B.E. (Mechanical Engineering)

2018 Regulations, Curriculum & Syllabi

Stay Ahead

BANNARI AMMAN INSTITUTE OF TECHNOLOGY
An Autonomous Institution Affiliated to Anna University - Chennai • Approved by AICTE • Accredited by NAAC with "A+" Grade
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BANNARI AMMAN INSTITUTE OF TECHNOLOGY, SATHYAMANGALAM
REGULATIONS 2018
(CHOICE BASED CREDIT SYSTEM)

(Common to all B.E./B.Tech. Degree Programmes)

Regulation 2018 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 2018 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 2018-2019 for Regular admission (Academic year 2019-2020 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. Electronics and Communication Engineering
vii. Electrical and Electronics Engineering
viii. Electronics and Instrumentation Engineering
ix. Mechanical Engineering
x. Mechatronics

B. Tech. Programmes

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

3. STRUCTURE OF THE PROGRAMME

3.1 Every programme shall have a distinct curriculum with syllabi consisting of theory, laboratory, project, soft-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** courses including Engineering Graphics, Engineering Practices, Basics of Electrical, Electronics, Civil, Mechanical Engineering, Engineering Mechanics and Computer Programming.

(iii) **Humanities and Social Science** courses including Language Courses, Management Courses, Soft Skills and Professional Ethics.

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

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

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 based on the following

Contact period per week	Credits
1 Lecture / 1 Tutorial period	1
2 laboratory Periods (Laboratory / Seminar / Project Work / etc.)	1

3.3 All the B.E. / B.Tech. Students will study Communicative English I during the First Semester. In the Second Semester, they will be divided into two streams based on their English language proficiency assessed in the Continuous Assessment during semester I, in which the upper segment will be provided an option to enroll and study Communicative English II / German / Japanese / French / Chinese / Hindi while the lower segment will study Communicative English II.

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) from 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 one and subject to a maximum of three courses as open elective from the list of electives of the branch / branches other than his / her branch of specialisation, if he/she satisfies the prerequisite for that particular course.

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 for the same batch of the students and a maximum batch size for a given course shall not exceed 40. In 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 SGPA/CGPA).

3.7 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.

3.8 A Student may be permitted to credit only one online course with the approval of the Departmental Consultative Committee constituted by the Head of the Department, subject to a maximum of three credits. The student needs to obtain certification or credit to become eligible for writing the End Semester Examination to be conducted by the CoE. A student can get exemption for a maximum of 3 credits during the entire programme (in lieu of Core elective or Open elective). The Head of the Department may identify a faculty member as coordinator for the course, who is responsible for the evaluation process. The course shall be evaluated through the End Semester Examination only. The evaluation methodology may be decided by the course faculty coordinator.

3.9 **Industrial Training / Internship**

The students may undergo Industrial training / Internship optionally for a period as specified in the table during summer / winter vacation and the credits earned will be indicated in the Mark Sheet. If the student earns three credits in Industrial Training / Internship, the student may drop one Professional Elective. In such cases, Industrial Training / Internship need to be undergone continuously from one organization only. However, if the number of credits earned is 1 or 2, these credits shall not be considered for classification of the degree. The students may also undergo Internship at Research organization / University (after due approval from the Department Consultative Committee) during summer / winter vacation, in lieu of Industrial training.

Duration of Training / Internship	Credits
2 Weeks	1
1 Month	2
2 Months	3

3.10 Socially Relevant Projects

A Student may be permitted to carry out a socially relevant project during semester II to semester VI in consultation with the Faculty Guide and submit the project report, in the prescribed format, at the end of the Semester for the valuation.

On successful completion of socially relevant project work, one credit will be indicated in the grade sheet (Additional credits), but these credits will not be considered for computing the CGPA.

4. VALUE ADDED COURSES

A Student can opt for the Value Added Courses offered by the various Department / Centres 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. 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 case, if a student fails to register in 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. The total number of credits that a student can add or drop is limited to 8, subject to a maximum of 2 courses in a given Semester. In such cases, the attendance requirement as stated in Clause 7 is mandatory.

6.4.3 The student shall register Project work I in semester VII and Project work II in semester VIII 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, he/she 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 continuous assessment courses (Laboratory/ Project work / Seminar or any other HSS/EEC courses) 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.

6.5.8 If a student fails to secure a pass in any theory courses (including elective) he/she is given a maximum of three arrear attempts to complete the courses. If the student still fails to secure a pass, he/she shall register for the same when offered next and repeat the course.

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 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 If a student has shortage of attendance in all the registered courses, he/she would not be permitted to move to the higher semester and has to repeat the current semester in the subsequent year.

7.6 In the case of reappearance (Arrear) registration for a course, the attendance requirement as mentioned in Clauses 7.1 - 7.3 is not applicable. However, the student has to register for examination in that course by paying the prescribed fee.

7.7 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. The Faculty Advisor also discusses with or informs the parents about the progress / performance of the students concerned.

The responsibilities of the faculty advisor shall be:

- To inform the students about the various facilities and activities available to enhance the student's curricular and co-curricular activities.
- To guide student enrollment and registration of the courses.
- To authorize the final registration of the courses at the beginning of each semester.
- To monitor the academic and general performance of the students including attendance and to counsel them accordingly.

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 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 laboratory 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.

10.4 For the End Semester examinations, both theory and 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 cum Evaluation committee of the Institute.

11. PASSING REQUIREMENTS AND PROVISIONS

11.1 The Passing requirement for a student in a course is determined based on the marks obtained both in Continuous Assessment and End Semester Examinations. If the student gets <50% of marks in End Semester Examination, then the student will be awarded only RA (Reappearance) grade.

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 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'.

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 If a candidate fails in the seventh semester examinations of Project work I, he/she has to resubmit the Project Report within 30 days from the date of declaration of the results. If he / she fails in the End semester examination of Project work II, he/she shall resubmit the Project Report within 60 days from the date of declaration of the results. The resubmission of the project report and the subsequent viva-voce examination will be considered as reappearance with payment of exam fee. In case a student fails in the resubmission of a project report and subsequent viva-voce examination, the student shall register for the course again, when offered next.

11.3 The passing requirement for the courses which are assessed only through continuous assessment (Laboratory and EEC courses except project work), shall be fixed as minimum 50% and the remaining grades are decided as per clause 12.4. If a candidate fails in EEC courses (Except Project work), he/she has to register and repeat the course within 30 days from the date of declaration of the results. In case a student fails to register within 30 days, he/she shall register for the course again, when offered next.

11.4 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	172	135
Agricultural Engineering	172	134
Automobile Engineering	170	133
Civil Engineering	171	133
Computer Science and Engineering	171	133
Electronics and Communication Engineering	172	131
Electrical and Electronics Engineering	170	131
Electronics and Instrumentation Engineering	170	131
Mechanical Engineering	170	131
Mechatronics	170	132
B.Tech. Programmes		
Biotechnology	172	134
Fashion Technology	172	134
Food Technology	170	132
Information Technology	170	132
Textile Technology	171	133

11.5 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 Autonomous institutions to Bannari Amman Institution of Technology or rejoins from previous regulation to this regulation.

11.6 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 of 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 12.4), while the Letter Grade is an index of the performance of a student in a said course.

12.3 Condition for Relative Grading

The minimum number of students for applying relative grading system is 30. If the students' strength is less than 30 then absolute grading system will be applied. The relative grading system shall not be applied for laboratory and EEC courses.

12.4 The performance of a student will be reported using Letter Grades in absolute grading, each carrying certain points as detailed below: In relative grading, grades will be decided by the faculty concerned. A student who earns a minimum of 6 grade points in a course is declared to have successfully passed the course.

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.

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

$$SGPA/CGPA = \frac{\sum_{1}^{n} C_i * g_i}{\sum_{1}^{n} C_i}$$

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 SGPA and all the semesters, under consideration, in the case CGPA.

12.6 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).

12.7 For the non credit courses grades shall be indicated as given in the Clause 16 and shall not be counted for the computation of SGPA/CGPA.

For the Co-curricular activities such as NCC / NSS / NSO / YRC, a satisfactory / not satisfactory grading will appear in the mark sheet. Every student shall put in a minimum of 75% attendance in the training and attend the camp compulsorily. The training and camp shall be completed during the first year of the programme. However, for valid reasons, the Head of the Institution may permit a student to complete this requirement in the second year. A satisfactory grade in the above co-curricular activities is compulsory for the award of degree.

12.8 **Revaluation:** A student, who seeks the re-valuation of the answer script, is directed to apply through proper application to the Controller of Examinations in the prescribed format through the Head of the Department. 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.

12.9 **Supplementary Examinations**: If a student fails to secure a pass in theory course(s) of VIII semester examination, he/she is eligible to appear for a one time Supplementary Examination which shall be conducted at the end of VIII semester, for the subjects of VIII semester alone within 30 days from the date of declaration of the results.

12.10 **Eligibility for the Award of Degree**

A student shall be declared to be eligible for the award of the B.E. / B.Tech. Degree provided the student has

i. Successfully gained the required number of total credits as specified in the curriculum corresponding to the student's programme within the stipulated time.
ii. Successfully completed the course requirements, appeared for the End-Semester examinations and passed all the courses prescribed in all the 8 semesters within a maximum period of 7 years reckoned from the commencement of the first semester to which the candidate was admitted.
iii. Successfully completed the NCC / NSS / NSO / YRC / Extra-curricular/ Co-curricular requirements.
iv. No disciplinary action is pending against the student.
v. The award of Degree must have been approved by the Syndicate of the University.

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 satisfies the following conditions shall be declared to have passed the examination in **First class with Distinction**:

- Should have passed the examination in all the courses of all the eight semesters (six semesters for lateral entry students) in the student's First Appearance within five years, which includes authorized break of study of one year. Withdrawal from examination (vide Clause 15) will not be considered as an appearance.
- Should have secured a CGPA of **not less than 8.50**
- Should **NOT** have been prevented from writing end semester examination due to lack of attendance in any of the courses.

13.2 **First Class**: A student who satisfies the following conditions shall be declared to have passed the examination in **First class**:

- Should have passed the examination in all the courses of all eight semesters (six semesters for lateral entry students) within five years, which includes one year of authorized break of study (if availed) or prevention from writing the End Semester Examination due to lack of attendance (if applicable).
- Should have secured a CGPA of **not less than 7.00**

13.3 **Second Class**: All other students (not covered in clauses 13.1 and 13.2) who qualify for the award of the degree shall be declared to have passed the examination in **Second Class.**

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 it is made within TEN working days before the commencement of the end semester examination in that course or courses and also recommended by the Head of the Department.

14.3 Notwithstanding the requirement of mandatory TEN working days' notice, applications for withdrawal for special cases under extraordinary conditions will be considered on the merit of the case.

14.4 If a student withdraws a course or courses from writing end semester examinations, he/she shall register the same in the subsequent semester and write the end semester examination(s).

14.5 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.

14.6 Withdrawal is permitted for the end semester examinations in the final semester, only if the period of study of the student concerned does not exceed 5 years as per clause 13.1 & 13.2.

15. AUTHORIZED BREAK OF STUDY FROM A PROGRAMME

15.1 A student is permitted to go on break of study for a fixed period of one year as a single break in the entire course of study.

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 / prevention due to lack of attendance, shall be governed by the Curriculum and Regulations in force at the time of rejoining. The students rejoining in new Regulations shall apply to the Dean Academics in the prescribed format through the Head of the Department at the beginning of the readmitted semester itself for prescribing additional/equivalent courses, if any, from any semester of the regulations in-force, so as to bridge the curriculum in-force and the old curriculum.

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 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:

I	**THEORY COURSES**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	Periodical Test I (10)	
	Periodical Test II (10)	
	Innovative Practices (30)	
	End Semester Examination	**50**
	Total Marks	**100**
II	**THEORY COURSES WITH LAB COMPONENT**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	Periodical Test I (10)	
	Periodical Test II (10)	
	Innovative Practices (30)	
	(Laboratory Assessment & Report)	
	End Semester Examination (QP pattern as per (I))	**50**
	Total Marks	**100**
III	**LABORATORY COURSES**	**Marks**
	Continuous Assessment	**100**
	Distribution of marks for Continuous Assessment:	
	Conduct of Experiment	
	i. Preparation (20)	
	ii. Experiment and Analysis of Results (20)	
	iii. Record (10)	
	Test – Cycle I (25)	
	Test – Cycle II (25)	
	Total Marks	**100**
IV	**PROJECT WORK I**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	<u>Review I</u>	
	Literature Survey (5)	
	Identification of topic and Justification (5)	
	Work plan (10)	
	<u>Review II</u>	
	Approach & Results (15)	
	Conclusion (15)	

	End Semester Examination	**50**
	Report[@] (20)	
	Presentation (20)	
	Viva voce (10)	
	Total Marks	**100**
V	**PROJECT WORK II**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	<u>*Review I*</u>	
	Progress (10)	
	<u>*Review II*</u>	
	Approach & Results (10)	
	<u>*Review III*</u>	
	Conclusion & Final Presentation (10)	
	Report (15)	
	Publication of Paper in Conferences / Journals (5)	
	End Semester Examination	
	Presentation (30)	**50**
	Viva voce (20)	
	Total Marks	**100**
VI	**LANGUAGE ELECTIVE**	**Marks**
	(CONTINUOUS ASSESSMENT ONLY)	
	<u>Test 1</u>	
	Listening (5)	
	Speaking (10)	**25**
	Reading (5)	
	Writing (5)	
	<u>Test 2</u>	
	Listening (5)	
	Speaking (10)	**25**
	Reading (5)	
	Writing (5)	
	Oral Exam	**50**
	Total Marks	**100**
VII	**ONE-CREDIT COURSE**	**Marks**
	(CONTINUOUS ASSESSMENT ONLY)	
	Test I	**50**
	Quiz/ Assignment	**50**
	Total Marks	**100**

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

VIII	**INDUSTRIAL TRAINING/ INTERNSHIP (CONTINUOUS ASSESSMENT ONLY)**	**Marks**
	Assessment by Industry	**30**
	Viva-voce	**20**
	Presentation	**30**
	Case Study / Report	**20**
	Total Marks	**100**

IX	**SOFT SKILLS (CONTINUOUS ASSESSMENT ONLY)**	**Marks**
	Test I	**25**
	Test II	**25**
	Final Examination	**50**
	Total Marks	**100**
	Grades (Excellent / Good / Satisfactory)	

X	**VALUE ADDED / CERTIFICATE COURSES (CONTINUOUS ASSESSMENT ONLY)**	**Marks**
	Test I	**25**
	Test II	**25**
	Final Evaluation / Test	**50**
	Total Marks	**100**
	Grades (Excellent / Good / Satisfactory)	

XI	**ENGINEERING GRAPHICS**	**Marks**
	Continuous Assessment	**100**
	Distribution of marks for Continuous Assessment:	
	Exercise (Minimum 10 Exercises/Modelling)	**60**
	Model Examination	**40**
	Total Marks	**100**

Optional Test: *A student becomes eligible to appear for an 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

In order to provide the experiential learning to the students, Head of the Department shall take efforts to arrange at least two industrial visits / field visits. 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. 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.

VISION OF THE DEPARTMENT

To excel in Mechanical Engineering education by imparting industry-relevant knowledge and skills, implementing effective teaching methodologies, nurturing innovation, and contributing to societal and entrepreneurial development.

MISSION OF THE DEPARTMENT

- To achieve a dynamic and inclusive learning environment through teaching pedagogies and continuous improvement of teaching and learning process.
- To enhance the knowledge and skills of students and faculty through research, industry collaboration, and continuous learning.
- To produce competent and innovative engineers capable of meeting the evolving needs of industry, society, and entrepreneurial development.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

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

I. Apply foundational knowledge and skills to effectively solve real-world problems, showcasing advanced problem-solving abilities, strong communication, and the ability to continuously upgrade expertise in response to emerging technologies

II. Innovate and implement engineering solutions through research and development to fulfill industrial and societal requirements

III. Assist in developing innovative thinking, engaging in entrepreneurial ventures or pursuing higher studies, upholding ethical practices, and contributing to a sustainable and healthy society

PROGRAM OUTCOMES (PO)

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **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.
3. **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.
4. **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.
5. **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.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **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.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

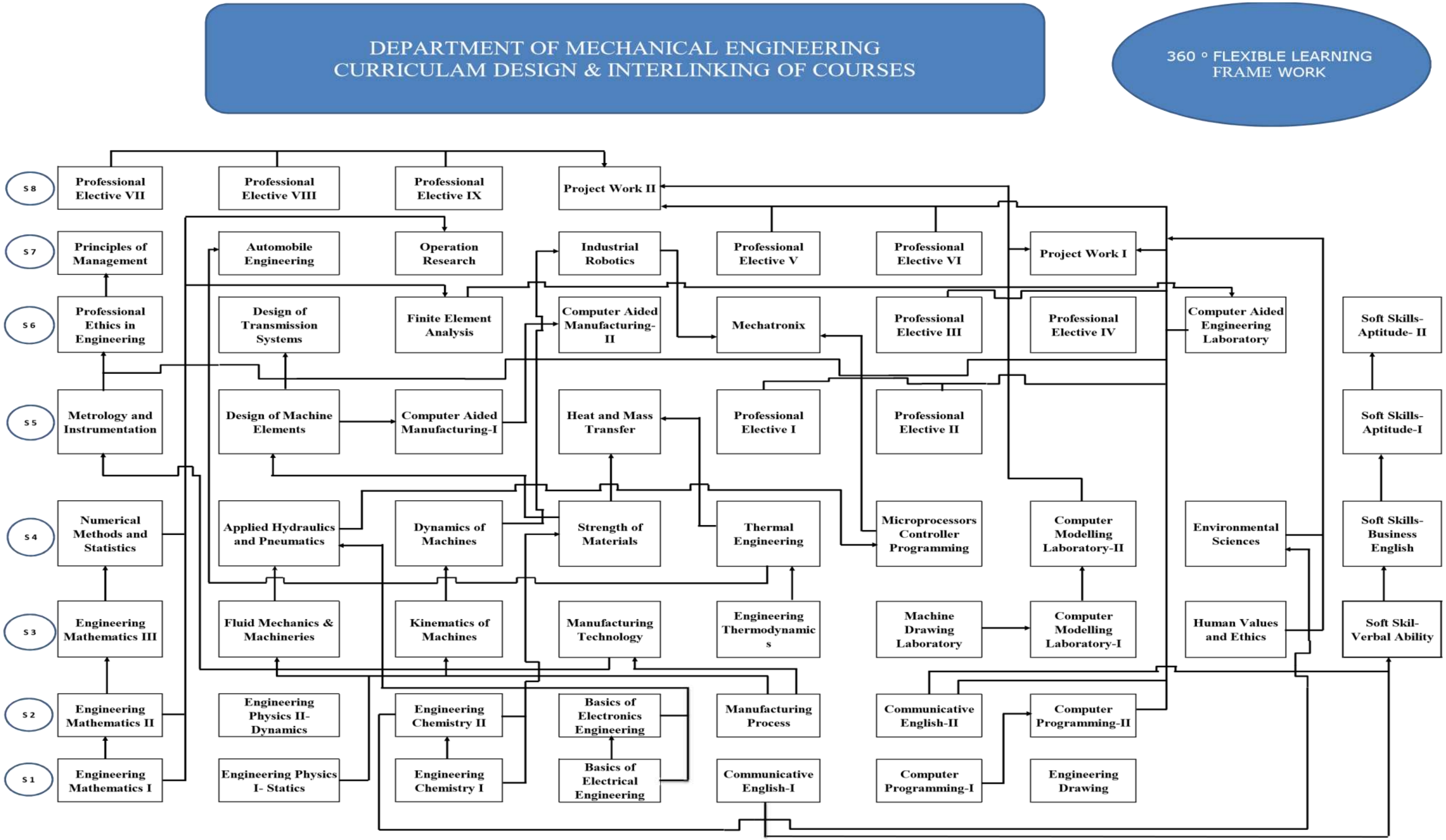
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

1. Design, analyse and evaluate the performance of mechanical systems.
2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost
3. Address all the fluid flow and energy transfer related problems of mechanical systems.

CORRELATION OF PEOs WITH POs AND PSOs

PEOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
PEO I	X	X	X	X	X					X		X	X	X	X
PEO II	X	X	X	X	X	X	X		X	X	X	X	X	X	X
PEO III	X	X	X	X	X	X	X	X				X	X	X	X


DEPARTMENT OF MECHANICAL ENGINEERING
CURRICULAM DESIGN & INTERLINKING OF COURSES
360 ° FLEXIBLE LEARNING FRAME WORK
S 8
Professional Elective VII
Professional Elective VIII
Professional Elective IX
Project Work II
S 7
Principles of Management
Automobile Engineering
Operation Research
Industrial Robotics
Professional Elective V
Professional Elective VI
Project Work I
S 6
Professional Ethics in Engineering
Design of Transmission Systems
Finite Element Analysis
Computer Aided Manufacturing-II
Mechatronix
Professional Elective III
Professional Elective IV
Computer Aided Engineering Laboratory
Soft Skills- Aptitude- II
S 5
Metrology and Instrumentation
Design of Machine Elements
Computer Aided Manufacturing-I
Heat and Mass Transfer
Professional Elective I
Professional Elective II
Soft Skills- Aptitude-I
S 4
Numerical Methods and Statistics
Applied Hydraulics and Pneumatics
Dynamics of Machines
Strength of Materials
Thermal Engineering
Microprocessors Controller Programming
Computer Modelling Laboratory-II
Environmental Sciences
Soft Skills- Business English
S 3
Engineering Mathematics III
Fluid Mechanics & Machineries
Kinematics of Machines
Manufacturing Technology
Engineering Thermodynamics
Machine Drawing Laboratory
Computer Modelling Laboratory-I
Human Values and Ethics
Soft Skil- Verbal Ability
S 2
Engineering Mathematics II
Engineering Physics II- Dynamics
Engineering Chemistry II
Basics of Electronics Engineering
Manufacturing Process
Communicative English-II
Computer Programming-II
S 1
Engineering Mathematics I
Engineering Physics I- Statics
Engineering Chemistry I
Basics of Electrical Engineering
Communicative English-I
Computer Programming-I
Engineering Drawing

DEPARTMENT OF MECHANICAL ENGINEERING - R2018
Minimum Credits to be Earned : 170

I SEMESTER

Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CIA	SEE	Total	
18ME101	ENGINEERING MATHEMATICS I	3	1	0	4	4	50	50	100	BS
18ME102	ENGINEERING PHYSICS I – STATICS	2	0	2	3	4	50	50	100	BS
18ME103	ENGINEERING CHEMISTRY I	2	0	2	3	4	50	50	100	BS
18ME104	BASICS OF ELECTRICAL ENGINEERING	2	0	2	3	4	50	50	100	ES
18HS101	COMMUNICATIVE ENGLISH I	1	0	2	2	3	100	0	100	HSS
18ME106	COMPUTER PROGRAMMING I	0	0	4	2	4	100	0	100	ES
18ME107	ENGINEERING DRAWING	0	0	4	2	4	100	0	100	ES
Total		**10**	**1**	**16**	**19**	**27**	**-**	**-**	**-**	**-**

II SEMESTER

Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CIA	SEE	Total	
18ME201	ENGINEERING MATHEMATICS II	3	1	0	4	4	50	50	100	BS
18ME202	ENGINEERING PHYSICS II - DYNAMICS	2	1	0	3	3	50	50	100	BS
18ME203	ENGINEERING CHEMISTRY II	2	0	2	3	4	50	50	100	BS
18ME204	BASIC ELECTRONICS ENGINEERING	2	0	2	3	4	50	50	100	ES
18ME205	MANUFACTURING PROCESSES	2	0	2	3	4	50	50	100	PC
	LANGUAGE ELECTIVE	1	0	2	2	3	100	0	100	HSS
18ME206	COMPUTER PROGRAMMING II	0	0	4	2	4	100	0	100	ES
Total		**12**	**2**	**12**	**20**	**26**	**-**	**-**	**-**	**-**

III SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
18ME301	ENGINEERING MATHEMATICS III	3	1	0	4	4	50	50	100	BS
18ME302	FLUID MECHANICS AND MACHINERY	2	1	2	4	5	50	50	100	ES
18ME303	ENGINEERING THERMODYNAMICS	3	1	0	4	4	50	50	100	ES
18ME304	MANUFACTURING TECHNOLOGY	2	0	2	3	4	50	50	100	PC
18ME305	KINEMATICS OF MACHINES	3	1	0	4	4	50	50	100	PC
18ME306	MACHINE DRAWING LABORATORY	1	0	2	2	3	100	0	100	PC
18ME307	COMPUTER AIDED MODELLING LABORATORY I	0	0	4	2	4	100	0	100	EEC
18GE301	SOFT SKILLS - VERBAL ABILITY	0	0	2	-	2	100	0	100	EEC
Total		**14**	**4**	**12**	**23**	**30**	**-**	**-**	**-**	**-**

IV SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
18ME401	NUMERICAL METHODS	3	1	0	4	4	50	50	100	BS
18ME402	APPLIED HYDRAULICS AND PNEUMATICS	2	0	2	3	4	50	50	100	PC
18ME403	DYNAMICS OF MACHINES	2	1	2	4	5	50	50	100	PC
18ME404	STRENGTH OF MATERIALS	2	1	2	4	5	50	50	100	PC
18ME405	THERMAL ENGINEERING	2	1	2	4	5	50	50	100	PC
18ME406	MICROPROCESSORS AND MICROCONTROLLER	2	0	2	3	4	50	50	100	ES
18 ME407	COMPUTER AIDED MODELLING LABORATORY II	0	0	4	2	4	100	0	100	EEC
18HS001	ENVIRONMENTAL SCIENCE	2	0	0	-	2	100	0	100	ES
18GE401	SOFT SKILLS – BUSINESS ENGLISH	0	0	2	-	2	100	0	100	EEC
Total		**15**	**4**	**16**	**24**	**35**	**-**	**-**	**-**	**-**

V SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
18ME501	METROLOGY AND INSTRUMENTATION	2	0	2	3	4	50	50	100	PC
18ME502	DESIGN OF MACHINE ELEMENTS	3	1	0	4	4	50	50	100	PC
18ME503	COMPUTER AIDED MANUFACTURING I	2	0	2	3	4	50	50	100	PC
18ME504	HEAT AND MASS TRANSFER	3	1	2	5	6	50	50	100	PC
	PROFESSIONAL ELECTIVE I	3	0	0	3	3	50	50	100	PE
	PROFESSIONAL ELECTIVE II	3	0	0	3	3	50	50	100	PE
18GE501	SOFT SKILLS - APT ITUDE I	0	0	2	-	2	100	0	100	EEC
Total		**16**	**2**	**8**	**21**	**26**	**-**	**-**	**-**	**-**

VI SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
18HS002	PROFESSIONAL ETHICS IN ENGINEERING	2	0	0	2	2	50	50	100	HSS
18ME602	MECHATRONICS	2	0	2	3	4	50	50	100	PC
18ME603	FINITE ELEMENT ANALYSIS	3	1	0	4	4	50	50	100	PC
18ME604	DESIGN OF TRANSMISSION SYSTEMS	3	1	0	4	4	50	50	100	PC
18ME605	COMPUTER AIDED MANUFACTURING II	2	0	2	3	4	50	50	100	PC
	PROFESSIONAL ELECTIVE III	3	0	0	3	3	50	50	100	PE
	PROFESSIONAL ELECTIVE IV	3	0	0	3	3	50	50	100	PE
18ME608	COMPUTER AIDED ENGINEERING LABORATORY	0	0	4	2	4	100	0	100	PC
18GE601	SOFT SKILLS - APTITUDE II	0	0	2	-	2	100	0	100	EEC
Total		**18**	**1**	**10**	**24**	**30**	**-**	**-**	**-**	**-**

VII SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
18HS003	PRINCIPLES OF MANAGEMENT	2	0	0	2	2	50	50	100	HSS
18ME702	AUTOMOBILE ENGINEERING	3	0	0	3	3	50	50	100	PC
18ME703	OPERATIONS RESEARCH	3	1	0	4	4	50	50	100	PC
18ME704	INDUSTRIAL ROBOTICS	2	0	2	3	4	50	50	100	PC
	PROFESSIONAL ELECTIVE V	3	0	0	3	3	50	50	100	PE
	PROFESSIONAL ELECTIVE VI	3	0	0	3	3	50	50	100	PE
18ME707	PROJECT WORK I	0	0	6	3	6	50	50	100	EEC
Total		**17**	**1**	**8**	**21**	**25**	**-**	**-**	**-**	**-**

VIII SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**SEE**	**Total**	
	PROFESSIONAL ELECTIVE VII	3	0	0	3	3	50	50	100	PE
	PROFESSIONAL ELECTIVE VIII	3	0	0	3	3	50	50	100	PE
	PROFESSIONAL ELECTIVE IX	3	0	0	3	3	50	50	100	PE
18ME804	PROJECT WORK II	0	0	18	9	18	50	50	100	EEC
Total		**0**	**0**	**18**	**18**	**27**	**-**	**-**	**-**	**-**

Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CIA	SEE	Total	
ELECTIVES										
LANGUAGE ELECTIVES										
18HS201	COMMUNICATIVE ENGLISH II	1	0	2	2	3	100	0	100	HSS
18HSH01	HINDI	1	0	2	2	3	100	0	100	HSS
18HSG01	GERMAN	1	0	2	2	3	100	0	100	HSS
18HSJ01	JAPANESE	1	0	2	2	3	100	0	100	HSS
18HSC01	CHINESE	1	0	2	2	3	100	0	100	HSS
18HSF01	FRENCH	1	0	2	2	3	100	0	100	HSS
PHYSICS ELECTIVES										
18GE0P1	NANOMATERIALS SCIENCE	3	0	0	3	3	50	50	100	BS
18GE0P2	SEMICONDUCTOR PHYSICS AND DEVICES	3	0	0	3	3	50	50	100	BS
18GE0P3	APPLIED LASER SCIENCE	3	0	0	3	3	50	50	100	BS
CHEMISTRY ELECTIVES										
18GE0C1	CORROSION SCIENCE AND ENGINEERING	3	0	0	3	3	50	50	100	BS
18GE0C2	ENERGY STORING DEVICES	3	0	0	3	3	50	50	100	BS
18GE0C3	POLYMER SCIENCE	3	0	0	3	3	50	50	100	BS
MATHEMATICS ELECTIVES										
18GE0M1	GRAPH THEORY AND COMBINATORICS	3	0	0	3	3	50	50	100	BS
18GE0M2	ALGEBRA AND NUMBER THEORY	3	0	0	3	3	50	50	100	BS
18GE0M3	MATHEMATICAL FINANCE AND QUEUEING THEORY	3	0	0	3	3	50	50	100	BS
DISCIPLINE ELECTIVES										
18ME001	COMPUTER AIDED DESIGN	3	0	0	3	3	50	50	100	PE
18ME002	DESIGN OF JIGS, FIXTURES AND PRESS TOOLS	3	0	0	3	3	50	50	100	PE
18ME003	NON - TRADIT IONAL MACHINING PROCESSES	3	0	0	3	3	50	50	100	PE
18ME004	WELDING TECHNOLOGY	3	0	0	3	3	50	50	100	PE
18ME005	ADVANCED STRENGTH OF MATERIALS	3	0	0	3	3	50	50	100	PE
18ME006	PROCESS PLANNING AND COST ESTIMATION	3	0	0	3	3	50	50	100	PE
18ME007	INTERNAL COMBUSTION ENGINES	3	0	0	3	3	50	50	100	PE
18ME008	REFRIGERATION AND AIR CONDITIONING	3	0	0	3	3	50	50	100	PE

18ME009	COMPOSITE MATERIALS	3	0	0	3	3	50	50	100	PE
18ME010	STATIST ICAL QUALITY CONTROL AND RELIABILITY ENGINEERING	3	0	0	3	3	50	50	100	PE
18ME011	MECHANICAL VIBRATIONS	3	0	0	3	3	50	50	100	PE
18ME012	SUPPLY CHAIN MANAGEMENT	3	0	0	3	3	50	50	100	PE
18ME013	COMPUTER INTEGRATED MANUFACTURING	3	0	0	3	3	50	50	100	PE
18ME014	ADVANCED CASTING AND FORMING PROCESSES	3	0	0	3	3	50	50	100	PE
18ME015	INDUSTRIAL SAFETY ENGINEERING	3	0	0	3	3	50	50	100	PE
18ME016	ADDIT IVE MANUFACTURING	3	0	0	3	3	50	50	100	PE
18ME017	NON – DESTRUCTIVE TESTING	3	0	0	3	3	50	50	100	PE
18ME018	RENEWABLE ENERGY SOURCES	3	0	0	3	3	50	50	100	PE
18ME019	CRYOGENIC ENGINEERING	3	0	0	3	3	50	50	100	PE
18ME020	ENGINEERING TRIBOLOGY	3	0	0	3	3	50	50	100	PE
18ME021	POWER PLANT ENGINEERING	3	0	0	3	3	50	50	100	PE
18ME022	OPTIMIZAT ION TECHNIQUES	3	0	0	3	3	50	50	100	PE
18ME023	DESIGN FOR MANUFACTURE AND ASSEMBLY	3	0	0	3	3	50	50	100	PE
18ME024	INDUSTRIAL ENGINEERING	3	0	0	3	3	50	50	100	PE
18ME025	INDUSTRIAL MAINTENANCE ENGINEERING	3	0	0	3	3	50	50	100	PE
18ME026	COMPUTATIONAL FLUID DYNAMICS	3	0	0	3	3	50	50	100	PE
18ME027	FUELS AND COMBUSTION	3	0	0	3	3	50	50	100	PE
18ME028	PRODUCTION AND OPERATIONS MANAGEMENT	3	0	0	3	3	50	50	100	PE
18ME029	GREEN MANUFACTURING	3	0	0	3	3	50	50	100	PE
18ME030	PRODUCT DEVELOPMENT AND REVERSE ENGINEERING	3	0	0	3	3	50	50	100	PE
18ME031	NANOMATERIALS AND NANOTECHNOLOGY	3	0	0	3	3	50	50	100	PE
18ME032	TOTAL QUALITY MANAGEMENT	3	0	0	3	3	50	50	100	PE
ENTREPRENEURSHIP ELECTIVES										
18GE0E1	ENTREPRENEURSHIP DEVELOPMENT I	3	0	0	3	3	50	50	100	PE
18GE0E2	ENTREPRENEURSHIP DEVELOPMENT II	3	0	0	3	3	50	50	100	PE

ONE CREDIT COURSES										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CIA	SEE	Total	
18ME0XA	GEOMETRIC DIMENSIONING AND TOLERANCING	1	0	0	1	-	100	0	100	EEC
18ME0XB	LEAN MANUFACTURING	1	0	0	1	-	100	0	100	EEC
18ME0XC	PIPING ENGINEERING	1	0	0	1	-	100	0	100	EEC
18ME0XD	PROBLEM SOLVING TECHNIQUES	1	0	0	1	-	100	0	100	EEC
18ME0XE	AUTOMOTIVE EXHAUST SYSTEM	1	0	0	1	-	100	0	100	EEC
18ME0XF	CONTINUOUS IMPROVEMENT	1	0	0	1	-	100	0	100	EEC
18ME0XG	INDIAN PATENT LAW	1	0	0	1	-	100	0	100	EEC
18ME0XH	RAILWAY TRACK TECHNOLOGY	1	0	0	1	-	100	0	100	EEC
18ME0XI	GLASS ENGINEERING	1	0	0	1	-	100	0	100	EEC
18ME0XJ	TOOL DESIGN AND MANUFACTURING	1	0	0	1	-	100	0	100	EEC
18ME0XK	5S-INTRODUCTION AND IMPLEMENTATION	1	0	0	1	-	100	0	100	EEC
18ME0XL	ENERGY AUDIT ING AND INSTRUMENTS	1	0	0	1	-	100	0	100	EEC
18ME0XM	INDUSTRIAL CONTROL VALVES	1	0	0	1	-	100	0	100	EEC
18ME0XN	INDUSTRIAL GEARBOX DESIGN	1	0	0	1	-	100	0	100	EEC
18ME0XO	PRODUCT VALIDATION TECHNIQUES AND ENVIRONMENTAL TESTING	1	0	0	1	-	100	0	100	EEC
18ME0XP	8D PROBLEM SOLVING METHODOLOGY	1	0	0	1	-	100	0	100	EEC
18ME0XQ	ADVANCED PRODUCT QUALITY PLANNING	1	0	0	1	-	100	0	100	EEC
18ME0XR	DESIGN OF ROTOR SHAFTS	1	0	0	1	-	100	0	100	EEC
18ME0XS	SAFETY MANAGEMENT IN INDUSTRY	1	0	0	1	-	100	0	100	EEC
18ME0XT	MODELLING AND ANALYSIS OF UNDERWATER ROBOTS	1	0	0	1	-	100	0	100	EEC
18ME0XU	IOT INTEGRATED AUTOMATION SYSTEMS	1	0	0	1	-	100	0	100	EEC
18ME0XV	AUTONOMOUS MOBILE ROBOT USING PYTHON C in ROS	1	0	0	1	-	100	0	100	EEC
ADDITIONAL ONE CREDIT COURSES										
18GE0XA	ETYMOLOGY	1	0	0	1	-	100	0	100	EEC
18GE0XB	GENERAL PSYCHOLOGY	1	0	0	1	-	100	0	100	EEC

18GE0XC	NEURO BEHAVIORAL SCIENCE	1	0	0	1	-	100	0	100	EEC
18GE0XD	VISUAL MEDIA AND FILM MAKING	1	0	0	1	-	100	0	100	EEC
18GE0XE	YOGA FOR HUMAN EXCELLENCE	1	0	0	1	-	100	0	100	EEC
18GE0XF	VEDIC MATHEMATICS	1	0	0	1	-	100	0	100	EEC
18GE0XG	HEALTH AND FITNESS	1	0	0	1	-	100	0	100	EEC
18GE0XH	CONCEPT, METHODOLOGY AND APPLICATIONS OF VERMICOMPOSTING	1	0	0	1	-	100	0	100	EEC
18GE0XI	BLOG WRITING	1	0	0	1	-	100	0	100	EEC
18GE0XJ	INTERPERSONAL SKILLS	1	0	0	1	-	100	0	100	EEC
18GE0XK	COMMUNITY SERVICE AND LEADERSHIP	1	0	0	1	-	100	0	100	EEC
18GE0XL	NAT IONAL CADET CORPS	1	0	0	1	-	100	0	100	EEC
18GE0XM	NEW AGE INNOVATION AND ENTREPRENEURSHIP	1	0	0	1	-	100	0	100	EEC
18GE0XN	DISRUPTIVE INNOVATION BASED STARTUP ACTIVITIES	1	0	0	1	-	100	0	100	EEC
18GE0XO	SOCIAL PSYCHOLOGY	1	0	0	1	-	100	0	100	EEC
OPEN ELECTIVES (Not for MECHANICAL Students)										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
18ME0YA	INDUSTRIAL PROCESS ENGINEERING	3	0	0	3	3	40	60	100	PE
18ME0YB	SAFETY ENGINEERING	3	0	0	3	3	40	60	100	PE
18ME0YC	MAINTENANCE ENGINEERING	3	0	0	3	3	40	60	100	PE
18ME0YD	BASICS OF NON-DESTRUCTIVE TESTING	3	0	0	3	3	40	60	100	PE
18ME0YE	DIGITAL MANUFACTURING	3	0	0	3	3	40	60	100	PE
18ME0YF	WORK STUDY AND ERGONOMICS	3	0	0	3	3	40	60	100	PE
18ME0YG	METROLOGY IN INDUSTRY	3	0	0	3	3	40	60	100	PE
18ME0YH	PLANT LAYOUT AND MATERIAL HANDLING	3	0	0	3	3	40	60	100	PE
18ME0YI	CONCEPTS OF ENGINEERING DESIGN	3	0	0	3	3	40	60	100	PE
18ME0YJ	OIL HYDRAULICS AND PNEUMATICS	3	0	0	3	3	40	60	100	PE
18ME0YK	ENERGY AUDIT ING AND MANAGEMENT	3	0	0	3	3	40	60	100	PE
18ME0YL	LEAN SIX SIGMA	3	0	0	3	3	40	60	100	PE
18ME0YM	HEATING VENTILAT ION AND AIRCONDIT IONING	3	0	0	3	3	40	60	100	PE

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	10	10	4	4	-	-	-	-	28	16%	15%	20%
2	ES	7	5	8	3	-	-	-	-	23	15%	15%	20%
3	HSS	2	2	-	-	-	2	2	-	8	5%	5%	10%
4	PC	-	3	9	15	15	16	10	-	68	40%	30%	40%
5	PE	-	-	-	-	6	6	6	9	27	16%	10%	15%
6	EEC	-	-	2	2	-	-	3	9	16	8%	10%	15%
Total		**19**	**20**	**23**	**24**	**21**	**24**	**21**	**18**	**170**	**100%**	**-**	**-**

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

18ME101 ENGINEERING MATHEMATICS I 3 1 0 4

Course Objectives

- Understand the concepts of vectors and Eigenvectors for different matrices to describe the stability of the linear systems in engineering fields
- Exemplify the concepts of differentiation and integration to identify the area of 2D and 3D surfaces in engineering problems.
- Explain the concepts of analytic functions in complex domain to predict the nature of different engineering systems.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Apply the concepts of complex numbers, vectors, and matrices to solve engineering and mathematical problems.
2. Intrepret the application of limits, continuity, differentiation, and integration to solve various engineering problems
3. Assess the various integration techniques, including substitution, integration by parts, and partial fractions, to solve application-based problems involving algebraic and transcendental functions.
4. Analyze extreme values, points of inflection, and apply optimization techniques, along with solving problems involving areas, volumes, and lengths of curves and solids using various methods.
5. Investigate the concepts of analytic functions, their properties, the determination of these functions using Milne-Thomson's method, and evaluate integrals in the complex plane.

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	2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
4	2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
5	3	3	2	-	-	-	-	-	-	-	-	-	-	-	2

UNIT I **9 Hours**

COMPLEX NUMBERS, VECTORS AND MATRICES

Complex plane, polar coordinates and polar form of complex numbers, powers and roots, fundamental theorem of algebra. Vector algebra in 2-D and 3-D space, dot product and cross product. Matrices : Eigen values and Eigen vectors, Properties of eigen values and eigen vectors.

UNIT II **9 Hours**

CALCULUS

Limits and Continuity of Functions: Limits of functions, types of limits, evaluation of limits, continuity of functions, properties of continuous functions. Derivatives: Derivatives, differentiability, rules and properties, differentiation of transcendental functions, higher order derivatives, implicit differentiation, and differentiation of hyperbolic functions. Integration: Anti-derivatives, Riemann Sum, indefinite and definite integration, Mean Value Theorem for definite integral, Fundamental Theorem of Calculus.

UNIT III **9 Hours**

INTEGRATION METHODS

Basic integration formulae for algebraic and transcendental functions. Integration by special devices: integration by parts, rationalizing substitution or trigonometric substitution, partial fractions, reduction formulas, improper integrals, convergence tests.

UNIT IV **9 Hours**

APPLICATIONS OF DERIVATIVES AND INTEGRATIONS

Extreme values, points of inflection and curve sketching, Rolles Theorem, Mean Value Theorem, optimization, indeterminate forms, L Hopitals Rule. Area between curves, volume of a general solid by slicing and cylindrical shell methods, volume of a solid of revolution, length of plane curves, area of a surface of revolution.

UNIT V **9 Hours**

COMPLEX ANALYSIS

Analytic Functions- Properties of Analytic function - Determination of Analytic Function using Milne Thompson method. Cauchys Integral Formula - Classification of Singularities - Cauchy"s Residue Theorem.

Tutorial: 15 Hours

Total: 60 Hours

Reference(s)

1. Finney RL, Weir MD and Giordano FR, Thomas Calculus, 10th edition, Addison-Wesley, 2001
2. Smith RT and Minton RB, Calculus, 2nd Edition, McGraw Hill, 2002.
3. Erwin Kreyszig , Advanced Engineering Mathematics, Tenth Edition, Wiley India Private Limited, New Delhi 2016.
4. Anton H, Calculus with Analytic Geometry, 5th edition, John Wiley & Sons, 1995.
5. Ayres F Jr and Mendelson E, Schaum s Outline of Theory and Problems of Calculus, 4th edition, McGraw Hill, 1999.

18ME102 ENGINEERING PHYSICS I-STATICS 2 0 2 3

Course Objectives

- Familiarise basic concepts and force systems
- Provide knowledge on statics of particles in space with moment
- Impart knowledge on equilibrium of rigid bodies
- Study the moment of surfaces and solids
- Learn the concepts of static friction

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO4.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

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PSO1. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply the fundamental principles of mechanics and force systems to analyze static equilibrium of particles.
2. Assess the effects of moments and couples on rigid bodies and simplify force-couple systems.
3. Analyze the solutions for rigid body equilibrium problems in two and three dimensions, including trusses, beams, and frames.
4. Develop methods to determine the properties of surfaces and solids, such as centroid, area, volume, and moment of inertia.
5. Investigate the behavior of objects on inclined planes by applying the laws of friction in ladder, wedge and rolling friction.

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	-	-	-	-	-	-	-	2	-	-	-	2	-	-
3	2	3	2	-	-	-	-	-	2	-	-	-	2	-	-
4	2	2	3	-	-	-	-	-	2	-	-	-	2	-	-
5	2	2	2	2	-	-	-	-	2	-	-	-	2	-	-

UNIT I **5 Hours**

BASIC CONCEPTS AND FORCE SYSTEM

Introduction to mechanics - idealization of mechanics - laws of mechanics - principle of transmissibility. Force- types - system of forces - resultant forces - composition of forces - resolution of force - free body diagram.

UNIT II **6 Hours**
STATICS OF PARTICLES AND FORCE SYSTEM
Equilibrium of particles. Moment of force, moment of couple - equilibrant moment about point. Simplification of force and couple systems.

UNIT III **7 Hours**
STATICS OF RIGID BODIES
Equilibrium of rigid bodies in two dimensions. Trusses - method of joints and method of sections. Beams - types of loads, supports and their reactions. Two and three force members - frames.

UNIT IV **6 Hours**
PROPERTIES OF SURFACES AND SOLIDS
Centroid - Determination of area, volume and mass - Pappus and Guldinus theorems - moment of inertia of plane and areas - radius of gyration, parallel axis and perpendicular axis theorems. Product of inertia, mass moment of inertia.

UNIT V **6 Hours**
FRICTION
Origin of friction - types - laws of friction - friction on horizontal and inclined planes, ladder and wedge friction - rolling resistance.

EXPERIMENT 1 **3 Hours**
Experimental verification of parallelogram law

EXPERIMENT 2 **3 Hours**
Experimental verification of Lamis theorem

EXPERIMENT 3 **4 Hours**
Experimental demonstration of principles of moments using bell crank lever apparatus.

EXPERIMENT 4 **3 Hours**
Determination of equilibrant force using polygon law of forces

EXPERIMENT 5 **4 Hours**
Experimental study of equilibrium of forces in concurrent co-planar systems.

EXPERIMENT 6 **3 Hours**
Experimental analysis of the reaction forces of a simply supported beam and compare the same with analytical results.

EXPERIMENT 7 **3 Hours**
Determination of centroid of laminas.

EXPERIMENT 8 **3 Hours**
Determination of moment of inertia of plane area.

EXPERIMENT 9 **4 Hours**
Determination of coefficient of friction between two surfaces.

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

18ME103 ENGINEERING CHEMISTRY I 2 0 2 3

Course Objectives

- To outline the importance and applications of metals and alloys
- To select and fabricate a suitable alloy for a mechanical application
- To choose and identify the elements using analytical techniques

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO6. 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.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Apply the concept of atomic structure and bonds to understand the metallic structure and properties
2. Analyze the metal-alloy system by applying the phase rule and condensed phase rule
3. Design appropriate alloy compositions for specific engineering applications by analyzing the purpose of alloying, functions and effects of alloying elements.
4. Construct TTT diagram and cooling curves for heat treatment processes in steels to achieve desired mechanical properties.
5. Evaluate the characteristics of chemical samples using UV, IR, and colorimetric spectroscopic techniques

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	-
3	2	2	2	-	-	2	-	-	-	-	-	-	-	2	-
4	2	2	-	-	-	2	-	-	-	-	-	-	-	2	-
5	2	-	-	-	-	2	2	-	-	-	-	-	-	2	-

UNIT I **6 Hours**

ATOMIC STRUCTURE AND CRYSTALLIZATION

Atomic structure: Introduction to fundamental concepts - dual nature of the electrons - periodic table - types of atomic interaction (ionic, covalent, coordinate covalent, metallic and Vanderwaals interactions). Metallic crystal structure - ceramic crystal structure - polymer crystal structure.

UNIT II **6 Hours**

PHASE RULE

Phase - component - degree of freedom - solubility limit - Gibbs phase rule - phase diagram - phase equilibrium applications - one component system (water system). Reduced phase rule: Two component systems (lead and silver system and Fe-Fe3C diagrams).

UNIT III **5 Hours**

FERROUS AND NON-FERROUS ALLOYS

Alloys: Purpose of alloying - function and effects of alloying elements - properties of alloys - classification of alloys. Composition, types, properties and applications of ferrous alloys (Steel, cast iron and stainless steel) Ã¢?? Non-ferrous alloys (Aluminium, copper, magnesium and nickel).

UNIT IV **7 Hours**

HEAT TREATMENT

Heat treatment of steel: Annealing - stress relief - recrystallization and spheroidizing - normalizing - hardening - tempering of steel - isothermal transformation diagram (TTT diagram) - cooling curves - carburizing - nitriding - cyaniding - carbonitriding - flame and induction hardening.

UNIT V **6 Hours**

SPECTROSCOPY

Beer-Lamberts law - Electromagnetic spectrum - electronic - vibrational - rotational transitions. Principle - instrumentation (Block diagram) - applications of UV visible - IR spectroscopy. Spectrophotometric estimation of iron (colorimetry).

FURTHER READING

Study the composition, properties and applications of different ferrous and non-ferrous alloys. Application of phase rule in mechanical engineering. Importance of analytical techniques for mechanical engineering.

EXPERIMENT 1 — 2 Hours

Instruction about safety rules, reagent handling and precautions need to be followed in lab.

EXPERIMENT 2 — 4 Hours

Measurement of grain size using optical metallurgical microscope.

EXPERIMENT 3 — 4 Hours

Estimation of copper content in brass by EDTA method.

EXPERIMENT 4 — 4 Hours

Microstructure analysis of steel/cast iron.

EXPERIMENT 5 — 4 Hours

Microstructure analysis of stainless steel

EXPERIMENT 6 — 4 Hours

Microstructure analysis of aluminium/copper

EXPERIMENT 7 — 4 Hours

Determination of hardenability using Jominy end quench test.

EXPERIMENT 8 — 4 Hours

Estimation of iron (thiocyanate method) in the given solution by spectrophotometric method

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, Materals Science and Engineering, Prentice Hall of India, Delhi, 2009.
4. P. C. Jain and Monica Jain, Engineering Chemistry, 16th Edition, DhanpatRai Publisher, New Delhi, 2016.
5. SashiChawla, Text Book of Engineering Chemistry, DhanpatRai Publications, New Delhi, 2013.
6. J. C. Kuriacose and J. Rajaram, Chemistry in Engineering & Technology, Vol. 1&2, TMH, 2009.

18ME104 BASICS OF ELECTRICAL ENGINEERING 2 0 2 3

Course Objectives

- To understand the basic concepts of electrical elements and measuring instruments.
- To indicate the electrical properties of material.
- To illustrate the construction and operation of various electrical machines.
- To illustrate the construction and operation of various electrical drives.
- To understand the various components used in electrical installations.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO4.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

PO6. 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.

PO12. 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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Apply the concepts of electrical elements and measuring instruments in simple electrical circuits
2. Analyze the electrical properties of engineering materials by applying standard testing procedures and laws
3. Investigate the operational characteristics of static and dynamic electrical machines used in engineering applications
4. Assess the performance and suitability of various electrical drives for different industrial and domestic scenarios.
5. Implement engineering knowledge to select appropriate components for electrical installations, including protection devices and wiring systems

Articulation Matrix

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

UNIT I **6 Hours**

ELECTRICAL ELEMENTS AND MEASURING INSTRUMENTS

Resistance, Inductance, Capacitance, Wires and Cables. Ammeter, Voltmeter, Wattmeter, Energy meter, Thermistor and Anemometer.

UNIT II **6 Hours**

ELECTRICAL PROPERTIES OF MATERIAL

Resistivity, Conductivity, Temperature co-efficient, Permittivity and Thermoelectricity. Identification of Materials by conducting resistivity test, Ohms law and Kirchhoff Law.

UNIT III **6 Hours**

ELECTRICAL MACHINES

Construction and operating characteristics: DC Motor, Single Phase Transformer, Three phase induction motor, Single phase induction motors, Synchronous Motor, and Stepper Motor.

UNIT IV **6 Hours**

ELECTRICAL DRIVES

Components of Electrical Drives, Selection of electric motor for drives, VFD for pumps and fans, Servo motor drive.

UNIT V **6 Hours**

ELECTRICAL INSTALLATIONS

Types of Protection devices: Fuses, MCB, ELCB, equipments for house wiring, simple house wiring and pump motor wiring.

EXPERIMENT 1 6 Hours

Measure the electric properties of the given material such as resistivity, conductivity, temperature co-efficient of resistance, permittivity and thermo electricity. Identify the material by conducting resistivity measurement test.

EXPERIMENT 2 6 Hours

Development of prototype electrical generator, motor and measure the voltage, speed and torque.

EXPERIMENT 3 6 Hours

Measure the mechanical input power, electrical output power and efficiency of synchronous generator.

EXPERIMENT 4 6 Hours

Measure the electrical input power, mechanical output power and efficiency of Variable frequency induction motor drive.

EXPERIMENT 5 6 Hours

Conduct an experiment to control the speed of stepper motor and servomotor drives.

Total: 60 Hours

Reference(s)

1. T.K.Nagsarkar and M.S.Sukhija, Basic of Electrical Engineering, Oxford University Press, 2011.
2. Laszlo Solymar, Donald Walsh, Richard R. A. Syms, Electrical Properties of materials, Oxford University press, 2014.
3. A. Sudhakar, Shyammohan S Palli, Circuits and Networks Analysis and Synthesis, Tata McGraw Hill, 2010.
4. G.K.Dubey, G, Fundamental of Electrical Drives, Narosa publishing House, New Delhi,2012.
5. B.L.Theraja, A.K.Theraja, A Text Book of Electrical Technology Volume II, S.Chand and Company Ltd, New Delhi, 2016.
6. V. D. Toro, Electrical Engineering Fundamentals, Prentice Hall India, 2014.

18HS101 COMMUNICATIVE ENGLISH I 1 0 2 2

Course Objectives

- Read and understand the main points on familiar matters regularly encountered in work, school, or leisure
- Listen and respond in most common situations where English is spoken
- Write simple connected texts on topics which are familiar or of personal interest
- Describe experiences and events, hopes and ambitions and briefly give reasons and explanations for opinions and plans

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3.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.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. 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.
PO12. 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
PSO1.Design, analyse and evaluate the performance of mechanical systems
PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Apply appropriate grammar and vocabulary expected at the BEC Preliminary exam level.
2. Analyze the general meaning of non-routine letters within one's work area, and short reports of a predictable nature.
3. Design straightforward, routine letters of a factual nature, and develop notes on routine matters, such as taking/placing orders.
4. Create simple presentations/demonstrations to enhance understanding.
5. Infer the predictable requests from visitors, state routine requirements, and offer advice within one's job area on simple matters.

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	-
2	2	2	-	-	-	-	-	-	3	3	-	2	2	2	-
3	1	2	2	-	-	-	-	-	3	3	-	2	2	2	-
4	1	2	2	-	-	-	-	-	3	3	-	2	2	2	-
5	2	-	-	-	-	-	-	-	3	3	-	2	2	2	-

UNIT I **9 Hours**

GRAMMAR

Tenses Future continuous, Past continuous, Past perfect, Past simple, Past tense responses, Present perfect continuous, Present perfect/past simple Reported speech Adverbs intensifiers Comparatives and superlatives Conditionals 2nd and 3rd Connecting words expressing cause and effect, contrast Phrasal verbs Prepositions of place Simple passive - Wh-questions in the past Question tags Will and going to, for prediction.

UNIT II **9 Hours**

READING

Understanding short real-world notices, messages Detailed comprehension of factual material; skimming and scanning skills - Interpreting visual information Reading for detailed factual information Reading for gist and specific information - Grammatical accuracy and understanding of text structure - Reading and information transfer.

UNIT III **9 Hours**

WRITING

Internal communication including note, message, memo or email - arranging / rearranging appointments, asking for permission, giving instructions - Business correspondence including letter, fax, email apologising and offering compensation, making or altering reservations, dealing with requests, giving information about a product.

UNIT IV **9 Hours**

LISTENING

Listening for specific information Listening for numbers and letters Note completion Listening for gist listening to monologues (presentations, lectures, announcements and briefings) listening to interacting speakers (telephone conversations, face-to-face conversations, interviews and discussions).

UNIT V **9 Hours**

SPEAKING

Exchanging personal and factual information expressing and finding out about attitudes and opinions organise a larger unit of discourse Turn-taking, negotiating, collaborating, exchanging information, expressing and justifying opinions, agreeing and/or disagreeing, suggesting, speculating, comparing and contrasting, and decision-making. 1. Goodbye party for Miss Pushpa T S - Nissim Ezekiel 2. Our Casuarina Tree - Toru Dutt 3 .Palanquin Bearers - Sarojini Naidu 4. The Tyger - William Blake 5. Ode on a Grecian Urn - John Keats

Total: 45 Hours

Reference(s)

1. Alexander Garrett, Cambridge BEC Preliminary Students Book with Answers, Cambridge University Press, 2016.
2. Lan Wood, Anne Williams and Anna Cowper. Pass Cambridge BEC Preliminary, Second Edition, New Delhi, 2014.
3. Norman Whitby. Cambridge Business Benchmark. Pre-Intermediate to Intermediate, Students Book. South Asian Edition, 2018.

18ME106 COMPUTER PROGRAMMING I 0 0 4 2

Course Objectives

- Understand the basics of C primitives, operators and expressions.
- Gain knowledge about the different primitive and user defined data types.
- Impart knowledge about the structural programming concepts.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO5. 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.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO11. 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.

PO12. 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.

PSO1.Design, analyse and evaluate the performance of mechanical systems

Course Outcomes (COs)

1. Apply fundamental data types and operators to perform arithmetic and logical operations in C programs.
2. Develop conditional and looping control structures to solve basic decision-making and repetitive problems.
3. Design programs using arrays and string functions to manage structured data efficiently.
4. Create user-defined data types like structures and functions, including recursion, to organize code logically.
5. Analyze control flow using switch cases, jumping statements, and loops to improve program behavior.

Articulation Matrix

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

EXPERIMENT 1 **6 Hours**
Implement a C program which include a fundamental data types Integer, Float, Double and Character.

EXPERIMENT 2 **6 Hours**
Implement a C program to perform the arithmetic operations using primitive data types.

EXPERIMENT 3 **6 Hours**
Implementation of logical, relational, bitwise, increment/decrement and Conditional Operators in C.

EXPERIMENT 4 **3 Hours**
Implementation of simple if else Conditional Statement.

EXPERIMENT 5 **3 Hours**
Implementation of nested if else Conditional Statement.

EXPERIMENT 6 **3 Hours**
Implementation of Switch Case Statement.

EXPERIMENT 7 **3 Hours**
Implement a C program using for Looping Statement.

EXPERIMENT 8 **3 Hours**
Implement a C program using Do-While Looping Statement.

EXPERIMENT 9 **3 Hours**
Implement a C program using While Looping Statement.

EXPERIMENT 10 **3 Hours**
Implementation of Jumping Statements

EXPERIMENT 11 **3 Hours**
Implementation of One Dimensional Array.

EXPERIMENT 12 **3 Hours**
Implementation of Two Dimensional Array.

EXPERIMENT 13 **3 Hours**
Implement a C program to perform String Manipulation Functions.

EXPERIMENT 14 **6 Hours**
Implement a C program using structures.

EXPERIMENT 15 **6 Hours**
Implement a C program which includes four categories of functions and recursive functions.

Total: 60 Hours

18ME107 ENGINEERING DRAWING 0 0 4 2

Course Objectives

- To provide knowledge on fundamentals of engineering drawings and conic sections.
- To impart skill on orthographic projections of points and lines.
- To familiarize on projection of planes and simple solids.
- To provide knowledge on section of solids and development of surfaces of simple solids.
- To impart skill on conversion of isometric view to orthographic projection and vice versa.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO5. 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.

PO5. 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.

PO6. 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.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PSO1. Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Apply engineering drawing standards by practicing lettering, numbering, dimensioning, and conic sections to understand its fundamental concepts.
2. Analyse the concept of projection and plot the points projections in all four quadrants and lines projection in the first quadrant.
3. Interpret the projections of basic planes and solids by changing their positions step by step.
4. Design and construct the cut sections and surface layouts of simple and truncated solids using different types of cutting planes.
5. Illustrate the orthographic and isometric views of basic machine components to develop visualization and orthographic drawing skills.

Articulation Matrix

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

UNIT I **10 Hours**

FUNDAMENTALS OF ENGINEERING DRAWINGS

Definition, standards, drawing tools, drawing sheets, scales, line and its types. Practices on lettering, numbering, dimension of drawings. Construction of conic sections-ellipse, parabola and hyperbola using eccentricity method.

UNIT II **12 Hours**

PROJECTION OF POINTS

Principles of projection, projection of points in four quadrants, first angle projection of straight lines - perpendicular to one plane, parallel and inclined to both planes.

UNIT III **10 Hours**

PROJECTION OF PLANES AND SOLIDS

Projection of simple planes and projection of simple solids parallel, perpendicular and inclined to one plane using change of position method.

UNIT IV **12 Hours**

SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES

Section of Solids - simple position with cutting plane parallel, perpendicular and inclined to one plane. Development of surfaces - simple and truncated solids.

UNIT V **16 Hours**

ORTHOGRAPHIC PROJECTIONS AND ISOMETRIC VIEW

Orthographic projections and isometric view of components used in engineering applications.

Total: 60 Hours

Reference(s)

1. K Venugpoal, Engineering Drawing and Graphics, Sixth edition, New Age International,2011.
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

18ME201 ENGINEERING MATHEMATICS II 3 1 0 4

Course Objectives

- Understand the concepts of partial derivatives and multiple integrals to define the area, volume and extreme values of various surfaces in engineering fields.
- Classify the sequences and series in linear systems is convergent or divergent.
- Formulate the real time engineering problem into mathematical model using ordinary differential equation and solve it by appropriate method.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PSO1. Design, analyse and evaluate the performance of mechanical systems

Course Outcomes (COs)

1. Apply partial differentiation in mechanical engineering contexts such as heat flow, stress-strain analysis, and fluid dynamics, and illustrate their behavior using graphs.
2. Infer the double and triple integrals to calculate area, volume, mass, and center of gravity in Cartesian coordinates
3. Investigate and solve first-order differential equations (separable, homogeneous, exact, Bernoulli's) to model mechanical engineering systems like fluid flow, heat transfer, and vibrations.
4. Analyze first-order differential equations such as separable, homogeneous, exact, and Bernoulli's to model mechanical systems like fluid flow, heat transfer, and vibrations
5. Develop solutions to second-order differential equations with constant coefficients using methods like undetermined coefficients, series solutions of differential equations

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	-	-
3	2	3	-	-	-	-	-	-	-	-	-	-	1	-	-
4	2	3	-	-	-	-	-	-	-	-	-	-	1	-	-
5	3	3	2	-	-	-	-	-	-	-	-	-	1	-	-

UNIT I **9 Hours**

PARTIAL DIFFERENTIATION

Functions of several variables, plotting of 2-variable functions, introduction to cylindrical and spherical coordinates, chain rule, total differential, gradient, directional derivatives, normal lines and tangent planes, extreme of functions of two variables, applications.

UNIT II **9 Hours**

MULTIPLE INTEGRALS

Double integrals, regions of integration, triple integrals, applications (Cartesian coordinates only-Greens theorem and Gauss Divergence theorem).

UNIT III **9 Hours**

ANALYTIC FUNCTIONS

Sequences and series, convergence and divergence of series, absolute convergence, conditional convergence, test for convergence and divergence. Power series for functions, interval of convergence, Taylor and Maclaurin series, Taylors Theorem with remainder.

UNIT IV **9 Hours**

FIRST ORDER DIFFERENTIAL EQUATIONS

Separable differential equations, homogeneous differential equations, exact differential equations, integrating factor, Bernoullis equation, applications.

UNIT V **9 Hours**

SECOND ORDER DIFFERENTIAL EQUATIONS

Second order homogeneous and non-homogeneous equations with constant coefficients, variation of parameters, method of undetermined coefficients, series solutions of differential equations, applications.

Tutorial: 15 Hours

Total: 60 Hours

Reference(s)

1. C. Ray Wylie and C. Louis Barrett, Advanced Engineering Mathematics, Tata McGraw-Hill Publishing 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. Glyn James, Advanced Engineering Mathematics, Third Edition,Wiley India, 2014.

18ME202 ENGINEERING PHYSICS II - DYNAMICS 2 1 0 3

Course Objectives

- Impart knowledge in kinematics of particles
- Familiarize the basic concepts of force, mass and acceleration
- Determine the nature of force associated with work and energy
- Summarize the motion of rigid bodies
- Solve the realistic problems related to rigid body kinetics

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO4.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

PO12. 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

PSO1. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply the mechanism of friction and various frictional forces involved in mechanical systems
2. Analyze the interrelation between force, mass and acceleration of particles using Newton's second law
3. Interpret the work-energy, impulse-momentum principles to understand the geometry of particles in motion
4. Investigate the geometry of rigid bodies under the influence of external applied forces
5. Assess 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	-	-	-	-	-	-	-	-	-	-	1	2	-	-
2	2	2	-	-	-	-	-	-	-	-	-	1	2	-	-
3	2	-	-	-	-	-	-	-	-	-	-	1	2	-	-
4	2	2	2	2	-	-	-	-	-	-	-	1	2	-	-
5	2	-	-	-	-	-	-	-	-	-	-	1	2	-	-

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.

UNIT II **6 Hours**

KINETICS OF PARTICLES I: FORCE, MASS AND ACCELERATION

Introduction to kinetics Newton second law of motion Equations of motion Problems on rectangular coordinates, normal and tangential components. Dynamic equilibrium Alembert principle.

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.

Tutorial: 15 Hours

Total: 45 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, First 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.

18ME203 ENGINEERING CHEMISTRY II 2 0 2 3

Course Objectives

- To understand the importance of electrochemistry in batteries and corrosion control.
- To realize the structure property relationship with properties of polymers.
- To identify the utility of smart materials in engineering applications.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Apply electrochemical principles to determine electrode potentials and analyze the performance of electrochemical and electrolytic cells, including primary and secondary batteries.
2. Analyze different types of corrosion and influencing factors to identify and suggest suitable corrosion control techniques for various industrial environments.
3. Evaluate the structure–property relationships and processing methods of thermoplastics and thermosetting polymers to select appropriate materials for engineering applications
4. Compare the properties of engineering materials such as glass, ceramics, cements, abrasives, and refractories to justify their suitability in specialized industrial and structural applications
5. Design material-based solutions using fiber-reinforced composites and smart materials by integrating their mechanical, thermal, and responsive properties for advanced engineering functions

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	-	-	-	-	2	-	-	-	-	-	-	2	-
3	2	1	2	-	-	-	-	-	-	-	-	-	-	2	-
4	2	1	-	-	-	-	-	-	-	-	-	-	-	2	-
5	1	1	2	-	-	-	-	-	-	-	-	-	-	2	-

UNIT I **6 Hours**

ELECTROCHEMISTRY

Electrodes Electrode potential (single & standard electrode potential). Cells: half cell cell reactions cell representation types (difference between electrochemical and electrolytic cells). Types of electrodes Calomel electrode determination of single electrode potential electrochemical series and its importance and ion-selective electrode (glass electrode measurement of pH using glass electrode). Batteries: Difference between cell and a battery Primary and secondary batteries Construction and working of Lead acid and Lithium battery.

UNIT II **6 Hours**

CORROSION SCIENCE

Corrosion: types of corrosion: chemical (types of oxide layer: stable, unstable, volatile and porous, Pilling-Bedworth rule) and electrochemical corrosion (hydrogen evolution and oxygen absorption mechanism). Types of electrochemical corrosion: Galvanic corrosion and differential aeration corrosion (pitting, stress, waterline and pipeline). Galvanic series and its applications. Factors influencing corrosion rate. Corrosion control methods: Sacrificial anode and impressed current cathodic protection. Metallic coating (galvanizing and tinning).

UNIT III **6 Hours**

STRUCTURE, CHARECTERISTICS AND APPLICATION OF POLYMERS

Monomers polymers polymerization functionality degree of polymerization classification of polymers polymer molecular weight. Types of polymerization: addition, condensation and copolymerization. Structure, properties and applications of thermosetting (epoxy resin and alkalite) and thermoplastics (polyvinyl chloride and polytetrafluoroethylene).Compounding of plastics injection and extrusion moulding.

UNIT IV **7 Hours**

ENGINEERING MATERIALS

Glass and ceramics: Types and properties of glass and ceramic materials. Portland cement: Properties setting and hardening of cement special cement water proof and white cement properties and uses. Abrasives: Definition Moh scale of hardness classification of abrasives natural abrasives artificial abrasives (silicon carbide and boron carbide). Refractories : Definition classification properties of refractories preparation, properties and uses of high alumina bricks, magnesite and zirconia bricks.

UNIT V **5 Hours**

ADVANCED MATERIALS

Composites: Introduction to composites classification, properties, application and morphology of fibre reinforced composites, metal matrix composites and ceramic composites. Smart material: Introduction to smart materials, properties and applications of shape memory alloys and phase changing materials.

EXPERIMENT 1 6 Hours

Estimation of iron in the given sample by potentiometric method using saturated calomel electrode and Preparation of 1N oxalic acid and 1M sodium carbonate solutions

EXPERIMENT 2 4 Hours

Determination of strength of hydrochloride acid present in the given solution by pH measurement.

EXPERIMENT 3 4 Hours

Determine the strength of mixtures of acid using a conductivity cell.

EXPERIMENT 4 4 Hours

Measurement of rate of corrosion on Zinc/mild steel in aerated/ neutral/ acidic/ alkaline solution by weight loss method.

EXPERIMENT 5 4 Hours

Determination of molecular weight of a polyvinyl alcohol using Ostwald viscometer.

EXPERIMENT 6 **4 Hours**

Testing of thermal stability of polymer using TGA Analyzer.

EXPERIMENT 7 **4 Hours**

Determination of molecular structure of given sample using FTIR spectroscopy.

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, Materals Science and Engineering, Prentice Hall of India, Delhi, 2009
4. P.C. Jain and Monica Jain, Engineering Chemistry, 16th Edition, Dhanpat Rai Publisher, New Delhi, 2016.
5. Sashi Chawla, Text Book of Engineering Chemistry, Dhanpat Rai Publications, New Delhi, 2013.
6. J.C. Kuriacose and J. Rajaram, Chemistry in Engineering & Technology, Vol. 1&2, TMH, 2009.

18ME204 BASIC ELECTRONICS ENGINEERING 2 0 2 3

Course Objectives

- To understand the basic concepts of semiconductor diodes and transistors.
- To illustrate the construction and operation of feedback amplifiers and oscillators.
- To learn the fundamentals of operational amplifiers and digital electronics.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
PO6. 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.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. 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.
PSO1.Design, analyse and evaluate the performance of mechanical systems

Course Outcomes (COs)

1. Infer the behavior of diodes in rectifier and regulator applications, and analyze the role of special electronic devices in basic circuit design
2. Analyze and simplify Boolean expressions using Karnaugh maps to understand logic behavior and circuit efficiency
3. Illustarte the working of analog ICs in various configurations and examine their characteristics.
4. Design basic analog circuits using the 741 Op-Amp by understanding its internal block diagram
5. Develop a control and interface circuits for actuators such as DC, servo, and stepper motors using appropriate electronic devices for embedded or automation applications.

Articulation Matrix

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

UNIT I **6 Hours**

ELECTRONIC DEVICES

Diode construction and working, application of diode, clipper, clamper and rectifier. BJT-construction and working, BJT as switch and amplifier. CRO, Function generator, multimeter and power supply.

UNIT II **6 Hours**

DIGITAL CIRCUITS

Number system, Boolean theorem, logic gates, Simplification of logic function, Combinational circuits- Adder, subtractor, Encoder, decoder, multiplexer, demultiplexer. Sequential circuits- latch, flip-flop, counter.

UNIT III **6 Hours**

ANALOG ICS

Op-Amp (IC 741) - characteristics, application of Op-Amp adder, subtractor, comparator, ADC and DAC. Timer - (555) Astable and monostable multivibrator.

UNIT IV **6 Hours**

SPECIAL ELECTRONIC DEVICES

Introduction to Op-Amp, Differential Amplifier Configurations, CMRR, PSRR, Slew Rate; Block Diagram, Pin Configuration of 741 Op-Amp, Characteristics of Ideal Op-Amp, Concept of Virtual Ground.

UNIT V **6 Hours**

INTERFACING ACTUATORS

Interfacing DC motor with electronic devices, Interfacing SERVO motor with electronic devices, Interfacing stepper motor with electronic devices.

EXPERIMENT 1 6 Hours

Design of regulated power supply. (5v,9v, 12v)

EXPERIMENT 2 6 Hours

BJT as switch and amplifier in Automatic Street light.

EXPERIMENT 3 6 Hours

Combinational circuit as adder, subtractor, encoder, decoder in vending machine.

EXPERIMENT 4 6 Hours

Sequential circuit as counter in water level controller.

EXPERIMENT 5 6 Hours

Application of op-Amp in measurement of temperature.

Total: 60 Hours

Reference(s)

1. David. A. Bell (2003), Laboratory Manual for Electronic Devices and Circuits, Prentice Hall, India
2. J Millman, C. Halkias & Satyabrata JIT, Electronic Devices and Circuits, Tata McGraw-Hill, 2010.
3. S. Salivahanan, N.Suresh Kumar and A.Vallavaraj, Electronic Devices and Circuits, Tata McGraw-Hill Education, 2008
4. D. Roy Choudhry, Shail Jain Linear Integrated Circuits, New Age International Pvt. Ltd., 2000.
5. M. Morris Mano, Michael D Ciletti Digital Design 4th edition Pearson, 2011.

18ME205 MANUFACTURING PROCESSES 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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO4.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

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Apply appropriate casting processes to produce simple metal components using moulds with cores
2. Implement the suitable welding techniques to join materials using appropriate welding equipment.
3. Analyze bulk deformation processes to recommend suitable methods based on functional and application requirements.
4. Investigate process parameters and diagnose defect causes in sheet metal forming techniques to optimize manufacturing performance.
5. Evaluate sheet metal and special forming processes by analyzing their process parameters, advantages, limitations, and suitability for different manufacturing scenarios

Articulation Matrix

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

UNIT I **6 Hours**

CASTING PROCESSES

Introduction to production processes and its classifications - Pattern Types and Allowances. Moulding sand - Types, Properties and Testing. Moulding machines and its types. Melting furnaces -Induction. Fettling and cleaning. Sand casting defects. Special casting processes - 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. 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 -Six 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.

EXPERIMENT 1 3 Hours

To demonstrate the various patterns used in sand casting and prepare a mould using split pattern in sand casting process.

EXPERIMENT 2 3 Hours

Casting of aluminium components

EXPERIMENT 3 **3 Hours**
Fabrication of simple structural shapes using manual Metal Arc Welding

EXPERIMENT 4 **3 Hours**
Fabrication of simple structural shapes using TIG and MIG welding

EXPERIMENT 5 **3 Hours**
Manufacturing of Simple sheet metal components using shearing and bending operations

EXPERIMENT 6 **3 Hours**
Drawing of cup shaped product

EXPERIMENT 7 **3 Hours**
To make a simple thermoplastic component using injection Moulding

EXPERIMENT 8 **3 Hours**
To make a simple component using compression Moulding

EXPERIMENT 9 **3 Hours**
3Extrusion of rod drawing

EXPERIMENT 10 **3 Hours**
To make a pet bottle using Blow Moulding

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

18ME206 COMPUTER PROGRAMMING II 0 0 4 2

Course Objectives

- To understand the basics of C++ and Java primitives, operators, and expressions, conditional and looping statements.
- To understand and apply the concepts of classes, inheritance, interfaces and packages.
- To develop programs using Stings and exception handling.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
PO4. 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.
PO5. 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.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO11. 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.
PO12. 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.
PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Apply basic programming concepts like data types, arrays, and control structures to build simple programs.
2. Develop object-oriented programs using classes, objects, constructors, and destructors.
3. Design applications using inheritance, overloading, and overriding for code reusability.
4. Illustrate the different function calling methods and friend functions to manage data flow.
5. Analyze static variables and packages to organize and reuse code effectively.

Articulation Matrix

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

EXPERIMENT 1 3 Hours

Working with basic data types and arrays.

EXPERIMENT 2 **3 Hours**
Implementation of control statements.

EXPERIMENT 3 **3 Hours**
Implementation of looping statements.

EXPERIMENT 4 **3 Hours**
Implementation of class and objects.

EXPERIMENT 5 **3 Hours**
Working with constructor and destructor.

EXPERIMENT 6 **3 Hours**
Implementation of types of Inheritance.

EXPERIMENT 7 **3 Hours**
Working with call by value and call by reference.

EXPERIMENT 8 **3 Hours**
Implementation of friend function.

EXPERIMENT 9 **3 Hours**
Implementation of overloading.

EXPERIMENT 10 **3 Hours**
Working with basic data types, static variables and arrays.

EXPERIMENT 11 **6 Hours**
Program on Classes and objects.

EXPERIMENT 12 **6 Hours**
Working with Methods.

EXPERIMENT 13 **6 Hours**
Implementation of Inheritance.

EXPERIMENT 14 **6 Hours**
Implementation of Overloading and Overriding.

EXPERIMENT 15 **6 Hours**
Implementation of Packages.

Total: 60 Hours

18ME301 ENGINEERING MATHEMATICS III 3 1 0 4

Course Objectives

- To gain knowledge on Fourier series and Laplace transform through practical applications.
- To understand the concepts of Fourier series and Boundary conditions, which will enable them to model and analyze the physical phenomena.
- To develop the foundations of probabilistic and statistical analysis mostly used in varied applications in Mechanical engineering

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO4.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

PSO1. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply Fourier series to represent various mechanical waveforms by classifying functions as even or odd and constructing appropriate full- or half-range series
2. Analyze the wave and heat conduction problems and find solutions for membrane vibrations by applying Fourier series methods.
3. Assess the Laplace and inverse Laplace transforms to solve differential equations in engineering contexts.
4. Infer expectation and variance of Binomial and Poisson distributions based on probability rules and characteristics of random variables
5. Investigate the statistical inference and hypothesis testing to assess and ensure the quality and reliability of mechanical 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	3	-	-	-	-	-	-	-	-	-	-	1	-	-
3	3	-	-	-	-	-	-	-	-	-	-	-	1	-	-
4	2	3	-	-	-	-	-	-	-	-	-	-	1	-	-
5	2	2	3	2	-	-	-	-	-	-	-	-	1	-	-

UNIT I **9 Hours**

FOURIER SERIES

Introduction-periodic functions- properties, even and odd functions- special wave form: square wave, half wave rectifier, full wave rectifier, saw-toothed wave and triangular wave - Eulers formulae for full range Fourier series, Fourier series for functions of period 2l -Dirichlets conditions - sum of Fourier series- Theorem for the convergence of Fourier series (statement only)- Fourier series of a function with its periodic extension - Half range Fourier series: construction of half range sine series, construction of half range cosine series. Parsevals identity (statement only).

UNIT II **9 Hours**

APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS

Classification of partial differential equations of second order-solution of: one dimensional wave equation, one dimensional heat equation, two dimensional heat equation and vibration of circular membrane.

UNIT III **9 Hours**

LAPLACE TRANSFORM

Laplace Transform: Applications, advantages and sufficient conditions for existence of Laplace transform- general properties of Laplace transform-Laplace transform of periodic function. Inverse Laplace Transform: general properties of inverse Laplace transform - use of partial fraction method to find of inverse Laplace transform - convolution -application of Laplace transform to differential equations with constant coefficients.

UNIT IV **9 Hours**

PROBABILTY THEORY

Probability: Classical definition and its limitations- axiomatic definition-some elementary deduction-frequency interpretation of probability -addition rule for 2 events (proof) and its extension to more than 2 events (statement only)- conditional probability and independent events -extension to more than 2 events (pairwise and mutual independence)- multiplication rule-Bayes theorem (statement only). Random variables: Definition of random variable- continuous and discrete random variables-probability density function & probability mass function for single variable only- distribution function and its properties (without proof)- definitions of expectation and variance, properties- some important discrete distributions: Binomial & Poisson distributions.

UNIT V **9 Hours**

MATHEMATICAL STATISTICS

Population and sample - Sampling distributions. Statistical estimation of parameters, confidence intervals. Testing of hypotheses - one-sample and two-sample inferences. Applications to statistical quality control and reliability analysis.

Tutorial: 15 Hours

Total: 60 Hours

Reference(s)

1. Kreyszig Erwin, Advanced Engineering Mathematics, 7th Edition, John Wiley, 1993.
2. Johnson Richard A. and Bhatacharyya Gouri K., Statistics, Principles and Methods, 3rd Edition, John Wiley, 1996
3. O'Neil Peter V., Advanced Engineering Mathematics, 4th Edition, PWS-Kent, 1995
4. James Glyn, Advanced Modern Engineering Mathematics, Addison-Wesley, 1993
5. Milton J. S. and Arnold Jesse C., Introduction to Probability and Statistics: Principles and Applications for Engineering and The Computing Sciences, McGraw Hill Inc, 3rd Edition, 1995

18ME302 FLUID MECHANICS AND MACHINERY 2 1 2 4

Course Objectives

- To impart knowledge on the properties of fluid and fluid statics principles
- To calculate the rate of flow and energy losses in flow through pipes.
- To emphasise the concepts of boundary layer theory and the importance of dimensional analysis
- To educate the working principles and performance analysis of fluid pumps.
- To provide knowledge on the working principle and performance curves of hydraulic turbines

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
PO4. 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.
PO5. 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.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. 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.
PO12. 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.
PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Interpret the fundamental properties of fluids and apply fluid statics principles to measure fluid pressure using appropriate methods.
2. Demonstrate the phenomenon of fluid motion using the continuity, Bernoulli's, and momentum equations, and quantify energy losses in various piping systems.
3. Apply dimensional analysis techniques to investigate the significance of dimensionless parameters and similitude in fluid flow over bodies.
4. Analyze the performance of hydraulic pumps using velocity triangles and evaluate their efficiency under varying conditions.
5. Investigate the working principles of hydraulic turbines using velocity triangles, and assess their performance through specific speed and characteristic curves.

Articulation Matrix

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

UNIT I **6 Hours**

FLUID PROPERTIES AND FLUID STATICS

Basics: Introduction, Properties of fluids-mass density, weight density, specific volume, specific gravity, viscosity, surface tension, capillarity, vapour pressure, compressibility and bulk modulus. Types of fluids, Types of fluid flow. Fluid statics-Fluid pressure at a point, Variation of pressure with a static fluid, Hydrostatic law Pressure head, Pascal's law, Measurement of pressure, Piezometric tube Manometry

UNIT II **6 Hours**

FLUID KINEMATICS AND DYNAMICS

Concept of control volume - continuity equation, Bernoullis equation and its applications-Momentum Equation- Hydraulic and energy gradient - Laminar flow through circular conduits and circular annuli Darcy Weisbach equation friction factor- Moody diagram- commercial pipes- minor losses- Flow through pipes in series and parallel.

UNIT III **6 Hours**

FLUID FLOW OVER BODIES AND DIMENSIONAL ANALYSIS

Boundary layer concepts-Types of boundary layer thickness -Lift and Drag of an aerofoil -Need for dimensional analysis -Methods of dimensional analysis using Buckingham pi theorem -Similitude - Types of similitude-Dimensionless parameters-Application of Dimensionless parameters-Model Analysis.

UNIT IV **6 Hours**

HYDRAULIC PUMPS

Euler's equation - Theory of roto-dynamic machines-Centrifugal pumps working principle- velocity triangle -work done by the impeller - performance curves - Reciprocating pump- working principle Rotary pumps -classification.

UNIT V **6 Hours**

HYDRAULIC TURBINES

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

EXPERIMENT 1 3 Hours

Visualize the flow using Reynolds apparatus

EXPERIMENT 2 3 Hours

Verification of Bernoullis theorem and Determine the coefficient of discharge using Venturimeter

EXPERIMENT 3 3 Hours

Determination of friction factor for a given set of pipes

EXPERIMENT 4 **3 Hours**

Determine the coefficient of discharge for a rotometer and orificemeter

EXPERIMENT 5 **3 Hours**

Determination of lift and drag force of an aerofoil.

EXPERIMENT 6 **3 Hours**

Performance test on tangential flow impulse turbine against constant head.

EXPERIMENT 7 **3 Hours**

Performance test on Francis turbine against constant head

EXPERIMENT 8 **3 Hours**

Performance test on reaction (Kaplan) turbine

EXPERIMENT 9 **3 Hours**

Performance test on centrifugal pump.

EXPERIMENT 10 **3 Hours**

Performance test on submersible pump/Gear pump.

Tutorial: 15 Hours

Total: 75 Hours

Reference(s)

1. Yunus A. Cengel, and John M. Cimbala, Fluid Mechanics, Third edition, Mc Graw Hill Education (India) Pvt. Ltd, 2014.
2. Dr R.K. Bansal , A text book of Fluid Mechanics and Hydraulic Machines, Tenth Edition, Laxmi Publications, New Delhi, 2018.
3. Frank .M. White, Fluid Mechanics, McGraw Hill Publishing Company Ltd, New Delhi, 8th Edition. 2017
4. R.C.Hibbler, Fluid Mechanics, Pearson, First edition, 2017.
5. S.K. Som and G. Biswas, Introduction to Fluid Machines, 3rd Edition, McGraw-Hill Education, 2017.
6. https://nptel.ac.in/courses/112105183/.

18ME303 ENGINEERING THERMODYNAMICS 3 1 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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO4. 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.

PO6. 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.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO12. 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

PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Apply the basic concepts and the zeroth law of thermodynamics to establish thermal equilibrium in engineering systems.
2. Assess the performance of the closed and open systems by applying the concept of first law of thermodynamics.
3. Analyze the performance of thermodynamic systems by applying the second law of thermodynamics and quantify irreversibility using entropy and availability.
4. Compare the properties and phase change behavior of pure substances by applying property relations and thermodynamic diagrams.
5. Investigate the air-standard performance of internal combustion engines and thermodynamic behavior of gas mixtures by applying thermodynamic principles.

Articulation Matrix

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

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, first law for Closed systems - constant pressure process, constant volume process, constant temperature process, adiabatic process, polytropic process, throttling process. First 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 first 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 der Waals 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, Thermodynamic properties, Psychrometric properties and processes - Psychrometric chart. Air standard cycles Otto, Diesel and Dual cycles- 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.

Tutorial: 15 Hours

Total: 60 Hours

Reference(s)

1. Y. Cengel and Boles, Thermodynamics - An Engineering Approach, Tata McGraw Hill Publishing Company Pvt. Ltd, New Delhi, 2011.
2. P.K. Nag, Engineering Thermodynamics, Tata McGraw Hill Publishing Company Pvt. Ltd, New Delhi, 2017.
3. J.P. Holman, Thermodynamics, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi, 2016.
4. R.K. Rajput, Engineering Thermodynamics, Laxmi Publications Pvt. Ltd., New Delhi, 2017.
5. Gordon J. Van Wylen, Richard E. Sonntag, Fundamentals of Classical Thermodynamics, December 31st 1978, John Wiley & Sons.
6. https://onlinecourses.nptel.ac.in/noc18_ae05/preview.

18ME304 MANUFACTURING TECHNOLOGY 2 0 2 3

Course Objectives

- To learn the metal cutting theory, measure the forces acting on the single point tool and calculate various forces involved in it.
- To familiarize about the construction, working and operations of centre, semi-automatic, automatic lathes. Also gain basic working skills for making simple components in centre and semi automatic lathe.
- To provide working skill and knowledge on construction and working of milling and gear cutting machines.
- To impart the knowledge on working of reciprocating, drilling, boring machines and provide working skill in slotting and drilling machines.
- To familiarize about the construction and working of broaching, grinding, fine finishing processes and to provide working skills in grinding machines

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO6. 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.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PO12. 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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Apply the principles of orthogonal and oblique cutting and evaluate metal cutting performance using Merchant's Circle.
2. Develop the simple cylindrical and stepped components by using lathe machines suited for specific applications.
3. Analyze milling and gear cutting processes to select suitable machines for manufacturing components based on workpiece specifications.
4. Demonstrate machining operations on basic components using suitable reciprocating and drilling machines, based on part geometry and production requirements.
5. Develop components with specified surface finish, texture, and dimensional accuracy using broaching and finishing processes.

Articulation Matrix

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

UNIT I **7 Hours**

METAL CUTTING THEORY

Introduction - Orthogonal, Oblique Cutting and types of chip formation. Mechanisms of metal cutting - Chip thickness ratio and Shear plane. Merchant's Circle - Deriving the forces, calculations. Cutting tool - Properties and materials, wear. Single point tool nomenclature, tool life and its calculations. Cutting fluids -properties.

UNIT II **6 Hours**

LATHE, SEMI AUTOMATS AND AUTOMATS

Introduction - Types- Centre Lathe - Construction, specification, operations. Mechanisms - Thread cutting. Work holding devices - Centres, chucks, carrier and catch plate and face plates. Calculation of machining time. Capstan and turret lathes - Introduction and turret indexing mechanism. Automats - single spindle, multi spindle and their types.

UNIT III **6 Hours**

MILLING MACHINE AND GEAR CUTTING MACHINES

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

UNIT IV **6 Hours**

RECIPROCATING MACHINES, DRILLING AND BORING MACHINES

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

UNIT V **5 Hours**

BROACHING AND FINISHING PROCESSES

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

EXPERIMENT 1 — 3 Hours

Measurement of cutting forces acting on the tool during turning operation using dynamometer.

EXPERIMENT 2 — 3 Hours

Exercise on step turning using orthogonal and oblique cutting tool.

EXPERIMENT 3 — 3 Hours

Exercise on grooving, thread cutting and boring using centre lathe

EXPERIMENT 4 — 3 Hours

Exercise on turning, drilling and tapping using capstan lathe.

EXPERIMENT 5 — 3 Hours

Machining of Pentagonal/Hexagonal/octagonal sides from cylindrical work piece using Milling machine

EXPERIMENT 6 **3 Hours**
Preparation of spur gear from cylindrical work piece using gear hobbing machine.

EXPERIMENT 7 **3 Hours**
Machining an internal key way using Slotter machine.

EXPERIMENT 8 **3 Hours**
Exercise on drilling and tapping operation using drilling machine.

EXPERIMENT 9 **3 Hours**
Machining a metal flat using surface grinding machine.

EXPERIMENT 10 **3 Hours**
Machining a shaft using cylindrical grinding machine.

Total: 60 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, 2014.
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

18ME305 KINEMATICS OF MACHINES 3 1 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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO12. 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.

PSO1. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply kinematic principles to determine degrees of freedom, mechanical advantage, and inversions in basic planar mechanisms.
2. Investigate velocity and acceleration in simple and complex planar mechanisms using graphical methods to support motion analysis.
3. Analyze the motion characteristics of different follower types and cam profiles to meet specific operating conditions.
4. Compare different types of gear systems and gear trains, and compute speed ratios and transmission parameters.
5. Evaluate belt and clutch drive parameters to develop the efficient friction-drive systems for power transmission applications.

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	2	-	-	-	-	-	-	-	-	-	2	2	-	-
3	2	3	-	-	-	-	-	-	-	-	-	2	2	-	-
4	2	3	-	-	-	-	-	-	-	-	-	2	2	-	-
5	2	2	3	-	-	-	-	-	-	-	-	2	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.

UNIT II **9 Hours**

KINEMATIC ANALYSIS OF MECHANISMS

Relative velocity of kinematic link, Rubbing Velocity of kinematic pair, Coriolis component of Acceleration. 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. Gear trains- Speed ratio, train value. Simple gear train, compound gear train, Epicyclic gear train- speed calculation by tabular method.

UNIT V **9 Hours**

FRICTION DRIVES

Introduction-Friction clutch, types -single plate and Multi plate 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.

Tutorial: 15 Hours

Total: 60 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. Sadhu Singh, Theory of Machines, Second Edition, Pearson Education, 2012.
4. Ballaney P L, Theory of Machines and Mechanisms, Khanna Publishers, New Delhi, 2005.
5. Rao J S and Dukkipati, Mechanism and Machine Theory, Wiley- Eastern Ltd., New Delhi, 2006.
6. https://nptel.ac.in/courses/112104121/1

18ME306 MACHINE DRAWING LABORATORY 1 0 2 2

Course Objectives

- To provide knowledge on reading of machine drawing with Geometric Dimensioning and Tolerancing (GD & T)
- To familiarize the representation of various machine element drawings
- To impart the significance of sectional views and its representation in drawings
- To provide knowledge on assembly drawings of mechanical supporting components
- To develop skill to draw the assembly drawings of machine tool and automobile components

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO5. 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..

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PO12. 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.

PSO1. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Illustrate the fundamentals of machine drawing, including BIS drawing codes, limits, fits, tolerances, surface roughness, and weld symbols.
2. Analyze various machine drawing types such as assembly, production, detailed, and patent drawings to infer their functional and design purposes.
3. Assemble mechanical components such as couplings, glands, and joints by interpreting detailed engineering drawings and bill of materials
4. Apply the concept of sectional views in machine elements to interpret the suitability of part integration within assemblies
5. Develop complete assembly drawings for machine components such as screw jack, plummer block, and connecting rod by integrating standard practices in sectional and detailed representations

Articulation Matrix

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

UNIT I **5 Hours**

INTRODUCTION TO MACHINE DRAWING AND GD

Importance of Machine Drawing - BIS-SP 46 Drawing codes - Classification of Machine Drawings: Assembly drawing, production drawing, detailed drawing, catalogues drawing, patent drawing - Geometric constraint and symbols - Fundamentals of Limits, Tolerances, Fits, surface roughness and its indication in drawings - Elementary weld symbols

UNIT II **5 Hours**

REPRESENTATION OF MACHINE ELEMENTS

Representation of hexagonal bolt and nut - Forms and proportions of rivet heads: chain and zigzag type - Representation of screws, taper keys, pins.

UNIT III **8 Hours**

INTRODUCTION OF SECTIONAL VIEWS

Sectional views: cutting plane and its representation, hatching of sections, full section, half section, local sections, revolved sections, thin sections - Sectional views of single parts: pedestal bearing, shaft support, bracket

UNIT IV **12 Hours**

ASSEMBLY DRAWINGS OF MECHANICAL SUPPORTING COMPONENTS

Reading of detailed drawings: Bill of materials, Assembly concept, sectional views of assembled drawings - Joint: Strap joint with Gib and Cotter - Coupling: Unprotected type flanged coupling - Gland and stuffing box.

UNIT V **15 Hours**

ASSEMBLY DRAWINGS OF MACHINE COMPONENTS

Machine tool parts: Screw jack, Plummer block, Machine Vice, Tail stock - Automobile component: Piston and connecting rod of Petrol engine.

Total: 45 Hours

Reference(s)

1. Gary R. Bertoline, Eric N. Wiebe, Technical Graphics Communication, IR WIN Graphic Series, 4th edition, Tata McGraw Hill, 2017
2. Brian Griffths, Engineering Drawing for Manufacture, Kogan Page Science, 2012
3. N.D. Bhatt, Machine Drawing, Charotar Publishing House Pvt. Ltd., 2014
4. K.R. Gopalakrishna, Machine Drawing, Subash stores, 20th edition, 2012
5. https://nptel.ac.in/syllabus/112106075/

18ME307 COMPUTER AIDED MODELLING LABORATORY I 0 0 4 2

Course Objectives

- To provide knowledge and skills to draw orthographic projections of simple components using geometric modeling 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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO4.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

PO5. 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.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PO12. 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.

PSO1. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply 3D modeling techniques to create orthographic views from given isometric drawings for mechanical components using CAD software tools.
2. Develop 3D assembly models of mechanical components and subsystems like bearings, shafts, and couplings, incorporating dimensional tolerances and constraints.
3. Create accurate assembly models of mechanical systems including piston–connecting rods, power drives, and suspensions, ensuring geometric compatibility and assembly relationships.
4. Simulate the motion of simple mechanical mechanisms and visualize their working using animation features in 3D modeling software.
5. Build a detailed technical documentation including exploded views and part lists for complex assemblies such as an I.C. engine, adhering to industrial drafting standards.

Articulation Matrix

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

EXPERIMENT 1 **6 Hours**

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

EXPERIMENT 2 **6 Hours**

Construct a three dimensional assembly model of bearing.

EXPERIMENT 3 **6 Hours**

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

EXPERIMENT 4 **6 Hours**

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

EXPERIMENT 5 **6 Hours**

Build a three dimensional assembly model of power drive system.

EXPERIMENT 6 **6 Hours**

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

EXPERIMENT 7 **6 Hours**

Construct a three dimensional assembly model of control valve.

EXPERIMENT 8 **6 Hours**

Generate a three dimensional assembly model of Jig/fixture.

EXPERIMENT 9 **6 Hours**

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

EXPERIMENT 10 **6 Hours**

Create technical documents for an I.C engine assembly using 3D via software.

Total: 60 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.

18GE301 SOFT SKILLS - VERBAL ABILITY 0 0 2 0

Course Objectives

- To help students gain adequate proficiency in vocabulary
- To read and understand unabridged text
- To help students become proficient in basic writing skills related to work place communication

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. 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.
PO12. 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
PSO1. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply verbal ability skills to approach placement test tasks with clarity and confidence
2. Analyze effective written communication for professional and workplace settings, and develop confidence in writing.

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	-	-	-	-	-	-	2	2	-	2	-	-	-

UNIT I **15 Hours**

INTRODUCTION

Synonyms - Antonyms - Word Groups - Verbal Analogies - Etymology - Critical Reasoning - Cloze Test - One Word Substitution - Idioms and Phrases - Text & Paragraph Completion.

UNIT II **15 Hours**

BASICS OF VERBAL APTITUDE

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. Murphy, Raymond. English Grammar in Use A Self-Study Reference and Practice Book for Intermediate Learners of English. IV Edition. United Kingdom: Cambridge University Press, 2012.
2. Lewis, Norman. Word Power Made Easy. New York: Pocket Books, 1991.
3. Baron''s The Official Guide for New GMAT Review, New Jersey: John Wiley & Sons, Inc. 2015

18ME401 NUMERICAL METHODS 3 1 0 4

Course Objectives

- To analyze a mathematical problem and determine which numerical technique to use to solve it.
- To understand the methods to solve polynomial equations and implement the mathematical ideas for interpolation numerically
- To summarize and apply the methodologies involved in solving problems related to ordinary and partial differential equations

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
PO6. 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.
PSO1. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply numerical methods to solve nonlinear equations and linear systems.
2. Implement finite difference tables for forward and backward interpolation.
3. Investigate the limitations of various numerical techniques for differentiation and integration.
4. Develop numerical solutions to ordinary differential equations using appropriate numerical methods.
5. Analyze finite difference methods to simulate partial differential equations for solving complex engineering problems

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	3	-	-	-	2	-	-	-	-	-	-	1	-	-
4	3	3	3	-	-	2	-	-	-	-	-	-	1	-	-
5	2	3	-	-	-	2	-	-	-	-	-	-	1	-	-

UNIT I **9 Hours**

APPROXIMATION

Approximation in numerical computation: Truncation and rounding errors- fixed and floating-pointarithmetic - propagation of errors.Numerical solution of algebraic equations: Bisection method - Regula-Falsi method - Newton-Raphson method. Numerical solution of a system of linear equations: Gauss elimination method - Matrix inversion- LU Factorization method - Gauss-Seidel iterative method

UNIT II **9 Hours**

INTERPOLATION

Interpolation: Newton forward/backward interpolation- Lagranges - Newtons divided difference Interpolation.

UNIT III **9 Hours**

NUMERICAL DIFFERENTIATION

Numerical single and double integration: Trapezoidal rule- Simpsons 1/3 rule - Expression for corresponding error terms.

UNIT IV **9 Hours**

NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATION

Numerical solution of ordinary differential equation: Eulers method - Runge-Kutta methods- Milnes Predictor-Corrector methods- Adams Predictor-Corrector methods - Finite Difference method.

UNIT V **9 Hours**

NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATION

Finite difference solution of parabolic equations by Crank-Nicholson method-elliptic equations by iterative methods-hyperbolic equations by explicit finite difference method.

Tutorial: 15 Hours

Total: 60 Hours

Reference(s)

1. Sankara Rao. K, Numerical Methods for Scientists and Engineers, Third Edition, Eastern Economy Edition, 2009.
2. Grewal B. S, Numerical Methods in Engineering and Science with Programms in C & C++, Ninth Edition, Khanna Publications, 2010.
3. Gerald C.F and Wheatley P.O,Applied Numerical Analysis, Seventh Edition, Pearson Education, New Delhi, 2006.
4. Jain M.K, Iyangar S.R.K and Jain R.K Numerical Methods for Scientific and Engineering Computation New Age International (P) Ltd , New Delhi, 2005.
5. S.S. Sastry, Introductory Methods of Numerical Analysis, Fifth Edition, PHI Learning Pvt. Ltd, 2012.
6. Burden R. L and Douglas Faires J, Numerical Analysis Theory and Applications, Cengage Learning, Ninth Edition, 2005.

18ME402 APPLIED HYDRAULICS AND PNEUMATICS

2 0 2 3

Course Objectives

- To learn about fluid power systems and its fundamentals.
- To impart knowledge on various types of hydraulic pumps and actuators.
- To learn about various fluid power control components and its functions.
- To study about various types of pneumatic components and servo system.
- To learn fluid power circuit design methods and its applications.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO4.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

PO5. 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.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PO12. 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.

PSO1. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply the basic principles of fluid power systems and infer the effects of fluid properties and flow types in hydraulic applications.
2. Illustrate the construction and working of various hydraulic pumps and actuators, and compare their performance characteristics.
3. Develop the control strategies using pressure, direction, and flow control valves to simulate the hydraulic circuits.
4. Investigate the components of pneumatic systems and servo mechanisms for automation purposes.
5. Design and simulate the hydraulic and pneumatic circuits using PLC for engineering applications.

Articulation Matrix

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

UNIT I **4 Hours**

FLUID POWER SYSTEMS AND FUNDAMENTALS

Introduction to fluid power, Advantages of fluid power, Application of fluid power system. Properties of hydraulic fluids-Fluid power symbols. Basics of Hydraulics-Applications of Pascals Law- Laminar and Turbulent flow- Reynolds number.

UNIT II **6 Hours**

HYDRAULIC SYSTEM AND COMPONENTS

Sources of Hydraulic Power: Pumping theory - Pump classification - Gear pump, Vane Pump, piston pump, construction and working of pumps - pump performance . Fluid Power Actuators: Linear hydraulic actuators - Types of hydraulic cylinders - Single acting, Double acting, special cylinders like tandem, Rodless, Telescopic, Cushioning mechanism, Rotary actuators- Gear, Vane and Piston motors

UNIT III **7 Hours**

CONTROL COMPONENTS

Construction and function of Control Components : Direction control valve - 3/2 , 4/2 , Shuttle and check valve. Pressure control valve: pressure reducing valve-pilot operated, relief valve - pilot operated and sequence valve. Flow control valve: pressure compensated and non-pressure compensated valves. Accumulators and Intensifiers: Types -weight and spring loaded - Accumulator circuits. Intensifier - Intensifier circuit.

UNIT IV **6 Hours**

PNEUMATIC SYSTEM COMPONENTS AND SERVO SYSTEMS

Pneumatic Components: Compressors- Piston compressor working, Filter, Regulator and Lubricator Unit. Air control valves: Quick exhaust valve and Muffler. Pneumatic actuators-types. Servo systems : Hydro Mechanical servo systems, Electro hydraulic servo systems. Fluidics-Introduction.

UNIT V **7 Hours**

DESIGN OF HYDRAULIC AND PNEUMATIC CIRCUITS

Introduction to PLC - ladder diagrams, PLC applications in fluid power control. Fluid Power Circuit Design, Speed control circuits, synchronizing circuit, Pneumo hydraulic circuit, Sequential circuit design for simple applications using cascade method.

EXPERIMENT 1 — 2 Hours

Identification of fluid power system components with its symbols.

EXPERIMENT 2 — 2 Hours

A study on pascals law with one application

EXPERIMENT 3 — 3 Hours

Simulation of single and double acting cylinder.

EXPERIMENT 4 — 3 Hours

Simulation of rotary actuator.

EXPERIMENT 5 — 3 Hours

Construction and simulation of basic hydraulic circuit using various control components.

EXPERIMENT 6 **3 Hours**

Construction and simulation of hydraulic circuit using intensifier and accumulator.

EXPERIMENT 7 **3 Hours**

Construction and simulation of basic pneumatic circuit, with and without quick exhaust valve.

EXPERIMENT 8 **3 Hours**

Construction and simulation of pneumatic circuit, with and without muffler.

EXPERIMENT 9 **4 Hours**

Simulation of speed control circuits and sequential circuit.

EXPERIMENT 10 **4 Hours**

Design a simple circuit using cascade method and verify theoretically.

Total: 60 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. James L. Johnson, Introduction to Fluid Power, Delmar Thomson Learning, 2003.
4. S. R. Majumdar, Pneumatic systems Principles and maintenance, Tata McGraw Hill Publishing Company Pvt Ltd. New Delhi, 2008
5. S.Illango,V. Soundarrajan, Introduction to Hydraulics and Pneumatics, Prentice hall of India, New Delhi, 2007.
6. https://www.youtube.com/watch?v=8xd7cWvMrvE

18ME403 DYNAMICS OF MACHINES 2 1 2 4

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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO4. 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.

PO5. 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.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PO12. 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.

PSO1. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Analyze the dynamic behavior of simple mechanisms and design flywheels for energy fluctuation control.
2. Apply force and couple polygon methods to determine the balancing mass required for rotating and reciprocating systems.
3. Infer the gyroscopic effect on ships and airplanes, and calculate the speed range of governors to assess system stability.
4. Evaluate the natural frequency of single degree of freedom systems under free and forced vibrations.
5. Investigate the single, two and three rotor system concepts to evaluate the natural frequencies of transverse and torsional vibrating systems.

Articulation Matrix

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

FUNDAMENTALS OF VIBRATION

Introduction-Terminology, Classification, elements of vibration, free undamped vibration, Free Damped vibration (Viscus Damping) - Damping ratio and logarithmic decrement. Forced 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.

EXPERIMENT 1 3 Hours

Determine the moment of inertia of object by flywheel.

EXPERIMENT 2 3 Hours

Dynamic analysis of four bar mechanism using CAD software

EXPERIMENT 3 3 Hours

Exercise on Balancing of reciprocating masses in slider crank mechanism.

EXPERIMENT 4 3 Hours

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

EXPERIMENT 5 3 Hours

Determine the characteristics and effort of Porter and Proell Governors.

EXPERIMENT 6 3 Hours

Analyze the gyroscopic effect using Gyroscope and verify its laws.

EXPERIMENT 7 **3 Hours**

Determination of natural frequency of single degree of freedom system.

EXPERIMENT 8 **3 Hours**

Determine the frequency of forced vibration using electro dynamic shaker.

EXPERIMENT 9 **3 Hours**

Determination of critical speed of shaft with concentrated loads (Whirling of shaft)

EXPERIMENT 10 **3 Hours**

Determine the natural frequency of cantilever beam.

Tutorial: 15 Hours

Total: 75 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. https://nptel.ac.in/courses/112104114/9

18ME404 STRENGTH OF MATERIALS 2 1 2 4

Course Objectives

- To provide knowledge about stress distribution and strains in regular and composite structures subjected to axial loads
- To familiarize about two dimensional stress systems and stresses in thin cylinders
- To give input on shear force, bending moment diagrams and evaluate the bending stress in different beams under transverse loading
- To impart knowledge on finding slope and deflection of beams and buckling of columns for different boundary conditions
- To provide awareness on stresses on shafts and helical springs based on theory of torsion

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO4.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

PO5. 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.

PO6. 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.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PO12. 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.

PSO1. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Analyze the stress and strains induced in regular and composite structures subjected to axial loads and temperature difference.
2. Assess the behaviour of thin cylinders and structures subjected to three dimensional axial loads
3. Investigate the strength criteria of beams by analyzing the shear force, bending moment, and induced bending stresses under transverse loading.
4. Analyze the slope and deflection of beams, along with the buckling loads of columns, under different boundary conditions.
5. Apply torsion equation in design of circular shafts and helical springs

Articulation Matrix

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

UNIT I **6 Hours**

STRESS, STRAIN AND DEFORMATION OF SOLIDS

Introduction to material properties, Stress-strain curve for ductile and brittle materials, Hooke's law, Stresses and strains due to axial force in Stepped and Composite bars, Stresses due to thermal effect in composite bars, Factor of safety, Poisson-ratio, Elastic constants and their relationship

UNIT II **6 Hours**

STRESSES IN TWO DIMENSIONS

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

UNIT III **6 Hours**

SHEAR FORCE, BENDING MOMENT AND STRESSES IN BEAMS

Types of supports, Loads and beams, Shear force and Bending Moment in Cantilever, simply supported and overhanging beams, Point of contra flexure. Theory of Simple Bending, Bending stress and 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 and simply supported beams by Double integration method and Macaulay's method. Types of Columns, Equivalent length, Euler and Rankine's formulae, Slenderness ratio

UNIT V **6 Hours**

TORSION IN SHAFT AND HELICAL SPRING

Torsion of circular solid and hollow shafts, shear strength, 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

EXPERIMENT 1 — 3 Hours

Find the hardness of the material using Rockwell hardness tester

EXPERIMENT 2 — 3 Hours

Calculate the hardness of the material using Brinell hardness tester

EXPERIMENT 3 — 3 Hours

Calculate the hardness of the material using micro Vickers hardness tester

EXPERIMENT 4 **3 Hours**

Plot stress-strain curve by observing the tensile behaviour of the given specimen

EXPERIMENT 5 **3 Hours**

Study the deflection of a simply supported beam and compare the experimental values of deflection with the theoretical values.

EXPERIMENT 6 **3 Hours**

Determine the compressive strength of the materials

EXPERIMENT 7 **3 Hours**

Calculate the strains in cylindrical vessels subjected to internal pressure through thin cylinder test setup

EXPERIMENT 8 **3 Hours**

Experimentally determine the strain energy of a material subjected to impact loading

EXPERIMENT 9 **3 Hours**

Determination of spring constant through load vs deflection curve

EXPERIMENT 10 **3 Hours**

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

Tutorial: 15 Hours

Total: 75 Hours

Reference(s)

1. S.S. Rattan, Strength of Materials, McGraw Hill Education (India) Private Limited, Chennai, Third Edition, 2017
2. F.P. Beer and R. Johnston, McGraw Hill Education India Private Limited, Seventh edition, 2017
3. S.S. Bhavikatti, Strength of Materials, Vikas Publishing House, New Delhi, Fourth edition, 2013
4. Egor P. Popov, Engineering Mechanics of Solids, Pearson India Education Services Pvt Ltd, New Delhi, 2015
5. William Nash and Nilanjan Malik, Strength of Materials (Schaum's Outline Series), McGraw Hill Education, Fourth Edition, 2017
6. https://onlinecourses.nptel.ac.in/noc18_ce17/preview

18ME405 THERMAL ENGINEERING 2 1 2 4

Course Objectives

- To study the components, systems and performance of internal combustion engines
- To integrate the concepts, laws and methodologies from the first course in thermodynamics into analysis of Brayton cycle and steam power cycles
- To provide knowledge on steam nozzles and steam turbines
- To impart knowledge on working principles and performance of air compressors
- To apply the thermodynamic concepts into refrigeration and air conditioning systems

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO4. 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.

PO5. 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.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PO12. 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.

PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Apply the thermodynamic principles to evaluate the performance of single-cylinder and multi-cylinder internal combustion engines.
2. Analyze the thermal performance of modified Brayton and Rankine cycles to enhance efficiency and work ratio.
3. Assess steam nozzle efficiency and turbine stage behavior through impulse and reaction principles, critical pressure ratios and velocity diagrams.
4. Investigate the reciprocating and rotary compressors with and without clearance volume, to select the suitable compressor for HVAC application
5. Design vapor compression systems with subcooling and superheating techniques for refrigeration and air conditioning applications.

Articulation Matrix

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

UNIT I **6 Hours**

INTERNAL COMBUSTION ENGINES

Internal combustion engines - classification, components and functions - Fuel supply systems - Ignition Systems - Lubrication system and cooling system - Performance calculation - Heat balance sheet.

UNIT II **6 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.

UNIT III **6 Hours**

STEAM NOZZLES AND TURBINES

Flow of steam through nozzles - shapes of nozzles, effect of friction, critical pressure ratio. Impulse and reaction turbines - compounding of turbines - velocity diagrams for simple and multistage turbines.

UNIT IV **6 Hours**

AIR COMPRESSORS

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, Work of compression. Rotary compressors - Centrifugal, vane and roots blower, screw compressors.

UNIT V **6 Hours**

REFRIGERATION AND AIR-CONDITIONING

Vapour compression refrigeration cycle - Effect of operating conditions on COP, 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.

EXPERIMENT 1 3 Hours

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

EXPERIMENT 2 3 Hours

Experimental study on performance test of 4-Stroke diesel engine

EXPERIMENT 3 **3 Hours**

Experimental study on heat balance test of 4-Stroke diesel engine

EXPERIMENT 4 **3 Hours**

Experimental study on performance test of 4-Stroke Petrol engine

EXPERIMENT 5 **3 Hours**

Morse test on multi-cylinder petrol engine

EXPERIMENT 6 **3 Hours**

Study of steam turbines and steam nozzles

EXPERIMENT 7 **3 Hours**

Experimental study on performance of two stage reciprocating air compressor

EXPERIMENT 8 **3 Hours**

Experimental study on rotary compressors

EXPERIMENT 9 **3 Hours**

Experimental study on determination of Coefficient of Performance of refrigeration system

EXPERIMENT 10 **3 Hours**

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

Tutorial: 15 Hours

Total: 75 Hours

Reference(s)

1. R.K. Rajput, Thermal Engineering, 10th edition, Lakshmi Publications, 2018
2. Mahesh M Rathore, Thermal Engineering, 1st edition, Tata McGraw Hill Education Private Limited, 2010
3. Ed. Frank Kreith, The CRC Handbook of Thermal Engineering, CRC Press LLC, 2000
4. Yunus A Cengel, Robert H Turner and John M Cimbala, Fundamentals of Thermal-Fluid Sciences, 5th edition, McGraw-Hill Education, 2016

18ME406 MICROPROCESSORS AND MICROCONTROLLER 2 0 2 3

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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO5. 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.

PSO1. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply the architecture and instruction set of 8085 and 8051 to develop simple assembly language programs.
2. Analyze the timing diagrams and addressing modes of microprocessor and microcontroller to interpret their operations accurately.
3. Design and develop interfacing solutions for memory and I/O devices using 8085 microprocessor.
4. Develop programs to interface ADC, DAC, sensors, and actuators using 8051 microcontroller for real-time applications.
5. Integrate various microprocessor-based system configurations and demonstrate applications such as LED displays and traffic light control.

Articulation Matrix

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

UNIT I **6 Hours**

8085 CPU

Functional Building Blocks of Processor - 8085 Pin Diagram - 8085 Architecture - Instruction set - Addressing modes -Timing diagrams - Assembly language programming - Stack - Interrupts.

UNIT II **6 Hours**

8085 INTERFACING

Memory interfacing - Interfacing, I/O devices - Interfacing Serial I/O (8251) - Parallel I/O (8255) - Keyboard / Display controller (8279).

UNIT III **6 Hours**

PERIPHERALS INTERFACING

ADC/DAC interfacing - Inter Integrated Circuits interfacing (I2C Standard) - Case studies: Traffic Light control, LED display interface using 8085 microprocessor.

UNIT IV **6 Hours**

8051 MICROCONTROLLER

Functional Building Blocks of 8051 Micro-controller - 8051 Micro-controller Hardware - I/O Pins, Ports and Circuits - Timing Diagram - External Memory - Interrupts.

UNIT V **6 Hours**

8051 PROGRAMMING AND APPLICATIONS

Special Function Registers(SFRs) - 8051 Instruction Set - Addressing Modes - Assembly Language Programming - I/O Port Programming - Case studies : Interfacing - Sensors, Stepper Motors using 8051 Micro-Controller.

EXPERIMENT 1 **4 Hours**

Programs for 8/16 bit Arithmetic operations (Addition / Subtraction) (Using 8085).

EXPERIMENT 2 **2 Hours**

Programs for 8 bit Arithmetic operations (Multiplication / Division) (Using 8085).

EXPERIMENT 3 **4 Hours**

Program for finding Ascending order and Descending order (Using 8085).

EXPERIMENT 4 **4 Hours**

Program for finding Maximum and Minimum number (Using 8085).

EXPERIMENT 5 **4 Hours**

Interfacing and Programming of 8279

EXPERIMENT 6 **2 Hours**

Interfacing and Programming of 8255

EXPERIMENT 7 **2 Hours**

Interfacing of Analog to Digital Converter (ADC) using 8085 microprocessor.

EXPERIMENT 8 **2 Hours**

Interfacing of Digital to Analog Converter (DAC) using 8085 microprocessor.

EXPERIMENT 9 **2 Hours**

Programming Arithmetic operation (Addition / Subtraction) using 8051 microcontroller.

EXPERIMENT 10 **4 Hours**

Programming Arithmetic operation (Multiplication / Division) using 8051 microcontroller.

Total: 60 Hours

Reference(s)

1. Ramesh S. Gaonkar, Microprocessor Architecture, Programming and application with 8085, Penram International Publishing, New Delhi, 2012.
2. John Uffenbeck, The 80x86 Family, Design, Programming and Interfacing, Pearson Education, New Delhi, 2012.
3. Mohammed Ali Mazidi and Janice Gillispie Mazidi, The 8051 Microcontroller and Embedded Systems, Pearson Education Asia, New Delhi, 2013.
4. A. K. Ray and K. M. Burchandi, Intel Microprocessors Architecture Programming and Interfacing, McGraw Hill International Edition, New Delhi, 2000.
5. M. Rafi Quazzaman, Microprocessors Theory and Applications, Intel and Motorola, Prentice Hall of India, New Delhi, 2003.
6. https://onlinecourses.nptel.ac.in/noc19_ee11/preview

18ME407 COMPUTER AIDED MODELLING LABORATORY II 0 0 4 2

Course Objectives

- To provide skills to create drafting from part and assembly models.
- To impart the skill to create surface models of automotive/ machine components
- To provide knowledge on generating models of sheet metal components .
- To provide knowledge to create simulation of assembly models/mechanisms
- To expose the knowledge to prepare the technical documents of complete assembly using Product Lifecycle Management (PLM) concepts

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO5. 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.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PO11. 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.

PO12. 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.

PSO1. Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Apply design concepts to create detailed 2D orthographic and sectional views from 3D part and assembly models, incorporating dimensional and geometric tolerances.
2. Design complex surface models to develop the automotive components and consumer products such as PET bottles.
3. Develop the surface model using sheet metal for automotive and HVAC systems.
4. Analyze fluid power systems to predict motion and collision responses using virtual simulation tools
5. Demonstrate Product Lifecycle Management (PLM) concepts by applying comprehensive technical documentation and 3D assembly models

Articulation Matrix

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

EXPERIMENT 1 **6 Hours**

Create a detailed orthographic view of machine components from part/ assembly models with tolerances

EXPERIMENT 2 **6 Hours**

Create the detailed 2D orthographic sectional views from 3D part/assembly models with geometrical features

EXPERIMENT 3 **6 Hours**

Generate a three dimensional surface models of automotive components

EXPERIMENT 4 **6 Hours**

Create a three dimensional surface models of pet bottles for specific capacities.

EXPERIMENT 5 **6 Hours**

Build sheet metal models of automotive components.

EXPERIMENT 6 **6 Hours**

Build sheet metal models of Air Conditioning Systems.

EXPERIMENT 7 **6 Hours**

Create simulation of slider crank mechanisms and analyze its collisions.

EXPERIMENT 8 **6 Hours**

Create simulation of hydraulic /pneumatic systems analyze its collisions

EXPERIMENT 9 **6 Hours**

Create a three dimensional assembly model and generate the detailed document with PLM concept.

EXPERIMENT 10 **6 Hours**

Prepare technical documents for an I.C. Engine Assembly with PLM concepts.

Total: 60 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
3. Theory of Modeling and Simulation, Bernard P. Zeigler, Herbert Praehofer, Tag Gon Kim, 2000
4. Product Lifecycle Management: 21st Century Paradigm for Product Realisation, John Stark, Springer, 2005

18HS001 ENVIRONMENTAL SCIENCE 2 0 0 0

Course Objectives

- Understand the interdisciplinary and holistic nature of the environment
- Identify the significance of natural resources and environment on the quality of life and stimulate the quest for sustainable development
- Assess the socio-economic, political and ethical issues in environmental science

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO4.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

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO12. 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

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Apply the interdisciplinary nature of environmental studies to understand and address the exploitation of natural resources
2. Analyze different types of ecosystems and biodiversity, their ecological values, and the role of professionals in preventing environmental degradation
3. Develop remedial actions for current environmental challenges related to pollution and its effective management
4. Design suitable strategies for the sustainable management of key components in environmental science
5. Investigate 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	-
2	2	3	-	-	-	-	-	2	-	-	-	2	-	2	-
3	2	2	2	-	-	-	-	2	-	-	-	2	-	2	-
4	1	2	2	-	-	-	2	2	-	-	-	2	-	2	-
5	2	2	2	2	-	-	2	2	-	-	-	2	-	2	-

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

Total: 30 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. Raven, P.H., Hassenzahl, D.M. & Berg, L.R., Environment. 8th edition. John Wiley & Sons, 2012.
3. T. G. Jr. Miller, S. Spoolman, New Environmental Science, 14th Edition, Wadsworth Publishing Co, New Delhi, 2014
4. Pepper, I.L., Gerba, C.P. & Brusseau, M.L., Environmental and Pollution Science, Academic Press, 2011.
5. A. K. De, Environmental Chemistry, 7th Edition, New age international publishers, New Delhi, 2014.

18GE401 SOFT SKILLS-BUSINESS ENGLISH 0 0 2 0

Course Objectives

- To acquire command of both the receptive skills (Listening, Reading) and the productive skills (Writing and Speaking) of English language
- To understand and make effective use of English language in business contexts

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO3. 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

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PO12. 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. Apply listening, reading, speaking, and writing skills in Business English to function effectively at the level of independent users.
2. Design strategies and study plans to develop the necessary skills to appear confidently 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	3	-	-	-	-	-	-	-	2	2	-	2	-	-	-
2	2	-	3	-	-	-	-	-	2	2	-	2	-	-	-

UNIT I **15 Hours**

LISTENING AND READING

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

UNIT II **15 Hours**

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 Hourx

Reference(s)

1. Whitehead, Russell and Michael Black. Pass Cambridge BEC Vantage Self - study Practice

18ME501 METROLOGY AND INSTRUMENTATION 2 0 2 3

Course Objectives

- To study the concepts of measurement and characteristics of instruments.
- To learn the methods for performing linear and angular measurements accurately.
- To provide knowledge on measurement of thread, gear and geometric tolerances using suitable instruments.
- To study the use of laser and advances in metrology for measuring the linear geometric dimensions.
- To provide knowledge on measurement of mechanical parameters using suitable instruments.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Apply principles of measurement systems, standards, and instrument characteristics to achieve precise engineering applications in metrology.
2. Demonstrate the operation of linear and angular measuring instruments to meet specific inspection requirements in metrology.
3. Contrast techniques for measuring screw threads, gears, roundness, and form deviations to select suitable methods for evaluating part conformity.
4. Investigate the role of interferometers, coordinate measuring machines, and surface roughness systems in evaluating the geometric accuracy of components.
5. Analyze methods for measuring force, torque, power, pressure, and temperature to ensure accurate data collection.

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	3	-	-	-	2	-	-	-	2	1	-	-	-	2	-
3	2	3	-	-	2	-	-	-	2	1	-	-	-	2	-
4	3	-	-	-	2	-	-	-	2	1	-	-	-	2	-
5	2	3	-	-	2	-	-	-	2	1	-	-	-	2	-

UNIT I **4 Hours**

BASICS OF METROLOGY

Introduction - Types of measuring system - Standards of measurements - Line, End and wavelength. Calibration, Characteristics of measuring instruments. Errors in Measurement - Types, Methods of measurement - Care of Measuring Instruments.

UNIT II **6 Hours**

LINEAR AND ANGULAR MEASUREMENTS

Linear Measuring Instruments: Vernier Caliper, Vernier Height and Vernier Depth Gauge, Inside, Outside and Depth Micrometer, Slip Gauge, Limit Gauge - Comparator: Mechanical, Pneumatic and Electrical - Angular Measurements: Bevel protractor, Sine bar, Angle Decker, Autocollimator.

UNIT III **7 Hours**

FORM MEASUREMENTS

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

UNIT IV **7 Hours**

ADVANCES IN METROLOGY

Interferometer: NPL Flatness, Laser, Michelson - Coordinate Measuring Machine: Basic concept, Types, Constructional features, Probes, Accessories - Surface Roughness 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.

EXPERIMENT 1 3 Hours

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

EXPERIMENT 2 3 Hours

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

EXPERIMENT 3 3 Hours

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

EXPERIMENT 4 3 Hours

Measurement of screw thread specifications by direct and indirect method.

EXPERIMENT 5 3 Hours

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

EXPERIMENT 6 3 Hours

Differentiate the work piece by its surface roughness value.

EXPERIMENT 7 3 Hours

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

EXPERIMENT 8 **3 Hours**

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

EXPERIMENT 9 **3 Hours**

Measurement of torque in a cantilever beam.

EXPERIMENT 10 **3 Hours**

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.

18ME502 DESIGN OF MACHINE ELEMENTS 3 1 0 4

Course Objectives

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

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO6. 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.

PO10. 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.

PO12. 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.

PSO1. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Analyze methods for measuring force, torque, power, pressure, and temperature to ensure accurate data collection.
2. Apply failure theories and fatigue design process to study the influence of steady, impact, and variable loading on machine elements.
3. Design shaft and coupling based on strength, stiffness, and critical speed to recommend it for automotive and other power transmission applications.
4. Interpret the behavior of bolted and welded joints under static and eccentric loading to ensure safety and reliability in mechanical structures
5. Implement constant and variable load conditions in the design of helical, leaf, and torsional springs to ensure their safety and functional reliability.
6. Analyze the given load, speed and application constraints to design the appropriate journal and rolling contact bearings for engineering applications such as motor and pump.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	2	-	-	-	1	-	1	2	-	-
2	2	2	3	-	-	2	-	-	-	1	-	1	2	-	-
3	2	2	-	-	-	2	-	-	-	1	-	1	2	-	-
4	2	2	3	-	-	2	-	-	-	1	-	1	2	-	-
5	2	2	-	-	-	2	-	-	-	1	-	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, eccentric loading. Design of welded joints - Butt and Fillet welded Joints - Strength of parallel and transverse 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.

Tutorial: 15 Hours

Total: 60 Hours

Reference(s)

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

18ME503 COMPUTER AIDED MANUFACTURING I 2 0 2 3

Course Objectives

- To educate the concept, applications and emerging trends in CNC machines
- 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 impart the knowledge on CNC programming basics
- To introduce programming of CNC turning center.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO5. 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.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PO11. 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.

PO12. 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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Apply machinery elements in CNC machines for industrial applications, demonstrating modern control strategies, including DNC and adaptive control.
2. Analyze the constructional features and motion control elements of CNC machines to evaluate their role in efficient system retrofitting and maintenance.
3. Illustrate the data flow of using modern communication protocols by analyzing the drive systems, sensors, PLC-based control architecture, and communication interfaces used in CNC systems
4. Demonstrate CNC part program using G & M codes for standard turning operations with FANUC and Siemens controllers, and simulate tool path movements using CAM software.
5. Develop CNC machining programs for multi-pass operations using canned cycles by collaborating modern CNC simulation tools, and communicating outcomes through experimental reports.

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	3	-	-	-	-	-	-	-	-	-	1	-	2	-
3	3	-	-	-	-	-	-	-	-	-	-	1	-	2	-
4	3	2	2	-	2	-	-		2	2	2	1	-	2	-
5	3	2	3	-	2	-	2	-	2	2	2	1	-	2	-

UNIT I **6 Hours**

FUNDAMENTALS OF CNC MACHINES

Introduction to Computer Numerical Control: Evolution of CNC Technology, CNC Systems - An Overview of Fundamental aspects of machine control, Different types of CNC machines - Advantages, disadvantages and applications of CNC machines- DNC and Adaptive control

UNIT II **6 Hours**

CONSTRUCTION OF CNC AND MOTION CONTROL

Constructional features and applications - Linear motion and Recirculating ball bearings - CNC controller and Interpolator - Maintenance and retrofitting. Tool magazines, ATC, APC, Chip conveyors.

UNIT III **6 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 IV **6 Hours**

BASICS OF CNC PROGRAMMING

Cutting tool Inserts - Materials, Classification, Nomenclature and Selection - Tool holders and Work holding devices - Coordinate system - Structure of a part program - G & M Codes -Programming for FANUC and SIEMENS controller. tool offset, work offset, cutter radius compensation

UNIT V **6 Hours**

PROGRAMMING OF CNC TURNING CENTRE

Single pass and canned cycle -Turning, facing and threading -Multi-pass canned cycle -Rough and Finish turning, facing, boring, pattern repeating, , threading, drilling, peck drilling, high speed drilling cycle, grooving - Subprogram.

EXPERIMENT 1 **5 Hours**

Simulation and NC part program generation on facing and step turning

EXPERIMENT 2 **5 Hours**

Simulation and NC part program generation on taper turning and profile turning

EXPERIMENT 3 **5 Hours**

Simulation and NC part program generation on grooving cycle and thread cutting

EXPERIMENT 4 **5 Hours**

Simulation and NC part program generation on drilling and boring cycle

EXPERIMENT 5 **10 Hours**

To make one of the following product: Push fit assembly/simple cylinder piston assembly/milling tool holder/needle valve spool

Total: 60 Hours

Reference(s)

1. P. Radhakrishnan, S. Subramanyan and V. Raja , CAD/CAM/CIM, New Age International Private Ltd, NewDelhi, 2008
2. P. Radhakrishnan, Computer Numerical Control Machines, New Central Book Agency, 2004.
3. HMT, Mechatronics, Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi, 2010.
4. Mikell P. Groover, Automation, Production System and Computer Integrated Manufacturing, Prentice Hall of India, New Delhi, 2008
5. M. M. M . Sarcar, Computer Aided Design and Manufacturing, Prentice Hall of India, New Delhi, 2008.
6. Mikell P. Groover, Mitchell Weiss and Roger N. Nagel G Odrey, Industrial Robotics, Tata McGraw Hill Publishing Company Pvt Ltd. New Delhi, 2007

18ME504 HEAT AND MASS TRANSFER 3 1 2 5

Course Objectives

- To familiarize conduction heat transfer mechanisms
- To expose the mechanisms of free and forced convection
- To develop the shape factor algebra for black body radiation and grey body radiation
- To demonstrate the phase change heat transfer and calculate the performance of heat exchanging devices
- To explain diffusion and convective mass transfer

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO4. 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.
PO5. 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.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. 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.
PO12. 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.
PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Apply Fourier's law to study the steady-state heat conduction in simple and composite systems including extended surfaces.
2. Analyze forced and free convection over different surfaces using heat transfer coefficients and non-dimensional numbers.
3. Assess the phenomena of radiative heat transfer between surfaces using radiation laws, shape factors, and radiation shields.
4. Investigate the boiling and condensation processes and analyze heat exchanger performance using LMTD and NTU methods
5. Interpret the concept of steady-state molecular diffusion and convective mass transfer by applying Fick's law

Articulation Matrix

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

UNIT I **10 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.

UNIT II **9 Hours**

CONVECTION

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

UNIT III **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 IV **10 Hours**

PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS

Boiling: Modes- correlations used. Condensation: Nusselt theory, types, correlations used. 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 V **8 Hours**

MASS TRANSFER

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

FOR FURTHER READING

Two dimensional steady state heat conduction. Use of Heisler Chart, Unsteady state conduction. Numerical methods in heat conduction.

EXPERIMENT 1 **3 Hours**

Determination of thermal conductivity for one dimensional steady state conduction

EXPERIMENT 2 **3 Hours**

Determination of heat transfer co-efficient by unsteady heat transfer

EXPERIMENT 3 **3 Hours**

Determination of heat transfer co-efficient by natural convection

EXPERIMENT 4 **3 Hours**

Determination of heat transfer co-efficient by forced convection

EXPERIMENT 5 **3 Hours**

Determination of Stefan-Boltzmann constant

EXPERIMENT 6 **3 Hours**

Determination of emissivity using emissivity apparatus

EXPERIMENT 7 **3 Hours**

Determination of overall heat transfer for film wise and drop wise condensation

EXPERIMENT 8 **3 Hours**

Determination of overall heat transfer co-efficient for a parallel and counterflow heat exchanger

EXPERIMENT 9 **3 Hours**

Experimentation on mass transfer

EXPERIMENT 10 **3 Hours**

Determination of overall heat transfer co-efficient for a fluidized bed heat transfer

Tutorial: 15 Hours

Total: 90 Hours

Reference(s)

1. Yunus A. Cengel, Heat and Mass Transfer: a Practical Approach, Tata McGraw Hill publishing Company private limited, New Delhi, 2017
2. J. P. Holman, Heat Transfer, Tata McGraw Hill publishing Company private limited, New Delhi, 2008
3. C. P. Kothandaraman and S. Subramanyan, Fundamentals of Heat and Mass Transfer, New Age International private limited, New Delhi, Rev. 3rd edition, 2006
4. Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, David P. DeWitt, Principles of Heat and Mass Transfer, ISBN: 978-1-119-38291-1 October 2017
5. R. K. Rajput, Heat and Mass Transfer, S Chand and Company, New Delhi, 2007
6. https://nptel.ac.in/courses/112101097/

18GE501 SOFT SKILLS - APTITUDE I 0 0 2 0

Course Objectives

- 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. It will provide a lot of activities and examples for a student to learn and develop these life skills.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Demonstrate various concepts of number systems and their techniques in solving the percentage, average and age problems.
2. Analyze the profit and loss of real time situations and the relation between ratio, proportion and variation.
3. Apply different techniques to find the distance, speed and time of various moving objects.
4. Develop the concepts of coding, sequences and series, data interpretation and critical reasoning to solve real time logical reasoning problems.

Articulation Matrix

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

UNIT I **4 Hours**

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.

UNIT II **2 Hours**

PERCENTAGE

Introduction - Definition and Utility of Percentage - Importance of base/denominator for percentage calculations-Concept of percentage values through additions-Fraction to percentage conversion table.

UNIT III **2 Hours**

AVERAGES AND AGES

Introduction-Average of different groups-Addition or removal of items and change in average-Replacement of some of the items.

UNIT IV **2 Hours**

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.

UNIT V **4 Hours**

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.

UNIT VI **2 Hours**

TIME AND WORK

Introduction-Basic concepts-Concepts on working with different efficiencies-Pipes and Cisterns-Work Equivalence (Man Days) -Alternative approach.

UNIT VII **2 Hours**

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.

UNIT VIII **2 Hours**

CODING AND DECODING

Introduction-Description of Coding method-Coding patterns - Concepts of Coding and Decoding-Problems involving Coding and Decoding methods.

UNIT IX **2 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 X **2 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 XI **2 Hours**

DIRECTION

Introduction to Direction - sense test - Overview of the wide variety of Direction problems-Direction-Plotting diagrams.

UNIT XII **2 Hours**

CRITICAL REASONING

Introduction-Basic concept of critical reasoning- Weaken the argument-Strengthen the argument-Flaw in the argument-Evaluate the conclusion.

Total: 30 Hours

Reference(s)

1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, Mc Graw Hill Publications.
2. U. Mohan Rao, Quantitative Aptitude for Competitive Examinations, Scitech Publications Pvt Ltd, India.
3. Dinesh Khattar, The Pearson Guide to Quantitative Aptitude for Competitive Examinations, Third Edition, Pearson Education Pvt Ltd, India, 2016.
4. Dr. R S Aggarwal, A Modern Approach to Verbal and Non Verbal Reasoning, Revised Edition, S Chand Publications.
5. Arun Sharma, How to prepare for Logical Reasoning for CAT & other Management Exams, Fifth Edition, Mc Graw Hill Publications.
6. Jaikishan and Premkishan, How to Crack Test of Reasoning in all Competitive Examinations, Revised Edition, Arihant Publicati

18HS002 PROFESSIONAL ETHICS IN ENGINEERING 2 0 0 2

Course Objectives

- To understand Human Values and ethical theory.
- To understand codes of ethics, work place responsibilities, rights, engineering experimentation, global issues and contemporary ethical issues.
- To understand personal ethics, legal ethics, cultural ethics and engineers responsibility.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3.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.

PO4.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

PO6. 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.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO11. 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.

PO12. 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

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Apply the moral and ethical characteristics of professionals in relation to respecting human values in the workplace.
2. Assess the professionalism of engineers through moral development theories and established codes of ethics.
3. Investigate risk factors through the study of historical industrial and technological disasters, and examine the ethical responsibilities of engineers as experimenters
4. Interpret workplace responsibilities and rights to support and uphold the fundamental rights of employees and professionals
5. Analyze the environmental, computer, and internet ethics that engineers should follow to address global challenges.

Articulation Matrix

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

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

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-ethic

18ME602 MECHATRONICS 2 0 2 3

Course Objectives

- To introduce the concept and working of sensors used in mechatronic system.
- To study the interface of actuators with mechatronic system.
- To provide knowledge on feedback mechanism for improving the reliability of mechatronic system.
- To impart knowledge on working and programming of microcontroller in mechatronic systems
- To learn the Programmable Logic Controller (PLC) used in mechatronic systems.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO4.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

PO5. 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.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PO12. 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

PSO1. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply measurement principles to select and integrate suitable sensors into basic mechatronic systems.
2. Design motion control systems by selecting and integrating suitable actuators to meet specific task requirements.
3. Analyze the behavior of open-loop and closed-loop control systems by applying transfer function concepts and modeling techniques to mechanical and electrical systems.
4. Develop the instruction sets and programming logic to perform arithmetic, logic, and data transfer operations for solving embedded system.
5. Design PLC programs for industrial automation, by integrating timers, counters, shift registers, and control instructions including master and jump functions.

Articulation Matrix

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

UNIT I **6 Hours**

SENSOR

Components of mechatronics system, Sensor-terminology - Potentiometer, Linear Variable differential transformer, strain gauge, Piezoelectric sensor, Optical encoder, Hall effect sensor, thermistor.

UNIT II **6 Hours**

ACTUATOR

Mechanical Actuation system - cam, gear, belt & chain, Ball screw, Pneumatic & hydraulic Actuation system. Electrical actuation system -relay & solenoid, working & control of Stepper & servo motor.

UNIT III **6 Hours**

FEEDBACK CONTROL

Open loop system, closed loop system, Transfer Function, Mathematical Modeling of Mechanical & Electrical system, First order system, second order system, Proportional control, derivative control, Integral control, PID control.

UNIT IV **6 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, Examples -Windscreen wiper motion, Car engine management.

UNIT V **6 Hours**

PROGRAMMABLE LOGIC CONTROLLER

Basic Structure - Input / Output Processing - Programming - Mnemonics - Timers, Internal relays and counters - Shift Registers - Master and Jump Controls. Examples -Pick and place robot. Car park barrier system.

EXPERIMENT 1 3 Hours

Design and implement a smart parking system using an ultrasonic sensor interfaced with a microcontroller

EXPERIMENT 2 3 Hours

Interfacing Encoder with microcontroller to measure position of DC motor

EXPERIMENT 3 3 Hours

Programming microcontroller to control the position of servo motor

EXPERIMENT 4 3 Hours

Design and simulation of pneumatic circuit using fluidsim software.

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EXPERIMENT 5 **3 Hours**
Design and simulation of PID controller for mechatronics system in MATLAB.

EXPERIMENT 6 **3 Hours**
Design and development of temperature control system using microcontroller

EXPERIMENT 7 **3 Hours**
Programming microcontroller for speed control of stepper motor.

EXPERIMENT 8 **3 Hours**
Programming microcontroller for speed control of DC motor.

EXPERIMENT 9 **3 Hours**
Design and simulation of double acting cyclinder circuit using PLC.

EXPERIMENT 10 **3 Hours**
Design and simulation of meter-in and meter-out circuit in Fluidsim.

Total: 60 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.
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

18ME603 FINITE ELEMENT ANALYSIS 3 1 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 in higher order and isoparametric elements.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO4.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

PO12. 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.

PSO1. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply numerical methods to formulate simple finite element models for structural analysis.
2. Illustrate bar, beam, and truss behavior through one-dimensional finite element analysis to support structural design decisions.
3. Analyze plane stress, plane strain, and axisymmetric conditions for structural applications
4. Investigate temperature distribution in 1D and 2D heat transfer using finite element methods.
5. Develop higher-order and isoparametric finite element models using numerical methods.

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	-	-	-	-	-	-	-	-	-	-	1	2	-	-
3	2	3	-	-	-	-	-	-	-	-	-	1	2	-	-
4	2	2	2	2	-	-	-	-	-	-	-	2	2	-	-
5	2	2	3	-	-	-	-	-	-	-	-	1	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, boundary condition and assembly of global equation-1D bar element and two node truss element- problems in the 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 the global equation for 1D and 2D triangular element heat conduction, heat generation with convective boundary conditions for the 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 noded and eight noded Isoparametric rectangular element using the natural coordinate system - problems. Gaussian quadrature method-problems.

FOR FURTHER READING

Construct the FEA steps for the structural and thermal analysis of machine elements

Tutorial: 15 Hours

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Total: 60 Hours

Reference(s)

1. S. S. Rao, Finite Element Method in Engineering, Elsevier India, 2017.
2. David V. Hutton, Fundamentals of Finite Element Analysis, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2017
3. Robert D. Cook, s. David, Malkucs Michael E. Plesha, Concepts and Applications of Finite Element Analysis, John Wiley, New Delhi, 2001.
4. T. R. Chandrupatla and A. D. Belegundu, Introduction to Finite Elements Engineering, Pearson Education, New Delhi, 2011.
5. S. S. Bhavikati, Finite Element Analysis, New Age International Publishers, 2015

18ME604 DESIGN OF TRANSMISSION SYSTEMS 3 1 0 4

Course Objectives

- To study the design procedure of belt and rope drive
- 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 multistage gear box
- To familiarize the students for design of I.C. Engine Components

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature,and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
PO6. 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.
PO10. 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.
PO12. 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.
PSO1. Design, analyse and evaluate the performance of mechanical systems

Course Outcomes (COs)

1. Apply the design principles to identify the specifications of flexible power transmission elements such as belts and wire ropes.
2. Design spur and helical gear through force analysis, stress evaluation, and failure criteria for power transmission applications.
3. Interpret the bevel and worm gear systems based on the geometry of gear, type of loading, and failure modes for efficient power transmission.
4. Develop the step ratio, kinematic arrangement, ray diagram, and gear teeth specifications for the design of multistage gearboxes employed in industrial applications.
5. Analyze the design of motion-converting mechanisms and internal combustion engine components, such as pistons and connecting rods, by applying fundamental design concepts.

Articulation Matrix

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

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 COMPONENTS

Design of Ratchet & pawl mechanism and Geneva mechanism. Design of I.C engines components such as piston and connecting rod.

Tutorial: 15 Hours

Total: 60 Hours

Reference(s)

1. V. B. Bhandari, Design of Machine Elements, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi, 2017.
2. R. L. Norton, Design of Machinery, Fifth Edition, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2013.
3. T. J. Prabhu, Design of Transmission Elements, Mani Offset, Chennai, 2015.
4. 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.
5. S. G. Kulkarni, Machine Design, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2010.

18ME605 COMPUTER AIDED MANUFACTURING II 2 0 2 3

Course Objectives

- To study the principle and applications of automated material handling and automated inspection
- To learn the concept of economics and testing of machine tools.
- To provide exhaustive skill on programming of CNC machining center.
- To learn the concept of NC code generation through CAD models.
- To educate the concept, applications macro and parametric programming.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO5. 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.

PO6. 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.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PO11. 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.

PO12. 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

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Apply various automated material handling systems and inspection methods to recommend appropriate solutions for specific manufacturing applications
2. Analyse economics and testing procedures to assess the performance and operational feasibility of CNC machines.
3. Develop CNC part programs for prismatic components using standard controller formats for machining centers.
4. Demonstrate the CAM software tools to generate NC codes from CAD models for automated manufacturing processes.
5. Create a macro and parametric programming strategies to automate CNC operations for customized manufacturing tasks.

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	3	-	-	-	-	-	-	-	-	2	1	-	2	-
3	3	2	3	-	2						-		-	2	-
4	2	2	2	-	2	1	1		2	2	1	1	-	2	-
5	3	2	3	-	2	-	-	-	2	2	1	1	-	2	-

UNIT I **6 Hours**

COMPUTER INTEGRATED MANUFACTURING

Industrial Robot - robot anatomy, robot control systems, and other specifications, end effectors. Automated Guided Vehicle (AGV) Systems and Automated Storage and retrieval system (AS/RS) - basic components, types and its application. Automated inspection principles- Off line & on line inspection, distributed inspection & final inspection.

UNIT II **6 Hours**

ECONOMICS AND TESTING OF MACHINE TOOLS

Factors influencing selection of CNC Machines Cost of operation of CNC Machines Practical aspects of introducing CNC machines in industries. Geometrical alignment test, national and international test charts, testing of CNC machine tools

UNIT III **6 Hours**

PROGRAMMING OF CNC MACHINING CENTRE

Machining cycles - Linear and circular interpolation, Contouring, rectangular and circular pocketing, drilling, peck drilling, high speed drilling, tapping , boring, back boring, counter boring.

UNIT IV **6 Hours**

PROGRAMMING USING CAM

CNC part programming using CAD/CAM software and interfacing with CNC machines - Component modeling, machine selection, tool selection, coordinate reference, step by step procedure, cutter location data, simulation, post processer.

UNIT V **6 Hours**

MACRO PROGRAMMING AND ADVANCED LEARNING

Introduction macro programming variables and its types, Introduction to parametric programming - Comparison to sub- programming, canned cycles and computer programming. Integration of addition axes features - programming, methodology.

EXPERIMENT 1 5 Hours

Simulation and NC part program generation on linear and circular interpolation

EXPERIMENT 2 5 Hours

Simulation and NC part program generation on contour milling

EXPERIMENT 3 5 Hours

Simulation and NC part program generation on drilling and peck drilling

EXPERIMENT 4 **5 Hours**

Simulation and NC part program generation on Mirror imaging in CNC Milling

EXPERIMENT 5 **10 Hours**

To make one of the following product: compression mould die/Injection mould die/simple mechanism/motor or turbine impeller assembly

Total: 60 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.

18ME608 COMPUTER AIDED ENGINEERING LABORATORY 0 0 4 2

Course Objectives

- To expose knowledge on the FEA software as a tool for the analysis of bars, trusses and beams.
- To model complex geometries and load conditions for the determination of stresses and strains.
- To perform plane stress, plane strain and axisymetric simulations using FEA software.
- To apply the knowledge of torsion, buckling and dynamics to solve dynamic problems using FEA software.
- To obtain temperature distribution for heat conduction using FEA software.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO5. 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.

PO6. 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.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PO12. 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

PSO1. Design, analyse and evaluate the performance of mechanical systems

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Investigate the temperature distribution and thermal stresses of thermal systems using FEA software.
2. Apply the finite element software tools to analyze stresses in bar, beam, and truss elements under static loading conditions.
3. Analyse complex geometries and load conditions for the determination of stresses and strains in engineering applications
4. Interpret plane stress, plane strain and axisymetric conditions to engineering problems and analyze using FEA software.
5. Simulate the torsional behavior of shafts, buckling of columns, and dynamic response of simple structures using FEA software.
6. Investigate the temperature distribution and thermal stresses of thermal systems using FEA software.

Articulation Matrix

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

EXPERIMENT 1 **4 Hours**

Structural analysis of a stepped bard to determine nodal displacements, stresses reaction forces.

EXPERIMENT 2 **4 Hours**

Analysis of simple and complex trusses to find displacements, stresses and reaction forces for the given loadings.

EXPERIMENT 3 **4 Hours**

Analysis of cantilever beam, simply supported beam and fixed beam under different boundary and loading conditions

EXPERIMENT 4 **4 Hours**

Analysis of corner angular plate with holes for the determination of Von mises stress and maximum deformation under static loading with one hole fixed and the other hole pressure loaded.

EXPERIMENT 5 **4 Hours**

Determination of Von mises stress and the maximum deformation that occur when a steel plate with holes is loaded as shown. The plate is constrained in y direction at bottom section and distributed load of 20 N pulling in the y-direction. The plate is made of steel with a Youngs modulus of $20x10^4$ N/mm^2 and the Poissons ratio of 0.3.

EXPERIMENT 6 **4 Hours**

Analysis of a compound bar under compression.

EXPERIMENT 7 **4 Hours**

Stress analysis of a thin plate with hole with uniform load along any one direction in plane stress.

EXPERIMENT 8 **4 Hours**

Analysis of a long cylindrical pressure vessel under plane strain.

EXPERIMENT 9 **4 Hours**

Analysis of shaft subjected to twisting moments.

EXPERIMENT 10 **4 Hours**

To solve a simple buckling problem to determine the deflection and reaction forces.

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EXPERIMENT 11 **4 Hours**

Modal analysis of Cantilever, Simply supported and Fixed beams under different boundary conditions

EXPERIMENT 12 **4 Hours**

Developing Design Guidelines to Prevent Buckling Failures in Structural Element of a bridge.

EXPERIMENT 13 **4 Hours**

Temperature distribution in circular and radial fins.

EXPERIMENT 14 **4 Hours**

Temperature distribution in 2D and 3 D components under different boundary conditions for a heat conduction analysis.

EXPERIMENT 15 **4 Hours**

Coupled temperature and stress analysis of a compound object to determine the thermal stresses.

Total: 60 Hours

Reference(s)

1. Stinivasan, K. C. Sambana adn RK Datti, Finite Element Analysis using Ansys 11.0, Paleti PHI Learning Pvt. Ltd, 2010.
2. Esam M. Alawadhi, Finite Element Simulations Using ANSYS, CRC Press, 2016.
3. Meung K, Finite Element Methods with Programming and Ansys, Lulu Com 2013
4. Saeed Moaveni, Finite Element Analysis Theory and Applications with Ansys, Pearson Education, 2014.

18GE601 SOFT SKILLS-APTITUDE II 0 0 2 0

Course Objectives

- 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. It will provide a lot of activities and examples for a student to learn and develop these life skills.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3.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
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. 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.
PSO1. Design, analyse and evaluate the performance of mechanical systems

Course Outcomes (COs)

1. Assess the concepts of probability, Sets, Permutation and Combinations in estimating data for real time problems.
2. Analyze the concept of logarithms, progressions and Simple and Compound interest to solve various practical problems.
3. Demonstrate the objects involving cubes and cuboids in determining the number of sides colored.
4. Develop various data from graphs and tables to determine ratio, percentage and averages.
5. Apply the logical reasoning skills for identifying age, relations, visual relations and puzzles.

.

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	3	-	-	-	-	-	-	2	2	-	-	1	-	-
3	2	2	3	-	-	-	-	-	2	2	-	-	1	-	-
4	2	2	3	-	-	-	-	-	2	2	-	-	1	-	-
5	3	-	-	-	-	-	-	-	2	2	-	-	1	-	-

UNIT I **2 Hours**

PERMUTATION AND COMBINATION

Definition-Fundamental rules-Theorems on Permutation-Theorems on Combination.

UNIT II **2 Hours**

PROBABILITY

Concept and Importance of Probability-Underlying factors for real Life estimation of probability-Basic facts about probability-Some important consideration while defining event.

UNIT III **2 Hours**

SYLLOGISM AND VENN DIAGRAM

Concepts on Syllogisms-Venn diagram-Interpretation-Venn diagram-solving.

UNIT IV **4 Hours**

SIMPLE INTEREST AND COMPOUND INTEREST

Introduction-Definition - Effect of change of P, R, T on simple interest-Amount-Amount becomes N times the principle-Repayment of debt in equal installments-Rate and time are numerically equal-Compound Interest-Conversion period-Basic formula-Special cases-To find the principle / Time /Rate-Difference between Compound Interest and Simple Interest-Equal annual installment to pay the borrowed amount.

UNIT V **2 Hours**

MIXTURES AND ALLIGATION

Definition-Alligation rule-Mean value (cost price) of the mixture-Some typical situations where allegation can be used.

UNIT VI **4 Hours**

CUBE AND LOGARITHM

Introduction-Basic Concepts of Cube and Cuboid-Problems involving cubes and cuboids of various dimensions-Problems involving coloured cubes and cuboids - Basic concepts of Logarithm-Laws of Logarithms including change of base-Common logarithm (base 10) - Properties of Logarithms to solve equations involving logarithmic expressions.

UNIT VII **2 Hours**

DATA INTERPRETATION

Introduction-Ratio-Percentage-Average-Tables - Graphs and Charts.

UNIT VII **2 Hours**

PROGRESSION AND LOGICAL REASONING

Arithmetic progression-Geometric progression-Harmonic progression-Theorems related with progressions.

UNIT IX **2 Hours**

PROBLEM ON AGES

Introduction-Basic concept-Usage of Percentage and Averages -Applications.

UNIT X **2 Hours**

ANALYTICAL REASONING

Introduction-Basic concept-Non verbal Analytical Reasoning -Arrangements.

UNIT XI **2 Hours**

BLOOD RELATION

Introduction-Basic concept-Kinds of relation-Tree diagram -Relations.

UNIT XII **2 Hours**

VISUAL REASONING

Introduction-Basic concepts-Odd man out-Next series-Mirror image and water image

UNIT XIII **2 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, Mc Graw Hill Publications.
2. U. Mohan Rao, Quantitative Aptitude for Competitive Examinations, Scitech Publications Pvt Ltd, India.
3. Dinesh Khattar, The Pearson Guide to Quantitative Aptitude for Competitive Examinations, Third Edition, Pearson Education Pvt Ltd, India, 2016.
4. Dr. R S Aggarwal, A Modern Approach to Verbal and Non Verbal Reasoning, Revised Edition, S Chand Publications.
5. Arun Sharma, How to prepare for Logical Reasoning for CAT & other Management Exams, Fifth Edition, Mc Graw Hill Publications.
6. Jaikishan and Premkishan, How to Crack Test of Reasoning in all Competitive Examinations, Revised Edition, Arihant Publications.

18HS003 PRINCIPLES OF MANAGEMENT 2 0 0 2

Course Objectives

- To develop cognizance about importance of management principles.
- To extract the functions and responsibilities of managers.
- To Study and understand the various HR related activities.
- To learn the application of the theories in an organization.
- To analyze the position of self and company goals towards business.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO12. 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

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Apply management principles to assess managerial roles, business types, and current organizational trends.
2. Implement planning processes and tools to create objectives, policies, and decisions
3. Assess organizational structures and HR practices for effective system design.
4. Analyze motivation, leadership, and communication strategies to influence organizational behavior.
5. Develop control techniques and IT tools to monitor performance and productivity.

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	-	-	-	-	-	-	1	-	-	-	1	-	2	-
3	3		-	-	-	-	-	1	-	-	-	1	-	2	-
4	2	2	-	-	-	-	-	1	-	-	-	1	-	2	-
5	2	2	2	-	-	-	-	1	-	-	-	1	-	2	-

UNIT I **6 Hours**

INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS

Definition of Management Science or Art Manager Vs Entrepreneur-types of managers - Managerial roles and skills Evolution of Management Scientific, Human Relations, System and Contingency approaches Types of Business organization - Sole proprietorship, partnership, Company - public and private sector enterprises - Organization culture and Environment Current Trends and issues in Management.

UNIT II **6 Hours**

PLANNING

Nature and purpose of planning - Planning process - Types of planning – Objectives - Setting objectives - Policies - Planning premises - Strategic Management - Planning Tools and Techniques - Decision making steps and process.

UNIT III **6 Hours**

ORGANIZING

Nature and purpose – Formal and informal organization - Organization chart - Organization Structure Types - Line and staff authority - Departmentalization - Delegation of authority - Centralization and decentralization - Job Design - Human Resource - Management - HR Planning, Recruitment, Selection, Training and Development, Performance Management, Career planning and management.

UNIT IV **6 Hours**

DIRECTING

Foundations of individual and group behaviour - Motivation-Motivation theories - Motivational techniques - Job satisfaction - Job enrichment - Leadership-types and theories of leadership - Communication-Process of communication - Barrier in communication Effective communication-Communication and IT.

UNIT V **6 Hours**

CONTROLLING

System and process of controlling - Budgetary and non-Budgetary control techniques - Use of Computers and IT in Management control - Productivity problems and management - Control and Performance-Direct and preventive control - Reporting.

Total: 30 Hours

Reference(s)

1. Robbins S, Management, (13th ed.), Pearson Education, New Delhi, 2017.
2. Stephen A. Robbins and David A. Decenzo and Mary Coulter, Fundamentals of Management, Pearson Education, 7th Edition, 2011.
3. Robert Kreitner and MamataMohapatra, Management, Biztantra, 2008.
4. L. M. Prasad, Principles and Practice of Management. 7th Edition, Sultan Chand & Sons, 2007.
5. P. C. Tripathi and P. N. Reddy, Principles of Management, Fourth Edition, Tata McGraw Hill, 2008.

18ME702 AUTOMOBILE ENGINEERING 3 0 0 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 and engine auxiliary 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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO4.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

PO6. 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.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO12. 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

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Demonstrate the operating principles and constructional features of key automobile components.
2. Illustrate the working of fuel supply systems and engine auxiliary units in internal combustion engines.
3. Investigate the functions and interactions of components in vehicle transmission and driveline systems.
4. Assess the various types of steering, suspension, and braking systems used in automobiles.
5. Analyze the operation of automotive electrical and electronic systems with reference to vehicle functionality

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	2	-	-	-	-	1	-	2	-
3	2	2	-	-	-	-	-	-	-	-	-	1	-	2	-
4	2		-	-	-	1	-	-	-	-	-	1	-	2	-
5	2	3	-	2	-	1	1	-	-	-	-	1	-	2	-

UNIT I **9 Hours**

VEHICLE STRUCTURE AND ENGINES

Types of Automobiles - vehicle construction, chassis, frame and body. Vehicle aerodynamics (various resistances and moments involved). Engine -Types and Construction. Lubrication system - Types and construction. Cooling system -Types and construction.

UNIT II **9 Hours**

FUEL SUPPLY AND ENGINE AUXILIARY SYSTEMS

Spark ignition engine- Electronic fuel injection system, mono-point and multi Point injection systems. Compression ignition engine-Inline fuel injection system, Common rail direct fuel injection system.Engines Supercharger, turbo charger, engine emission control by 3 Way catalytic controller.Emission norms (Euro and BS)

UNIT III **9 Hours**

TRANSMISSION AND DRIVE LINES

Clutch- Types- single plate clutch, multi plate clutch.Gearbox - Types- synchromesh gearbox, sliding mesh gear box, constant mesh gearbox. Automatic transmission system. Fluid flywheel, torque convertors, propeller shaft, slip joint, universal Joints,differential and rear axle drives - hotchkiss drive and torque tube drive.

UNIT IV **9 Hours**

STEERING, BRAKES AND SUSPENSION

Wheels and Tyre Construction. Steering geometry and types of steering - rack and pinion steering gear, recirculating ball type steering 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 **9 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. Different electronic control unit used in the engine management, block diagram of the engine management system. IoT in automobiles and its application.

FOR FURTHER READING

Active Suspension System (ASS), Electronic Brake Distribution (EBD), Electronic Stability Program(ESP), Traction Control System (TCS), Global Positioning System (GPS),Electric, Hybrid vehicle.

Total: 45 Hours

Reference(s)

1. Crouse and Anglin, Automotive Mechanism, Tata McGraw Hill Publishing Company Private Limited, New Delhi, 2003.
2. Newton, Steeds and Garet, Motor vehicles, Butterworth Publishers, 2000.
3. S. Srinivasan, Automotive Mechanics, Tata McGraw Hill Publishing Company Private Limited, New Delhi, 2003.
4. Joseph Heitner, Automotive Mechanics, East-West Press, 2006.
5. H. M. Sethi, Automobile Technology, Tata McGraw Hill Publishing Company Private Limited, New Delhi, 2007.
6. Kirpal Singh, Automobile Engineering Volume.1 and 2, Standard Publishers, New Delhi,2013.

18ME703 OPERATION RESEARCH 3 1 0 4

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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
PO4.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
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO12. 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
PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Apply the principles of linear programming to formulate and solve engineering problems using graphical and simplex methods.
2. Analyze transportation and assignment problems to evaluate and compare allocation strategies using MODI and Hungarian methods.
3. Develop project networks for the given problems to determine critical paths and project durations using CPM and PERT techniques.
4. Investigate single and multi-server queuing models to interpret and assess system performance in service systems.
5. Develop sequencing strategies and replacement policies using analytical models to optimize industrial operations.

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	-	-	-	-	-	-	-	-	-	2	-	2	-
3	2	2	3	-	-	-	-	-	-	-	-	2	-	2	-
4	2	2	2	3	-	-	-	-	-	-	-	2	-	2	-
5	2	2	3	-	-	-	-	2	-	-	-	2	-	2	-

UNIT I **9 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 **9 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 **9 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 **9 Hours**

QUEUING MODELS

Queuing 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 **9 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.

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Tutorial: 15 Hours

Total: 60 Hours

Reference(s)

1. Frederick S. Hiller, Gerald J. Liberman, Introduction to Operations Research: Concepts and Cases, 8th edition, Tata McGraw-Hill Publishing Company Private Limited, 2010.
2. Hamdy A. Taha, Operation Research - An Introduction, Pearson Publications, 2010.
3. Prem Kumar Gupta, D. S. Hira, Introduction to Operations Research, S.Chand and Co, 2004.
4. R. Panneerselvam, Operations Research, second edition, Prentice Hall of India, 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.

18ME704 INDUSTRIAL ROBOTICS 2 0 2 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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO5. 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.

PO6. 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.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO10. 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.

PO12. 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

PSO1. Design, analyse and evaluate the performance of mechanical systems

PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems

.**Course Outcomes (COs)**

1. Apply robotic anatomy and joint configurations to analyze the structure and functions of industrial manipulators.
2. Demonstrate the principles of actuation and gripping for configuring drive systems and end effectors in industrial robotic applications.
3. Analyze sensing and machine vision solutions to effectively integrate robotic systems into industrial applications
4. Design models of robotic motion based on forward and inverse kinematics principles and construct suitable robot programs
5. Develop robotic implementations across various industries to enhance productivity and automation efficiency.

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	-	-	-	-	2	-	-	-	-	-	-	2	-	2
3	2	2	3	-	-	-	2	-	-	-	-	2	2	-	2
4	2	2	3	-	2	-	-	2	-	2	-	2	2	-	-
5	2	2	3	-	-	2	2	2	-	-	-	2	2	-	2

UNIT I **6 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 **6 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 **6 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 **6 Hours**

ROBOT KINEMATICS AND 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 **6 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

EXPERIMENT 1 3 Hours

Study of various types of robots.

EXPERIMENT 2 3 Hours

Geometric Modeling: As an example of a geometric modeling system a SCARA robot is modeled in a common modeling language using an industrial robot simulation system

EXPERIMENT 3 **3 Hours**

Identification of various component in pneumatic and hydraulic drive system

EXPERIMENT 4 **3 Hours**

Automating the operation of a machine vice according to specified need using pilot valves.

EXPERIMENT 5 **3 Hours**

Load cell measurement

EXPERIMENT 6 **3 Hours**

Displacement measurement using LVDT

EXPERIMENT 7 **3 Hours**

Forward and Inverse Kinematics: The forward and inverse kinematics of the SCARA robot are derived and calculated in a simulation software.

EXPERIMENT 8 **3 Hours**

Offline Programming: The previously modelled SCARA robot is then programmed offline, also using the industrial robot simulation system.

EXPERIMENT 9 **3 Hours**

Programming a parallel kinematic robot for a pick and place application

EXPERIMENT 10 **3 Hours**

Programming the robot for a drilling application

Total: 60 Hours

Reference(s)

1. M. P. Groover, Industrial Robotics Technology, Programming and Applications, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2nd Edition, 2012.
2. D. Richard, Klafter, A. Thomas, Chmielewski and Michael Negin, Robotics Engineering, An Integrated Approach, Prentice Hall of India, New Delhi, 2010.
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. https://nptel.ac.in/courses/1121031

18ME707 PROJECT WORK I 0 0 6 3

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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO4. 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.

PO5. 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.

PO6. 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.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PO11. 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.

PO12. 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.

PSO1. Design, analyse and evaluate the performance of mechanical systems

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems

Course Outcomes (COs)

1. Apply technical knowledge to a real-world problem by identifying requirements and using appropriate tools or techniques to address it
2. Develop innovative technical strategies and methodologies to address and solve complex engineering problems
3. Apply relevant tools, algorithms, and techniques to design and implement effective solutions for the given project.
4. Evaluate the performance of the developed solution / prototype through systematic testing, validation, and cost-effectiveness analysis to verify its compliance with specified project requirements.
5. Prepare comprehensive technical documentation and deliver effective oral presentations to communicate project outcomes

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Articulation Matrix

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

18ME804 PROJECT WORK II 0 0 18 9

Course Objectives

- To develop skills to formulate a technical project.
- To develop skills to formulate a technical project.
- 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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
PO4. 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.
PO5. 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.
PO6. 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.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. 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.
PO11. 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.
PO12. 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.
PSO1. Design, analyse and evaluate the performance of mechanical systems
PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost
PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems

Course Outcomes (COs)

1. Apply technical knowledge to a real-world problem by identifying requirements and using appropriate tools or techniques to address it
2. Develop innovative technical strategies and methodologies to address and solve complex engineering problems
3. Apply relevant tools, algorithms, and techniques to design and implement effective solutions for the given project.
4. Evaluate the performance of the developed solution / prototype through systematic testing, validation, and cost-effectiveness analysis to verify its compliance with specified project requirements.
5. Prepare comprehensive technical documentation and deliver effective oral presentations to communicate project outcomes

Articulation Matrix

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

18HS201 COMMUNICATIVE ENGLISH II **1 0 2 2**

Course Objectives

- Read and understand ideas of complex text on both concrete and abstract topics
- Listen and understand technical discussions in his/her field of specialisation
- Produce clear, detailed text on a wide range of subjects and explain a viewpoint on a topical issue giving the advantages and disadvantages of various options
- Interact with a degree of fluency and spontaneity that makes regular interaction without strain

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PO12. 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

PSO1.Design, analyse and evaluate the performance of mechanical systems

Course Outcomes (COs)

1. Apply appropriate grammar and business-related vocabulary to understand and produce written communication at the BEC Vantage level.
2. Analyze the general meaning of non-routine business letters and reports on both predictable and unpredictable topics.
3. Develop simple factual reports and compose factual non-routine letters in a business context.
4. Illustrate questioning skills to get correct information, understand answers, and share or record messages clearly at work.
5. Design simple, prepared presentations on familiar business-related topics by applying basic opinions and limited arguments.

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	2	3	-	-	-	-	-	-	3	3	-	2	2	-	-
3	2	2	3	-	-	-	-	-	3	3	-	2	2	-	-
4	3	-	-	-	-	-	-	-	3	3	-	2	2	-	-
5	2	2	2	-	-	-	-	-	3	3	-	2	2	-	-

UNIT I **9 Hours**

GRAMMAR3

Tenses - Future continuous, Future perfect, Future perfect continuous, Past perfect, Past perfect continuous - Adjectives and adverbs - Mixed conditionals - Modals - can't have, needn't have - Modals of deduction and speculation - Narrative tenses - Passives - Phrasal verbs, extended - Relative clauses - Reported speech - Will and going to, for prediction - Wish - Would expressing habits, in the past.

UNIT II **9 Hours**

READING

Scanning and reading for gist - Understanding text structure - Reading for gist and specific information - Vocabulary and structure - Understanding sentence structure and error identification

UNIT III **9 Hours**

WRITING

A message, memo or email, Giving instructions, explaining a development, asking for comments, requesting information, agreeing to requests - Business correspondence: explaining, apologising, reassuring, complaining, short report: describing, summarising - proposal: describing, summarising, recommending, persuading.

UNIT IV **9 Hours**

LISTENING

Listening for and noting specific information - Listening to identify topic, context, Function - Following the main points and retrieving specific information from the text.

UNIT V **9 Hours**

SPEAKING

Giving personal information: Talking about present circumstances, past experiences and future plans, expressing opinions, speculating - Organising a larger unit of discourse: Giving information and expressing and justifying opinions - Turn-taking: negotiating, collaborating, exchanging information, expressing and justifying opinions, agreeing/disagreeing, suggesting, speculating, comparing and contrasting, and decision making. 1.A Horse and Two Goats - R K Narayan 2. My Lord the Baby - Rabindranath Tagore 3. Twist in the Tale - Jeffery Archer.4.The Third and Final Continent - Jhumpa Lahiri 5.The Gift of the Magi - O Henry

Total: 45 Hours

Reference(s)

1. Guy Brook-Hart, "BEC Vantage: Business Benchmark Upper-Intermediate- Student's Books" 1st Edition, Cambridge University Press, New Delhi, 2006.
2. Ian Wood, Paul Sanderson, Anne Williams with Marjorie Rosenberg, "Pass Cambridge BEC Vantage- Student's Book" 2nd Edition, Cengage Learning, New Delhi, 2014
3. Michael Handford, Martin Lisboa, Almut Koester, Angela Pitt, "Business Advantage - Student's Book Upper-Intermediate" Cambridge University Press, New Delhi, 2014.
4. Cambridge Examinations Publishing, "Cambridge BEC VANTAGE - Self-study Edition", Cambridge University Press, UK, 2005.

18HSH01 HINDI **1 0 2 2**

Course Objectives

- To help students acquire the basics of Hindi
- To teach them how to converse in Hindi on simple day- to -day situations
- To help students understand a simple technical text in Hindi

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PO12. 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. Demonstrate correct pronunciation of Hindi vowels and consonants and classify them based on sound types (plosives, fricatives, nasals)
2. Apply rules of gender in noun usage and analyze differences between masculine and feminine forms in given texts.
3. Construct grammatically correct sentences using various pronouns and tenses; evaluate and correct sentence structures.
4. Assess classified vocabulary in real-life contexts and analyze the relationships among thematic vocabulary groups
5. Develop short dialogues and spoken expressions for real-life situations; evaluate clarity and appropriateness in spoken communication.

Articulation Matrix

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

UNIT I **9 Hours**

VOWELS AND CONSONANTS

Hindi Alphabet: Introduction (Self introduction) - Vowels - Consonants - Plosives - Fricatives - Nasal sounds - Vowel Signs - Chandra Bindu & Visarg -Table of Alphabet -Vocabulary.

UNIT II **9 Hours**

NOUNS

Nouns: Genders -Masculine & Feminine -Reading Exercises

UNIT III **9 Hours**

PRONOUNS AND TENSES

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

Classified Vocabulary: Parts of body -Relatives Spices Eatables -Fruit & Vegetables -Clothes -Directions -Seasons Professions.

UNIT V **9 Hours**

CONVERSATIONS

Speaking - Telling the times -Saying the Numbers from 1 to 50 Speaking practice for various occasions.

Total: 45 Hours

Reference(s)

1. B.R. Kishore, Self Hindi Teacher for Non-Hindi Speaking People, Vee Kumar Publications (P) Ltd., New Delhi, 2009.
2. Hindi Prachar Vahini - 1
3. Videos, Stories, Rhymes and Songs.

18HSG01 GERMAN **1 0 2 2**

Course Objectives

- To help students appear for the A1 level Examination
- To teach them how to converse fluently in German in day-to-day scenarios

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PO12. 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. Analyze individual German phonemes by carefully listening to identify and differentiate distinct sounds accurately.
2. Apply basic German sounds and vocabulary to develop accurate pronunciation and speaking skills.
3. Develop reading comprehension by understanding short passages on familiar topics in German.
4. Design simple written texts using basic sentence structures effectively in German.
5. Illustrate the fundamental grammar and appropriate vocabulary to complete a variety of language tasks accurately.

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	-	-	-
2	3	-	-	-	-	-	-	-	2	2	-	2	-	-	-
3	1	2	3	-	-	-	-	-	2	2	-	2	-	-	-
4	1	2	3	-	-	-	-	-	2	2	-	2	-	-	-
5	2	-	-	-	-	-	-	-	2	2	-	2	-	-	-

UNIT I **9 Hours**

INTRODUCTION

Introduction to the German language-Alphabets-Numbers Greetings -Days and Seasons-Working with Dictionary.

UNIT II **9 Hours**

LANGUAGE AND ITS COMMON USE

Nouns -articles-Speaking about oneself-Listening to CD supplied with books-paying special attention to pronunciation

UNIT III **9 Hours**

TECHNICAL DEUTSCHE

Regular &Irregular verbs -Personal pronouns-family-Introduction to types of sentences

UNIT IV **9 Hours**

INTERROGATION

Question words -Types of Questions -Nominative case-Verb Conjugation -country -nationalities

UNIT V **9 Hours**

IMPLEMENTATION

Verbs to be & to have -conjugation -Hobbies -Framing basic Questions and answers

Total: 45 Hours

Reference(s)

1. Kursbuch and Arbeitsbuch, NETZWERK A1 DEUTSCH ALS FREMDSPRACHE, Goyal Publishers & Distributers Pvt. Ltd., New Delhi, 2015.
2. Langenscheidt Eurodictionary, German English / English German, Goyal Publishers & Distributers Pvt. Ltd., New Delhi, 2009.
3. Grundkurs, DEUTSCH Lehrbuch Hueber Munichen, 2007.

18HSJ01 JAPANESE 1 0 2 2

Course Objectives

- To train students for N5 Level Examination
- To teach them use basic Japanese sentences in day-to-day conversation
- To make students familiar with the Japanese cultural facets and social etiquette

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PO12. 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. Apply knowledge of the Japanese alphabet by recognizing and writing basic characters accurately.
2. Develop speaking skills by using basic sounds of the Japanese language in everyday contexts.
3. Formulate the appropriate vocabulary to engage in simple conversations in Japanese.
4. Design grammatically correct sentences by applying essential grammar rules in both written and spoken Japanese.
5. Analyze spoken Japanese conversations to comprehend contextual meaning, recognize key expressions, and respond appropriately in real-life communication scenarios.

Articulation Matrix

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

UNIT I **9 Hours**

SELF INTRODUCTION / DEMONSTRATIVES / NOUN MODIFIERS

Introduction to Japanese Japanese script - Pronunciation of Japanese (Hiragana (Katakana) Long vowels - Pronunciation of in,tsu,ga -Letters combined with ya,yu,yo - Daily Greetings and Expressions Numerals. Speaking: Self Introduction - Listening: Listening to Greetings, Listening to specific information: Numbers, Time

UNIT II **9 Hours**

TIME EXPRESSION / VERBS - PAST

Introduction to time -Introduction of verbs -Listening to specific information

UNIT III **9 Hours**

ADJECTIVES

Word Sentence -Introduction to Adjectives -Technical Japanese Vocabulary -Pair Activity Day to day situational conversation. Listening to Japanese Alphabet Pronunciation -Simple Conversation

UNIT IV **9 Hours**

CONJUGATION OF II ADJECTIVE

Past tense of Noun sentences and Na adjective sentences -Past tense of ii adjective sentences -houga adjective desu -Technical Japanese Vocabulary -Individual Activity - Listening to conversation with related particles

UNIT V **9 Hours**

CONJUGATION OF VERBS - TE FORM / TA FORM / NAI FORM / PLAIN FORM

N gahoshidesu - V masu form tai desu - Verb te form - Technical Japanese Vocabulary -Listening to different Counters, simple conversations with verbs and adjectives

Total: 45 Hours

Reference(s)

1. Minna no Nihongo Japanese for Everyone Elementary Main Textbook1-1, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.
2. Minna no Nihongo Japanese for Everyone Elementary Main Textbook 1-2 Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.

18HSC01 CHINESE **1 0 2 2**

Course Objectives

- To help students appear for HSK Level 1 Exam
- To help students acquire the basics of Chinese language
- To teach the students how to converse in Chinese in various situations

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PO12. 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. Analyze individual sounds of Chinese by listening attentively to recognize and differentiate phonetic elements.
2. Apply basic sounds and vocabulary in spoken communication to build foundational speaking skills.
3. Develop reading comprehension skills by interpreting and analyzing short passages on familiar topics to extract main ideas and relevant details.
4. Design simple written texts by effectively using basic sentence structures to clearly convey ideas.
5. Interpret the basic grammar and appropriate vocabulary to complete language tasks accurately and meaningfully.

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	-	-	-
2	3	-	-	-	-	-	-	-	2	2	-	2	-	-	-
3	1	2	3	-	-	-	-	-	2	2	-	2	-	-	-
4	1	2	3	-	-	-	-	-	2	2	-	2	-	-	-
5	3	-	-	-	-	-	-	-	2	2	-	2	-	-	-

UNIT I **9 Hours**

Hello | 1. Initials and Finals of Chinese | b,p,m,f,d,,n,l,g,k,h,j,q,x | 2. Tones Four | 3. Chinese Syllables | 4. Tone S

UNIT II **9 Hours**

Thank you | Initials and Finals of Chinese | The Neutral Tone | Rules of Tone Marking and Abbreviation

UNIT III **9 Hours**

1. What""s your name - In the school; -In the classroom; -In the school | The Interrogative Pronoun | 2 The Sentence | 3 Interrogative Sentences with

UNIT IV **9 Hours**

She is my Chinese teacher | In the library | The Interrogative Pronouns | The Structural Particle | The interrogative Particle

UNIT V **9 Hours**

Her daughter is 20 years old this year | 1.The Interrogative Pronoun | 2. Numbers below 100 |
3.Indicating a Change | The Interrogative Phrase

Total: 45 Hours

18HSF01 FRENCH **1 0 2 2**

Course Objectives

- To prepare the students for DELF A1 Examination
- To teach them to converse fluently in French in day-to-day scenarios

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PO12. 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. Apply knowledge of the French alphabet and basic vocabulary to enhance familiarity with foundational language elements.
2. Analyze individual French sounds by listening carefully to distinguish and identify phonetic components.
3. Create the basic French sounds and vocabulary in spoken interactions to develop oral proficiency.
4. Develop reading comprehension skills by engaging with short passages on familiar topics.
5. Design accurate responses in French by applying grammar rules and appropriate vocabulary while completing language tasks.

Articulation Matrix

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

UNIT I **9 Hours**

ENTRER EN CONTACT

La langue franÃƒÂ§aise, alphabets, les numÃƒÂ©ros, les jours, les mois. Grammaire Les verbes s appeler, etre, avoir, les articles definis, indefinis Communication Saluer, s informer sur quelqu un, demander de se presenter Lexique L alphabet, les nationalites, l age, les pays, les couleurs, les jours de la semaine, les mois de l annee, les professions

UNIT II **9 Hours**

PARTAGER SON LIEU DE VIE

Les francais et leur habitat, des habitations insolites -Grammaire Verbes Conjugaison Present (Avoir / Etre / ER, IR, RE Regulier et Irregulier) Adjectifs les propositions de lieu. Communication Chercher un logement, decrire son voisin, s informer sur un logement - Lexique L habitat, les pieces, l equipement, la description physique

UNIT III **9 Hours**

VIVRE AU QUOTIDIEN LES LOISIRS DES FRANCAIS, LES GOUTS DES AUTRES, LES ACTIVITES QUOTIDIENNES

Grammaire Articles contractes, verbes vouloir, pouvoir, devoir, adjectifs interrogatifs, future proche Communication Exprimer ses gouts, parler de ses loisirs, justifier un choix, exprimer une envie - Lexique le temps libre et les loisirs, les saisons, les activites quotidiennes, le temps (le matin, le soir, la nuit)

UNIT IV **9 Hours**

COMPRENDRE SON ENVIRONNEMENT SOUVRIR A LA CULTURE

Grammaire Verbes Finir, Sortir, les adjectifs demonstratifs, le passe compose, l imparfait Communication Propose a quelqu un de faire quelque chose, raconter une sortie au passe, parler d un film Lexique Les sorties, la famille, l art, les vetements et les accessoires

UNIT V **9 Hours**

GOUTER A LA CAMPAGNE

Grammaire La forme negative, les verbes acheter, manger, payer, articles partitifs, le pronom en de quantite Communication Accepter et refuser une invitation, donner des instructions, commander au restaurant Lexique Les services et les commerces, les aliments, les ustensiles, l argent

Total: 45 Hours

Reference(s)

1. Grammaire Progressive du Francais, CLE International, 2010
2. Saison1, Marie Noelle Cocton et al, Didier, 2014.
3. Preparation a l examen du DELF A1 Hachette
4. Reussir le DELF A1 Bruno Girardeau
5. Website: Francais Linguaphone Linguaphone Institute Ltd., London, 2000.
6. Francais Harrisonburg : The Rosetta Stone : Fairfield Language Technologies, 2001

18GE0P1 NANOMATERIALS SCIENCE 3 0 0 3

Course Objectives

- To impart knowledge on Nanoscience.
- To explore different techniques of producing nanomaterials.
- To create expertise on the applications of nanomaterials in various fields.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO4.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

PO12. 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. Apply fundamental principles of nanoscience to classify nanomaterials based on their structure and properties.
2. Analyse the five synthesis methods of nanomaterials by comparing their efficiency, scalability, and applicability.
3. Design nanomaterial-based solutions for applications in electronics, energy storage, and biomedical fields by evaluating their functional properties.
4. Investigate the structural, optical, and electronic properties of nanomaterials using techniques such as electron microscopy and spectroscopy.
5. Assess real-world applications of nanomaterials in emerging fields such as spintronics, MEMS/NEMS, and quantum computing, evaluating their performance.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-
2	2	2	-	-	-	-	-	-	-	-	-	1	-	-	-
3	2	1	2	-	-	-	-	-	-	-	-	1	-	-	-
4	1	1	2	2	-	-	-	-	-	-	-	1	-	-	-
5	2	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 - 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 physical method: physical vapour deposition, RF sputtering, CVD- chemical method: colloidal and sol-gel methods - template based growth of nanomaterials - ordering of nanosystems, self-assembly and self-organization.

9 Hours

UNIT III

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.

9 Hours

UNIT IV

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- quantum well laser- quantum efficiency of semiconductor nanomaterials.

9 Hours

UNIT V

NANOMACHINES AND NANODEVICES

Microelectromechanical systems (MEMS) and Nanoelectromechanical systems (NEMS)-fabrication, actuators-organic FET- principle, description, requirements, integrated circuits- single electron transistor - - organic photovoltaic cells- spintronics.

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.

18GE0P2 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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO4.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

PO12. 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. Assess the band gap, drift current, and diffusion current densities associated with carrier transport in semiconductors.
2. Analyze the energy band diagram in thermal equilibrium and the space charge width of a PN junction
3. Apply the operation of a Bipolar Junction Transistor at different modes and configurations.
4. Illustrate the principles of charge storage in floating-gate transistors for non-volatile memory applications
5. Investigate the efficiency factors affecting the performance 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	-	-	-	-	-	-	-	-	-	-	1	-	-	-
2	2	1	-	-	-	-	-	-	-	-	-	1	-	-	-
3	2	-	-	-	-	-	-	-	-	-	-	1	-	-	-
4	2	-	-	-	-	-	-	-	-	-	-	1	-	-	-
5	2	1	2	2	-	-	-	-	-	-	-	1	-	-	-

UNIT I **9 Hours**

ENERGY BANDS AND CARRIER TRANSPORT PROPERTIES

Energy Bands: Formation of energy bands - doping effects - energy levels - electron and hole concept in semiconductor. Carrier transport: Carrier drift-drift current density - conductivity- diffusion current density - total current density.

UNIT II **9 Hours**

P-N JUNCTION

Basic structure and fabrication process of p-n junction - current - voltage characteristics - energy band diagram - equilibrium Fermi levels - depletion region - junction breakdown phenomena - zener - avalanche breakdown.

UNIT III **9 Hours**

BIPOLAR JUNCTION TRANSISTOR

The basic transistor action - operation in the active mode - current gain - static characteristics - carrier distribution in emitter, base and collector region - modes of operation - current - voltage characteristics of common base and emitter configuration - frequency response and switching of bipolar transistor.

UNIT IV **9 Hours**

MOSFET

The ideal MOS diode - basic fundamentals and characteristics - types - CMOS and BiCMOS - CMOS inverter - MOSFET on insulator - thin film transistor (TFT) - silicon on insulators (SOI) devices - MOS Memory structures - DRAM and SRAM.

UNIT V **9 Hours**

PHOTONIC DEVICES

Radiative transitions and optical absorption-light emitting diodes-organic LED - infrared LED - semiconductor laser - temperature effect - photo detector - photo diode - silicon and compound semiconductor solar cells – efficiency.

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.

18GE0P3 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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO4.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

PO12. 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. Analyze the principles of light absorption and emission in lasers, applying Einstein's relations to understand the conditions for stimulated emission and light amplification
2. Assess the principles and applications of various laser types to evaluate their unique characteristics.
3. Apply laser technologies to evaluate their impact on scientific research and advancements.
4. Investigate the effectiveness and safety of laser therapies in medical applications.
5. Evaluate the efficiency of laser applications in material processing and industrial technologies.

Articulation Matrix

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

UNIT I **9 Hours**

LASER FUNDAMENTALS

Introduction - principle - absorption and emission of light - thermal equilibrium - Einstein's prediction - Einstein's relations - A and B coefficients - condition for large stimulated emission - spontaneous and stimulated emission in optical region - light amplification - condition for light amplification - population inversion- Components of lasers - pumping methods - pumping mechanisms - optical resonator.

UNIT II **9 Hours**

LASER BEAM CHARACTERISTICS AND TYPES

Characteristics of laser - Classification of lasers - principle, construction, working, energy level diagram and applications of molecular gas laser (CO2 laser) - liquid laser (dye laser) - excimer laser - Solid state laser (Nd:YAG laser) - semiconductor laser (homojunction laser).

UNIT III **9 Hours**

LASERS IN SCIENCE

Introduction - Harmonic generation (SHG) - Stimulated Raman emission - lasers in chemistry - laser in nuclear energy - lasers and gravitational waves - rotation of the earth - measurement of distance - Light detection And Ranging (LIDER) - velocity measurement – holography.

UNIT IV **9 Hours**

LASERS IN MEDICINE AND SURGERY

Light induced biological hazards: Eye and skin - Eye laser surgery - photocoagulations - homeostasis - dentistry - laser angioplasty - different laser therapies - advantages & disadvantages - laser endoscopy.

UNIT V **9 Hours**

LASERS IN INDUSTRY

Applications in material processing: laser welding - hole drilling - laser cutting - Lasers in electronics industry: information storage - bar code scanner- Lasers in defence: laser based military weapons - laser walls.

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.

18GE0C1 CORROSION SCIENCE AND ENGINEERING 3 0 0 3

Course Objectives

- To analyse the loss incurred due to corrosion in different sectors and terminologies related to corrosion.
- To identify forms and types of corrosion with suitable mechanism.
- To apply various methods of corrosion control, corrosion testing and monitoring.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO4.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

PO7. 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. Illustrate the fundamental principles of corrosion science to calculate corrosion rates, analyze metal degradation and interpret Pourbaix diagrams to predict corrosion behavior in various industrial environments
2. Interpret different corrosion types on metals when exposed to air, water and at high temperatures (> 100 °C)
3. Assess the mechanism of corrosion on steel, iron, zinc and copper metal surfaces
4. Investigate the corrosion rate of metals using electrochemical testing methods under defined environmental conditions
5. Analyze the suitable 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		-	-	-	-	-	-	-	-	-	-	-	-	-
2	2	-	-	-	-	-	1	-	-	-	-	-	-	-	-
3	3		-	-	-	-	-	-	-	-	-	-	-	-	-
4	2	2	2	2	-	-	-	-	-	-	-	-	-	-	-
5	3	3	-	-	-	-	1	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

CORROSION

Importance of corrosion - spontaneity of corrosion - units of corrosion rate (mdd and mpy) - direct and indirect damage by corrosion - importance of corrosion prevention in industries - Pilling Bedworth ratio and its significance - passivation - area relationship in both active and passive states of metals – 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-Catastrophic oxidation corrosion.

UNIT III **9 Hours**

MECHANISM OF CORROSION

Hydrogen embrittlement - corrosion fatigue - filiform corrosion - fretting damage and microbes induced corrosion. Corrosion mechanism on steel, iron, zinc and copper metal surfaces.

UNIT IV **10 Hours**

CORROSION RATE AND ITS ESTIMATION

Rate of corrosion: Factors affecting corrosion. Electrochemical methods of polarization: Tafel extrapolation polarization and linear polarization. Weight loss method - testing for intergranular susceptibility and stress corrosion. Non-destructive testing methods: Visual testing - liquid penetrant testing - magnetic particle testing - Ultrasonic monitoring, and eddy current testing.

UNIT V **10 Hours**

CORROSION CONTROL METHODS

Fundamentals of cathodic protection - types of cathodic protection (sacrificial anodic and impressed current cathodic protection). Stray current corrosion, problems and its prevention. Protective coatings: Metal coatings: Hot dipping (galvanizing, tinning and metal cladding) - natural inhibitors. Selection of suitable design for corrosion control.

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.html.

18GE0C2 ENERGY STORING DEVICES 3 0 0 3

Course Objectives

- To compare the energy density of commercialized primary and secondary batteries.
- To classify the fuel cells and compare their efficiency in different environmental conditions.
- To demonstrate the various energy storage devices and fuel cells.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO4.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

PO7. 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. Interpret the parameters required for operation of a cell to evaluate the capacity of energy storage devices.
2. Analyze the electrodes, electrolytes, and cell reactions of various primary and secondary batteries, and infer the selection criteria for commercial battery systems based on their application requirements.
3. Illustrate the fuel cells based on their construction, current production, and applications
4. Assess the methods of storing hydrogen fuel along with their environmental applications.
5. Investigate the future prospects of renewable energy, hydrogen economy, and the efficiency of various generations of solar cells in energy production.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-		-	-	-	-	-	-	-	-	-	-	-	-
2	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
3	3	-		-	-	-	-	-	-	-	-	-	-	-	-
4	2	-		-	-	-	-	-	-	-	-	-	-	-	-
5	2	2	2	2	-	-	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 lithium and lead acid battery - 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, and mercuric oxide - recycling/safe disposal of used cells. Secondary batteries: lead acid - nickel-cadmium - lithium ion batteries - rechargeable zinc alkaline battery. Reserve batteries: Zinc-silver oxide - lithium anode cell - photo galvanic cells. Battery specifications for cars and automobiles. Extraction of metals from battery materials.

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 and photocatalytic water splitting. 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. Solar Cells: First, second, third and fourth generation solar cell - photo biochemical conversion cell.

Total: 45 Hours

Reference(s)

1. N. Eliaz, E. Gileadi, Physical Electrochemistry, Fundamentals, Techniques and Applications, Wiley, 2019.
2. J. Garche, K. Brandt, Electrochemical Power sources: Fundamentals Systems and Applications, Elsevier, 2018
3. S.P. Jiang, Q. Li, Introduction to Fuel Cells, Springer, 2021.
4. A. Iulianelli, A. Basile, Advances in Hydrogen Production, Storage and Distribution, Elsevier, 2016.
5. M.M. Eboch, The Future of Energy, From Solar Cells to Flying Wind Farms, Capstone, 2020.

18GE0C3 POLYMER SCIENCE 3 0 0 3

Course Objectives

- To explain the properties of different polymers with its mechanism.
- To select the appropriate polymerization techniques to synthesize the polymers.
- To identify suitable polymers for various industrial applications.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO4.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

PO7. 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. Illustrate the various types of mechanisms involved in polymerization reactions, including initiation, propagation, termination, and chain transfer processes.
2. Implement and analyze the suitable polymerization techniques to synthesize high-quality polymers.
3. Assess the structural, thermal, and mechanical properties of polymers for diverse applications.
4. Investigate the polymer processing methods to design polymer products.
5. Interpret the polymers employed 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	-		-	-	-	-	-	-	-	-	-	-	-	-
2	1	-		-	-	-	-	-	-	-	-	-	-	-	-
3	2	-		-	-	-	-	-	-	-	-	-	-	-	-
4	1	1	2	2	-	-	-	-	-	-	-	-	-	-	-
5	1	-		-	-	-	1	-	-	-	-	-	-	-	-

UNIT I **10 Hours**

POLYMERS AND ELASTOMERS

Classification of polymers - Mechanism: Addition polymerization - free radical, cationic, anionic and co-ordination (Ziegler-Natta) polymerization - copolymerization - condensation polymerization (nylon-6,6) - ring opening polymerization (nylon-6). Elastomers: Natural rubber and synthetic rubber: styrene -butadiene rubber (SBR), butyl, neoprene, thiocol rubbers. High performance polymers: polyethers, polyether ether ketone (PEEK), polysulphones and 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: TGA and DSC - Testing tensile strength - Izod impact - Compressive strength - Rockwell hardness - Vicot softening point - 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 plastics 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 – E waste management. Polymer for biomedical applications: artificial organs, controlled drug delivery, Scaffolds in tissue Engineering – waste management.

Total: 45 Hours

Reference(s)

1. V. R. Gowarikar, N. V. Viswanathan and JayadevSreedhar, "Polymer Science", New Age International (P) Ltd., New Delhi, 2021.
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, 2008.
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.
7. Common Biocompatible Polymeric Materials for Tissue Engineering and Regenerative Medicine (2019), Materials Chemistry and Physics https://doi.org/10.1016/j.

18GE0M1 GRAPH THEORY AND COMBINATORICS 3 0 0 3

Course Objectives

- To comprehends the graph as a modeling and analysis tool in computer science & Engineering.
- To introduce the structures such as graphs & trees and techniques of counting and combinations, which are needed in number theory based computing and network security studies in Computer Science.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3.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.

PO4.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 principles of graph theory, counting, and recurrence relations to solve problems in discrete mathematics and theoretical computer science.
2. Analyze graph structures, colorings, and connectivity properties to assess relationships and dependencies within discrete systems.
3. Investigate efficient combinatorial solutions using permutations, combinations, and generating functions to address complex counting and optimization problems.
4. Develop mathematical models involving planar graphs, matching, network flows, and recurrence relations for practical applications in computing and engineering.
5. Design models and strategies using Euler and Hamiltonian paths, chromatic polynomials, and generating functions through real-world examples and problem-solving scenarios.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Graphs - Introduction - Isomorphism - Sub graphs - Walks, Paths, Circuits - Connectedness - Components - Euler graphs - Hamiltonian paths and circuits - Trees - Properties of trees - Distance and centers in tree - Rooted and binary trees.

UNIT II **9 Hours**

TREES, CONNECTIVITY

Spanning trees - Fundamental circuits - Spanning trees in a weighted graph - cut sets - Properties of cut set - All cut sets - Fundamental circuits and cut sets - Connectivity and separability - Network flows - 1-Isomorphism - 2-Isomorphism - Combinational and geometric graphs - Planer graphs - Different representation of a planer graph.

UNIT III **9 Hours**

MATRICES, COLOURING AND DIRECTED GRAPH

Chromatic number - Chromatic partitioning - Chromatic polynomial - Matching - Covering - Four color problem - Directed graphs - Types of directed graphs - Digraphs and binary relations - Directed paths and connectedness - Euler graphs.

UNIT IV **9 Hours**

PERMUTATIONS

Fundamental principles of counting - Permutations and combinations - Binomial theorem - combinations with repetition - Combinatorial numbers - Principle of inclusion and exclusion - Derangements - Arrangements with forbidden positions.

UNIT V **9 Hours**

GENERATING FUNCTIONS

Generating functions - Partitions of integers - Exponential generating function - Summation operator - Recurrence relations - First order and second order - Non-homogeneous recurrence relations - Method of generating functions.

Total: 45 Hours

Reference(s)

1. NarsinghDeo, Graph Theory: With Application to Engineering and Computer Science, Prentice Hall of India, 2003.
2. Grimaldi R.P., Discrete and Combinatorial Mathematics: An Applied Introduction, Addison Wesley, 1994.
3. Rosen K.H., Discrete Mathematics and Its Applications, McGraw Hil, 2007.
4. Clark J. & Holton D.A., A First Look at Graph Theory, Allied Publishers, 1995.
5. Mott J. L, Kandel A. & Baker T.P., Discrete Mathematics for Computer Scientists and Mathematicians, Prentice Hall of India, 1996.
6. Liu C.L, Elements of Discrete Mathematics, McGraw Hill, 1985.

18GE0M2 ALGEBRA AND NUMBER THEORY 3 0 0 3

Course Objectives

- Understand the basic notions of groups, rings, fields which will then be used to solve related problems.
- Examine the key questions in the Theory of Numbers.
- Implement the integrated approach to number theory and abstract algebra, and provide a firm basis for further reading and study in the subject.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3.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.

PO4.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 concepts of algebraic structures such as groups, rings, fields, and finite fields to solve problems in number theory and cryptography.
2. Analyze polynomials over finite fields and factorization techniques to understand their role in modern algebra and coding theory.
3. Investigate algorithms like Euclidean and base-b representation to solve problems involving divisibility, prime numbers, and canonical decompositions.
4. Design mathematical models using Diophantine equations, congruences, and the Chinese Remainder Theorem to solve problems in modular arithmetic and system designs.
5. Develop applications of classical number theory theorems such as Euler's, Fermat's, Wilson's and multiplicative functions in cryptography and number patterns.

Articulation Matrix

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

UNIT I **9 Hours**

FIELDS

Group Theory - Rings and Polynomials - Fields.

UNIT II **9 Hours**

FINITE FIELDS AND POLYNOMIALS

Finite Fields - Irreducible Polynomials over Finite fields - Factorization of Polynomials over Finite Fields.

UNIT III **9 Hours**

DIVISIBILITY THEORY AND CANONICAL DECOMPOSITIONS

Division algorithm- Base-b representations - number patterns - Prime and composite numbers - Fibonacci and Lucas numbers - Fermat numbers - GCD - Euclidean Algorithm - Fundamental theorem of Arithmetic - LCM.

UNIT IV **8 Hours**

DIOPHANTINE EQUATIONS AND CONGRUENCES

Linear Diophantine equations - Congruence s - Linear Congruence s - Applications: Divisibility tests - Modular Designs - Chinese remainder theorem - 2x2 linear systems.

UNIT V **10 Hours**

CLASSICAL THEOREMS AND MULTIPLICATIVE FUNCTIONS

Wilson s theorem - Fermat s Little theorem - Euler s theorem - Euler s Phi functions - Tau and Sigma functions - Perfect numbers - Mersenne Primes - Mobius Function.

Total: 45 Hours

Reference(s)

1. Lidl.R., and Pilz. G., Applied Abstract Algebra, Springer-Verlag, New Delhi, 2nd Edition, 2006.
2. Thomas Koshy, Elementary Number Theory with Applications, Elsevier Publications, New Delhi, 2002.
3. San Ling and Chaoping Xing, Coding Theory: A first Course, Cambridge Publications, Cambridge, 2004.
4. Niven.I, Zuckerman.H.S., and Montgomery, H.L., An Introduction to Theory of Numbers, John Wiley and Sons, Singapore, 2004.

18GE0M3 MATHEMATICAL FINANCE AND QUEUEING THEORY

3 0 0 3

Course Objectives

- To provide the required fundamental concepts in probability and queueing models and apply these techniques in networks, image processing etc.
- Acquire skills in analyzing queueing models.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3.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.

PO4.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 concepts of stochastic calculus, including Brownian motion, Ito integration, and the Feynman-Kac formula, to model random processes in continuous time.
2. Analyze statistical data using parameter estimation, regression techniques, hypothesis testing, and normality assessments with practical implementation in R.
3. Investigate the Black-Scholes-Merton framework for its application in derivative pricing, risk-neutral measures, and self-financing strategies.
4. Design and evaluate queuing models for Markovian and non-Markovian systems to assess system performance.
5. Develop simulations and case studies to analyze real-world applications of stochastic models and queuing theory in finance and operations research.

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	3	2	2	-	-	-	-	-	-	-	-	-	-	-
4	2	3	3	-	-	-	-	-	-	-	-	-	-	-	-
5	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

APPLIED STOCHASTIC CALCULUS

Brownian motion - Constructions - Non-differentiability - Quadratic variation - Stochastic integration - Construction of Ito integral and properties, the Ito formula - Feynman-Kac formula

UNIT II **9 Hours**

STATISTICS

Basic parameter estimation - Maximum likelihood estimation - Distributions - Regression techniques - Tests for normality - QQ plots - Hypothesis testing - Numerical examples in R.

UNIT III **9 Hours**

CONTINUOUS-TIME FINANCE

Black-Scholes-Merton model of stock prices as geometric Brownian motion, derivation of the Black-Scholes-Merton partial differential equation, the Black-Scholes formula and simple extensions of the model, self-financing strategies and model completeness, risk neutral measures, the fundamental theorems of asset pricing, continuous time optimal stopping and pricing of American options, forwards and futures in Black-Scholes-Merton model.

UNIT IV **9 Hours**

QUEUEING THEORY

Markovian queues - Birth and Death processes - Single and multiple server queueing models - Little s formula - Queues with finite waiting rooms - Finite source models.

UNIT V **9 Hours**

NON-MARKOVIAN QUEUES AND QUEUEING NETWORKS

M/G/1 queue - Pollaczek Khinchin formula - M/D/1 and M/EK/1 as special cases - Series queues - Open and closed Jackson networks.

Total: 45 Hours

Reference(s)

1. M. Capinski and T. Zastawniak, Mathematics for Finance: An Introduction to Financial Engineering, Springer, 2005.
2. S. Shreve, Stochastic Calculus for Finance, Vol. 1 and Vol. 2, Springer, 2004.
3. G. R. Grimmett and D. R. Stirzaker, Probability and Random Processes, 3rd Edition, Oxford University Press, 2001.
4. Taha, H.A., Operations Research, Pearson Education, Asia, 8th Edition, 2007.

18ME001 COMPUTER AIDED DESIGN 3 0 0 3

Course Objectives

- To provide knowledge of 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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO5. 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.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PO12. 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

PSO1. Design, analyse and evaluate the performance of mechanical systems

Course Outcomes (COs)

1. Interpret two- and three-dimensional geometric transformations such as translation, scaling, rotation, and reflection to model engineering components in CAD systems.
2. Illustrate curve and surface modeling techniques, including Hermite, Bezier, B-spline, and rational representations, to infer their suitability for specific design scenarios.
3. Apply boundary representation and constructive solid geometry to create and validate accurate solid models for manufacturing prototypes.
4. Analyze assembly models to check fit, avoid interference, and ensure they work correctly by using tolerances and mass properties.
5. Evaluate the use of standard CAD data exchange formats like IGES, STEP, STL, and DXF for facilitating effective communication between CAD and CAM systems.

Articulation Matrix

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

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. Donald Hearn, M. Pauline Baker, Computer Graphics, Prentice Hall of India, New Delhi, 2014.
3. Richard M. Lueptow, Graphics Concepts for Computer-Aided Design, Pearson EducationIndia, 2006.
4. William M. Neumann, Robert F. Sproul, Principles of Computer Graphics, Tata McGraw Hall Publishing Company Pvt Ltd., New Delhi, 2005.
5. Mikell P. Groover, Emory W. Zimmers, CAD/CAM Computer-Aided Design and Manufacturing, Prentice Hall of India, New Delhi, 2007.

18ME002 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 different types of fixtures for the producing the part.
- To introduce about press working terminologies and press accessories.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO5. 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.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PO12. 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.

PSO1. Design, analyse and evaluate the performance of mechanical systems

Course Outcomes (COs)

1. Illustrate the objectives, challenges, and design principles of jigs and fixtures, including fits, tolerances, and geometric dimensioning standards used in tool design.
2. Analyze various locating and clamping methods using the 3-2-1 principle to infer optimal configurations based on design constraints and degrees of freedom.
3. Design jigs for machining operations by integrating suitable elements like drill bushes, indexing mechanisms, and automation for increased efficiency and precision.
4. Develop fixture systems for milling, boring, grinding, and welding operations using modular design approaches and material selection principles.
5. Formulate press tool systems, including progressive and compound dies, by simulating blank development, strip layout, and calculating tonnage requirements for forming operations.

Articulation Matrix

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

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**

DESIGN OF 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.

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

18ME003 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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO6. 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.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO12. 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.
PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Apply the basic principles of non-traditional machining processes to the indicate its need and classification.
2. Illustrate the working principles, equipment, and process parameters of mechanical energy-based machining processes such as AJM, WJM, and USM.
3. Interpret the working principles, power circuits, and tool-material interactions involved in Electrical Discharge Machining and Wire EDM for conductive material machining.
4. Assess the electro-chemical and chemical machining techniques for their precision, material suitability, and machining efficiency.
5. Analyze thermal energy-based machining processes such as LBM, EBM, and PAM for cutting hard-to-machine materials in advanced manufacturing applications

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	3	-	-	-	-	-	2	-	-	-	-	1	-	2	-
3	3	-	-	-	-	2	2	-	-	-	-	1	-	2	-
4	3	3	-	-	-	2	2	-	-	-	-	1	-	2	-
5	3	2	-	-	-	2	2	-	-	-	-	1	-	2	-

UNIT I **7 Hours**

NON-TRADITIONAL 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.

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, NewYork,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

18ME004 WELDING TECHNOLOGY 3 0 0 3

Course Objectives

- To study the principles of welding process, gas welding, arc welding and their applications.
- To provide knowledge on resistance welding process, parameters and its applications.
- To study the solid-state welding process, parameters and its applications.
- To know about special welding process and the welding automation for mass production.
- To learn the welding metallurgy, design and testing of weldments.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO4. 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.

PO12. 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.

PSO1. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply the fundamental principles of gas and arc welding processes, including power sources, metal transfer modes, and types of weld joints, to select appropriate welding techniques for various materials and applications.
2. Analyze the working mechanisms, advantages, limitations, and applications of various resistance welding processes to evaluate their suitability for different industrial scenarios.
3. Apply knowledge of solid-state welding processes such as friction, diffusion, and ultrasonic welding to select appropriate processes based on joint requirements and material characteristics.
4. Apply special welding processes including thermit, electron beam, and underwater welding, and develop automation strategies for their implementation in aerospace, nuclear, and transport industries.
5. Design different types of weld joints using standard welding symbols and dimensions, and formulate proper welding procedures considering material weldability and mechanical requirements.

Articulation Matrix

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

UNIT I **9 Hours**

WELDING PRINCIPLES, GAS AND ARC WELDING PROCESSES

Classifications of Welding Processes - Power sources, Arc characteristics, V-I characteristics, Metal transfer modes, electrodes and fluxes. Types of Weld joints, Weld position.
Gas welding: Oxyacetylene welding (OAW), Oxyhydrogen welding (OHW).
Arc welding: Shielded Metal Arc Welding (SMAW), Submerged Arc Welding (SAW), Gas Tungsten Arc Welding (GTAW/TIG), Gas Metal Arc Welding (GMAW/MIG), Plasma Arc Welding (PAW) and Electroslag welding (ESW), Electro gas Welding process (EGW) - Advantages, limitations and its applications.

UNIT II **9 Hours**

RESISTANCE WELDING PROCESSES

Spot welding (RSW), Seam welding (RSEW), Projection welding (PW), Resistance Butt welding, Flash Butt welding (FW), Percussion welding, High frequency resistance welding process and High frequency induction welding process - Advantages, limitations and its applications.

UNIT III **9 Hours**

SOLID STATE WELDING PROCESSES

Forge welding (FOW), Friction welding (FRW), Explosive welding (EXW), Ultrasonic welding (USW), Cold welding (CW), Diffusion bonding (DFW), Roll welding (ROW) and Hot pressure welding (HPW) processes - Advantages, limitations and its applications.

UNIT IV **9 Hours**

SPECIAL WELDING PROCESSES AND WELDING AUTOMATION

Thermit welding (TW), Atomic Hydrogen welding (AHW), Electron beam welding (EBW), Laser Beam welding (LBW), Friction stir welding (FSW), Under Water welding, Welding automation in aerospace, nuclear and surface transport vehicles.

UNIT V **9 Hours**

DESIGN OF WELD JOINTS, TESTING OF WELDMENTS, CODES AND STANDARDS

Welding symbols, welding dimension, design of various welded joints Weldability of Aluminium, Copper, Cast Iron and Stainless steels. Destructive tests: Tensile Testing, Ductility Testing, Toughness Testing, Fatigue Testing. Non-destructive testing: Visual Inspection, Liquid Penetrant Testing, Magnetic Particle Testing, Radiographic Testing and Ultrasonic Testing of weldments. Codes and Standards: Introduction to codes and standards, Welding and Welder Qualification, Procedure Qualification Record (PQR), Welding Procedure Specification (WPS), and Welder Performance Qualification (WPQ).

Total: 45 Hours

Reference(s)

1. David H. Phillips, Welding Engineering: An Introduction, Wiley, 2016.
2. Parmer R.S., Welding Engineering and Technology, 3rd edition, Khanna Publishers, New Delhi, 2015
3. Parmer R.S., Welding Processes and Technology, Khanna Publishers, New Delhi, 2004.
4. Nadkarni S.V., Modern Arc Welding Technology, 1st edition, Oxford IBH Publishers, 2005.
5. AWS Welding Hand Book, Welding Process, 9th Edition, Vol- 1&2, 2005.
6. https://nptel.ac.in/courses/112107089/

18ME005 ADVANCED STRENGTH 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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO12. 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.

PSO1. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply the deformation and dislocation behaviour of materials subjected to loading
2. Apply the deformation behaviour in materials subjected to higher temperatures
3. Analyze the deformation behaviour in materials subjected to low temperatures and embrittlement
4. Analyze the working conditions to design appropriate strengthening mechanisms that enable materials to withstand operational stresses and environmental factors effectively.
5. Design the materials to inhibit crack initiation, withstand fracture and fatigue loading

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	3	-	-	-	-	-	-	-	-	-	1	2	-	-
3	2	3	-	-	-	-	-	-	-	-	-	1	2	-	-
4	2	2	3	-	-	-	-	-	-	-	-	1	2	-	-
5	2	2	3	-	-	-	-	-	-	-	-	1	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 (Transformation 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 - Pari's Law - Cyclic stress-strain behavior - Design and evaluation of materials against 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.

18ME006 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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO12. 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. Apply the principles of process planning to select suitable machines, materials, and processes for manufacturing components.
2. Analyze various cost elements including direct, indirect, and overhead expenses involved in manufacturing operations.
3. Analyze various cost elements including direct, indirect, and overhead expenses involved in manufacturing operations.
4. Estimate machining time for operations like turning, drilling, boring, shaping, milling, and grinding with given process parameters
5. Analyze and compute the total production cost in forging, welding, and foundry operations using appropriate cost estimation techniques for accurate manufacturing planning.

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	2	-	-	-	-	-	-	-	-	-	1	2	-	-
3	2	2	2	-	-	-	-	-	-	-	-	1	2	-	-
4	3	2	2	-	-	-	-	-	-	-	-	1	2	-	-
5	3	2	2	-	-	-	-	-	-	-	-	1	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. S. K. Mukhopadhyay, Production Planning and Control-Text and cases, Prentice Hall of India Private Limited, 2015.
3. Chitale.A.C., Gupta.R.C., Product Design and Manufacturing, Prentice Hall of India Private Limited, 2011
4. Peter scallan, Process planning, Design/Manufacture Interface, Elsevier science technology Books, Dec-2003
5. https://nptel.ac.in/courses/112107238/27

18ME007 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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO4. 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.

PO6. 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.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO12. 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.

PSO3.Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Apply the concepts of combustion phenomena, to evaluate the thermal efficiency and performance characteristics of spark ignition engines.
2. Analyze the stages of combustion, knocking tendencies, and fuel injection characteristics in compression ignition engines for optimizing engine control
3. Formulate suitable emission control strategies such as EGR, SCR, and catalytic converters to meet prescribed environmental standards.
4. Investigate the physicochemical properties, advantages, and limitations of alternative fuels to assess their compatibility and performance in internal combustion engines
5. Illustrate the role of advanced engine technologies such as lean-burn systems, variable valve timing, and HCCI in reducing emissions and enhancing efficiency in internal combustion engines

Articulation Matrix

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

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 **9 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 **8 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 IN I.C ENGINES

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

Total: 45 Hours

Reference(s)

1. John B. Heywood, Internal Combustion Engine Fundamentals, Tata McGraw Hill Publishing Company Private limited., New Delhi,2015
2. R. B. Mathur and R. P. Sharmal Internal Combustion Engines, Dhanpat Rai Publications, 2010
3. B.P.Pundir, Internal combustion Engines Combustion and Emissions, Narosa Publishing House Private limited, New Delhi, 2017
4. V. Ganesan, Internal Combustion Engines, Tata McGraw Hill Publishing Company Private limited., New Delhi, 2013
5. W.W. Pulkrabek, Engineering Fundamentals of the Internal Combustion Engine, Prentice Hall, 2006
6. https://onlinecourses.nptel.ac.in/noc19_me10

18ME008 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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO6. 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.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO12. 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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems

Course Outcomes (COs)

1. Apply the principles of air refrigeration system operation to solve aircraft refrigeration system performance problems.
2. Analyze the performance of vapor compression refrigeration systems by incorporating subcooling and superheating techniques, and propose a suitable method to achieve enhanced system performance
3. Assess the applicability of non-conventional refrigeration systems with conventional systems to recommend a suitable system for cooling applications.
4. Interpret psychrometric data using charts to solve air conditioning problems in applications such as HVAC design for residential or commercial buildings
5. Select an suitable air conditioning systems by evaluating the parameters involved in system selection and load estimation to ensure optimal performance for indoor environmental conditions.

Articulation Matrix

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

UNIT I **9 Hours**

AIR REFRIGERATION SYSTEMS AND REFRIGERANTS

First and Second law of thermodynamics applied to refrigerating machines - Reversed Carnot cycle, unit of refrigeration, co-efficient of performance. Air refrigeration: Bell-Coleman cycle, Types of air refrigeration systems. Refrigerants- Desirable properties of refrigerants, Recent substitute for refrigerants.

UNIT II **9 Hours**

VAPOR COMPRESSION SYSTEM

Need for modification of Carnot cycle, Ideal and actual vapour compression cycle, Improvements in simple vapour compression system using flash chamber and flash inter cooler. Compound vapor compression system- Need for compound compression, two stage compression and various arrangements for improvement in coefficient of performance.

UNIT III **9 Hours**

OTHER REFRIGERATION SYSTEMS

Principle, Components, working, limitations and applications of Steam jet refrigeration system, Thermo-electric refrigeration system, Electrolux refrigeration system,Vortex refrigeration system and Cascade refrigeration system.

UNIT IV **9 Hours**

APPLIED PSYCHROMETRY

Principle and properties of psychometric of air, 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

Comfort Air Conditioning - parameters, requirements, concept of effective temperature, infiltration, internal heat gains, comfort charts. Industrial Air conditioning. Air conditioning systems and their types, selection of system, Components and controls of air distribution, Window air conditioner, split air conditioner, Central air conditioner, load estimation.

Total: 45 Hours

Reference(s)

1. C. P. Arora, Refrigeration and Air Conditioning, Tata McGraw Hill Publishing Company Private Limited, New Delhi, 2017.
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. https://nptel.ac.in/courses/112105129/

18ME009 COMPOSITE MATERIALS 3 0 0 3

Course Objectives

- To provide fundamental knowledge in reinforcement and matrix materials.
- To impart knowledge on polymer matrix composites.
- 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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO4. 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.

PO12. 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.

PSO1.Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Assess the need, characteristics, and constituents of composite materials including types of reinforcements, forms, and matrix materials.
2. Apply suitable processing techniques for polymer matrix composites to meet functional and industrial requirements.
3. Interpret the characteristics, processing methods, and applications of metal matrix composites using the rule of mixtures and reinforcement effects.
4. Develop ceramic matrix composites using advanced processing techniques for high-temperature and aerospace applications.
5. Analyze laminated composite structures considering mechanical behavior, failure theories, and structural performance.

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	2	-
3	2	3	-	-	-	-	-	-	-	-	-	-	2	2	-
4	2	2	3	2	-	-	-	-	-	-	-	-	2	2	-
5	2	3	-	-	-	-	-	-	-	-	-	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.

Total: 45 Hours

Reference(s)

1. P.K. Mallick, Fiber Reinforced Composites Materials, Manufacturing and Design, MarceDekker 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, JohWiley 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.

18ME010 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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO4. 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.

PO12. 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

PSO1. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Interpret the Statistical Process Control (SPC) charts to track the performance of a production process over time and identify trends and variations.
2. Apply the standard sampling plan to select a representative sample from a lot in order to assess its quality and ensure that inspection results accurately reflect the overall quality of the product or process.
3. Demonstrate the Taguchi method using factorial experiments to optimize products and processes, making them less sensitive to variation.
4. Validate the performance of systems and products using reliability functions, and evaluate the reliability of the system and its models.
5. Analyze the reliability design process to identify causes of failure and assess their effects for economic analysis and life-cycle cost evaluation.

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	-	-	-	-	-	-	-	-	-	-	1	2	-	-
3	3	-	-	-	-	-	-	-	-	-	-	1	2	-	-
4	3	2	1	1	-	-	-	-	-	-	-	1	2	-	-
5	3	2	-	-	-	-	-	-	-	-	-	1	2	-	-

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(MTBF),Mean Time To Repair(MTTR), 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 FOR 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.

Total: 45 Hours

Reference(s)

1. Amitava Mitra, Fundamentals of Quality Control and improvement, Wiley,2013.
2. Patrick D connor, Practical Reliability Engineering,Wiley,2012.
3. Charles E Ebling, An Introduction to Reliability and Maintainability Engineering,Overseas Press,2011
4. David J Smith, Reliability, Maintainability and Risk: Practical Methods for Engineers, Butterworth-Heinemann,2011
5. Dhillon, Engineering Maintainability, How to design for reliability and easy maintenance, PH India publications, 2008.
6. https://nptel.ac.in/courses/112107238/49

18ME011 MECHANICAL VIBRATIONS 3 0 0 3

Course Objectives

- To learn the fundamental concept of vibration of single degree of freedom (DOF) system.
- To expose knowledge on vibration of Two DOF system.
- To expose knowledge on vibration of Multi- DOF system.
- To learn the governing equation of vibration of continuous systems.
- To describe various instruments and control methods used in vibration analysis.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO4. 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.

PSO1.Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Analyze the dynamic behavior of Single Degree of Freedom (SDF) systems—including free and forced vibrations, damping effects, and energy methods—to evaluate and predict real-world mechanical vibration responses.
2. Model and analyze two-degree-of-freedom (TDF) mechanical systems to determine natural frequencies, mode shapes, and dynamic responses using principles such as orthogonality, coordinate coupling, and Lagrange's equations.
3. Formulate and solve multi-degree-of-freedom (MDF) vibration problems using exact and approximate methods to determine natural frequencies, mode shapes, and system behavior.
4. Analyze the vibrational behavior of continuous systems such as strings, shafts, and beams using analytical and approximate methods including Rayleigh and Rayleigh-Ritz techniques.
5. Apply vibration measurement techniques and control methods to monitor, analyze, and reduce vibrations in mechanical systems using transducers, damping, isolation, and absorbers.

Articulation Matrix

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

UNIT I **9 Hours**

SINGLE DEGREE OF FREEDOM (SDF)

Fundamentals of vibration. Single Degree of Freedom - Responses of undamped free vibration - Viscous damping - Damped free vibration - Reponses of undamped forced vibration and damped forced vibration - Response of damped system under base excitation - Rotating unbalance. Introduction to Energy methods.

UNIT II **9 Hours**

TWO DEGREE FREEDOM SYSTEM (TDF)

General equation of motion - Principal mode of vibration - Coordinate coupling - Orthogonolity principle - Rectilinear and torsional systems - Natural frequencies of undamped free vibration systems - Equations of motion for forced vibrations and damped free vibration - Dynamic vibration absorber - Lagrange"s equation.

UNIT III **9 Hours**

MULTI-DEGREE FREEDOM SYSTEM (MDF)

Exact Analysis of MDF Modelling of MDF systems by equations of motion from Newton's law - Influence coefficients - Stiffness coefficients and Generalised coordinate - Eigenvalue problems and solution to eignvalue problems. Approximate methods in MDF Determination of natural frequencies by Dunkerley's method, matrix iteration method. Rayleigh's and Holzer's 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's Method and Rayleigh-Ritz method

UNIT V **9 Hours**

VIBRATION MEASUREMENT AND CONTROL

Transducers - Vibration Pickups - Frequency Measuring Instruments - Vibration exciters. Control of vibration- Control of Natural frequencies - Introduction to damping. Vibration Isolation - Vibration Absorbers.

Total: 45 Hours

Reference(s)

1. Rao,S. S. Mechanical Vibrations, Pearson Education, 2011.
2. Thomson W.T. Theory of Vibration with Applications, CBS Publishers and Distributors, New Delhi, 2006.
3. Mallik, A, K, Principles of Vibration Control, Affiliated East-West Press Pvt. Ltd, 2004.
4. Rao V. Dukkipati J. Srinivas. Text book of Mechanical Vibrations, PHI Learning Pvt Ltd, New Delhi, 2016.
5. Graham Kelly G and Shashidar K. Kudari, Mechanical Vibrations, Tata McGraw-Hill Publishing Company Ltd New Delhi, 2007.
6. http://nptel.ac.in/courses/112103111/

18ME012 SUPPLY CHAIN MANAGEMENT 3 0 0 3

Course Objectives

- To understand the individual processes of supply chain management and their interrelationships within individual companies and across the supply chain
- To understand the components of supply chain management
- To understand the tools and techniques useful in implementing supply chain management
- To understand the concept of retail logistics and contemporary issues.
- To understand the concept of ware house management.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO12. 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.

PSO1.Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply the fundamental concepts, functions, and elements of supply chain and logistics in manufacturing and retail environments.
2. Implement the strategies and IT tools to effectively manage retail distribution, replenishment, transport cycles, and green transport solutions.
3. Analyze the order management and reverse logistics processes, including perfect order metrics, return policies, and reverse logistics network design.
4. Apply the contemporary retail logistics challenges such as shrinkage, green logistics, and outsourcing to 3PL/4PL providers with reference to Indian retail practices.
5. Implement the role of IT in warehouse management processes, cross-docking operations to enhance warehouse performance and value-added services.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Concepts of Supply Chain and Logistics - Elements of Supply Chain - Elements of Logistics - Manufacturing Supply Chain - Functions of Manufacturing Supply Chain - Retail Supply Chain - Functions of Retail Supply Chain -Scope of Retail Logistics - Retail Supply Chain Management as a subset of Retail Management -Retail supply chain elements.

UNIT II **9 Hours**

MANAGING RETAIL LOGISTICS

Retail Distribution - Retail Replenishment - Direct Store Delivery - Managing Retail Home Delivery - IT for Retail distribution and replenishment -Measures for Retail Distribution and replenishment - Retail logistics -Retail Transport -Transportation Cycle of a retailer - Using IT in Transport Management -Green Transport

UNIT III **9 Hours**

ORDER MANAGEMENT AND REVERSE LOGISTICS

Order Management -Order Management Process - Concept of perfect order- Perfect order measures -Multi channel logistics -Retail Return and reverse logistics -Return Policy - Return Process -Reverse Logistics- Reverse logistics process -Designing reverse supply chain Network - Reverse Logistics Challenges - Application for Reverse Management

UNIT IV **9 Hours**

RETAIL LOGISTICS AND CONTEMPORARY ISSUES

Managing retail shrinkage -Elements and causes of shrinkage - Approach for shrinkage reduction - Green retailing - Green Logistics -Green Infrastructure -Green IT - Managing Logistics Service Provider - 3PLs/LSPs -Services outsourced to LSP/3PL -Major drivers of logistics outsourcing - Benefits of using 3PL/LSP -Evolution of 4 PL - Retail Logistic Service Provider - An Indian perspective

UNIT V **9 Hours**

WAREHOUSE MANAGEMENT

Cross Docking -Advantages of cross docking - How cross docking works -Cross Docking Functions - Necessary ingredients for Cross Docking - How cross docking saves time -Warehouse Process Maturity Model -IT in warehouse Management - Measures of warehouse Management - Retail Warehousing -Basic Functions of retail warehouse-Value added services of a Retail Warehouse

Total: 45 Hours

Reference(s)

1. Rajesh Ray, Supply Chain Management for Retailing, Tata McGraw Hill Education Private Ltd
2. Janat Shah, Supply Chain Management, Text and Cases, Pearson Education, 2009
3. Sunil Chopra and Peter Meindl, Supply Chain Management-Strategy Planning and Operation, PHI Learning / Pearson Education, 2007.
4. Ballou Ronald H, Business Logistics and Supply Chain Management, Pearson Education, 5th Edition, 2007.
5. David Simchi-Levi, Philip Kaminsky, Edith Simchi-Levi, Designing and Managing the Supply Chain: Concepts, Strategies, and Cases, Tata McGraw-Hill, 2005.
6. Altekar Rahul V, Supply Chain Management-Concept and Cases, PHI, 2005.

18ME013 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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO5. 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.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PO12. 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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Illustrate the evolution of manufacturing systems and illustrate how CAD/CAM integration, automation protocols, and external communication systems enhance modern manufacturing.
2. Compare the coding systems like DCLASS, MICLASS, and OPITZ to infer their role in Group Technology and facility design for cellular manufacturing.
3. Apply the computer-aided process plans using variant and generative approaches, integrating them with shop floor control systems and automated data collection technologies.
4. Analyze the flexible manufacturing systems (FMS) and their layout, components, and computer control to validate their efficiency in real-time shop floor scenarios.
5. Develop database architectures and communication protocols like MAP/TOP to simulate seamless data flow and integration in an open CIM environment.

Articulation Matrix

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

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

18ME014 ADVANCED CASTING AND FORMING PROCESSES 3 0 0 3

Course Objectives

- To understand the concept design of gating in casting process.
- To impart knowledge on special casting processes like investment, centrifugal, die casting, and continuous casting.
- To understand the concept of theory of metal forming processes.
- To understand the working principle of bulk deformation processes.
- To expose the methods of sheet metal forming operations and powder metallurgy.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Apply the fundamental concepts of process planning and cost estimation in manufacturing environments.
2. Analyze the cost estimation procedures to identify the components of direct, indirect, and overhead costs.
3. Compute the overall production cost for forging, welding, and casting operations through systematic estimation techniques.
4. Estimate the machining time for lathe, drilling, boring, shaping, milling, and grinding operations using standard formulas.
5. Design an optimal process plan by selecting suitable machines, materials, and cost-effective manufacturing processes.

Articulation Matrix

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

UNIT I **7 Hours**

CASTING DESIGN

Introduction - Principles and Design considerations in casting, Elements of a gating system, design of gating and risering, Designing for directional solidification - casting defects, causes and its inspection - hot coating, cold coating and warm coating.

UNIT II **10 Hours**

ADVANCED CASTING PROCESSES

Investment casting, Shell mould casting, Continuous casting process-Reciprocating moulding process, direct chill process, materials, defects and its applications. 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 and low pressure die casting.

UNIT III **6 Hours**

THEORY OF METAL FORMING

Metallurgical aspects of metal forming - slip twining - mechanics of plastic deformation - effects of temperature - strain rate - microstructure and friction in metal forming - spring back effect - yield criteria and their significance - classification of metal forming processes.

UNIT IV **10 Hours**

BULK DEFORMATION PROCESSES

Forging and Rolling - Introduction, classification, equipment types, die design and its types, press tools, processes, parameters and force calculation. Classification of extrusion processes tool, equipment and principle of these processes - influences of friction - Extrusion force calculation - Defects and analysis - Rod/wire drawing tool equipment and principle of processes - defects - Tube drawing and sinking processes - Mannesmann processes of seamless pipe manufacturing.

UNIT V **12 Hours**

SHEET METAL FORMING AND POWDER METALLURGY PROCESSES

Classification - conventional and HERF processes - Presses - types and selection of presses formability - diagram formability of sheet metals - Principle, process parameters equipment and application of the following processes - Deep drawing, spinning - stretch forming, plate bending, press brake forming Explosive forming - electro hydraulic forming - magnetic pulse forming - Powder Metallurgy Technique - Advantages - applications - Powder preform forging - powder rolling Tooling, process parameters and applications.

Total: 45 Hours

Reference(s)

1. Jain P.L, Principles of Foundry Technology, Tata McGraw Hill Publications, New Delhi, 2014.
2. Heine R.W, Carl Loper and Rosenthal P.C, Principles of Metal Casting, Tata McGraw Hill Publications, New Delhi, 2012.
3. J. P Kaushish, Manufacturing process., Prentice Hall of India Learning Private Limited, second edition, New Delhi, 2015
4. Dieter G.E, Mechanical Metallurgy, Tata McGraw Hill Company, New Delhi,2015
5. Mikell P. Groover, Automation, Production System and Computer Integrated Manufacturing, Prentice Hall of learning, New Delhi, 2015
6. B.L. Juneja, Fundamentals of metal forming processes, New Age International private Limited, New Delhi,2012

18ME015 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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO4.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

PO6. 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.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice

PO10. 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.

PSO1. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Analyze the evolution and application of safety management systems using job safety analysis, accident causation models, and performance monitoring techniques.
2. Apply statutory provisions from the Factories Act, Tamil Nadu Factories Rules, and environmental regulations to ensure legal compliance in industrial settings.
3. Evaluate safety practices in engineering industries involving machinery, gas handling, metal forming, and protective equipment to identify risks and recommend improvements.
4. Assess safety systems in chemical industries through process safety analysis, HAZOP studies, plant maintenance strategies, and emergency planning.
5. Design comprehensive safety reports and plans for construction projects by incorporating regulatory guidelines, hazard identification, and safe equipment usage.

Articulation Matrix

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

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 Reporting and Investigation - 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, Electricity Rules.

UNIT III **10 Hours**

SAFETY IN ENGINEERING INDUSTRIES

Safety in machine shop, Principles of machine guarding - Personal protective equipment- Safety in handling industrial gases - Safety in cold forming and hot working of metals- 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, Plant maintenance and emergency planning, management of maintenance-HAZOP study.

UNIT V **8 Hours**

SAFETY IN CONSTRUCTION INDUSTRY

Construction regulations, contractual clauses, permit to work, - Education and training-Hazards of construction and prevention- excavation, scaffolding, dismantling, road works, construction of high rise buildings - Working at heights,-Working on fragile roofs, work permit systems-Construction machinery, cranes, chain pulley blocks, earth moving equipment, conveyors- Manual handling, Safety in demolition work, - 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.

18ME016 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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO12. 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

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Apply the steps of the additive manufacturing process, use suitable file formats, and compare it with traditional manufacturing methods
2. Assess the principles, construction, and applications of liquid polymer and solid-based AM systems like SLA, DLP, FDM, and LOM.
3. Analyze powder-based additive manufacturing processes such as SLS, DMD, EBM, and LENS with respect to process parameters and material suitability.
4. Investigate the structure and operation of open-source 3D printers and evaluate rapid tooling methods for industrial applications.
5. Develop solutions for medical, automotive, aerospace, and other sectors using reverse engineering techniques and AM technologies

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	2	3	-	-	-	-	-	-	-	-	-	2	-	2	-
4	2	2	2	-	-	-	-	-	-	-	-	2	-	2	-
5	2	2	2	-	-	-	-	-	-	-	-	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), Continuous Liquid Interface Production (CLIP), Photo polymerization process, 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), Color Jet Printing, 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

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 Technologies 3D Printing, Rapid Prototyping and Direct Digital Manufacturing, Springer, 2015 http://www.springer.com/978-1-4939-2112-6
4. L.W. Liou, F.W. Liou, Rapid Prototyping and Engineering applications: A toolbox for prototype development, CRC Press, 2013.
5. Yang, L., Hsu, K., Baughman, B., Godfrey, D., Medina, F., Menon, M., Wiener, S., Additive Manufacturing of Metals: The Technology, Materials, Design and Production, Springer, 2017 https://doi.org/10.1007/978-3-319-55128-9
6. www.all3dp.com, www.3dprintingindustry.com, www.reprap.org, www.thingiverse.com

18ME017 NON - DESTRUCTIVE TESTING 3 0 0 3

Course Objectives

- To learn different surface inspection techniques.
- To provide knowledge on sub surface testing methods.
- 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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Apply the principles, advantages, and limitations of surface NDT methods like Visual Inspection and Liquid Penetrant Testing.
2. Analyze the subsurface techniques such as Magnetic Particle and Eddy Current Testing for detecting material defects.
3. Illustrate the Ultrasonic testing methods, including Pulse-Echo and Phased Array, for flaw detection and weld inspection.
4. Assess the quality of Radiographic Testing techniques, including exposure parameters, film handling, and safety aspects.
5. Infer the applications of advanced NDT methods such as Acoustic Emission, Thermography, Leak Testing, and Laser Stereography for industrial use.

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	-	-	-	-	-	-	-	-	-	-	-	2	-
3	3	-	-	-	-	-	-	-	-	-	-	-	-	2	-
4	3	2	2	-	-	-	-	-	-	-	-	-	-	2	-
5	3	-	-	-	-	-	-	-	-	-	-	-	-	2	-

UNIT I **9 Hours**

SURFACE TECHNIQUES

Introduction and Scope of NDT, Discontinuities and Defects in various manufactured Components, Various physical characteristics of materials and their applications in NDT, Relative merits and limitations of NDT, Types of NDT techniques, 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**

SUB SURFACE TECHNIQUES TESTING

Magnetic Particle Testing (MPT) - Principles, applications, magnetization methods, magnetic particles - Dry particle technique and Wet fluorescent particle technique - Advantages and Limitations. Eddy Current Inspection - Principle, Methods, Equipment for ECT, Techniques, Sensitivity, Application, scope and limitations

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 NDT TECHNIQUES

Acoustic Emission Testing (AET) Principle - Instrumentation and applications, advantages and limitations. Infra-Red Thermography (IRT) - Principle, Techniques and applications. Leak Testing - Principle, Testing Procedure and applications. LASER Stereography- Typical applications- Requirements - advantages and disadvantages.

Total: 45 Hours

Reference(s)

1. Charles J. Hellier, "Handbook Of Nondestructive Evaluation", McGraw-Hill Education; 2 edition 2012.
2. Baldev Raj, Jayakumar T, Thavasimuthu M, "Practical Non-Destructive Testing", Narosa Publishing, 2009.
3. ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 2001.
4. Mc Gonnagle W T, "Non-Destructive Testing", McGraw Hill Book Co., 1988.
5. Louis Cartz, "Non-Destructive Testing", ASM International, Metals Park Ohio, US, 1995.
6. https://onlinecourses.nptel.ac.in/noc19_mm07/course

18ME018 RENEWABLE ENERGY SOURCES 3 0 0 3

Course Objectives

- To learn about solar radiation and solar thermal system application.
- To provide knowledge on fundamentals and sizing of solar photovoltaics.
- To study about the potential and energy conversion process of Wind Energy and Bio Energy.
- To impart fundamental knowledge about Ocean Thermal Energy and Geothermal Energy.
- To provide knowledge about the recent trends in Hydrogen and Fuel Cells.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO4. 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.

PO6. 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.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems

Course Outcomes (COs)

1. Apply the principles of solar radiation and thermal conversion to examine various solar collectors and thermal applications for power generation.
2. Analyze the performance of solar PV systems by applying the photovoltaic principles.
3. Illustrate the principles, technologies, and site selection criteria of wind and bio energy systems for efficient energy conversion and sustainable applications.
4. Investigate the working methodologies, resource potential, and technological devices of ocean and geothermal energy systems for effective energy harnessing.
5. Develop hydrogen-based energy systems and fuel cell technologies for clean and sustainable energy applications.

Articulation Matrix

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

UNIT I **9 Hours**

SOLAR THERMAL SYSTEMS

Solar radiation spectrum, Radiation measurement, Estimation of average solar radiation, Introduction to solar collectors (liquid flat- Plate collector - Air heater and concentrating collector) Solar distillation,Solar drying, Solar thermal system for power generation.

UNIT II **9 Hours**

SOLAR PHOTOVOLTAIC SYSTEMS

Operating principle, Photovoltaic cell concepts, Cell, module, array, Voltage current characteristics of a solar cell, Series and parallel connections, Maximum power point tracking, Applications - Battery charging, Pumping, Lighting

UNIT III **9 Hours**

WIND ENERGY AND BIO ENERGY

Basic principles of wind energy conversion - classification of wind turbines, wind power generation curves, wind data and energy estimation. Site selection considerations - Merits and demerits of wind energy systems. Biofuels classification, Biomass gasification- Technologies for utilisation of biomass, Biogas - Production, factors affecting biogas production, biogas plants.

UNIT IV **9 Hours**

OCEAN THERMAL 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 V **9 Hours**

HYDROGEN AND FUEL CELLS

Basic properties of hydrogen. Technologies of hydrogen production. Transformation of hydrogen energy - hydrogen economy. Fuel cells - operating principle, Alkaline Fuel cells (AFC), Phosphoric Acid Fuel cells (PAFC), Polymer Electrolyte Membrane Fuel cells (PEMFC), Specific characteristics, advantages and applications.

FOR FURTHER READING

Design of Solar Thermal Systems, PV Panel Sizing, Economic Analysis of Wind Energy, Need for Hybrid Systems, Fuel cell Hybrids

Total: 45 Hours

Reference(s)

1. Rai. G.D., Non Conventional Energy Sources, Khanna Publishers, New Delhi, 2011.
2. Twidell, J.W. & Weir, A., Renewable Energy Sources, EFN Spon Ltd., UK, 2006
3. Boyle, Godfrey. 2004. Renewable Energy (2nd edition). Oxford University Press, 450 pages (ISBN: 0-19- 926178-4).
4. Schaeffer, John. 2007. Real Goods Solar Living Sourcebook: The Complete Guide to Renewable Energy Technologies and Sustainable Living (30th anniversary edition). Gaiam.
5. Sukhatme, Suhas P., and J. K. Nayak. Solar energy. McGraw-Hill Education, 2017.
6. https://onlinecourses.nptel.ac.in/noc19_ge11/course

18ME019 CRYOGENIC ENGINEERING 3 0 0 3

Course Objectives

- To learn about the cryogenic material properties and applications of cryogenics.
- 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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO4. 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.

PO12. 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

PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Apply the cryogenic principles to analyse material and fluid properties at cryogenic temperatures and their applications across various fields.
2. Assess the performance, figure of merit, liquefaction yield, and efficiency of various gas liquefaction methods.
3. Apply the principles of gas separation and purification to compare ideal separation methods and rectification processes using theoretical plate calculations and Murphree efficiency.
4. Analyze the working principles of Stirling, Gifford-McMahon, and Pulse Tube cryocoolers to compare their operational characteristics and practical applications.
5. Investigate the design and function of cryogenic Dewar vessels, transfer lines, insulation systems, and instrumentation techniques used for temperature, flow, and level measurement.

Articulation Matrix

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

Total: 45 Hours

Reference(s)

1. Mamata Mukhopadhyay, Fundamental of Cryogenic Engineering, PHI learning Private Limited, New Delhi, 2014.
2. Thomas M. Flynn, Cryogenics Engineering, Marcel Dekker, New york, 2005.
3. G.G. Haselden, Cryogenics Fundamentals, Academic Press Inc., London, 1999.
4. K.D. Timmerhaus and T.M. Flynn, Cryogenics Process Engineering, Plenum Press, New York, 1989.
5. Randall F. Barron, Cryogenic System, 2nd edition, Oxford University Press, New York, 1985.
6. https://nptel.ac.in/downloads/112101004/

18ME020 ENGINEERING TRIBOLOGY 3 0 0 3

Course Objectives

- To impart basic knowledge on friction and wear
- To provide knowledge on behavior of surface contacts
- To learn about frictional behavior of sliding and rolling contacts
- To learn the wear mechanisms and its consequences under different contact conditions
- To identify the appropriate lubrication method based on contact conditions

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO4.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.

PO12. 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.

PSO1. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply fundamental tribological principles to assess material suitability for engineering applications.
2. Investigate the deformation and stress behavior in engineering surfaces by applying surface characterization and contact mechanics.
3. Analyze friction mechanisms and evaluate the effects of frictional heating and instability in mechanical systems.
4. Interpret wear models and measurement techniques to predict and control wear in different materials and applications.
5. Infer the Reynolds and Ertel-Grubin equations for tribological applications to demonstrate the performance characteristics of lubricants and lubrication regimes.

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	2	2	3	-	-	-	-	-	-	-	1	2	-	-
3	2	3	2	-	-	-	-	-	-	-	-	1	2	-	-
4	3	2	2	-	-	-	-	-	-	-	-	1	2	-	-
5	2	3	2	-	-	-	-	-	-	-	-	1	2	-	-

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 behavior and friction instability, sliding and rolling friction, frictional heating and temperature rise, Friction measurement techniques.

UNIT IV **9 Hours**

WEAR AND ITS MEASUREMENT

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. Elasto hydrodynamic Lubrication- Principle and application, pressure - viscosity term in Reynolds equation, Hertz theory, Ertel-Grubin Equation.

Total: 45 Hours

Reference(s)

1. Prasanta Sahoo, Engineering Tribology, 3rd edition, Prentice-Hall India, New Delhi, 2011.
2. Bharat Bhushan, Introduction to Tribology, 2nd edition, Wiley Publication, 2013.
3. I.M. Hutchings, Friction and Wear of Engineering Material, Edward Arnold, London, 2002.
4. Neale, M.J., Bearings-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/

18ME021 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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO12. 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

PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Apply principles of boiler operation and thermodynamic cycles to evaluate the performance of high-pressure, supercritical, and fluidized bed boilers.
2. Design a coal handling and combustion system for a steam power plant, integrating mechanical stokers, pulverizers, and electrostatic precipitators to optimize performance and meet environmental standards.
3. Analyze nuclear and hydel power plant layouts, types of reactors, and energy generation principles to assess their suitability for sustainable power production.
4. Illustrate the principles of thermodynamics and fuel utilization to identify the efficient operation of diesel and gas turbine power systems under different operating conditions
5. Demonstrate a hybrid power system by integrating multiple renewable sources such as wind, solar, and OTEC technologies to meet variable energy demands efficiently.

Articulation Matrix

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

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.

Total: 45 Hours

Reference(s)

1. S. C. Arora, S. Domkundwar, A course in Power Plant Engineering, Dhanpatrai & Sons, New Delhi, 2013.
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, 2016.

18ME022 OPTIMIZATION TECHNIQUES 3 0 0 3

Course Objectives

- To impart knowledge on concept of optimization and problem formation.
- To provide knowledge on optimization methods for single variable unconstrained problems
- To educate about multi-objective unconstrained optimization problems solving algorithms.
- To impart concepts of constrained non-linear optimization problems
- To provide input on non-traditional optimization techniques to solve engineering problems

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO4. 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.

PO5. 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

PO6. 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.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO12. 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.

PSO1. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Analyze the fundamental concepts of design optimization and interpret problem formulation procedures for engineering systems
2. Apply appropriate mathematical techniques to compute the optimal solution for single-variable unconstrained optimization problems
3. Analyze the solution strategies for multivariable unconstrained optimization problems using appropriate analytical or numerical methods.
4. Design systematic approaches to obtain solutions for constrained non-linear optimization problems relevant to engineering applications
5. Apply non-traditional optimization techniques, such as genetic algorithms and simulated annealing, to address complex 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	1	-	-	-	-	-	1	2	-	-
2	3	2	2	1	1	1	1	-	-	-	-	1	2	-	-
3	3	2	2	2	1	1	1	-	-	-	-	1	2	-	-
4	3	2	2	2	1	1	1	-	-	-	-	1	2	-	-
5	3	2	2	2	1	1	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.

Total: 45 Hours

Reference(s)

1. Singiresu S.Rao, Engineering Optimization: Theory and Practice, Fourth Edition, Wiley IndiaPvt 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.LtdNew Delhi, 2011.
4. R.Saravanan, Manufacturing optimization through intelligent techniques, First Edition, Taylor& Francis Publications, CRC Press, New Delhi, 2006.
5. Optimization Techniques and Applications with Examples, Xin-She Yang, Wiley India Pvt Ltd, Delhi,2018.

18ME023 DESIGN FOR MANUFACTURE AND ASSEMBLY 3 0 0 3

Course Objectives

- To learn the way of specifying geometric dimensioning and tolerancing in engineering drawing
- To familiarize the design considerations for designing components for the casting, welding and forming processes.
- To familiarize the design guidelines while designing components which are manufacturing by different machining processes.
- To learn the factors affecting easy assembly of parts into a final product
- To impart knowledge about the product life cycle assessments and environmental impact of materials, manufacturing methods and the way to minimize it

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO4.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.

PO5. 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

PO12. 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

PSO1.Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Analyze geometric dimensioning and tolerance features to determine their influence on functional dimensions and overall assembly precision.
2. Design cast, welded, and formed components by applying manufacturing design principles to minimize defects and ensure production feasibility.
3. Implement design for manufacture and assembly (DFM & DFA) strategies to enhance machining efficiency and assembly effectiveness.
4. Apply design for assembly (DFA) principles to reduce part count and handling time, thereby increasing assembly efficiency.
5. Formulate eco-friendly design strategies by incorporating lifecycle assessment and sustainability practices in product development.

Articulation Matrix

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

UNIT I **10 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, profile, orientation, run out and Feature tolerance. Tolerance Limits for Assembly - Cumulative effect of Tolerances

UNIT II **10 Hours**

DESIGN CONSIDERATIONS FOR CASTINGS, WELDING AND FORMING

Casting - Pattern, Mould, Casting hole - cast, Cored and Machined holes, Parting line - 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 components for casting, welding, forging and machining processes. Design components for 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.

18ME024 INDUSTRIAL ENGINEERING 3 0 0 3

Course Objectives

- To impart the knowledge on production system 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 equipments.
- To learn about system analysis and different types of maintenance.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO4.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.

PO12. 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

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Apply industrial engineering principles to select suitable plant layouts for the given production systems.
2. Analyze process planning and production control methods to improve scheduling, routing, and resource utilization in manufacturing systems.
3. Investigate work systems and ergonomics to identify optimize human-machine interactions.
4. Develop inventory models and material handling layouts to enhance production flow and reduce operational costs.
5. Design system-level strategies by integrating maintenance practices to ensure reliability and continuity in industrial operations.

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	3	-	-	-	-	-	-	-	-	-	1	-	2	-
3	2	2	-	2	-	-	-	-	-	-	-	1	-	2	-
4	2	2	2	-	-	-	-	-	-	-	-	1	-	2	-
5	2	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. Production system Analysis, Input-output model, Productivity, Factors affecting productivity. Plant layout, Criteria for a good layout, Types of layout - Process layout, Product layout, Combination layout, and Fixed position layout. Material 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 - Definition, Classification and coding system, Formation of component family. Production planning - Introduction, Functions, 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. The flow diagram, String diagram, Multiple activity chart, Principles of motion economy, Therbligs, SIMO chart, Stopwatch procedure. Ergonomics- applications of ergonomic principles in the shop floor- work benches-seating arrangement.

UNIT IV **9 Hours**

INVENTORY MANAGEMENT AND MATERIAL HANDLING

Inventory - Definition, Objectives, Classification, Functions, Economic order quantity, Economic batch quantity, Inventory models, ABC analysis. Material Requirement Planning(MRPI), Manufacturing Resource Planning (MRPII), Operating cycle, Just in Time manufacturing system, KANBAN technique, Material handling - Definition, Functions, Principles, Equipment selection, and Equipment types.

UNIT V **9 Hours**

SYSTEM ANALYSIS AND MAINTENANCE

System concept, System analysis, System engineering, Techniques, Applications. Value analysis/ Engineering - Definition, Types of values, Aim, Technique, Procedure, Advantages, Applications, Value engineering versus Value control. Plant maintenance department - Objectives, Importance, Duties, Functions, and Responsibilities. Types of maintenance - Breakdown, Scheduled, Preventive and Predictive. Plant maintenance schedule - Introduction, Procedure.

FOR FURTHER READING

Industrial Psychology, Industrial relations, Industrial legislation, 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.

18ME025 INDUSTRIAL MAINTENANCE ENGINEERING 3 0 0 3

Course Objectives

- To Understand 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 few methods and instruments for condition monitoring
- To Learn few repair methods for basic machine elements.
- To Learn few repair methods for material handling equipment

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO4.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.

PO6. 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.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PSO2. 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 of maintenance management to improve equipment reliability and system performance.
2. Develop preventive and total productive maintenance strategies to enhance operational productivity.
3. Assess maintenance process performance and recommend corrective actions for continuous improvement.
4. Analyze appropriate repair techniques for basic machine elements to ensure operational efficiency.
5. Select the suitable maintenance and repair methods for material handling equipment based on operational needs.

Articulation Matrix

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

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 & packing

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. Garg M. R., Industrial Maintenance, S. Chand & Co., 1986
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.

18ME026 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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO4. 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.

PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Apply the fundamental equations of fluid dynamics, including the Navier–Stokes equations, and classify partial differential equations to establish a foundation for solving fluid flow problems.
2. Apply finite difference techniques to discretize and solve governing equations for fluid flow and analyze the stability, convergence, and accuracy of numerical methods for various flow regimes.
3. Analyze the finite volume method to discretize and solve one-dimensional and two-dimensional fluid flow problems, and analyze pressure-velocity coupling for steady-state flows.
4. Apply weighted residual and variational approaches of finite element method to solve steady-state heat conduction and incompressible flow problems in one-dimensional and two-dimensional domains.
5. Develop structured and unstructured computational grids using algebraic and differential grid generation techniques, and implement body-fitted coordinate methods to model complex geometries.

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	3	3	2	2	-	-	-	-	-	-	-	-	-	-	2
4	2	2	-	2	-	-	-	-	-	-	-	-	-	-	2
5	3	3	2	2	-	-	-	-	-	-	-	-	-	-	2

UNIT I **9 Hours**

INTRODUCTION

Introduction - Applications and impact of CFD in diverse fields - Navier Stroke equations in 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 **9 Hours**

FINITE DIFFERENCE METHOD

Basics and discretization of simple and complex governing equations. Applications. Incompressible 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 **9 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 **9 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 **9 Hours**

NUMERICAL GRID GENERATION

Introduction. Algebraic grid generation. Differential Grid Generation. Structured and unstructured grids. Body fitted Coordinate Method.

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. S. C. Gupta, Applied Computational Fluid Dynamics, Wiley India Pvt. Ltd., New Delhi, 2019
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, Pearson Education Ltd., New Delhi, 2007.
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/.

18ME027 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 expose the knowledge on combustion kinetics of fuels

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO6. 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.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO12. 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.

PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Apply standard fuel testing procedures to assess properties, calorific value, flash point, and viscosity of the fuel for automotive applications.
2. Analyze combustion parameters such as stoichiometric air-fuel ratio, excess air, and thermal efficiency for given fuels using thermodynamic principles
3. Investigate syngas composition and thermal efficiency to select appropriate feedstocks in the gasification process
4. Interpret a layout of basic combustion process by applying combustion principles, selecting appropriate fuels, and considering energy efficiency
5. Develop a combustion control strategy by integrating kinetic mechanisms and flame stability principles to improve thermal efficiency and ensure operational safety

Articulation Matrix

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

UNIT I **8 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 - Bomb Calorimetry- DuLong's Formula for CV Estimation- Flue gas Analysis- Orsat Apparatus

UNIT II **10 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. Properties of Liquid Fuels - Calorific Value, Specific Gravity, Flash & Fire Point, Octane Number, and Cetane Number-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

UNIT IV **9 Hours**

COMBUSTION: STOICHIOMETRY

Stoichiometry - Mass Basis and Volume Basis - Fuel and Flue Gas Compositions - Calculations - Excess Air Calculation from flue gas analysis. Rapid Methods for solid, liquid and gaseous fuels. Thermodynamics - Heat of combustion- Equilibrium constants of combustion reactions - Enthalpy - Temperature diagrams - Flame Temperature - Theoretical -Adiabatic and Actual

UNIT V **9 Hours**

COMBUSTION: KINETICS

Combustion Processes - Stationary Flame - Surface or Flameless Combustion -Submerged Combustion - Pulsating and Slow Combustion Explosive Combustion. Mechanism of Combustion - Chain reactions - Thermal mechanism - Ignition and Ignition Energy - Spontaneous Combustion - Flame Propagation-Ignition Limits - Limits of Inflammability

FOR FURTHER READING

Coal Burning Equipments - Oil Burners - Vaporizing Burners, Atomizing Burners - Design of Burners. Gas Burners - Atmospheric Gas Burners - Air Aspiration Gas Burners

Total: 45 Hours

Reference(s)

1. Samir Sarkar, Fuels & Combustion, 3rd Edition, University press, 2009
2. Bhatt, Vora Stoichiometry, 4th Edition, Tata McGraw Hill, 2004
3. Blokh AG, Heat Transfer in Steam Boiler Furnace, Hemisphere Publishing Corpn,2003.
4. Civil Davies, Calculations in Furnace Technology, Pergamon Press, Oxford, 1986
5. Sharma SP, Mohan Chander, Fuels & Combustion, Tata McGraw Hill, 1984
6. https://nptel.ac.in/courses/103105110/

18ME028 PRODUCTION AND OPERATIONS MANAGEMENT 3 0 0 3

Course Objectives

- To learn the concept of production and operations management
- To familiarize in identifying the facility location
- To introduce the concept of various forecasting methods
- To emphasise the need of material management and inventory control
- To educate on aggregate production planning

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO11. 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.

PSO1.Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply the principles of integrated production and operations management to improve system, capital, labour, and personnel productivity using industry best practices.
2. Analyze various facility location models and procedures to determine optimal plant and warehouse locations based on cost, revenue, and qualitative factors.
3. Demonstrate the forecasting techniques using qualitative and quantitative models to predict future demand and support decision-making in production systems.
4. Implement materials management strategies and inventory control models to optimize purchasing, storing, and inventory levels in a manufacturing environment.
5. Formulate aggregate production plans by evaluating planning strategies, requirements, and steps to align production with organizational goals and market demand.

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	-	-	-	-	-	-	-	-	2	-	1	-	-
3	3	2	-	-	-	-	-	-	-	-		-	1	-	-
4	3	-	-	-	-	-	-	-	-	-	2	-	1	-	-
5	3	2	2	-	-	-	-	-	-	-	2	-	1	-	-

UNIT I **9 Hours**

INTRODUCTION

Integrated Production Management, System Productivity, Capital Productivity, Labour Productivity, Personnel Productivity, Training; Operations Management and Strategy, Tools for Implementation of Operations, Industry Best Practices.

UNIT II **9 Hours**

FACILITY LOCATION

Factor influencing plant & warehouse location, impact of location on cost & revenue. Facility location procedure & models; qualitative models, Breakeven analysis, Single facility location model, Multi facility location model, Minimax location, Total & partial covering model

UNIT III **9 Hours**

FORECASTING

Need for forecasting, the forecasting process, Forecasting methods- qualitative methods, Quantitative models-Time series forecasting models, moving averages, exponential smoothing with trend and seasonal adjustment, multi-item forecasting, Simple and multiple linear regression models, monitoring and controlling forecasts

UNIT IV **9 Hours**

MATERIALS MANAGEMENT AND INVENTORY CONTROL

Material Management, Components of Integrated Material Management- Materials planning, Inventory Control, Purchase Management, Stores Management; Inventory control, Models of Inventory controls - Purchase model, Manufacturing model

UNIT V **9 Hours**

AGGREGATE PRODUCTION PLANNING

Aggregate planning system, Requirement of Aggregate Plan, Steps in Developing an Aggregate Plan, Advantages of Aggregate Plan, Aggregate Planning Strategies, Planning Options. Selecting the Method in Aggregate Planning, Aggregate Planning in Services.

Total: 45 Hours

Text Book(s)

1. Panneerselvam,R. Production and Operations Management, PHI, 2018.
2. R.B. Khanna, Production and operations management, PHI, 2015

Reference(s)

1. Jay Heizer and Barry Render, Operations Management, Pearson College Division, 2013
2. N. Chary, Production and operations management, Tata McGraw- Hill Publishing Company Ltd, NewDelhi. 2008.
3. https://onlinecourses.nptel.ac.in/noc18_me26/preview

18ME029 GREEN MANUFACTURING 3 0 0 3

Course Objectives

- Learn and understand the basic concept of green manufacturing and its significance
- Learn and understand the societal implications of green manufacturing
- Apply the concept of Green manufacturing in real time environment
- Learn the analytical methods and Techniques of green manufacturing
- Apply and analyze green manufacturing in design, implementation and its economics in industrial environment

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO4. 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.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO12. 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.
PSO1. Design, analyse and evaluate the performance of mechanical systems
PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Analyze the drivers, barriers, and environmental impacts associated with adopting green manufacturing strategies under regulatory, economic, and competitive contexts.
2. Apply the role of financial, ecological, and societal metrics to assess sustainability through green supply chain strategies and material-energy flow analysis.
3. Interpret the principles and technology wedges of green manufacturing to evaluate life cycle benefits and environmental impact of production systems.
4. Validate green energy technologies such as solar, wind, and fuel cells to determine cost-benefit and emission mitigation potential in manufacturing applications.
5. Demonstrate process monitoring and energy profiling techniques in green manufacturing to optimize energy usage and reduce resource waste.

Articulation Matrix

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

UNIT I **8 Hours**

INTRODUCTION

Why GM-Definition-Motivation and Barrier to GM-regulatory pressure-economic incentive-competitive advantage-Pillars of GM-environmental impact-carbon emission- waste generation-energy consumption-strategies for GM

UNIT II **9 Hours**

METRICS FOR GREEN MANUFACTURING(GM)

Overview of metrics-Financial metrics- Metrics for ecology- metrics for society-Multiple metrics-Material and energy flow analysis-Green supply chain-definition-motivation-techniques of green supply chain-future of green supply chain

UNIT III **10 Hours**

PRINCIPLES OF GM

Technology wedges for GM-Five principles of GM-Mapping of principles- Closed loop production system-Life cycle of production system-benefits- machine tools and energy consumption

UNIT IV **8 Hours**

GM THROUGH GREEN ENERGY SUPPLY

Green energy technologies-solar photovoltaics-wind energy-fuel cell- applications-technology performance-cost benefit of emission mitigation-examples of green house gas emission mitigation.

UNIT V **10 Hours**

TECHNOLOGY FOR GREEN MANUFACTURING

Process monitoring system-electrical flow-fluid flow-cutting fluid-compressed air-water-case study-energy consumption and spindle rpm profile

FURTHER READING

Future of green manufacturing, Case Study : semi conductor manufacturing, Green supply chain

Total: 45 Hours

Reference(s)

1. David Dornfeld, Chris Yuan, Nancy Diaz, Teresa Zhang, and Athulan Vijayaraghavan, Introduction to Green manufacturing, First Edition, Springer, 2013
2. DAVID R. HILLIS, J. BARRY DUVALL, Improving Profitability Through Green Manufacturing, First Edition, JOHN WILEY & SONS, INC, 2012
3. Jiri Klemes, Ferenc Friedler, Igor Bulatov, Petar Varbanov, Sustainability in the Process Industry, First Edition, Mc Graw Hill, 2011
4. M. Thirugnanasambandam, CO2 Emission Mitigation Through Energy Conservation- A practical Guide, First Edition, Shanlax Publishers, India, 2018

18ME030 PRODUCT DEVELOPMENT AND REVERSE ENGINEERING 3 0 0 3

Course Objectives

- To develop a new product by practicing a typical NPD Process followed in Industry
- To learn value engineering and product design tools to design a product
- To perform the Engineering Change Management process for a product
- To familiarize with the concept and design guidelines for manufacturing parts by different machining processes
- To educate the emerging trends and applications of reverse engineering and Additive manufacturing technology

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO6. 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.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PSO1. Design, analyse and evaluate the performance of mechanical systems

Course Outcomes (COs)

1. Interpret the concepts of idea, strategic planning, and product design in new product development, and analyze the factors involved in commercialization and collaboration
2. Implement the engineering principles and product design tools such as QFD, CAD, robust design, DFX, DFM, DFA, and ergonomics to enhance product functionality, manufacturability, and user experience.
3. Assess the principles of Product Data Management and the Engineering Change Management (ECM) process, including the roles and steps involved in implementing engineering changes in industry.
4. Apply design guidelines for manual assembly and various manufacturing processes, and utilize sustainable product design strategies for product development in the automobile industry.
5. Integrate reverse engineering tools such as CMM, laser scanners, CT, and MRI for point data acquisition in rapid prototyping across medical, manufacturing, automotive, aerospace, electronics, and retail industries.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO NEW PRODUCT DEVELOPMENT

Product life cycle - Product policy of an organization. Selection of a profitable product, Product design process- New product strategy-Idea generation and screening- Concept development and testing -Business analysis -Product development testing and analysis -Commercialisation - Collaboration- Gantt chart - product life cycle management

UNIT II **9 Hours**

VALUE ENGINEERING AND PRODUCT DESIGN TOOLS

Value engineering in product design; Advantages, Applications in product design- Introduction to product design tools, QFD, Computer Aided Design, Robust design, DFX, DFM, DFA, Ergonomics in product design

UNIT III **9 Hours**

ENGINEERING CHANGE MANAGEMENT

Product Data Management - Engineering Change Management process- Impact of ECM- Typical steps followed - Different roles in an ECM Process- Participating in an ECM process -Engineering Change Request - Engineering Change Notice - Engineering Change Orders

UNIT IV **9 Hours**

DFMA GUIDELINES

Product design for manual assembly, Design guidelines for metallic and non-metallic products to be manufactured by different processes such as casting, machining, injection molding etc - Design for Environment (DFE) methods - Design guide lines - Lifecycle assessment- Design to minimize material usage - Design for disassembly, Recyclability, Remanufacture, Energy efficiency - Design to regulations and standards

UNIT V **9 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

Total: 45 Hours

Reference(s)

1. T. Karl, Ulrich and D. Steven, and Eppinger, Product Design and Development, Mcgraw Hill 2009
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. Kevin otto, Kristin wood, Product Design: Techniques in Reverse Engineering and New Product Development, Pearson education, 2003
6. https://nptel.ac.in/courses/112107217/

18ME031 NANOMATERIALS AND NANOTECHNOLOGY 3 0 0 3

Course Objectives

- To provide knowledge on basic concepts and size dependent properties of nano materials
- To familiarize nano materials based on property and structure
- To impart knowledge on different synthesis techniques of nano materials
- To perform different characterization techniques.
- To apply the concepts of nano materials in Nano devices.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO4. 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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Illustrate the fundamentals of nanoscience and the influence of nanoscale dimensions on material properties
2. Compare different nano forms of carbon and metal oxides in terms of structure, functionalization, and applications
3. Formulate suitable synthesis methods for nanomaterials using top-down and bottom-up approaches.
4. Investigate nanomaterial characterization techniques and validate their structural and thermal behavior.
5. Design nano-enabled devices for applications in electronics, biotechnology, and energy, and illustrate their engineering relevance.

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	-	-	-	-	-	-	-	-	-	-	-	2	-
3	2	2	3	-	-	-	-	-	-	-	-	-	-	2	-
4	2	2	-	3	-	-	-	-	-	-	-	-	-	2	-
5	2	1	3	-	-	-	-	-	-	-	-	-	-	2	-

UNIT I **9 Hours**

INTRODUCTION

Nano scale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering Classifications of nanostructured materials- nano particles- quantum dots, nanowires-ultra thin films multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties.

UNIT II **9 Hours**

NANO MATERIALS

Nano forms of Carbon - Buckminster fullerene- graphene and carbon nanotube, Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT) - Nano metal oxides- ZnO, TiO2, MgO, ZrO2,NiO, nano alumina, CaO, AgTiO2, Ferrites, Nano clays-functionalization and applications-Quantum wires.

UNIT III **9 Hours**

SYNTHESIS OF NANO MATERIALS

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 nano materials -ordering of nano systems, self-assembly - DC sputtering and RF sputtering process

UNIT IV **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 X ray diffraction techniques - thermo gravimetric analysis of nano materials

UNIT V **9 Hours**

APPLICATIONS

Nano InfoTech: Information storage- nano computer, molecular switch, super chip, nano crystal, Nano bio technology: nano probes in medical diagnostics and biotechnology, Nano medicines, Targeted drug delivery, Bio imaging - Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)- Nano sensors, nano crystalline silver for bacterial inhibition, Nanoparticles for sun barrier products - In Photostat, printing, solar cell, battery.

Total: 45 Hours

Reference(s)

1. G Timp, Nanotechnology, AIP press/Springer, 1999
2. Akhlesh Lakhtakia, The Hand Book of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations. Prentice- Hall of India (P) Ltd, New Delhi, 2007
3. William A. Goddard, Donald Brenner, Handbook of Nano science, Engineering, and Technology, CRC Press, 2012.
4. Charles P. Poole Jr and Frank J. Owens, Introduction to Nanotechnology, Wiley Inter science, 2007
5. Guozhong Cao, Y. Wang, Nanostructures and Nano materials-Synthesis, Properties & Applications, Imperials College Press, 2011

18ME032 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 learn the seven tools of statistical quality and management
- To impart knowledge on TQM tools for continuous improvement
- To introduce international quality management systems

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO12. 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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Illustrate the fundamental principles, philosophies, and historical evolution of Total Quality Management to implement continuous process improvement.
2. Apply effective strategies for leadership, customer satisfaction, employee involvement, and supplier partnerships to enhance organizational quality culture.
3. Analyze process variations and performance using statistical quality control tools such as control charts and capability studies to ensure product consistency.
4. Develop and apply tools like Benchmarking, QFD, TPM, and FMEA to solve quality-related issues and improve product and process performance.
5. Design quality management systems in accordance with ISO standards and audit requirements to ensure organizational compliance and continuous improvement.

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	-
3	2	3	-	-	-	-	-	-	-	-	-	2	-	2	-
4	2	2	3	-	-	-	-	2	-	-	-	2	-	2	-
5	1	2	3	-	-	-	-	-	-	-	-	2	-	2	-

UNIT I **9 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

UNIT III **9 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 **9 Hours**

TQM TOOLS

Benchmarking, Quality Function Deployment (QFD) - House of Quality, QFD Process, and Benefits - Taguchi Quality Loss Function - Total Productive Maintenance (TPM), FMEA - Stages of FMEA, Case studies

UNIT V **9 Hours**

QUALITY SYSTEMS

Need for ISO 9000 and Other Quality Systems - Elements, Implementation of Quality System, Documentation, Quality Auditing, ISO 9000:2015, ISO 9001:2015 and ISO 9004:2018, TS 16949, ISO 14000, ISO 50001 - Concept, Requirements and Benefits

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, SouthWestern 2002
4. Dr.S.Kumar, Total Quality Management, Laxmi Publications Ltd. New Delhi, 2006
5. P.N.Muherjee, Total Quality Management, Prentice Hall of India, New Delhi, 2006

18GE0E1 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.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO6. 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.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO12. 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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Illustrate the nature, scope, and types of entrepreneurships, and evaluate the role of entrepreneurial personality traits and processes in fostering economic development.
2. Apply creativity and innovation techniques such as lateral thinking, brainstorming, and reversal methods to develop viable business ideas through the generation of alternatives and analogies.
3. Infer the provisions of business laws to design a compliant framework for business formation and operations including contracts, partnerships, and company memoranda.
4. Assess ultrasonic testing techniques, including phased array and angle beam methods, to evaluate internal defects in structural and welded components.
5. Select the effective production systems and facility layouts to develop operational strategies that optimize plant location, capacity planning, inventory management, lean manufacturing, and Six Sigma principles.

Articulation Matrix

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

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, Fractional, 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

18GE0E2 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

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO12. 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.

PSO1.Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply the marketing concepts including segmentation, positioning, and strategy formulation to identify the behavior of dynamic market environments
2. Interpret human resource practices, financial systems, and government initiatives to understand organizational behavior and policy impact
3. Demonstrate the implications of direct and indirect taxation systems on business decisions with support from real-time case examples
4. Analyze the institutional and financial support mechanisms provided by central, state, and local government bodies for business development
5. Formulate a comprehensive business plan covering capital planning, marketing, operations, HR, and financial viability assessment.

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	-	-	-	1	2	-	-
3	3		-	-	-	-	-	2	-	-	-	1	2	-	-
4	2	3	-	-	-	-	-	2	-	-	-	1	2	-	-
5	2	2	2	-	-	-	-	2	-	-	-	1	2	-	-

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

18ME0XA 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,

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO4.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.

PO10. 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.

PSO1.Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply the proper system of symbols and notations used in engineering drawings to communicate design intent regarding the shape, size, orientation, and location of parts and assemblies.
2. Design individual and related geometric features using form, profile, orientation, location, and runout tolerances.
3. Analyze the specification of profile and radius refinements using the profile of a conical feature.

Articulation Matrix

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

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, McGraw Hill, 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.

18ME0XB 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.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO6. 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.
PO10. 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.
PO11. 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.
PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Interpret the principles of Lean Manufacturing including Toyota Production System, workplace organization, and types of wastes to assess value flow and support continuous improvement.
2. Apply lean tools such as Just-In-Time, Kanban, TPM, 5S, and SMED to eliminate unnecessary process steps, reduce setup time, and implement lean strategies in production environments.

Articulation Matrix

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

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

18ME0XC 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

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO6. 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.

PSO1.Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Illustrate the quality control problem-solving process using structured methodologies and steps.
2. Demonstrate the use of quality control tools to analyze and solve basic quality-related problems.

Articulation Matrix

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

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.

18ME0XD 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

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PSO1.Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Apply structured problem-solving techniques using the seven-step story approach and quality control tools to identify and resolve quality-related issues in engineering processes.
2. Analyze quality problems using tools like cause-and-effect diagrams, Pareto charts, and control charts, and validate solutions through systematic observation, root cause analysis, and standardization techniques.

Articulation Matrix

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

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.

18ME0XE 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

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO5. 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.

PSO1.Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Analyze the influence of exhaust manifold geometry, flow uniformity, and pressure losses on system performance using theoretical concepts.
2. Design the automotive exhaust manifold using CATIA V5 considering structural layout, component integration, and emission control requirements.
3. Analyze exhaust gas flow in the manifold using CFD to optimize CPSI, space velocity, and pressure drop for improved pollution control.

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	3	-	2	-	-	-	-	-	-	-	2	-	-
3	2	3	-	-	2	-	-	-	-	-	-	-	2	-	-

UNIT I **15 Hours**

AUTOMOTIVE EXHAUST SYSTEM

Exhaust system - Exhaust system Function -Parts - Types - Catalytic Convertor - Types - 2 way - 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, 2009.

18ME0XF 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.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

PSO3.Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Apply the principles of Lean Manufacturing, including the Toyota Production System, workplace organization, waste identification, and visual control methods, to enhance operational efficiency in manufacturing and service sectors.
2. Analyze the continuous improvement methodologies such as KAIZEN by identifying gaps, formulating problem statements, collecting and analyzing data, and executing corrective and preventive actions to achieve strategic business goals.

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	2	-	-	-	-	-	-	-	-	-	-	-	3	3

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 - Underutilization 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

18ME0XG 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.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO6. 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.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PSO1.Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Interpret the key provisions and procedures of the Indian Patent Act relevant to filing, examination, and grant of patents.
2. Assess the patentability of inventions based on the criteria outlined in Indian patent law.
3. Analyze the legal framework governing patent rights, infringement, and enforcement mechanisms in India.

Articulation Matrix

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

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

18ME0XH RAILWAY TRACK TECHNOLOGY 1 0 0 1

Course Objectives

- To familiar about Indian Railway and types
- To understand the Railway track and its types.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO4.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.
PSO1.Design, analyse and evaluate the performance of mechanical systems.
PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Analyze the Indian railway system and illustrate the classification and functions of different types of rails.
2. Apply the principles of railway engineering to describe the components and structure of the railway track system.

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	3	2	-	1	-	-	-	-	-	-	-	-	2	1	-

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.

18ME0XI 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.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PSO3.Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Analyze the classification of engineering glasses and relate their properties to appropriate industrial applications
2. Illustrate the complete glass manufacturing process and describe various treatment techniques used in the glass industry.

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

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

18ME0XJ TOOL DESIGN AND MANUFACTURING 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 &
- equipments 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.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO5. 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.

PO10. 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.

PO12. 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.

PSO1.Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply the design considerations, molding techniques, and defect-avoidance methods in plastic component manufacturing for applications in industries such as automotive and consumer goods.
2. Analyze various molding defects such as warpage, weld lines, and sink marks to infer their root causes and recommend suitable corrective methods in plastic processing.
3. Design plastic product tooling systems by integrating elements such as core-cavity structure, heating/cooling circuits, and material specifications for effective molding and post-processing operations.

Articulation Matrix

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

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

18ME0XK 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.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PSO1.Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Implement the 5S methodology by applying systematic workplace organization techniques including SEIRI, SEITON, SEISO, SEIKETSU, and SHITSUKE to improve efficiency, safety, and quality in engineering environments.
2. Analyze the impact of 5S implementation through practical audits, visual controls, and continuous improvement strategies to sustain a clean and productive work environment.

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	-
2	2	3	-	-	-	-	-	-	-	-	-	-	3	3	-

UNIT I 15 Hours

5S - INTRODUCTION AND IMPLEMENTATION

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.

Total: 15 Hours

Reference(s)

1. 5S's : Five Keys to a Total Quality Environm, Takashi Osada, 2003
2. 5 Pillars of the Visual Workplace : The Sourcebook for 5S Implementation, Hiroyuki Hirano, 2019

18ME0XL 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

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PSO3.Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Apply the principles of the Energy Conservation Act 2001 to evaluate energy audit processes and recommend strategies for efficient energy usage.
2. Apply the specifications and operational techniques of energy auditing instruments to measure parameters like pressure, flow, power consumption, and waste heat recovery.
3. Analyze the performance and limitations of energy auditing instruments, including their suitability for specific applications, to optimize energy measurement and calculation techniques.

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	2	-	-	-	-	-	-	-	-	-	-	-	-	2
3	2	2	-	-	-	-	-	-	-	-	-	-	-	-	2

UNIT I **15 Hours**

ENERGY AUDITING AND INSTRUMENTS

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

Reference(s)

1. CO2 Emission Mitigation through Energy Conservation- A Practical Guide. b y Dr. M. Thirugnanasambandam, Published by Shanlax Publishers- 2018.
2. Energy Audit Manual published by Energy Management Centre, Govt of Kerala , Kerala – Manual-2017.

18ME0XM INDUSTRIAL CONTROL VALVES 1 0 0 1

Course Objectives

- To understand the basics of control valves and its applications
- To understand the global market outlook, competition, growth in industries and job opportunities in a global scale.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PSO1.Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Analyze the fundamentals of control valves and illustrate their manufacturers, global presence, and market outlook.
2. Apply the principles of control valve operation to interpret their industrial applications in power plants and compressors.

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	2	-	-	-	-	-	-	-	-	-	-	2	-	-

UNIT I **15 Hours**

INTRODUCTION TO CONTROL VALVES

Introduction-Principle of control valve-Classification of control valve-application of control valve-advantages and disadvantages of control valve in power plant and compressor industries-The makers in global scale-Indigenized control valves makers in India-Market overlook and trends-Job opportunities.

Total: 15 Hours

Reference(s)

1. Control Valves, Guy Borden, 1998
2. Control Valves: Practical Guides for Measurement and Control by Guy Borden (Editor)

18ME0XN INDUSTRIAL GEAR BOX DESIGN 1 0 0 1

Course Objectives

- To provide knowledge of industrial gear design and safety of gear safety
- To understand the lubrication systems and heat treatment of gears
- To impart the knowledge on gear life calculation for planetary gear.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO4.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.

PSO1.Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply gear design principles to select the appropriate type of gears, material, and heat treatment method for industrial gearbox design.
2. Design a gearbox for effective operation by selecting the proper bearing, seal, and lubrication system.
3. Analyze planetary gearbox configurations to calculate load distribution and bearing life and recommend maintenance strategies.

Articulation Matrix

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

UNIT I **15 Hours**

INDUSTRIAL GEARBOX DESIGN

Gears-Introduction, type of gear drives, tooth profile, loads on gear tooth and safety, bearing and seal selection, lubrication system, material, heat treatment and gear engineering drawing format. Planetary gearbox- Introduction, different planetary gear arrangement, planet bearing load and life calculation, gearbox installation, maintenance, Practical applications.

Total: 15 Hours

Reference(s)

1. Gustav Niemann Machine elements, Design and Calculation in Mechanical Engineering, Volume-II-Gears- Translated by K. Lakshminarayanan, M.A. Parameswaran and G.V.V. Rayudu.
2. Handbook of Gear Design, by Gitin M Maitra section edition, Tata McGraw Hil

18ME0XO PRODUCT VALIDATION TECHNIQUES AND ENVIRONMENTAL TESTING

1 0 0 1

Course Objectives

- To know the new product development processes & its various stages
- To learn various standards followed in product validation processes
- To Understand the basic and advanced methods of Product validation techniques

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO5. 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.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO10. 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.

PO11. 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.

PSO1.Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply the stages of the product development process and the principles of product validation to ensure quality, reliability, and performance in engineering products.
2. Apply international testing standards (ISO, ASTM, JIS, MIL, DIN) to perform and interpret mechanical, chemical, electrical, and environmental tests for product evaluation.
3. Simulate testing environments and procedures using appropriate equipment, ensuring proper maintenance, calibration, and documentation in compliance with NABL accreditation norms.

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	3	2	2	-	-	-	-	-	-	-	1	-	2	-	-
3	3	2	2	-	1	-	1	-	-	1	1	-	2	-	-

UNIT I **15 Hours**

TESTING AND REPORTS

Introduction on Product development process& its stages. Product validation and its importance. Standards adopted for testing like ISO, ASTM, JIS, MIL, DIN. Mechanical Test-Tensile, compressive, impact, Torsional, Fatigue, Creep, Vibration, Shock tests, drop test, Scratch resistance. Chemical test-chemical resistance, corrosion resistance test, Flammability test; Environmental test-Temperature storage, Humidity storage, Thermal cycling, thermal shock, solar radiation, UV effects, water ingression protection, Dust ingression protection, Altitude test, readability test. Electrical tests-EMI test, steady state electrical environment test. Test facility used for various test, Testing environments ,maintenance & calibration of testing equipment's, acceptance & rejection criteria based on test outcomes ,test report, NABL accreditation and its importance.

Total: 15 Hours

Reference(s)

1. Tomer Sharon ,"Validating Product Ideas Through User Lean Research", Rosanfeld, 2016.
2. Dennis F.X. Mathaisel, "Engineering for Sustainability", CRC Press, 2013

18ME0XP 8D PROBLEM SOLVING METHODOLOGY 1 0 0 1

Course Objectives

- To understand the 8D problem solving methodology.
- To implement 8D problem solving methodology using 7QC Tools.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO4.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

PO5. 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.

PO11. 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.

PSO1.Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply the 8D Problem Solving Methodology and Why-Why Analysis to systematically identify, analyze, and resolve engineering problems.
2. Apply the 7 QC Tools, including Pareto Diagram, Cause and Effect Diagram, Control Charts, and Histograms, to interpret data and improve quality in practical industrial scenarios.

Articulation Matrix

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

UNIT I **15 Hours**

PROBLEM SOLVING METHODOLOGY

Problem Solving Methodology Concept and Advantages- 8D Problem Solving Methodology - Why - Why Analysis -7 QC Tools -Stratification, Pareto Diagram, Cause and Effect Diagram, Check Sheet, Control Chart/Graph, Histogram, Scatter Diagram Practical Applications of 8D Problem Solving Methodology & 7 QC Tools.

Total: 15 Hours

Reference(s)

1. L.Suganthi and Anand A Samuel, Total Quality Management, PHI Learning, 2009.

18ME0XQ ADVANCED PRODUCT QUALITY PLANNING 1 0 0 1

Course Objectives

- To acquire the knowledge on advanced product quality planning
- To understand the terminology relating to APQP and PPAP.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

PSO3.Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Apply the principles of Advanced Product Quality Planning (APQP) including process flow, Quality Function Deployment (QFD), Failure Mode and Effects Analysis (FMEA), and control plans to ensure product quality in manufacturing and service sectors.
2. Analyze the Production Part Approval Process (PPAP) by interpreting process flow diagrams, capability studies, design records, and corrective & preventive actions to meet customer-specific requirements and regulatory standards.

Articulation Matrix

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

UNIT I **15 Hours**

ADVANCED PRODUCT QUALITY PLANNING

APQP -Basic concept, Elements, Five phases of APQP, Process flow, QFD, FMEA and Control plan. PPAP -Process flow diagram, Process capability study report, Design records & engineering change notes, Sub contractor control and Corrective & preventive actions

Total: 15 Hours

Reference(s)

1. D H Stamatis, Advanced Product Quality Planning, Taylor & Francis, 2001

18ME0XR DESIGN OF ROTOR SHAFTS 1 0 0 1

Course Objectives

- To understand types of screw compressor types, and rotor shafts design procedure used in industrial applications.
- To acquire the knowledge of shafts to support and transmit power, procedure of bending and twisting moments, equivalent bending and torsion in the screw compressor rotors.
- To know the importance of stress-concentration raisers and method of reducing the same, by calculating the stress concentration factors on static and fatigue basis.
- To learn use of the standard templates and tools to design the shafts.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PSO1.Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Analyze the types of shafts and their industrial applications, and illustrate the functions of components fitted onto shafts.
2. Apply design principles to calculate stress levels in shafts and develop optimum shaft designs considering stress concentration and factor of safety.
3. Demonstrate the theory and calculations of shaft component assembly to analyze assembly and disassembly procedures.

Articulation Matrix

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

UNIT I **15 Hours**

DESIGN OF ROTOR SHAFTS

Introduction on Screw Compressors, Types, Machine Elements, Types of Shafts – Introduction, applications screw compressors, Industrial and Automotive segments. Shear force, bending and twisting moment diagram for various types of Shafts- theory, example calculations and practices for screw compressors. Calculation of different types of stress levels across the shaft containing coupling, bearings, gears, etc. Calculation of equivalent bending and torsional moments - design the shaft with adequate safety factor. Features which causes stress concentration, method of calculating the stress concentration factors in static and fatigue basis. Standard templates used for the calculation of stress concentration factors and design of shafts. Corrected endurance limit by using standard ANSI / ASME - B106.1M-1985. Method of components assembly - theory and calculation and disassembly procedure.

Total: 15 Hours

Reference(s)

1. Compressor Handbook: Principles and Practice Tony Giampaolo, MSME, PE, CRC Press
2. Screw Compressor Modelling, Design and Use, City University , London
3. COMPRESSOR HANDBOOK Paul C. Hanlon McGRAW-HILL
4. Bearings in twin screw compressors, Application handbook, SKF
5. Design of Machine Elements Book by V. B. Bhandari
6. A Textbook of Machine Design Textbook by J.K. Gupta and R.S. Khurmi
7. Mechanical Design Second Edition By Peter R. N. Childs
8. Standard ANSI/ASME B106.1M-1985,

18ME0XS SAFETY MANAGEMENT IN INDUSTRY 1 0 0 1

Course Objectives

- To understand the procedure for accident prevention.
- To study the methods of safety performance monitoring.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO6. 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.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PSO1.Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply industrial safety procedures by conducting safety audits, measuring workplace environmental conditions, and complying with ISO 14001 and ISO 45001 standards.
2. Design an emergency preparedness plan by analyzing fire accident scenarios, identifying prevention and control measures, and conducting mock drills using appropriate fire detection and suppression systems.

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	2	3	2	-	-	2	2	-	-	-	-	-	3	-	-

UNIT I 15 Hours

Safety audit – shop floor, electrical, excavation, scaffolding- Measurement of noise, light, temperature and personal air sampling and analysis - ISO 14001 and IS0 45001. Fire prevention – science of combustion, classes of fire, types of fire- fire detection and control- smoke and flame detector, alarm system, hydrant, sprinkler- portable extinguishers- selection and operation - emergency preparedness and mock drill.

Total: 15 Hours

Reference(s)

1. National Safety Council, Accident Prevention Manual for Industrial Operations, N. S. C. Chicago, 1988.
2. H.W Heinrich, Prevention Industrial Accident McGraw-Hill Company, New York, 1991.
3. IS 14489: - code of practice on occupational safety and health.
4. ISO 14001: - environment management system.
5. ISO 45001: - Health safety management system.
6. Handbook of fire technology, R S Gupta, orient blackswan, 2010.

18ME0XT MODELLING AND ANALYSIS OF UNDERWATER ROBOTS 1 0 0 1

Course Objectives

- To understand the basics of underwater robots and its practical applications.
- To understand the design concepts and simulation of vehicle structure.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3.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.
PO5. 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.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. 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.
PO12. 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
PSO1.Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply principles of buoyancy, stability, and waterproofing to illustrate the functional requirements of underwater robot components and propulsion systems.
2. Analyze the influence of hydrodynamic forces, flow patterns, and pressure distribution on the locomotion and performance of underwater robots.
3. Design and simulate the structural model of an underwater robot, including the pressure hull, skeletal frame, and fluid flow characteristics using Navier-Stokes-based analysis.

Articulation Matrix

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

UNIT I **15 Hours**

Introduction to Underwater Robots - Conceptual design - Basic components and structure of underwater robots. Propulsion systems and locomotion mechanisms. Buoyancy and stability considerations. Material selection and waterproofing techniques. - Modeling of Pressure hull and pressure canister - Modeling of skeletal frame - Assembly of Underwater robots. Fluid Flow Simulation - Navier-Stokes equations - robot's geometry - Boundary conditions. Drag and Hydrodynamics - drag forces - hydrodynamic forces and moments - flow patterns and pressure distribution.

Total: 15 Hours

Reference(s)

1. Dr. Steven W. Moore, Harry Bohm, and Vickie Jensen, Underwater Robotics: Science, Design & Fabrication, Marine Advanced Technology Education (MATE) Center, 2010.
2. Sabiha Wadoo, Pushkin Kachroo ·Autonomous Underwater Vehicle Modeling, Control Design and Simulation, CRC Press, 2017

18ME0XU IOT INTEGRATED AUTOMATION SYSTEMS 1 0 0 1

Course Objectives

- To understand the knowledge about Industrial Automation using modern machines.
- To integrate the internet of things with automation systems.
- To develop IoT integrated automation systems with modern visualizations platforms.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO5. 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.

PSO1.Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Design an automated industrial process by incorporating appropriate sensors, actuators, and control logic to streamline production operations effectively.
2. Develop a simulation model in CODESYS integrated with Factory I/O to analyze, test, and validate the control logic for real-time industrial automation systems.

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	2	2	3	-	2	-	-	-	-	-	-	-	2	-	-

UNIT I 15 Hours

Industrial Automation Components – Factory Automation & Process Automation. Data manipulations and Acquisition in PLC: Analog sensors Types and Interfacing with PLC - Acquire value from pressure, temperature, flow with ESP32/Raspberrypi/PLC - Modules and Sensors Interfacing (IR sensor, Ultrasonic sensors, Soil moisture sensor) using Raspberry pi/node mcu - Modules and Actuators Interfacing (Relay, Motor, Buzzer) using Raspberry pi/node mcu - Configure and communicate MCU with PLC - Bluetooth, I2C, SPI, RFID, Ethernet, Modbus - SCADA and storage in Local PC / Server - Pneumatic application control and monitor using Arduino through Cloud. Design and practices: Pneumatics, Electro pneumatics, Hydraulics, and Electro hydraulics. Programming techniques of a controller: PLC programming - Instruction lists. Ladder diagram and sequential function chart programming techniques, HMI programming, VFD & Servo programming. Hands-on practices of IOT: IOT application in controlling a load through intranet & internet - MQTT Communication - Industrial IoT Application through Case study - PLC control in Industrial applications - Grabbing the content from a web page, Sending data on the web. Case study: Health monitoring, Iot smart city, Smart irrigation, Robot surveillance.

Total: 15 Hours

Reference(s)

1. Introduction to PLCs, Second Edition 2nd Edition Jay F. Hooper, 2006.
2. PLC Controls with Ladder Diagram (LD): IEC 61131-3 and introduction to Ladder programming Tom Mejer Antonsen, 2021.
3. Create projects using Codesys & Factory IO.

18ME0XV AUTONOMOUS KINEMATICS AND CONTROL IN ROS 1 0 0 1

Course Objectives

- Understand the technical challenges in the kinematic model and design of autonomous robots in the ROS platform.
- Develop the control algorithm for navigation, path planning and obstacle avoidance for mobile robots using Python/C++ in ROS.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3.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.
PO5. 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.
PSO1.Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Design the forward and inverse kinematic models for a mobile robot using the Robot Operating System (ROS) platform to simulate realistic robotic movements.
2. Develop a simulation model in CODESYS integrated with Factory I/O to analyze, test, and validate the control logic for real-time industrial automation systems.

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	2	2	3	-	2	-	-	-	-	-	-	-	2	-	-

UNIT I **15 Hours**

Getting started with ROS, ROS architecture and commands: Master, nodes, topics, messages, services, parameters and actions, Writing ROS programs, ROS Turtlesim, ROS Tools: Rviz and Gazebo, Keyboard Control/TeleOp of turtlesim, LIDAR Data. Rviz visualization - Robot model stl file - URDF robot model implementation. Basics of Navigation, Localization and Odometry, Dead reckoning/ Scan Matching, Simultaneous Localization and Mapping - Hector SLAM - Cartographer, Particle filter localization - Path planning - DWA planner, TEB planner - Obstacle avoidance - PID algorithm - Robot arm Robot path planning and trajectory control using ROS.

Total: 15 Hours

Reference(s)

1. Morgan Quigley, Brian Gerkey, William D. Smart, "Programming Robots with ROS", O'Reilly Media, Inc., 2015.
2. Wyatt Newman "A Systematic Approach to Learning Robot Programming with ROS", CRC press, 1st Edition, 2017

18GE0XA 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 words enter the language, and how it continues to be dynamic.
- To demonstrate the importance of a broad-based vocabulary for effective oral and written communication.

Programme Outcomes (POs)

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. 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.
PO12. 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.
PSO1.Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply the various forms of wordplay, idiomatic expressions, and etymological origins to enhance comprehension and effective use of English language conventions in professional contexts.
2. Analyze the structural components and origins of English words, to develop linguistic awareness and apply this knowledge to improve vocabulary and language precision.

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	-	-

UNIT I **7 Hours**

CONVENTIONS

Acronyms, Abbreviations, Initializes, 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.

18GE0XB GENERAL PSYCHOLOGY 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.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO4.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.

PO6. 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.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PO12. 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.

PSO1.Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Analyze the foundational concepts of psychology, including the mind-body relationship and psychological methods, to understand human behavior and mental processes.
2. Integrate and assess motivational and intelligence theories to formulate strategies that address diverse human needs and cognitive differences in academic, workplace, and social environments.
3. Design and propose interventions or models that address social influence, group dynamics, and attitude change, based on a deep understanding of social cognition, stereotypes, prejudice, and discrimination.

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	3	3	2	-	-	2	-	-	1	2	-	2	1	-	-
3	3	3	2	-	-	2	2	-	2	2	-	2	1	-	-

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

18GE0XC NEURO BEHAVIORAL 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.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO6. 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.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO10. 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.
PO12. 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.
PSO1.Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply the knowledge of the basic structure and function of human physiology and neurobiology to understand human behavior.
2. Apply the effects of neurochemicals and hormones on behavior and mental health.
3. Analyze the effectiveness of relaxation techniques and psycho-educational methods for behavior modification and promoting mental well-being.

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	3	-	-	-	2	-	2	-	-	-	2	1	-	-
3	2	-	-	-	-	3	-	3	-	3	-	3	1	-	-

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

18GE0XD VISUAL MEDIA AND FILM MAKING 1 0 0 1

Course Objectives

- To acquire fundamental knowledge on development of filmmaking as an art
- 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

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO6. 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.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO10. 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.
PO12. 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.
PSO1.Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Analyze the significance of visual media and illustrate the key techniques used in visual communication.
2. Construct visual clippings using appropriate techniques and assess their effectiveness in conveying intended messages.

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	3	-	-	2	-	2	-	-	-	2	1	-	-

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) 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.

18GE0XE 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

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO6. 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.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO12. 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.
PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Apply yoga techniques in their daily lives to improve overall health and well-being
2. Apply yoga techniques for increased focus, concentration, and mindfulness, leading to better stress management and emotional regulation
3. Analyze the origin, evolution, and contemporary relevance of Yoga, including the philosophies of major Yoga schools and the Eight Limbs of Yoga, to understand its role in holistic well-being.

Articulation Matrix

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

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 – Mudras Relaxation - 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

18GE0XF VEDIC MATHEMATICS 1 0 0 1

Course Objectives

- To improve their calculation speed, analytical thinking and numerical skills

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PSO1.Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply vedic sutras to perform fast arithmetic operations like addition, subtraction, and multiplication.
2. Demonstrate vedic methods to efficiently compute squares, square roots, cubes, and cube roots of numbers.
3. Implement vedic techniques to analyze and solve linear and quadratic equations in order to maximize computing accuracy and speed.

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	2	-	-	-	-	-	-	-	-	-	-	2	-	-
3	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-

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

18GE0XG 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.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Illustrate the need, types, and importance of physical fitness to promote lifelong health and well-being.
2. Develop yoga postures, pranayama, and meditation techniques to improve physical and mental health
3. Analyze the role of balanced diet and nutrition in maintaining a healthy lifestyle and identify preventive measures for common diseases.

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	3	-	-	-	-	-	-	-	-	-	-	2	-
3	2	2	-	-	-	-	-	-	-	-	-	-	-	2	-

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

18GE0XH 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 procedures of biodegradation of unwanted solid residues.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO5. 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.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO10. 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.

PO11. 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.

PO12. 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.

PSO1.Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply the ecological roles of earthworms and sustainable practices in vermiculture to promote organic farming and waste management.
2. Design and maintain effective vermicomposting systems using appropriate equipment and methodologies to optimize biodegradation and humus production.
3. Apply market research, quality control, and strategic marketing techniques to promote vermiculture products, fostering small-scale and commercial ventures with a focus on environmental and economic impact.

Articulation Matrix

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

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 equipment, 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

18GE0XI BLOG WRITING 1 0 0 1

Course Objectives

- To sharpen and improve writing skills, including draft writing, voice, and format.
- To develop general and global knowledge.
- To experiment with non-written forms of online communications, including images, audio and video.
- To be able to add content to your website without the assistance of a web designer.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3.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.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO10. 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.
PO12. 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.
PSO1.Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply the principles of digital content writing to structure and develop engaging blog posts for targeted audiences.
2. Demonstrate effective use of language, tone, and storytelling techniques to convey ideas clearly and persuasively in blog format
3. Formulate ethical guidelines, copyright norms, and originality standards to publish and promote blog content across suitable digital platforms.

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	1	-	-	-	-	-	-	2	-	1	1	-	-
3	2	-	-	-	-	-	-	2	-	2	-	1	1	-	-

UNIT I **7 Hours**

Concept: What is blog writing? Types of blog posts -personal experience, opinion, reviews, advice, news/updates. Focusing your blog - concept, audience, uniqueness, posts. Company blogs. Structure: Types of structure - inverted pyramid, feature article, list, story, other options. Creating effective openings. Planning a post.

UNIT II **8 Hours**

Voice: Defining and achieving voice. Exploring various voices. Stylistic tips, rhythm, verbs, interesting words, senses, emphasis. Smartness and sarcasm. Reliability - accuracy, provability, specificity. Transparency about payments. Sample Blogs and Activities

Total: 15 Hours

Reference(s)

1. The Elements of Blogging: Expanding the Conversation of Journalism, by Mark Leccese and Jerry Lanson. (Taylor & Francis, 2015) ISBN: 978-1-13-802154-9. $29.95 paperback.
2. Blogging Heroes, by Michael Banks. Choose 15 of the 30 interviews/profile segments to read, be sure to include the segments on Chris Anderson and Brian Lam.
3. Complete Guide to Blogging, Huffinghton Post

18GE0XJ INTERPERSONAL SKILLS **1 0 0 1**

Course Objectives

- To communicate and work effectively, both individually and in groups
- To be able to understand and manage ones own and others emotions
- To define and solve problems by making decisions about the best course of action.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO6. 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.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. 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.
PO11. 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.
PO12. 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.
PSO1.Design, analyse and evaluate the performance of mechanical systems.
PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.
PSO3.Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Demonstrate effective interpersonal traits such as active listening, team collaboration, empathy, and emotional intelligence for enhanced workplace communication and interaction.
2. Implement conflict resolution strategies and decision-making techniques to handle negotiation, persuasion, and problem-solving in professional and team settings.

Articulation Matrix

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

UNIT I **7 Hours**

INTRODUCTION

Conversational Skills - Active Listening - Team working Empathy - Emotional Intelligence

UNIT II **8 Hours**

SKILLS

Conflict Resolution and Mediation skills - Decision making and Problem Solving - Negotiation and Persuasion skills

Total: 15 Hours

Reference(s)

1. Stephen P. Robbins, Phillip L. Hunsaker, Training in Interpersonal Skills, Pearson, 2015
2. Robert B. Cialdini, Influence: The Psychology of Persuasion, Harper Business; Revised Edition, 2006
3. Suzanne C De Janasz, Karen O Dowo & Beth Z Schneder, Interpersonal Skills in Organisations, McGraw-Hill Education; 5th Edition, 2014

18GE0XK COMMUNITY SERVICE AND LEADERSHIP 1 0 0 1

Course Objectives

- Understand the role of National Service Scheme in community
- Identify the needs and problems of the community and involve in problem solving
- Develop competence required for group living and acquire leadership qualities.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3.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.
PO6. 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.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PSO1.Design, analyse and evaluate the performance of mechanical systems.
PSO3.Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Interpret the philosophy, objectives, and structure of NSS, and analyze the role of NSS activities in addressing community issues through effective mobilization and stakeholder engagement.
2. Develop leadership qualities and community service skills by participating in health, hygiene, sanitation, and entrepreneurship initiatives, aligning with national programs like Swachh Bharat Abhiyan.

Articulation Matrix

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

UNIT I **15 Hours**

COMMUNITY SERVICE AND LEADERSHIP DEVELOPMENT

Introduction and Basic Concepts of NSS: History-philosophy-aims & objectives of NSS- Emblem, flag, motto, song, badge- Organizational structure roles and responsibilities functionaries. NSS Programmes and Activities: Concept of regular activities, special camping, Day Camps-Basis of adoption of village/slums-Methodology of conducting Survey -Financial pattern of the scheme -Coordination with different agencies-Maintenance of the Diary. Community Mobilization: Mapping of community stakeholders-Designing the message in the context of the problem and the culture of the community-Identifying methods of mobilization-Youth-adult partnership. Health, Hygiene & Sanitation: Definition, needs and scope of health education- Food and Nutrition - Safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan). Entrepreneurship Development: Definition & Meaning - Qualities of good entrepreneur - Steps/ways in opening an enterprise -Role of financial and support service Institutions.

Total: 15 Hours

Reference(s)

1. A Hand book on National Service Scheme, Anna University, Chennai, 2012
2. http://nss.nic.in/intro.asp
3. Delgado-Gaitn and Concha, The Power of Community: Mobilizing for Family and Schooling New York: Rowman & Littlefield Publishing, Inc. 2001
4. James Bailey, Guide to Hygiene and Sanitation in Aviation, World health organization, 2nd edition. 1980
5. Anuradha Basu, Mark Casson, Nigel wadeson and Bernard Yeung, The oxford hand book of entrepreneurship, Oxford Press. 2009

18GE0XL NATIONAL CADET CORPS 1 0 0 1

Course Objectives

- To understand the importance of NCC and its organization.
- To realize the skills in the applications of drill and weapon training.
- To analyze the factors in National unity
- To identify the utility of smart materials in engineering applications.

Programme Outcomes (POs)

PO6. 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.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Demonstrate and apply drill and weapon handling skills accurately and safely during practical parade and training sessions.
2. Analyze the role of NCC in promoting national integration and addressing social issues through cadet activities.
3. Demonstrate appropriate leadership and disaster response strategies during emergencies.

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	-
3	-	-	-	-	-	2	-	-	2	-	-	-	-	2	-

UNIT I 7 Hours

NCC STRUCTURE AND TRAINING

NCC ORGANIZATION: National Cadet Corps: Aim and Objectives - Administrative and Organizational pattern - NCC flag and NCC song - Duties, Responsibilities and Conduct by NCC Cadets - Badges of ranks in NCC and Armed forces- Types of NCC camps - Eligibility conditions for writing B and C certificate examinations. Cadet welfare society and Career opportunities for NCC cadets.

DRILL AND WEAPON TRAINING Drill: Aims of drill - Types of drill - Foot drill, Arms drill and Ceremonial drill. Word of commands, Guard of honour. Weapon training - Rifles used in NCC: Parts and Characteristics of 0.22 and INSAS - Stripping, Assembling and Cleaning of weapons.

NATIONAL INTEGRATION AND SOCIAL AWARENESS National Integration: Introduction - Constitution of India- Importance and Necessity - Factors affecting National integration - Role of NCC in National integration. Social service and its need - Rural development programs - NGOs role and Contribution - Social Security schemes.

UNIT II **8 Hours**

PERSONALITY DEVELOPMENT AND LEADERSHIP

PERSONALITY DEVELOPMENT AND LEADERSHIP Personality Development: Introduction - Factor influences in personality development. Leadership: Leadership traits and Skills - Indicator of good leader - Honour code concept - Type of leaders - Case studies of effective leader.

DISASTER MANAGEMENT AND FIRST AID Disaster types - Natural and Manmade disasters. Role of NCC cadets in disaster management. Civil defense: Civil defense measures - Civil defense services. First aid: First aid kits and Equipment's - First aid for snake bite, Sun stroke and Drowning - Respiration -Types of respiration.

Total: 15 Hours

Reference(s)

1. Cadets Hand book Common subject, DG NCC, New Delhi.
2. Cadets Hand book Special subject, DG NCC, New Delhi
3. Misra R.C and Sanjaykumar Mishra, A HAND BOOK OF NCC(English), Kanti Prakashan, 2016
4. Gupta R. K, NCC: Handbook of NCC Cadets for A, B and C Certificate Examinations (English) RPH Editorial Board, 2018.

18GE0XM NEW AGE IINOVATION AND ENTREPRENEUISHIP 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.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO12. 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.

PSO1.Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply foundational concepts of entrepreneurship to identify opportunities and develop effective startup strategies
2. Analyze the financial, legal, and ethical challenges involved in launching and sustaining a new venture.
3. Design a comprehensive business plan incorporating market strategy, funding sources, IPR, and talent management for a new-age startup.

Articulation Matrix

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

UNIT I **15 Hours**

NEW AGE INNOVATION AND ENTREPRENEURSHIP

Introduction to Entrepreneurship - Opportunity Identification ideation -M V P Positioning as an Entrepreneur Starting own Business - Developing Effective Business Model - Industry and Competitor Analysis - Building Business Plan, Mentoring 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-Western Cengage Learning, 6th Edition, 2012
2. Alex Osterwalder and Yves Pigneur, Business Model Generation, published by 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

18GE0XN DISRUPTIVE INNOVATION BASED STARTUP ACTIVITIES 1 0 0 1

Course Objectives

- To make the participants understand as to how to get along with the task disruption led innovations.
- To get the budding young entrepreneurs to appreciate the structured knowledge of the dynamics of operationalizing creativity-based disruption strategy.

Programme Outcomes (POs)

PO3.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.

PO4.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

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PSO1.Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

PSO3.Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Develop idea generation and creative communication skills that lead to disruptive innovation (DI)–based startup activities.
2. Innovate management concepts in disruptive innovation (DI)–based entrepreneurship to develop new business models and bring new products and services to market.
3. Analyze the application of disruptive innovation (DI) theories to complex problems and opportunities to identify the right customers.

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	-	-	-	1	-	-	-	-	1	-	-
3	-	-	-	3	-	-	-	1	-	-	-	-	1	-	-

UNIT I **15 Hours**

DISRUPTIVE INNOVATION

Creativity linked innovation, Differences between Disruptive & incremental Innovations - Historical, theoretical, and practical evolution of disruptive innovation (DI). - Idea generation & communication of creativity leading to DI. Innovation management concepts in DI based entrepreneur generation - How do firms bring in new business models and get new products and services to the market. Investor preferences in core versus new or disruptive business models - disruptors and the disrupted frameworks for assessing company's capabilities and rethinking product, market and strategy - Right customers for DI: strategy in a world that is changing so rapidly, Application of disruptive theories to complex problems and opportunities.

Total: 15 Hours

Reference(s)

1. https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1540-5885.2005.00177.x
2. http://www.brinq.com/workshop/archives/2005/01/08/what-is-disruptive-innovation
3. https://hbr.org/2006/12/disruptive-innovation-for-social-change

18GE0XO SOCIAL PSYCHOLOGY 1 0 0 1

Course Objectives

- To provide a basic understanding of social psychology.
- Defining psychological & physical changes during puberty age.
- To provide an awareness of various psychological problems and social problems.
- To explain social and work psychology of people and the need for mental health.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3.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.
PO6. 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.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PSO1.Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Analyze the basics of human behavior in the workplace and society to understand social roles, attitudes, and interpersonal dynamics.
2. Apply psychological principles to recognize and manage common psychological, physical, and social problems in daily life.
3. Develop effective interpersonal and social skills for improved personal relationships and responsible social behavior.

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	-	-	-	2	-	-
2	2	3	2	-	-	3	2	-	2	-	-	-	2	-	-
3	1	2	2	-	-	2	2	-	2	-	-	-	2	-	-

UNIT I **7 Hours**

INTRODUCTION

Introduction - Ice breaker - Time Line - Tasks and Challenges of the age(Erik Erikson)Physical changes - Introduction to Reproductive Health - Reproductive Organs - Menstruation - Changes during Puberty - Abortions - Contraception - Difference between Sex and Gender - Introduction to the origins of Patriarchy - Gender.

UNIT II **8 Hours**

PSYCHOLOGY

Developmental changes - Attraction - Friendship - Differences and Similarities - Images of Beauty and Body Image -Introduction to Media-Feedback - Sexuality - Boundaries Relationships - Marriage - Love - Emotional Health - Sexual Abuse and Safety - Role of Media - Abortions, Contraception, Wrapping up the Course.

Total: 15 Hours

Reference(s)

1. Baron, R. A.,Branscombe.N.R.(2016).Social Psychology,14th Ed. New Delhi;Pearson Education
2. Morgan,C.T., King,R.A.,Weisz,J.R.,&Schopler,J.(1993). Introduction to Psychology,7th Ed. New Dehi: Tata McGraw Hill.

18ME0YA 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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems..

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO4.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.

PO12. 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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Apply industrial engineering principles to select suitable plant layouts for the given production systems.
2. Analyze process planning and production control methods to improve scheduling, routing, and resource utilization in manufacturing systems.
3. Investigate work systems and ergonomics to identify optimize human-machine interactions.
4. Develop inventory models and material handling layouts to enhance production flow and reduce operational costs.
5. Design system-level strategies by integrating maintenance practices to ensure reliability and continuity in industrial operations.

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	-	-	-	-	-	-	-	-	-	-	-	2	-
3	2	2	-	2	-	-	-	-	-	-	-	1	-	2	-
4	2	2	3	-	-	-	-	-	-	-	-	1	-	2	-
5	2	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 (material movement) pattern, Workstation Selection and design.

UNIT II **10 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 **8 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 **10 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.

UNIT V **8 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.

Total: 45 Hours

Reference(s)

1. Khanna O.P., Industrial Engineering and management, Dhanpat Rai Publications.,2010
2. Martand T.Telsang, Industrial Engineering and Production Management, S Chand Publishers,2006
3. Panneerselvam R., Production and operations management, Heritage Publishers, 2006
4. Ravi Shankar, Industrial Engineering and Management, Golgotia Publications Pvt. Ltd., New Delhi, 2009

18ME0YB 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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems..

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO5. 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.

PO6. 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.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PO12. 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

PSO1. Design, analyse and evaluate the performance of mechanical systems

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Analyze the accident causation models and safety performance indices to develop effective job safety analysis and accident investigation techniques.
2. Design the compliant safety and health frameworks for industrial operations, by analyzing the Factory Act 1948 and Tamil Nadu Factories Rules.
3. Apply the machine guarding principles and personal protective equipment standards, to develop safety protocols for metalworking and inspection processes.
4. Interpret the HAZOP study and safety valve principles, to design safe process systems and emergency plans for chemical plant operations.
5. Develop safety strategies for high-rise building, excavation, and confined space work, by analyzing construction hazards and regulations.

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	2	2	2	-	3	-	-	3	-	-	-	-	2	1	-
3	2	-	-	-	-	-	-	-	-	-	-	3	1	-	2
4	3	-	-	-	-	-	-	-	2	-	-	-	2	-	1
5	2	3	2	-	2	-	-	-	-	3	-	-	-	3	-

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 Reporting and Investigation - 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, Electricity Rules.

UNIT III **10 Hours**

SAFETY IN ENGINEERING INDUSTRIES

Safety in machine shop,- Principles of machine guarding - Personal protective equipment- Safety in handling industrial gases - Safety in cold forming and hot working of metals- 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, Plant maintenance and emergency planning, management of maintenance HAZOP study.

UNIT V **8 Hours**

SAFETY IN CONSTRUCTION INDUSTRY

Construction regulations, contractual clauses, permit to work, - Education and training-Hazards of construction and prevention- excavation, scaffolding, dismantling, road works, construction of high rise buildings - Working at heights,-Working on fragile roofs, work permit systems-Construction machinery, cranes, chain pulley blocks, earth moving equipment, conveyors- Manual handling, Safety in demolition work, - 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.

18ME0YC MAINTENANCE ENGINEERING 3 0 0 3

Course Objectives

- To understand the principles, objectives and importance of maintenance adopted in industry for successful progress.
- To introduce different maintenance categories, its merits and types of lubrication.
- To expose the idea of condition monitoring, methods and instruments used for allied measurements.
- To learn about failure analysis and repair methods for few mechanical elements.
- To promote computerization in maintenance and inventory management.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3.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.
PO4.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
PO6. 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.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO11. 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.
PO12. 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
PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Interpret the principles and objectives of planned maintenance activities to establish effective maintenance systems and economic planning strategies.
2. Formulate different maintenance categories and schedules to implement the lubrication techniques and Total Productive Maintenance (TPM). strategies
3. Analyze condition monitoring methods using temperature, noise, vibration, and wear parameters to assess equipment health and optimize maintenance scheduling.
4. Investigate failure causes in mechanical systems and apply suitable non-destructive testing and repair methods to restore component functionality.
5. Implement computer-aided maintenance management systems (CAMMS) for effective resource planning, spare parts tracking, and performance reporting.

Articulation Matrix

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

UNIT I **9 Hours**

PRINCIPLES OF MAINTENANCE PLANNING

Basic principles of maintenance planning - Objectives and principles of planned maintenance activity - Importance and benefits of sound maintenance systems - Maintenance organization - Maintenance economics.

UNIT II **9 Hours**

MAINTENANCE CATEGORIES AND LUBRICATION

Maintenance categories - Comparative merits of each category - Preventive maintenance, Maintenance schedules, Repair cycle - Total Productive Maintenance - Principles and methods of lubrication.

UNIT III **9 Hours**

CONDITION MONITORING

Condition based maintenance - Cost comparison with and without Condition Monitoring - Methods and instruments for condition monitoring - Noise, vibration, wear and temperature measurement.

UNIT IV **9 Hours**

FAILURE ANALYSIS AND REPAIR METHODS

Failure analysis - Failures and their development - Role of Non Destructive Testing in failure analysis - Repair methods for bearings, cylinder block, fuel pump, shaft.

UNIT V **9 Hours**

COMPUTER AIDED MAINTENANCE MANAGEMENT

Approach towards Computerization in maintenance - computer-aided maintenance management system (CAMMS) - Advantages of CAMMS - spare parts and inventory centre performance reporting.

FURTHER READING

Retrofitting, objectives, classification of retrofitting, cost effectiveness through retrofitting (economical aspects), circumstances leading to retrofitting, features and selection for retrofitting.

Total: 45 Hours

Reference(s)

1. Srivastava S.K, Maintenance Engineering, S Chand and Company, 2010.
2. Mishra R.C, Pathak K, Maintenance Engineering and Management, Second edition, Prentice Hall India Learning Pvt. Ltd., 2012.
3. Keith Mobley R, Lindley R. Higgins and Darrin J. Wikoff, Maintenance Engineering Handbook, Seventh edition, McGraw-Hill Professional, 2008.
4. Davies A, Handbook of Condition Monitoring: Techniques and Methodology, Springer, 2012.
5. Otegui Jose Luis, Failure Analysis, Fundamentals and Applications in Mechanical Components, Nineteenth edition, Springer, 2014.

18ME0YD BASICS OF NON-DESTRUCTIVE TESTING 3 0 0 3

Course Objectives

- To learn different surface inspection techniques.
- To provide knowledge on sub surface testing methods.
- 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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems..

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO6. 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.

PO12. 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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Apply visual inspection and liquid penetrant testing techniques to detect surface discontinuities in engineering components.
2. Analyze subsurface flaws in materials using magnetic particle testing and eddy current inspection techniques.
3. Evaluate internal flaws in structural and welded components using ultrasonic testing techniques, including phased array and angle beam methods.
4. Interpret radiographic testing results using X-rays and gamma rays to characterize internal defects from both film and digital radiographic data.
5. Design appropriate non-destructive testing approaches using advanced techniques such as acoustic emission, infrared thermography, leak testing, and laser-based methods for specialized application

Articulation Matrix

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

UNIT I **9 Hours**

SURFACE TECHNIQUES

Introduction and Scope of NDT, Discontinuities and Defects in various manufactured Components, Various physical characteristics of materials and their applications in NDT, Relative merits and limitations of NDT, Types of NDT techniques, 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**

SUB SURFACE TECHNIQUES

Magnetic Particle Testing (MPT) - Principles, applications, magnetization methods, magnetic particles - Dry particle technique and Wet fluorescent particle technique - Advantages and Limitations. Eddy Current Inspection - Principle, Methods, Equipment for ECT, Techniques, Sensitivity, Application, scope and limitations

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 NDT TECHNIQUES

Acoustic Emission Testing (AET) Principle - Instrumentation and applications, advantages and limitations. Infra-Red Thermography (IRT) - Principle, Techniques and applications. Leak Testing - Principle, Testing Procedure and applications. LASER Stereography- Typical applications- Requirements - advantages and disadvantages.

Total: 45 Hours

Reference(s)

1. Charles J. Hellier, "Handbook Of Nondestructive Evaluation", McGraw-Hill Education; 2 edition 2012.
2. Baldev Raj, Jayakumar T, Thavasimuthu M, "Practical Non-Destructive Testing", Narosa Publishing, 2009.
3. ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 2001.
4. Mc Gonnagle W T, "Non-Destructive Testing", McGraw Hill Book Co., 1988
5. Louis Cartz, "Non-Destructive Testing", ASM International, Metals Park Ohio, US, 1995.
6. https://onlinecourses.nptel.ac.in/noc19_mm07/course

18ME0YE DIGITAL MANUFACTURING 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 develop simple program for CNC lathe and Milling machines.
- To provide an exhaustive knowledge on various generic process and benefits of Additive Manufacturing.
- To familiarize about materials and process parameters of liquid and solid based AM techniques.
- To educate powder based methodology and emerging trends with case studies, applications of AM techniques.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO4.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

PO5. 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.

PSO1. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply CAD modeling techniques (wireframe, surface, and solid modeling) to design mechanical components using Constructive Solid Geometry (CSG) and Boundary Representation (B-rep) methods.
2. Analyze CNC machine operations and formulate G-code programs for turning and milling operations using linear and circular interpolation.
3. Develop an understanding of additive manufacturing (AM) processes and analyse their advantages over traditional CNC machining.
4. Design and develop 3D models for AM by converting CAD files into STL format, verifying and repairing them for defect-free part fabrication.
5. Analyze different AM systems and apply them in reverse engineering, medical, automotive, aerospace, and electronics industries.

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	2	-	-	-	-	-	-	-	-	-	-	2	-	-
3	3	2	3	-	-	-	-	-	-	-	-	-	2	-	-
4	2	2	3	2	3	-	-	-	-	-	-	-	2	-	-
5	2	2	2	2	3	-	-	-	-	-	-	-	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. 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), Digital Light Processing (DLP), 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), Color Jet Printing (CJP), Electron Beam Melting (EBM) and Laser Engineered Net Shaping (LENS) - Working Principle, Construction, Process Variables, Materials and Applications. Reverse Engineering using 3D scanner. Application of Additive Manufacturing in Medical field, Manufacturing, Automotive industries, Aerospace and Electronics and Retail industries.

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 Technologies 3D Printing, Rapid Prototyping and Direct Digital Manufacturing, Springer, 2015 http://www.springer.com/978-1-4939-2112-6
6. www.grabcad.com, www.all3dp.com

18ME0YF WORK STUDY AND ERGONOMICS 3 0 0 3

Course Objectives

- To develop concepts related to principles of productivity & work study as a tool for increasing the efficiency and effectiveness in organizational systems
- To study the existing method, compare and propose a new method
- To provide the usage of the various tools and techniques used in work measurement
- To develop basic ideas of ergonomics and its design
- To develop concepts related Man-Machine Interfaces and Design of Displays and controls

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO6. 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.

PSO1. Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Apply work study principles to calculate the basic work content of a job and find ways to improve efficiency of production system.
2. Implement job task analysis to assess stress, fatigue, and musculoskeletal risks, and design work systems to mitigate these risks effectively.
3. Illustrate time study techniques to determine basic, allowed, and standard times for better time management in job tasks.
4. Analyze ergonomic principles in design to improve human-machine interactions, reduce fatigue, and improve productivity.
5. Develop man-machine interfaces and display/control systems in accordance with ergonomic standards and guidelines to enhance usability and safety.

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	-	-	-	-	2	-	-	-	-	-	-	2	2	-
3	3	-	-	-	-	-	-	-	-	-	-	-	2	2	-
4	2	3	-	-	-	2	-	-	-	-	-	-	2	2	-
5	2	2	3	-	-	2	-	-	-	-	-	-	2	2	-

UNIT I **8 Hours**

PRODUCTIVITY AND WORK STUDY

Definition of productivity, factors affecting productivity, definition, objective & scope of work study, human factors in work study, work study & management, work study & supervisor, work study &worker.

UNIT II **9 Hours**

METHOD STUDY

Definition, objective & scope, charts to record movements in shop, process charts, flow process charts, Multiple activity charts, two handed process charts, SIMO chart, principles of motion economy

UNIT III **8 Hours**

WORK MEASUREMENT

Definition, objectives, techniques of work measurement, work sampling, need of confidence levels, sample size determination, random observation with simple problems. Time study: Definition, time study equipments, selection of jobs, steps in time study, breaking jobs into elements, recording information, rating, standard performance, scales of rating, factors affecting rate of working, allowances, standard time determination

UNIT IV **10 Hours**

INTRODUCTION TO ERGONOMICS

Introduction to Ergonomics: Human factors and ergonomics Physical Ergonomics: human anatomy, and some of the anthropometric, physiological and bio mechanical characteristics. Cognitive: mental processes, such as perception, memory, reasoning, Organizational ergonomics: optimization of socio-technical systems, organizational structures, policies, processes. Environmental ergonomics: human interaction with the environment.

UNIT V **10 Hours**

MAN-MACHINE INTERACTION

Machine interaction cycle, Man-machine interfaces, Displays :factors that control choice of display, visual displays- qualitative displays; moving pointer displays, moving scale displays, digital displays Indicators, auditory displays, tactile displays. Factors affecting effectiveness of displays. Quantitative displays, check-reading displays, representational displays. Design guidelines for displays and controls. Standards for ergonomics in engineering and design, displays and controls.

Total: 45 Hours

Reference(s)

1. S. Dalela and Sourabh,Work Study and Ergonomics. Standard publishers 2013
2. Wesley Woodson, Peggy Tillman and Barry Tillman,Human Factors Design Handbook, McGraw-Hill; 2ndedition, 1992
3. Ralph M. Barnes,Motion and Time Study, Wiley International, 7th Edition
4. Mark S. Sanders and Ernest J. McCormick ,Human Factors in Engineering Design, 4th edition, 2013
5. B. Niebel and Freivalds, Niebel, Methods Standards and Work Design, McGraw-Hill, 12th Edition, 2009,

18ME0YG METROLOGY IN INDUSTRY 3 0 0 3

Course Objectives

- To familiarize the concept of metrology and measurement standards.
- To learn about the linear and angular measurements.
- To impart knowledge on measurement of straightness and surface roughness.
- To educate on the screw thread terminologies and comparator.
- To emphasis measurement procedure for machine tool metrology.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO4.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.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Illustrate the fundamental principles of metrology, types of measurement methods, instrument characteristics, and the importance of calibration and care.
2. Compare various linear and angular measuring instruments based on their suitability for different industrial applications
3. Develop methods to measure geometrical and dimensional tolerances, including surface finish, straightness, roundness, and cylindricity using standard comparators
4. Formulate appropriate measurement strategies for evaluating threads, gears, and radius using form measurement instruments.
5. Validate advanced measurement systems including coordinate measuring machines, interferometry, and machine tool alignment techniques for achieving precision inspection.

Articulation Matrix

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

UNIT I **7 Hours**

INTRODUCTION TO METROLOGY

Definition, types, need for inspection, methods of measurement, selection of instruments, errors in measurement, units - Characteristics of measuring instrument : sensitivity, Accuracy, Readability, Reliability, Repeatability and Reproducibility - Measurement standards, calibration, care taking of measuring instruments.

UNIT II **8 Hours**

LINEAR AND ANGULAR MEASUREMENTS

Linear metrology: Steel rule, calipers, vernier caliper, vernier height gauge, vernier depth gauge, micrometers, slip gauge, limit gauging and its classification - Limits, fit and tolerances. Angular Measurements: Bevel protractor and Sine bar.

UNIT III **10 Hours**

MEASUREMENT OF GEOMETRICAL AND DIMENSIONAL TOLERANCE

Measurement of straightness, flatness, squareness, parallelism, roundness and cylindricity. Measurement of surface finish: Introduction, terminology, specifying roughness on drawings, surface roughness parameters, factors affecting surface roughness, roughness measurement methods, precautions in measurement. Comparator: Features of comparators, classification of comparators, different comparators, advanced comparators.

UNIT IV **10 Hours**

FORM MEASUREMENT

Screw thread metrology: Introduction, screw thread terminology, errors in thread - External screw thread measurement: Tool makers microscope, Floating carriage micrometer and pitch gauge - Internal thread measurement: Taper parallels and roller method. Gear measurement: Introduction, types of gears, gear terminology, gear tooth vernier caliper, profile projector, Parkinson gear tester - External and Internal Radius measurement.

UNIT V **10 Hours**

ADVANCED AND MACHINE TOOL METROLOGY

Digital devices - Interferometry: Principle of interference, interference patterns, NPL flatness interferometer - Coordinate Measuring: Basic concept, Types, Constructional features, Probes and Accessories - Computer Aided Inspection: Machine Vision System - Measurement of Temperature: Infrared Thermometer - Machine tool alignment test on Lathe, Drilling and Milling machine.

Total: 45 Hours

Reference(s)

1. R. K. Jain, Engineering Metrology, Khanna Publishers, New Delhi, 2009.
2. K.J. Hume,Engineering Metrology, Macdonald and Co. (publisher) London, 1970.
3. Czichos (Ed),The Springer handbook of metrology and Testing, 2011.
4. Jay. L. Bucher (ed), The Metrology Hand book- American Society for Quality, 2012.
5. Smith GT, Industrial Metrology, Spinger, 2002
6. https://onlinecourses.nptel.ac.in/noc18_me62/

18ME0YH PLANT LAYOUT AND MATERIAL HANDLING 3 0 0 3

Course Objectives

- To provide knowledge in Selection of plant locations.
- To offer knowledge in developing layout for various industries incorporating the safety aspects.
- To provide knowledge on creating and maintaining safe working environment
- To impart knowledge in Manual Material Handling and Lifting Tackles
- To educate on Manual Material Handling equipment

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO6. 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.

PSO1. Design, analyse and evaluate the performance of mechanical systems

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Analyze plant location based on land, utilities, safety, and future expansion for selecting suitable industrial sites.
2. Design safe plant layouts for industries by planning equipment placement, emergency systems, and access routes.
3. Demonstrate effective implementation of ventilation, lighting, and 5S techniques to maintain workplace safety.
4. Develop manual handling methods and lifting tackles for safe movement of heavy and hazardous materials.
5. Implement appropriate material handling equipment based on application, safety, and maintenance needs.

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	-
2	2	2	3	-	-	2	-	-	-	-	-	-	2	2	-
3	3	-	-	-	-	2	-	-	-	-	-	-	2	2	-
4	2	2	3	-	-	2	-	-	-	-	-	-	2	2	-
5	3	-	-	-	-	2	-	-	-	-	-	-	2	2	-

UNIT I **9 Hours**

PLANT LOCATION

Selection of plant locations, territorial parameters, considerations of land, water, electricity, location for waste treatment and disposal, further expansions-Safe location of storage of chemicals in the form of bullets, spheres, cylinders for LPG, LNG, CNG, acetylene, ammonia, chlorine - explosives and propellants.

UNIT II **9 Hours**

PLANT LAYOUT

Safe layout, equipment layout, safety system, fire hydrant locations, fire service rooms, facilities for safe effluent disposal and treatment tanks, site considerations, approach roads, plant railway lines, security towers. Safe layout for process industries, engineering industry, construction sites, pharmaceuticals, pesticides, fertilizers, refineries, food processing, nuclear power stations, thermal power stations, metal powder manufacturing, fireworks and match works.

UNIT III **9 Hours**

PLANT ATMOSPHERE

Principles of good ventilation, purpose, physiological and comfort level types, local and exhaust ventilation, hood and duct design, air conditioning, ventilation standards, application. Purpose of lighting, types, advantages of good illumination, glare and its effect, lighting requirements for various work, standards-Housekeeping, principles of 5S.

UNIT IV **9 Hours**

MANUAL MATERIAL HANDLING AND LIFTING TACKLES

Preventing common injuries, handling specific shape machines and other heavy objects - accessories for manual handling - problems with hazardous materials - storage and handling of cryogenic liquids -shipping and receiving - personal protection ergonomic considerations. Fiber rope and wire rope, types, strength and working load inspection, - slings, types, method of attachment, rated capacities, alloy chain slings, hooks and attachment, inspection.

UNIT V **9 Hours**

MATERIAL HANDLING EQUIPMENTS

Hoisting apparatus - cranes, types, design and construction, guards and limit devices, signals, maintenance safety rules, inspection checklist - conveyors, types, applications. Powered industrial trucks, principles, operators selection and training and performance test, maintenance, electric trucks, gasoline operated trucks, LPG trucks - power elevators, types of drives, requirements for the physically challenged, types-Escalator, safety devices and brakes, moving walks - man lifts, construction, brakes, inspection.

Total: 45 Hours

Reference(s)

1. M.P. Alexandrov. Material handling equipment Mir Publishers, Moscow,1981
2. Accident prevention manual for industrial operations N.S.C., Chicago, 2012
3. Spivakosky, Conveyors and related Equipment, Vol.I and II Peace Pub. Moscow, 1985.
4. Apple M. James Plant layout and material handling, 3rd edition, John Wiley and sons.1978
5. Encyclopedia of occupational safety and health, ILO Publication, 2009
6. Industrial ventilation (A manual for recommended practice), American conference of Governmental Industrial Hygiene, USA, 1984

18ME0YI CONCEPTS OF ENGINEERING DESIGN 3 0 0 3

Course Objectives

- To provide knowledge on fundamental engineering principles and problem identification.
- To acquire knowledge about concept generation and concept selection.
- To learn the detailed design process and design of manufacture and assembly.
- To impart knowledge on planning for manufacture and design review.
- To impart knowledge on report preparation and intellectual property right.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO12. 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.

PSO1. Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Apply the principles and interfaces of engineering design to construct a Product Design Specification (PDS) for a defined engineering problem.
2. Analyze structured ideation techniques such as brainstorming and morphological analysis to generate and evaluate creative design concepts using decision matrices.
3. Demonstrate the ability to integrate decision-making models with design for manufacturing, assembly, and environment in the engineering design process.
4. Design cost-effective manufacturing plans using QFD, value engineering, safety factors, and ISO quality concepts for optimized material selection and production.
5. Develop professional design reports and presentation techniques while recognizing the significance of intellectual property rights and patenting processes in engineering design.

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	3	-	-	-	-	2	-	-	-	-	1	1	-	-
3	2	2	2	-	-	-	-	-	-	-	-	1	-	2	-
4	2	2	2	-	-	-	2	-	-	-	-	1	1	2	-
5	2	2	2	-	-	-	-	-	-	-	-	1	-	2	-

UNIT I **9 Hours**

PRINCIPLES AND PROBLEM IDENTIFICATION

Engineering design- introduction and definition, Considerations of a good design, Engineering design interfaces, Principles of engineering design, Problem identification, Design process, Product Design Specification (PDS) criteria, Content of a PDS.

UNIT II **9 Hours**

CONCEPT GENERATION AND SELECTION

Identifying customer needs, Societal considerations in engineering, Creativity and problem solving, creativity methods - Brainstorming, Morphological analysis, Concept selection - Subjective decision-making, Criteria ranking, Criteria weighting, Datum method, Computer aided decision making.

UNIT III **9 Hours**

DESIGN PROCESS

Detailed description of design process, five basic patterns of decision making, decision making based on state of knowledge, Design for manufacturing (DFM), Design for Assembly (DFA), Industrial design, Design for environment, engineering design principles.

UNIT IV **9 Hours**

PLANNING FOR MANUFACTURE

Quality function deployment (QFD), Design review, Value analysis/engineering, Factor of safety, Materials selection, break even analysis - problem, cost evaluation, Elements of cost, ISO concepts.

UNIT V **9 Hours**

REPORT PREPARATION AND INTELLECTUAL PROPERTY RIGHTS

Presentation Techniques - Introduction, Concept sketches, Scheme drawing, Design Validation Design report. Intellectual Property Rights - Introduction, Patent, Trademark, copyright, Patentability, patenting process.

Total: 45 Hours

Reference(s)

1. Ken Hurst, Engineering Design Principles, Elsevier Science and Technology Books, 2004.
2. George E Dieter, Engineering Design, Tata McGraw Hill publishing Company Pvt Ltd, New Delhi, 2008
3. Danlel E. Whitney, Mechanical Assembles: Design Manufacture and Role in Product Development, Oxford University, Press, 2008
4. K. Otto, Product Design, Pearson Publications, 2005.
5. Richard Birmingham, Graham Cleland, Robert Driver and David Maffin, Understanding Engineering Design, Prentice Hall of India, 1997
6. www.patentoffice.nic.in

18ME0YJ OIL 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 working functions
- To provide knowledge on the selection of hydraulic components
- To learn about various types of pneumatic components and servo systems
- To emphasis fluid power circuit design methods and its applications

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO4.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

PO5. 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.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO11. 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.

PO12. 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.

PSO3.Address all the fluid flow and energy transfer related problems of mechanical systems

Course Outcomes (COs)

1. Illustrate the construction and working principles of hydraulic pumps, motors, and actuators by applying Pascal's Law in fluid power systems.
2. Investigate the functions of hydraulic valves, accumulators, and intensifiers to infer their influence on pressure, flow, and direction control within a fluid power system.
3. Apply appropriate selection strategies for hydraulic components including pumps, actuators, valves, hoses, and reservoirs based on operational requirements and load conditions.
4. Analyze the construction and working principles of pneumatic components such as compressors, FRL units, valves, actuators, and servo systems used in automation applications.
5. Design fluid power circuits such as speed control, synchronization, and sequential circuits using methods like cascade and stepper sequencing to simulate real-world industrial applications.

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	3	2	-	-	-	-	-	-	1	-	2	-	-	-	2
3	-	-	2	1	-	-	-	-	1	-	2	-	-	-	2
4	3	-	-	-	-	-	-	-	1	-	2	2	-	-	2
5	3	2	1	-	2	-	-	-	1	-	2	2	-	-	1

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, construction and working principles - Fluid power Actuators - Single acting, Double acting, cushioning and telescopic cylinder, construction and working principles. Gear Motors, Vane motors, Piston 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, 7th Edition, Pearson Education, New Delhi, 2013
2. Andrew Parr, Hydraulics and Pneumatics, 2nd Edition, Butterworth Heinemann, New Delhi, 2006.
3. S.R Majumdar, Oil Hydraulic Systems: Principles and Maintenance, McGraw Hill publishing company Pvt. Ltd. 28th Edition New Delhi, 2017.
4. S.R.Majumdar, Pneumatic systems-Principles and maintenance, McGraw Hill publishing company Pvt. Ltd., New Delhi, 2017.
5. S.Ilango Introduction to Hydraulics and Pneumatics, 3rd Revised Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2017.

18ME0YK ENERGY AUDITING AND MANAGEMENT 3 0 0 3

Course Objectives

- To emphasis on the concept of energy management and its importance
- To impart the knowledge on energy auditing and instrument selection skills
- To learn about the energy management tools and financial analysis
- To perform an energy efficiency assessment in thermal systems
- To measure the performance and efficiency of electrical utilities

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO6. 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.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Apply the principles of energy management and policy to assess energy consumption patterns and recommend renewable and energy-efficient solutions.
2. Implement energy auditing techniques and methodologies to identify conservation opportunities in industrial systems such as boilers, HVAC, and compressed air systems.
3. Investigate financial analysis techniques, including cash flow, NPV, ROI, and IRR, to evaluate the cost-effectiveness of energy management initiatives.
4. Analyze energy performance and efficiency improvement opportunities in thermal utilities such as boilers, furnaces, pumps, and HVAC systems, with a focus on steam distribution and recovery systems.
5. Compare the efficiencies and performance of electrical systems, including motors, lighting, and power factor improvement, to optimize energy consumption in compliance with the Electricity Act 2003.

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	-	-	-	-	-	-	-	2
3	3	2	-	-	-	2	2	-	-	-	-	-	-	-	2
4	3	2	-	-	-	2	2	-	-	-	-	-	-	-	2
5	3	2	-	-	-	2	2	-	-	-	-	-	-	-	2

UNIT I **8 Hours**

GENERAL ASPECTS OF ENERGY MANAGEMENT

Current energy scenario - India and World, Current energy consumption pattern in global and Indian industry, Principles of Energy management, Energy policy, Energy action planning, Energy security and reliability, Energy and environment, Need of Renewable and energy efficiency.

UNIT II **9 Hours**

ENERGY AUDITING

Energy audit - need, types of energy audit, Components of energy audit, Energy audit methodology, Instruments, equipment used in energy audit, Analysis and recommendations of energy audit - examples for different applications, Energy audit reporting. Energy conservation opportunities in boiler and steam system, furnace, HVAC system, pumping system, cooling tower and compressed air system.

UNIT III **8 Hours**

ENERGY ECONOMICS

Importance of energy management, Financial analysis techniques - cash flow, discount rate, simple payback period, Net present value (NPV) and cash flow, Return on Investment (ROI) and Internal Rate of Return (IRR), life cycle costing.

UNIT IV **10 Hours**

ENERGY EFFICIENCY IN THERMAL UTILITIES

Energy performance assessment and efficiency improvement of boilers, furnaces, heat exchangers, fans and blowers, pumps, compressors and HVAC systems. Steam distribution, assessment of steam distribution losses, steam leakages, steam trapping, condensate and flash steam recovery system.

UNIT V **10 Hours**

ENERGY EFFICIENCY IN ELECTRICAL MOTOR AND LIGHTING SYSTEM

Electricity billing, Electrical load management and maximum demand control, Power factor improvement and its benefit, Selection and location of capacitors, Distribution and transformer losses. Electrical motors-types, efficiency and selection. Speed control, Energy efficient motors. Electricity Act 2003. Lighting - Lamp types and their features, recommended illumination levels, lighting system energy efficiency.

FOR FURTHER READING

Cogeneration - need, applications, advantages, classification, the cogeneration design process. Waste heat recovery - classification and application, potential for waste-heat recovery in industry, commercial WHR devices, saving potential.

Total: 45 Hours

Reference(s)

1. Albert Thumann, Terry Niehus, William J. Younger, Handbook of Energy Audit, The Fairmont Press Inc., 9th Edition, 2013.
2. Wayne C. Turner, Steve Doty, Energy Management Handbook, The Fairmont Press Inc., 6th Edition, 2007.
3. Abbi Y. A., Jain Shashank, Handbook on Energy Audit and Environment management Press, TERI, New Delhi, 2006.
4. Energy Performance assessment for equipment and Utility Systems.-Vol. 2, 3 & 4 Bureau of Energy Efficiency, Govt. of India.
5. Anthony L Kohan, Boiler Operator's Guide Fourth Edition, McGraw Hill, 4th Edition, 1997.
6. http://www.aipnpc.org/GuideBooks.aspx

18ME0YL LEAN SIX SIGMA 3 0 0 3

Course Objectives

- To acquire the knowledge to deliver consistently high quality and value added products and services to the customers in a lean environment
- To introduce quality management concepts of industrial processes through Six Sigma
- To develop the ability to define and measure the intensity of the industrial problems
- To analyse and improve the industrial processes
- To design and control the industrial processes

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO11. 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

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Interpret the principles of Lean Manufacturing including the Toyota Production System and 5S methodology to identify and minimize manufacturing wastes.
2. Assess the framework of Six Sigma and its personnel, project, and process requirements to improve organizational efficiency and quality.
3. Apply the lean tools such as SIPOC, Value Stream Maps, and Pareto charts to identify improvement opportunities in manufacturing systems.
4. Analyze process data using tools like cause-and-effect diagrams and scatter plots to determine root causes and implement improved solutions through PICK charts.
5. Develop control techniques and Design for Lean Six Sigma (DFLSS) tools including QFD, FMEA, and DOE to sustain and standardize process improvements.

Articulation Matrix

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

UNIT I **9 Hours**

LEAN MANUFACTURING

History evolution - Power laws of speed - Toyota production system - Lean manufacturing overview - Pull production and Cellular manufacturing, Obstacles of lean; Over production, Waiting, Work in progress, Transportation, Inappropriate processing, Excess motion or ergonomic problems, Defective products, Under utilization of employees - Just in time manufacturing - 5S workplace maintenance.

UNIT II **9 Hours**

SIX SIGMA

Difference between six sigma and TQM - Elements of successful deployment - Personnel requirements: Developing a training plan, Training needs analysis, Hierarchy of staffs - Process improvement: Elimination of variation, improvement of process flow and speed - Customer focus - Project selection - 5 laws of Six sigma - DMAIC problem solving.

UNIT III **9 Hours**

DEFINE AND MEASURE STAGES

Objectives of Define - Project definition - Process definition - Team formation - Tools: SIPOC diagram, Value stream maps. Objectives of Measure - Process definition - Metric definition - Process baseline estimation - Measurement system analysis - Tools: Time value maps, Pareto charts.

UNIT IV **9 Hours**

ANALYSE AND IMPROVE STAGES

Objectives of Analyse - Value stream analysis - Analysing source of variation - Determining process drivers - Tools: Cause and effect diagrams, Scatter plots. Objectives of Improve - Defining new process - Assessing benefits of proposed system - Implementation and verification - Tools: PICK charts.

UNIT V **9 Hours**

CONTROL STAGE AND DESIGN FOR LEAN SIX SIGMA

Objectives of Control - Standardization of new methods - Measuring impact - Tools: control charts, charts for variables, charts for attributes. Design for lean six sigma: Quality Function Deployment, Failure Mode Effect Analysis, Design of experiments.

Total: 45 Hours

Reference(s)

1. Dennis P Hobbs, Lean manufacturing implementation, J.Ross publication, 2004
2. Jay Arthur, Lean six sigma Demystified, Tata McGraw-Hill publication, New Delhi, 2007
3. Paul Keller, Six sigma Demystified, Tata McGraw-Hill publication, New Delhi, 2005
4. Mike George, Dave Rowlands, Bill Kastle, What is Lean Six Sigma?, Tata McGraw-Hill publication, New Delhi, 2004
5. Tapan P. Bagchi, Six Sigma, NPTEL Course, link : https://nptel.ac.in/courses/110105039/

18ME0YM HEATING VENTILATION AND AIRCONDITIONING 3 0 0 3

Course Objectives

- To provide knowledge on heat transfer, heating and cooling load
- To learn the different methods of ventilation and its rates
- To study methods of air Distribution, diffusion and applications of ventilation
- To impart knowledge on Psychometric processes and its applications
- To provide knowledge on different components and parameters involved in designing of air conditioning systems

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.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.

PO6. 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.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PSO1.Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

PSO3.Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Apply the principles of air conditioning to classify and compare systems such as window, split, VRV, and central air conditioning systems.
2. Assess the environmental factors, thermal exposure, and internal, external heat sources, students are expected to estimate the heat loads in buildings.
3. Implement appropriate duct design methods and select suitable fans based on system specifications, airflow requirements, and energy efficiency considerations.
4. Illustrate pump working principle and calculate water velocity to optimize flow efficiency in chilled and hot water distribution systems.
5. Design air distribution, chilled water systems, and select appropriate HVAC equipment and components for efficient system layout and installation.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO HEAT TRANSFER, HEATING AND COOLING LOAD

Heat transfer in wall and roof, sol-air temperature, insulation, cooling load temperature difference - Fenestration, types of glass, sun shade, shading coefficient, maximum radiation, cooling load factor. Cooling Load Estimation - Design conditions, outdoor, indoor - External load, wall, roof, glass - Internal load, occupancy, lighting, and equipments - Ventilation, air quantity, and loads - Load estimation methods. Heating load estimation - Vapour transfer in wall, vapour barrier, load estimation basics

UNIT II **8 Hours**

VENTILATION

Ventilation - Need, threshold limits of contaminants, estimation of ventilation rates, decay equation, air flow around buildings. Methods of Ventilation - Natural, wind effect, stack effect, combined effect - Mechanical, forced, exhaust, combined - Displacement ventilation

UNIT III **8 Hours**

AIR DISTRIBUTION, DIFFUSION AND VENTILATION APPLICATION

Air Distribution - Ducts, types, fittings, air flow, friction chart, methods of sizing, Balancing. Air Diffusion - Isothermal jet, throw, drop, types of outlets, ADPI, outlet/inlet selection, Ventilation System Design - Exhaust ducts, filters, blowers, hoods, chimney. Industrial Ventilation - Steel plants, car parks, plant rooms, mines.

UNIT IV **10 Hours**

HUMAN COMFORT AND PSYCHROMETRIC PROCESS

Human Comfort - Heat transfer from body, convection, radiation, conduction, evaporation, clothing resistance, activity level - Concept of human comfort - Thermal response - comfort factors - Environmental indices - Indoor air quality. Psycrhometric - Evolution of air properties and psychrometric chart - Basic Psychrometric processes - Bypass factor and Sensible heat ratio.

UNIT V **10 Hours**

AIR CONDITIONING

AC Equipments - Filters, types, efficiency - Fans-basic equations, parallel and series configurations - Air washer, adiabatic, heated and cooled - Cooling tower, enthalpy potential, types, tower efficiency, NTU and characteristics, sizing and off design performance - Cooling and dehumidifying coil, dry and wet, sizing, performance. Summer and Winter AC - Simple summer AC process, Room sensible heat factor, Coil sensible heat factor, ADP - Precision AC - Winter AC.

Total: 45 Hours

Reference(s)

1. Auto Heating and Air Conditioning - Chris Johanson. Goodheart - Willcox Company, Inc. ISBN 978-1-61960-763-7; 4th edition.
2. Haines, W.R. and Wilson, C.L., HVAC Systems Design Handbook, McGraw Hill, 2nd Ed., New Delhi, 1994.
3. Legg, R.C., Air Conditioning Systems - Design, Commissioning and maintenance, Batsford Ltd, London 1991.
4. ASHRAE Handbook Ã¢?? HVAC Systems and Equipments, American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc., Atlanta, USA, 2008.
5. McQuiston, F.C., Parker, J.D. and Spitler, J.D. Heating, Ventilating and Air Conditioning, John Wiley & Sons Inc., 2001.