoes accelerated corrosion.

15CH202 APPLIED CHEMISTRY 3 0 2 4

Course Objectives

- understand the necessity of water softening processes
- aware the causes and consequences of corrosion
- acquaint the applications of alloying and phase rule in metallurgy
- recognise the fundamentals and applications of fuels
- characterize the chemical compounds using analytical techniques.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. attribute the internal and external treatment methods for the removal of hardness in water for domestic and industrial applications.
2. Analyze the type of corrosion, factors influencing rate of corrosion on metals and corrosion control methods
3. Differentiate ferrous and non ferrous alloys based on its properties, applications and illustrate the importance of phase rule in the field of mettallurgy
4. Distinguish the three types of fuels based on calorific value for selected applications
5. Apply suitable analytical methods for the estimation of elements in aqueous media

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2		1											
2	2	3													
3	1	2													
4	2	1													
5	2	3		1											

UNIT I **10 Hours**

WATER PURIFICATION

Hardness of water - classification of hardness (temporary and permanent) - units of hardness (ppm, mg/l, degree Clark, degree French) - expression of hardness in terms of calcium carbonate equivalence - estimation of hardness by EDTA Method - Uses of water for industrial purpose - requirements of boiler feed water - disadvantages of using hard water in industrial boilers: scale, sludge, priming, foaming and caustic embrittlement. Removal of dissolved salts from hard water: internal conditioning (phosphate, carbonate, calgon and colloidal methods), external conditioning (ion exchange process, reverse osmosis, electrodialysis). Uses of water for domestic purpose - municipal water treatment (screening, aeration, coagulation, sedimentation, filtration and disinfection of water - break point chlorination).

UNIT II **8 Hours**

CORROSION SCIENCE

Corrosion - chemical and electrochemical corrosion - Pilling-Bedworth rule - mechanism (types of oxide layer, oxygen absorption - hydrogen evolution) - Galvanic series -types of electrochemical corrosion: Galvanic corrosion - differential aeration corrosion (pitting, pipeline and waterline)-Factors influencing corrosion (nature of metal and environment). Corrosion control: sacrificial anode - impressed current method.Protective coatings - paint -constituents and functions.

UNIT III **9 Hours**

ALLOYS AND PHASE RULE

Alloys: purpose of alloying - function and effects of alloying elements - properties of alloys - classification of alloys. Ferrous alloys: nichrome and stainless steel. Non-ferrous alloys: brass and bronze. Heat treatment of alloys (annealing, hardening, tempering, normalising, carburizing and nitriding).

Phase rule: phase - component - degree of freedom - phase rule - phase diagram - applications- one component system (water system). Reduced phase rule - two component system (lead and silver system).

UNIT IV **10 Hours**

FUELS

Classification - characteristics - calorific value - solid fuel - coal - types - analysis of coal (proximate and ultimate analysis) - processing of coal to coke - carbonization - types (low temperature and high temperature carbonization) - manufacture of metallurgical coke (Otto Hoffmann method). Liquid fuels - petroleum - refining of crude oil - knocking - octane number - cetane number. Liquid fuel from coal (Bergius process). Gaseous fuels - natural gas (CNG) - coal gas - producer gas - syn gas - shale gas.

UNIT V **8 Hours**

INSTRUMENTAL METHODS

Beer - Lamberts law. Principle, instrumentation (block diagram only) and applications: Ultra violet spectroscopy - Infrared spectroscopy - Atomic absorption spectroscopy - Colorimetry (estimation of transition metal) - Flame photometry (estimation of alkali metal).

FOR FURTHER READING

Synthesis and applications of bio-fuels.

1 **2 Hours**

EXPERIMENT 1

Preparation of N/10 oxalic acid and N/10 sodium carbonate solution.

2 **4 Hours**

EXPERIMENT 2

Water quality of BIT campus - River - Bore well water with respect to hardness, TDS and pH.

3 **4 Hours**

EXPERIMENT 3

Conductometric titration of mixture of acids (HCl CH3COOH).

4 **4 Hours**

EXPERIMENT 4

Determination of strength of hydrochloric acid in a given solution using pH meter.

5 **4 Hours**

EXPERIMENT 5

Determination of the strength of Fe(II) in the given sample by potentiometric method.

6 **4 Hours**

EXPERIMENT 6

Measurement of rate of corrosion on mild steel in aerated / neutral / acidic / alkaline medium by weight loss method.

7 **4 Hours**

EXPERIMENT 7

Estimation of copper content in brass by EDTA method.

8 **4 Hours**

EXPERIMENT 8

Estimation of iron (thiocyanate method) in the given solution by spectrophotometric method.

Total: 75 Hours

Reference(s)

1. A. Pahari and B.Chauhan, Engineering Chemistry, Infinity Science press LLC, New Delhi, 2010.
2. M. Munjal and S.M. Gupta, Wiley Engineering Chemistry, Second edition, Wiley India Pvt. Ltd, New Delhi, 2013.
3. Willard Merritt and Dean Settle, Instrumental methods of analysis, CBS publishers, Seventh edition, 2012.
4. Jain and Jain, Engineering Chemistry, Dhanpat Rai Publishers New Delhi, 16th Edition, 2013.
5. R. Mukhopadhy and S. Datta, Engineering Chemistry, New age international Pvt. Ltd, New Delhi, 2010.
6. Shashi Chawla, Engineering Chemistry, Dhanpat Rai Publishers New Delhi, 2nd Edition, 2003.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	1	1	1		3	4	2			4	4				1			1				1			23
2	1	1	1		2	2	1			2	2			2	1			1				1			17
3	1	1	1		4	4	3		1	2					2							1			20
4	5	3	2		3	1	1		1				1	2	1		1	1				1			23
5	1					3					3				7			2				1			17
																								Total	100

Assessment Questions
Remember

1. Define the term hardness of water.
2. List any two internal conditioning methods to convert hard water to soft water.
3. List the two types of electrochemical corrosion.
4. Recall any two reasons for galvanic corrosion.
5. List the four major objectives of alloying steel.
6. State Gibbs phase rule.
7. Define octane number.
8. State Beer-Lambert's law.
9. Recall any four applications of colorimetry.

Understand

1. Compare temporary and permanent hardness in water.
2. Illustrate the estimation of carbonate, non-carbonate and total hardness by EDTA method.
3. Identify the needs of corrosion control methods with suitable examples.
4. Indicate the two suitable conditions for electrochemical corrosion to occur.
5. Classify the three types of alloys based on metal composition.
6. For one component water system, the triple point is an invariant point. Reason out.
7. Distinguish between syn gas and coal gas.
8. With a neat diagram, explain the processes involved in Bergius process to get synthetic petrol.
9. Diiferentiate chromophore and auxochrome with an example.
10. Infer the role of ammonium thiocyanate in the colorimetric estimation of iron.

Apply

1. Illustrate the necessary steps involved in municipal water treatment.
2. Suggest a suitable laboratory method to estimate carbonate, non-carbonate and total hardness of water.
3. Sketch a suitable protection method to prevent ship's hull made of iron from corrosion.
4. Assess the effects of alloying elements.
5. Apply Gibbs phase rule for one component water system with a neat diagram.
6. Find the combusted products of the following components.
   (i) 2H2 (ii) CH4

7. Find the application of colorimetry for the estimation of iron.
8. Calculate the number of the modes of vibrations for the following molecules.
   (i) C6H6 (ii) CO2

Analyse

1. How can the effect of caustic embrittlement in boiler be resolved?
2. Identify the problems created in boilers if priming and foaming takes place.
3. Increase in temperature increases corrosion rate. Justify
4. Zinc is more corroded when coupled with copper than lead – Reason out.
5. Distinguish ferrous and non-ferrous alloys with examples.
6. Arrange the following materials based on their increasing calorific value.

   peat, lignite, bituminous, wood, anthracite and sub-bituminous.

Evaluate

1. Bolt and nut made of the same metal is preferred in practice. Give reason.
2. Support the statement "Coke is a better fuel than coal".
3. Calculate the absorbance if 10% of light is transmitted.

4. Determine the effect of pH of the conducting medium on corrosion.
5. Determine the number of phases present in the following systems.
   (i) Two miscible liquids (alcohol & water)
   (ii) Two immiscible liquids (benzene & water)

Create

1. Derive the probable reason and possible solution for the following:

   i) Stainless steel should not be used to build ship hull.
   ii) Small anodic area results in intense corrosion.
   iii) Metal under water drop undergoes accelerated corrosion.

2. AAS is a better method for environmental analysis than calorimetric analysis. Justify.

15ME001 COMPUTER AIDED DESIGN 3 0 0 3

Course Objectives

- To provide knowledge on fundamentals of CAD and geometric transformations.
- To understand the various geometric modeling concepts.
- To identify the common visual realism algorithms.
- To impart the knowledge on parts assembly logics and consideration factors.
- To study the available data exchange formats for CAD model transportation.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
m. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Explain the fundamentals of CAD and geometric transformations concepts.
2. Describe the various representation of geometric curves,surfaces and solids.
3. Identify the importance of visual realism algorithms.
4. Identify the significant factors in computer aided assembly.
5. Explain the geometrical model data exchanging formats to transfer CAD Models between various platforms.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2												3		
2	3	2											3		
3	2	1											2		
4	2	2											3		
5	2	1											3		

UNIT I **9 Hours**

FUNDAMENTALS

Product cycle, Sequential and Concurrent Engineering, CAD - Architecture, Tools, applications - Coordinate systems - Two and Three dimensional Transformations - Translation - Scaling - Reflection - Rotation, Windowing - clipping and Viewing.

UNIT II **10 Hours**

GEOMETRIC MODELING

Representation of curves - Hermite, Bezier, B-Spline and rational curves - Surface Modeling - surface patch - Bezier and B spline surface. Solid Modelling - Boundary representation and Constructive Solid Geometry.

UNIT III **9 Hours**

VISUAL REALISM

Coherence - types. Hidden line removal algorithm - Priority and Area oriented algorithms. Hidden Surface removal algorithm - Depth buffer and Warnock's algorithms. Hidden solid removal algorithm, Ray Tracing algorithm, Shading and Coloring - types. Computer Animation.

UNIT IV **8 Hours**

ASSEMBLY OF PARTS

Assembly modeling - Interference of Positions and orientations - CAD Tolerance Analysis - geometrical Mass Properties - degree of freedom - Constraints and Simulation concepts.

UNIT V **9 Hours**

DATA EXCHANGE FORMATS

Database Management System - CAD Standards File types - IGES, PDES, PARASOLID, ACIS, Data - Database - Structures - Types, DXF, STL and STEP Files. Communication Standards - File Transfer between CAD and CAM package.

FOR FURTHER READING

Graphics manipulation and Editing - Parametric Representation of Synthetic Curves - Applications of CAD in FEM

Total: 45 Hours

Reference(s)

1. Ibrahim Zied, CAD/CAM-Theory and Practice, Tata McGraw Hall Publishing Company Pvt. Ltd., New Delhi, 2009.
2. P.Radhakrishnan, CAD-CAM-CIM, New Age International Publishers, New Delhi 2000.
3. Donald Hearn, M. Pauline Baker, Computer Graphics, Prentice Hall of India, New Delhi, 2005.
4. Richard M. Lueptow, Graphics Concepts for Computer-Aided Design, Pearson Education-India, 2006.
5. William M. Neumann, Robert F. Sproul, Principles of Computer Graphics, Tata McGraw Hall Publishing Company Pvt Ltd., New Delhi, 2005.
6. Mikell P. Groover, Emory W. Zimmers, CAD/CAM Computer-Aided Design and Manufacturing, Prentice Hall of India, New Delhi, 2007.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	5	5			5	5																			20
2	4					12																			16
3	2		8			8																			18
4	2	5	5			10																			22
5	2	6			2	6					8														24
																								Total	100

Assessment Questions

Remember

1. Define data structure.
2. What are the activities carried out in design analysis?
3. List out the activities of synthesis in design process.
4. Define the translation.
5. List the types of shading.
6. List any five modeling packages.
7. What are the basic entities of wire frame modeling?
8. List the four types of modeling data of product description.
9. Define data structure.
10. What are the limitations found in the general wire frame modeling system?
11. Define degree of freedom.
12. Define Data.

Understand

1. Compare CAD and CAM.
2. Predict the meaning of data structure in Database Management System?
3. Classify data structures.
4. Illustrate the working of “Rotation” in graphics fundamentals.
5. How to do clipping process in Computer Graphics?
6. Differentiate CSG and B-REP technique of solid modeling.
7. Differentiate Constant and Gouraud shading techniques.
8. Distinguish any two differences between 2D and 3D wireframe models.
9. What do you mean by Loopback test in verification of IGES processor?
10. How to construct a CSG model?
11. Give you an idea about the importance of clipping.
12. Differentiate Z-Buffer and Warnock’s algorithm.

Apply

1. Generate a translation transformation matrix to move 3 units in X axis and 5 units in Y axis of any given line.
2. Derive the translation transformation matrix. Generate the matrix to move 3 units in X axis and 5 units in Y axis of any given line.
3. How hidden line can be removed from the given object? Apply suitable algorithm for the hidden line removal.
4. Select and explain a suitable algorithm for hidden surface removal of the given object which obscure with other object.
5. Generate a translation transformation matrix to move 3 units in X axis and 5 units in Y axis of any given line.

15ME002 APPLIED HYDRAULICS AND PNEUMATICS **3 0 0 3**

Course Objectives

- To impart knowledge on various types of hydraulic pumps and actuators.
- To learn about various hydraulic components and its functions.
- To provide knowledge about the selection of hydraulic components.
- To study about various types of pneumatic components and servo systems.
- To learn fluid power circuit design methods and its applications.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Identify suitable hydraulic pumps and actuators for different applications.
2. Choose the suitable hydraulic components for various applications.
3. Select the suitable fluid power components for various applications.
4. Choose the suitable pneumatic components for different applications.
5. Design fluid power circuit for given applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1											1		
2	2	1													
3	1	2										1	2		
4	2	1	1												
5	1	1	3									2	2		

UNIT I **10 Hours**

HYDRAULIC PUMPS AND ACTUATORS

Introduction to fluid power system- Applications of Pascal's Law- Hydraulic pumps - Pumping theory, classification - Gear pump, Vane pump, piston pump, lobe pump, construction and working principles - Fluid power Actuators-Single acting, Double acting, cushioning and telescopic cylinder, construction and working principles. Gear Motors, Vane motors.

UNIT II **10 Hours**

HYDRAULIC COMPONENTS

Direction control valve - check valve, shuttle valve, 3/2 , 4/2 and 4/3 way valve and solenoid valve - Actuation methods. Pressure control valves-pressure relief valve, compound pressure relief valve, pressure reducing valve, unloading valve, sequence valve, counterbalance valve. Flow control valves-types. Accumulators and intensifier - Types.

UNIT III **8 Hours**

SELECTION OF HYDRAULIC COMPONENTS

Selection factors-Selection of pumps. Actuators- cylinders, motors versus load-Piston rod buckling. Selection of Hydraulic pipe and hoses, valves, reservoir, filters, Accumulators and intensifiers

UNIT IV **9 Hours**

PNEUMATIC COMPONENTS

Compressors- Filter, Regulator, Lubricator (FRL) unit, mufflers. Valves- direction control valves - shuttle valve, two way air piloted valve, push button valve, quick exhaust valve, lever control valve and solenoid valve - Pneumatic actuators. Servo system - Hydro mechanical, Electro hydraulic and proportional valve.

UNIT V **8 Hours**

DESIGN OF FLUID POWER CIRCUIT

Fluid power circuits- Speed control circuits, synchronizing circuit, sequential circuit and design for simple application using cascade and stepper sequencer method. Application of Accumulator and Intensifier circuit.

FOR FURTHER READING

Design and simulation of simple circuit using Simulation software. Causes and trouble shootings of fluid power system.

Total: 45 Hours

Reference(s)

1. Anthony Esposito, Fluid power with applications, Pearson Education, New Delhi, 2011
2. S.R Majumdar, Oil hydraulics, Tata McGraw Hill publishing company Pvt. Ltd. New Delhi, 2004.
3. S.R.Majumdar, Pneumatic systems-Principles and maintenance, Tata McGraw Hill publishing company Pvt. Ltd., New Delhi, 2008.
4. S.Ilango Introduction to Hydraulics and Pneumatics, Prentice Hall of India Pvt. Ltd., New Delhi, 2007.
5. Andrew Parr, Hydraulics and Pneumatics, Jaico Publishing House, 2006.
6. www.nptel.ac.in/course/112106175

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	8				12																				20
2	2	2			2	4				10															20
3	2				8					10															20
4	4				4					12															20
5		4			10					6															20
																								Total	100

Assessment Questions

Remember

1. Define fluid power system.
2. List three basic methods of transmitting power.
3. Draw any two fluid power symbols.
4. State Pascal’s law.
5. Define pump.
6. What is the function of hydraulic actuator?
7. List the types of hydraulic cylinder.
8. What is the function of hydraulic motor?
9. Define intensifier ratio.
10. What is significant function of air filter?
11. What do you mean by Filter?
12. What do you meant by sequencing cylinders?

Understand

1. Differentiate Hydraulic and pneumatic System.
2. Why pressure is not controlled by direction control valve?
3. Why lobe pump is low noise than gear pump?
4. Differentiate Pump and Actuator.
5. What are relationships between flow rate and pressure in hydraulic circuit?
6. When do you prefer poppet type hydraulic valves?
7. Distinguish between a pressure control valve and pressure relief valve.
8. Why is pressure measurement considered in the hydraulic system?
9. Why is a pressure relief valve used in a hydraulic system?
10. Why are mufflers used in pneumatic system?

Apply

1. Draw a circuit using step counter method for the following sequence A+ B+ B- A- Where A and B stands for cylinders, (+) indicates extension and (–) indicates retraction of cylinders.
2. Consider an automatic drilling machine. The complete cycle is as follows: Cylinder A extends to clamp the work piece, then cylinder B extends to drill a hole and then retracts. Cylinder A then retracts to unclamp the work piece. Design a control circuit applying the step-counter method. The circuit is provided with a start valve to avoid continuous cycling.

Analyse

1. A cylinder has a bore of 125mm diameter and a rod of 70m diameter. It drives a load of2000 kg vertically up and down at a maximum velocity of 3m/s. the load is slowed down torest in the cushion length of 50mm. if the relief value is set at 140 bar, determine theaverage pressure in the cushions while extending and retracting.
2. A cylinder has a bore of 125mm diameter and a rod of 70m diameter. It drives a load of 2000 kg vertically up and down at a maximum velocity of 3m/s. the load is slowed down torest in the cushion length of 50mm. if the relief value is set at 140 bar, determine theaverage pressure in the cushions while extending and retracting.

15ME003 DESIGN OF JIGS, FIXTURES AND PRESS TOOLS

3 0 0 3

Course Objectives

- To provide knowledge on design principles for designing the jigs and fixtures.
- To impart knowledge on locating and clamping principles for designing jigs and fixtures.
- To introduce the different types of jigs for producing the part.
- To study the different types of fixtures for producing the part.
- To introduce about press working terminologies and press accessories.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Explain the design aspects of jigs and fixtures.
2. Identify the suitable locators and clamps for jigs, fixtures and press tools.
3. Design a suitable jig for producing a part the given component.
4. Design a suitable fixture for the given component producing a part.
5. Design a suitable press tool dies and Press tools for the given simple components.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2					1							1		
2	2	1				1							1		
3	2	1	3			1						2	1		
4	2	1	3			1						2	1		
5	2	1	3			1						2	2		

UNIT I **7 Hours**

TOOL DESIGN

Objectives, Challenges and Requirements, Production and Inspection Devices. Jigs and Fixtures - Differences, Design principles, Advantages, Essential Features, Materials used. Introduction to

Limits, Fits and Tolerances, International Tolerance Grades, Geometric Dimensioning and Tolerancing.

UNIT II **8 Hours**

LOCATION AND CLAMPING

Location - Principles, Basic rules, Degrees of Freedom, 3-2-1 Principle, Locating Methods, Types of Locators, Standard Parts. Clamping - Principles, Types of Mechanical Actuation Clamps, Pneumatic, Hydraulic, Magnetic, Vacuum, Electrostatic clamping, Epoxy Resin Clamping. Factors considered for Design of Jigs and Fixtures.

UNIT III **10 Hours**

UNIT III JIGS

Jigs - Elements, Construction, Types and Materials for Jig Elements. Drill bushes - Types, Special Bushes, Bush Clearance. Automatic drill jig, Rack and pinion operated, Indexing, Air operated Jig components - Design of Jigs for given components.

UNIT IV **10 Hours**

FIXTURES

General Design Principles of Fixture. Types of Boring, Lathe, Milling and Broaching fixtures - Setting Block. Grinding, Planing and Shaping fixtures. Inspection - Gauging, Measuring and Supplement fixtures. Welding, Assembly and Modular fixtures. Design of fixtures for given component.

UNIT V **10 Hours**

PRESS TOOLS

Mechanical Presses - Working terminology, Elements, Types and Press Accessories. Types of Dies, Punches and Strippers. Pressure pad, Knockouts, Stops and Pilots. Bending, Forming, Drawing and Deep Drawing - Dies and its Types. Spring-back phenomenon and Draw Ratio. Progressive, Combination and Compound Dies. Design and Development of Dies - Blank Development, Strip Layout, Computation of capacities and tonnage requirements.

FOR FURTHER READING

Analysis of Clamping forces - Tolerance and Error Analysis - Design considerations in forging, extrusion, casting and plastic dies.

Total: 45 Hours

Reference(s)

1. Edward G. Hoffman, Jig and Fixture Design, Cengage Learning, New Delhi, 2004
2. C. Elanchezhian, Design of Jigs, Fixtures and Press Tools, Eswar Press, Chennai, 2010
3. P. H. Joshi, Jigs & Fixtures, Tata McGraw Hill Education Private Limited, New Delhi 2012
4. Hiram E Grant, Jigs and Fixtures, Tata McGraw Hill Education Private Limited, New Delhi, 2011
5. C. Donaldson, G. H. Lecain and V. C. Goold, Tool Design, Tata McGraw Hill Education Private Limited, New Delhi, 2011
6. Fred Herbert Colvin, Lucian Levant Hass, Jigs and Fixtures: A Reference Book Showing Many Types of Jigs and Fixtures in Actual Use, and Suggestions for Various Cases, Nabu Press, 2011

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	6					6				8															20
2	6					6				8															20
3	4					8				8															20
4	4					8				8															20
5	4					4				12															20
																								Total	100

Assessment Questions

Remember

1. What is meant by tooling?
2. List the production devices.
3. Define tolerance.
4. List seven objectives of tool design.
5. State the challenges faced by a tool designer?
6. Define repeatability.
7. What is 'spring back' in bending?
8. List the skills of a tool designer.
9. What is a bulging operation?
10. What is Notching?

Understand

1. Contrast jig and fixture.
2. Why should the tool be foolproof?
3. Why clearance is required between bush and work piece?
4. Why should the locator be only half as long as the part thickness?
5. Why should the secondary locator be relieved?
6. Why must clamped areas have support?
7. Where should locators contact the part? Why?
8. Why must clamped areas have support?
9. How can tool forces be used to advantage?
10. How can rough cast surfaces be located?

Apply

1. Illustrate with neat sketches, step by step procedure of constraining the degrees of freedom using 3-2-1 principle.
2. Indicate how various features of part can be used for locating different parts.
3. Must all fixtures remain stationary while the tool moves?
4. Justify the selection of compound die over a progressive die. Explain the working of a compound die with neat sketch.
5. A steel cup of height 30 mm and internal diameter 40 mm with a flange width of 10 mm is to be deep drawn from a sheet l mm thick. Determine the diameter of the blank and the drawing force. What is the draw ratio? Can the cup be drawn in a single operation and sketch any two views of a draw die?
6. Design a broaching fixture to perform broaching operation on sides of a square block of size 50 mm x 50 mm.
7. Two plates are to be held at right angles to fabricate an L-shaped component by gas welding. Suggest a suitable fixture.
8. Estimate the blanking force to cut a blank of 25 mm wide and 30 mm long from a 1.5 mm thick metal strip, if the ultimate shear stress of the material is 450 N/ mm2. Also determine the work done if the percentage penetration is 25 percent of material thickness.

9. A steel cup of height 30 mm and internal diameter 40 mm with a flange width of 10 mm is to be deep drawn from a sheet l mm thick. Determine the diameter of the blank and the drawing force. What is the draw ratio?

15ME004 NON - TRADITIONAL MACHINING PROCESSES

3 0 0 3

Course Objectives

- To introduce basics of non-traditional machining processes.
- To study the mechanical energy based non-traditional machining processes.
- To provide knowledge on electrical energy based non-traditional machining process.
- To impart knowledge on chemical and electro-chemical energy based processes.
- To impart knowledge on thermal energy based machining processes.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
n. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Explain the basics of non-traditional machining processes.
2. Select the suitable mechanical energy based non-traditional machining processes for the given industrial applications.
3. Find the suitable machining processes for machining electrically conductive materials.
4. Choose appropriate chemical and electro-chemical energy based processes for precision machining
5. Select the suitable thermal energy based process for cutting and machining of the hard materials.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1			1		1					1		2	
2	2	2			1		2					1		2	
3	2	2			1		2					1		2	
4	2	2			1		2					1		2	
5	2	2			1		2					1		2	

UNIT I **7 Hours**

UNCONVENTIONAL MACHINING PROCESS

Introduction - Need - Classification - Energies employed in the processes - Brief overview of Abrasive jet machining(AJM), Water jet machining(WJM), Ultrasonic machining(USM), Electric discharge machining(EBM), Electro-chemical machining(ECM), Electron beam machining(EBM), Laser beam machining(LBM), Plasma arc machining(PAM).

UNIT II **10 Hours**

MECHANICAL ENERGY BASED PROCESSES

Abrasive Jet Machining, Water Jet Machining and Ultrasonic Machining - Working Principles, Equipment, Process parameters, Material removal rate, Applications.

UNIT III **10 Hours**

ELECTRICAL ENERGY BASED PROCESSES

Electric Discharge Machining - Working Principles, Equipment, Process Parameters, Material removal rate, Electrode / Tool, Power Circuits, Tool Wear, Dielectric, Flushing, Wire cut EDM - Applications.

UNIT IV **10 Hours**

CHEMICAL AND ELECTRO-CHEMICAL ENERGY BASED PROCESSES

Chemical machining - Etchants, Maskants - techniques. Electro-chemical machining - Working principle, Equipment, Process Parameters, Material removal rate, Electrical circuit. Electro-chemical grinding - Electro-chemical honing - Applications.

UNIT V **8 Hours**

THERMAL ENERGY BASED PROCESSES

Laser Beam machining, Plasma Arc Machining - Principles, Equipment. Electron Beam Machining - Principles, Equipment, Types, Beam control techniques, Material removal rate - Applications.

FOR FURTHER READING

Abrasive water jet machining- Micro EDM- Electric discharge grinding and drilling- Electro-stream drilling- Electro-chemical deburring.

Total: 45 Hours

Reference(s)

1. P. K. Mishra, Non Conventional Machining, Narosa Publishing House, New Delhi, 2007.
2. P. C. Pandey and H.S.Shan, Modern Machining Processes, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi, 2008.
3. Joao Paulo Davim, Nontraditional Machining Processes: Research Advances, Springer, New York,2013.
4. Paul De Garmo, J.T.Black, and Ronald.A.Kohser, Material and Processes in Manufacturing, Prentice Hall of India Pvt. Ltd., New Delhi, 2011.
5. Vijaya Kumar Jain, Advanced Machining Processes, Allied Publishers Pvt. Ltd., New Delhi, 2005.
6. Hassan El-Hofy, Advanced Machining Processes: Nontraditional and Hybrid Machining Processes, McGraw-Hill Professional, New delhi, 2005

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	
1	4					12					4														20
2		4				4					12														20
3	4					8					8														20
4		4				8					8														20
5	4					4					12														20
																								Total	100

Assessment Questions

Remember

1. What is an abrasive?
2. State any two characteristics of a good dielectric fluid.
3. List out the main parts of AJM process.
4. What is the function of sonatrode?
5. Mention four applications of unconventional machining.
6. What is the principle of EDM?
7. What are all the tool material used in ECM processes?
8. What are the advantages of chemical machining?
9. What are the types of LASERS?
10. Define: Plasma.

Understand

1. Identify the processes that can machine electrically conductive materials.
2. Compare electrolyte and dielectric fluid.
3. How EBM differs from PAM?
4. How ECG differs from ECM?
5. How the grinding wheel used in ECG, is able to conduct electricity?
6. Why two types of mirrors are used in producing LASER light in Ruby laser?
7. How water can machine hard materials like metals?
8. How electrochemical honing differs from conventional honing.
9. How to produce plasma?

Apply

1. Why short circuiting happens in ECM?
2. Knowing all the parameters of EDM process, how to arrive the material removal rate?
3. In which cases the chemical machining can be conveniently applied?
4. Which method can give better surface finish, an EDM or an EBM? Justify.
5. How to find out the material removal rate for a metal and an alloy machined using ECM?

15ME005 WELDING TECHNOLOGY 3 0 0 3

Course Objectives

- To study working principle of welding processes and its parameters.
- To provide knowledge on special welding processes.
- To study the welding metallurgy and design of weldments.
- To know about automation in welding processes.
- To learn about the welding defects, inspection and testing.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
n. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Explain the construction and working of welding process and its parameters.
2. Assess the suitable special welding techniques for industrial requirements.
3. Select the welding symbol, welding metallurgy and weld ability of special metals.
4. Implement the welding automation techniques in the real time applications.
5. Select the suitable inspection and testing methods to test the welded components.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2		1	1	1	1	1					2		1	
2	2		1	1	1	1	1					2		1	
3	2	1	1	2								2		1	
4	2		1	1	2	1						2		1	
5	2	2	1	2	1						1	2		1	

UNIT I **8 Hours**

BASICS AND PRINCIPLES OF WELDING PROCESS

Classification - Weld joints, Position, edge preparation, fluxes, filler rod- safety aspects in welding - Fusion welding - Gas Tungsten Arc Welding, gas metal arc welding, submerged arc welding. Resistance welding-spot, seam, projection, percussion, flash. Atomic hydrogen arc welding, Thermit welding

UNIT II **8 Hours**

SPECIAL WELDING PROCESSES

Electron beam and Laser beam welding - plasma arc welding - stud welding - friction welding - explosive welding - ultrasonic welding - roll bonding-diffusion bonding - cold welding - welding of plastics- Underwater welding.

UNIT III **10 Hours**

WELD DESIGN AND METALLURGY

Welding symbols, welding dimension, No. of examination, area of examination, Nondestructive testing symbol - welding design, selection of joint, selection of weld type-allowable strengths of welding, fatigue strengths of welds. Welding Metallurgy of steel, solidification of weld metal, gas metal reaction, slag metal reaction. Weldability of cast iron, steel, stainless steel, aluminum alloys.

UNIT IV **9 Hours**

WELDING AUTOMATION

Automation - welding operation, structure analysis, and classification - Introduction to robotic welding system, types, and selection mechanics - Design of welding robots - Joint tracking system. Welding fixtures.

UNIT V **10 Hours**

WELD DEFECTS AND INSPECTION AND TESTING OF WELDING

Weld defect - Surface and subsurface defects - Sources of weld defect - Inspection and testing of welds. Destructive Testing - Tensile Tests, Impact Tests, Bend Tests. Non-destructive Testing - Liquid Penetrant Testing, Magnetic Particle Testing, Eddy Current Testing, Radio-Graphic Testing, Ultrasonic Testing. Tightness test - Testing of pipe, plate, boiler, drum, tank. Acceptance levels of arc welding defects

FOR FURTHER READING

Case studies- Application of underwater welding and explosive welding.

Total: 45 Hours

Reference(s)

1. Little, Welding technology, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi,2004.
2. R. S. Parmer, Welding Processes & Technology, Khanna Publishers, New Delhi, 2008.
3. O. P. Khanna, A text book of Welding Technology, Dhanpatrai publications, Second Edition - New Delhi, 2002.
4. Metals Hand Book, Volume 6, American Society for Metals, 2005.
5. Sindokou, Welding metallurgy, A Jhon wiley & sons,Inc. Publication, Second Edition-New Jersey, 2003.
6. www.weldingtypes.net

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	
1	10					5					5														20
2	5					10					5														20
3	5					10					5														20
4	10					10																			20
5	10					10																			20
																								Total	100

Assessment Questions

Remember

1. Define weldability?
2. Define Brazing?
3. Define the term HAZ?
4. Define the structure of an electric arc.
5. What is mean by arc mechanism?
6. What is arc length?
7. State any two weld defects.
8. What is meant by arc blow? State its causes and remedies?
9. List out the classification and coating scheme for electrodes.

Understand

1. What are the difficulties encountered in overhead welding?
2. Which welding processes applicable for welding CI? Why?
3. Which welding process is applicable for welding Al? Why?
4. What are the capabilities of MIG welding process?
5. What is preheating and why it is done?
6. What is the purpose of heat treatment in welding?
7. How the welding is related with the properties of metals?
8. When the porosity occurs in welds? What its remedy?
9. What is meant by welding in vertical position?
10. What is the cause of undercuts in welding?
11. Why stainless steel are not possible to weld by submerged arc process?
12. How the electron beam welding is relevant for welding of thick plates.

Apply

1. In which situation we can use resistance welding?
2. What are the applicability's of atomic hydrogen welding?
3. Which welding process is suitable for welding alloy steels?Why?
4. What is the application of spray transfer mechanism in GMAW process?
5. In which situation we can use laser beam welding?

15ME006 MECHANICAL BEHAVIOUR OF MATERIALS

3 0 0 3

Course Objectives

- To provide knowledge on deformation mechanisms in materials.
- To learn high temperature deformation phenomena.
- To impart knowledge on various fracture mechanism.
- To provide knowledge on the various strengthening mechanisms in materials.
- To impart knowledge on fatigue failure for different cyclic loading conditions.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
m. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Explain the deformation mechanisms of different materials.
2. Describe the phenomenon of high temperature deformation & failure
3. Explain the types of fracture modes and its mechanisms.
4. Express the concept of different strengthening mechanisms and its advantages
5. Describe about fatigue failure and its characteristics.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2		1		1	2							2		
2	2		1		1	2							2		
3	2		1		1	2							2		
4	2		1		1	2							2		
5	2		1		1	2							2		

UNIT I **9 Hours**

BASIC CONCEPT OF MATERIAL BEHAVIOR

Deformation - Types - Elastic deformation - Elastic modulus, linear elastic deformation- Rubber elasticity, Elasticity -Plastic deformation, Yield strength of a perfect crystal, Dislocations - Edge, Screw and Mixed dislocation, Slip and Twinning, Interaction of moving dislocations

UNIT II **9 Hours**

HIGH TEMPERATURE DEFORMATION

Creep mechanism - Dislocation glide at low temperature, Differential flow creep mechanisms - Creep in two phase alloys - Independent and sequential process -Deformation mechanism maps - Engineering aspects of creep design -Introduction to Super plasticity, Hot working of metals, Dynamic Recovery and recrystallization.

UNIT III **9 Hours**

TENSILE FRACTURE AT LOW TEMPERATURE AND EMBRITTLEMENT

Theoretical strength of a crystalline solid - Types of low temperature tensile fracture (Mode I, Mode II, Mode III Brittle fracture) - Ductile fracture, Introduction to Embrittlement fracture and types - Characteristics of Liquid Metal Embrittlement (LME), Solid Metal Embrittlement (SME), Hydrogen Embrittlement (HE) and Stress Corrosion Cracking (SCC).

UNIT IV **9 Hours**

STRENGTHENING MECHANISMS

Strengthening Mechanism-Types-Work hardening, Boundary strengthening, solid solution strengthening, Particle hardening- Deformation of two phase aggregates- Precipitation hardening in aluminum alloys, Patented steel wire, Martensite, Ausforming, TRIP (Transformed induced plasticity) steel, Maraging steel

UNIT V **9 Hours**

FRACTURE MECHANICS AND FATIGUE

Importance of Fracture Mechanics, Griffith Fracture Theory-Crack Driving Force & Energy Release Rate-Stress intensity factors - Fracture Toughness - Crack initiation and propagation- Material design for fracture toughness- Characteristics of fatigue fracture - Fatigue crack growth rates - Paris Law - Cyclic stress-strain behavior - Design and evaluation of materials against fatigue.

FOR FURTHER READING

Case studies: Creep-fatigue interaction, Ductile to brittle transition temperature, Corrosion fatigue, Fretting fatigue.

Total: 45 Hours

Reference(s)

1. Thomas H Courtney, Mechanical Behavior Materials, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2000
2. R. W. Hertzberg, Deformation and Fracture Mechanics of Engineering Materials, John Wiley & Sons, New Delhi, 2000.
3. M. A. Meyers and K. Chawla, Mechanical Behavior of Materials, Prentice Hall of India, New Delhi, 2001.
4. George E. Dieter, Mechanical Metallurgy, Tata McGraw Hill Publishing Company Pvt. Ltd, New Delhi, 2007.
5. F. A. Mcclintock, and A. S. Argon, Mechanical Behavior of Materials, Addison Wesley Reading , Mass, New Delhi, 1966.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1		10				5				5															20
2		10				5				5															20
3		10				5				5															20
4		10				5				5															20
5		10				5				5															20
																								Total	100

Assessment Questions

Remember

1. State Hook's Law.
2. Define true stress–strain.
3. Define ductile fracture.
4. What is theoretical cohesive strength of solids?
5. What are the two standards of the minimum creep rate?
6. What is a Burger's vector?
7. What is homologous temperature?
8. Define Super plasticity.
9. Which test is used to measure toughness?
10. Define Endurance Limit.
11. What is Dislocation?
12. What are the various methods to increase fatigue strength?
13. Draw Goodman diagram for fatigue loading.
14. What is Bauschinger Effect?
15. List at least two factors that promote transition from ductile to brittle fracture.
16. Define fracture toughness.
17. What is TRIP steel?

Understand

1. Differentiate between fatigue and creep failures.
2. Differentiate between slip and twin (give at least 2 differences).
3. Differentiate between slip and twin (give at least 2 differences).
4. Why are bulb filaments made of single crystals?
5. Why is Annealing done after cold working?
6. Differentiate between Edge and Screw dislocation.
7. Specific strength of materials is very high when they are in fiber size but lower when they are in bar form – Why?
8. Why fatigue strength decreases as size of a part increases beyond around 10 mm?
9. Draw the Goodman straight line and the soderberg straight line for design under fatigue loads.
10. Differentiate between cold working and Annealing.
11. Compare tension test and torsion test in terms of the state of stress and strain developed.
12. Differentiate between Ausforming and Martempering.
13. How is S–N curve constructed?

Apply

1. Discuss about slip planes and slip direction (slip system) in FCC, BCC and HCP metals.
2. The toughness of a 700 MPa yield structural steel is estimated to be 140 MPa. what size and mass of SEN bend test specimen is necessary, and what capacity of Testing Machine would be required? Assume fracture at $\alpha = 0.5$.
3. Estimate the life of the component of the previous problem with an initial crack size of 5 mm, if the material yield is 250 MPa. Assume a plastic configuration factor of $(1 - \alpha)$.

15ME007 PROCESS PLANNING AND COST ESTIMATION 3 0 0 3

Course Objectives

- To introduce the process planning concepts.
- To impart the importance of cost estimation process and procedures.
- To study the procedure to calculate direct, indirect and overhead expenses.
- To learn the procedure to estimate the various machine costs.
- To learn procedure to estimate the machining time for Lathe, drilling, boring, shaping, milling and grinding operations.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Design, analyse and evaluate the performance of mechanical systems.
n. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Explain the concepts of process planning and cost estimation.
2. Assess the importance of cost estimation process and its procedures.
3. Compute direct, indirect and over head expenses.
4. Determine the production cost of forging, welding, and foundry.
5. Find the machining time for Lathe, drilling, boring, shaping, milling and grinding operations

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1								1		2	1	1	1	
2	3	1	-					1	1		2	1	1		
3	2	1	2					1	2		2	2	1	2	
4	3	1	2					2	1		2	2	2	2	
5	3	1	2						1			2	2	2	

UNIT I **9 Hours**

PROCESS PLANNING

Definition - Objective - Scope - Process planning activities - Approaches - Manual, Computer Aided Process planning - Retrieval, Generative and Semi- generative - Selection processes - Machine selection - Material selection parameters - Set of documents for process planning. Production time calculation - Selection of cost optimal processes.

UNIT II **8 Hours**

INTRODUCTION TO COST ESTIMATION

Objectives and functions of Estimating - Costing - Importance and aims of Costing - Difference between Costing and Estimation - Methods of Costing - Types of estimates - Methods of estimates - Importance of Realistic Estimates - Estimating procedure.

UNIT III **8 Hours**

ELEMENTS OF COST

Introduction - Material Cost - Direct and Indirect - Labour cost - Direct, Indirect and Determination of Direct Labour Cost - Expenses - Direct and Indirect - Analysis of overhead expenses - Administrative expenses - Selling and Distributing expenses - Allocation of overhead expenses- Depreciation - Causes and methods of depreciation.

UNIT IV **10 Hours**

PRODUCTION COST ESTIMATION

Estimation in forging shop - Losses in forging and forging cost - Problems - Estimation in Gas cutting and welding shop - Material cost, Labour cost and Finish on cost -Problems - Estimation in foundry shop - Pattern cost, Foundry cost and casting cost - Problems

UNIT V **10 Hours**

ESTIMATION OF MACHINING TIME

Importance of machine time calculations - Estimation of machining time for Lathe, drilling, boring, shaping, milling and grinding operations - Problems

FOR FURTHER READING

Case studies in Plant Layout design, Equipment selection, and process planning, Cost Evaluation of Layout - Implementation process.

Total: 45 Hours

Reference(s)

1. R. Kesavan, E.Elanchezhian, B.Vijaya Ramnath, Process planning and cost estimation, New Age International Publications, 2008
2. M.Adithan, Process Planning and Cost Estimation, New Age International Publications, 2007.

3. Peter scalon, Process planning, Design/Manufacture Interface, Elsevier science technology Books, Dec-2002.
4. B. P. Sinha, Mechanical Estimating and Costing, Tata McGraw Hill Publishing Company Private. Limited., 2001.
5. S. K. Mukhopadhyay, Production Planning and Control-Text and cases, Prentice Hall of India Private Limited, 2007.
6. Chitale.A.V., Gupta.R.C., Product Design and Manufacturing, Prentice Hall of India Private Limited, 2000.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	3				2	4	3			3	2				3										20
2		2				2	2			5	5			2	2										20
3		2				4	6							4	4										20
4	2						4				4			5	5										20
5		4				6				6	4														20
																								Total	100

Assessment Questions

Remember

1. Define process planning.
2. Define breakeven point.
3. List three commercially available Computer Aided Process Planning systems (CAPP).
4. List four methods of costing.
5. Define ladder of cost.
6. State overhead expenses.
7. Outline indirect labour cost?
8. Define Depreciation due to Physical Decay.
9. Describe tong hold loss?
10. List various data required to make a cost estimate.

Understand

1. Classify the effect of simplification.
2. Illustrate the factors that affect process planning.
3. Compare manual process planning with computer aided process planning.
4. Illustrate the factors for calculating probable cost of the product.
5. Differentiate between estimating and costing in terms of organizing department.
6. Justify that process material is direct material.
7. How to determine the direct labour cost?
8. When do you prefer allocation of overhead expenses by unit rate?
9. Differentiate hot forging and cold forging.
10. In general, what is the amount of scale loss considered?

Apply

1. What will be the weight of the material required to produce it. The density of material is 2.681 gm/cc. Find also the material cost if its rate is Rs.13.60 per kg.
2. A Cast Iron factory has employees of 25 persons. It consumes material worth Rs. 35,000 pays workers at the rate of Rs. 5 per hour and incurs total overheads of Rs.20,000. In a particular

month (25 days) workers and an overtime of 150 hours and were paid double than the normal rate. Find
i) The total cost, and
ii) The man hour rate of overheads. Assume 8 hours working days.

Analyse

1. Classify the technological framework of process by using a block diagram.
2. Compare and contrast the features of variant and generative CAPP systems.

15ME008 INTERNAL COMBUSTION ENGINES 3 0 0 3

Course Objectives

- To learn about the combustion phenomenon in spark ignition engines.
- To learn about the combustion phenomenon in compression ignition engines.
- To study the causes, effects and control of pollutants from an Internal Combustion engine.
- To provide the knowledge of alternate fuels in Internal Combustion engines.
- To impart the knowledge on recent developments in Internal Combustion engines.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
o. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Examine the combustion phenomenon in spark ignition engines.
2. Examine the combustion phenomenon in compression ignition engines.
3. Distinguish the causes,effects and control of pollutants from an IC engine.
4. Identify the uses of alternate fuels in Internal Combustion engines.
5. Illustrate the recent developments in Internal Combustion engines.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2														2
2	2														2
3	2						2								1
4	2		1				2								1
5	2											1			1

UNIT I **9 Hours**

SPARK IGNITION ENGINES

Spark ignition engine- Mixture requirements, carburetors, fuel injection systems, mono point and multipoint injection, stages of combustion, normal and abnormal combustion, factors affecting knocking-combustion chambers.

UNIT II **10 Hours**

COMPRESSION IGNITION ENGINES

States of combustion in Compression Ignition Engine - combustion knock in compression ignition engines, methods of controlling knock. Direct and indirect injection systems. Combustion chambers. Fuel spray behaviour-spray structure, spray penetration and evaporation. Air motion-turbocharging.

UNIT III **10 Hours**

POLLUTANT FORMATION AND CONTROL

Pollutant -formation of Oxides of Nitrogen in spark ignition and compression ignition engines, hydrocarbon emission - carbon monoxide formation - particulate emissions. Measurement of exhaust emissions- Non dispersive infrared gas analyzer, gas chromatography, chemiluminescent analyser and flame ionization detector, smoke meters. Methods of controlling emissions- Catalytic converters and particulate traps. Exhaust gas recirculation and Selective catalytic Reduction

UNIT IV **7 Hours**

ALTERNATIVE FUELS

Bio-fuels, alcohol, hydrogen, natural gas and liquefied petroleum gas, bio gas, properties, suitability, engine modifications, merits and demerits as fuels

UNIT V **9 Hours**

RECENT TRENDS

Lean Burn Engines - stratified charge engines, homogeneous charge compression ignition, plasma Ignition. Variable valve timing, multi-valving, tuned manifolding, camless valve gearing, Variable compression ratio engines

FOR FURTHER READING

Combustion stoichiometry, physical factors affecting ignition delay, euro and british standard norms, biodiesel production process, stirling engine

Total: 45 Hours

Reference(s)

1. V. Ganesan, Internal Combustion Engines, Tata McGraw Hill Publishing Company Private limited., New Delhi, 2012
2. John B. Heywood, Internal Combustion Engine Fundamentals, Tata McGraw Hill Publishing Company Private limited., New Delhi,2008
3. R. B. Mathur and R. P. Sharmal Internal Combustion Engines, Dhanpat Rai Publications, 2008
4. B.P.Pundir, Internal combustion Engines Combustion and Emissions, Narosa Publishing House Private limited, New Delhi, 2010
5. W.W. Pulkrabek, Engineering Fundamentals of the Internal Combustion Engine, Prentice Hall, 2006
6. http://nptel.ac.in/courses/112104033/1

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	
1	4	4			8					4															20
2	4	4				8				4															20
3	4	4			8	4																			20
4	4	8			4	4																			20
5	4	4			4	8																			20
																								Total	100

Assessment Questions

Remember

1. Define the terms Octane number.
2. Define the term Cetane number.
3. Classify major pollutants from Spark ignition Engine exhaust.
4. Define homogenous charge compression ignition.
5. Classify the types of combustion chambers used in compression ignition engine.
6. Classify the types of combustion chambers used in compression ignition engine.
7. State any four functions of carburetor.
8. Define delay period with respect to a compression ignition engine.
9. Define ‘tumble’ motion of air.
10. Define particulate trap.

Understand

1. Compare liquefied petroleum gas and petrol as fuel for Spark ignition engine.
2. List any two salient features of gasoline direct injection engine.
3. Explain the effect of Cut-off ratio in the efficiency of a Diesel cycle?
4. Differentiate 2-stroke and 4-stroke engines based on construction.
5. Compare direct and indirect injection systems.
6. How hydrogen can be used in Spark ignition engines.
7. Discuss the properties of alcohol as engine fuel.
8. Indicate the features of mono point and multi point injection systems.
9. How can the octane rating of a fuel be improved?
10. How can the alternate fuels be selected for a petrol engine?
11. How can the alternate fuels be selected for a diesel engine?

Apply

1. For the same compression ratio and heat rejection, which cycle is most efficient: Otto or Diesel?
2. What will happen when petrol is used in a diesel engine?
3. What will happen when diesel is used in a petrol engine?

15ME009 REFRIGERATION AND AIR-CONDITIONING 3 0 0 3

Course Objectives

- To provide the knowledge on air refrigeration systems.
- To study the working of single and multistage vapour compression refrigeration systems.
- To learn the operation of vapour absorption and other refrigeration systems.
- To impart the knowledge about Psychometrics and its applications.
- To learn the parameters involved in design of air conditioning systems.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
o. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Illustrate the principle of operation of air refrigeration systems.
2. Explain the components and working of vapor compression refrigeration systems.
3. Demonstrate the working of vapour absorption and other refrigeration systems.
4. Resolve the psychometric problems in various applications.
5. Determine the parameters involved in design of air conditioning systems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3													3
2	2				2										3
3	2						3					1			3
4	3	2			2							1			3
5	2	2			2							3			3

UNIT I **9 Hours**

INTRODUCTION

Recapitulation of Thermodynamics- Thermodynamics processes pertaining to refrigeration and air conditioning. First and Second law of thermodynamics applied to refrigerating machines, Carnot principles, unit of refrigeration, co-efficient of performance, Air refrigeration cycle. Reversed Carnot cycle, Bell-Coleman cycle. Air refrigeration systems- Types, thermodynamic processes, priority criteria, and suitability.

UNIT II **9 Hours**

VAPOR COMPRESSION SYSTEM

Need for modification of Carnot cycle, Thermodynamic processes in vapour compression cycle. Simple vapour compression system, various conditions of vapour refrigerant in the system, improvement in simple system. Flash chamber, Flash inter cooler. Compound vapor compression system- Need for compound compression, two stage compression and various arrangements for improvement in coefficient of performance. Refrigerants. Desirable properties of refrigerants - R-12, R-22, R-717, R-134, Butane. Recent substitute for refrigerants.

UNIT III **9 Hours**

VAPOUR ABSORPTION AND OTHER REFRIGERATION SYSTEMS

Vapor absorption system -System components, representation of system on various charts, steam ejector system, representation on T-s and P-v plane, applications and limitations, co- efficient of performance-Thermo-electric and vortex refrigeration systems. Cascade refrigeration system.

UNIT IV **9 Hours**

APPLIED PSYCHROMETRY

Principle and properties of psychrometry, Representation of various psychometric processes on psychometric chart and their analysis, by-pass factor, sensible heat factor, room sensible heat factor, equipment sensible heat factor, grand sensible heat factor, apparatus dew point, ventilation and infiltration, energy efficiency ratio. Use of psychometric charts. Cooling and heating load calculations.

UNIT V **9 Hours**

AIR CONDITIONING SYSTEMS

Human Comfort and Air Conditioning - requirements of temperature and humidity-concept of effective temperature, comfort charts. Air Conditioners - Air conditioning systems and their types, selection of system, Components and controls of air distribution, Window air conditioners, split air conditioners, Central air conditioners, Human comfort parameters, load estimation, infiltration, internal heat gains

FOR FURTHER READING

Two and three stage compression to improve COP. domestic refrigerator. Procedure of leak detection, evacuation and charging of refrigerant, Refrigeration controls.

Total: 45 Hours

Reference(s)

1. C. P. Arora, Refrigeration and Air Conditioning, Tata McGraw Hill Publishing Company Private Limited, New Delhi, 2008.
2. Langley and C. Billy, Refrigeration and Air conditioning, Ed. 3, Engle wood Cliffs (NJ), Prentice Hall of India, New Delhi, 2009.
3. Roy J. Dossat, Principles of Refrigeration, Pearson Education, New Delhi, 2007.
4. N. F Stoecker and Jones, Refrigeration and Air Conditioning, Tata McGraw Hill Publishing Company, New Delhi, 2008.
5. Manohar Prasad, Refrigeration and Air Conditioning, Wiley Eastern Limited, 2007.
6. J. B Hains, Automatic Control of Heating & Air conditioning, Tata McGraw Hill Publishing Company Private Limited, 2005

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	
1	2	4				2					12														20
2		2				2					8				8										20
3		8				2					8				2										20
4		2				2					8				8										20
5	2						12								6										20
																								Total	100

Assessment Questions
Remember
1. Define Room sensible heat factor.
2. Define Equipment sensible heat factor.
3. Define 'ton of refrigeration'.
4. List the components of cooling load estimate.
5. Define co-efficient of performance.
6. List the functions of throttling valve.
7. What is meant by Cascade system?
8. Define specific humidity.
9. Define by-pass factor for cooling coil.
10. Define Ozone depletion potential.

Understand
1. Compare the vapour compression and vapour absorption refrigeration systems.
2. Represent the following psychrometric process using skeleton psychrometric chart
   a) Cooling and dehumidification b) Evaporative cooling.
3. How does the actual vapour compression cycle differ from that of the ideal cycle?
4. Differentiate absolute humidity and relative humidity.
5. Why reciprocating compressor cannot be used as a vacuum pump for producing high vacuum?
6. Why a throttle valve is used in vapour compressor refrigerator?
7. Compare the use of two position valve with the use of a modulating valve.
8. Differentiate between comfort air-conditioning and industrial air-conditioning.
9. Classify fans.

Apply
1. A one tonne refrigerator on vapour compression cycle works within the temperature limits of 268 K and 313 K.Refrigerant leaves the compressor dry and saturated.Calculate the COP (i) if there is no sub-cooling and (ii) If the refrigerant is sub-cooled by 20 deg.C.Also calculate the power required to run the refrigerator in both the cases.The properties of the refrigerant is

Temp K	Enthalpy (kJ/kg)			Entropy (kJ/kg K)			Specific heat (kJ/kgK)
	hf	hg	hfg	sf	sg	sfg	Cpl
268	31.5	---	154	0.125	---	0.574	1.03
313	74.59	203.2	---	-5	0.6825	---	---

2. The atmospheric air at 760 mm of Hg, dry bulb temperature 15 deg.C and wet bulb temperature 11deg.C enters a heating coil whose temperature is 41 deg.C. Assuming by-pass factor of heating coil as 0.5, determine dry bulb temperature, wet bulb temperature and relative humidity of the air leaving the coil.Also determine the sensible heat added to the air per kg of dry air.

Analyse

1. Design a vapour compression refrigeration system that will maintain the refrigerated space at -15°C while operating in an environment at 20°C using refrigerant 134a as a working fluid.
2. A multi-storied shopping mall has installed 5 x 110 TR reciprocating compressors of which four Compressors are in use for 16 hours per day. Due to higher energy cost shopping mall chief engineer has decided to replace reciprocating compressors with screw compressors. Chief engineer needs following input from energy consultant.
   i) Comparison of power consumption of both reciprocating and screw compressors
   ii) Annual cost savings (for 350 days operation). Present unit cost Rs 6.50 per kWh, investor 220 TR machine Rs 30 lakh
   iii) What should be the size of cooling tower required for proposed screw compressors?

15ME010 TOTAL QUALITY MANAGEMENT 3 0 0 3

Course Objectives

- To learn concepts, dimension quality and philosophies of TQM.
- To study the TQM principles and its strategies.
- To expose the seven statistical quality and management tools.
- To impart knowledge on TQM tools for continuous improvement.
- To introduce QMS and EMS.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

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

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

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

k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

m. Design, analyse and evaluate the performance of mechanical systems.

n. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Use the concepts, dimension of quality and philosophies of TQM.
2. Apply the principles of TQM and its strategies in industries.
3. Apply the statistical quality tools and seven management tools.
4. Choose the suitable TQM tools for continuous improvement.
5. Use the concept of QMS and EMS in industries.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1					2		3		2			1	1	
2						2		3	3	3	2		1	1	
3	2	3	1		2				1	1			1	1	
4	1	2	2						1	2			1		
5						2	2	2		1			2	2	

UNIT I **8 Hours**

INTRODUCTION

Definition of Quality - Dimensions of Quality - Quality Planning - Quality costs - Analysis Techniques for Quality Costs - Basic concepts of Total Quality Management - Historical Review - Quality Statements - Strategic Planning, Deming Philosophy - Crosby philosophy - Continuous Process Improvement - Juran Trilogy, PDSA Cycle, 5S, Kaizen - Obstacles to TQM Implementation

UNIT II **9 Hours**

TQM PRINCIPLES

Principles of TQM, Leadership - Concepts - Role of Senior Management - Quality Council, Customer satisfaction - Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement - Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits - Supplier Partnership - Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures - Basic Concepts, Strategy, Performance Measure

UNIT III **11 Hours**

STATISTICAL PROCESS CONTROL (SPC)

The seven tools of quality - Statistical Fundamentals - Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables X bar and R chart and attributes P, nP, C, and u charts, Industrial Examples, Process capability, Concept of six sigma - New seven Management tools

UNIT IV **8 Hours**

TQM TOOLS

Benchmarking - Reasons to Benchmark - Benchmarking Process, Quality Function Deployment(QFD) - House of Quality, QFD Process, and Benefits - Taguchi Quality Loss Function - Total Productive Maintenance (TPM) - Concept, Improvement Needs, and FMEA - Stages of FMEA-Case studies

UNIT V **9 Hours**

QUALITY SYSTEMS

Need for ISO 9000 and Other Quality Systems - ISO 9000:2000 Quality System - Elements, Implementation of Quality System, Documentation, Quality Auditing, ISO 9000:2005 ISO 9001:2008 and ISO 9004:2009 , TS 16949, ISO 14000, AS9100 - Concept, Requirements and Benefits

FOR FURTHER READING

Case Study: TQM Quality and Environmental Concepts in real World Applications.

Total: 45 Hours

Reference(s)

1. DaleH.Bester filed, Total Quality Management, Pearson Education Inc., New Delhi, 2003.
2. N.Gupta and B.Valarmathi, Total Quality Management, Tata McGraw-Hill Publishing Company Pvt. Ltd., New Delhi,2009.
3. James R.Evans and William M.Lidsay, The Management and Control of Quality, South-Western 2002.
4. DrS.Kumar, Total Quality Management, Laxmi Publications Ltd. New Delhi, 2006
5. P.N.Muherjee, Total Quality Management, Prentice Hall of India, New Delhi, 2006.
6. E. Rathakrishnan, Gas Dynamics, 5th edition, PHI Learing Private Limited, 2013.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	8					8					4														20
2	8					6					6														20
3	6	2				10				2															20
4	10					8					2														20
5	6					8					6														20
																								Total	100

Assessment Questions

Remember

1. Define the term Total Quality Management.
2. Write the names of any four gurus of Total Quality Management.
3. Define the term Quality.
4. How the quality can be quantified?
5. List the obstacles for TQM implementation.
6. Mention some concepts of leadership.
7. Write the functions of quality council.
8. What meaning is conveyed through vision statement?
9. State the meaning of performance appraisal.
10. What is a scatter diagram?
11. How the loss of reduced speed is measured?

Understand

1. How the suppliers are rated?
2. How a process flow diagram can be used as a quality improvement tool?
3. What is the difference between a document and a record?
4. Differentiate between the chance causes and assignable causes of variations.
5. Why Poisson distribution curve is used for preparing c-chart?
6. How the service quality affects company's performance?
7. Why the implementation of TQM is necessary?
8. How environmental management systems are benefit to industries?
9. What is the difference between histogram and check sheet?
10. Differentiate defect and defective.
11. How should control charts be used by shop-floor personnel?
12. Differentiate discrete and variable data, with suitable example?

Apply

1. Assuming that the life in hours of an electric bulb is a random variable following normal distribution with a mean of 2000 hrs and standard deviation of 840 hrs. Find the expected number of bulbs from a random sample of 2000 bulbs having life
   i) More than 3000 hrs

ii) Between 2600 and 2800 hrs.

2. A certain product has been statistically controlled al a process average of 36.0 and a S:D. of 1.00.The product IS presently being sold to two users who have different specification requirements. User has established a specification of 38.00Â fourÂ for the product, and user R has specification 36.

   (i) Based on the present process set up, what percent of the product produced will not meet the specifications set up by user ?

   (ii) What percent of the product will not match the specifications of user B?

   (iii) Assuming that the two users' needs are equal, a suggestion is made to shift the process target to 37.0. At this suggested value, what percent of the product will not meet the specifications of user ?

   (iv) At the suggested process target, what percent or the product will not meet the specifications ofÂ user B?

   (v) Do you think .that this shift to a process target of 37.0 would be desirable? Explain your answer.

3. (i) Determine the trial control limits, construct the np chart and state whether the process is in control.

   (ii) If any point goes outside the control limits, determine the revised control limits eliminating that point.

   (iii) An industrial product was subjected to inspection with a batch size of 500 for consecutive days. The number of defective pieces found are 33, 42, 44, 56, 60, 43, 55, 42, 28 and 70. Draw a p-chart and discuss.

   (iv) How is process Decision Program Chart (PDPC) used? Give an example.

4. The mean weight of 500 male students at a certain college is 65.6 kg and tile standard deviation is 10 kg.

   Assuming tl1at the weights are normally distributed, find how many students, weigh

   i) more than 75.5 kg, and

   ii) between 55.5 and 75.5 kg

5. At a certain examination 10% of the students who appeared for the paper in statistics got less than 30 marks and 97% of the students got less than 62 marks. Assuming tire distribution is normal, find the mean and tile standard deviation of the distribution

15ME011 COMPOSITE MATERIALS AND MECHANICS

3 0 0 3

Course Objectives

- To provide fundamental knowledge in reinforcement and matrix materials.
- To impart knowledge on polymer matrix composites.
- To expose the characteristics and different fabrication techniques of metal matrix composites.
- To impart knowledge on ceramic matrix composites.
- To provide knowledge on advanced composites.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
n. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Identify suitable reinforcement and matrix materials for different applications
2. Select appropriate fabrication technique for specific application of polymer matrix composite.
3. Select suitable processing method for the fabrication of metal matrix composites
4. Select suitable fabrication method for specific application of ceramic matrix composite.
5. Identify the advanced composites for appropriate applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2												2	
2	2	2										1		2	
3	2	2										1		2	
4	2	2										1		2	
5	2	2										2		2	

UNIT I **9 Hours**

INTRODUCTION TO COMPOSITES

Fundamentals of composites, characteristics, need for composites, Enhancement of properties, Reinforcements - glass fibers, boron fibers, carbon fibers, organic fibers, aramid fibers, ceramic fibers, oxide and nonoxide fibers, Forms of reinforcements - Roving, Woven fabrics, Non woven, random mats, whiskers, Matrix materials - Polymers - Thermosetting resins, thermoplastic resins , Metals, Ceramic materials

UNIT II **9 Hours**

POLYMER MATRIX COMPOSITES

Processing of polymer matrix composites- hand lay-up, Spray lay-up processes, Compression molding- SMC Reinforced reaction injection molding, Resin transfer molding, Pultrusion, Filament winding, Applications of polymer matrix composites

UNIT III **9 Hours**

METAL MATRIX COMPOSITES

Characteristics of MMCs, Various types of Metal matrix composites, Advantages and limitations of MMCs, Effect of reinforcements on properties-Volume fraction - Rule of mixtures, Processing of MMCs - Liquid state processing- stir casting, squeeze casting, infiltration, solid state processing - Powder metallurgy, Diffusion bonding, In-situ processes, applications of MMCs.

UNIT IV **9 Hours**

CERAMIC MATRIX COMPOSITES

Need for CMCs, Processing of CMCs- cold pressing and sintering, hot pressing, infiltration, chemical vapor deposition and chemical vapor impregnation, sol-gel and polymer pyrolysis, high temperature synthesis properties and applications in aerospace and space fields.

UNIT V **9 Hours**

ADVANCES IN COMPOSITES

Carbon fiber composites - properties, chemical vapor deposition - oxidative etching, liquid phase oxidation carbon/carbon composites - properties and applications of C/C Composites, future scope of c-c composites, multi-filament superconducting composites.

FOR FURTHER READING

Quality inspection methods for composites and Applications of smart composites.

Total: 45 Hours

Reference(s)

1. P.K. Mallick, Fiber Reinforced Composites Materials, Manufacturing and Design, Marcel Dekker Inc, 2003.
2. K. Autar Kaw, Mechanics of Composite Materials, CRC Press, 2006.
3. B.D. Agarwal and L.J. Broutman, Analysis and Performance of Fiber Composites, John Wiley and Sons, New York, 2000.
4. Ronald Gibson, Principles of Composite Material Mechanics, Tata McGraw Hill, 2004.
5. K.K. Chawla, Composite materials, Springer Verlag, 2007.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	5					5			5					5											20
2		5				5				5					5										20
3		5					5			5									5						20
4		5				5			5					5					5						25
5			5							5					5										15
																								Total	100

Assessment Questions

Remember

1. What is mean by composites?
2. What is the need for composites?
3. List out any five advantages of composite.
4. What are all the types composite based on matrix?
5. Draw neat sketches for (i) fiber (ii) particulate and (iii) laminar composites and mark the different constituents.
6. State any two functions of matrix in composite materials.
7. State any two functions of reinforcement in composite materials.
8. What is mean by Whiskers?
9. What is mean by Thermoset Matrix Materials?
10. What is mean by lamina?
11. Define laminate.

Understand

1. How the composite differs from alloy?
2. Why the composite is an orthotropic material?
3. What is use of fillers in composites?
4. Why small diameter fiber is preferred in composite?
5. What are the advantages of ceramics over metals as fibers?
6. Why Sol-gel technique is used for manufacturing glass fiber?
7. Why the polymer matrix composite used in large proportion in aerospace?
8. Why the hand lay-up process mostly preferred?
9. How composite is manufactured by RTM process?
10. How the liquid state processes used for manufacturing of MMCs?
11. What is the use of control systems in an autoclave molding process?

Apply

1. How many elastic constants are required to describe stress to strain relation for an isotropic material, an orthotropic material and an anisotropic material?

Analyse

1. What is ratio to be required for mixing the hardener in epoxy for curing purpose?
2. How the fiber angle can be changed in filament winding machine?

Evaluate

1. Find out the young’s modulus of composite having 60% volume fraction of fiber. Ef= 68.9 GPa and
   Em = 3.45GPa
2. Evaluate the effect of fiber volume fraction in composite.
3. Give the solution to avoid improper mixing of reinforcement in MMC.

15ME012 STATISTICAL QUALITY CONTROL AND RELIABILITY ENGINEERING

3 0 0 3

Course Objectives

- To familiarize with various statistical process control methods.
- To study the methods and characteristics of sampling.
- To introduce Taguchi method of experimental design.
- To describe the concept of reliability and its models.
- To impart knowledge on design of reliability process.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
m. Design, analyse and evaluate the performance of mechanical systems.
n. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Identify Use the different statistical process control charts.
2. Explain the importance of sampling methods and its characteristics.
3. Implement the Taguchi method for experimental design.
4. Evaluate the reliability concept with their models.
5. Determine and analyze the reliability process.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	3		2									1	
2	2	2	3		2									1	
3	3	2	3		2								2		
4	2	3	2		2								1		
5	2	3	2		1								1		

UNIT I **8 Hours**

QUALITY AND STATISTICAL PROCESS CONTROL

Quality-Definition, Quality Assurance-Variation in process-Factors, Process capability. Control charts variables X, R and X, Attributes P, C and U-Chart tolerance design. Establishing and interpreting control charts-Charts for variables. Quality rating-Short run.

UNIT II **10 Hours**

ACCEPTANCE SAMPLING

Lot by lot sampling-Types, Probability of acceptance in single, double, multiple sampling plans-Operating Characteristic curves-Producer's risk and consumer's risk-Acceptable Quality Limit, Lot Tolerance Percent Defective, Average Outgoing Quality, Concepts-Standard sampling plans for average outgoing quality and Lot Tolerance Percent Defective, Use of standard sampling plans.

UNIT III **7 Hours**

EXPERIMENTAL DESIGN AND TAGUCHI METHOD

Fundamentals-Factorial experiments, Random design, Latin square design, Taguchi method-Loss function-Experiments, Signal/Noise ratio and performance measure, Orthogonal array.

UNIT IV **9 Hours**

CONCEPT OF RELIABILITY

Definition, reliability vs quality, reliability function-Mean Time Between Failures, Mean Time To Repair, availability, bathtub curve-time dependent failure models-Distributions-Normal, weibull, log normal-Reliability of system and models-serial, parallel and combined configuration -Markove analysis, load sharing systems, standby systems, co-variant models, static models, dynamic models.

UNIT V **11 Hours**

DESIGN OF RELIABILITY

Reliability design process, system effectiveness, economic analysis and life cycle cost, reliability allocation, design methods, parts and material selection, derating, stress strength and analysis, failure analysis, identification determination of causes, assessments of effects, computation of criticality index, corrective action, System safety-analysis of down-time-Repair time distribution, stochastic point processes system repair time, reliability under preventive maintenance state dependent system with repair.

FOR FURTHER READING

Optimization techniques for system reliability with redundancy, Methods applied to optimal system reliability in Industries

Total: 45 Hours

Reference(s)

1. Amata Mitra, Fundamentals of Quality Control and improvement, Pearson Education, 2002.
2. Patrick D connor, Practical Reliability Engineering, John-Wiley and Sons Inc, 2002.
3. Charles E Ebling, An Introduction to Reliability and Maintainability Engineering, Tata McGraw Hill, 2000
4. David J Smith, Reliability, Maintainability and Risk: Practical Methods for Engineers, Butterworth 2002.
5. Dhillon, Engineering Maintainability, How to design for reliability and easy maintenance, PH India publications, 2008.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	5										5		5		5										20
2		5				5				5	5		5												25
3	5										5				5										15
4	5					5				5	5														20
5	5				5					5	5														20
																								Total	100

Assessment Questions

Remember

1. Define Quality.
2. Define attributes.
3. Define Variables.
4. What is clearance?
5. Define short run.
6. What do you mean by long run in a company?
7. What is sampling?
8. Define sample and population.
9. What is meant by alternative and null hypothesis?
10. Define Analysis of variance.

Understand

1. Classify product quality and process quality
2. Classify product quality and process quality
3. Classify length and flatness interferometers?
4. Contrast quality control and quality assurance.
5. Illustrate the process variability and state causes behind variability.
6. Indicate the different ways of constructing operating characteristic curves?
7. Differentiate between mean time to failure and mean time between failures based on their applicability.
8. Contrast quality and reliability.
9. Discuss on philosophy behind statistical quality control.
10. Formulate why optimization is important in establishing reliability of products? What are the approaches to optimize the product reliability?
11. What do you understand by statistical control of production process?

Apply

1. Explain the need for precision measurement in an engineering industry.
2. Assess the considerations involved in choosing between sampling and complete inspections? Between variables and attributes?
3. Perform maintainability and mention various parameters to measure in an industry.
4. A random sample of the weights of 100 students from a large population of students in a university having a standard deviation of 5 kg, has an average weight of 58 kg. Find the 95% and 99% confidence limits for the average weight of all students of the university.
5. Explain the step-by-step procedure for constructing the OC curve for a single sampling plan.
6. Demonstrate the OC curve of the single sampling plan n = 300 and c = 5.
7. Find the factors to be considered in designing reliability in a industry.
8. Explain with examples the application of redundancy in system design.
9. With the help of a schematic diagram explain the role of reliability in product design and development.

Analyse

1. During the manufacture of superior quality chalks, the main parameter controlling the quality is the density of the chalks. Experience has shown that the chalk gives good performance if the density is between 4.5 and 5.0 g/cm3. If the sample of 100 pieces gives an average of 4.8 and a standard deviation of 0.2, is the process aimed at proper density? Discuss with help of Cp and Cpk. values.
2. Quality control is to be introduced for the chromium content present in an alloy the nominal percentage of which is 5%. It is desired that the percentage will not vary by more than 0.25%, either way. Sampling inspection is carried out taking samples of 5 pieces at a time at regular intervals. Twenty samples gave the following results as shown in table below. Comment on the suitability of the process of the present technique of manufacture and calculate the proportion defective.
3. The Stosh Motor Company, manufactures bolts for its model X-350 high-performance racing engine. If defective, the bolts typically have damaged threads or improper diameters. A defect

can be easily discovered by threading the bolt into a block of steel with a hole of correct threading and diameter. If a defective bolt is passed to the assembly line there is a chance that the threads in the engine block hole will be damaged or that bolt may work itself loose during operation of the engine. The historical proportion defective average has been 0.015. Setup a suitable control chart for this process. Assume that management wants 99 percent of the normal variation to fall within the control limits. The sample size is 16. The numbers of defects found in the last five samples were 1, 1, 2, 2, and 3 respectively. Is there a need for concern?

4. Assuming all the plotted points are inside the 3σ limits in a control chart, state the additional rules to identify the process variations and shows the same graphically.
5. The Metropolitan Tlansit Company encourages the customers to comment on the service they provide and it is considered normal to receive 4 complaints per week. Over the past six weeks, the following numbers of complaints were registered: 2,1 ,3, 5, 1 and 6. The company uses two-sigma control limits on its c-chart. Is there any reason for management to take action?
6. Consider a certain raw material for which a single-sampling plan using attributes is needed. The AVERAGE OUTGOING QUALITY is 0.01 and the LTPD is 0.040. Two plans have been proposed. Plan I : n = 100, c = 3 and Plan 2 : n = 200, c = 6. Are these two plans equivalent? Substantiate your response by determining the producer's risk and consumer's risk for each plan.
7. You presently have an acceptable sampling plan in which n = 50, c = 1, but you are unsatisfied with its performance. The AVERAGE OUTGOING QUALITY is 0.01 and the LTPD is 0.05. What are the producer's and consumer's risks for this plan? Specify a plan that will decrease the producer's risk and the consumer's risk. Specify the producer's and consumers new risks. Compare the AOQLs for your plan and the old plan. Assume the lot size is 1000 units.
8. In a double sampling plan, N 5,000, n1 = 100, n2=100, c1 =0 and c2=1. Use Poisons table to compute the probability of acceptance of l% defective lot. Assume a lot rejected by this sampling plan will be 100% inspected. What will be the AOQ if the submitted product is 1% defective? Considering both the inspection of rejected lots, what will be the average number of articles inspected per lot if the submitted product is 1% defective?
9. An industrial unit has installed four electric drives, they are connected to two engines driven generators such the each generator supplying power independently to two drives. If the reliability of the each electric drive is 0.9 and that of the generator set is 0.8, what is the probability that at least two of the drives are available for running the unit?

15ME013 MECHANICAL VIBRATIONS 3 0 0 3

Course Objectives

- To study the fundamental concept of vibration of single degree of freedom (DOF) system.
- To provide knowledge on vibration of Two DOF system.
- To impart knowledge on vibration of Multi- DOF system.
- To learn the governing equation of vibration of continuous systems.
- To study various instruments and control methods used in vibration analysis.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Explain basic elements of vibration of single DOF system.
2. Calculate the natural frequency of vibration of Two DOF system.
3. Estimate the natural frequency of vibration of Multi DOF system.
4. Perform vibration analysis for vibration of continuous systems.
5. Select suitable instruments and control method for measurement and control of vibration.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2											1		
2	1	3											1		
3	1	3											1		
4	2	3											1		
5	3				1							1			

UNIT I **9 Hours**

FUNDAMENTALS OF VIBRATION

Basic concepts - One degree of freedom - Free vibration -undamped and viscous damping system. Forced vibration - harmonically excited vibration - Equation of motion, Response of damped system under harmonic force, Response of Damped system under base excitation and rotating unbalance - Duhamels Integral - Impulse Response function.

UNIT II **8 Hours**

TWO DEGREE FREEDOM SYSTEM

Equation of motion - Free and Forced vibration Analysis- Coordinate Couplings and Principal Coordinates - Transfer function approach - Lagranges equation.

UNIT III **10 Hours**

MULTI-DEGREE FREEDOM SYSTEM

Influence Coefficients and stiffness coefficients- Flexibility Matrix and Stiffness Matrix - Eigen Values and Eigen Vectors-Matrix Method, Matrix Iteration Method -Approximate Methods: Dunkerley, Rayleighs and Holzer Method.

UNIT IV **9 Hours**

VIBRATION OF CONTINUOUS SYSTEMS

Introduction- Transverse vibration of string- Longitudinal vibration of shaft - torsional vibration of shaft- lateral vibration of beam- Rayleigh Method, Rayleigh - Ritz method.

UNIT V **9 Hours**

VIBRATION MEASUREMENT AND CONTROL

Transducer - Vibration Pickups - Frequency Measuring Instruments - Vibration exciter - dynamic Testing Machine - Machine Condition Monitoring and diagnosis. Control of vibration- control of Natural frequencies - Introduction to damping - vibration Isolation - Vibration Absorber.

FOR FURTHER READING

Columb damping, Response of undamped system under harmonic force- forced vibration with elastically coupled viscous dampers - Experimental modal Analysis - solution of Transfer function approach.

Total: 45 Hours

Reference(s)

1. S.S.Rao, Mechanical Vibrations, Pearson Education, 2011.
2. Thomson W.T. Theory of Vibration with Applications, CBS Publishers and Distributors, New Delhi, 2006.
3. A.K. Mallik, Principles of Vibration Control, Affiliated East-West Press Pvt. Ltd, 2004.
4. R.N. Iyengar , Elements of Mechanical Vibration, I K International Publishing House Pvt. Ltd, New Delhi, 2007
5. S.Graham Kelly and Shashidar K.Kudari, Mechanical Vibrations, Tata McGraw-Hill Publishing Company Ltd New Delhi, 2007.
6. http://nptel.ac.in/courses/112103111/

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	4	4				4					8														20
2	2					6									12										20
3						4					4			8				4							20
4											6				6				8						20
5	4	6				10																			20
																								Total	100

Assessment Questions

Remember

1. Define vibration
2. What is vibration absorber?
3. Define resonance.
4. State degrees of freedom
5. Define frequency.
6. Define simple harmonic motion.
7. What is vibration isolation?
8. Define critical speed of the shaft.
9. What is transmissibility ratio?
10. What is vibration isolation?
11. Define normal mode.

Understand

1. What are three elementary part of a vibrating system?
2. How can we make a system to vibrate in one of its natural made?
3. How does a continuous system differ from a discrete system in the nature of its equation of motion?
4. Why is it important to find the natural frequency of a vibrating system?
5. What happens to the response of an undamped system at resonance?
6. How many natural frequencies does a continuous system have?
7. What is the difference between a vibration absorber and a vibration isolator?
8. What is the difference between deterministic and random vibration?
9. How do you connect several springs to increase the overall stiffness?

Apply

1. Consider two pendulums of length L. Determine the natural frequency of each pendulum. If k=100 N/m, m1=2 kg, m2=5kg, L=0.20m, a=0.10m.Â Find the natural frequency and amplitude ratio of the given system.

Analyse

1. A gun barrel weighing W kg has a recoil spring whose stiffness is K kg/m. If W = 450kg, K = 36000 kg/cm and the barrel recoils 1m on firing determine.
   (a)The initial recoil velocity of the barrel.
   (b)The critical damping coefficient of a dashpot which is engaged at the end of the recoil stroke.
   (c)The time required for the barrel to return to a position 5cm from its initial position.
2. A tennis ball hits the tennis racket and imparts a velocity of 1.5m/sec to the racket tip. The natural frequency and damping ratio of the tennis racket are given to be 31.45Hz and 0.0297 respectively. Determine the maximum displacement of the racket tip.

Evaluate

1. A 20 kg block is attached to a spring stiffness 6 x 104 N/m. The block slides on a horizontal surface with a coefficient of friction are 0.3. If the block is displaced 50 mm and released, evaluate how long will it take before the block returns to rest.
2. An air compressor, running at a constant speed of 1200 rpm, is having large amplitude of vibration. A vibration absorber is added. The weight of the compressor is 500 lb and the compressor has an unbalance of 1.00 in-lb. Calculate the weight and the spring constant of the absorber if the natural frequencies of the system should be at least 10% from the impressed frequency

15ME014 FLEXIBLE MANUFACTURING SYSTEMS 3 0 0 3

Course Objectives

- To introduce the basics of Flexible Manufacturing System (FMS).
- To impart the knowledge on importance of Group Technology (GT).
- To understand the material handling layout configuration with computer controlled system.
- To know the concept of FMS using simulation software and data base system.
- To study the work volume of Robot and its applications.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
n. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Compare the benefits of FMS over conventional manufacturing system.
2. Apply the group technology concepts in machine cell design.
3. Construct the material handling layout with computer controlled system for machine cell.
4. Select suitable simulation software for applying the FMS concept.
5. Identify the suitable robot configuration for automation in FMS.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1											1		1	
2	2	2										1		2	
3	1	2			1							1		2	
4	2				2							2		1	
5	1				2							2		2	

UNIT I **8 Hours**

INTRODUCTION TO FLEXIBLE MANUFACTURING SYSTEM

Introduction to FMS - Types of production, characteristics, flexibility in machining systems and its types, need, flexible automation, benefits and application.

UNIT II **10 Hours**

GROUP TECHNOLOGY

Group Technology (GT) - Part families, parts classification and coding systems , features and OPITZ, production flow analysis, cellular manufacturing, composite part concept, machine cell design, types of machine cell designs, key machine concept, grouping parts and machines by rank order clustering, benefits and applications.

UNIT III **9 Hours**

COMPONENTS AND COMPUTER CONTROL SYSTEM OF FMS

FMS - Flexibility, types, components - Workstation, material handling and storage system - Functions of the handling system, material handling equipment and layout configuration, computer control system, planning and implementation issues.

UNIT IV **7 Hours**

COMPUTER SOFTWARE, SIMULATION AND DATABASE OF FMS

FMS simulation software- System issues, types of simulation software, specification, limitations and application of simulation. Manufacturing data systems - Data flow, FMS database systems and planning.

UNIT V **11 Hours**

ROBOTIC TECHNOLOGY AND APPLICATIONS

Introduction to Robotic elements - Joints, links, robot configurations, work volume, types of robot control, end effectors and sensors in robotics. Applications - Material handling, welding, assembly and inspection.

FOR FURTHER READING

Case study - FMS modelling with performance evaluation using AUTOMOD software and Implementation of FMS in manufacturing industry.

Total: 45 Hours

Reference(s)

1. Mikell P. Groover, Automation Production Systems and Computer Integrated Manufacturing System, Prentice Hall of India, PTR Upper Saddle River, NJ, USA, 2007.
2. S. R. Prasad, R. Prabhakar and S. Dhandapani, Intelligent Flexible Autonomous Manufacturing Systems, Tata McGraw Hill Publishing Private Limited., New Delhi, 2000.
3. N. K. Jha, Handbook of Flexible Manufacturing Systems, Academic Press Incorporation, San Diego, 1991.
4. Satya Ranjan Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill Publishing Company Private Limited., New Delhi, 2009.
5. Joseph Talvage and Roger G. Hannam, Flexible manufacturing systems in practice, Marcel Dekker Incorporation, NewYork, 1987.
6. Nanua Singh, Systems Approach to Computer Integrated Design and Manufacturing, John Wiley Sons, Incorporation New York, NY, USA, 2011.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	8					12																			20
2	4					4					12														20
3	8					12																			20
4	8					12																			20
5	4					4					12														20
																								Total	100

Assessment Questions

Remember

1. Define flexible automation.
2. What is meant by programmable automation?
3. Define fixed automation.
4. List any four reasons for automation.
5. What are the four factors influencing the best machine arrangement in cells?
6. List the four FMS layout configurations.
7. List the planning and design issues of FMS.
8. What are the types of FMS simulation software?
9. What are the two basic categories of automated storage systems?
10. What are the five various elements of robot?

Understand

1. What is the difference between product layout and process layout?
2. How the part families are formed?
3. What is the difference between hierarchical structure and chain type structure in a classification and coding system?
4. What are the typical objectives when implementing cellular manufacturing?
5. What is the difference between virtual machine cell and formal machine cell?
6. How to select the proper material handling system for FMS?
7. When do we use knowledge based scheduling?
8. Differentiate AS/RS and Carousel storage.
9. How do you classify robots from the viewpoints of application of FMS?
10. How the robot can be used in assembly?
11. What is the difference between repeatability and accuracy in a robotic manipulator?

Apply

1. Using notation scheme for defining manipulator configurations, draw diagrams of the following robots:
   a) TRT
   b) VVR
   c) VROT
2. The linear joint of a (type L) certain industrial robot is actuated by a piston mechanism. The length of the joint when fully retracted is 600mm and when fully extended is 1000mm. If the robot's controller has an eight bit storage capacity, determine the control resolution for this robot.

15ME015 COMPUTER INTEGRATED MANUFACTURING 3 0 0 3

Course Objectives

- To introduce the basic concepts of Computer Integrated Manufacturing (CIM).
- To provide knowledge on Group Technology and Computer Aided Process Planning.
- To impart knowledge on Shop Floor Control and Flexible Manufacturing Systems.
- To learn the various CIM implementation and data communication techniques.
- To provide knowledge on the concept of Manufacturing automation protocol, Technical office protocol and database terminology.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
n. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Assess CAD/CAM integration for changing manufacturing and management scene.
2. Construct a machine cell using the concepts of Group Technology and Computer Aided Process Planning
3. Select the suitable material handling and storage system for Flexible Manufacturing Systems.
4. Choose the suitable CIM implementation and data communication techniques.
5. Use various protocols and database terminology in CIM.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	1												2	
2	1	2	2		1									2	
3	1	1												2	
4	1	1												2	
5	1													2	

UNIT I **8 Hours**

INTRODUCTION

The changing manufacturing and management scene, External communication, Islands of automation and software, dedicated and open systems,manufacturing automation protocol, introduction to CAD/CAM integration.

UNIT II **10 Hours**

GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING

Classification and coding - DCLASS, MICLASS and OPITZ coding systems. Facility design using G.T. - Benefits of G.T - cellular manufacturing. Process planning, role of process planning in CAD/CAM integration- approaches to computer aided process planning- variant approach and generative approaches.

UNIT III **9 Hours**

SHOP FLOOR CONTROL AND FMS

Shop floor control phases -factory data collection system -automatic identification methods- Bar code technology - automated data collection system. FMS- components of FMS- types -FMS workstation-material handling and storage systems- FMS layout-computer control systems-application and benefits

UNIT IV **9 Hours**

CIM IMPLEMENTATION AND DATA COMMUNICATION

System modeling tools- ICAM definition (IDEF) models, activity cycle diagram, CIM open system architecture (CIMOSA) - manufacturing enterprise wheel- CIM architecture- Product data management, implementation-software. Communication fundamentals- local area networks (LAN) - topology -LAN implementations - network management and installations.

UNIT V **9 Hours**

OPEN SYSTEM AND DATABASE FOR CIM

Open systems-open system inter-connection - manufacturing automation protocol and technical office protocol-(MAP/TOP).Development of databases -database terminology-architecture of database systems- data modeling and data associations -relational data bases - database operators - advantages of data base and relational database.

FOR FURTHER READING

Paperless factory, introduction virtual reality and applications, virtual prototyping and manufacturing Instrumentation and Measurement, virtual enterprises.

Total: 45 Hours

Reference(s)

1. Mikell P Groover,Automation of production systems and computer integrated manufacturing, Pearson Education, United States of America, 2008.
2. Lee Kunwoo, CAD,CAM,CAE systems, Addison Wesley, United States of America, 1999
3. Kant Vajpayee S, Principles of Computer Integrated Manufacturing, Prentice Hall, New Delhi, 2003
4. Radhakrishnan P, Subramanyan S and Raju V, CAD,CAM,CIM, Second Edition New Age International Pvt. Ltd, New Delhi, 2000

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	10					6					4														20
2	6					10					4														20
3	10					4					6														20
4	4					8					8														20
5	6					8					6														20
																								Total	100

Assessment Questions

Remember

1. Define CIM
2. What do you mean by MAP?
3. List out the structures of coding system available.
4. What is the key machine concept in cellular manufacturing?
5. State the major areas of CIM.
6. Write down the equipment/devices used in Factory Data Collection Systems.
7. Define Group Technology.
8. List out the stages in Group Technology.
9. Define Part families.
10. List out the premises for the developed of DCLASS code.

Understand

1. What do you understand by the term islands of automation?
2. Why the GT code is used in the manufacturing industry?
3. Differentiate between the variant process planning and generative process planning approaches.
4. How the Shop Floor Control is achieved?
5. Why Generative approach is mostly preferred than Variant CAPP?
6. Compare the Manufacturing Automation Protocol and Technical Office Protocol.
7. Give the classification of Automation.
8. Write any two benefits of FMS
9. How FMS classified based on flexibility?
10. Which is ideal state in computer based manufacturing applications?

Apply

1. Apply rank order clustering technique to the part-machine incidence matrix to identify logical part families and machine groups.
2. A roller conveyor moves tote pans in one direction at 150 ft/min between a load station and an unload station, a distance of 200 ft. The time to load parts into a tote pan at the load station is 3 sec per part. Each tote pan holds 8 parts. In addition, it takes 9 sec to load a tote pan onto the conveyor. Determine: (a) spacing between tote pan centers flowing in the conveyor system and (b) flow rate of parts on the conveyor system. (c) Consider the effect of the unit load principle. Suppose the tote pans were smaller and could hold only one part rather than eight. Determine the flow rate in this case if it takes 7 sec to load a tote pan onto the conveyor (instead of 9 sec for the larger tote pan) and it takes the same 3 sec to load the part into the tote pan

15ME016 ADVANCED CASTING AND FORMING PROCESSES 3 0 0 3

Course Objectives

- To understand the concept design of gating in casting process and advanced casting process like shell mould casting.
- To impart knowledge on special casting processes like investment and continuous casting.
- To learn the process of centrifugal and die casting processes.
- To understand the working principle of metal forming methods such as extrusion and drawing.
- To expose the methods of forging and sheet metal forming operations.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
n. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Design the sand moulding process gating system and explain the shell moulding process
2. Select the suitable casting process for the given component and explain the investment and continuous casting process
3. choose the suitable casting process for the given componmeent and explain the centrifugal casting and die casting process
4. Select the suitable bulk deformation process based on application.
5. Explain the sheet metal forming processes and make simple sheet metal components.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	1									2		2	
2	2	2										2		2	
3	2	2										2		2	
4	2	2	1									2		2	
5	2	2										2		2	

UNIT I **9 Hours**

INTRODUCTION AND SHELL MOULD CASTING

Introduction- Principles and design for gating- directional solidification- casting defects and its inspection - Disamatic process. Shell mould casting- Introduction, hot coating, cold coating and warm coating, casting defects and their causes.

UNIT II **9 Hours**

INVESTMENT CASTING AND CONTINUOUS CASTING

Investment casting- Introduction, pattern, mould materials, block mould, ceramic shell mould, advantages and limitations. Continuous casting process-Introduction - Reciprocating moulding process, direct chill process, materials, defects and its applications

UNIT III **9 Hours**

CENTRIFUGAL AND DIE CASTING

Centrifugal casting- Types of centrifugal casting, calculation of rotation speed of the mould equipment. Die casting - types, dies for permanent mould castings, machines, design consideration for die casting method and low pressure die casting

UNIT IV **9 Hours**

METAL FORMING METHODS

Metallurgical aspects of metal forming- yield criteria, stress strain relationship, slip, twinning, mechanics of plastic deformation, effects of temperature, strain rate. Extrusion - Introduction, tool equipment, influence of friction, force calculation. Drawing - Rod / wire drawing, tool, equipment and defects.

UNIT V **9 Hours**

FORGING AND SHEET METAL FORMING

Forging- Introduction, classification, equipment types, die design and its types, press tools, processes, parameters and force calculation. Sheet metal forming-formability of sheet metals, tools, shearing operations, deep drawing, stretch forming, plate bending, explosive forming, electro hydraulic forming.

FOR FURTHER READING

Select the suitable manufacturing process and list the sequence of operations for making cups, kitchen utensils, metallic water taps, jewellery, radio antennas and spanner

Total: 45 Hours

Reference(s)

1. Jain P.L, Principles of Foundry Technology, Tata McGraw Hill Publications, New Delhi, 2009.
2. Heine R.W, Carl Loper and Rosenthal P.C, Principles of Metal Casting, Tata McGraw Hill Publications, New Delhi, 2008.
3. J. P Kaushish, Manufacturing process., Prentice Hall of India Learning Private Limited, second edition, New Delhi, 2013
4. Dieter G.E, Mechanical Metallurgy, Tata McGraw Hill Company, New Delhi,2013
5. Mikell P. Groover, Automation, Production System and Computer Integrated Manufacturing, Prentice Hall of learning, New Delhi, 2009
6. B.L. Juneja, Fundamentals of metal forming processes, New Age International private Limited, New Delhi,2006.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	4					12					4														20
2	2					12								6											20
3	4					10					6														20
4	4					6					10														20
5	6					6								8											20
																								Total	100

Assessment Questions

Remember

1. Define casting.
2. What do you mean by pattern allowance?
3. What is the function of riser?
4. List any four parameters of sand moulding process.
5. List any six casting defects.
6. Define shell mould casting.
7. Define recrystallization temperature.
8. Define blanking.
9. State the use of ejector pins in die casting.
10. List any four extrusion defects.

Understand

1. Difference between pattern and core.
2. What are the different types of sand mould ?
3. What is the reason for inspection and testing of castings?
4. Why metal patterns are used in shell mould casting?
5. Why venting is necessary in die casting and how it is achieved?
6. Why there are two entry points in centrifugal casting?
7. Compare the process of pressure die casting and permanent mould casting.
8. Why roller leveling is necessary on rolling process?
9. How the metal is prepared for drawing process?
10. How can the cutting forces be reduced in sheet metal operation?
11. Why extrusion process is not suitable making large parts?
12. Why allowance should be given for pattern material?

Apply

1. Identify the pattern material and type of pattern based on the application requirement of the following components
   a) Gears
   b) Rocker arm
   c) Engine block
   d) Brake drum
2. A block of lead 25mm x 25mm x 150mm is pressed between flat dies to a size 6.25mm x 100mm x 150 mm. If the uniaxial flow stress is 6.9 Mpa and μ= 0.25. Determine the pressure distribution over the 100mm dimension and the total forging load
3. Determine the maximum possible reduction for cold rolling a 300 mm thick slab when μ= 0.8 and the roll diameter is 600mm. what is the maximum reduction on the mill for hot rolling when μ= 0.5
4. Calculate the rolling load if steel is hot rolled 30 percent from a 40 mm thick slab using a 900mm diameter roll. The slab is 760mm wide. Assume μ= 0.30. The plane strain flow stress is 140 MPa at entrance and 200 Mpa at the exit from the roll gap due to the increasing velocity.

Analyse

1. Rolling process reduces the thickness of plates and sheets. However is it possible to reduce the thickness by simply stretching the material? Would this be a feasible process?
2. What changes would you expect in the strength, hardness and ductility of metal after being drawn through dies?

15ME017 INDUSTRIAL SAFETY ENGINEERING 3 0 0 3

Course Objectives

- To study the principles of safety management system.
- To introduce the provisions contained in the industrial laws.
- To provide knowledge on safety requirements for engineering industry.
- To learn safety requirement for chemical industry.
- To study the various safety measures adopted in construction industries.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
n. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Explain safety management system of an industry.
2. Implement the provisions of acts and rules in industries.
3. Implement and review the safety performance followed in various industries
4. Evaluate safety appraisal in chemical industries.
5. Generate safety reports on construction industries.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1					2	2									
2						2	2	2							
3						3	2	1	2						
4	2	2				3	2	1	2						
5	2	2	2			3	2	1		2				1	

UNIT I **8 Hours**

SAFETY MANAGEMENT

Concepts - Evolution, International Labour Organization (ILO), National Safety Council, Techniques - Job Safety Analysis (JSA), Safety survey, Safety inspection, Safety Sampling, Accident Investigation and Reporting - Concept of an accident, Accident causation models, cost of accident, investigation, Safety Performance Monitoring - Safety indices.

UNIT II **10 Hours**

SAFETY AND LAW

Factory Act 1948-Safety and Health chapters, Tamil Nadu Factories Rules- Safety and Health chapters, Environment and Pollution Laws, ,Building and other construction works act 1996,Motor Vehicle Rules, Explosive Act 1983, Boiler Act.

UNIT III **10 Hours**

SAFETY IN ENGINEERING INDUSTRIES

Safety in metal working machinery and wood working machines, principles, standards and codes - Principles of machine guarding - zero mechanical state (ZMS),types of guards, Personal protective equipments- Safety in handling industrial gases, storage and handling of gas cylinders- Safety in cold forming and hot working of metals- Power press, forging, safety in furnaces, Safety in finishing, inspection and testing, heat treatment, electro plating, leak test, radiography.

UNIT IV **9 Hours**

SAFETY IN CHEMICAL INDUSTRIES

Safety in process design, unit operations, pressure vessel, heat exchanger, safety valves -Plant commissioning and inspection, pressure vessel, non-destructive testing, vibration, corrosion Plant maintenance and emergency planning, management of maintenance HAZOP study, ALOHA SOFTWARE

UNIT V **8 Hours**

SAFETY IN CONSTRUCTION INDUSTRY

Causes of fatal accidents, Construction regulations, contractual clauses, permit to work, Quality assurance in construction- Education and training Hazards of construction and prevention- excavation, scaffolding, dismantling, road works, construction of high rise buildings - Working at heights, Occupational Safety and Health Administration (OSHA) requirement for working at heights- Working on fragile roofs, work permit systems-Construction machinery, inspection and testing of cranes, chain pulley blocks, earth moving equipment, conveyors- Manual handling, Safety in demolition work, keys to safe demolition, health hazards from demolition, fire and explosion hazard- Safety in confined spaces

FOR FURTHER READING

Case Studies- Major accidents at Flixborough, UK, Seveso, Italy, Victoria Dock, India, Bhopal, India.

Total: 45 Hours

Reference(s)

1. Blake R.B., Industrial Safety, Prentice Hall, Incorporated, New Jersey,1973.
2. National Safety Council, Accident Prevention Manual for Industrial Operations, Chicago, 1988
3. Subramanian V., The Factories Act, 1948, with Tamil Nadu Factories Rules , 1950, Madras
4. Environmental Pollution Control Act, 1986
5. BOCW Act,1996, Madras Book agency, Chennai-1
6. Explosive Act, 1884, Eastern Book Company, Lucknow -266 001.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1		2					6				10														18
2			8				4				10														22
3			4		4															10					18
4			4		8																		10		22
5			4		6		10																		20
																								Total	100

Assessment Questions

Remember

1. Which year International LaborOrganization (ILO) was formed?
2. Define job safety analysis.
3. What is the duty of certifying surgeon in factory?
4. Define a factory.
5. How much weight an adult is permitted to carry?
6. What are the principles of guarding for a machinery?
7. Define permanent partial disability.
8. Define zero mechanical state (ZMS).
9. What is cold forming process?
10. What safety precautions to be taken in the construction of high rise building?

Understand

1. Why workers were losing legal battles with the Occupiers?
2. Even President of USA could not enforce safety rules. Why?
3. Under what circumstances safety survey is carried out?
4. Why competent persons are required for inspection?
5. Why water type should not be used for electrical fires?
6. Why braces are used in scaffolding?
7. How pressure vessels are inspected?
8. How non-destructive testing is carried out?
9. How corrosion is controlled?
10. What are the health effects of vibration?
11. How safety belts are tested?

Apply

1. Conduct a job safety analysis for a chemical factory for a product.
2. Make a safety inspection check list for a refinery.
3. Use accident causation model for an accident.

4. Design a Transport Emergency Card (TREM) for a vehicle transporting explosives.
5. Draft a safety committee minutes of meeting imagining 5 agenda points.
6. Prepare a maintenance schedule for compressor overhauling.
7. Design a work permit system for a welding job.

Analyse

1. Use a suitable accident causation model for a worker who slipped and fell into an acid storage tank and that was fatal.

Evaluate

1. In a factory of 1000 workers work 45 hours a week. In that year there were 25 accidents resulting in a loss 2500 hours. Calculate frequency rate, incident rate and severity rate.

Create

1. Create a safety monitoring methodology for hazardous factory dealing with the manufacture of explosives.

15ME018 INDUSTRIAL ROBOTICS 3 0 0 3

Course Objectives

- To learn the construction and fundamentals of robots.
- To provide knowledge on types of drives and end effectors in robots.
- To impart knowledge on sensors and machine vision system.
- To study the kinematics of robots and its programming method.
- To provide knowledge on the applications of robots in industries.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Identify the components and construction of robot manipulator.
2. Select a suitable drive and an end effector for industrial robots.
3. Choose sensors and machine vision system for industrial robots.
4. Formulate forward & inverse kinematics and construct program for robots.
5. Discuss the usage and applications of robots in industries.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2														
2	2											1			
3	1														
4	3	2										1	2		
5	1											2			

UNIT I **9 Hours**

FUNDAMENTAL OF ROBOTICS PROCESS

Robot -Definition -Robotics and Automation - Law of robotics -Robot Anatomy -Co-ordinate Systems, Work Envelope, classification - Specifications - Pitch, Yaw, Roll, Joint Notations, Pay Load - Need for Robots.

UNIT II **9 Hours**

ROBOT DRIVE SYSTEM AND END EFFECTORS

Pneumatic Drives, Hydraulic Drive, Mechanical Drives and Electrical Drives. End Effectors - Grippers -Pneumatic gripper, Hydraulic Grippers, Magnetic Grippers, Vacuum Grippers, and Mechanical Grippers -Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers.

UNIT III **9 Hours**

SENSORS AND MACHINE VISION SYSTEMS

Sensors - types - tactile sensors, proximity and range sensors, contact and non-contact sensors, velocity sensors, touch and slip sensors, force and torque sensors. Robotic vision systems, imaging components, image representation, picture coding, object recognition and categorization, visual inspection.

UNIT IV **9 Hours**

ROBOT KINEMATICS AND ROBOT PROGRAMMING

Forward Kinematics, Inverse Kinematics and Differences; Forward Kinematics and Reverse Kinematics of Manipulators with Two, Three Degrees of Freedom (In 2 Dimensional), Four Degrees of Freedom (In 3 Dimensional) - Deviations and Problems. Teach Pendant Programming, Lead through programming, Robot programming Languages - VAL Programming - Motion Commands, Sensor Commands, End effecter commands, and Simple programs.

UNIT V **9 Hours**

IMPLEMENTATION AND APPLICATION

Implementation of Robots in Industries - Various Steps- Application of robots in machining - Welding -Assembly - Material handling - Loading and unloading - hostile and remote environments. Inspection and future application

FOR FURTHER READING

Networking, Internet of things and cloud computing, Micro motor and micro gripper, SCARA robots, wheeled robots, Bipedal robots (humanoid robots), hexapod robots.

Total: 45 Hours

Reference(s)

1. M. P. Groover, Industrial Robotics Technology, Programming and Applications, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2001.
2. D. Richard, Klafter, A. Thomas, Chmielewski and Michael Negin, Robotics Engineering, An Integrated Approach, Prentice Hall of India, New Delhi, 2001.
3. K. S. Fu, R. C. Gonzalez and C. S. G. Lee, Robotics Control, Sensing, Vision and Intelligence, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2003
4. Yoram Koren, Robotics for Engineers, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2004.
5. James G. Keramas, Robot Technology Fundamentals, Cengage Learning, 2011.
6. Subir Kumar Saha, Introduction to Robotics, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2008.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	8					12																			20
2		4				8					8														20
3		4				8					8														20
4		4				4					12														20
5		4				4					12														20
																								Total	100

Assessment Questions
Remember
1. What is a manipulator?
2. Define ‘robot arm’
3. Give the standard definition for an industrial robot.
4. State the three laws of robot.
5. What is accuracy?
6. What is work volume of a robot?
7. What is proximity sensor?
8. What is touch sensor?
9. What is force sensor?
10. What are the types of robot programming?
11. What is a teach pendant?
12. When the forward kinematics is advantageous?

Understand
1. Differentiate accuracy and repeatability.
2. How to increase the accuracy of a robot arm?
3. Why the payload is calculated with load at the outer position of the arm?
4. Classify industrial robots.
5. Why RCC is required?
6. Which application is easiest to program for a robot?
7. What kind of end effector is required to stack the glass plates? Why?
8. Electric drives are not suitable for handling inflammable products. State the reason.
9. Why force sensor is needed for a robot?
10. Why safety is important in robot zone?

Apply
1. A frame F has been moved 9 units along x-axis and 5 units along the y-axis of the reference frame. Find the new location of the frame.
2. A cool drink bottling company needs to utilize robot in the packing section. How to do it? Justify your answer.
3. Write a program to flange drilling operation using VAL programming.
4. What type of robots can be applied in inspection? Give reasons.
5. A LPG cylinder is to be arc welded using a robot; how to program it for automation?

15ME019 ADDITIVE MANUFACTURING 3 0 0 3

Course Objectives

- To provide knowledge on generic steps of Additive Manufacturing (AM) technique.
- To learn the concept and applications of liquid and solid based AM processes.
- To impart knowledge on powder based AM processes.
- To introduce the concept of open source 3D printers and rapid tooling.
- To expose the emerging trends and applications of Additive Manufacturing technology.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
n. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Explain the generic steps and classification of Additive Manufacturing processes.
2. Select the suitable material and AM process based on applications.
3. Identify the suitable AM process to fabricate metallic components.
4. Design their own open source 3D printer based on application.
5. Implement the reverse engineering techniques for developing prototype

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1										1		2	
2	2	1										1		2	
3	2	1										1		3	
4	2	1	3		1							1		2	
5	2	1	2		1							2		2	

UNIT I **7 Hours**

INTRODUCTION

Needs - Impact of AM and Rapid Tooling on Product Development - Distinction between AM and CNC Machining- The Generalized AM Process chain - CAD Model - Input file formats - Generation and Conversion of STL file - File Verification and Repair - Build File Creation - Part Construction - Part Cleaning and finishing - RP Benefits - Classification of RP systems

UNIT II **7 Hours**

LIQUID POLYMER AND SOLID BASED SYSTEMS

Stereolithography Apparatus (SLA), Digital Light Projection (DLP), Photo polymerization process, Solid Ground Curing (SGC), Fused Deposition Modeling (FDM) and Laminated Object Manufacturing (LOM) - Working Principle, Construction, Materials and Applications.

UNIT III **10 Hours**

POWDER BASED SYSTEMS

Selective Laser Sintering (SLS), Three dimensional Printing (3DP), Direct Metal Deposition (DMD), Ballistic Particle Manufacturing (BPM), Electron Beam Melting (EBM) and Laser Engineered Net Shaping (LENS)- Working Principle, Construction, Process Variables, Materials and Applications

UNIT IV **11 Hours**

OPEN SOURCE PRINTER AND RAPID TOOLING

Concept of open source 3D printer - Structural details, Control mechanism - Materials and Applications. Introduction to rapid tooling (RT) - Direct and Indirect tooling - Silicone rubber moulding, Epoxy tooling, Spray Metal Coating, 3D printing direct, Electro Optical Sintering (EOS) - Working Principle, Materials and Applications

UNIT V **10 Hours**

REVERSE ENGINEERING AND APPLICATIONS OF ADDITIVE MANUFACTURING

Reverse Engineering - Application of CMM, Laser scanner, CT and MRI scan in acquiring point data - Software for STL file processing. Application of Rapid prototyping in Medical field, Manufacturing, Automotive industries, Aerospace and Electronics and Retail industries. Leading manufacturer of RP systems

FOR FURTHER READING

Case studies related to medical and manufacturing applications - Rapid Manufacturing

Total: 45 Hours

Reference(s)

1. C. K. Chua, K. F. Leong and C. S. Lim, Rapid prototyping: Principles and applications, Cambridge University Press, 2010.
2. D. T.Pham and S. S.Dimov, Rapid manufacturing, Springer-Verlag, London, 2001.
3. I. Gibson, D. W. Rosen, and B. Stucker, Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010
4. L.W. Liou, F.W. Liou, Rapid Prototyping and Engineering applications: A toolbox for prototype development, CRC Press, 2013.
5. A. K. Kamrani, E. A. Nasr, Rapid Prototyping: Theory and practice, Springer, 2006
6. www.reprap.org , www.thingiverse.com

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1		6				8																			14
2		6				4				4					4										18
3		8				8									6										22
4		8				8				4					4										24
5		4				8				6					4										22
																								Total	100

Assessment Questions
Remember

1. Define Additive Manufacturing.
2. State triangulation algorithm.
3. Classify AM processes.
4. Label any four process parameters affecting model creation in Stereolithography.
5. Define Tessellation.
6. List any two neutral file format.
7. Define photo polymerization.
8. List any two applications of LENS process.
9. List any four the materials used in direct metal laser sintering process.
10. Define Rapid Tooling.
11. List any three advantages of *stl* process.
12. Indicate the salient features of SLA process.
13. Illustrate the information flows from data creation to STL file formatting across an RP system.

Understand

1. Select the post processing operations needed for SL made parts.
2. Illustrate the need of support material with an example in SLS process.
3. Indicate the application of carbon dioxide atmosphere in SLS process.
4. Represent the method to prevent lateral distortion of paper prototype by water absorption in LOM process.
5. Select the process to develop prototypes for medical applications and justify your selection.
6. Represent the functions can be carried out on point cloud data using Reverse Engineering software? How do these tools differ from conventional 3D CAD software?
7. Interpret the application of extrusion-based technology for bone tissue engineering compared to other methods.
8. How process parameters affect surface finish, dimensional accuracy of parts manufactured in stereolithography process?
9. Illustrate the process of generating 3D objects from Computerized Tomography.

Apply

1. Assess why surface modeling software is not ideal for describing models that are to be made using AM, even though the STL file format is itself a surface approximation. What kind of problems may occur when using surface modelling only?
2. Make use of solid sheet concepts to develop metallic sheet LOM process.
3. Evaluate the effect of process parameters in Selective Laser Sintering Process?
4. Consider what a fabrication system in the home might look like, with the ability to manufacture many of the products around the house. How do you think this could be implemented?
5. Is it possible to modify the STL file format to include descriptions that may give it multiple material capability? What are the benefits and drawbacks of doing so?

Analyse

1. Differentiate Direct and Indirect tooling.
2. In what ways is extrusion-based AM similar to CNC pocket milling and in what ways is it different?
3. In AM processes often a larger shrinkage value is found in the X–Y plane than in the Z direction before post-processing. Why might this be the case?
4. Compare and contrast SLA and SGC processes.
5. Differentiate between Material removal and material addition process.

15ME020 NON - DESTRUCTIVE TESTING 3 0 0 3

Course Objectives

- To learn different surface inspection techniques.
- To provide knowledge on magnetic particle testing.
- To impart knowledge on ultrasonic testing method.
- To provide knowledge on radiography testing method.
- To study various special non destructive testing methods.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
n. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Select appropriate surface inspection techniques for the components to be inspected
2. Explain the magnetic particle testing method for ferrous materials.
3. Select and explain the suitable testing method for testing internal defects.
4. Apply radiography testing methods for different suitable applications.
5. Choose the suitable special non-destructive technique for various applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3												2	
2	2	3												2	
3	2	3												2	
4	2	2	3											2	
5	2	3										2		2	

UNIT I **9 Hours**

SURFACE TECHNIQUES

Concepts of Non-Destructive testing (NDT) - Discontinuities and Defects in various manufacturing Component-Types of NDT techniques, Introduction to Standards and Specifications (ASME, ASTM, AWS) - Visual or Optical Testing, Direct and remote visual inspection and Aides-Liquid Penetrant Testing (LPT) Principles - Types and properties of liquid penetrants and developers - Preparation of test materials - Advantages and limitations - Application of penetrants to parts - Fluorescent penetrant test

UNIT II **9 Hours**

MAGNETIC PARTICLE TESTING

Magnetic Particle Testing (MPT) Principles, applications - Magnetization methods, magnetic Particles, - Dry particle technique and Wet fluorescent particle technique, demagnetization, Advantages and limitations - Magnetic Flux Leakage Testing Principle, Instrumentation and applications - Electromagnetic Induction Techniques, Principle - Instrumentation and applications of Eddy Current Testing (ECT)

UNIT III **9 Hours**

ULTRASONIC TESTING

Ultrasonic Testing (UT) Principle, Types and characteristics of Ultrasonic waves, Attenuation, Couplants, Probes - Inspection methods-Pulse echo, Transmission and Phased Array techniques (PAUT) , Types of scanning and displays, Angle beam inspection of welds, Calibration of ASTM Test blocks, International Institute of Welding IIW) reference blocks, Applications

UNIT IV **9 Hours**

RADIOGRAPHY TESTING

Radiographic testing (RT) Principle, Sources of X-rays and Gamma rays and their characteristics - Absorption, scattering-Filters and screens, imaging modalities - Film radiography and Digital Radiography - Problems in shadow formation, Exposure factors, film handling and storage Inverse square law, Exposure charts, and Radiographic equivalence. Penetrometers, Safety in radiography, Applications.

UNIT V **9 Hours**

SPECIAL TECHNIQUES

Acoustic Emission Testing (AET) Principle - Advantages and limitations - Instrumentation and applications - Infra Red Thermography (IRT), Contact and non-contact inspection methods, Pressure and Leak Testing - Testing Procedure and applications, LASER Shearography - Typical applications-Requirements - advantages and disadvantages.

FOR FURTHER READING

Case studies - Study of Importance of using NDT in Aircraft welded Structures-casted Automobile components-Marine Structures-Bridges-Towers.

Total: 45 Hours

Reference(s)

1. Baldev Raj, Jayakumar T, Thavasimuthu M, Practical Non-Destructive Testing, Narosa Publishing, 1997.
2. Mc Gonnagle,Non-Destructive Testing, McGraw Hill Book Co., 1988.
3. Barry Hull and Vernon John, Non Destructive Testing, Macmillan, 1989.
4. V-17, Non-Destructive Evaluation and Quality Control, American Society of Metals, Metals Park, Ohio, USA, 2001

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	8					5				5				2											20
2	8					5				5				2											20
3	8					5				5				2											20
4	8					5				5				2											20
5	8					5				5				2											20
																								Total	100

Assessment Questions

Remember

1. What are the different types of surface techniques?
2. What is the different between Defects or discontinuities?
3. For detection of surface weld defects or discontinuities which NDT methods commonly used?
4. For detection of internal weld defects or discontinuities which NDT methods commonly used?
5. What are the factors affecting the choice of NDT method?
6. What is Destructive Testing (DT)?
7. List the 5 destructive testing methods widely used in materials testing.
8. What are penetrometers in radiographic testing? Mention uses.
9. What is the equation for sound waves in a material?
10. What are the three basic factors affecting thermal measurements?
11. What are the applications of X-Rays?

Understand

1. Compare destructive and non-destructive testing.
2. Explain the sequence of operation of penetrant testing?
3. What is a Holograph? How can it be used in NDT?
4. Explain demagnetization in Magnetic particle testing? How do you ensure it?
5. How does the ultrasonic frequency affect the penetration and resolution?
6. Explain the double wall single image technique used in Radiographic testing?
7. Mention the properties of X and gamma rays.
8. Explain the term Thermography?
9. Explain thermography techniques. Mention two of its applications in NDT?
10. Explain the principle of penetrant testing?

Apply

1. Explain the various methods of LPI and explain advantages and limitations of LPI?
2. What are the indirect methods used for Visual Inspection?
3. What is Acoustical Holography, what are the applications and limitations?
4. What are the different types of transducers used in UT technique?
5. What are the different types of sources used in RT method and what are the safety precautions required in RT?
6. Which NDT method is suitable for Testing Aerospace welded structures?
7. Which NDT method is suitable for Testing surface cracks?

Analyse

1. Compare liquid penetrant test and magnetic particle test.
2. Compare Ultrasonic test and Radiographic Test
3. Why magnetic particle test is not suitable for Al alloys?
4. Compare Eddy current test and Acoustic emission test.

15ME021 RENEWABLE ENERGY SOURCES 3 0 0 3

Course Objectives

- To learn about solar radiation and solar thermal systems.
- To provide knowledge on fundamentals of Photovoltaic systems.
- To study about the working of ocean and geothermal energy sources.
- To impart the knowledge on wind energy system.
- To learn about bio mass energy sources and its utilization.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
o. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Explain solar radiation and its conversion into heat using solar collectors.
2. Summarise the characteristics of solar photovoltaic system.
3. Illustrate the working of ocean and geothermal energy sources.
4. Compute wind energy potential and design of wind energy systems.
5. Select the bio mass energy sources and its conversion technologies.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2					1	2							2
2	2	2					1	2							2
3	2	2					1	2							2
4	2	2					1	2							2
5	2	2					2	2							2

UNIT I **9 Hours**

SOLAR RADIATION AND SOLAR THERMAL SYSTEMS

Solar radiation at the Earth's surface, solar radiation measurements, solar radiation data, estimation of average solar radiation. Introduction to conversion of solar radiation into heat, flat plate collectors, concentrating collectors – Types.

UNIT II **9 Hours**

SOLAR PHOTOVOLTAIC SYSTEMS

Introduction to photovoltaic system, Voltage current characteristics of a solar cell, interconnection of solar cells, efficiency of a solar cell, configuration of solar photovoltaic panel, merits and limitations and its applications.

UNIT III **9 Hours**

UNIT III OCEAN ENERGY AND GEOTHERMAL ENERGY

Wave energy - Energy from waves, energy potential. Conversion devices. Tidal energy - energy potential, conversion systems. Ocean thermal energy conversion -Methodology, Applications. Geothermal energy - classification of geothermal resources, schematic of geothermal power plants, operational and environmental problems

UNIT IV **9 Hours**

WIND ENERGY

Basic principles of wind energy conversion - classification of wind turbines, wind turbine rotor, regulating system for rotor, wind power generation curves, wind data and energy estimation. Site selection considerations - Merits and demerits of wind energy systems

UNIT V **9 Hours**

BIO-ENERGY

Biomass resources - Conversion technologies - Biochemical conversion, Biomass gasification, Pyrolysis. Biogas - Production, factors affecting biogas production, biogas plants. Energy recovery from urban waste, power generation from liquid waste, biomass cogeneration, bio-fuels

FOR FURTHER READING

Hydrogen energy, Solar production of hydrogen, selection of optimum wind energy generators, power generation from landfill gas, power from satellite stations

Total: 45 Hours

Reference(s)

1. D. P. Kothari, K. C. Singal and Rakesh Ranjan, Renewable Energy Sources and Emerging Technologies, Prentice Hall of India , New Delhi, 2009
2. Godfrey Boyle, Renewable energy power for sustainable future, Oxford University Press in association with the Open University, New Delhi,2004
3. S. A. Abbasi and Naseema Abbasi, Renewable energy sources and their environmental impact Prentice Hall of India, New Delhi,2001
4. John W. Twidell and Anthony D. Weir, Renewable energy resources, English Language Book Society (ELBS), 2006
5. G. D. Rai, Renewable Energy Sources, Khanna Publishers, New Delhi 2000
6. http://nptel.ac.in/courses/112105051/

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	4	4				8			4																20
2	4	8			4	4																			20
3		4			4	8			4																20
4	4	4			8	4																			20
5	4	4			8	4																			20
																								Total	100

Assessment Questions
Remember

1. State various subsystems in a solar thermal energy conversion system.
2. State the principle of solar thermo electric convertors.
3. What are the applications of solar PV system?
4. Classify the types of geothermal fluids? What is the temperature range?
5. Define geothermal gradient?
6. Define geothermal deposit?
7. State the various forms of Ocean Thermal Resources.
8. State the merits and limitations of Ocean Energy Conversion Plants.
9. State limitations of ocean wave energy
10. State the essential features of a probable site for a wind farm.
11. Define yaw control and pitch control.
12. Classify the types of fuel cells
13. Define hydrogen energy.
14. Define nuclear fusion
15. Define Molten Carbonate Fuel Cells (MCFC)
16. Define is Solid Oxide Fuel Cells (SOFC)

Understand

1. Compare the following types of collectors to be used for a solar thermal power plant with respect to temperature, Concentration ratio, Suitability) Flat plate collector ii) Evacuated tube collector.
2. Differentiate distributed collector system and central receiver system in solar thermal applications.
3. State the reasons for preferring thermal storage in solar power plants.
4. Define hot dry rock geothermal source? How is it used?
5. Compare a geothermal power plant and a thermal power plant.
6. Describe a binary cycle geothermal power plant.
7. Differentiate between ocean wave energy and ocean tidal energy.
8. Compare ocean waves and ocean tides with references to the period, energy density and energy conversion plants.
9. How a wind farm is controlled? Which are the hierarchical control levels?
10. Describe the construction of a typical three blade horizontal shaft wind turbine generator unit.
11. What is the difference between fuel cell and battery?
12. Derive an expression for electromotive force of a fuel cell.
13. Write the principle of oscillating air column ocean wave machine.
14. State the various main equipments and main auxiliaries in a Municipal Waste to Energy Incineration plant. State the typical ratings.
15. State the various principal routes of Biomass energy conversion to useful energy.

Apply

1. Calculate the angle made by beam radiation with the normal to a flat collector on December 1, at 9.00 AM., solar time for a location at 28^o 35’ N. The collector is tilted at an angle of latitude plus 10^o, with the horizontal and is pointing due south.
2. Wind at 1 standard atmospheric pressure and 15^oC temperature has a velocity of 10 m/s. The turbine has diameter of 120 m and its operating speed in 40 r.p.m at maximum efficiency. Calculate
   a. The total power density in the wind stream
   b. The maximum obtainable power density assuming efficiency is 40%
   c. The total power produced in kW
   d. The torque and axial thrust.
3. Why geothermal energy has not been used commercial in India?
4. For a parabolic collector of length 2 m, the angle of acceptance is 15o. Find the concentration ratio of the collector.
5. What are the main four fusion reactions, which are considered for use in fusion reactors? Which one is most favorable reaction?

15ME022 CRYOGENIC ENGINEERING 3 0 0 3

Course Objectives

- To learn about the cryogenic material properties and applications of cryogens.
- To impart knowledge on Liquefaction cycles.
- To provide knowledge about gas separation and purification.
- To study the working of various cryo coolers.
- To learn about the construction of Dewar vessels and cryogenic instrumentation.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Explain the effect of material properties at cryogenic temperatures and applications of cryogens.
2. Compute the figure of merit and yield of various liquefaction cycles.
3. Assess the performance of rectification column for gas separation.
4. Compare the Stirling, Gifford-McMahon and Pulse tube cry coolers based on power consumption, pressure ratio and Coefficient of Performance.
5. Explain the construction of Dewar vessels and cryogenic instrumentation

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1										2	2		
2	3	2											2		
3	2	2	3										2		
4	2												2		
5	2												2		

UNIT I **7 Hours**

INTRODUCTION TO CRYOGENICS

Insight on cryogenics - properties of cryogenic fluids - material properties at cryogenic temperatures - Applications of cryogenics in space programs, superconductivity, cryo metallurgy, biological and medical applications

UNIT II **9 Hours**

LIQUEFACTION CYCLES

Basics of Refrigeration - Methods of production of low temperatures - Joule Thompson expansion - inversion curve. Gas Liquefaction cycles - Carnot liquefaction cycle, Simple Linde Hampson cycle, Precooled Linde-Hampson cycle, Simple Claude cycle, Dual pressure Claude cycle - Figure of merit and yield of liquefaction cycle.

UNIT III **11 Hours**

SEPARATION AND PURIFICATION SYSTEMS

Basics of Gas separation - Ideal separation of gases, characteristics of mixtures and the governing laws - T-C and H-C diagrams. Principle of Rectification - Rectification column - Theoretical plate calculations using McCabe-Thiele method, murphee efficiency. Gas purification.

UNIT IV **9 Hours**

CRYOGENIC REFRIGERATORS

Cryocoolers - Fundamentals, classification, comparison and applications. Working of Stirling, Gifford-McMahon and Pulse tube cryocoolers

UNIT V **9 Hours**

STORAGE AND INSTRUMENTATION

Cryogenic Dewar vessels construction and design, cryogenic transfer Lines. Cryogenic insulation - vacuum, powder, multi layer, micro-sphere and foam-fibrous insulation - concept of vapour coated shields. Cryogenic instrumentation - temperature, flow and level measurements.

FOR FURTHER READING

Vacuum pumps - safety in cryogenic systems - pressure relief valves, rupture disc, safety precautions and protection measures

Total: 45 Hours

Reference(s)

1. K. D. Timmerhaus and T. M. Flynn, Cryogenic Process Engineering, Plenum Press, New York, 1989.
2. Thomas M. Flynn, Cryogenic Engineering, Marcel Dekker, New York, 2005
3. Randall F. Barron, Cryogenic Systems, 2nd edition, Oxford University press, New York, 1985.
4. G. G. Haselden, Cryogenic Fundamentals, Academic Press Inc., London, 1999
5. Mamata Mukhopadhyay, Fundamentals of Cryogenic Engineering, PHI learning Private Limited, New Delhi, 2014.
6. R. B Scott, Cryogenic Engineering, Van Nostrand and Company Inc., 1985

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	4				4	6				6															20
2						4	8												8						20
3	2	2			4	12																			20
4	2	2			4	12																			20
5	2	2			4	12																			20
																								Total	100

Assessment Questions

Remember

1. Define cryogenic engineering.
2. List the properties of Cryogenic fluids?
3. Define Inversion Curve.
4. Draw T-s diagram of Precooled LindeHampson Cycle.
5. State the working principle of rectification column.
6. State the benefits of cryosurgery.
7. State the purpose of cryogenic vessel insulation.
8. Define multi-layer insulation.
9. Describe see back effect.
10. List the various types of insulation systems for space propulsion.
11. Define cryogenic propellants.
12. List the various Liquid level measurement techniques
13. How thermal properties of materials are affected by low temperatures?
14. When do you prefer cryogenic separator of Helium?

Understand

1. Why carbon steel cannot be used as a good cryogenic fluid storage material?
2. How electrical properties of materials are affected by low temperatures?
3. Differentiate between the Dual pressure Claude and Heylandt process?
4. Where the Philips helium liquefaction process is employed? Why?
5. For what type of application, you would prefer to use propellant feed system in rocket propulsion?
6. Differentiate refrigeration and liquefaction.
7. What do you understand by sub atmospheric pressure?
8. Cryogenic engineering will help to reduce the energy growth in India. Discuss.
9. How the pressure ratio of compressor and temperature affect the yield?
10. What is the purpose of Optical liquid level indicator?
11. What do you understand by Thermal shields and insulation?
12. Differentiate between the fatigue and impact strength.

Analyse

1. Discuss the effect of low temperature on mechanical properties of materials.
2. Analyze the electrical properties of materials at cryogenic temperatures.
3. Identify the effect of cryogenic temperatures on thermal properties of materials.
4. Identify a suitable material for low temperature applications.
5. Why Stainless steel is best suitable for cryogenic applications. Analyze.

Evaluate

1. Evaluate the liquid yield, the work per unit mass compressed, the work per unit mass liquefied, and the figure of merit for a simple LindeHampson system using nitrogen as the working fluid. The system operates between 1 atm and 300K at point 1 and 200atm and point

2. The compressor may be assumed to be 75% reversible and the temperature of approach is 10°C.

2. An ideal gas mixture of 30% methane and 70% hydrogen by volume is to be separated at 300K. Determine the minimum power requirement to produce 1 kg/s of hydrogen.
3. An ideal gas mixture of 30% methane and 70% hydrogen by volume is to be separated at 300K. Determine the minimum power requirement to produce 1 kg/s of hydrogen.
4. Determine the inside heat transfer coefficient and friction factor for flow of nitrogen gas at 150K and 1 atm inside a 12 mm inside diameter smooth tube that is coiled in a 600 mm diameter helix. The tube wall has a temperature of 160K, and the mass flow rate of the nitrogen gas is 30 kg/s.
5. Determine the threshold field strength for indium at 3 K, assuming that the parabolic rule for the transition curve is valid for indium.
6. When an external magnetic field of 0.0150 tesla is applied to an indium wire, the material changes from the superconducting state to the normal state. Determine the temperature of the wire.
7. An ideal gas mixture of 30% methane and 70% hydrogen by volume is to be separated at 300K. Determine the minimum power requirement to produce 1 kg/s of hydrogen.

15ME023 ENGINEERING TRIBOLOGY 3 0 0 3

Course Objectives

- To impart basic knowledge on friction and wear.
- To provide knowledge on behaviour of surface contacts.
- To learn about frictional behaviour of sliding and rolling contacts.
- To learn the wear mechanisms and its consequences under different contact conditions.
- To identify the appropriate lubrication type based on contact conditions.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Explain the fundamental of friction and wear.
2. Identify and use surface contact characteristics for particular applications.
3. Apply the characteristics of friction for various applications
4. Analyze the wear mechanism and measure wear rate.
5. Select suitable lubrication type for particular application

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3						1								
2	2	1									1		1		
3	2	2					1						1		
4	3	2					1					1	1		
5	2	1					1					1	1		

UNIT I **7 Hours**

INTRODUCTION

Introduction to Tribology, Factors influencing Tribological phenomena, Properties of materials relevant to friction and wear.

UNIT II **9 Hours**

CONTACT BEHAVIOUR OF SURFACE

Engineering surfaces - Surface characterization, Contact of engineering surfaces: Hertzian and nonhertzian contact, Contact pressure and deformation in non-conformal contacts.

UNIT III **9 Hours**

FRICTION

Causes of friction, Stick-slip friction behaviour and friction instability, sliding and rolling friction, frictional heating and temperature rise, Friction measurement techniques.

UNIT IV **9 Hours**

WEAR

Wear and wear types, Mechanisms of wear, wear of metals and non-metals. wear models - asperity contact, constant and variable wear rate, geometrical influence in wear models, wear damage, wear measurement and controlling techniques.

UNIT V **11 Hours**

LUBRICATION

Lubricants- physical and chemical properties, types of additives. Selection of lubricants, Hydrodynamic lubrication-principle and application, Reynolds equation. Elastohydrodynamic Lubrication- Principle and application, pressure - viscosity term in Reynolds equation, Hertz theory, Ertel-Grubin Equation.

FOR FURTHER READING

Biotribology, Nanotribology, Green Tribology.

Total: 45 Hours

Reference(s)

1. Prasanta Sahoo, Engineering Tribology, Prentice-Hall India, 3rd edition, New Delhi, 2011.
2. Bharat Bhushan,, Introduction to Tribology, Wiley Publication, 2nd edition, 2013.
3. I.M. Hutchings, Friction and Wear of Engineering Material, Edward Arnold, London, 2002.
4. Neale, M.J. Tribology Hand Book, Butterworth Heinemann, 2005.
5. T.A. Stolarski, Tribology in Machine Design, Industrial Press Inc., 2000.
6. http://www.nptel.iitm.ac.in/downloads/110105039/

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1		5					5				5				5										20
2		5					5				5								5						20
3							5				5				5				5						20
4			5								5				5				5						20
5	5	5				5					5														20
																								Total	100

Assessment Questions

Remember

1. Define friction and what the laws of friction.
2. What is Coulomb friction and sticking friction?
3. Define fretting wear.
4. What are the characteristics of adhesive and abrasive wear?

5. What are the situations in which abrasive wear occur?
6. Mention any four methods of applying surface coatings.
7. What is meant by hydrostatic lubrication?
8. Write the salient features of hydrostatic lubrication.
9. What are the advantages of hydrostatic bearings?
10. Define basic load rating.
11. What are the components of surface geometry?
12. What are the major causes for the failure of rolling bearings?
13. List any four rolling bearing failures.
14. What are the main reasons for the vibration of oil lubricated journal bearings?

Understand

1. How surface properties are important from the point of tribology?
2. Why composite wear rate is less than that of aluminium for lower limiting pressure?
3. How will you evaluate friction factor experimentally?
4. Sliding friction is dependent on surface roughness, why?
5. What is all the design features affecting bearing vibration.
6. When will you go for hydrostatic lubrication system?
7. How does viscous index number influence in selection of lubricants?
8. How are lubricants classified?
9. What are the properties required for a good lubricant?
10. Distinguish between hydrodynamic and Elasto hydrodynamic lubrication. Explain in detail two applications for Elasto hydro dynamic lubrication.
11. Why is selective assembly used in ball bearing manufacturing?
12. What do you understand by life of rolling element bearings?
13. What are bearings performance measurements?
14. Why bearings are preloaded in machine tool spindle drive application?

Apply

1. Discuss the wear properties of metallic and non metallic material.
2. Discuss the friction properties of metallic and non metallic material.
3. Describe the characteristics and causes of rolling bearing failures and preventive measures.
4. Explain the types of additives used and their functions for the manufacturing of engine oils.
5. Explain the set-up of four ball and pin-on-disc type friction and wear measuring instrument.
6. Discuss the nature and types of failure in tribological components.

Analyse

1. Explain the influence of the following in determining sliding friction of metals:
   Surface finish
   Surface energy
   Hardness
2. Explain the types of additives used and their functions for the manufacturing of engine oils.
3. Derive the equation for the load bearing capacity, frictional power loss, energy losses of a hydrostatic step bearing.
4. Derive the equation for pressure acting on hydrostatic annular thrust bearing.

Evaluate

1. A ball bearing is operating on work cycle of 3 hours consisting of: 1. a radial load of 3 kN at 1440 r.p.m for one quarter cycle. 2. a radial load of 5 kN at 720 r.p.m for half cycle. 3. a radial load of 2.5 kN at 1440 r.p.m for the remaining cycle.The expected life of the bearing is 10000 hours. Calculate the load carrying capacity of the bearing.

Create

1. The following data is given for a journal bearing :Radial load of 3.2 kN, Journal speed of 1490 r.p.m, journal diameter of 50 mm, bearing length of 50 mm, radial clearance of 0.05 mm, viscosity of 25 cP.Calculate for the given conditions: a. Coefficient of friction. b. Power loss owing to friction. c. Minimal film thickness d. Flow requirement of oil in litres /minute e. Temperature rise in the bearing.

15ME024 POWER PLANT ENGINEERING 3 0 0 3

Course Objectives

- To impart the knowledge on boilers and steam power plant.
- To learn about the various components associated with steam power plant.
- To study the working of nuclear and hydel power plant.
- To learn about the working of diesel and gas turbine power plant.
- To provide the knowledge on power plants using renewable energy and economics of power plants.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
o. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Explain the working principle of steam power plant and boilers.
2. Assess the function of various systems in steam power plant.
3. Select the suitable components for nuclear power plants and hydel power plants.
4. Expose the working of diesel and gas turbine power plant.
5. Explain the different sources of renewable energy and calculate the economics of power plants

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2				1	2								3
2	2						1								3
3	2					1	2								3
4	2					1	1								3
5	2	3	2				1				2				3

UNIT I **9 Hours**

INTRODUCTION TO POWER PLANTS AND BOILERS

Layout of Steam power plant - Components, Selection. Steam Boilers and Cycles - High Pressure and Super Critical Boilers, Fluidized Bed Boilers. Combined Power Cycles. Comparison and Selection.

UNIT II **9 Hours**

STEAM POWER PLANT

Fuel and Ash Handling - Combustion Equipment for burning coal, Mechanical Stokers, Pulveriser, Electrostatic Precipitator, and Mechanical Collectors. Draught - different types. Surface Condenser types. Cooling Towers. Pollution controls.

UNIT III **9 Hours**

NUCLEAR AND HYDEL POWER PLANTS

Nuclear Energy - Fission, Fusion Reaction. Layout - Types of Reactors, Pressurized Water Reactor, Boiling Water Reactor, Waste Disposal and safety. Hydel Power Plant - Layout, Essential Elements, pumped storage. Selection of Turbines, Governing of Turbines.

UNIT IV **9 Hours**

DIESEL AND GAS TURBINE POWER PLANTS

Layout of Diesel power Plant - Components, Selection of Engine Type, applications. Gas Turbine Power Plant - Layout, Fuels, Gas Turbine Material. Open and Closed Cycles - Reheating, Regeneration and Intercooling.

UNIT V **9 Hours**

OTHER POWER PLANTS AND ECONOMICS OF POWER PLANTS

Geo thermal power plant. Ocean thermal energy conversion (OTEC). Tidal power plant. Solar thermal power plant. Wind energy. Wind turbines. Magneto hydrodynamic generator (MHD). Cost of Electric Energy - Fixed and operating Costs, Economics of load sharing.

FOR FURTHER READING

Renovation and modernization of aged power plants - Maintenance aspects of power plants

Total: 45 Hours

Reference(s)

1. 1. S. C. Arora, S. Domkundwar, A course in Power Plant Engineering, Dhanpatrai & Sons, New Delhi, 2008.
2. K.K.Ramalingam, Power Plant Engineering, Scitech Publications (India) Private Limited, 2002.
3. P. K. Nag, Power plant Engineering, Tata McGraw Hill Company Private Limited, New Delhi, 2014.
4. G. R. Nagpal, Power Plant Engineering, Khanna Publishers, New Delhi, 2002.
5. G. D. Rai, Introduction to Power Plant Technology, Khanna Publishers, New Delhi, 2013.
6. R. K. Rajput, Power Plant Engineering, Laxmi Publications, New Delhi, 2007.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2	4	9		1	4																			20
2		5			2	2	6		1	4															20
3	1	4			1	4			2		8														20
4		5				2	8		2	3															20
5	1	4			1		4			2	8														20
																								Total	100

Assessment Questions

Remember

1. List out the factors to be considered in the selection of power plant.
2. Define super critical boilers.
3. List the advantages of modern high pressure boilers.
4. State the advantages of regenerative feed heating in steam power cycle.
5. List the application for diesel engine power plant.
6. List out the factors to be considered for the selection of diesel engine.
7. List the different types of burners used to burn pulverized fuel.
8. State the pollution caused by the power plant.
9. State the advantages of pulverized fuel firing system.
10. List the different types of firing system.
11. List the cause of smoke.
12. Define power plant economics.
13. Define nuclear chain reaction.
14. State the functions of control rod, moderator, coolant and reflector.

Understand

1. Compare the diesel engine power plant with steam power plant.
2. Compare base load plant and peak load plant.
3. Compare the gas turbine power plant with steam power plant.
4. Compare the performance of the combined cycle operation with the other cycles.
5. Differentiate hand firing and mechanized firing of fuel.
6. Compare the Nuclear fission and nuclear fusion process.
7. Explain load factor, load curve, load duration curve.
8. Classify the reactors.
9. Classify the different types of MHD.
10. Compare the performance of the combined cycle operation with the other cycles.

Apply

1. A base load plant power station and standby power station share a common load as follows:
   Base load station annual output = 200 x 10^3MWh
   Base load station capacity = 48MW
   Maximum demand on base load station =45 MW
   Standby station capacity = 25MW
   Standby station annual output = 200 x 10^3MWh
   Maximum demand on standby station = 15MW
   Determine the following for the both power stations: a) Load factor, b) Capacity factor.
2. The peak load on a thermal power plant is 75MW. The loads having maximum demands of 35MW, 20MW, 15MW and 18MW are connected to the power plant. The capacity of the power plant is 90MW and the annual load factor is 0.53. Calculate
   The average load on the power plant
   The energy supplied per year
   c) The demand factor

d) The diversity factor.

3. The yearly duration curve of a certain plant can be considered a straight line from 30,000 kW to 10,000 kW. To meet this load, three turbine generator units, two rated at 15,000 kW each and one at 7500 kW are installed. Evaluate: 1) Installed capacity 2)Plant factor 3) Maximum demand 4) Load factor 5) utilization factor
4. For a steam power plant, some data is given as follows:
   Maximum demand=50,000 kW
   Load factor=75%
   Coal consumption=0.85 kg per kWh
   Boiler efficiency=83%
   Turbine efficiency =92%
   Price of coal=Rs. 52 per ton
   Calculate: a) Thermal efficiency of the station,
   b)Coal bill of the station for one year.

15ME025 OPTIMIZATION TECHNIQUES 3 0 0 3

Course Objectives

- To formulate design optimization problems for engineering applications
- To provide knowledge on single variable unconstrained problems
- To learn multi-objective unconstrained optimization problems
- To introduce concepts of constrained non-linear optimization problems
- To interpret non-traditional optimization techniques for engineering problems

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Formulate design optimization problem from real world applications.
2. Compute the solution for single variable unconstrained optimization problems.
3. Determine the solution for multivariable unconstrained optimization problems.
4. Find the solution for the constrained non-linear optimization problems.
5. Apply non-traditional optimization techniques to solve engineering problems

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	1											1		
2	3	2	2										1		
3	3	2	2										1		
4	3	2	2										1		
5	3	2	2		1							1	2		

UNIT I **9 Hours**

INTRODUCTION

Introduction to design optimization-Historical development, the design process, Conventional Vs Optimum design process - Statement of an optimization problem- Optimum design problem formulation - process steps, Problem formulation for engineering applications - Two-bar bracket, Design of coil springs - Classifications of optimization problems.

UNIT II **9 Hours**

SINGLE VARIABLE NONLINEAR UNCONSTRAINED OPTIMIZATION ALGORITHMS

Optimality criteria - Unimodal function - Eliminating methods - Exhaustive search, Dichotomous search, Interval halving method, Fibonacci search method, Golden section search method. Point estimation method (Powell's algorithm) - Gradient-based methods - Newton-Raphson method (Taylor's series expansion), Bisection method, Secant method, Cubic search method.

UNIT III **9 Hours**

MULTI VARIABLE NONLINEAR UNCONSTRAINED OPTIMIZATION ALGORITHMS

Optimality criteria - Unidirectional search - Direct search methods - Evolutionary optimization method, Random search methods, Simplex search method, Hooke-Jeeves pattern search method, Indirect search (gradient) methods- Cauchy's (steepest descent) method, Newton's method, Conjugate gradient method.

UNIT IV **9 Hours**

CONSTRAINED NONLINEAR OPTIMIZATION ALGORITHMS AND SPECIALIZED PROGRAMMING

Introduction, Characteristics - Indirect search methods - Transformation methods, Penalty function method, Method of multipliers - Sensitivity analysis - Kuhn-Tucker conditions, Theorems. Test problems on three-bar truss, welded beam design. Direct search minimization methods- Variable elimination method, Complex search method and Random search methods - Feasible direction method. Integer programming - Penalty function method, Branch and Bound method.

UNIT V **9 Hours**

NONTRADITIONAL OPTIMIZATION TECHNIQUES

Genetic Algorithms (GA)- principle, difference and similarities between GA and traditional methods, constrained optimization, GA operators, Real-coded and Advanced GAs - Simulated Annealing - Neural Network based Optimization.

FOR FURTHER READING

Unconstrained algorithms - Variable matric method (Davidson-Fletcher-Powell method). Constrained algorithms - Geometric programming- Primal-Dual relationship. Powell's quadratic function.

Total: 45 Hours

Reference(s)

1. Singiresu S.Rao, Engineering Optimization: Theory and Practice, Fourth Edition, Wiley India Pvt Ltd, Delhi,2009.
2. Kalyanmoy Deb, Optimization for Engineering Design- Algorithms and Examples, Second Edition, PHI Learning Pvt. Ltd., New Delhi,2012.
3. Jasbir Singh Arora, Introduction to Optimum design, Third Edition, Elsevier India Pvt.Ltd. New Delhi, 2011.
4. R.Saravanan, Manufacturing optimization through intelligent techniques, First Edition, Taylor & Francis Publications, CRC Press, New Delhi, 2006.
5. http://www.nptelvideos.in/2012/12/design-and-optimization-of-energy.html
6. http://nptel.ac.in/courses/112106064/

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	
1	2					4				12															18
2	2					5													12						19
3	3					6					12														21
4	4					5													12						21
5	4					5				12															21
																								Total	100

Assessment Questions

Remember

1. Define optimization.
2. List five engineering applications of optimization.
3. What is design space?
4. What are objective function contours?
5. What is Newton –Rapshon method?
6. What is an integer programming problem?
7. Write the Taylor's series expansion of a function *f*(x).
8. Define saddle point and indicate its significance.
9. State Kuhn-Tucker conditions.
10. What is a one-dimensional minimization problem?
11. Define Fibonacci numbers.
12. What is a uni-modal function?
13. What is an exhaustive search method?
14. State the necessary conditions for unconstrained minimum of a function.
15. What is arithmetic – geometric inequality?

Understand

1. How do you solve a maximization problem as a minimization problem?
2. Suggest a simple method of handling multiple objectives in an optimization problem.
3. What happens when m=n in a standard LP problem?
4. How many basic solutions can an LP problem have?
5. Why linear programming is important in several types of industries?
6. Is the decomposition method efficient for all LP problems?
7. Interpret golden mean.
8. Differentiate Newton and Quasi-Newton methods?
9. Identify the limitations of classical methods in solving a one-dimensional minimization problem?
10. Represent the necessary and sufficient conditions for the unconstrained minimum of a function.
11. Write the characteristics of a direct search method?
12. Interpret the use of extrapolating the objective function in the penalty function approach?
13. Why Rosen rock method is called pattern search method?
14. Why the search directions are reset to steepest descent directions periodically in the DFP method?

Apply

1. Under what condition can a polynomial in n variables are called a posynomial?
2. Demonstrate the necessary and sufficient conditions for the maximum of a multi variable *f*(x).
3. Can a slack variable be in the basis at the optimum point of an LP problem?
4. How do you detect an unbounded solution in the simplex procedure?
5. How do you identify the presence of multiple optima in the simplex method?

6. Suggest a method of finding the minimum of multimodal function.
7. Prove that a convex function is unimodal.
8. Write a computer program, in the form of a subroutine, to implement the golden section method.
9. Suggest possible convergence criteria that can be used in direct search methods.
10. Check whether the univariate method is a conjugate directions method.
11. Demonstrate how the degree of difficulty defined for a constrained geometric programming problem?
12. Show how to solve a trajectory optimization problem using dynamic programming.
13. Compute the procedure for tabu search optimization.
14. Execute the procedural steps for partical swarm optimization technique.
15. Construct suitable optimization procedure for optimum design of simple four bar linkage mechanism.

Evaluate

1. Use three iterations of the golden section search method in order to maximize the functionf(x) = 10+x3-2x-5e(x).
2. Minimize $f(x1,x2)=x1-x^{2}+2x^{23}+2x1x^{2}+x22$ from the starting point X1 = {00} using Powell’s method.

15ME026 DESIGN FOR MANUFACTURE AND ASSEMBLY

3 0 0 3

Course Objectives

- To introduce the way of specifying dimension and tolerance in engineering drawing by using Geometric dimensioning and tolerancing.
- To indicate the design considerations while casting, welding and forming of components.
- To familiarize with the concept and design guidelines for manufacturing parts by different machining processes.
- To study the factors affecting easy assembly of parts into a final product.
- To impart knowledge about the environmental impact of products manufactured and engineering ways to minimize it.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply Geometric Dimensioning and Tolerancing techniques in Engineering Drawing
2. Apply the design considerations to minimize difficulty in fabrication of components by casting, welding and forming processes.
3. Use the design for manufacturing concept to reduce machining time and manufacturing cost Design for Manufacture tools for minimizing effort and cost in manufacturing a product by in machining processes.
4. Perform the parts assembly of the given component using DFA guidelines
5. Design components taking into consideration the environmental impact it have while manufacturing and during its lifecycle.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2			1										
2	3	2	1												
3	3	2	1		1								1		
4	3	2			1							1	1		
5	3	2	1		1							1	1		

UNIT I **11 Hours**

GEOMETRIC DIMENSIONING AND TOLERANCING

Tolerance Chains and identification of functionally important dimensions. International Tolerance Grades, Surface finish, Attainable tolerance grades and different machining processes. Geometric Dimensioning and Tolerancing - Location, Form and Feature tolerance. Tolerance Limits for Assembly - Cumulative effect of Tolerances - Sure fit law, normal law and truncated normal law - Tolerance zone conversions.

UNIT II **9 Hours**

DESIGN CONSIDERATIONS FOR CASTINGS, WELDING AND FORMING

Casting - Pattern, Mould, Parting line - Cast, Cored and Machined holes - Redesign of castings based on parting line considerations - Minimizing core requirements. Welding - Stresses in welding - Measures to combat contraction stresses - Welding sequence - Joints in Welding - Weldability of steel - Design of welded structures. Form design aspects for Forging and sheet metal components.

UNIT III **8 Hours**

DESIGN FOR MANUFACTURE - MACHINING CONSIDERATIONS

Design for Manufacture Guidelines - 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 Manufacture: Machinability, Economy, Clampability, Accessibility, Assembly. Redesign for Manufacture - Examples.

UNIT IV **8 Hours**

DESIGN FOR ASSEMBLY

Design for Assembly(DFA) Guidelines - Minimizing number of Parts - Insertion and Fastening - Design Guidelines for Part Handling - Effect of Part Symmetry, Part Thickness, Part Size, Weight on Handling Time - Types of Manual Assembly Methods - Effect of Assembly layout on Part Acquisition Time - Assembly Efficiency - DFA index.

UNIT V **9 Hours**

DESIGN FOR ENVIRONMENT

Environmental objectives - Global issues, Regional and local issues - Basic Design for Environment (DFE) methods - Design guide lines - Lifecycle assessment - AT&T's (American Telephone and Telegraph Company) environmentally responsible product assessment, Weighted sum assessment method, Lifecycle assessment method - Techniques to reduce environmental impact - Design to minimize material usage - Design for disassembly, Recyclability, Remanufacture, Energy efficiency - Design to regulations and standards.

FOR FURTHER READING

Case studies - Design considerations in casting, welding, forging, machining. Design components with minimizing environmental impact.

Total: 45 Hours

Reference(s)

1. Gene R. Cogorno, Geometric Dimensioning and Tolerancing for Mechanical Design, McGraw-Hill Professional, New Delhi, 2011.
2. Harry Peck, Designing for Manufacture, Pitman Publishing, London, 1973.
3. Robert Matousek, Engineering Design - A Systematic Approach, Blackie and Son Limited, London, 1974.
4. M. F. Spotts, Dimensioning and Tolerance for Quantity Production, Prentice Hall, New Jersey, 2007.
5. J.G. Bralla, Hand Book of Product Design for Manufacturing, McGraw-Hill Publications, New Delhi, 2000.
6. Kevin otto, Kristin wood, Product Design: Techniques in Reverse Engineering and New Product Development, Pearson education, 2003.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	6					4								10											20
2						6				8				6											20
3	2					8				10															20
4						6				6				8											20
5	2					6				6				6											20
																								Total	100

Assessment Questions

Remember

1. Define tolerance.
2. State the three types of fits.
3. Specify the IT tolerance grades for parts manufactured by drilling, milling, turning and Grinding.
4. What is tolerance stack?
5. Define Maximum Material Condition.
6. Define Least Material Condition.
7. List the different symbols used to specify surface finish.
8. List any four Design for Manufacture guidelines.
9. Give two examples for better form design of welded members.
10. What are the techniques to reduce environmental impact?
11. Mention any four Design for Assembly guidelines.
12. Draw five symbols of geometric tolerance.
13. Define manufacturability.
14. What are global environmental issues?

Understand

1. Contrast unilateral and bilateral tolerance.
2. Why tolerance is specified for features on engineering drawing?
3. Distinguish cast hole and core hole.
4. Which features can be used as datum for machining?
5. What is meant by simplification by separation?
6. Distinguish clampability and accessibility.
7. What are the types of welding?
8. What are defects in casting?
9. What are remedies of shrinkage effect?

10. What are the steps involved in minimizing the material usage?
11. Explain in detail in AT&T's Product assessment method.

Apply

1. Sketch a design example which eliminates the need for core in casting.
2. Explain in detail about the assembly limits, Datum features & tolerance stack.
3. With suitable sketches explain design for machinability.
4. Illustrate with an example, how machining area can be reduced.
5. How the amalgamation can be simplified?
6. What do you understand by redesigning a machined component, and why it is necessary? Explain with an example.
7. Discuss the design considerations for minimum material usage and for remanufacture.
8. With suitable examples and sketches, discuss considerations to obviate cores in casting.
9. Explain in detail of design to minimize the material in design.
10. Illustrate with example, design for energy efficiency.

Analyse

1. A drawing of a type of caster assembly that is commonly found on heavy boxes. Using the assembly advisor, Analyze the ease or difficulty of assembling the caster. What suggestions would you make in the design in order to reduce assembly costs? Can you estimate the approximate savings in assembly costs?
2. Pictorial drawings of some of the thin-walled parts. Would you anticipate any difficulty in sand casting these parts? Explain.
3. How an uneconomical design is identified and modified? Illustrate with an example.

15ME027 INDUSTRIAL ENGINEERING 3 0 0 3

Course Objectives

- To impart the knowledge on production planning methodologies and layout design.
- To study the process planning methodologies and control.
- To learn the concept of work study and ergonomics.
- To provide knowledge on inventory management and material handling equipment.
- To study the importance of value engineering and plant maintenance.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
n. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost..

Course Outcomes (COs)

1. Select the suitable production planning methodologies production system and plant layout for the industry design for given
2. Structure the process planning and control to increase the productivity.
3. Execute the effective work study and ergonomics for better productivity.
4. Choose the suitable material handling equipment and assess the inventory control.
5. Apply the concept of system, value engineering and plant maintenance for industrial application

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	1												
2	2	2	1											2	
3	1	2	3												
4	2	3	1												
5	2	3	1											2	

UNIT I **9 Hours**

INDUSTRIAL ENGINEERING PRODUCTION SYSTEM

Industrial engineering - Concept, History and development, Applications, Roles of Industrial engineer- Production management, Industrial engineering versus production management, operations management - Production system Analysis, Input output model, Productivity, Factors affecting productivity - Plant layout, Criteria for good layout, Types of layout - Process layout, Product layout, Combination layout and Fixed position layout, Flow pattern, Workstation design.

UNIT II **9 Hours**

PROCESS PLANNING AND PRODUCTION CONTROL

Introduction to Process planning Definition, Procedure, Process selection, Machine capacity, process sheet, Process analysis - Group technology, classification and coding system, formation of component family - Production planning, loading, scheduling. Production control dispatching, routing - Progress control bar, curve, gantt chart, route and schedule chart

UNIT III **9 Hours**

WORK STUDY AND ERGONOMICS

Work study - Definition, Need, Advantages, objectives of method study and work measurement, method study procedure, Process chart symbols, outline process chart, flow process chart, multiple activity chart, flow diagram, string diagram, operation analysis, principles of motion economy, therbligs, SIMO chart, stop watch procedure, micro & macro motion study, ergonomics- applications of ergonomic principles in the shop floor work benches seating arrangement, Industrial physiology

UNIT IV **9 Hours**

INVENTORY MANAGEMENT

Inventory control, classification, management, objectives, functions. Economic order quantity, Economic batch quantity, inventory models, ABC analysis, Material Requirement Planning(MRPI), Manufacturing Resource Planning(MRP II), Operating cycle, KANBAN technique, lean manufacturing, Supply chain management - Material handling Functions, Principles, Engineering and economic factors, Material handling equipment selection, maintenance, types

UNIT V **9 Hours**

SYSTEM ANALYSIS AND MAINTANENCE

System concept - system analysis, systems engineering, techniques and applications. Value analysis-Aim, technique, procedure, advantages, value engineering, value control, types of values. Plant maintenance -objectives, importance, maintenance engineer duties, functions and responsibilities. Types breakdown, scheduled, preventive and predictive - Plant maintenance schedule, Condition monitoring

FOR FURTHER READING

Applied anthropometry, Biostatic mechanics, Estimation and costing concepts

Total: 45 Hours

Reference(s)

1. Khanna O.P., Industrial Engineering and management, DhanpatRai Publications., 2010.
2. Panneerselvam R., Production and operations management, Heritage Publishers., 2006.
3. MartandT.Telsang, Industrial Engineering and Production Management, S Chand Publishers, 2006.
4. Ravi Shankar, Industrial Engineering and Management, Golgotia Publications Pvt. Ltd., New Delhi, 2009.
5. Jan Dul, Bernard Weerdmeester, Ergonomics for Beginners: A Quick Reference Guide, CRC Press, Taylor and Francis group, 2008.
6. Lee J. Krajewski, Larry P.Ritaman, Operations Management , Addison Wesley, 2007

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2	2				11					5														20
2			10		2					8															20
3	2					10					8														20
4	2		5				10				3														20
5		5	5			5			5																20
																								Total	100

Assessment Questions

Remember

1. What is meant by process planning?
2. State the general approaches to process planning.
3. List four benefits of Material Handling.
4. What is industrial engineering?
5. List out four roles of industrial engineer.
6. What is the use of SIMO chart?
7. What is work sampling?
8. Define inventory.
9. What do you mean by ABC analysis?
10. What is mean by just in time in manufacturing?
11. Define KANBAN technique.
12. What is Ergonomics?

Understand

1. Distinguish plant layout and process layout.
2. Explain in detail the need for layout study.
3. Illustrate the various types of layout with example.
4. How the Production system Sequences?
5. How to do the Workplace management and utilization of optimum manpower?
6. Where to apply the ABC analysis?
7. How will you differentiate protective and productive maintenance?
8. How will you handle materials using forklift?
9. Process material is direct material (True / False).

Apply

1. Choose the best layout method for a bolt manufacturing unit.
2. Select the best equipment to handle cylinder.
3. Explain the maintenance engineer's role when there is a machine fault.
4. Choose the industry where Just In Time can be implemented effectively.
5. Explain how will you implement value engineering concept in an industry.
6. Apply lean manufacturing concept in a car manufacturing industry.
7. Apply the project planning procedure for new industry.
8. Choose the best ergonomic posture for lifting an object.
9. Sketch the procedure for handling glasses.
10. Explain the storage management in a food industry if you are incharge of it.
11. Explain how you will solve the problem of back pain in employees working in your organization handling heavy objects where equipments should not be used.
12. Sketch the process flow to be followed in auto auxiliary industry manufacturing steering.
13. Explain on-load and off-load testing used in condition monitoring with its flow chart

15ME028 INDUSTRIAL MAINTENANCE ENGINEERING

3 0 0 3

Course Objectives

- To study the principles, functions and practices adapted in industry for the effective maintenance management.
- To learn the concept of preventive and Total Productive Maintenance.
- To study the few methods and instruments for condition monitoring.
- To know the few repair methods for basic machine elements.
- To learn few repair methods for material handling equipment.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
n. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Apply the principles, functions and practices in the process and manufacturing industry for the effective maintenance management
2. Implement the preventive maintenance and total productive maintenance for improving productivity
3. Assess the process performance to take corrective measures.
4. Identify the suitable methods to repair the basic machine elements.
5. Select the suitable methods to repair material handling equipment.

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2												2	
2					2	2	1							2	
3	1	2	1		2	2	2								
4	2	2	2		1	1	1								
5	1	2				2	1								

UNIT I **9 Hours**

PRINCIPLES AND PRACTICES OF MAINTENANCE PLANNING

Basic Principles of maintenance planning - Objectives and principles of planned maintenance activity - Importance and benefits of sound maintenance systems - Reliability and machine availability - Mean Time Between Failures, Mean Time To Repair and Mean Waiting Time - Factors of availability - Maintenance organization - Maintenance economics.

UNIT II **9 Hours**

MAINTENANCE POLICIES PREVENTIVE MAINTENANCE

Maintenance categories - Comparative merits of each category - Preventive maintenance, maintenance schedules, repair cycle - Principles and methods of lubrication - Total Productive Maintenance.

UNIT III **9 Hours**

CONDITION MONITORING

Condition based maintenance - Cost comparison with and without Condition Monitoring - On-load testing and offload testing - Methods and instruments for Condition Monitoring - Temperature sensitive tapes - Pistol thermometers - wear-debris analysis.

UNIT IV **10 Hours**

REPAIR METHODS FOR BASIC MACHINE ELEMENTS

Failure analysis - Failures and their development - Logical fault location methods - Sequential fault location - Repair methods for beds, slide ways, spindles, gears, lead screws and bearings.

UNIT V **8 Hours**

REPAIR METHODS FOR MATERIAL HANDLING EQUIPMENT

Repair methods for material handling equipment Equipment records Job order systems Use of computers in maintenance.

FOR FURTHER READING

Tribology in Maintenance, friction wear and lubrication, friction & wear mechanisms, prevention of wear, types of lubrication mechanisms, lubrication processes. Lubricants - types, general and special purpose, additives, testing of lubricants, degradation of lubricants, seal & packings

Total: 45 Hours

Reference(s)

1. Srivastava S.K., Industrial Maintenance Management, S. Chand and Company, 2002.
2. Venkataraman .K, Maintancence Engineering and Management, Prentice Hall of India Private Limited, 2007.
3. Andrew K.S.Jardine, Albert H.C.Tsang, Maintenance, Replacement and Reliability, Taylor and Francis, 2006.
4. Mishra R.C., Pathak.K, Maintenance engineering and Management, Prentice Hall of India Private Limited, 2012.
5. Higgins R.L, R.Keith Mobley, Darrin Wikoff, Maintenance Engineering Handbook, The McGraw-Hill Companies Inc. 2008.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	
1	3	3			2	4	2			4	2														20
2	2	2			2	4								5	5										20
3		2			4	4			5	5															20
4		4				4	2			4	6														20
5		4			2	2	4				5			3											20
																								Total	100

Assessment Questions

Remember

1. Define Reliability.
2. Define failure rate.
3. List the main factors of maintenance cost.
4. State the types of maintenance budget.
5. State the components of maintenance cost.
6. What are the types of maintenance?
7. List the purpose of lubrication.
8. Define the term Preventive Maintenance.
9. Define corrective maintenance approach.
10. Give the eight pillars of Total Productive Maintenance.
11. What are two main types of infrared thermography?
12. What are called Time- Dependent Failures?
13. Define Fault Tree diagrams.
14. Define Root Cause Analysis (RCA).

Understand

1. Give the merits of condition based maintenance.
2. Classify various planned maintenance approach.
3. What is total productive maintenance and discuss its similarities with Total Quality Management (TQM)?
4. What does safety, health and environment pillar of Total Productive Maintenance (TPM) aims at?
5. What are the causes of vibration?
6. How to analyze the vibration?
7. Why the temperature monitoring is necessary?
8. Mention the various costs involved in costing of condition monitoring.
9. What is the aim of Event Tree Analysis (ETA)?
10. What are cause and effect diagrams?

Apply

1. Explain on-load and off-load testing used in condition monitoring with their flow chart?

Analyse

1. What are all the steps involved in preventive maintenance and why preventive maintenance is better than reactive maintenance?
2. What is leakage monitoring? Explain some of the leakage mediums used for condition monitoring.

15ME029 COMPUTATIONAL FLUID DYNAMICS 3 0 0 3

Course Objectives

- To provide the knowledge on fundamental governing equations of fluid mechanics and heat transfer
- To acquire knowledge on formulation of governing Equations for fluid flow problems in finite difference method
- To study the steady and unsteady state diffusion type problems using finite volume method.
- To impart one dimensional and two dimensional elements in finite element techniques for fluid flow problems.
- To learn the structured and unstructured grids generation techniques.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
m. Design, analyse and evaluate the performance of mechanical systems.
n. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.
o. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Formulate the fundamental governing equations of fluid mechanics and heat transfer.
2. Solve the fluid dynamics problems using finite difference method.
3. Construct finite volume equations for steady and unsteady state diffusion type problems.
4. Apply the finite element methods for fluid flow problems.
5. Generate the grids using grid generation techniques for simple and complex geometries.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3												2	
2	1	3		2											2
3	3	2			1										2
4	2	3			1										-
5	1		3	2									2		

UNIT I **9 Hours**

INTRODUCTION

Introduction - Applications and impact of CFD in diverse fields - Governing equations of fluid dynamics-continuity - momentum and energy - generic integral form for governing equations -Initial and Boundary conditions. Classification of partial differential equations-Elliptic, Parabolic and Hyperbolic types.

UNIT II **10 Hours**

FINITE DIFFERENCE METHOD

Basics and discretization of simple and complex governing equations. Applications. In compressible in-viscid Flows - Illustrative and physical examples of Elliptic, Parabolic and Hyperbolic equations - Discretization of partial Differential Equations. Implicit, explicit and Crank Nicolson finite difference methods for viscous flows. Stability, convergence, accuracy.

UNIT III **10 Hours**

FINITE VOLUME METHOD

Basic rules for FV Discretization. Finite Volume (FV) Discretization of one and two dimensional steady state diffusion type problems - 1-D convection-diffusion type problem - Unsteady flows - implementation of boundary conditions in Finite Volume. Solution of discretized equations. Solution algorithm for Pressure Velocity coupling in steady flows - Pressure-velocity coupling - SIMPLE scheme.

UNIT IV **8 Hours**

FINITE ELEMENT METHOD IN FLUIDS

Over view of Finite Element Techniques in Computational Fluid Dynamics. Weighted residual and Variational formulations. Finite element interpolation. One and two dimensional elements. Steady state conduction and incompressible potential flow problems.

UNIT V **8 Hours**

NUMERICAL GRID GENERATION

Introduction. Algebraic grid generation. Differential Grid Generation. Structured and unstructured grids. Body fitted Coordinate Method.

FOR FURTHER READING

Case studies on transient conduction, boundary layer over a flat plate, convection analysis of internal/external flow.

Total: 45 Hours

Reference(s)

1. J. D. Anderson., Jr. Computational Fluid Dynamics- The Basic with Applications, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2004

2. F. John Wendt (Editor), Computational Fluid Dynamics - An Introduction, Springer Verlag, Berlin, 1992
3. S. V. Patankar, Numerical Heat Transfer and Fluid Flow, Hemisphere, New York, 2004.
4. H. K. Versteeg and W. Malalasakera, An Introduction to Computational Fluid Dynamics The Finite Volume Method, Addison Wesley Longman Limited, England, 1999.
5. K. A. Hoffman, Computational Fluid Dynamics for Engineering, Engineering Education System, Austin, Texas 2005.
6. Introduction to computational fluid dynamics http://nptel.ac.in/courses/112105045/.

Assessment Pattern

Unit/RBT	**Remember**				**Understand**				**Apply**				**Analyse**				**Evaluate**				**Create**				**Total**
	F	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	
1	10					5																			15
2		5				10				5			5												25
3		10				10					5														25
4		5				10				5															20
5		5					5			5															15
																								Total	100

Assessment Questions

Remember

1. What are the main elements involved in a complete CFD analysis?
2. What are the Units in continuity, momentum and energy equation?
3. Define Continuum.
4. Write continuity equation in polar co-ordinate?
5. What is the meaning of a streamline?
6. Write the momentum and energy equation for two-dimensional Cartesian co-ordinate.
7. Write the central difference form of equation for Poisson's equation.
8. What is the main difference between structured and unstructured mesh?
9. What type of boundary condition can be used on the computational domain?
10. What is the main purpose of the post-processing stage?
11. Define thermal diffusivity.
12. Write the shape function for quadratic and cubic polynomial in FEM.
13. Name the sources of energy that contribute to the energy equation.

Understand

1. What are the differences between solving a fluid-flow problem analytically compared with solving numerically? What are the advantages and disadvantages of each method?
2. What are the main advantages and disadvantages of discretization of the governing equations through finite difference method?
3. Classify error in numerical computation.
4. Compare implicit and explicit methods in finite difference form.
5. Differentiate between compressible and incompressible flow.
6. What does the convergence criterion control?
7. Fluids such as oils have a high Prandtl number ($Pr >> 1$). What does this suggest?
8. The Nusselt number is a ratio of two fluid properties. What are they?

Apply

1. Why is it important to correctly define the computational domain for the fluid flow problem? Give an example of this.
2. What is Newton's second law of motion?
3. The Reynolds number is a ratio of two fluid properties. What are they?

4. With a suitable example, indicate the significance of upwind differencing scheme.
5. Write force balance equation for all the forces acting on a differential control volume?
6. Write simplified equation for one-dimensional inviscid, incompressible, laminar flow?
7. Write momentum equation for y-direction?
8. Apply Fourier's law of heat conduction to obtain the heat flux in the x-direction.
9. Obtain the general analytical solution for Laplace equation for one dimensional case.
10. Without experimental data for turbulent inlet profiles, what is the recommended method to consider turbulence effects?

Analyse

1. Which of the following: forward difference, backward difference and central difference is most accurate and why?
2. Explain the Lagrangian description of a fluid motion?
3. What is Eulerian description of fluid motion? How does it differ from Lagrangian description?
4. Where is the data resolved in the finite volume scheme?
5. Why it is favourable to start off with a coarse mesh when solving CFD problem?
6. Which method converges to a solution quicker, Gauss-Siedel or Jacobi method and Why?
7. Can Gaussian elimination method be used to solve a system of non-linear algebraic equation? Explain.
8. Describe the concept of stability.
9. Provide a definition on the concept of convergence?
10. What are some problems/difficulties in setting up correct boundary conditions?
11. Why do we need outlet boundary condition for an inlet boundary condition?
12. What are the main advantages and disadvantages of discretization of the governing equations through the finite-volume method?

Evaluate

1. Is the finite volume method more suited for the structure or unstructured mesh geometries? Why?
2. A streak of dye is released into an internal flow and its motion is tracked and recorded. Is this a Lagrangian or Eulerian measurement?

15ME030 Fuels and combustion 3 0 0 3

Course Objectives

- To introduce the characteristics of fuels.
- To provide knowledge on types and properties of solid and liquid fuels.
- To impart knowledge on types and properties of gaseous fuels.
- To learn about the stoichiometry and kinetics of combustion.
- To introduce different types of air pollution and its control.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
o. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Categorize the characteristics of fuels.
2. Compare the types and properties of solid and liquid fuels.
3. Interpret the types and properties of gaseous fuels.
4. Formulate the stoichiometry and kinetics of combustion.
5. Recognize the causes of air pollution and its control.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2													
2	2														
3	2														
4	3	2													2
5	3						2								

UNIT I **9 Hours**

FUEL CHARACTERISTICS

Fuels- Types and Characteristics of Fuels-Determination of Properties of Fuels-Fuels Analysis-Proximate and Ultimate Analysis-Moisture Determination- Calorific Value-Gross and Net Calorific Values -Calorimetry- DuLong's Formula for CV Estimation- Flue gas Analysis- Orsat Apparatus.

UNIT II **9 Hours**

SOLID AND LIQUID FUELS

Solid Fuels: Wood and Wood charcoal - Origin of coal - Composition of coal- Analysis and properties of different grades of coal - preparation and storage of coal - coal washing -Briquetting. Liquid coals:

Origin of petroleum fuels - Production - Composition - Petroleum refining - Variousgrades of petro - Products - Properties and testing - Alcohol shale oil - Gasification of liquid fuels -Synthetic fuels - Storage and handling of liquid fuels

UNIT III **9 Hours**

GASEOUS FUELS

Classification - Composition and Properties - Estimation of Calorific Value - Gas Calorimeter. Rich and Lean Gas - Wobbe Index - Natural Gas - Dry and Wet Natural Gas - Stripped NG - Foul and Sweet NG - LPG - LNG - CNG - Methane - Producer Gas - Gasifiers - Water Gas Town Gas - Coal-Gasification - Gasification Efficiency - Non - Thermal Route - Biogas - Digesters - Reactions - Viability - Economics.

UNIT IV **9 Hours**

COMBUSTION: STOICHIOMETRY AND KINETICS

Stoichiometry - Mass Basis and Volume Basis - Excess Air Calculation - Fuel and Flue Gas Compositions - Calculations - Rapid Methods - Combustion Processes - Stationary Flame- Surface or Flameless Combustion -Submerged Combustion - Pulsating and Slow Combustion Explosive Combustion.

Mechanism of Combustion - Ignition and Ignition Energy - Spontaneous Combustion - Flame Propagation - Solid - Liquid and Gaseous Fuels Combustion - Flame Temperature - Theoretical - Adiabatic and Actual - Ignition Limits - Limits of Inflammability.

UNIT V **9 Hours**

AIR POLLUTION

Types of pollution-Combustion - Generated air pollution - Effects of air pollution - Pollution of fossil fuels and its control - Pollution from automobiles and its control.

FOR FURTHER READING

Advances in Fuels and Combustion

Total: 45 Hours

Reference(s)

1. Civil Davies., Calculation in furnace Technology, Pergamon Press, 2009.
2. Samir sarkar., Fuels and combustion., Orient longman, 2007.
3. Obrert Edward, I.C Engines and Air pollution, Harper and Row publishers, 2012.
4. Blokh AG, Heat Transfer in Steam Boiler Furnace, Hemisphere Publishing, 2005
5. P.N.Muherjee, Total Quality Management, Prentice Hall of India, New Delhi, 2006.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	4	4			2	6					4														20
2	4	4				6					6														20
3	2	6			4	6				2															20
4	4	6			4	4					2														20
5	4	4			4	2				6															20
																								Total	100

Assessment Questions

Remember

1. List the types of fuels
2. Define calorific value of a fuel

3. Define briquetting
4. Define Petroleum refining
5. Define natural gas
6. Define coal gasification
7. How coal is classified?
8. Define Stoichiometry
9. Define Flame Propagation
10. Define fossil fuels

Understand

1. List the properties of fuel
2. Differentiate net and gross calorific value
3. List the types of solid fuels
4. List the types of liquid fuels
5. State the properties of LPG
6. State the properties of CNG
7. State the properties of methane
8. Differentiate Mass Basis and Volume Basis stoichiometry
9. List the types of pollution
10. List the effect of air pollution

Apply

1. How to control air pollution in automobiles
2. The ultimate analysis of a coal tar fuel is C90%, H2 6.0%, S 0.3%, N2 1.2% and 02 2.5%. It is burned with 20% excess air and the flue gas leaves the combustion chamber at 300oC. Calculate the heat loss with the flue gases per kg of dry fuel. (Neglect the ash of coal tar fuel.)
3. What are the basic elements exhausted with the flue gases which are hazardous for human health? What are the effects of SO2, NOX and Hydrocarbons on the human lives.

15GE001 ENTREPRENEURSHIP DEVELOPMENT I 3 0 0 3

Course Objectives

- Study of this subject provides an understanding of the scope of an entrepreneur, key areas of development, financial assistance by the institutions, methods of taxation and tax benefits, etc

Course Outcomes (COs)

1. Able to gain Knowledge about entrepreneurship, motivation and business.
2. Able to develop small scale industries in different field.

UNIT I **9 Hours**

BASICS OF ENTREPRENEURSHIP

Nature, scope and types of Entrepreneurship, Entrepreneur Personality Characteristics, Entrepreneurship process. Role of entrepreneurship in economic development

UNIT II **9 Hours**

GENERATION OF IDEAS

Creativity and Innovation, Lateral Thinking, Generation of Alternatives, Fractionation, Reversal Method, Brain Storming, Analogies

UNIT III **9 Hours**

LEGAL ASPECTS OF BUSINESS

Contract act-Indian contract act, Essential elements of valid contract, classification of contracts, sale of goods act- Formation of contract of sale, negotiable instruments- promissory note, bills and cheques, partnership, limited liability partnership (LLP), companies act-kinds, formation, memorandum of association, articles of association.

UNIT IV **9 Hours**

BUSINESS FINANCE

Project evaluation and investment criteria (cases), sources of finance, financial statements, break even analysis, cash flow analysis.

UNIT V **9 Hours**

OPERATIONS MANAGEMENT

Importance- functions-deciding on the production system- facility decisions: plant location, plant layout (cases), capacity requirement planning- inventory management (cases)-lean manufacturing, Six sigma.

Total: 45 Hours

Reference(s)

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi: 2005
2. Prasanna Chandra, Projects Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill Publishing Company Limited, New Delhi: 2000.
3. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill: 2006

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	
1	3							2	2			1		2			2		2		2		4		20
2		3					2			2		2		2		2			3			4			20
3			3			2					2				2			4		3			4		20
4				3			2			2			2			3		4						4	20
5		1		2				2		2		2			2				5			4			20
																								Total	100

Assessment Questions
Remember

1. What is entrepreneurship?
2. What are the factors that motivate people to go into business?
3. Define a small-scale industry
4. Who is an intrapreneur?
5. State functions of SISI
6. What is serial entrepreneur?
7. What is Technopreneurship?
8. What is reversal method?
9. What is brainstorming?
10. What do you mean by term business idea?
11. Mention any two schemes Indian government provides to the development of entrepreneurship
12. What is a project report?
13. What is project scheduling?
14. Mention any four techniques available for project scheduling.
15. What is contract act?
16. Define MOU.
17. Mention any five external sources of finance to an entrepreneur.
18. Classify the financial needs of an organization
19. Why is motivational theories important for an entrepreneur?

Understand

1. Why is entrepreneurship important of growth of a nation?
2. Mention the essential quality required for someone to be an entrepreneur.
3. How is network analysis helpful to the development of an entrepreneur?
4. Mention the essential requirements for a virtual capital.
5. How under-capitalization affects an entrepreneur
6. Mention the causes of dissolution of a firm.
7. How important is the support of IDBI to an entrepreneur?
8. What are the salient features of New Small Enterprise Policy, 1991?
9. Why scheduling is very important for a production design?

Apply

1. If you want to become as an entrepreneur, what will be your idea?
2. Select any one of the creative idea generation method and suggest an innovation that you can implement in your business.

3. Write a short notes on various legal aspects that you have to consider to run you business.
4. How will you generate your capital and other financial supports?

5. In case of getting enough financial support, plan your business and plot the various stages using any of the tools or techniques

Create

1. Draft a sample project report for your business
2. Do a network analysis using PERT and CPM for your business plan.
3. Write a brief report to apply to a financial organization for seeking financial support to your business

15GE002 ENTREPRENEURSHIP DEVELOPMENT II 3 0 0 3

Course Objectives

- Evolve the marketing mix for promoting the product / services
- Handle the human resources and taxation
- Understand Government industrial policies / support provided and prepare a business plan

Course Outcomes (COs)

1. Increase in awareness of the entrepreneurship Development for engineering decisions.

UNIT I **9 Hours**

MARKETING MANAGEMENT

Marketing environment,Segmentation, Targeting and positioning, Formulating marketing strategies,Marketing research, marketing plan, marketing mix (cases)

UNIT II **9 Hours**

HUMAN RESOURCE MANAGEMENT

Human Resource Planning (Cases), Recruitment, Selection, Training and Development, HRIS, Factories Act 1948 (an over view)

UNIT III **9 Hours**

BUSINESS TAXATION

Direct taxation, Income tax, Corporate tax, MAT, Tax holidays, Wealth tax, Professional tax (Cases).Indirect taxation, Excise duty, Customs, Sales and Service tax, VAT, Octroi, GST (Cases)

UNIT IV **9 Hours**

GOVERNMENT SUPPORT

Industrial policy of Central and State Government, National Institute-NIESBUD, IIE, EDI. State Level Institutions-TIIC, CED, MSME, Financial Institutions

UNIT V **9 Hours**

BUSINESS PLAN PREPARATION

Purpose of writing a business plan, Capital outlay, Technical feasibility, Production plan, HR plan, Market survey and Marketing plan, Financial plan and Viability, Government approvals, SWOT analysis.

Total: 45 Hours

Reference(s)

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi: 2005.
2. Philip Kotler., Marketing Management, Prentice Hall of India, New Delhi: 2003
3. Aswathappa K, Human Resource and Personnel Management - Text and Cases, Tata McGraw Hill: 2007.
4. Jain P C., Handbook for New Entrepreneurs, EDII, Oxford University Press, New Delhi: 2002.
5. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill: 2006.
6. http://niesbud.nic.in/agencies.htm

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2	2			2	2			2	2					2	2				2				2	20
2	2									6					6							6			20
3		3				2					3			3					3		3			3	20
4			3				3			3					3		3		3				2		20
5			3				3					3			3						3	2		3	20
																								Total	100

Assessment Questions
Remember

1. Who are Fabian Entrepreneur?
2. Mention the three functions of NSIC?
3. Narrate the role of IDBI in the development of Entrepreneurship?
4. What are the stages in a Project Lifecycle?
5. Give the meaning of Feasibility Report
6. What is Motivating Training?
7. Who is a Small Scale Entrepreneur?
8. How to develop Rural Entrepreneur?
9. What are the Social Problems of Women Entrepreneur?
10. What are the types of entrepreneurs?
11. List the various qualities of entrepreneur.
12. What is entrepreneurship training?
13. State the role of NISIET.
14. List the challenges and opportunities available in SSI's?

Understand

1. What are the elements of EDP?
2. How would you Classify Projects?
3. What is the role played by commercial banks in the development of entrepreneur?
4. What are the target groups of EDP?
5. What are the major problems faced by Small Entrepreneur?
6. What are the problems & prospects for women entrepreneur in India?

Apply

1. Describe the various functions performed by Entrepreneurs?
2. Explain the role of different agencies in the development of Entrepreneur?
3. Discuss the criteria for selecting a particular project?
4. Describe the role of Entrepreneur in the Development of Country?
5. Define business idea. Elaborate the problems and opportunities for an entrepreneur.
6. Elaborate the schemes offered by commercial banks for development of entrepreneurship.
7. Explain the significant role played by DIC & SISI for the development of entrepreneurship.

Analyse

1. Differentiate between entrepreneur and entrepreneurship
2. What are the problems of Women entrepreneurs and discuss the ways to overcome these barriers?
3. Discuss the importance of small scale industries in India

Evaluate

1. Review the entrepreneurial growth by the communities of south India.
2. Critically examine the growth and development of ancillarisation in India.

Create

1. Design a short entrepreneurship development programme for farmer.
2. "All economy is the effect for which entrepreneurship is the cause"-Discuss.
3. Discuss the various sources and collection of credit information of entrepreneurs
4. Discuss the role of the government both at the Central and State level in motivating and developing entrepreneurship in India.
5. Briefly explain the recommendation and policy implication for survival of SME's.
6. Developing countries like India need imitative entrepreneurs rather than innovative entrepreneurs". Do you agree? Justify your answer with examples.
7. Discuss the “Culture of Entrepreneurship” and its role in economic development of a nation. What factors contribute to nurturing such a culture?

15GE0P1 NANOMATERIALS SCIENCE 3 0 0 3

Course Objectives

- Understand the fundamentals of physics of nanomaterials
- Correlate on multidisciplinary branch
- Acquire the knowledge in nanomaterials synthesis, compile and analyze data and draw conclusions at nano level

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Classify the size dependant properties of different nanomaterials
2. Explain different experimental methods used for the preparation of nanomaterials
3. Analyse the data using different characterization techniques
4. Illustrate the different techniques to synthesize semiconductor nanostructures and utilize them for application
5. Identify the impact of nanomaterials and their applications in Nano devices

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2													
2	3	1													
3	3	2													
4	3	2													
5	3	1													

UNIT I **9 Hours**

NANO SCALE MATERIALS

Introduction-Feynman's vision-national nanotechnology initiative (NNI) - past, present, future - classification of nanostructures,nanoscale architecture - effects of the nanometer length scale - changes to the system total energy, and the system structures- effect of nanoscale dimensions on various properties -magnetic properties of nanoscale materials -differences between bulk and nanomaterials and their physical properties.

UNIT II **9 Hours**

NANOMATERIALS SYNTHESIS METHODS

Top down processes - mechanical milling, nanolithography and types based on radiations - Bottom up process - chemical vapour deposition, plasma enhanced CVD, colloidal and sol-gel methods - template based growth of nanomaterials - ordering of nanosystems, self-assembly and self-organization - DC sputtering and RF sputtering process.

UNIT III **9 Hours**

CHARACTERIZATION TECHNIQUES

General classification of characterization methods - analytical and imaging techniques - microscopy techniques - electron microscopy, scanning electron microscopy, transmission electron microscopy, atomic force microscopy - diffraction techniques - X-ray spectroscopy - thermogravimetric analysis of nanomaterials.

UNIT IV **9 Hours**

SEMICONDUCTOR NANOSTRUCTURES

Quantum confinement in semiconductor nanostructures - quantum wells, quantum wires, quantum dots, super lattices-epitaxial growth of nanostructures-MBE, metal organic VPE, LPE - carbon nano tubes- structure, synthesis and electrical properties -applications- fuel cells - quantum efficiency of semiconductor nanomaterials.

UNIT V **9 Hours**

NANOMACHINES AND NANODEVICES

Microelectromechanical systems (MEMS) and Nanoelectromechanical systems (NEMS)-fabrication, actuators-organic FET- principle, description, requirements, integrated circuits- organic LEDs - basic processes, carrier injection, excitons, optimization - organic photovoltaic cells- nano motors -bio nano particles-nano - objects - applications of nano materials in biological field.

FOR FURTHER READING

Application of graphene in various field - supercapacitors - third generation solar cell-dye sensitized solar cell (DSSC) -fuel cells.

Total: 45 Hours

Reference(s)

1. Willam A. Goddard, Donald W.Brenner, Handbook of Nanoscience, Engineering, and Technology, CRC Press, 2012.
2. Charles P. Poole Jr and. Frank J. Owens, Introduction to Nanotechnology, Wiley Interscience, 2007.
3. Guozhong Cao, Y. Wang, Nanostructures and Nanomaterials-Synthesis, Properties & Applications, Imperials College Press, 2011.
4. T. Pradeep, NANO: The Essentials Understanding Nanoscience and Nanotechnology, McGraw - Hill Education (India) Ltd, 2012.
5. Robert W. Kelsall, Ian W. Hamley, Mark Geoghegan, Nanoscale Science and Technology, John Wiley and Sons Ltd, 2006
6. Viswanathan B, AuliceScibioh M, Fuel cells: Principles and Applications, University Press, 2009.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	3	4	4		2					4				3					4						24
2	2	3	4		4	4				3				4											24
3	2	4	2			2	2				2			2											16
4		2			2	4				2				4					3						17
5	2	4				3	2				4				4										19
																								Total	100

Assessment Questions
Remember

1. Explain the term nano
2. List three types of classifications of nanomaterials.
3. Recall the principle behind lithography.
4. Define top-down and bottom-up approach.
5. Name two types of nanoarchitecture
6. Define nanocomposites.
7. Recall the principle of electron microscopy.
8. List 5 characterization techniques in nanotechnology.
9. Define quantum well and quantum wire.
10. Write the allotropy of carbon.

Understand

1. Explain the effect of nanometer length scale.
2. Can affect the system total energy when particle size reduced? Justify.
3. Explain plasma enhanced CVD.
4. Identify the difference between self-assembly and self-organization.
5. Name 3 synthesis process under bottom-up approach.
6. Explain contact mode in AFM.
7. Is it possible to explain the entire details of the sample by taking one characterization technique? if no, justify.

Apply

1. Find three day to day live commercial application of nanotechnology?
2. Choose two template methods used to obtain nanowire or nanorods.
3. Construct the experimental setup for organic LED.
4. Find 4 industrial applications of CNT.

Analyse

1. Differentiate between bulk and nanomaterials.
2. Identify the roll of nanoparticles in biological field.
3. Distinguish between glow discharge and RF sputtering.
4. Criticize the future challenges for nanotechnology?

Evaluate

1. Nanomaterials, do they exist in nature? If yes, Identify the nanomaterials and recognize.

15GE0P2 SEMICONDUCTOR PHYSICS AND DEVICES

3 0 0 3

Course Objectives

- Impart knowledge in physical properties of semiconducting materials
- Analyze the factors affecting the operation of semiconductor devices
- Apply the physics of semiconductors to develop semiconductor devices

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Exemplify the drift and diffusion current densities due to carrier transport in semiconductors
2. Analyze the electric field and space charge width of PN junction under different biasing
3. Explain the charge flow, temperature effects, turn on and turn off transients in PN junction diode
4. Illustrate the operation of Bipolar Junction transistor at different modes and different configurations.
5. Represent the working mechanism of opto-electronic devices

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1															
2	2	1													
3	2	1													
4	2	1													
5															

UNIT I **9 Hours**

CARRIER TRANSPORT IN SEMICONDUCTORS

Carrier drift - drift current density - mobility effects on carrier density - conductivity in semiconductor - carrier transport by diffusion - diffusion current density - total current density - breakdown phenomena - avalanche breakdown.

UNIT II **9 Hours**

PHYSICS OF P-N JUNCTION

Basic structure-Built in potential barrier, Electric field and space charge width of P-N junction under zero, forward and reverse bias- Diffusion capacitance - one sided and linearly graded junctions.

UNIT III **9 Hours**

P-N JUNCTION DIODE

Qualitative description of charge flow in p-n junction - boundary condition - minority carrier distribution - ideal p-n junction current - temperature effects - applications - the turn on transient and turn off transient.

UNIT IV **9 Hours**

BIPOLAR JUNCTION TRANSISTOR

Introduction to basic principle of operation - the modes of operation - amplification - minority carrier distribution in forward active mode - non-ideal effects - base with modulation - high injection emitter band gap narrowing - current clouding - breakdown voltage - voltage in open emitter configuration and open base configuration.

UNIT V **9 Hours**

OPTO ELECTRONIC DEVICES

Optical absorption in a semiconductor, photon absorption coefficient - electron hole pair generation - solar cell - homo junction and hetero junction - Photo transistor - laser diode, the optical cavity, optical absorption, loss and gain - threshold current.

FOR FURTHER READING

Organic semiconductors- diodes - transistors-working and applications

Total: 45 Hours

Reference(s)

1. Donald A Neamen, Semiconductor Physics and Devices, Tata McGraw Hill, 2012.
2. S. M. Sze and M. K. Lee, Semiconductor Devices, Physics and Technology, John-Wiley & Sons, 2015.
3. Ben. G. Streetman and S. K. Banerjee , Solid State Electronic Devices, Pearson Education Ltd, 2015.
4. C. Kittel, Introduction to Solid State Physics, John-Wiley & Sons, 2012.
5. J. Millman and C. Halkias, Electronic Devices and Circuits, Tata McGraw Hill, 2010.
6. Hagen Klauk, Organic Electronics: Materials, Manufacturing and Applications, Wiley-VCH, 2006.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	3	4	4		2					2				3					2						20
2	2	3	4		4	4				3				4											24
3	2	4	2		2	2					4			4											20
4		2			2	4				2				4					4						18
5	2	4				2	2				4				4										18
																								Total	100

Assessment Questions

Remember

1. Define drift current density
2. Recall diffusion capacitance
3. Write the ideal diode equation
4. List the three modes of transistor operation

5. State the principle of solar cell

Understand

1. Identify the two scattering mechanisms that affect mobility of charge carriers in semiconductors
2. Sketch the energy band diagram of a P-N junction under thermal equilibrium
3. Exemplify the boundary conditions used to calculate minority carrier distribution in a junction diode
4. Explain the base width modulation occur in transistors
5. Illustrate the working mechanism of a phototransistor

Apply

1. By applying the concept of scattering, explain the mobility of holes in a semiconductor.
2. Apply Poission equation to space charge region and hence derive the electric field under zero bias
3. Show that the minority carrier concentrations in a diode decay exponentially with distance away from the junction to their thermal-equilibrium values.
4. Derive an expression for excess minority current in the emitter region under forward action mode by applying the ambipolar transport equation.
5. Show that the minority carrier concentrations in a diode decay exponentially with distance away from the junction to their thermal-equilibrium values.

Analyse

1. Differentiate drift current and diffusion current
2. Space charge width increases upon reverse bias. Justify
3. Silicon is preferred over germanium for the manufacture of semiconductor devices. Justify
4. Compare emitter bandgap narrowing and current crowding.
5. Differentiate homojunction and heterojunction laser

15GE0P3 APPLIED LASER SCIENCE 3 0 0 3

Course Objectives

- Impart knowledge on laser science
- Explore different strategies for producing lasers
- Create expertise on the applications of lasers in various fields

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Illustrate the transition mechanisms and the components of a laser system
2. Compare the different types of lasers based on pumping method, active medium and energy levels
3. Compute the rotation of earth, velocity and distance using lasers and apply the same for day today applications
4. Analyze the role of lasers in surgical and endoscopy applications
5. Apply the laser techniques in industrial applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1													
2	2	1													
3	2														
4	2														
5	2														

UNIT I **9 Hours**

LASER FUNDAMENTALS

Introduction - principle - Einstein's prediction - spontaneous emission - stimulated emission - Einstein's relations - A and B coefficients - population inversion - condition for large stimulated emission - spontaneous and stimulated emission in optical region - light amplification. Components of lasers: active medium - pumping - pumping mechanisms - resonant cavity.

UNIT II **9 Hours**

CHARACTERISTICS AND TYPES OF LASERS

Introduction - directionality - intensity - coherence - monochromaticity. Classification of lasers - principle, construction, working, energy level diagram and applications of CO2 laser - dye laser - excimer laser - Nd:YAG laser - semiconductor laser.

UNIT III **9 Hours**

LASERS IN SCIENCE

Harmonic generation - stimulated Raman emission - lasers in chemistry - laser in nuclear energy - lasers and gravitational waves - LIGO - rotation of the earth - measurement of distance - velocity measurement - holography.

UNIT IV **9 Hours**

LASERS IN MEDICINE AND SURGERY

Eye laser surgery - LASIK - photocoagulations - light induced biological hazards: Eye and skin - homeostasis - dentistry - laser angioplasty - laser endoscopy - different laser therapies.

UNIT V **9 Hours**

LASERS IN INDUSTRY

Applications in material processing: laser welding - hole drilling - laser cutting. Laser tracking: LIDAR. Lasers in electronics industry: ranging - information storage - bar code scanner. Lasers in defence: laser based military weapons - laser walls.

FOR FURTHER READING

Q-switching - mode locking - thermo-optic effects - astronomy lasers - fighting crime with lasers - laser engraving.

Total: 45 Hours

Reference(s)

1. K. Thiyagarajan and A. K. Ghatak, LASERS: Fundamentals and Applications, Springer, USA, 2015.
2. M. N. Avadhanulu, An Introduction to Lasers Theory and Applications, S. Chand Publisher, 2013.
3. W. Koechner, M. Bass, Solid State Lasers: a graduate text, Springer Verlag, New York, 2006.
4. K. P. R. Nair, Atoms, Molecules and Lasers, Narosa Publishing House, 2009.
5. K. R. Nambiar, Lasers: Principles Types and Applications, New Age International Publications, 2006.
6. A. Sennaroglu, Solid-State Lasers and Applications, CRC Press, 2006.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2	2			2	2	1		2	3	1			2			1	2							20
2	2	2			3	2	2		2	2			1	1			1		2						20
3	3				2	2	1		2		3		2	1	1			1	2						20
4	2	2			2	1	1		2	2	1		2	2	1			1	1						20
5	2	1			1		3		2		2		2	1			1	2	3						20
																								Total	100

Assessment Questions

Remember

1. Recognise the term LASER
2. Define stimulated absorption
3. Define spontaneous emission
4. Define stimulated emission

5. Distinguish between spontaneous and stimulated emission
6. State population inversion
7. List the four characteristics of lasers
8. Mention the five medical applications of lasers
9. State the principle behind the holography
10. Recall the term resonant cavity

Understand

1. Identify the condition needed for laser action
2. Interpret the pumping of atoms
3. Exemplify the optical excitation occurs in three level laser systems
4. Explain the determination of rotation of earth using laser
5. Summarize the application of lasers in welding and cutting
6. Explain the term LASIK
7. Classify the different types of lasers based on materials
8. Illustrate the working of laser in material processing

Apply

1. Predict the condition for laser action
2. Derive the Einstein's A and B coefficients
3. Deduce the expression for large stimulated emission
4. Construct the experimental setup for distance measurement
5. Find the applications of lasers in stimulated Raman
6. Assess the wavelength of emission of GaAs semiconductor laser whose bandgap energy is 1.44 eV.

Analyse

1. Laser beam should be monochromatic, Justify?
2. Differentiate ordinary light source from laser source
3. Compare the working of gas lasers with excimer laser
4. Four level laser systems are more efficient than three level laser systems. Justiify**?**

Evaluate

1. Determine the intensity of laser beam be focused on an area equal to the square of its wavelength. For He-Ne laser wavelength is 6328 A^0 and radiates energy at the rate of 1mW.
2. Choose the appropriate lasers for the materials processing in industry

15GE0C1 CORROSION SCIENCE 3 0 0 3

Course Objectives

- Recognize the terminologies used in corrosion science.
- Impart knowledge about the various types of corrosion and its mechanism.
- Understand the various methods of corrosion control, corrosion testing and monitoring.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. evaluate if corrosion can occur under specific operating conditions in a given equipment or construction and indicate regions of immunity, corrosion and passivity of a metal
2. compare different corrosion types on metals when exposed to air, water and at high temperatures (> 100 C)
3. identify the corrosion mechanism on steel, iron, zinc and copper metal surfaces
4. calculate the rate of corrosion on metals using electrochemical methods of testing
5. propose the correct materials, design and operation conditions to reduce the likelihood of corrosion in new equipment and constructions

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1													
2	2						1								
3	1	3													
4	2	2													
5	3	3													

UNIT I **9 Hours**

CORROSION

Importance of corrosion - spontaneity of corrosion - passivation - direct and indirect damage by corrosion - importance of corrosion prevention in industries - area relationship in both active and passive states of metals - Pilling Bedworth ratio and its significance - units of corrosion rate (mdd and mpy) - importance of pitting factor - Pourbaix digrams of Mg, Al and Fe and their advantages and disadvantages.

UNIT II **7 Hours**

TYPES OF CORROSION

Eight forms of corrosion: uniform, galvanic, crevice corrosion, pitting, intergranular corrosion, selective leaching, erosion corrosion and stress corrosion. High temperature oxidation, kinetics of protective film formation and catastrophic oxidation corrosion.

UNIT III **9 Hours**

MECHANISM OF CORROSION

Hydrogen embrittlement - cracking - corrosion fatigue - filliform corrosion - fretting damage and microbes induced corrosion - corrosion mechanism on steel, iron, zinc and copper metal surfaces - thick layer and thin layer scale formation - in situ corrosion scale analysis.

UNIT IV **10 Hours**

CORROSION RATE AND ITS ESTIMATION

Rate of corrosion: factors affecting corrosion - electrochemical methods of polarization - Tafel extrapolation polarization, linear polarization, impedance techniques - weight loss method - susceptibility test - testing for intergranular susceptibility and stress corrosion. Visual testing - liquid penetrant testing - magnetic particle testing - eddy current testing.

UNIT V **10 Hours**

CORROSION CONTROL METHODS

Fundamentals of cathodic protection - types of cathodic protection. Stray current corrosion problems and its prevention. Protective coatings: anodic and cathodic coatings - metal coatings: hot dipping (galvanizing, tinning and metal cladding) - natural inhibitors. Selection of sacrificial anode for corrosion control.

FOR FURTHER READING

Corrosion issues in supercritical water reactor (SCWR) systems.

Total: 45 Hours

Reference(s)

1. Mouafak A. Zaher, Introduction to Corrosion Engineering, CreateSpace Independent Publishing Platform, 2016.
2. E.McCafferty, Introduction to Corrosion Science, Springer; 2010 Edition, January 2010.
3. R. Winstone Revie and Herbert H. Uhlig, Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering, 4th Edition, John Wiley & Science, 2008.
4. Mars G. Fontana, Corrosion Engineering, Tata McGraw Hill, Singapore, 2008.
5. David E.J. Talbot (Author), James D.R. Talbot, Corrosion Science and Technology, Second Edition (Materials Science & Technology), CRC Press; 2nd Edition, 2007.
6. http://corrosion-doctors.org/Corrosion-History/Eight.htm

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	1	2	2		1	2	1		1	1	1		1	1	2		2	1			1				20
2	1	3			2	1	1			2			1	2			1	1					1		16
3	2	1			1	4	1			3				2			2	2				2			20
4	1	1	1		2	3	1		2	2	1		2	1	1		1	2					1		22
5	1	2			1	2			2	3			2	3			1	2			1	2			22
																								Total	100

Assessment Questions
Remember

1. Define Corrosion
2. Mention the five types of corrosion
3. Define dry corrosion. Explain the mechanism.
4. What are corrosion inhibitors? Give two examples.
5. What are corrosion inhibitors? Give two examples.
6. Write the working principle of Tafel polarization techniques.
7. How polarization and impedance techniques are used to measure the corrosion products?
8. Define cathodic protection.
9. ellaborate non-electrochemical and electrochemical methods of corrosion testing and monitoring.
10. What is Tafel linear polarization?
11. What is Tafel linear polarization?
12. In corrosion, which criteria involves nature of the metal
    a. Temperature
    b. Humidity
    c. pH
    d. Purity of the metal
13.
    1. An example of corrosion measurement technique is
    b. Tribometer
    c. non-destructive testing
    d. rupture testing
    e. Charpy test

1.
    1. In the weight loss method, the preferred duration of exposure of test samples to corrosive media is
    b. 10 days
    c. 1 month
    d. 1 year
    e. 1 day

1.
    1. The long term corrosion protection method is
    b. Impressed current method
    c. Proper choice of metal for the designing
    d. Cathode protection
    e. Sacrificial anode method

1. Indicate two purposes of corrosion testing.
2. Write the principal of anodic protection method.

Understand

1. Explain the mechanism of electrochemical corrosion.
2. Identify the relation between the two units used to measure corrosion rate.
3. Illustrate the Pourbaix digrams of Mg/Al/Fe and their limitations.
4. List the eight forms of corrosion. Explain each type with an example.
5. What are the factors influencing the corrosion rate? Explain.
6. Discuss the Pilling-Bedworth rule.

7. Differentiate between electrochemical and dry corrosion.
8. How inhibitors are used to protect the corrosion rate of the metal? Explain.
9. What are consequences of Pilling-Bedworth ratio?
10. List the difference between filliform corrosion and pitting corrosion.
11. By which method can we prevent corrosion in ship hulls?
    a. Sacrificial anode method
    b. Impressed current method
    c. Deaeration method
    d. Deactivation method

12.
    1. In order to form a protective oxide layer, the ratio of the volume of oxide formed to that of metal consumed should be
    b. greater than one
    c. less than one
    d. much greater than one
    e. none of the above

1.
    1. Stress corrosion is often observed in
    b. Welding
    c. Boilers
    d. Alloys
    e. Quenching of metals

1.
    1. A very dangerous form of corrosion which is difficult to monitor is
    b. Galvanic
    c. Pitting
    d. Crevice
    e. Stress

1.
    1. The method to overcome the disadvantages of Tafel plot is
    b. Weight loss method
    c. linear polarization
    d. organic coating
    e. non-destructive test

1.
    1. In sacrificial anodic protection
    b. an artificial cathode is connected to the metal to be protected
    c. an anodic metal is coated on the surface of the metal to be protected
    d. protection of the metal given by galvanizing the metal
    e. an artificial anode is connected to the metal to be protected

1.
    1. …………..is mostly used in sacrificial anode method.
    b. Zinc
    c. Magnesium
    d. Copper
    e. Platinum

1.
    1. Corrosion can be prevented by

b. Alloying
c. Tinning
d. Galvanizing
e. all of above

1.
    1. Which of following metals could provide cathodic protection to Fe?
    b. Al & Cu
    c. Al & Zn
    d. Zn & Cu
    e. Al & Ni

1.
    1. Galvanization is
    b. coating Zn on steel
    c. coating steel on steel
    d. coating SiC on steel
    e. coating rubber on steel

1. What is Tafel equation? Mention its application.
2. How is corrosion minimized by proper designing of equipment?
3. Mention the three visual corrosion testing methods.
4. Indicate the principles of cathodic protection.
5. Describe sacrificial anode with two examples.
6. What is a sacrificial anode? How does it protect a submerged pipeline?
7. Discuss the susceptibility tests for intergranular corrosion.
8. With a neat sketch of diagram, explain the principal and applications of impressed current method.

Apply

1. Area relationship between the anodic and cathodic part in galvanic corrosion. Discuss.
2. Describe alternatives to protective coatings.
3. How Tafel polarization and impedance techniques used to measure the corrosion products?
4. Name any two polarization methods for corrosion testing and monitoring.
5. Mention any two applications of susceptibility test.
6. Differentiate corrosion measurement from corrosion monitoring
7. Define cathodic protection? Under what conditions is this protection more useful?
8. Illustrate Tafel extrapolation polarization for the determination of corrosion rate.
9. Illustrate Tafel extrapolation polarization for the determination of corrosion rate.
10. Illustrate Tafel extrapolation polarization for the determination of corrosion rate.
11. Discuss the determination of corrosion rate by weight loss method.
12. Explain the control of corrosion by the use of sacrificial anodes and by impressed current cathodic protection.

Analyse

1. Explain why corrosion rate of metal is faster in aqueous solution than atmosphere air?
2. Why pitting corrosion is localized corrosion? Explain.
3. Compare the effects of corrosion products.
4. Identify different forms of corrosion in the metal surface.
5. What are the major implications of enhanced techniques of corrosion product analysis?
6.

1. When zinc is coupled to steel and corrosion is tested in various environments, which one of the following happens?
   b. The corrosion rate of steel increases while that of zinc is decreased
   c. The corrosion rate of zinc is increased while that of steel is decreased
   d. The corrosion rates of both decrease
   e. The corrosion rates of both increase

1.
   1. Which corrosion control technique is most suitable inthe case of buried iron pipelines?
   b. Sacrificial anodic method
   c. Impressed current cathodic protection
   d. Electroplating
   e. Cathodic inhibitors

1. Outline the draw backs of cathodic protection?
2. For what purpose Mg bars are used in ships?
3. List any four corrosion inhibitors.
4. Discuss the importance of design and material selection in controlling corrosion.
5. Differentiate sacrificial anodic protection from impression current method.
6. Analyze the role of sacrificial anode method in the prevention of corrosion.
7. Explain how corrosion of metals controlled by sacrificial anode technique.
8. Compare sacrificial anode method and impressed current method.
9. List and explain the 6 design rules that should be followed to prevent corrosion.

15GE0C2 ENERGY STORING DEVICES AND FUEL CELLS 3 0 0 3

Course Objectives

- Understand the concept, working of different types of batteries and analyze batteries used in electric vehicles.
- Identify the types of fuel cells and to relate the factors of energy and environment.
- Analyze various energy storage devices and fuel cells.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Analyze the parameters required for operation of a cell to evaluate the capacity of energy storage devices
2. Identify the electrodes, electrolyte and cell reactions of different types of primary, secondary batteries and infer the selection criteria for commercial battery systems with respect to commercial applications
3. Differentiate fuel cells based on its construction, production of current and applications
4. Identify different methods for the production of hydrogen fuel and its environmental applications
5. Relate energy and environmental based on the importance and types of renewable energy for sustainable development

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	1													
2	2	3													
3	3	1		1											
4	2	2													
5	3	3		1											

UNIT I **6 Hours**

BASICS OF CELLS AND BATTERIES

Components - classification - operation of a cell - theoretical cell voltage - capacity - specific energy - energy density of practical batteries - charge efficiency- charge rate - charge retention - closed circuit voltage, open circuit voltage current density - cycle life - discharge rate-over charge-over discharge.

UNIT II **10 Hours**

BATTERIES FOR PORTABLE DEVICES AND ELECTRIC VEHICLES

Primary batteries- zinc-carbon, magnesium, alkaline, manganous dioxide, mercuric oxide, silver oxide batteries - recycling/safe disposal of used cells. Secondary batteries - introduction, cell reactions, cell representations and applications - lead acid, nickel-cadmium and lithium ion batteries - rechargeable zinc alkaline battery. Reserve batteries: Zinc-silver oxide, lithium anode cell, photogalvanic cells. Battery specifications for cars and automobiles.

UNIT III **10 Hours**

TYPES OF FUEL CELLS

Importance and classification of fuel cells - description, working principle, components, applications and environmental aspects of the following types of fuel cells: alkaline fuel cells, phosphoric acid, solid oxide, molten carbonate and direct methanol fuel cells.

UNIT IV **10 Hours**

HYDROGEN AS A FUEL

Sources and production of hydrogen - electrolysis - photocatalytic water splitting - biomass pyrolysis -gas clean up - methods of hydrogen storage- high pressurized gas - liquid hydrogen type - metal hydride - hydrogen as engine fuel - features, application of hydrogen technologies in the future - limitations.

UNIT V **9 Hours**

ENERGY AND ENVIRONMENT

Future prospects of renewable energy and efficiency of renewable fuels - economy of hydrogen energy - life cycle assessment of fuel cell systems. Solar Cells: energy conversion devices, photovoltaic and photoelectrochemical cells - photobiochemical conversion cell.

FOR FURTHER READING

Energy conservation, Over utilization, Energy demanding activities.

Total: 45 Hours

Reference(s)

1. M. Aulice Scibioh and B. Viswanathan, Fuel Cells: Principles and Applications, University Press, India, 2009.
2. F. Barbir,PEM fuel cells: Theory and practice,Elsevier, Burlington, MA, Academic Press, 2013.
3. M. R. Dell Ronald and A. J. David, Understanding Batteries, Royal Society of Chemistry, 2001.
4. J. S. Newman and K. E. Thomas-Alyea, Electrochemical Systems, Wiley, Hoboken, NJ, 2012.
5. Shripad T. Revankar, Pradip Majumdar, Fuel Cells: Principles, Design, and Analysis, CRC Press, 2016.
6. Thomas B. Reddy, Linden's Handbook of Batteries, 4th Edition, McGraw Hill Professional, 2010

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2	2			1	2	2			1			1	3				1							15
2	4	1			4	5	2			2			1	2				1							22
3	3				4	6	2		1	3			1	1				1							22
4	1	2			4	4	1			4			2	4											22
5	2	2			2	5				3			2	3											19
																								Total	100

Assessment Questions
Remember

1. How galvanic cell is differing from electrolytic cell?
2. How is the potential of an electrochemical cell calculated?
3. List any four characteristics of primary batteries.
4. Mention any two characteristics and applications of zinc-carbon battery.
5. Recognize any two applications and characteristics of primary magnesium batteries.
6. Identify the applications and characteristics of Zn/HgO primary batteries.
7. Indicate any two applications of Zn/alkaline/MnO_2 battery.
8. Mentioned any two applications of Zn/Ag_2O primary battery.
9. Define capacity of a cell
10. Define discharge rate of a battery.
11. Describe the construction, cell reaction and applications of zinc-carbon battery.
12. Explain the construction, chemistry, advantages and uses of mercuric oxide battery.
13. Explain the major components and reaction of direct methanol fuel cell. List two applications.
14. Explain the working principle, components and applications of alkaline fuel cells
15. Discus the conversion of sunlight into electrical power in photoelectrochemical cells.

Understand

1. Mention the five different types of energy storage devices
2. Define the term battery
3. List any two differences between battery and cell.
4. Mention the three major components of cell.
5. Classify the batteries based on their cell reversibility.
6. Define cycle Life of a cell.
7. Explain the construction, cell reaction and applications of silver oxide batteries.
8. With a neat sketch explain the construction and working of phosphoric acid fuel cell.
9. Explain the major components and reactions of direct methanol fuel cell
10. Explain the production of hydrogen photobiochemical conversion cell.

Apply

1. Specific gravity is an indicator of charge in lead acid battery – Justify.
2. Illustrate the process of water electrolysis for the production of hydrogen.
3. How is the potential of an electrochemical cell calculated?
4. How is the potential of an electrochemical cell calculated?

Analyse

1. In the mid-winter car battery is not working –reason out.
2. Discuss the hydrogen energy strategies for sustainable development.
3. How galvanic cell is differing from electrolytic cell?
4. How batteries are rated?
5. Differentiate between primary and secondary batteries.

15GE0C3 POLYMER CHEMISTRY AND PROCESSING

3 0 0 3

Course Objectives

- Impart knowledge on the basic concepts of polymers and its mechanism
- Use the appropriate polymerization techniques to synthesize the polymers and its processing
- Select the suitable polymers for various applications

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

Course Outcomes (COs)

1. Illustrate the types of mechanism of polymerization reactions and analyze the natural and synthetic polymers
2. Identify the suitable polymerization techniques to synthesize the high quality polymers
3. Characterize the polymers to identify the structural, thermal ,mechanical and electrical features for specific applications
4. Apply the polymer processing methods to design polymer products
5. Identify and analyze the polymers used in electronic and biomedical applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1													
2	1	2													
3	2	2													
4	1	1	2												
5	1	3	2												

UNIT I **10 Hours**

POLYMERS AND ELASTOMERS

Classification of polymers - Mechanism: Addition polymerization - free radical polymerization - cationic, anionic and co-ordination (Ziegler-Natta) polymerization, copolymerization, condensation polymerization (nylon-6,6) ring opening polymerization (nylon-6). Elastomers: Natural rubber - vulcanization - synthetic rubber: styrene -butadiene rubber (SBR), butyl, neoprene, thiocol rubbers. High performance polymers: polyethers, polyether ether ketone(PEEK), polysulphones, polyimides.

UNIT II **8 Hours**

POLYMERIZATION TECHNIQUES

Homogeneous and heterogeneous polymerization - bulk polymerization (PMMA, PVC) solution polymerization - polyacrylic acid, suspension polymerization (ion-exchange resins) - emulsion polymerization (SBR) - advantages and disadvantages of bulk and emulsion polymerization. Melt solution and interfacial poly-condensation.

UNIT III **8 Hours**

CHARACTERIZATION AND TESTING

Characterization of polymers by Infrared Spectroscopy (IR) and Nuclear Magnetic Spectroscopy (NMR) - Thermal properties by TGA and DSC, Testing tensile strength, Izod impact, Compressive strength, Rockwell hardness, Vicot softening point. Test for electrical resistance, dielectric constant, dissipation factor, arc resistance and dielectric strength - water absorption.

UNIT IV **9 Hours**

POLYMER PROCESSING

Moulding: Compression - injection - extrusion and blow mouldings. Film casting - calendering. Thermoforming and vacuum formed polystyrene - foamed polyurethanes. Fibre spinning: melt, dry and wet spinning. Fibre reinforced plactics fabrication: hand-layup - filament winding and pultrusion.

UNIT V **10 Hours**

SPECIALITY POLYMERS

Preparation and properties of heat resistant and flame retardant polymers. Polymers for electronic applications: liquid crystalline, conducting and photosensitive polymers. Polymer for biomedical applications: artificial organs, controlled drug delivery, hemodialysis and hemofiltration.

FOR FURTHER READING

Biodegradable polymers

Total: 45 Hours

Reference(s)

1. V. R. Gowarikar, N. V. Viswanathan and Jayadev Sreedhar, Polymer Science, New Age International (P) Ltd., New Delhi, 2015.
2. Joel R. Fried, Polymer Science and Technology, Prentice Hall of India (P). Ltd., 2014
3. F. W. Billmeyer, Text Book of Polymer Science, John Wiley & Sons, New York, 2007
4. Barbara H. Stuart, Polymer Analysis, John Wiley & Sons, New York, 2008
5. George Odian , Principles of Polymerization, John Wiley & Sons, New York, 2004
6. R. J. Young and P. A. Lovell, Introduction to Polymers, CRC Press, New York, 2011

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	1	1	3		2	2	3		2	2	3		1	1	1										22
2	1	1	4		1	1	3		1	1	3		1	1											18
3	1	1	1		1	1			1	2	2			2			1	1	4						18
4	1				1	2	2		3	2	2		2	2	1								2		20
5	1	1	1		2	2	1		2	2	3		2	2	3										22
																								Total	100

Assessment Questions
Remember

1. Recall two factors that govern termination of cationic polymerization.
2. Identify the monomers used in styrene -butadiene rubber.
3. Give an examples for the thermosetting and thermoplastic polymers.
4. What is copolymerization? Give an example
5. Name two synthetic polymers which are used for making textile fibres.
6. Define the role of Ziegler – Natta catalysts
7. List the examples of Ziegler – Natta catalysts.
8. Identify the four types of polymerization technique.
9. List any two disadvantages of suspension polymerization.
10. Point out the advantages of bulk polymerization technique.
11. Why does natural rubber need compounding?
12. List any four applications of injection moulding process.
13. List the various additives in processing of plastics.
14. List the two properties of heat resistant polymers .
15. Mention the application of flame retardant polymers.

Understand

1. Classify the polymers based on source
2. Discuss the addition and chain growth polymerization with example
3. Compare addition and condensation polymerization reaction with example for each type .
4. Explain homogeneous and heterogeneous polymerization.
5. Explain the mechanism involved in addition polymerization of vinylChloride
6. Explain the condensation polymerization method taking nylon 6,6,nylon synthesis as a representative example.
7. Discuss the preparation method and any three properties of Polysulphone.
8. Summaries the salient features, advantages and disadvantages of bulk and emulsion polymerization techniques.
9. Compare the homogeneous and heterogeneous polymerization method.
10. With a neat sketch, discuss the functioning of melt, dry and wet spinning process.
11. Illustrate the compression and extrusion moulding of plastics with diagram neat diagram.
12. Explain the coordination polymerization mechanism using a sutable example.

Apply

1. Relate the various steps involved in anionic and cationic polymerisation using suitable examples.
2. Select the suitable polymerization techniques for synthesis of PMMA and SBR
3. Assess the characterisation techniques used to find the structure of polymer .
4. Find the method to process the composite materials with example.
5. Execute the filament – winding Technique for manufacturing of rocket motor bodies.

Analyse

1. Distinguish between addition and condensation polymerisation.
2. Natural rubber need vulcanization –Justify.
3. Compare the salient features, advantages and disadvantages of solution and suspension polymerization techniques.
4. Bring out the differences between thermoforming and vacuum-forming process.
5. Outline the applications of polymer in controlled drug delivery and artificial organs.

Evaluate

1. Judge the biomedical applications of polymers in Hemo dialysis and hemo filtration.
2. Choose the suitable moulding Technique for polyvinyl chloride.

15ME0YA INDUSTRIAL PROCESS ENGINEERING 3 0 0 3

Course Objectives

- To impart the knowledge on production planning methodologies and layout design.
- To learn about production planning and its control methods.
- To provide the knowledge of work study, process charts and ergonomic condition.
- To impart the knowledge on inventory control and material handling.
- To learn about system analysis and different types of maintenance processes.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
n. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Select proper plant layout for the required production system.
2. Plan the resources required for the production and to perform the control methods.
3. Apply work study method, prepare charts to outline the process and develop ergonomic condition suitable for the processes.
4. Analyze the inventory required based on production needs and material handling.
5. Explain the system and different types of maintenance process for smooth operations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	1												
2	2	2	1											2	
3	1	2	3												
4	2	3	1												
5	2	3	1											2	

UNIT I **9 Hours**

INDUSTRIAL ENGINEERING AND PRODUCTION SYSTEM

Industrial engineering - Concept, History and development, Applications, Roles of Industrial engineer- Production management, Industrial engineering versus production management, operations management. Plant layout, Criteria for good layout, Types of layout - Process layout, Product layout, Combination layout and fixed position layout, Flow pattern, Workstation design.

UNIT II **9 Hours**

PROCESS PLANNING AND PRODUCTION CONTROL

Introduction to Process planning-Definition, Procedure, Process selection, Machine capacity, Process sheet, Process analysis - Group technology, classification and coding system, formation of component family - Production planning, loading, scheduling. Production control -dispatching, routing - Progress control bar, curve, Gantt chart, route and schedule chart.

UNIT III **9 Hours**

WORK STUDY AND ERGONOMICS

Work study - Definition, Need, Advantages, objectives of method study and work measurement, method study procedure, Process chart - symbols, outline process chart, flow process chart, principles of motion economy, ergonomics- applications of ergonomic principles in the shop floor- work benches-seating arrangement, Industrial physiology.

UNIT IV **9 Hours**

INVENTORY MANAGEMENT

Inventory control, classification, management, objectives, functions. Economic order quantity, Economic batch quantity, inventory models, ABC analysis, Material Requirement Planning(MRPI), Manufacturing Resource Planning (MRPII), Operating cycle, lean manufacturing, Supply chain management - Material handling. Engineering and economic factors.

UNIT V **9 Hours**

SYSTEM ANALYSIS AND MAINTENANCE

System concept - system analysis, systems engineering, value engineering, value control, types of values. Plant maintenance - objectives, importance. Maintenance engineer - duties, functions and responsibilities. Types - breakdown, scheduled, preventive and predictive - Plant maintenance schedule, Condition monitoring.

FOR FURTHER READING

Applied anthropometry, Biostatic mechanics, Estimation and costing concepts.

Total: 45 Hours

Reference(s)

1. Khanna O.P., Industrial Engineering and management, Dhanpat Rai Publications.,2010.
2. Panneerselvam R., Production and operations management, Heritage Publishers, 2006
3. Martand T.Telsang, Industrial Engineering and Production Management, S Chand Publishers,2006
4. Ravi Shankar, Industrial Engineering and Management, Golgotia Publications Pvt. Ltd., New Delhi, 2009
5. Jan Dul, Bernard Weerdmeester, Ergonomics for Beginners: A Quick Reference Guide, CRC Press, Taylor and Francis group,2008
6. Lee J. Krajewski, Larry P.Ritaman, Operations Management, Addison Wesley, 2007.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2	2				11					5														20
2			10		2					8															20
3	2					10					8														20
4	2		5				10				3														20
5		5	5			5			5																20
																								Total	100

Assessment Questions

Remember

1. What is meant by process planning?
2. State the general approaches to process planning.
3. Define the term productivity.
4. List four benefits of Material Handling.
5. What is industrial engineering?
6. What is work sampling?
7. List out four roles of industrial engineer.
8. Define Ergonomics?
9. What do you mean by ABC analysis?
10. What is mean by just in time in manufacturing?

Understand

1. Distinguish plant layout and process layout.
2. Illustrate the various types of layout with example.
3. How the Production system Sequences?
4. How to do the Workplace management and utilization of optimum manpower?
5. Where to apply the ABC analysis?
6. How will you differentiate protective and productive maintenance?
7. How will you handle materials using forklift?
8. Process material is direct material (True / False).
9. Choose the industry where Just In Time can be implemented effectively.

Apply

1. Choose the best layout method for a bolt manufacturing unit.
2. Select the best equipment to handle cylinder.
3. Apply lean manufacturing concept in a car manufacturing industry.
4. Apply the project planning procedure for new industry.
5. Explain the maintenance procedure for an industry.
6. Explain the storage management in a food industry if you are in charge of it.
7. Explain how you will solve the problem of back pain in employees working in your organization handling heavy objects where equipment should not be used.
8. Sketch the process flow to be followed in auto auxiliary industry manufacturing steering.

15ME0YB SAFETY ENGINEERING 3 0 0 3

Course Objectives

- To explain the principles of safety management and techniques.
- To explain the principles of safety management and techniques. To interpret the provisions contained in the various industrial Acts and Laws.
- To recall the safety provisions practiced in industries.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
n. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Apply the principles and techniques of safety management.
2. Refer and quote from the rule books.
3. Identify and understand safety provisions installed in the Engineering Industries.
4. Identify and understand safety provisions installed in the Chemical Industries.
5. Diagnose and understand safety provisions installed in the Construction Industries.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1					2	2									
2						2	2	2							
3						3	2	1	2						
4	2	2				3	2	1	2						
5	2	2	2			3	2	1	2					1	

UNIT I **8 Hours**

SAFETY MANAGEMENT

Concepts - Evolution, International Labour Organization (ILO), National Safety Council, Techniques - Job Safety Analysis (JSA), Safety survey, Safety inspection, Safety Sampling, Accident Investigation and Reporting - Concept of an accident, Accident causation models, cost of accident, investigation, Safety Performance Monitoring - Safety indices.

UNIT II **10 Hours**

SAFETY AND LAW

Factory Act 1948-Safety and Health chapters, Tamil Nadu Factories Rules- Safety and Health chapters, Environment and Pollution Laws, ,Building and other construction works act 1996, Motor Vehicle Rules, Explosive Act 1983, Boiler Act.

UNIT III **10 Hours**

SAFETY IN ENGINEERING INDUSTRIES

Safety in metal working machinery and wood working machines, principles, standards and codes - Principles of machine guarding - zero mechanical state (ZMS), types of guards, Personal protective equipments- Safety in handling industrial gases, storage and handling of gas cylinders.

UNIT IV **9 Hours**

SAFETY IN CHEMICAL INDUSTRIES

Safety in process design, unit operations, pressure vessel, heat exchangers, safety valves - Plant commissioning and inspection, pressure vessel, non-destructive testing, vibration, corrosion Plant maintenance and emergency planning, ALOHA SOFTWARE.

UNIT V **8 Hours**

SAFETY IN CONSTRUCTION INDUSTRY

Working at heights, Occupational Safety and Health Administration (OSHA) requirement for working at heights- Working on fragile roofs, work permit systems- Construction machinery, inspection and testing of cranes, chain pulley blocks, earth moving equipment, conveyors- Manual handling, fire and explosion hazard- Safety in confined spaces

Total: 45 Hours

Reference(s)

1. Blake R.B., Industrial Safety, Prentice Hall, Incorporated, New Jersey, 1973.
2. National Safety Council, Accident Prevention Manual for Industrial Operations, Chicago,1988
3. Subramanian V., The Factories Act, 1948, with Tamil Nadu Factories Rules ,1950 Madras Book Agency, 21st Edition,Chennai-1.
4. Environmental Pollection Control Act, 1986
5. BOCW Act,1996, Madras Book agency,Chennai-1
6. Explosive Act,1884, Eastern Book Company,Lucknow - 266 001.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1		2					6				10														18
2			8				4				10														22
3			4		4															10					18
4			4		8																		10		22
5			4		6		10																		20
																								Total	100

Assessment Questions

Remember

1. Which year International LabourOrganisation (ILO) was formed?
2. Define job safety analysis.
3. What is the duty of certifying surgeon in a factory?
4. Define a factory.
5. Which rule number in Tamil Nadu Factories Rules 1950 gives the qualification of Safety Officers?
6. How much weight an adult is permitted to carry?
7. Under what circumstances Sational Safety council was started?
8. Define zero mechanical state (ZMS).
9. What is cold forming process?
10. What safety precautions to be taken in the construction of high rise building?

Understand

1. Why workers were losing legal battles with the Occupiers?
2. Under what circumstances safety survey is carried out?
3. Why competent persons are required for inspection?
4. Which type of fire hydrant is to be used for oil fires?
5. Why water type should not be used for electrical fires?
6. What parameters to be considered in designing exit ways in a multi-sorey building?
7. Why braces are used in scaffolding?
8. In chemical plants during starting and shut down accidents are likely. Reason out.
9. How pressure vessels are inspected?
10. How non-destructive testing is carried out?
11. How corrosion is controlled?
12. How safety belts are tested?

Apply

1. Conduct a job safety analysis for a chemical factory for a product.
2. Make a safety inspection check list for a refinery.
3. Use accident causation model for an accident.
4. Explain any two accident causation model.
5. Explain how fire load is calculated for a petroleum storage tank.
6. Design a Transport Emergency Card (TREM) for a vehicle transporting explosives.
7. Draft a safety committee minutes of meeting imagining 5 agenda points.
8. Write a model investigation report for a fatal fire accident.
9. Prepare a maintenance schedule for compressor overhauling.
10. Design a work permit system for a welding job.

Analyse

1. Use a suitable accident causation model for a worker who slipped and fell into an acid storage tank that was fatal.
2. In a factory of 1000 workers work 45 hours a week. In that year there were 25 accidents resulting in a loss 2500 hours. Calculate frequency rate, incident rate and severity rate.

Create

1. Create a safety monitoring methodology for an hazardous factory dealing with the manufacture of explosives.

15ME0YC MAINTENANCE ENGINEERING 3 0 0 3

Course Objectives

- To understand the principles, functions and practices adapted in industry for the successful management of maintenance activities.
- To educate different maintenance categories like Preventive maintenance, condition monitoring and repair of machine elements.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Explain principles, functions and practices adapted in industry for the successful management of maintenance activities.
2. Demonstrate the various policies preventive maintenance.
3. Explain Preventive maintenance concepts.
4. Explain condition monitoring concepts.
5. Carryout various repair methods of machine elements.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2													
2	2	2													
3					2	2	1								
4	1	2	1		2	2	2								
5	2	2	2		1	1	1								

UNIT I **9 Hours**

PRINCIPLES MAINTENANCE PLANNING

Basic Principles of maintenance planning - Objectives and principles of planned maintenance activity - Importance and benefits of sound maintenance systems - Reliability and machine availability.

UNIT II **9 Hours**

PRACTICES OF MAINTENANCE PLANNING

Mean Time Between Failures, Mean Time To Repair and Mean Waiting Time - Factors of availability - Maintenance organization - Maintenance economics.

UNIT III **9 Hours**

MAINTENANCE POLICIES - PREVENTIVE MAINTENANCE

Maintenance categories - Comparative merits of each category - Preventive maintenance, maintenance schedules, repair cycle - Principles and methods of lubrication - Total Productive Maintenance.

UNIT IV **10 Hours**

CONDITION MONITORING

Condition based maintenance - Cost comparison with and without Condition Monitoring - On-load testing and offload testing.

UNIT V **8 Hours**

REPAIR METHODS

Failure analysis - Failures and their development - Repair methods for Maintenance.

FOR FURTHER READING

Types of lubrication mechanisms, lubrication processes. Lubricants - types, general and special purpose, additives, testing of lubricants, degradation of lubricants, seal & packing's.

Total: 45 Hours

Reference(s)

1. Srivastava S.K., Industrial Maintenance Management, S. Chand and Company, 2002.
2. Venkataraman.K, Maintenance Engineering and Management, Prentice Hall of India Learning, Pvt. Ltd., 2007.
3. Andrew K.S.Jardine and Albert H.C.Tsang, Maintenance, Replacement and Reliability, Taylor and Francis, 2006.
4. Mishra R.C. and Pathak.K, Maintenance engineering and Management, PHI Learning, Pvt.Ltd., 2012.
5. Higgins R.L, R.Keith Mobley and Darrin Wikoff, Maintenance Engineering Handbook, McGraw-Hill Companies Inc. 2008.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	3	3			2	4	2			4	2														20
2	2	2			2	4								5	5										20
3		2				4	4			5	5														20
4		4				4	2			4	6														20
5		4			2	2	4				5			3											20
																								Total	100

Assessment Questions

Remember

1. Define Reliability.
2. List the main factors of maintenance cost.

3. Define failure rate.
4. State the types of maintenance budget.
5. Differentiate brake down and preventive maintenance.
6. List the purpose of lubrication.
7. Define the term Preventive Maintenance.
8. Define corrective maintenance approach.
9. Define maintenance action rate.
10. What are two main types of infrared thermography?
11. What are called Time- Dependent Failures?

Understand

1. Give the merits of condition based maintenance.
2. Classify various planned maintenance approach.
3. What is total productive maintenance and discuss its similarities with Total Quality Management (TQM)?
4. What does safety, health and environment pillar of Total Productive Maintenance (TPM) aims at?
5. What are the causes of vibration?
6. How to analyze the vibration?
7. Why the temperature monitoring is necessary?
8. What is the aim of Event Tree Analysis (ETA)?
9. What are cause and effect diagrams?

Apply

1. Explain on-load and off-load testing used in condition monitoring with their flow chart?

Analyse

1. What are all the steps involved in preventive maintenance and why preventive maintenance is better than reactive maintenance?
2. What is leakage monitoring? Explain some of the leakage mediums used for condition monitoring.

15ME0YD BASICS OF NON-DESTRUCTIVE TESTING

3 0 0 3

Course Objectives

- Explain the basic principles and different types of Non-Destructive testing methods
- Identify the appropriate method of inspecting surface cracks
- Demonstrate the step by step inspection procedure of Non-Destructive testing.
- Apply the advanced Non-Destructive testing techniques to identify the defects.
- Select the suitable Non-Destructive testing techniques for particular Engineering applications

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
n. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Select appropriate nondestructive testing method for defects detection in manufactured/operating parts.
2. Perform non-destructive tests according to Standard test methods in engineering industries.
3. Utilize the advantages of nondestructive testing methods over other destructive tests, for quality control in real-time applications.
4. Select the appropriate Non Destructive testing methods for various engineering applications
5. Utilize the recent Non-destructive technique for various engineering applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2				1		1			1				2	
2	2				1		2			1				2	
3	2				1		1			2				2	
4	2				1		2			2				2	
5	2				3		1			2				2	

UNIT I **9 Hours**

SURFACE TECHNIQUES

Concepts of Non-Destructive testing (NDT) - Discontinuities and Defects in various manufacturing Component-Types of NDT techniques, Introduction to Standards and Specifications (ASME, ASTM, AWS) - Visual or Optical Testing, Direct and remote visual inspection and Aides-Liquid Penetrant

Testing (LPT) Principles - Types and properties of liquid penetrants and developers - Preparation of test materials - Advantages and limitations- Application of penetrants to parts - Fluorescent penetrant test

UNIT II **9 Hours**

MAGNETIC PARTICLE TESTING

Magnetic Particle Testing (MPT) Principles, applications - Magnetization methods, magnetic Particles, - Dry particle technique and Wet fluorescent particle technique, demagnetization, Advantages and limitations - Magnetic Flux Leakage Testing Principle, Instrumentation and applications - Electromagnetic Induction Techniques, Principle - Instrumentation and applications of Eddy Current Testing (ECT)

UNIT III **9 Hours**

ULTRASONIC TESTING

Ultrasonic Testing (UT) Principle, Types and characteristics of Ultrasonic waves, Attenuation, Couplants, Probes - Inspection methods-Pulse echo, Transmission and Phased Array techniques (PAUT), Types of scanning and displays, Angle beam inspection of welds, Calibration of ASTM Test blocks, International Institute of Welding IIW) reference blocks, Applications.

UNIT IV **9 Hours**

RADIOGRAPHY TESTING

Radiographic testing (RT) Principle, Sources of X-rays and Gamma rays and their characteristics - Absorption, scattering-Filters and screens, imaging modalities - Film radiography and Digital Radiography - Problems in shadow formation, Exposure factors, film handling and storage Inverse square law, Exposure charts, and Radiographic equivalence. Penetrometers, Safety in radiography, Applications.

UNIT V **9 Hours**

SPECIAL TECHNIQUES

Acoustic Emission Testing (AET) Principle - Advantages and limitations - Instrumentation and applications - Infra Red Thermography (IRT), Contact and non-contact inspection methods, Pressure and Leak Testing - Testing Procedure and applications, LASER Shearography - Typical applications - Requirements - advantages and disadvantages.

FOR FURTHER READING

Study of Importance of using NDT in Aircraft welded Structures - casted Automobile components-Marine Structures-Bridges-Towers.

Total: 45 Hours

Reference(s)

1. Baldev Raj, Jayakumar T, Thavasimuthu M, Practical Non-Destructive Testing, Narosa Publishing, 1997.
2. Mc Gonnagle,Non-Destructive Testing, McGraw Hill Book Co., 1988.
3. Barry Hull and Vernon John, Non Destructive Testing, Macmillan, 1989.
4. Non-Destructive Evaluation and Quality Control, Vol.17,American Society of Metals, Metals Park, Ohio, USA, 2001
5. www.nptel.ac.in/courses/114106035/35.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	8					5				5				2											20
2	8					5				5				2											20
3	8					5				5				2											20
4	8					5				5				2											20
5	8					5				5				2											20
																								Total	100

Assessment Questions

Remember

1. What are the different types of surface techniques?
2. What is the different between Defects or discontinuities?
3. List the 5 major NDT methods.
4. What are the factors affecting the choice of NDT method?
5. What is Destructive Testing (DT)?
6. List the 5 destructive testing methods widely used in materials testing.
7. What are penetrometers in radiographic testing? Mention uses.
8. What is the equation for sound waves in a material?
9. What are the three basic factors affecting thermal measurements?
10. What are the applications of X-Rays?
11. What is a Holograph? How can it be used in NDT?

Understand

1. Compare destructive and non-destructive testing.
2. How does the ultrasonic frequency affect the penetration and resolution?
3. What are the properties of a good penetrant?
4. What are the magnetization techniques used in MPI?
5. Compare liquid penetrant test and magnetic particle test.
6. Compare Ultrasonic test and Radiographic Test.
7. Explain the various methods of LPI and explain advantages and limitations of LPI.

Apply

1. What are the indirect methods used for Visual Inspection.
2. Mention MPI technique with neat diagram.
3. Explain the 4different types of Ultrasonic testing techniques and write their applications.
4. What are the different types of transducers used in UT technique?
5. Describe the film processing, interpretation and evaluation of test results in RT method.
6. What are the different types of sources used in RT method and what are the safety precautions required in RT?
7. Mention the physics of ECT and explain various applications in engineering field.
8. Select a suitable Non-contact Non Destructive testing method for the inspection of Space Shuttle leading edge and explain about that method.

Analyse

1. Why magnetic particle test is not suitable for Al alloys?
2. Which NDT method is suitable for testing non metals?
3. Why radiographic test is not suitable for structures applications?
4. Compare Eddy current test and Acoustic emission test.
5. Which NDT method is suitable for testing Valves?

15ME0YE RAPID PROTOTYPING 3 0 0 3

Course Objectives

- To understand the process of generating 3D Computer Aided Design (CAD) model by different method
- To explain the constructional features and to develop simple program for CNC lathe and Milling machines.
- To provide an exhaustive knowledge on various generic process and benefits of Rapid Prototyping Techniques (RPT).
- To familiarize about materials and process parameters of liquid and solid based RP techniques.
- To educate powder based methodology and emerging trends with case studies, applications of Additive Manufacturing (AM) technology.

Programme Outcomes (POs)

a.Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b.Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
l.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m.Design, analyse and evaluate the performance of mechanical systems.
n.Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Design a 3D model from the 2D data.
2. Develop a CNC program for simple components.
3. Generate *stl* file to feed into RP machine.
4. Select appropriate liquid or solid materials based RP process to the respective application
5. Select appropriate process for aerospace, automotive, electronics, manufacturing and medical applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1				2							1	2		
2	1				2							1		2	
3	2	1			2							1		2	
4	2	1			1							1		2	
5	2	1			2							1		2	

UNIT I **9 Hours**

CAD MODELING

Introduction - Design process - Stages. CAD - Input and Output devices, Modeling methods - Wire frame modelling, Surface modelling, Solid modelling - Constructive Solid Geometry and Boundary Representation Techniques. CAD/CAM data exchange - IGES, STEP. Product Life cycle management (PLM).

UNIT II **10 Hours**

AUTOMATION AND CNC MACHINES

Introduction to Automation - Definition, types, reasons for automating. CNC Machines - Principles, types, features, advantages, applications and CNC Machine structure - Linear motion bearings, Recirculating ball bearings, drive system, and control system. CNC Lathe and Milling programming - Linear and circular interpolation, threading and drilling programs.

UNIT III **7 Hours**

ADDITIVE MANUFACTURING

Introduction - Impact of Additive Manufacturing (AM) and Tooling on Product Development - Distinction between AM and CNC Machining- The Generalized AM Process chain - CAD Model - Input file formats - Generation and Conversion of STL file - File Verification and Repair - Build File Creation - Part Construction - Part Cleaning and finishing - AM Benefits - Classification of AM process

UNIT IV **8 Hours**

LIQUID AND SOLID MATERIAL BASED SYSTEMS

Stereo lithography Apparatus (SLA), Solid Ground Curing (SGC), Fused Deposition Modelling (FDM) and Laminated Object Manufacturing (LOM) - Working Principle, Construction, Process, Materials and Applications

UNIT V **11 Hours**

POWDER BASED PROCESSES AND APPLICATIONS OF ADDITIVE MANUFACTURING

Selective Laser Sintering (SLS), Three dimensional Printing (3DP), Electron Beam Melting (EBM) and Laser Engineered Net Shaping (LENS) - Working Principle, Construction, Process Variables, Materials and Applications. Application of Additive Manufacturing in Medical field, Manufacturing, Automotive industries, Aerospace and Electronics and Retail industries.

FOR FURTHER READING

Open source 3D printer - Case studies related to medical and manufacturing applications - Rapid Manufacturing.

Total: 45 Hours

Reference(s)

1. Ibrahim Zeid, R.Sivasubramania, CAD/CAM Theory and Practice, Tata McGraw Hill, 2010.
2. M. Aditan, B.S. Pabala, CNC Machines, New age International, 2012.
3. C. K. Chua, K. F. Leong and C. S. Lim, Rapid prototyping: Principles and applications, Cambridge University Press, 2010.
4. D. T.Pham, S. S.Dimov, Rapid manufacturing, Springer-Verlag, London, 2001.
5. I. Gibson, D. W. Rosen, and B. Stucker, Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010
6. N. Hopkinson, R. J. M. Hague, P. M. Dickens, Rapid Manufacturing - An Industrial Revolution for Digital Age, John Wiley & Sons Limited, 2006.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1		6					6				4														16
2		4					4				4				4								8		24
3		6					8								4										18
4		6					8								4										18
5		6					8				5				5										24
																								Total	100

Assessment Questions

Remember

1. List the CAD tools required to support various phases of the design.
2. List out the various principles of geometric based software.
3. Classify four different geometric modeling techniques.
4. Classify three types of automation.
5. Define CNC.
6. State triangulation algorithm.
7. Define Tesselation.
8. List the different RP formats.
9. State the limitations of LOM.
10. Define photo polymerisation?

Understand

1. Compare FDM with SLA.
2. Indicate the post processing operations necessary for RP processes.
3. Interpret why support materials not necessary in SLS process.
4. Summarize the process of generating *stl* file.
5. Represent the process of photo polymerization process.
6. Show the process of Solid ground curing.
7. How information flows from data creation to STL file formatting across an RP system?
8. Indicate the need of carbon dioxide atmosphere in SLS process.
9. Represent the method to prevent lateral distortion of paper prototype by water absorption in LOM process.
10. Select the process to develop prototypes for medical applications and justify your selection.

Apply

1. Show the concept of PLM for an automotive industry.
2. Construct the layout of CNC applied to wood carving machine.
3. Construct the classification table showing the process of generating various geometric models.
4. Asses why surface modeling software is not ideal for describing models that are to be made using AM, even though the STL file format is itself a surface approximation. What kind of problems may occur when using surface modelling only?
5. Find the process parameters affect surface finish, dimensional accuracy of parts manufactured in stereolithography process
6. Thermosetting plastics are used as FDM materials. Suggest the modifications, to accommodate those plastics also as a raw material in open source printers.
7. Choose the suitable slide way for the CNC tool/work piece movement.
8. Select the method of fabrication to refurbish the ship propeller blades. Why?
9. Predict the effect of process parameters in Selective Laser Sintering Process?

10. Provide three instances where a layer-based approach has been used in fabrication, other than AM.
11. Make a list of the different metal AM technologies that are currently available on the market today. How can you distinguish between the different systems? What different materials can be processed in these machines?

Analyse

1. Differentiate open and closed loop feedback system.
2. Contrast material addition and material removal process.
3. Compare and contrast SLA and SGC processes.
4. Why is extrusion-based AM more suitable for medical scaffold architectures, compared with SLS-fabricated scaffolds made from a similar material?
5. What are the key material property considerations when selecting a secondary support material for direct printing and FDM? Would these considerations change when considering supporting metals deposited using a beam deposition process?

Create

1. Write a NC part program for the following component of given diagram. Consider the feed rate as 50 mm/min and speed = 1500 rpm and minimum depth of cut = 2 mm.
2. Create the NC program for milling model using drilling.
3. Create the NC program for the given model

15ME0XA GEOMETRIC DIMENSIONING AND TOLERANCING

1 0 0 1

Course Objectives

- To understand the basics of GD&T and its practical applications
- To understand the proper way to specify dimensions and tolerances, symbols, datum, position, location, run out and profile

Course Outcomes (COs)

1. Classify the standards and fundamentals of limits, fits and tolerance.
2. Explain the rules and symbols of dimension and tolerance in various products.

UNIT I **15 Hours**

GEOMETRIC DIMENSIONING AND TOLERANCING

Introduction to Geometric Dimensioning and Tolerancing - Dimensioning and Tolerancing Fundamentals -Symbols, Terms, and Rules-Datum Application, Datum feature identification-Inclined, cylindrical datum feature. Form flatness, straightness, circularity, cylindricity - Position Maximum Material Condition, Least material Condition - Location - Position, Coaxiality - Concentricity Symmetry Exercises - Run out - Definition, circular run out, total run out Profile Definition, Specifying profile, radius refinement with profile of conical feature.

Total: 15 Hours

Reference(s)

1. Gene R Cogorno, Geometric Dimensioning and Tolerancing for Mechanical Design,McGrawHill, 2006
2. Alex Krulikowski, Fundamentals of Geometric Dimensioning and Tolerancing, Delmar Cengage Learning, 1997
3. Gary K Griffith, Geometric Dimensioning and Tolerancing: Application and Inspection,Prentice Hall, 2001.

15ME0XB LEAN MANUFACTURING 1 0 0 1

Course Objectives

- To acquire the general knowledge to deliver consistently high quality and value added products and services to the customer in a lean environment
- To understand the terminology relating to lean operations in both service and manufacturing organizations

Course Outcomes (COs)

1. Summarize the quality requirements to provide products and services in lean environment
2. Implement technologies related lean operations and its significance in manufacturing processes

UNIT I **15 Hours**

LEAN MANUFACTURING

History Evolution - Toyota production system - Lean manufacturing overview - Work place organization - Visual controls - Pull production and cellular manufacturing - Value flow pull - Value and perfection lean Mapping the present Mapping the future - Product and process development Value stream analysis - Over production - Waiting - Work In Progress - Transportation - Inappropriate processing - Excess motion or ergonomic problems - Defected products - Under-utilization of employees - Just In Time - Kanban tooling - Total Productive Maintenance 5S - Single Minute Die Exchange - Lean six sigma - Flow charting - Identifying and eliminating unnecessary steps - Setup time - reduction approaches - Steps in implementing lean strategy Lean accounting system

Total: 15 Hours

Reference(s)

1. Dennis P Hobbs, Lean Manufacturing Implementation, J. Ross Publications,2004
2. Jeffrey K Liker, The Toyota Way-14 Management Principles, Mc-Graw Hill, New York, 2004
3. Pascal Dennis, Lean Production Simplified, Productivity Press, USA, 2002
4. James P Womack, Daniel T. Jones, Lean Thinking: Banish waste and create wealth in your corporation, Simon & Schuster, UK Limited, Free Press, 2003
5. Jay Arthur, Lean Six-Sigma Demystified,Tata McGraw-Hill Company, New Delhi, 2007
6. Richard J Schonberger, World Class Manufacturing, Free Press, 2008

15ME0XC PIPING ENGINEERING 1 0 0 1

Course Objectives

- To impart knowledge on piping processes.
- To create expertise in Preparation of Plot Plan-Preparation of Equipment Layouts

Course Outcomes (COs)

1. Construct the process diagram for piping network
2. Plan the process layouts and design efficient piping systems

UNIT I **15 Hours**

PIPING ENGINEERING

Introduction to Piping, Process Diagrams (PFD, UFD, P&ID, Line List etc) Pipe Fittings- Pipe Flanges, Valves and Piping Special Items -Various codes and standards used in power and process industries-. Overview of Technical Queries and Technical Bid Evaluations - Preparation of Plot Plan-Preparation of Equipment Layouts-Preparation of Piping General Arrangement Drawings-Preparation of Cross Sectional Drawings-Piping Isometric Drawings-Material Take off-Preparation of Piping Material Specification-, Valve Material Specification-Pipe Wall thickness Calculations-Branch reinforcement calculations-Introduction to Stress Analysis-Types of stresses-Significance of forces and moments in piping system-Expansion Loop and Bellows-Pipe Supports-Support Types-Support Selection-Support Location-Support Span Calculation

Total: 15 Hours

Reference(s)

1. Sam Kannappan, Introduction to piping stress analysis, John Wiley & sons, 2006.
2. Mohinder L. Nayyar, Piping Engineering Hand book, McGraw Hill, 2000.
3. M. W. Kellogg Company, Design of Piping Systems - John Wiley & Sons, 2006.

15ME0XD PROBLEM SOLVING TECHNIQUES 1 0 0 1

Course Objectives

- To understand the basic concepts of quality control method of problem solving
- To create an awareness and understanding of quality control tools & techniques

Course Outcomes (COs)

1. Explain the quality control method of problem solving techniques.
2. Carry out quality control measures using the quality control tools & techniques

UNIT I **15 Hours**

PROBLEM SOLVING TECHNIQUES

Quality Control Tools and story -seven steps of story -seven quality control tools-problem definition - observation - analysis - solution identification - actions and execution - checking - standardization - case study -basic problem solving.

Total: 15 Hours

Reference(s)

1. L.Suganthi and Anand A Samuel, Total Quality Management, PHI Learning, 2009.

15ME0XE AUTOMOTIVE EXHAUST SYSTEM 1 0 0 1

Course Objectives

- To understand the concepts and design of exhaust systems and catalytic converters
- To disseminate information about various types of exhaust systems and strategies relevant to Indian automotive industry
- To identify the various factors to be considered for selection of exhaust manifold system

Course Outcomes (COs)

1. Explain the various factors influencing the performance of exhaust systems and catalytic converters
2. Execute design and modeling of exhaust manifold systems
3. Implement the CFD tool to improve the automotive exhaust systems

UNIT I **15 Hours**

AUTOMOTIVE EXHAUST SYSTEM

Exhaust system - Exhaust system Function -Parts - Types - Catalytic Convertor - Types -2WAY -3 WAY CATCON Mufflers - Types - Principles - Design trade off - BS IV and above norms - EGR - SCR- EGR Function - Pollution control - SCR - Function -Pollution control - CATIAV5 application for Exhaust system - Modeling - Assembly - Drafting - Basics with Exhaust manifold modeling practical session - CFD analysis - Uniformity index - Space velocity - Flow analysis - Pressure drop - CPSI optimization

Total: 15 Hours

Reference(s)

1. Dr. Kirpal Singh, Automobile Engineering (Volume II), Standard publishers distributors.
2. Ronald M. Heck, Robert J. Farrauto and Suresh T. Gulati, Catalytic Air Pollution Control: Commercial Technology, Wiley, 3rd Edition, Feb 2009.

15ME0XF CONTINUOUS IMPROVEMENT 1 0 0 1

Course Objectives

- To acquire the general knowledge to deliver consistently high quality and value added products and services to the customer in a Manufacturing environment
- To understand the terminology relating to continuous improvement in manufacturing organizations

Course Outcomes (COs)

1. Identify the continuous improvement metrics
2. Understand and appreciate various tools applied and methodology adopted to run a KAIZEN event

UNIT I **15 Hours**

CONTINUOUS IMPROVEMENT

History -Evolution - Toyota production system - Lean Manufacturing - Fundamentals, Importance, Definitions, Phases, Lead time - Supplier - Manufacturer - Customer Chain, Work place organization - Visual controls - Pull production and cellular manufacturing -Waste identification - Over production - Waiting - Work In Progress - Transportation - Inappropriate processing - Excess motion or ergonomic problems - Defected products - Under utilization of employees - Organizations Vision, Mission, Strategy Deployment and Key performance Indicators. Importance of Measurement. Gap Analysis, Identification of KAIZEN projects. Methodology, team formation, Problem statement, Data collection, Brainstorming, Analysis, containment action, corrective action and preventive action. Overview of performance metrics visual control.

Total: 15 Hours

Reference(s)

1. Dennis P Hobbs, Lean Manufacturing Implementation, J. Ross Publications, 2004
2. Jeffrey K Liker, The Toyota Way-14 Management Principles, Mc-Graw Hill, New York, 2004
3. Pascal Dennis, Lean Production Simplified, Productivity Press, USA, 2002
4. James P Womack, Daniel T. Jones, Lean Thinking: Banish waste and create wealth in your corporation, Simon & Schuster UK Limited, Free Press, 2003
5. Jay Arthur, Lean Six-Sigma Demystified, Tata McGraw-Hill Company, New Delhi, 2007
6. Richard J Schonberger, World Class Manufacturing, Free Press, 2008.

15ME0XG INDIAN PATENT LAW 1 0 0 1

Course Objectives

- To make students familiar about Indian patent law
- To make the students find the patentability of any invention
- To make the students aware of legal background of various process of Indian Patent

Course Outcomes (COs)

1. Summarize the various provisions of Indian Patent Law
2. Find patentability of any invention
3. Assess the legal provisions of Indian patent system

UNIT I **15 Hours**

INDIAN PATENT LAW

Preliminary, Inventions Not Patentable, Applications for Patents, Publication and Examination of Applications, Opposition Proceedings to Grant of Patents, Anticipation , Provisions for Secrecy of Certain Inventions, Grant of Patents and Rights Conferred Thereby, Patents of Addition, Restoration of Lapsed Patents, Surrender and Revocation of Patents, Register of Patents, Patent Office and Its Establishment, Powers of Controller Generally, Working of Patents, Compulsory Licenses and evocation, Central Government, Suits Concerning Infringement of Patents, Appeals to the Appellate Board, Penalties, Patent Agents, International Arrangements

Total: 15 Hours

Reference(s)

1. Indian Patent Act ,1970
2. Indian Patent Rules,2003
3. www.ipindia.nic.in

15ME0XH RAILWAY TRACK TECHNOLOGY 1 0 0 1

Course Objectives

- To familiar about Indian Railway and types
- To understand the Railway track and its types.

Course Outcomes (COs)

1. Summarize Indian Railway system and types of rails
2. Explain Railway track system

UNIT I **15 Hours**

RAILWAY TRACK TECHNOLOGY

Indian Railway overview, Evolution, Structure, Grades, Coning of Wheels and Caning of Rails, Types of Rails, Rail Material, Rail Joints, Sleepers, Rail and Sleeper Fastening, Railway Curves, Track Maintenance, Modern Track Construction, Track Inspection, High Speed Tracks and Special Tracks, Derailment Investigations.

Total: 15 Hours

Reference(s)

1. Railway Track Engineering, Fourth Edition, by J.S.Mundrey, McGraw Hill Education (India) Private Limited, 2009

15ME0XI GLASS ENGINEERING 1 0 0 1

Course Objectives

- To understand the basics of Glass making and various types in real world practice
- To understand the applications of commercial and special purpose glasses for various engineering applications

Course Outcomes (COs)

1. Classify glasses and select suitable glass for suitable engineering application.
2. Explain the glass making and treatment processes in a glass Industry.

UNIT I **15 Hours**

GLASS ENGINEERING

Introduction, History of Glass, Raw Materials & Manufacturing Process, Glass Properties, Care and Storage, Glass Processing, Types of glass based on application, Float Glass, Processed Glasses - (Laminated Safety Glass, Heat Treated Glass, Curved Toughened Glass, Insulated Glass), Reflective & Coated Glass, Special Purpose Glasses for fire resistance, bullet proof & sound proof requirements, Decorative Glass, Standards and Testing, Fields of application - applied engineering - facades - selection of glass for facades.

Total: 15 Hours

Reference(s)

1. Glass Engineering Handbook, by Errol Bertram Shand (Author), W. H. Armistead (Foreword), Literary Licensing, LLC (May 19, 2012)
2. Introduction to Glass Science and Technology , Royal Society of Chemistry, James E Shelby, 12 Jan 2005

15ME0XJ PLASTICS - DESIGN, PROCESSING, TOOLING, ASSEMBLY AND TESTING 1 0 0 1

Course Objectives

- To know the various plastic materials used in Automotive, home appliance, Medical fields
- To Understand the basic and advanced methods of plastic processing and the tooling & equipmentÃ¢??s used for it.
- To learn various post processing requirements such as painting, foiling, pad printing.
- To learn the various plastic joining processes and plastic testing methods.

Course Outcomes (COs)

1. Classify the plastic material and its applications
2. Explain the plastic processing methods & machine, tooling used for it
3. Indicate the post processing requirements and its significance
4. Assess the plastic joining processes characteristics

UNIT I **15 Hours**

PLASTICS - DESIGN, PROCESSING, TOOLING, ASSEMBLY AND TESTING

Introduction on Plastics, Types of plastics - Thermo plastics, Thermo setting plastics, Applications in Automobiles, Home appliances etc., Basic concepts on plastic design, Mould flow analysis Plastic processing- Preheating, Molding, Molding types - Injection molding, compression molding, Roto molding , 2K molding., Tooling- Core, Cavity, Inserts, heating & cooling circuits , Tool materials, Molding machines - Types, Tonnage & other specifications. Molding defects -Warpage, Catching, Weld line, burning, Sink marks etc, Method of avoiding defects Post molding process- Annealing, Texturing, color foiling, Pad printing, Painting etc., Assembly of Plastics- Ultrasonic welding, Heat sinking, Vibration welding. Testing of Plastics-UV testing, scratch resistance, Flammability, Resistance against chemicals, impact test.

Total: 15 Hours

Reference(s)

1. Hand book of Plastic Technologies - Charles A Harper
2. Plastic Engineering - R.J Crawford
3. Plastic Materials and Processes-A Concise Encyclopedia - Charles A. Harper&Edward M. Petrie

15ME0XK 5S - INTRODUCTION AND IMPLEMENTATION

1 0 0 1

Course Objectives

- To impart the knowledge on 5S fundamental and implementation concepts
- To provide the 5S training for implementation in engineering fields

Course Outcomes (COs)

1. Demonstrate various steps of 5S implementation principles
2. Practice 5S in real time life and engineering fields

UNIT I **15 Hours**

TOPICS

Need for implementing 5S and advantages-Explanation on 5S- methodology -zone formation, individual responsibility, hidden and common area and no man- land-Introduction to SEIRI-Tagging system, Disposal Policy, SEIRI Museum - 1S Practical - Introduction to SEITON -PEEP, Points for Storage, Safety, Quantity Identification - 2S Practical - Introduction to SEISO-Cleaning methods, Schedules, Accessories, Responsibilities - 3S Practical, Introduction to SEIKETSU - Evolving Standard Practices, Visual Controls - 4S Practical- Introduction to SHITSUKE- Self audit, Check lists. Evaluation - 5S Practical, Management audit, Jagruthi groups, Motivation, Awards, manuals.

Practice: Form students group, assign areas and do 5S practice.

Total: 15 Hours

15ME0XL ENERGY AUDITING AND INSTRUMENTS

1 0 0 1

Course Objectives

- To acquire knowledge about various thermal and electrical energy audit instruments used in the field as per Bureau of Energy Efficiency, Govt. of India
- To gain the skill in using the Energy Audit Instruments for field measurements

Course Outcomes (COs)

- Apply the measurement skill of energy related parameters in industrial environment
- Interpret the measurements for its accuracy and genuineness
- Express the analytical skill in quantification of energy flow in and out of an energy system

Introduction to Energy Conservation Act 2001, Basics of Energy Audit, Instruments : Clip on power meter, Infrared Thermometer, Vane Anemometer, Pitot tube with digital pressure meter, Stroboscope, Hygrometer, Combustion efficiency Monitor, Light Meter, Specifications, Limitations, applications and measurement calculations for Pressure, flow (Air and Water), power consumption, waste heat recovery calculations.

Total: 15 Hours

Textbooks

1. Energy Audit Manual published by Energy Management Centre, Govt of Kerala , Kerala – Manual-2017.

Reference

1. CO_2 Emission Mitigation through Energy Conservation- A Practical Guide. by Dr. M. Thirugnanasambandam, Published by Shanlax Publishers- 2018.

15GE0XA HEALTH AND FITNESS 1 0 0 1

Course Objectives

- To understand the fundamental concepts about physical fitness & its types, training and assessment of physical fitness

Course Outcomes (COs)

1. Acquire the knowledge and training of the individual physical, mental and social concepts
2. Understand the fundamental concepts of yogic practice and physical fitness
3. To acquire the knowledge about nutrition and health consciousness

UNIT I **5 Hours**

FITNESS

Meaning & Definition - Need & importance of Physical fitness-Types Physical fitness - Exercise, Training and Conditioning and it is important

UNIT II **5 Hours**

YOGA AND MEDITATION

Meaning and definition - Principles of practicing - Basic Asana and it important - Pranayama and Meditation - Relaxation Techniques

UNIT III **5 Hours**

NUTRITION AND BALANCE DIET

Nutrition and Balance Diet: Needs and Important - Significant of Nutritional Food - Tips for balance diet. Common Diseases for IT professionals: Common diseases - cause - prevention - First aid for common sports injuries.

Total: 15 Hours

Reference(s)

1. Anderson, Bob., Pearl, Bill.,&Burke, Edmund R., (2001). Getting in Shape Workout Programs for Men&Women. Mumbai: Jaico Publishing House
2. Baechle, Thomas. R, & Earle, Roger. W., (2000). Essentials of Strength Training and Conditioning. Champaign: Human Kinetics
3. Iyengar, BKS., (2003). The Art of Yoga. New Delhi: Harper Collins Publishers
4. Singh, Hardayal, (1995). Science of Sports training. New Delhi: D.V.S. Publications
5. Begum, Raheena. M., (2002). A Textbook of Foods, Nutrition and Dietetics. New Delhi: Sterling Publishers Private Limited

15GE0XB FOUNDATION COURSE IN COMMUNITY RADIO TECHNOLOGY

1 0 0 1

Course Objectives

- The course focuses on community radio technology and various program productions techniques for radio broadcasting
- provide solutions for real world applications

Course Outcomes (COs)

1. Understand the hardware required for field recording and setting up a studio and carry out studio and field recording
2. Examine the available options for telephony interfaces for radio
3. Demonstrate proper techniques of wiring, fixing of connectors, soldering and use of tools and equipment for studio work

UNIT I **2 Hours**

INTRODUCTION TO COMMUNITY RADIO

Evolution of Community Radio (CR) in India- principles behind setting up of CR- policy guidelines and their impact on technology and content of a CR station- fundamental principles behind deciding the technology for a CR station.

UNIT II **2 Hours**

STUDIO TECHNOLOGY

Properties and components of sound-difference between analogue and digital audio-hardware required for field recording and setting up a studio-fundamental principles for setting up an audio studio

UNIT III **2 Hours**

AUDIO PRODUCTION

Concept of recording and storing audio-hardware related to audio recording-open source software solutions for audio production- telephony interfaces for radio- audio Post Production

UNIT IV **2 Hours**

STUDIO OPERATIONS

Wiring, fixing of connectors, soldering and use of tools and equipment- preventive and corrective maintenance of studio and equipment.

UNIT V **2 Hours**

RADIO TRANSMISSION TECHNOLOGY

Components of the FM transmission chain- FM transmitter-different types of FM antenna - coaxial cable- propagation and coverage of RF signals-FM transmitter setup

UNIT VI **2 Hours**

MODULARITY AND CODE REUSABILITY

FUNCTIONS

Defining a function - Calling a function - Pass by reference - Function arguments - return - statements - Scope of variables - Recursion - Import statement - from...import statement - from...import * statement

UNIT VII **3 Hours**

ADVANCED CONCEPTS

File-Handling-Operations-Opening and closing files - Reading and writing files - Renaming and deleting files - Directories in Python-Handling Runtime Errors - Exception Handling Exceptions - Handling exceptions - Raising exceptions - user-defined exceptions Object Oriented Programming in Python - Classes and Objects - Methods - Principles of Object Orientation - Inheritance - Polymorphism - Encapsulation

Total 15 Hours

Reference(s)

1. UNESCO (2001). Community Radio Handbook
2. Vinod Pavarala, Kanchan K Malik, -Other Voices: The Struggle for Community Radio in India-SAGE Publications India,2007
3. Steve Buckley, Mark Raboy, Toby Mendel, Kreszentia Duer, Monroe E. Price, - Siochr--Broadcasting, Voice, and Accountability: A Public Interest Approach to Policy, Law, and Regulation- University of Michigan Press, 2008
4. www.floridasound.com
5. www.mediacollege.com
6. www.procosound.com

15GE0XC VEDIC MATHEMATICS 1 0 0 1

Course Objectives

- To improve their calculation speed, analytical thinking and numerical skills

Course Outcomes (COs)

1. Solve problems creatively in mathematics and its applications

UNIT I **15 Hours**

VEDIC MATHEMATICS

Addition- Subtraction- System of Multiplication- Squaring numbers- Cube roots- Square roots- Solution of simultaneous equations- Solutions of Quadratic equations

Total: 15 Hours

Reference(s)

1. Dhaval Bathia, Vedic Mathematics, JAICO Publishing House, 29th Edition, Mumbai, 2014
2. Jagadguru Swami Sri Bharathi Krsna Tirthaji Maharaja, Vedic Mathematics, Motilal Banarsidass Publishers Private Limited, New Delhi, 1997

15GE0XD INTRODUCTION TO ALGORITHMS 1 0 0 1

Course Objectives

- Analyze the asymptotic performance of algorithms, Divide and conquer and Dynamic Problems
- Use Sorting and Searching algorithms for arranging the data
- Apply important algorithmic techniques to solve the real world Problem

Course Outcomes (COs)

1. Apply Divide and conquer and Dynamic Programming Algorithm techniques to Provide the solutions for simple Problems
2. Design algorithms for Performing Sorting and Searching of data
3. Construct the Graph, Heap and BST for the given Data information

UNIT I **15 Hours**

INTRODUCTION TO ALGORITHMS

Algorithm Design Techniques: Divide and Conquer, Dynamic Programming, Sorting and Searching, Basic graph algorithms -Simple Data Structures: Heaps, Balanced Search Trees

Total: 15 Hours

Reference(s)

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, Second Edition, Pearson Education, 2015
2. Thomas H. Cormen. Charles E. Leiserson. Ronald L. Rivest. Clifford Stein, Introduction to Algorithms, Second Edition, MIT Press, 2014
3. J.P.Tremblay and P.G.Sorenson, An Introduction to Data Structures with Application II Edition, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2008

15GE0XE ETYMOLOGY 1 0 0 1

Course Objectives

- To increase vocabulary and enhance use, knowledge, and understanding of the English language
- To stimulate an appreciation for the English language, including how it developed, how new wordsenter the language, and how it continues to be dynamic
- To demonstrate the importance of a broad-based vocabulary for effective oral and written communication

Course Outcomes (COs)

1. Examine prefixes, roots, and suffixes of Latin, Greek, Germanic, and Anglo-Saxon origin.
2. Explore the historical aspects of language, including the infusion of Indo-European languages, semantic changes, and the influence of world events

UNIT I **7 Hours**

CONVENTIONS

Acronyms - Abbreviations - Initialisms - Jargon - Neologisms - Idiomatic Expressions - Euphemisms - Spoonerisms - Malapropisms - Mondegreens - Words Derived from Latin - Words Derived from Greek - Words Derived from - Germanic/Anglo-Saxon - Abstract word Acronym - Affix Analogy - Antonym - Apheresis - Blend word Assimilation - Colloquial language Clipped word

UNIT II **8 Hours**

WORD ANALYSIS

Concrete word Derivative - Dialect Diminutive suffix - Dissimilation Doublet - Etymology Euphemism - Figurative word Homonym - Hybrid word Inflection - Informal language Infusion - Jargon Linguistics - Loan words Metathesis - Modify - Philology Onomatopoeia - Romance language Prefix - Semantics - Root-base word - Suffix Slang - Word component Synonym

Total: 15 Hours

Reference(s)

1. Norman, Lewis. Word Power Made Easy,Goyal Publisher. Edition 2.2014.
2. C T Onions. The Oxford Dictionary of English Etymology.Volume 11, Issue 1.70, Wynford Drive, Don Mills, Ont.Oxford University Press.1965.
3. Nurnberg W, Maxwell and Rosenblum, Morris, How to build a better Vocabulary, Completely Revised and Updated, Popular Library.1961

15GE0XF HINDUSTANI MUSIC 1 0 0 1

Course Objectives

- To have an awareness on aesthetic and therapeutic aspects of Hindustani music
- To identify and differentiate the various styles and nuances of Hindustani music
- To apply the knowledge accumulated throughout the duration of the course by way of improvisation, composition and presentation

Course Outcomes (COs)

1. Have Basic knowledge of aesthetic and therapeutic value of Hindustani Music

UNIT I **5 Hours**

AESTHETICS

Introduction to music - Aesthetics of Hindustani Music - Classification (Raga, instruments, style as per the presentation and the gharaanaas) - Folk music, Dhamaar, Dhrupad

UNIT II **10 Hours**

COMPOSITION AND THERAPEUTIC VALUE

Taal and Raga - Bandeesh, Taraanaa - Madhya and drut laya, Vilambit khyaal as demonstration - Therapeutic benefits of Hindustani music - Stage performance

Total: 15 Hours

Reference(s)

1. Devdhar B.R., Raga bodh (Part 1 & 2), Devdhar School of Indian Music, Mumbai, 2012.
2. Vasant, Sangeet Vishaarad , Hathras, Uttar Pradesh, 2015
3. raag-hindustani.com/
4. play.raaga.com/Hindustani
5. raag-hindustani.com/Scales3.html
6. www.poshmaal.com/ragas.html

15GE0XG CONCEPT, METHODOLOGY AND APPLICATIONS OF VERMICOMPOSTING

1 0 0 1

Course Objectives

- To understand the importance of safe methods of treating solid wastes generated through various human activities
- To appreciate the skills / devices / practices associated with the compact proceedures of biodegradation of unwanted solid residues

Course Outcomes (COs)

1. Understand the role of recycling of garbage leading to the sustenance of our health and environment.
2. Recognize the organic farming practices and production of healthy food products.
3. Prepare and maintain tips for small scale compost units and thereby becoming more environmentally conscious

UNIT I **15 Hours**

VERMICOMPOSTING TECHNOLOGY

Ecological roles and economic importance of earthworms - need for earthworm culture - scope and importance of vermiculture - limiting factors - types of worm culturing and the relative benefits - Small scale and commercial methods: process & advantages - Vermicomposting equipments, devices - Design and maintenance of vermi bed - Products from vermiculture (matter & humus cycle) - vermicastings in organic farming/horticulture - Marketing the products of vermiculture - quality control, market research, marketing techniques - Applied vermiculture: use of urban solids & farm/ industrial residues for vermicomposting - Constraints of vermiculture and its future perspectives - Artificial Earthworm as a standalone biodegradation assembly.

Total: 15 Hours

Reference(s)

1. Sultan Ahmed Ismail, 2005. The Earthworm Book, Second Revised Edition. Other India Press, Goa, India.4
2. Vermiculture Technology; Earthworms, Organic Wastes and Environmental Management, 2011, Edited by Clive A Edwards, Norman Q Arancon & Rhonda Sherman, CRC Press
3. www.organicgrowingwithworms.com.au
4. New York Times - Scientists Hope to Cultivate and Immune System for Crops

15GE0XH AGRICULTURE FOR ENGINEERS 1 0 0 1

Course Objectives

- To impart the basic knowledge of agricultural and horticultural crops, cropping systems
- To study the weed and nutrient management, irrigation water requirement and its quality

Course Outcomes (COs)

1. Understand the science of Agriculture
2. Summarize and apply the methodologies needed in agriculture based on the field conditions.
3. Develop enough confidence to identify the crop patterns in real world and offer appropriate solutions

UNIT I **5 Hours**

AGRONOMICAL PRACTICES AND CROPS

Definition and scope of agronomy , Classification of Crops, agricultural and horticultural crops Effect of Different Weather Parameters on Crop Growth and Development , Principal of Tillage, Tilth and Its Characteristics, Role of Water in Plant and Its Absorption, Conduction and Transpiration of Water and Plant Processes, Soil Water Extraction Pattern and Plant Response. Introduction to weeds, Weeds Control.

UNIT II **3 Hours**

CROP ROTATION, CROPPING SYSTEMS, RELAY AND MIXED CROPPING

Crop Rotation, Different Cropping Systems - I, Different Cropping Systems - II, Scope of Horticultural Crops, Soil Requirement for Fruits, Vegetables and Flowers Crops, Climatic Requirement for Fruits, Vegetables and Flowers Crops.

UNIT III **2 Hours**

PLANT NUTRIENTS

Essential Plant Nutrients, Nutrient Deficiency, Toxicity and Control Measures. Chemical fertilizers, fertilizer Reaction in Soil and Use Efficiency

UNIT IV **5 Hours**

QUALITY OF IRRIGATION WATER AND IRRIGATION METHODS

Quality of Irrigation Water, Poor Quality of Irrigation Water and Management Practices. Surface Irrigation methods, and micro irrigation methods

Total: 15 Hours

Reference(s)

1. SP. Palaniappan, and S. Sivaraman, Cropping systems in the tropics- Principles and Management, New Age international publishers, New Delhi, (2nd edition), 1998.
2. S.Sankaran and V.T Subbaiah Mudaliar, Principles of Agronomy, The Bangalore Printing and Pubg Co, Bangalore, 1993.
3. P.Balasubramain and SP. Palniappan, Principles and Practices of Agronomy, Agrobios publishers, Ludhiana, 2001.
4. T.Yellamanda Reddy and G.H. Sankara Reddi, Principles of Agronomy, Kalyani publishers, Ludhiana, 2005
5. B.Chandrasekaran, B. , K. Annadurai and E. Somasundaram, A Text book of Agronomy, Scientific publishers, Jodhpur, 2007

6. George Acquaah, Horticulture-principles and practices, Prentice-Half of India Pvt. Ltd., New Delhi, 2002.

15GE0XI INTRODUCTION TO DATA ANALYSIS USING SOFTWARE 1 0 0 1

Course Objectives

- To familiarize students on the features of MS Excel
- To enable the students to use Excel in the area of critical evaluation.
- To Facilitate the student to construct graphs

Course Outcomes (COs)

1. Create versatile Excel document.
2. Apply built in functions for data analysis.
3. Prepare dynamic Charts

UNIT I **4 Hours**

EXCEL FUNDAMENTALS AND EDITING

Starting and Navigating a Worksheet- Entering Information - Hyperlinks - Saving - Editing Techniques - Entering a Series of Labels, Numbers and Dates - Checking Errors.

UNIT II **3 Hours**

FORMATTING

Formatting Cells - Changing Column Widths and Row Heights - Creating Conditional Formatting - Using Styles - Creating and Modifying Templates - Changing Page Breaks.

UNIT III **3 Hours**

POWER ORGANIZING AND CUSTOMIZING EXCEL

Managing Worksheets - Referencing Cells in Other Worksheets - Using More than One Work Book - Managing Shared Work Books - Protecting Worksheets and Workbooks. Adjusting Views - Setting Printing Options - Using Multiple Panes - Customizing Excel Using the Options Dialog Box.

UNIT IV **2 Hours**

CRUNCHING NUMBERS

Building a Formula - Using Basic Built-in Functions - Using Functions to Analyze Data - Using Names in Functions - Array Functions

UNIT V **3 Hours**

WORK SHEET CHARTS

Planning a Chart - Creating Chart - Formatting a Chart - Adding Labels and Arrows

Total: 15 Hours

Reference(s)

1. Michael J. Young, Michael Halvorson, -Office System 2007 Edition- Prentice-Hall of India (P) Ltd., New Delhi, 2007
2. Curtis D. Frye, Microsoft Office Excel 2007 Step by Step, Microsoft Press, 2007
3. Mark Dodgeand Craig Stinson, Ã¢??Microsoft Office Excel 2007 Inside Out- Microsoft Press, 2007

15GE0XJ ANALYSIS USING PIVOT TABLE 1 0 0 1

Course Objectives

- To familiarize students on the features of Pivot Table.
- To enable the students to use Pivot Table in the area of data analysis.
- Facilitate the student to construct the charts for visualization of data

Course Outcomes (COs)

1. Able to construct the Pivot Table and Group, Sort, Filter the Data to do the analysis.
2. Able to do the Calculation with in Pivot Table for advance analysis.
3. Capable of Constructing Pivot Charts to make visual presentation

UNIT I **3 Hours**

PIVOT TABLE FUNDAMENTALS

Introduction about Pivot Table, Why and When to use the Pivot Table, Anatomy of the Pivot Table, Limitations, Preparing the Source Data, Creating the Pivot Table.

UNIT II **3 Hours**

GROUPING PIVOT TABLE DATA

Grouping the Items in a Report Filter, Grouping Text Items, Grouping Dates by Month, Grouping Dates Using the Starting Date, Grouping Dates by Fiscal Quarter, Grouping Dates by Week, Grouping Dates by Months and Weeks, Grouping Dates in One Pivot Table Affects Another Pivot Table, Grouping Dates Outside the Range.

UNIT III **3 Hours**

SORTING AND FILTERING PIVOT TABLE DATA

Sorting a Pivot Field: Sorting Value Items, Sorting Text Items, Sorting Items in a Custom Order. Filtering a Pivot Field: Manual Filter, Label Filter, Value Filter, Multiple Filters

UNIT IV **3 Hours**

CALCULATIONS WITHIN THE PIVOT TABLES

Using Formulae: Creating a Calculated Field with and without -IF Condition, Calculated Item, Using Custom Calculations: % of Column, % of Row, % of Total, % Of, Running Total, Difference From, % Difference From, Index

UNIT V **3 Hours**

PIVOT CHARTS

Creating a Normal Chart from Pivot Table Data, Filtering the Pivot Chart, Changing the Series Order, Changing Pivot Chart Layout Affects Pivot Table, Changing Number Format in Pivot Table Affects Pivot Chart, Converting a Pivot Chart to a Static Chart, Refreshing the Pivot Chart, Creating Multiple Series for Years

Total: 15 Hours

Reference(s)

1. Debra Dalgleish, -Excel 2007 - PivotTables Recipes A Problem-Solution Approach- Apress, 2007, (ISBN-13 (pbk): 978-1-59059-920-4)
2. Bill Felen and Michael Alexander, -Pivot Table Data Crunching for Microsoft Office 2007- Pearson Education, Inc., QUE Series.

3. Wayne L. Winston, -Microsoft Office Excel 2007: Data Analysis and Business Modeling- Microsoft Press, 2007
4. John Walkenbach, -Microsoft Office Excel 2007- Wiley Publishing, Inc. 2007
5. Mark Dodgeand Craig Stinson, -Microsoft Office Excel 2007 Inside Out- Microsoft Press, 2007
6. Curtis D. Frye, Microsoft Office Excel 2007 Step by Step, Microsoft Press, 2007

15GE0XL INTERVIEW SKILLS 1 0 0 1

Course Objectives:

- To develop an understanding of interview dynamics and techniques, and its importance in career enhancement.
- To train students to face interviews.

Course Outcomes (COs):

1. Demonstrate appropriate interview skills and attend all types of interviews
2. Participate in group discussions with confidence

Interview preparation - Overcoming interview nerves - Types of Interview - Handling questions - Group Discussion - Dynamics of group discussion - Presentation skills - E-mail etiquette - Body Language.

Total: 15 hours

References:

1. Gray Jack, Interviewing: Interview Questions - Job Interviews, New York : Great Reads Publishing, 2015.
2. Corfield Rebecca, Successful Interview Skills, New York: Kogan Page, 2006.
3. Carnegie Dale, How to Win Friends and Influence People, New York: Simon & Schuster, 1998.
4. Butterfield Jeff, Soft Skills for Everyone, New Delhi: Cengage Learning, 2014.

15GE0XN JOURNALISM AND MASS COMMUNICATION

1 0 0 1

Course Objectives

- To offer a basic knowledge of mass communication and its various forms
- To provide a basic understanding of mass communication in India

Course Outcomes (COs)

1. Understand the underlying principles of Journalism
2. Understand the importance, functions & scope of mass communication
3. Follow and adapt to the periodic changes in media

UNIT I **15 Hours**

JOURNALISM AND MASS COMMUNICATION

What is News - Components of a Newspaper - Structure of an Article - How to Write Headlines - Introduction to Script Writing - News Reporting - Advertising and Marketing - Online Journalism - Rules of Editing - Proof Reading - Optimization and Key Words - Media Ethics - TV Studies - Media Propaganda - Identifying Fake News - International Communication

Total: 15 Hours

Reference(s)

1. Kumar, Keval. Mass Communication in India. IV Ed. Jaico Publishing House: 2012
2. Agarwal, S.K. A Handbook of Journalism & Editorial Excellence. Jaico Publishing House: 2012

15GE0XO VISUAL MEDIA AND FILM MAKING 1 0 0 1

Course Objectives

- To acquire fundamental knowledge on development of film making as an art, and video production
- To provide students a basic understanding of the techniques and nuances of visual medium
- To inculcate an ability to plan and produce a short film

Course Outcomes (COs)

1. Understand the significance and techniques of visual medium
2. Analyse and produce visual clippings

UNIT I **15 Hours**

ART OF FILMMAKING

History of Cinema (Origin and Narrative) - Cinema as a visual medium -Significance of Editing - Styles of Editing - Editing as a methodology (Hollywood-s Invisible Editing) - Technical Aspects of Editing (Final Cut Pro (FCP), AVID and Premire Pro) - Basics of video production (pre-production to post-production) - Different types of shots and angles - Film style and Narrative - (Italian Neo-realism, Avant Garde, Russain Formalism, Alternative Cinema etc.,) -Regional Cinema to National Cinema- Basics of Script Writing (Double and Single Column) - Basics of Video Production (script to screen) Ã¢?? Final submission of a script for five minutes short film

Total: 15 Hours

Reference(s)

1. Monaco, James, How to Read a Film: Movies, Media, and Beyond. Auckland: OUP, 2009
2. Belavadi, Vasuki, Video Production. India: OUP, 2013

15GE0XP YOGA FOR HUMAN EXCELLENCE 1 0 0 1

Course Objectives

- To know about the history and schools of yoga
- To know the difference between supreme consciousness and individual consciousness
- To apply the knowledge by the way of practice and introspection

Course Outcomes (COs)

1. Understand the historical aspects and schools of yoga
2. Ensure their physical & mental wellness through yoga practice
3. Develop the power to concentrate and have stress free mind

UNIT I **15 Hours**

YOGA FOR HUMAN EXCELLENCE

What is Yoga - History of Yoga - Yoga in todays scenario- Schools of Yoga - Eight Limbs of Yoga - Sathvic, Rajasic, Tamasic Foods and Thoughts - Science of Yoga Loosening Exercises - Yogasanas & Benefits - Super Brain Yoga - Surya Namaskar Standing Asanas - Sitting Asanas - Prone Asanas - Supine Asanas - MudrasRelaxation - Pranayama - Meditation

Total: 15 Hours

Reference(s)

1. Vethathiri Publications, Yoga Practices-2, Erode, 2012
2. Iyengar B.K.S. Yoga: Wisdom & Practice, B.K.S. Iyengar, 2009
3. Ramesh Partani, The Complete Secret, Ru Education, 2013
4. http://www.sarvyoga.com/
5. http://www.wikihow.com/Do-Superbrain-Yoga

15GE0XQ CARNATIC MUSIC 1 0 0 1

Course Objectives

- To know the basics of Carnatic Music
- To foster a blend of practical and theoretical understanding of Carnatic Vocal music
- To give a brief understanding of History of Indian Music, Evolution of the Raga system, Tala system, Structure of compositions

Course Outcomes (COs)

1. Develop an understanding of the basics of Carnatic music
2. Understand the aspects of Carnatic music which will help to create a strong foundation in Carnatic Music

UNIT I **15 Hours**

CARNATIC MUSIC

History of Carnatic music - History of Carnatic Composers - Music Technical Terms Part I: Music, Nadam, Sangeetham, Marga Sangeetham, Suddha Sangeetham, Desiya Sangeetham, Kalpita, Kalpana, Ahata Nadam, Anahata Nadam, Shruthi, Swaram, Swarasthanas, Seven Swaras, Tamil Swaras, Prakruthi, Vikruthi, Kamala, Tivra, Twelve Swaras, Arohanam, Avarohanam, Swarna Kalas, Thala Symbols, Sthayi - Music Technical Terms Part II: Ragas, Janaka Ragas, Janya Ragas, Melakartha Ragas, Upanga Ragas, Bhashanga Ragas, Akshara Kalas, Sangathi, Anya Swaram, Chakras and Meanings, Jaaru, Poorvangam, Thadu and Madu, Saptaham, Ashtakam, Uthrangam, Gamaga, Abhyasa Ghanam, Sapta Kriyas, Nisapta Kriyas, Three Sathanas, Sabahaa gananas, Alapana, Thala, Laghu, Dhrutham - Jantavarisai - Classification

Total: 15 Hours

Reference(s)

1. Bhagyalekshmy, S. Ragas in Carnatic Music. CBH Publications, 2003
2. Deva, Bigamudre Chaitanya. An Introduction to Indian Music. Publications Division, Ministry of Information and Broadcasting, Government of India, 2015
3. Sambamoorthy, P. South Indian Music. Indian Music Pub. House, 1954

15GE0XR GENERAL PSYCOLOGY 1 0 0 1

Course Objectives

- To provide a basic understanding of psychology
- Defining Psychology and the subject matter of psychology
- To provide an awareness of various methods and branches of psychology
- To explain social and work psychology of people and the need for mental health

Course Outcomes (COs)

1. Understand the basics of human behavior in the workplace and society at large
2. Understand the different fields of psychology and its uses
3. Deal people effectively in their personal and social life

UNIT I **15 Hours**

GENERAL PSYCOLOGY

Psychology - Introduction - Mind body relationship - Methods and Scope of Psychology Motivation-Types of Needs- Motivational Cycle- Intelligence: Concept of Intelligence and IQ- measurement - Social psychology: individual behavior and group behavior - Group dynamics- group formation-social influence-social cognition, stereotypes- prejudice- discrimination - Definitions, formation of attitude, factors of attitude formation-change of attitude

Total: 15 Hours

Reference(s)

1. Atkinson & Atkinson, Introduction to Psychology, 6th Ed McGraw-Hill Publications. 1975
2. Mishra, B. K, Psychology: The study of human behavior, 2nd Ed New Delhi: Prentice Hall of India Learning Pvt. Ltd. 2016
3. Baron, R.A., Branscombe. N.R, Social Psychology, 14th Ed. New Delhi; Pearson Education. 2016
4. Morgan, C.T., King, R.A., Weisz, J.R., & Schopler, J. Introduction to Psychology, 7th Ed. New Delhi: Tata McGraw Hill. 1993

15GE0XS NEURO BEHAVIOURAL SCIENCE 1 0 0 1

Course Objectives

- To provide an introduction to the Cognitive Neuro Science of languages
- To provide an understanding of the Cognitive processes

Course Outcomes (COs)

1. Identify the psychological problems that will impact mental health
2. Value ethical conduct in professional and personal life
3. Recognize the need for rationale and evidence in decision-making

UNIT I **15 Hours**

NEURO BEHAVIOURAL SCIENCE

Introduction to physiology - Anatomy - Neuro Biology - Psycho Neuro Science Behaviour and Hormones - Behaviour Modifications - Relaxation Therapy - Psycho Education for minds

Total: 15 Hours

Reference(s)

1. Beck, Robert. Handbook of Physiology. Vol I. Oxford University Press March 15,1996
2. Horon C Philip. Sexology and Mind. Academic Press. 1993
3. Blatteis M.Clark and Melvin J. Fregly. Handbook of Physiology Sect 4, Oxford University Press. March 15, 1996

15GE0XT INNOVATION AND ENTREPRENEURSHIP

1 0 0 1

Course Objectives

- To make the participants understand as to how to get along with the task of setting independent business units and on the various facets of running a business
- To get the budding young entrepreneurs to appreciate the structured knowledge of the dynamics of operationalizing a business opportunity

Course Outcomes (COs)

1. Understanding entrepreneurship as an important career option
2. Concept and methodology of idea translation to viable start-ups
3. Events to occur in the building of a technology based venture for students or working professionals or women
4. Overview of Indian trends in the start-up scene

UNIT I **15 Hours**

NEW AGE INNOVATION AND ENTREPRENEURSHIP

Introduction to Entrepreneurship - Opportunity Identification - ideation -MVPPositioning as an Entrepreneur - Starting own Business - Developing Effective Business Model - Industry and Competitor Analysis - Building Business PlanMentoring Session with Investors- Legal and Ethical Foundation for Startup - Types of startups and licensing systems - MSME -Evaluating the Financial Strength of a New Venture/Project - Getting Funding - Types of Sources - VCs, Angel funding, PE etc. -Marketing Strategies for New Ventures - IT Systems - IPR - Strategies for New Venture Growth - Talent Acquisition and Management for New Ventures - Valuation Challenge in Entrepreneurship - Intrapreneurship - Sustainability - Exit strategies and Start-up trends in India.

Total: 15 Hours

Reference(s)

1. Kathleen R. Allen, Launching New Ventures, South-WesternCengage Learning, 6th Edition, 2012
2. Alex Osterwalder and Yves Pigneur, Business Model Generation, publishedby the authors, 2010
3. Branson. R. -Business stripped bare- New York, Penguin books, 2011
4. Moris MH, Kuratko DF and Covin JG, Corporate entrepreneurship and innovation, 3 edition, Mason, Oh; CENGAGE/SOUTH WESTERN publisher, 2011.

15MEV01 INTORDUCTION TO RISK ANALYSIS

Course Objectives

- To understand the importance of risk analysis.
- To understand the working principles instruments.
- To understand the risk assessment techniques.
- To create awareness on various soft wares in risk analysis.
- To understand the methods to carry out consequence analysis.

Course Outcomes (COs)

1. Explain the importance of risk analysis.
2. Demonstrate the working principles instruments.
3. Demonstrate risk assessment techniques.
4. Apply consequent analysis techniques.
5. Explain the methods to carry out consequence analysis.

HAZARD, RISK ISSUES AND HAZARD ASSESSMENT

Introduction, hazard monitoring-risk issue – Probability, reliability, Hazard assessment, procedure, methodology; safety audit, checklist analysis, what-if analysis, safety review.

INSTRUMENTATION

Applications of Advanced Equipments and Instruments- Thermocalorimetry, Differential Scanning Calorimeter (DSC), Thermo Gravimetric Analyzer (TGA), Principles of operations, Applications, advantages. Explosive Testing, Deflagration Test, Detonation Test, Ignition Test, Sensitive Test, Impact Sensitive Test (BAM) and Friction Sensitive Test (BAM).

RISK ANALYSIS QUANTIFICATION AND SOFTWARE

preliminary hazard analysis (PHA), hazard operability studies (HAZOP), Fault Tree Analysis & Event Tree Analysis, Logic Symbols, fire explosion and toxicity index(FETI) - Hazard analysis(HAZAN)- Failure Mode and Effect Analysis(FMEA)- Basic concepts of Software on Risk analysis. ALOHA

CONSEQUENCES ANALYSIS

Introduction to modeling procedures, Basic concepts used in Consequence Analysis, Fire Radiation Models - Pool Fires, Flares, Torch Fires, BLEVEs and Fireballs, Release Models- Liquid, Vapor, Aerosol, Vapor Dispersion - Source Models, Aerosols, Pool, Vaporization, Dense Gas Dispersion, Momentum Jet Dispersion, Explosions - TNT Models, TNO Multi- Energy, Baker- Strehlow, Examples of model applications to accidental releases.

CASE STUDIES

Past accident analysis as information sources for Hazard analysis and consequences analysis of chemical accident, Mexico disaster, Flixborough, Bhopal, Seveso, Pasadena, Feyzin disaster (1966), Port Hudson disaster- convey report, hazard assessment of nonnuclear installation- Richmond report, risk analysis of size potentially Hazardous Industrial objects- Rasmussen masses report, Reactor safety study of Nuclear Power Plant.

Total: 45 Hours

Reference(s)

1. P. Frank. Less Butterworth-Hein, Loss Prevention in Process Industries (Vol.I, II and III), Butterworth-Hein UK 1990.
2. F.I. Khan, S.A. Abbasi, Advanced Risk Assessment In Chemical Process Industries, Discovery Publishing House, 2000.
3. Center for Chemical Process Safety (CCPS), Quantitative Risk assessment in Chemical Industries, Institute of Chemical Industries, Centre for Chemical process safety. Second Edition, 2000.
4. Guidelines for Hazard Evaluation Procedures, Centre for Chemical Process safety, AICHE 2008.

5. https://www.easa.europa.eu/essi/
6. http://www.hse.gov.uk/research/hsl
7. http://www.questconsult.com/services/training/introduction-consequence-analysis/

15MEV02 MODELING USING CATIA V5

Course Objectives

- To acquire knowledge in sketching and constraining.
- To acquire knowledge in creating solid models using various features of CATIA V5.
- To have a clear idea in assembling the modeled parts using CATIA V5.
- To impart knowledge in drafting and sectioning.
- To impart knowledge in wireframe and surface modeling using various features of CATIA V5.

Course Outcomes (COs)

1. Make sketching and constraining using CATIA V5.
2. Model any three dimensional objects by CATIA V5.
3. Construct assembly after part modeling using CATIA V5.
4. Make sectioning and drafting using CATIA V5.
5. Make wireframe and surface modeling, using CATIA V5.

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INTRODUCTION TO CATIA V5

Modifying Units - Modifying the Grid Settings - Understanding the Sketcher Terms - Specification Tree - Grid -Snap to Point - Construction/Standard Element - Select Toolbar .Drawing Sketches Using the Sketcher Tools. Drawing Lines, Center Lines, Rectangles, and Parallelograms. Creating Points, Drawing Circles, Arcs, Profiles.

DRAWING SKETCHES IN THE SKETCHER

Sketching Tools - Drawing Ellipses, Splines, Keyhole Profiles , Hexagons, Editing and Modifying Sketches - Trimming , Quick Trim , Filleting , Chamfering, Mirroring Translating, Rotating Scaling, Offsetting, Modifying ,Deleting.

CONSTRAINING SKETCHES AND CREATING BASE FEATURES

Constraining Sketches, Adding Geometrical Constraints -Defining Constraints , Exiting the Sketcher Workbench , Creating Base Features by Extruding , Revolving Sketches , Rotating, Modifying the View , Tutorial 1 , Tutorial 2 & Exercise 1 Exercise 2 .

REFERENCE ELEMENTS AND SKETCH-BASED FEATURES

Importance of Sketching Planes - Reference Elements, Reference Planes , Creating Points , Creating Reference Lines ,Other Sketch-Based Features ,Creating Drafted Filleted Pad Features , Multi-Pad Features , Pocket Features , Drafted Filleted Pocket Features , Multi-Pocket , Groove .

CREATING DRESS-UP AND HOLE FEATURES

Advanced Modeling Tools - Creating Hole Features - Fillets - Chamfers -Adding a Draft to the Faces of the Model - Shell Feature. Editing Features of a Model.

TRANSFORMATION FEATURES AND ADVANCED MODELING TOOLS

Transformation Features - Translating Bodies -Rotating -Creating Symmetry -Mirroring - Creating Rectangular Patterns, Circular Patterns , User Patterns. Advanced Modeling Tools - Creating Rib Features - Slot Features - Multi-Sections Solids

ASSEMBLY MODELING

Assembly Modeling - Types of Assembly Design Approaches -Creating Bottom-Up Assemblies - Creating Top-Down Assemblies -Editing Assemblies.

WORKING WITH THE DRAFTING WORKBENCH

The Drafting Workbench -Starting a New File in the Drafting Workbench -Type of Views-Generating Drawing Views -Automatically Generating Views - Individual Drawing Views - Exploded View - Editing and Modifying Drawing Views- Modifying the Hatch Pattern of Section Views. Inserting the Frame and the Title Block - Annotations, Generating the Bill of Material (BOM) -Generating Balloons.

WORKING WITH THE WIREFRAME AND SURFACE MODELING

Need of Surface Modeling - Creating Wireframe Elements - Creating Circles - Splines - Helix - Surfaces - Extruded Surfaces - Revolved Surfaces -Spherical Surfaces - Cylindrical Surfaces - Offset Surfaces - Sweep Surfaces- Multi-Sections Surfaces -Operation on Shape Geometry - Surface Operations.

Total: 45 hours.

Reference(s)

1. CATIA: Introduction to Modeling, Version 5, Release 21, Ascent, Center for Technical Knowledge, 2012.
2. Richard Cozzens, CATIA V5 Workbook Release V5-6R2013, SDC Publications, 2013.

15MEV03 MODELING IN SOLID WORKS

Course Objectives

- To acquire knowledge in sketching and constraining.
- To acquire knowledge in creating solid models using various features of Solidworks.
- To have a clear idea in assembling the system using Solidworks.
- To impart knowledge in drafting and sectioning.
- To impart knowledge in simulation and animations using various features of Solidworks.

Course Outcomes (COs)

1. Make sketching and constraining using Solid Works
2. Model any three dimensional objects by Solid Works.
3. Construct assembly after part modeling using Solid Works.
4. Make sectioning and drafting using Solid works
5. Create simulation and animations using various features of Solidworks.

SKETCHING

Introduction to Solid Works, Working tools and tool box. 2D - Line, spline - Types, Circle, ellipse, Parabola and Arc-Types, Rectangle-types, fillet , chambering, Polygon- Types, text operations, point. 3D - Line, spline- Types, Circle, ellipse, Parabola and Arc-Types, Rectangle-types, fillet , chambering, Polygon- Types, text operations, point, 3D Curves, Dimension -types, Viewing option of the Drawing, 2D Plane, Axis, point and its types. Editing Commands - Trimming, Converting Options.

PART MODELING

Creation –Extrude, Revolve, Swept, Loft boundary options, 3D Plane, Axis &Point Making. Cutting – Extrude cut, Revolve cut, Swept cut, Loft cut, boundary cut, 3D fillet and chamber, Spring Formation, Hole Wizard. Editing Options - Pattern and its types, Rib, Draft, Shell, Wrap, Dome, and Mirror.

ASSEMBLY MODELING

Inserting Part Drawing, Edit Component, insert Component, Mate, Smart Fasteners, Move and Rotating Component, Hide/Show the Component, Assembly features, New Motion Study, Bill of Materials, Explode views, Explode line Sketches, Animation – Options.

DRAFTING

Drawing Layout and Sheet size, drawing insert, Viewing Drawing – Standard and Model, Projected and Auxilary, Section Detail views, Breaking and joining the Object. Annotation- Smart Dimensions, Note, Text insert, Surface Finish symbols, Tolerance indications, Area Fill (Hatch), Markings, Tables of data and Bill of Materials.

PRACTICE SESSION

Automobile Component, Engine components, Machine tool Component Part and Assembly.

Total : 45 Hours.

Reference(s)

1. Dassault Systèmes SolidWorks 2015: Advanced Part Modeling, Dassault Systèmes SolidWorks Corporation, 2014.
2. Paul Tran, SolidWorks 2014 Part I - Basic Tools, SDC Publications, 2013.

15MEV04 CORE JAVA PROGRAMMING

Course Objectives

- To design, write, debug and run Java programs using JDK tools
- To create a programs using decision making statements and looping statements
- To control the abnormal termination of the program using exception handling mechanism
- To develop User Defined packages and interfaces
- To develop Graphical User Interface applications using Applet

Course Outcomes

1. Design a class for real world objects using Java program.
2. Apply control structures to perform decision making and iterations for the simple problems
3. Develop programs using inheritance and exception handling mechanisms in Java
4. Create packages to group the classes for application development.
5. Develop simple GUI application for the real world problems.

JAVA BASICS

Overview- Environment Setup Basic - Syntax - Object & Classes - Basic Data types - Variable Types - Modifier Types

BASIC OPERATORS

Basic Operators - Loop Control - Decision Making -Numbers Methods-Characters Methods-Strings Methods-Arrays-Date & Time

ARRAYS

Methods- Type - Overloading - Exceptions – Try Catch – Multiple try catch – Finally – Inhertiance – Base class –child class – super .

POLYMORPHISM

Polymorphism – Method overriding – Interfaces- creating interfaces – implementing Interfaces-packages

INPUT / OUTPUT METHODS

Files and I/O – Byte Streams – Character Streams - GUI Programs-Java Applets

Total: 45 Hours

Reference(s)

1. Herbert Schildt, Java -Complete Reference, 8th edition Tata McGraw Hill, 2012.
2. Kathy sierra and Bert Bates Head, First Java, second edition, Oreilly, 2010.
3. Harvey M. Deitel and Paul J. Deitel, Java How to Program, Prentice Hall of India, 2010.
4. Gary Cornell and Cay S.Horstmann, Core Java Vol.1 and Vol.2, Sun Microsystems Press, 2008
5. Herbert Schildt, Java(R) 7, A Beginners Guide, Tata McGraw Hill, 2010.

15MEV05 FUNDAMENTALS OF VALUE ENGINEERING

Course Objectives

- To impart knowledge on Value Engineering concepts.
- To familiarize techniques for implementing Value Engineering projects.
- To provide special technique skills for solving problems.
- To understand methods to prepare job plans.
- To bring out salient features out of case studies.

Course Outcomes (COs)

1. Understand the concepts of Value Engineering.
2. Use the techniques in Value Engineering projects.
3. Acquire the skill to handle trivial situations.
4. Prepare job plans.
5. Get lessons out of various case studies.

CONCEPTS

Introduction, Value, Value engineering job plan, Organizing Value Engineering Study, Function, Cost, Work, Benefits.

TECHNIQUES

Value Engineering, Techniques Employed - Brain Storming, Gordon Technique, Feasibility Ranking, Morphological Analysis Technique, Probabilistic Approach, Make Or Buy Technique.

SPECIAL TECHNIQUES

Function-Cost-Worth Analysis, Function Analysis System Technique (FAST), Customer Oriented FAST Diagram, Weighted Evaluation Method, Equal Importance Method, Descending Order Of Importance Method, Evaluation Matrix, Break-Even Analysis, Life Cycle Cost.

VALUE-ENGINEERING JOB PLAN

Selection of Project, Function Phase, Creative Phase, Evaluation Phase, Investigation Phase, Implementation Phase, Audit.

VALUE ENGINEERING CASES

Design Modification of a Tail Lamp Bracket Assembly With Shroud, Modification of the Manufacturing Process of Support Cross Member, Production and Productivity, Cost Reduction, Intensive Cost Search, Vendor Assistance and Expertise.

Total: 45 Hours

Reference(s)

1. Miles, Lawrence D. Techniques of Value Analysis and Engineering, Mc Graw –Hill, 1972.
2. Drucker, Peter F, Management, Tasks, Responsibilities, Practices, Allied Publishers Private Limited, 1975
3. Anil Kumar Mukhopadhyaya, Value Engineering, Response Books, New Delhi, 2003.

15MEV06 TOOL DESIGN AND MANUFACTURING

Course Objectives
- To understand mechanics of metal cutting, materials, heat treatment and tool design.
- To acquire knowledge of principles in work holding devices.
- To understand principles of designing jigs, fixtures and dies for industrial applications.
- To acquire the concept of press tool operation and die making procedures.
- To understand the complex shapes and machining in dies and moulds.

Course Outcomes (COs)
1. Apply metal cutting methods and design the tools.
2. Design work holding devices.
3. Develop jigs and fixtures for conventional and automated manufacturing.
4. Develop press tools and dies for forming of parts
5. Apply micro machining techniques to machine complex shapes

Introduction to tool materials, heat treating, general motions of machine tools – metal cutting principles, mechanics of metal cutting – chip formation – friction and temperature. Cutting tool design. Cutting tool selection, chip formation, tool wear, cutting forces, control of the causes of tool wear and failure.

Work holding principles, general considerations, Locating principles, work piece surfaces, types of location, degrees of freedom, basic locating rules, locational tolerances, fool proofing, basic types of locators, clamping principles, types of clamps, standard components, other elements. Various types of fixtures, designing fixture - developing the preliminary fixture design - computer applications in fixture design and analysis.

Fundamentals of cutting tool design - types and its properties, tool geometry - design of single and multi point cutting tools, design of press working tools, power presses, cutting (shearing) operations, die and punch design, selection of die sets – simple and progressive die - bending die – single and double action die. Introduction – principle of operation –Wire cut EDM – Electrical Discharge Machining (EDM) – Electro Chemical Machining (ECM) in die making applications

Total: 45 Hours

Reference(s)

1. G C Sen and A. Battacharya, Principles of Metal Cutting, New Central Book Agency, India, 1969
2. E. K. Henriksen, Jig and Fixture Design Manual, Industrial Press, New York, 1973
3. C Donaldson, G H Lecain and V C Goold, Tool Design, TMH, 1978
4. J R Paquin and R E Crowley, Die Design Fundamentals, New York-Industrial Press Inc, 2005
5. P K Mishra, Nonconventional Machining, Narosa Publishing House, New Delhi, 2008

15MEV07 CNC PROGRAMMING AND OPERATIONS

Course Objectives
- To understand GD & T, process planning and quality requirements.
- To acquire the knowledge of tooling and work holding devices used in CNC machining.
- To acquaint with CNC machine features and controls.
- To acquire the knowledge of CNC programming and tool path simulation.
- To understand set up procedure of tooling and job in CNC machine and operation of the CNC machines.

Course Outcomes (COs)

1. Apply GD & T and plan the process, operations and quality in CNC machining.
2. Select method of tooling and work holding devices for machining in CNC machining.
3. Operate the CNC controller, load and edit the CNC program.
4. Prepare the CNC program and simulate tool path.
5. Setup the tooling, job in CNC machine and operate the machine.

Emphasis on tooling and work holding requirements, cutting tool materials (H.S.S., carbide, ceramic and diamond) selection. Introduction to process planning, quality control charting - Statistical Process Control (SPC) techniques and geometric dimensioning and tolerancing (GD&T).
Introduction to machining technology, Computerized Numerical Control (CNC), Familiarization of control panel, machine tool set-up operation and programming. Apply accident prevention practices and procedures, work-holding, tooling, machine set-up and operation, program proof-out and quality control. Set-up, align, and zero-out work holding devices, tooling adapters, and tool holders.
Perform dry/first/production runs and inspections, adjusting various register values to assure tool qualification, and part dimensionality. Communicate and apply piece-part set-up and inspection procedures. Analyze program problems and perform basic editing operations via Manual Data Input (MDI) operations, edit canned cycle functions utilizing calculations / data, Demonstrate upload/downloading and other Distributed Networked Computer (DNC) functions on a shop floor computer network. Part program preparation of turning, facing and taper turning cycles. Simulation and machine operations.

Total: 45 Hours

Reference(s)

1. P. Radhakrishnan, Computer Numerical Control Machines, New Central Book Agency, India, 2004.
2. HMT, Mechatronics, Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi, 2010.
3. Hillwig, Lenzi, Precision Machining Technology: Workbook and Projects Manual Cengage Learning (ISBN 9781285444550), 2015.
4. Richard A. Gizelbach, CNC Machining Fundamentals and Applications, Goodheart-Wilcox Company, Inc. 2009.
5. T.K. Kundra, P.N. Rao and N.K. Tiwari, CNC and Computer Aided Manufacturing, Tata McGraw Hill, Delhi, 1991.
6. M. Fitzpatric, Machining and CNC Technology, McGraw-Hill College, 2004.

15MEV08 WELDING INSPECTION AND TESTING

Course Objectives

- To provide knowledge on the different welding process, Selection of power source and Electrodes for metallic materials.
- To impart knowledge on the welding design for various metal structures .
- To demonstrate the response of weld material to mechanical loading through mechanical property correlation.
- To Acquiring the necessary background for understanding Nondestructive testing process
- To recall welding standards and codes.

Course Outcomes (COs)

1. Select suitable welding process, power source, Electrode for different materials.
2. Acquire the knowledge of weld design and weld geometry.
3. Evaluate weld metal property against fracture in real-time applications.
4. Acquire the knowledge of different nondestructive testing inspection process.
5. Attain knowledge of welding standards and codes.

Welding and Allied Process

Arc welding power source - Gas welding and cutting, Fusion welding – Introduction of Shielded Metal Arc welding -Gas Tungsten Arc welding - Gas Metal Arc welding - Submerged Arc welding. Weldability of carbon steel and low alloy steel- Heat Treatment of weldments.

Weld Design, Codes & Standards

Welding symbols-Welding design - Selection of joint - Electrode Designation & Types -. Weld defects- Surface and subsurface defects –Distortion and Residual Stress– Causes of weld defect & Remedial action. Welding Procedure Specification- ASME codes for Consumables and welding position - Safety in welding.

Destructive Testing

Metal Properties - Destructive Testing as per ASTM standards- Tensile Tests, Impact Tests, Hard ness Test -Bend Tests. Weld Microstructure study, Fractography-SEM &TEM,

NDT- Surface & Subsurface Tecchniques

Concepts of Non-Destructive testing (NDT) - Visual or Optical Testing -Liquid Penetrant Testing (LPT) Principles - Preparation of test materials - Advantages and limitations - Fluorescent penetrant test. Magnetic Particle Testing (MPT) Principles, applications - Dry particle technique and Wet fluorescent particle technique, Eddy Current Testing (ECT)

NDT- Ultrasonic Testing & Radiography Testing

Ultrasonic Testing (UT) Principle, Couplants, Probes - Inspection methods-Pulse echo, Transmission and Phased Array techniques, Angle beam inspection of welds, Calibration of ASTM Test blocks (International Institute of Welding IIW) reference blocks. Radiographic testing (RT) Principle, Sources of X-rays and Gamma rays and their characteristics, Safety in radiography, Applications.

Total: 45 Hours

Reference(s)

1. Howard.B. Cary, Modern Welding Technology Fifth Edison, Prentice Hall, Ohio-2005
2. R. S. Parmer, Welding Processes & Technology, Khanna Publishers, New Delhi, 2008.
3. Mechanical Testing &Evaluation, Volume 8, American Society for Metals, 2005.
4. Baldev Raj, Jayakumar T, Thavasimuthu M, Practical Non-Destructive Testing, Narosa Publishing, 1997
5. ASNT Hand Book, Non Destructive Testing 4Th Edison, vol-10, 2006
6. www.weldingtypes.net.

15MEV09 PUMP INSPECTION AND TESTING

Course Objectives

- To gain knowledge on standard industrial practice of pump inspection and testing.
- To understand various industrial requirements on pump inspection.
- To provide knowledge about various test procedures, their limitations and its corresponding acceptance criterion pertained to pump inspection.
- To obtain knowledge on the industrial pump testing procedures.
- To provide knowledge to analyze the characteristic curves of pump with respect to the client requirements.

Course Outcome (CO's):

1. Understand the basic requirements in the pump inspection and testing.
2. Demonstrate practical limitations and acceptance criterion for case specific inspection and testing
3. Identify shop test requirements based on the characteristic to be tested.
4. Understand the procedure to be followed for various pump test conditions.
5. Analyze the performance graphs to identify the pump performance in order to meet the client requirement.

INTRODUCTION
Need for pump inspection and testing – Stages – Reference documents and their acceptance criterion – Responsibility classification – Requirement categorization – Inspection requirements – Shop tests requirements – Inspection and testing checklist – Shop test procedure.

INSPECTION REQUIREMENTS
Material identification as per standards – Heat test for materials – Material of Construction classification – Casting defect checks – Mill test – NDT – Heat treatment test – Welding review – Casting repair classification – Procedure for major repairs.

SHOP TEST REQUIREMENTS
Hydrostatic test – Pressure parts – Cooling passage – Chloride content – Mechanical seals – Unit integrity – Vibration level – alignment – Pump performance – NPSH.

PERFORMANCE TESTING
Testing configuration – shop test stand limitations – Test equipment and instrumentation – Test stand setup – Recorded test data list – Performance curve – Acceptance criteria check.

NPSH TESTING
Testing configuration – flow point graphical representation – Recorded test data list – NPSH testing procedure – NPSH test log – NPSH curve.

Total: 45Hours

Reference(s)

1. American Petroleum Institute (API) 610 – Centrifugal pumps for general refinery services.
2. American Petroleum Institute (API) 674 – Positive displacement pumps for general refinery services.
3. ANSI/ASME Standard B73.1M – Specification for horizontal end suction centrifugal pumps for chemical process.
4. ANSI/ASME Standard B73.2M – Specification for vertical centrifugal pumps for chemical process.
5. ANSI/HI 6.6 – Reciprocating pump tests
6. ANSI/HI 5.1-5.6 – Sealless rotodynamic pumps for nomenclature, definitions, application, operation and test.

15MEV10 PRODUCT LIFE CYCLE MANAGEMENT

Course Objectives

- To understanding PLM Concepts
- To understand the methodologies and application of virtual 3D CAD product design in functioning PLM environments.

- To manage the product related documents in PLM environments.
- To understand the methodologies and application of change management and relational 3D CAD product design within the confines of a Product Data Management (PDM) system in PLM environments.
- To enable product development team members to fully participate in the process.

Course Outcomes (COs)

- Understand PLM Environment.
- Interact and have working experience in PLM Processes.
- Understand the Need of Engineering Change Management.
- Play the various roles in a typical ECM Process followed in Industry.
- Understand the how New Product Development process works.
- Play the various roles in a typical NPD Process followed in Industry.

INTRODUCTION

Introduction to PLM – PLM Environments- Role of 3D Solid Modelling in PLM- Design Process – Review & Release Management- Revision and Version – Document Management- Bill of Material- Relationship explorer- collaboration.

ENGINEERING CHANGE MANAGEMENT

Introduction to Engineering Change Management process- Impact of ECM- Typical steps followed – Different roles in an ECM Process- Participating in an ECM process – Problem Report – Engineering Change Request – Engineering Change Notice – Audit process- Change release process.

INTRODUCTION TO NEW PRODUCT DEVELOPMENT

NPD process – what's involved - Step 1: New product strategy- Step 2: Idea generation and screening- Step 3: Concept development and testing - Step 4: Business analysis - Step 5: Product development and testing - Step 6: Commercialisation – Collaboration- Grant chart – Discussion

Total: 45 Hours

References

1. T. Karl, Ulrich and D. Steven, and Eppinger, Product Design and Development, mcgraw Hill 2009.
2. K. Otto, K. Wood, Product Design, Pearson, 2001.
3. David Bed worth, Mark Henderson and Phillip Wolfe, Computer Integrated Design and Manufacturing, McGraw Hill Inc, 2009.
4. T. Quatrain, Visual Modeling with Rational Rose and UML, Addison Wesley, 2005.
5. Wind-Chill R5.0 Reference Manuals, 2004.

15MEV11 SHEET METAL TOOLS - DESIGN AND MANUFACTURING PROCESS

Course Objectives

- To understand mechanics of metal cutting, materials, heat treatment and tool design
- To acquire knowledge of principles in work holding devices.
- To understand principles of designing jigs, fixtures and dies for industrial applications.
- To acquire the concept of press tool operation and die making procedures.
- To understand the complex shapes and machining in dies and moulds.

Course Outcomes (COs)

1. Apply metal cutting methods and design the tools.
2. Design work holding devices.
3. Develop jigs and fixtures for conventional and automated manufacturing.
4. Develop press tools and dies for forming of parts
5. Apply micro machining techniques to machine complex shapes

UNIT I **10 Hours**

SHEET METAL TOOL DESIGN AND MANUFACTURING PROCESS

Introduction to tool materials, heat treating, general motions of machine tools metal cutting principles, mechanics of metal cutting chip formation friction and temperature. Cutting tool design. Cutting tool selection, chip formation, tool wear, cutting forces, control of the causes of tool wear and failure.

UNIT II **35 Hours**

SHEET METAL TOOL DESIGN AND MANUFACTURING PROCESS

Work holding principles, general considerations, locating principles, work piece surfaces, types of location, degrees of freedom, basic locating rules, locational tolerances, fool proofing, basic types of locators, clamping principles, types of clamps, standard components, other elements. Various types of fixtures, designing fixture - developing the preliminary fixture design - computer applications in fixture design and analysis.

Fundamentals of cutting tool design - types and its properties, tool geometry - design of single and multi point cutting tools, design of press working tools, power presses, cutting (shearing) operations, die and punch design, selection of die sets simple and progressive die - bending die single and double action die. Introduction principle of operation -Wire cut EDM Electrical Discharge Machining (EDM) Electro Chemical Machining (ECM) in die making applications

Total: 45 Hours

Reference(s)

1. G C Sen and A. Battacharya, Principles of Metal Cutting, New Central Book Agency, India, 1969
2. E. K. Henriksen, Jig and Fixture Design Manual, Industrial Press, New York, 1973
3. C Donaldson, G H Lecain and V C Goold, Tool Design, TMH, 1978
4. J R Paquin and R E Crowley, Die Design Fundamentals, New York-Industrial Press Inc, 2005
5. P K Mishra, Nonconventional Machining, Narosa Publishing House, New Delhi, 2008

15MEV12 3D VIA COMPOSER

Course Objectives

- To describe the importance of technical communication and 3D Via composer
- To provide knowledge on various interfaces
- To explain the assembly, views, pane and collaborative actors
- To impart knowledge visibility, digger tool and view mode
- To explicate the animation of a 3D model and publication of technical document

Course Outcomes (COs)

1. Understand the importance of technical communication and 3D Via composer.
2. Realize the available interfaces of 3D Via composer.
3. Create different frames of 3D models using assembly, views, pane and collaborative actors.
4. Make various views by using visibility, digger tool and view mode.
5. Understand the steps to be followed to create the animation of 3D model and publication of the technical document.

UNIT I **12 Hours**

INTRODUCTION TO 3D VIA

Technical communication - Importance, Difficulties, Uses, Applications, Difference between a CAD model and marketing image software. 3D Via Composer - Uses, Applications, End users. Pre-requisites - Engineering Graphics, Machine Drawing, 3D Part modeling, Assembly details, Importance of Sectional Views and Bill of Material, Animation.

UNIT II **9 Hours**

INTERFACES OF 3D VIA COMPOSER

Seven main panels, File imports, Viewport, Actor - Geometry actors and Collaborative actors, View mode and animation mode, Compass, Active pan, Ribbon menu, Quick access tool bar, Timeline, Mouse operated commands - Zoom in/out, Rotate, Pan. Navigation tool bar - camera alignment, Select actors - Select by Color, Instances, Inside/Across sphere, etc. Zoom mode, Viewport reframe, Keyboard controls. Projection views - Perspective view and Isometric view.

UNIT III **8 Hours**

ASSEMBLY, VIEWS PAN AND COLLABORATIVE ACTORS

Assembly - Selection of required actors, Creation of selection set. Views - Capturing views, Create viewport position, Update views. Collaborative Actors - Annotations, Callouts, Cameras, Coordinate systems, cutting planes, Magnetic lines. Transformation tools - Translate, Rotate, Explode, Align.

UNIT IV **8 Hours**

VISIBILITY, DIGGER TOOL AND VIEW MODE

Visibility tools - Show/hide the geometry, Invert visibility, Unghost. Digger tool - Digger Radius, Percentage drag, display/hide tool, Onion skin, X-Ray, Clipping plane, Zoom, pointer, Light change, picture capturing, lock/unlock depth direction, center change. View mode - Smooth, shaded, technical, bounding boxes. Ground options - Shadow, mirror, grid.

UNIT V **8 Hours**

ANIMATION AND PUBLISHING OF TECHNICAL DOCUMENT

Animations - Key frame, Animating the position and property changes, path selection, Compound animations, Kinematic animations. Publishing Panel Views, Bill of material, Technical illustration, High resolution image. Project Publishing.

Total: 45 Hours

Reference(s)

1. 3D Via composer V6R2013 Fact sheet (Software quick view), Dassault Systems, 2012.
2. Richard Cozzens, CATIA V5 Workbook Release V5-6R2013, SDC Publications, 2013.
3. Website: www.3ds.com (Highlights the software platform, uses and applications)
4. Webinar Video: https://www.youtube.com/watch?v=oap7M1nHBcU

15MEB01 ENGINEERING MECHANICS-STATICS

Course Objectives

- To familiarise on various methods of adding and resolving various force systems in a real world environment.
- To provide knowledge on understanding the effects of forces on a point and at a distance and to arrive at equivalent systems from the given force system.
- To provide knowledge on various support conditions of a rigid body and deciding a support system for given condition.
- To expose students with impact of geometries of load bearing systems and make them calculate moment of inertia of various cross sections.
- To make students understand concepts of friction under various applications and make them calculate frictional forces induced.

Course Outcomes (COs)

1. Draw a free body diagram from the given real world system and add or subtract or resolve the forces involved in the system.
2. Calculate the moment created by the applied force with reference to any reference in a three dimensional space.
3. Determine the appropriate support system for the given real world system by calculating the reactions generated.
4. Suggest suitable cross section or geometry for a load bearing support to prevent it from collapsing due to bending.
5. Calculate the frictional force involved in various real world systems.

UNIT I **5 Hours**

BASIC CONCEPTS AND FORCE SYSTEM

Introduction to mechanics - idealization of mechanics - laws of mechanics - principle of transmissibility - vector - addition, subtraction and product. Force- types - system of forces - resultant forces - composition of forces - resolution of force-free body diagram for real world systems.

UNIT II **6 Hour**

STATICS OF PARTICLES AND FORCE SYSTEM

Equilibrium of particle in space, moment of couple-equilibrant Moment about point and specific axis- moment at couple- simplification of force and couple systems

UNIT III **7 Hours**

STATICS OF RIGID BODIES

Equilibrium of rigid bodies in two and three dimensions - beams - types of loads, supports and their reactions Two and three force Members-Static determinacy.

UNIT IV **7 Hours**

PROPERTIES OF SURFACES AND SOLIDS

Determination of centroid of areas, volumes and mass - Pappus and Guldinus theorems - moment of inertia of plane and areas Parallel axis theorem radius of gyration of area- product of inertia- mass moment of inertia.

UNIT V **5 Hours**

FRICTION

Introduction - mechanism of friction-types -laws of friction - friction on horizontal and inclined planes, ladder and wedge friction - rolling resistance.

FOR FURTHER READING

Moment of Inertia of flywheel - Internal force of a member - Equilibrium of rigid bodies in three dimensions: Ball and socket joint.

Total: 30 Hours

Reference(s)

1. F.P. Beer, and Jr. E.R Johnston, Vector Mechanics for Engineers - Statics and Dynamics, Tata McGraw-Hill Publishing Company, New Delhi, 2007.
2. N.H.Dubey, Engineering Mechanics- Statics and Dynamics, Tata McGraw-Hill Publishing Company, New Delhi, 2013.
3. Irving H. Shames, Engineering Mechanics - Statics and Dynamics, Pearson Education Asia Pvt. Ltd., 2006.
4. R.C.Hibbeller, Engineering Mechanics: Combined Statics & Dynamics, Prentice Hall, 2009.
5. D. P. Sharma, Engineering Mechanics, Dorling Kindersley (India) Pvt. Ltd., New Delhi, 2010.
6. S. Rajasekaran and G. Sankara subramanian, Fundamentals of Engineering Mechanics, Vikas Publishing House Pvt. Ltd., New Delhi, 2005.

15MEB02 ENGINEERING GRAPHICS

Course Objectives

- To learn conventions and use of drawing tools in making engineering drawings.
- To understand the fundamentals of points, line, plane solid and perspective projection drawings.
- To understand the fundamental concepts of orthographic projections and section of solids.
- To impart the basic concepts of isometric projections and development of surfaces through simple examples.
- To provide the practice for converting simple drawing into the computer aided drawing.

Course Outcomes (COs)

1. Recognize the conventions and apply dimensioning concepts while drafting simple objects.
2. Draw simple drawings using points, line, plane solid and perspective projection concepts.
3. Draw the orthographic and section of solid drawings from three dimensional objects.
4. Draw the isometric objects and development of surfaces from simple engineering parts.
5. Draw simple engineering drawings using computer aided drawing tool.

UNIT I **12 Hours**

BASIC DRAWINGS & PROJECTIONS

Importance - conventions - ISO and BIS - drawing tools and drawing sheets - lettering, numbering, dimensioning, lines and symbols. Principles-first and third angle projections - Points - first angle projection of points Straight lines - parallel, perpendicular and inclined to one reference plane-Solid - cylinders, pyramids, prisms and cones- perspective projections.

UNIT II **8 Hours**

ORTHOGRAPHIC PROJECTIONS AND SECTION OF SOLIDS

Orthographic Projections - concepts - front view, top view and side view of simple solids -Section of Solids-simple illustrations.

UNIT III **10 Hours**

ISOMETRIC PROJECTIONS AND DEVELOPMENT OF SURFACES

Importance- orthographic to isometric projection- simple and truncated solids. Development of surfaces - cylinders, pyramids, prisms, cones and simple truncated objects.

Total: 30 Hours

Reference(s)

1. K Venugpoal, Engineering Drawing and Graphics, Third edition, New Age International, 2005.
2. Basant Agrawal, Mechanical drawing, Tata McGraw-Hill Education, 2008.
3. Engineering Drawing Practice for Schools & Colleges, BUREAU OF INDIAN STANDARDS-SP46, 2008.
4. N. D. Bhatt and V. M. Panchal, Engineering Drawing, Charotar Publishing House Pvt. Limited, 2008.
5. K.V.Natarajan, A Text Book of Engineering Graphics, Dhanalakshmi Publishers, 2013.
6. George Omura, Brian C. Benton, Mastering AutoCAD 2015 and AutoCAD LT 2015: Autodesk Official Press, Wiley Publisher, 2015.