# DEPARTMENT OF MECHANICAL ENGINEERING

Course Book for

**B. Tech. in Mechanical Engineering**

For

**Academic Year: 2026-27**

(Admitted Year: 2025 – 2026 Onwards)

**Visvesvaraya National Institute of Technology,**

**Nagpur-440 010 (MH)**

## Institute Vision Statement

To contribute effectively to the National and International 1ndeavor of producing quality human resource of world class standard by developing a sustainable technical education system to meet the changing technological needs of the Country and the World incorporating relevant social concerns and to build an environment to create and propagate innovative technologies for the economic development of the Nation.

## Institute Mission Statement

The mission of VNIT is to achieve high standards of excellence in generating and propagating knowledge in engineering and allied disciplines. VNIT is committed to providing an education that combines rigorous academics with joy of discovery. The Institute encourages its community to engage in a dialogue with society to be able to effectively contribute for the betterment of humankind.

## Department Vision Statement

To produce quality human resource of high standard in mechanical engineering who can contribute favorably to the technological and socio-economic development of the nation.

## Department Mission Statement

To develop state of the art facilities related to mechanical engineering. To attract highly qualified faculty to the mechanical engineering department. To promote participation of industries in academics, research and consultancy. To undertake research at regional and national level.

## Brief about Mechanical Department

Department of Mechanical Engineering is one of the oldest departments started in 1960, currently department is offering 1 UG and 4 PG programmes. Faculty members of the department are highly motivated for teaching and conducting research in the diversified fields of mechanical engineering.

# INDEX

## List of faculty Members

| Sr No | Faculty Name | Areas of specialization |
|---|---|---|
| 1 | Dr. A. M. Kuthe | Manufacturing |
| 2 | Dr. S. B. Thombre | Thermal Engineering |
| 3 | Dr. A. B. Andhare | Manufacturing |
| 4 | Dr. V. R. Kalamkar | Thermal Engineering |
| 5 | Dr. Y. M. Puri | Manufacturing and Industrial Engineering |
| 6 | Dr. J. G. Suryawanshi | Thermal Engineering |
| 7 | Dr. R. V. Uddanwadikar | Design Engineering |
| 8 | Dr. S. S. Chiddarwar | Manufacturing and Design Engineering |
| 9 | Dr. D. B. Zodpe | Thermal Engineering |
| 10 | Dr. A. S. Dhoble | Thermal Engineering |
| 11 | Dr. H.P. Jawale | Design Engineering |
| 12 | Dr. M. S. Kotambkar | Design Engineering |
| 13 | Dr. A. K. Singh | Design and Thermal Engineering |
| 14 | Dr. Trushar B Gohil | Thermal Engineering |
| 15 | Dr. T. V. K. Gupta | Manufacturing |
| 16 | Dr. Ravikumar Dumpala | Manufacturing |
| 17 | Dr. D. A. Jolhe | Industrial Engineering |
| 18 | Dr. P. V. Kane | Industrial Engineering |
| 19 | Dr. V. M. Nistane | Design Engineering |
| 20 | Dr. N. K. Lautre | Industrial Engineering |
| 21 | Dr. G. Tiwari | Design Engineering |
| 22 | Dr. A. A. Thakre | Design and Industrial Engineering |
| 23 | Dr. K. M. Asthankar | Industrial Engineering |
| 24 | Dr. P. D. Sawarkar | Thermal Engineering |
| 25 | Dr. S Roga | Thermal Engineering |
| 26 | Dr. Rahul Tarodiya | Thermal Engineering |
| 27 | Dr. N. A. Reddy | Design Engineering |
| 28 | Dr. R. P. Soni | Thermal Engineering |
| 29 | Dr. A. A. Baxy | Design Engineering |

**UG/ PG Programmes Offered by Mechanical Department:**

The department offers following undergraduate and postgraduate programmes

| | Program | Description |
|---|---|---|
| **UG** | B. Tech in Mechanical Engineering | Intake: 115 |
| **PG** | M. Tech. in<br>**1.** Computer Aided Design & Manufacturing<br>**2.** Production and Industrial Engineering<br>**3.** Heat Power Engineering.<br>**4.** Bio Medical Engineering (Interdisciplinary) | <br>Intake : 23<br>Intake : 23<br>Intake : 23<br>Intake : 14 |

## Credit System at VNIT:

Education at the Institute is organized around the semester-based credit system of study. The prominent features of the credit system are a process of continuous evaluation of a student's performance / progress and flexibility to allow a student to progress at an optimum pace suited to his/her ability or convenience, subject to fulfilling minimum requirements for continuation. A student's performance/progress is measured by the number of credits he/she has earned, i.e. completed satisfactorily. Based on the course credits and grades obtained by the student, grade point average is calculated. A minimum number of credits and a minimum grade point average must be acquired by a student in order to qualify for the degree.

## Course credits assignment

Each course, except a few special courses, has certain number of credits assigned to it depending on lecture, tutorial and laboratory contact hours in a week.

For Lectures and Tutorials: One lecture hour per week per semester is assigned one credit and For Practical/ Laboratory/ Studio: One hour per week per semester is assigned half credit.

Example: Course XXXXXX with (3-0-2) as (L-T-P) structure, i.e. 3 hr Lectures + 0 hr Tutorial + 2 hr Practical per week, will have (3x1 + 0x1 + 2x0.5 =) 4 credits.

## Grading System

The grading reflects a student's own proficiency in the course. While relative standing of the student is clearly indicated by his/her grades, the process of awarding grades is based on fitting performance of the class to some statistical distribution. The course coordinator and associated faculty members for a course formulate appropriate procedure to award grades. These grades are reflective of the student's performance vis-à-vis instructor's expectation. If a student is declared pass in a subject, then he/she gets the credits associated with that subject.

Depending on marks scored in a subject, a student is given a Grade. Each grade has got certain grade points as follows:

| Grade | Grade points | Description |
|---|---|---|
| AA | 10 | Outstanding |
| AB | 9 | Excellent |
| BB | 8 | Very good |
| BC | 7 | Good |
| CC | 6 | Average |
| CD | 5 | Below average |
| DD | 4 | Marginal (Pass Grade) |
| FF | 0 | Poor (Fail) /Unsatisfactory / Absence from end-sem exam |
| NP | - | Audit pass |
| NF | - | Audit fail |
| SS | - | Satisfactory performance in zero credit core course |
| ZZ | - | Unsatisfactory performance in zero credit core course |
| W | - | Insufficient attendance |

## Performance Evaluation

The performance of a student is evaluated in terms of two indices, viz, the Semester Grade Point Average (SGPA) which is the Grade Point Average for a semester and Cumulative Grade Point Average (CGPA) which is the Grade Point Average for all the completed semesters at any point in time. CGPA is rounded up to second decimal.

The Earned Credits (ECR) are defined as the sum of course credits for courses in which students have been awarded grades between AA to DD. Grades obtained in the audit courses are not counted for computation of grade point average

Earned Grade Points in a semester (EGP) = **Σ** (Course credits x Grade point) for courses in which AA- DD grade has been obtained

SGPA = EGP / Σ (Course credits) for courses registered in a semester in which AA- FF grades are awarded

CGPA= EGP / Σ(Course credits) for courses passed in all completed semesters in which AA- DD grades are awarded.

**Attendance Rules**

1. All students must attend every class and 100% attendance is expected from the students. However, in consideration of the constraints/ unavoidable circumstances, the attendance can be relaxed by course coordinator only to the extent of not more than 25%. Every student must attend minimum of 75% of the classes actually held for that course.
2. A student with less than 75% attendance in a course during the semester, will be awarded W grade. Such a student will not be eligible to appear for the end semester and re- examination of that course. Even if such a student happens to appear for these examinations, then, answer books of such students will not be evaluated.
3. A student with W grade is not eligible to appear for end semester examination, re-examination & summer term.

## Program Outcomes for B. Tech in Mechanical Engineering

1) The graduates will be able to apply knowledge of basic sciences (math, physics, chemistry etc.) and engineering (core and elective subjects) in getting solutions to mechanical engineering related problems.
2) The graduates will be able to design and conduct experiments as well as analyze and interpret data.
3) The graduates will be able to design a system or a component of a system for a specific task within realistic constraints.
4) The graduates will be able to undertake multi disciplinary courses and tasks.
5) The graduates will be able to formulate and apply the knowledge of mathematical techniques in solving the governing equations of a system under consideration.
6) The graduates will be able to develop industrial and professional ethics and managerial skills.
7) The graduates will be able to communicate effectively their point of views
8) The graduates will be able to study the impact of mechanical systems on the global, economic, environmental and societal context.
9) The graduates will acquire attitude for life- long learning.
10) The graduate will be able to use modern tools, software, equipment etc. to analyze and obtain solution to the problems.
11) The graduates will be able to participate in competitive examinations for success

## Program Credit Structure

***Mechanical Engineering Department***

**Name of UG Program:** B. Tech in Mechanical Engineering

| Sr. No. | Category of Course - PC | Symbol | Earned Credit Requirement |
|---|---|---|---|
| 1. | Basic Sciences | BS | 16 |
| 2. | Engineering Sciences | ES | 16 |
| 3. | Institute Core | IC | 02 |
| 4. | Departmental Core | DC | 71 |
| 5. | Mandatory Non-Credit | MNC | |
| **Sr. No.** | **Category of Course - PE** | **Symbol** | **Earned Credit Requirement** |
| **6.** | Institute Elective | IE | 06 |
| **7.** | Departmental Elective | DE | 43 |
| **8.** | Humanities & Management | HM | 3 |
| **9.** | Open Course | OC | 3 |
| | **Total** | | 160 |

| | PC | | | | | | PE | | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **BS** | **ES** | **HU** | **IC** | **DC** | **MNC** | **IE** | **OC** | **HM** | **DE*** | | **MR#** | **HN#** |
| **Sem** | | | | | | | | | | | | | |
| **I** | 8 | 8 | 3 | 0 | 2 | Physical Edu. | 0 | 0 | 0 | 0 | 21 | | |
| **II** | 8 | 8 | 0 | 2 | 0 | Life Skill | 3 | 0 | 0 | 0 | 21 | | |
| **III** | 0 | 0 | 0 | 0 | 20 | Third MNC | 0 | 0 | 0 | 2 | 22 | 3 | |
| **IV** | 0 | 0 | 0 | 0 | 17 | Fourth MNC | 3 | 0 | 0 | 0 | 20 | 3 | |
| **V** | 0 | 0 | 0 | 0 | 16 | 0 | 0 | 0 | 0 | 7 | 23 | 3 | 3 |
| **VI** | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 10 | 20 | 3 | 4 |
| **VII** | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 10 | 13 | 3 | 4 |
| **VIII** | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 3 | 0 | 14 | 21 | | 4 |
| **Total** | 16 | 16 | 3 | 2 | 71 | 0 | 6 | 3 | 0 | 43 | 160 | 15 | 15 |

*DE courses also include optional summer internship of minimum six weeks (1 credit) & Semester long internship (6 credits) in 7th or 8th semester

# Note - Minor and Honours Course are Optional

**1st Semester**

| Sr. No. | Course Code | Course Title | L–T– P | Credits | Course Type | Pre-requisites |
|---|---|---|---|---|---|---|
| **Program Core** | | | | | | |
| 1. | CHLA101 | CHEMICAL SCIENCE FOR MATERIALS AND ENERGY SYSTEMS | 3-0-0 | 3 | BS | |
| 2. | MALA103 | CALCULUS AND DIFFERENTIAL EQUATIONS | 3-1-0 | 4 | BS | |
| 3. | HULA101 | ENGLISH AND CORPORATE COMMUNICATION | 2-0-2 | 3 | IC | |
| 4. | MELA102 | ENGINEERING DRAWING | 3-0-0 | 3 | ES | |
| 5. | AMLA101 | ENGINEERING MECHANICS | 3-0-0 | 3 | ES | |
| 6. | CHPA102 | CHEMISTRY LABORATORY | 0-0-2 | 1 | BS | |
| 7. | MEPA102 | ENGINEERING DRAWING PRACTICAL | 0-0-2 | 1 | ES | |
| 8. | AMPA101 | ENGINEERING MECHANICS LABORATORY | 0-0-2 | 1 | ES | |
| 9. | MEPA103 | WORKSHOP | 0-0-4 | 2 | DC | |
| **Program Elective** | | | | | | |
| | | | | | | |

| Credits | BS | ES | HU | IC | DC | IE/DE/HM/OC | Minor | Honor | Total |
|---|---|---|---|---|---|---|---|---|---|
| **1st Sem** | 8 | 8 | 3 | 0 | 2 | 0 | 0 | 0 | 21 |
| **Cumulative** | 8 | 8 | 3 | 0 | 2 | 0 | 0 | 0 | 21 |

**2nd Semester**

| Sr. No. | Course Code | Course Title | L–T– P | Credits | Course Type | Pre-requisites |
|---|---|---|---|---|---|---|
| **Program Core** | | | | | | |
| 1. | PHL1XX | PHYSICS FOR MECHANICAL ENGINEERING | 3-0-0 | 3 | BS | |
| 2. | MAL211 | COMPLEX VARIABLES, INTEGRAL TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS | 3-1-0 | 4 | BS | |
| 3. | CSL101 | COMPUTER PROGRAMMING | 3-0-2 | 4 | ES | |
| 4. | EEL1XX | ELECTRICAL ENGINEERING | 3-0-0 | 3 | ES | |
| 5. | ICLXXX | ENVIRONMENTAL STUDIES | 2-0-0 | 2 | IC | |
| 6. | | INSTITUTE ELECTIVE 1 | 3-0-0 | 3 | IE | |
| 7. | PHP1XX | PHYSICS LAB FOR MECHANICAL ENGINEERING | 0-0-2 | 1 | BS | |
| 8. | EEP1XX | ELECTRICAL ENGINEERING LABORATORY | 0-0-2 | 1 | ES | |
| **Program Elective** | | | | | | |
| 9. | MEDXXX | SUMMER INTERNSHIP MIN 6 WEEKS (OPTIONAL) | - | 1 | DE | |

| Credits | BS | ES | HU | IC | DC | IE/DE/HM/OC | Minor | Honor | Total |
|---|---|---|---|---|---|---|---|---|---|
| **2nd Sem** | 8 | 8 | 0 | 2 | 0 | 3 | 0 | 0 | 21 |
| **Cumulative** | 16 | 16 | 3 | 2 | 2 | 3 | 0 | 0 | 42 |

**3rd Semester**

| Sr. No. | Course Code | Course Title | L–T–P | Credits | Course Type | Pre-requisites |
|---|---|---|---|---|---|---|
| **Program Core** | | | | | | |
| 1. | MELA201 | MANUFACTURING PROCESS-I | 3-0-0 | 3 | DC | |
| 2. | MELA202 | ENGINEERING THERMODYNAMICS | 3-1-0 | 4 | DC | |
| 3. | MELA203 | THEORY OF MACHINE - I | 3-1-0 | 4 | DC | |
| 4. | MELA204 | COMPUTATIONAL METHODS IN MECHANICAL ENGINEERING | 3-1-0 | 4 | DC | |
| 5. | MELA205 | SOLID MECHANICS | 3-0-0 | 3 | DC | |
| 6. | MEPA201 | MANUFACTURING PROCESS-I LAB | 0-0-2 | 1 | DC | |
| 7. | MEPA205 | SOLID MECHANICS | 0-0-2 | 1 | DC | |
| **Program Elective** | | | | | | |
| 5. | MEPA206 | COMPUTER AIDED DRAFTING AND MODELLING | 0-1-2 | 2 | DE | |
| 6. | Minor #1 | MINOR 1 (OPTIONAL) | 3-0-0 | 3 | MR | |

| Credits | BS | ES | HU | IC | DC | IE/DE/HM/OC | Minor | Honor | Total |
|---|---|---|---|---|---|---|---|---|---|
| **3rd Sem** | 0 | 0 | 0 | 0 | 20 | 0/2/0/0 | 3 | 0 | 22 |
| **Cumulative** | 16 | 16 | 3 | 2 | 22 | 3/2/0/0 | 3 | 0 | 64 |

**4th Semester**

| Sr. No. | Course Code | Course Title | L–T– P | Credits | Course Type | Pre-requisites |
|---|---|---|---|---|---|---|
| **Program Core** | | | | | | |
| 1. | MEL202 | FLUID MECHANICS | 3-0-0 | 3 | DC | |
| 2. | MEL301 | THEORY OF MACHINE-II | 3-0-0 | 3 | DC | |
| 3. | MEL303 | ENERGY CONVERSION-I | 3-0-0 | 3 | DC | |
| 4. | MEL304 | MACHINE DESIGN-I | 3-0-0 | 3 | DC | |
| 5. | MEL313 | MACHINE DRAWING | 2-0-0 | 2 | DC | |
| 6. | MEP202 | FLUID MECHANICS LAB | 0-0-2 | 1 | DC | |
| 7. | MEP301 | THEORY OF MACHINE-II | 0-0-2 | 1 | DC | |
| 8. | MEP313 | MACHINE DRAWING | 0-0-2 | 1 | DC | |
| **Program Elective** | | | | | | |
| 9. | | INSTITUTE ELECTIVE 2 | 3-0-0 | 3 | IE | |
| 10. | MEDXXX | SUMMER INTERNSHIP MIN 6 WEEKS (OPTIONAL) | - | 1 | DE | |
| | Minor #2 | MINOR 2 (OPTIONAL) | 3-0-0 | 3 | MR | |

| Credits | BS | ES | HU | IC | DC | IE/DE/HM/OC | Minor | Honor | Total |
|---|---|---|---|---|---|---|---|---|---|
| **4th Sem** | 0 | 0 | 0 | 0 | 17 | 3/0/0/0/ | 3 | 0 | 20 |
| **Cumulative** | 16 | 16 | 3 | 2 | 39 | 6/2/0/0 | 6 | 0 | 84 |

**5th Semester**

| Sr. No. | Course Code | Course Title | L–T– P | Credits | Course Type | Pre-requisites |
|---|---|---|---|---|---|---|
| **Program Core** | | | | | | |
| 1. | MEL302 | HEAT TRANSFER | 3-1-0 | 4 | DC | |
| 2. | MEL305 | MANUFACTURING PROCESS II | 3-0-0 | 3 | DC | |
| 3. | MEL307 | FLUID MACHINES | 3-0-0 | 3 | DC | |
| 4. | MEL308 | ENERGY CONVERSION- II | 3-0-0 | 3 | DC | |
| 5. | MEP302 | THERMAL LAB | 0-0-2 | 1 | DC | |
| 6. | MEP305 | MANUFACTURING PROCESS II | 0-0-2 | 1 | DC | |
| 7. | MEP307 | FLUID MACHINES | 0-0-2 | 1 | DC | |
| **Program Elective** | | | | | | |
| 8. | | DEPARTMENTAL ELECTIVE | 3-0-2 | 4 | DE | |
| 9. | | DEPARTMENTAL ELECTIVE | 3-0-0 | 3 | DE | |
| | Minor #3 / Honor #1 | MINOR course 3/DE for HONOURS (OPTIONAL) | 3-0-0 | 3 | MR/DE | |

| Credits | BS | ES | HU | IC | DC | IE/DE/HM/OC | Minor | Honor | Total |
|---|---|---|---|---|---|---|---|---|---|
| **5th Sem** | 0 | 0 | 0 | 0 | 16 | 0/7/0/0 | 3 | 3 | 23 |
| **Cumulative** | 16 | 16 | 3 | 2 | 55 | 6/9/0/0 | 9 | 3 | 107 |

**6th Semester**

| Sr. No. | Course Code | Course Title | L–T– P | Credits | Course Type | Pre-requisites |
|---|---|---|---|---|---|---|
| **Program Core** | | | | | | |
| 1. | MEL309 | MACHINE DESIGN-II | 3-0-0 | 3 | DC | |
| 2. | MEL311 | METROLOGY AND QUALITY ASSURANCE | 3-0-0 | 3 | DC | |
| 3. | MEL312 | MECHANICAL MEASUREMENTS | 3-0-0 | 3 | DC | |
| 4. | MEP314 | MECHANICAL MEASUREMENT AND METROLOGY | 0-0-2 | 1 | DC | |
| **Program Elective** | | | | | | |
| 5. | MEL4XX | DEPARTMENTAL ELECTIVE | 3-0-0 | 3 | DE | |
| 6. | MEL4XX | DEPARTMENTAL ELECTIVE | 3-0-0 | 3 | DE | |
| 7. | MEL4XX | DEPARTMENTAL ELECTIVE | 3-0-2 | 4 | DE | |
| 8. | MED406 | SUMMER INTERNSHIP MIN 6 WEEKS (OPTIONAL) | - | 1 | DE | |
| | Minor #4/ Honor #2 | MINOR COURSE 4/DE FOR HONOURS (OPTIONAL) | 3-0-0 | 3/4 | MR/DE | |

| Credits | BS | ES | HU | IC | DC | IE/DE/HM/OC | Minor | Honor | Total |
|---|---|---|---|---|---|---|---|---|---|
| **6th Sem** | 0 | 0 | 0 | 0 | 10 | 0/10/0/0 | 3 | 4 | 20 |
| **Cumulative** | 16 | 16 | 3 | 2 | 65 | 6/19/0/0 | 12 | 7 | 127 |

**7th Semester**

| Sr. No. | Course Code | Course Title | L–T– P | Credits | Course Type | Pre-requisites |
|---|---|---|---|---|---|---|
| **Program Core** | | | | | | |
| 1. | MED401 | PROJECT PHASE-I | | 3 | DC | |
| **Program Elective** | | | | | | |
| 2. | MEL4XX | DEPARTMENTAL ELECTIVE | 3-0-0 | 3 | DE | |
| 3. | MEL4XX | DEPARTMENTAL ELECTIVE | 3-0-0 | 3 | DE | |
| 4. | MEL4XX | DEPARTMENTAL ELECTIVE | 3-0-0 | 3 | DE | |
| | | | 0-0-2 | 1 | | |
| 5. | MEL4XX | DEPARTMENTAL ELECTIVE | 3-0-0 | 3 | DE | |
| | | | 0-0-2 | 1 | | |
| 6. | MED406 | SEMESTER LONG INTERNSHIP | - | 6 | DE | |
| | Minor #5/ Honor #3 | MINOR course 5/DE for HONOURS (OPTIONAL) | 3-0-0 | 3/4 | MR/DE | |

| Credits | BS | ES | HU | IC | DC | IE/DE/HM/OC | Minor | Honor | Total |
|---|---|---|---|---|---|---|---|---|---|
| **7th Sem** | 0 | 0 | 0 | 0 | 3 | 0/14/0/0 | 3 | 4 | 17 |
| **Cumulative** | 16 | 16 | 3 | 2 | 68 | 6/33/0/0 | 15 | 11 | 144 |

**8th Semester**

| Sr. No. | Course Code | Course Title | L–T– P | Credits | Course Type | Pre-requisites |
|---|---|---|---|---|---|---|
| **Program Core** | | | | | | |
| 1. | MED402 | PROJECT PHASE-II | | 3 | DC | |
| **Program Elective** | | | | | | |
| 2. | MEL4XX | DEPARTMENTAL ELECTIVE | 3-0-0 | 3 | DE | |
| 3. | MEL4XX | DEPARTMENTAL ELECTIVE | 3-0-0 | 3 | DE | |
| | | | 0-0-2 | 1 | | |
| 4. | MEL4XX | DEPARTMENTAL ELECTIVE | 3-0-0 | 3 | DE | |
| 5. | | OPEN ELECTIVE | 3-0-0 | 3 | OC | |
| 6. | MEL4XX | DE for HONOURS (OPTIONAL) | 3-0-0 | 3 | DE | |
| | | | 0-0-2 | 1 | | |

| Credits | BS | ES | HU | IC | DC | IE/DE/HM/OC | Minor | Honor | Total |
|---|---|---|---|---|---|---|---|---|---|
| **8th Sem** | 0 | 0 | 0 | 0 | 3 | 0/10/0/3 | 0 | 4 | 16 |
| **Cumulative** | 16 | 16 | 3 | 2 | 71 | 6/43/0/3 | 15 | 15 | 160 |

*DE courses also include optional summer internship of minimum six weeks (1 credit) & Semester long internship (6 credits) in 7th or 8th semester

*Note - Minor and Honours Course are Optional

## List of Electives: For Odd Semester

| Sr. No. | Course Code | Course Title | L–T–P | Credits | Course Type | Pre-requisites |
|---|---|---|---|---|---|---|
| 1 | MEPA206 | Computer Aided Drafting and Modelling | 0-1-2 | 2 | Practical | |
| 2 | MEL317 | Mobile Robotics | 3-0-0 | 3 | | |
| 3 | MEL402 | Surface Engineering | 3-0-0 | 3 | Theory | |
| 4 | MEL403 | Operation Research | 3-0-0 | 3 | Theory | |
| 5 | MEL406 | Dynamics of Mechanical System | 3-0-0 | 3 | Theory | |
| 6 | MEL407 | Bio Mechanics | 3-0-0 | 3 | Theory | |
| 7 | MEL408 | Supply Chain Management | 3-0-0 | 3 | Theory | |
| 8 | MEL410 | Computer Aided Design | 3-0-0 | 3 | Theory | |
| 9 | MEP410 | | 0-0-2 | 1 | Practical | |
| 10 | MEL412 | Air Conditioning | 3-0-0 | 3 | Theory | |
| 11 | MEL414 | Tribology | 3-0-0 | 3 | Theory | |
| 12 | MEL417 | Power Plant Engineering | 3-0-0 | 3 | Theory | |
| 13 | MEL420 | Finite Element Method | 3-0-0 | 3 | Theory | |
| 14 | MEP420 | | 0-0-2 | 1 | Practical | |
| 15 | MEL425 | Reliability and Maintenance Engineering | 3-0-0 | 3 | Theory | |
| 16 | MEL428 | Machine Tool Design | 3-0-0 | 3 | Theory | |
| 17 | MEL431 | Advanced Mechanism | 3-0-0 | 3 | Theory | |
| 18 | MEL433 | Design for Manufacturing and Assembly | 3-0-0 | 3 | Theory | |
| 19 | MEL435 | Computational Fluid Dynamics | 3-0-0 | 3 | Theory | |
| 20 | MEP435 | | 0-0-2 | 1 | Practical | |
| 21 | MEL436 | Mechatronics | 3-0-0 | 3 | Theory | |
| 22 | MEP436 | | 0-0-2 | 1 | Practical | |
| 23 | MEL437 | Composite Materials | 3-0-0 | 3 | Theory | |
| 24 | MEL439 | Product Design and Development | 3-0-0 | 3 | Theory | |
| 25 | MEL440 | Machine Vision & Its Application | 3-0-0 | 3 | Theory | |
| 26 | MEL452 | Advanced Machining Processes | 3-0-0 | 3 | Theory | |
| 27 | MEL458 | Aerial Robotics | 3-0-0 | 3 | Theory | |
| 28 | MEL4XX | Vehicle Dynamics | 3-0-0 | 3 | Theory | |

## List of Electives: For Even Semester

| Sr. No. | Course Code | Course Title | L–T–P | Credits | Course Type | Pre-requisites |
|---|---|---|---|---|---|---|
| 1 | MEL310 | Manufacturing Processes Automation | 3-0-0 | 3 | Theory | |
| 2 | MEP310 | | 0-0-2 | 1 | Practical | |
| 3 | MEL318 | Two Phase Flow and Heat Transfer | 3-0-0 | 3 | Theory | |
| 4 | MEP318 | | 0-0-2 | 1 | Practical | |
| 5 | MEL401 | Control Systems | 3-0-0 | 3 | Theory | |
| 6 | MEL405 | Optimization | 3-0-0 | 3 | Theory | |
| 7 | MEL409 | Advanced Mechanics of Solids | 3-0-0 | 3 | Theory | |
| 8 | MEL413 | Fracture Mechanics | 3-0-0 | 3 | Theory | |
| 9 | MEL415 | Mechanical Vibration | 3-0-0 | 3 | Theory | |
| 10 | MEL416 | Industrial Robotics | 3-0-0 | 3 | Theory | |
| 11 | MEL418 | Advanced Stress Analysis | 3-0-0 | 3 | Theory | |
| 12 | MEL422 | Automobile Engineering | 3-0-0 | 3 | Theory | |
| 13 | MEP422 | Automobile Engineering | 0-0-2 | 1 | Practical | |
| 14 | MEL424 | Industrial Engineering & Management | 3-0-0 | 3 | Theory | |
| 15 | MEL426 | Refrigeration & Cryogenics | 3-0-0 | 3 | Theory | |
| 16 | MEP426 | | 0-0-2 | 1 | Practical | |
| 17 | MEL429 | Renewable Energy Sources | 3-0-0 | 3 | Theory | |
| 18 | MEL430 | Advanced IC Engines | 3-0-0 | 3 | Theory | |
| 19 | MEP430 | | 0-0-2 | 1 | Practical | |
| 20 | MEL432 | Computer Graphics and Solid Modelling | 3-0-0 | 3 | Theory | |
| 21 | MEP432 | | 0-0-2 | 1 | Practical | |
| 22 | MEL438 | Adv Refrigeration and Air Conditioning | 3-0-0 | 3 | Theory | |
| 23 | MEP438 | | 0-0-2 | 1 | Practical | |
| 24 | MEL443 | Air Pollution Control | 3-0-0 | 3 | Theory | |
| 25 | MEL444 | Solar Energy Utilization | 3-0-0 | 3 | Theory | |
| 26 | MEL448 | Artificial Intelligence in Manufacturing | 3-0-0 | 3 | Theory | |
| 27 | MEL449 | Advanced Turbo Machinery | 3-0-0 | 3 | Theory | |
| 28 | MEP452 | Machine System Design | 0-1-4 | 3 | Practical | |
| 29 | MEL456 | Design of Fixtures in Manufacturing | 3-0-0 | 3 | Theory | |
| 30 | MEL4XX | Smart Manufacturing and Quality 4.0 | 3-0-0 | 3 | Theory | |
| 31 | MEL4XX | Noise Vibration and Harshness | 3-0-0 | 3 | Theory | |

# Semester I

| Course Code & Course Title: | CHLA101: CHEMICAL SCIENCE FOR MATERIALS AND ENERGY SYSTEMS | | |
|---|---|---|---|
| Course Type: | BS | | |
| Name of the programme(s): | B. Tech. | | |
| L – T – P | 3-0-0 | No. of Credits | 3 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objectives: |
|---|---|

i. To understand the fundamental principles of Water treatment, electrochemical phenomenon including corrosion, electrochemical series and battery Technology.

ii. To explore the chemistry components and applications of fuel and lubricants.

To gain knowledge of chemistry of Engineering materials high energy materials and catalysis.

| 2. | Course Outcomes: |
|---|---|
| CO1 | Understand the fundamentals of water chemistry, electrochemistry |
| CO2 | Understanding the fundamentals of fuels, lubricants and spectroscopic techniques. |
| CO3 | Gaining the knowledge of the material synthesis and chemistry of engineering materials. |
| CO4 | Recognize the role of high energy materials, adsorption and the catalytic process. |

| 3. Detailed Description of the Course | | |
|---|---|---|
| **Topics** | **CO(s) Addressed** | **Duration in weeks** |
| **Water Chemistry:** Sources, conservation of water, impurities in water and their effects. WHO guideline and BIS guideline for drinking water. Chemistry involved in sedimentation, coagulation and sterilization. Softening of water, lime- soda process. Ion-exchange process (zeolite and ion exchange resin) and numerical problem. Boiler troubles, causes and effects, methods of prevention. | CO1 | 2 |
| **Electrochemical Phenomenon and Corrosion:**<br>Electrochemical and galvanic series, polarization, decomposition potential, over voltage. Introduction to electrochemical characterization techniques – potentiometry, conductometry, cyclic voltammetry.<br>Theories of corrosion, types of corrosion, factors influencing corrosion. | CO1 | 2 |

| | | |
|---|---|---|
| Corrosion Control: Design and material selection, anodic and cathodic protection, protective coatings, corrosion inhibitors. | | |
| **Battery Technology:** Introduction, types and properties of batteries: Primary cells, Secondary cells (Lithium-ion battery: Chemistry involved, Cathode materials, Anode materials, Electrolytes and Separators).<br>Fuel Cells. Solar cells. | CO1 | 1 |
| **Fuels and Lubricants:** Fuels: Classification of fuels, Solid Fuels, Calorific Value, proximate and ultimate analysis, Carbonization, Liquid fuels, Knocking in I/C engine, Octane no, cetane no, combustion problems. Biofuels.<br>Lubricants: Mechanism of friction, Classification: Solid, Semisolid, Liquid. Properties and applications of lubricants. | CO2 | 2 |
| **Spectroscopy:** Interaction of radiation with matter, Molecular/Atomic Spectroscopy: Principles and applications of optical (UV-Vis) spectroscopy, Atomic absorption spectroscopy, Flame photometry, Inductively coupled plasma – Optical emission spectroscopy (ICP-OES), Vibrational (IR and Raman) spectroscopy and interpretation. | CO2 | 2 |
| **Industrially relevant processes for materials synthesis:** Chemical methods of material synthesis: Sol-gel, co-precipitation, Pechini's method. Emulsions.<br>Introduction to PVD and CVD, thin films.<br>Thermochemistry, Heat and energy changes, Phase transitions. | CO3 | 1 |
| **Chemistry of Engineering Materials:** Cement: Introduction, manufacturing and properties, fly ash utilization.<br>Polymers: Structure property relationship. Synthesis, properties and applications of industrial grade polymers [polyester, polyethylene terephthalate (PET), silicone, nylon, polyurethane, isoprene and Bakelite]. Conducting Polymers. | CO3 | 2 |
| **Chemistry of High Energy Materials:** Explosives: Introduction. Analytical techniques: trace and bulk level, requisites, oxygen balance, classification, properties and applications. Rocket propellants. | CO4 | 1 |
| **Adsorption and Catalysis:** Physical adsorption, chemisorption, Freundlich's expression, Langmuir adsorption isotherm.<br>Industrial applications of adsorption, Heterogeneous Catalysis. | CO4 | 1 |

| 4. | Text books |
|---|---|

i) Dara, S. S. and S.S. Umare, A Text Book of Engineering Chemistry (Twelfth edition); S. Chand, 2014. ISBN-13: 978-8121903592

ii) Jain and Jain, Engineering Chemistry, 17th Eds; Dhanpat Rai publishing. ISBN-13: 978-9352165728

iii) Shashi Chawla, A Text Book of Engineering Chemistry. ISBN-13: 978-8177001938

| 5. | Reference Book(s) and Other Required Material |
|---|---|

i) An Introduction to Electrochemistry, S. Glasstone, 2nd Edition, East west press (Pvt.) Limited. ISBN-13: 978-8176710138

ii) P.W. Atkins, Physical Chemistry, Oxford University Press. ISBN-13: 978-0198814740

iii) Bradley D. Fahlman, Materials Chemistry, 4th Eds; Springer, 2023. ISBN-13: 978-3031187834

| 6. | Evaluation Details: |
|---|---|

a) Mid Term Examination: 30 Marks
b) Continuous Assessment: 20 Marks
c) End Term Examination: 50 Marks

Total Marks: 100

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | 2 |
| CO2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 1 | 2 | 1 | 2 |
| CO3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 2 |
| CO4 | 3 | 2 | 3 | 2 | 1 | 2 | 3 | 2 | 1 | 1 | 2 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): NA |
|---|---|

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MALA103 - CALCULUS AND DIFFERENTIAL EQUATIONS** | | |
| **Course Type:** | **BS** | | |
| **Name of the programme(s):** | **B. Tech.** | | |
| **L – T – P** | **3-1-0** | **No. of Credits** | **4** |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

The objective of this subject is to expose students to understand the basic Differential calculus, Integral calculus of several variables and their applications in science and engineering.

| **2.** | **Course Outcomes:** |
|---|---|
| **CO1** | Deal with differential calculus of functions of several variables and their applications. |
| **CO2** | Understand concepts of multiple integrals and their applications in Engineering problems. |
| **CO3** | Understand the concepts of vector calculus and its applications in Engineering and Science. |
| **CO4** | Solve a certain class of ordinary differential equations related to Science and Engineering. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| **Differential Calculus of Function of Several Variables:** Partial derivatives and their geometrical interpretation, tangent plane and normal line, chain rules, Jacobian, Taylor's theorem (without proof), maxima and minima, saddle points. | | CO1 | 3 |
| **Multiple Integrals:** Double integrals, change of order of integration, change of variables, applications to area, volumes, mass, center of gravity. Triple integrals and change of variables in triple integrals. Application of triple integrals to volume, mass, center of mass, and moments of inertia. | | CO2 | 4 |
| **Vector Calculus:** Scalar and vector fields, gradient of scalar point function, directional derivatives, divergence, curl, solenoidal and irrotational fields. Vector integration: line, surface and volume integrals. Green's theorem, Stoke's theorem, and Gauss divergence theorem (without proof). | | CO3 | 3 |
| **Ordinary Differential Equations:** Second and higher order differential equations: linear equations with constant coefficients, linear independence and dependence, method of variation of parameters, Cauchy's equation. | | CO4 | 3 |

| 4. | Text books |
|---|---|

i) E. Kreyszig, Advanced Engineering Mathematics, John Wiley Publications, 10th Edition, 2011.

ii) R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publishers, 2005.

iii) James Stewart, Calculus: Early Transcendentals, 5th Edition, Thomson™ Brooks/Cole, 2007.

iv) G.B. Thomas and R.L. Finney, Calculus and Analytic Geometry, 9th Edition, Addison Wesley Longman, Inc.

| 5. | Reference Book(s) and Other Required Material |
|---|---|

i) Ghorpade, S. R., and Limaye, B. V., A Course in Multivariable Calculus and Analysis, Springer, 2010.

ii) Greenberg, M. D., Advanced Engineering Mathematics, 2nd ed., Pearson Education, 2002.

iii) Piskunov, N., Differential and Integral Calculus (Vol. 1 & Vol. 2), Mir Publishers/CBS Publishers and Distributors (India).

| 6. | Evaluation Details: |
|---|---|

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %

b) Teacher Defined Assessment: 20 %

c) End Semester Exam: 50-60 %

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | | | | | | | | |
| CO2 | 3 | 2 | 1 | | | | | | | | |
| CO3 | 3 | 2 | 1 | | | | | | | | |
| CO4 | 3 | 2 | 1 | | | | | | | | |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): NA |
|---|---|

| Course Code & Course Title: | HULA101 - ENGLISH AND CORPORATE COMMUNICATION | | |
|---|---|---|---|
| Course Type: | IC | | |
| Name of the programme(s): | B. Tech | | |
| L – T – P | 2-0-2 | No. of Credits | 3 |
| Pre-requisites: Course Code(s) & Name(s) | Nil | | |
| Course Equivalence: Course Code(s) & Name(s) | HUL101 | | |

| 1. | Course Objective: |
|---|---|

To impart the students with the skills they need in their academics and later in their professional pursuit

| 2. | Course Outcomes: |
|---|---|
| CO1 | Acquaint learners with basic of communication |
| CO2 | Familiarize learners with nuances of corporate communication |
| CO3 | Emphasize the importance of verbal and non-verbal communication |
| CO4 | Discuss key features of corporate communication |
| CO5 | Prepare learners for workplace challenges |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| Topics | | CO(s) Addressed | Duration in weeks |
| **Introduction to Communication**<br>• Principles of Communication<br>• Channels of Communication<br>• Inclusive Communication Practices<br>• Speaking and Listening Skills for Communication | | CO1 | 2 |
| **Introduction to Corporate Communication**<br>• Different Forms of Corporate Communication<br>• Factors Influencing Corporate Communication<br>• Interpersonal Communication<br>• Communication for Effective Leadership | | CO2 | 2 |
| **Verbal and Non-verbal Communication**<br>• Reading and Writing Skills for Corporate Communication | | CO3 | 4 |

| | | |
|---|---|---|
| • Nonverbal Communication in Corporate Setting<br>• Interview and Group Discussion<br>• Presentation Skills | | |
| **Features of Corporate Communication**<br>• Levels of Corporate Communication<br>• Barriers to Communication<br>• Organizational Communication<br>• Dos and don'ts of corporate communication | CO4 | 2 |
| **Strategies of Communication**<br>• Negotiating Conflict and Management<br>• Crisis Communication<br>• Emotional Intelligence and Stress Management<br>• Ethics in Corporate Communication | CO5 | 2 |

| 4. | **Text books** |
|---|---|

i) Joep Cornelissen, *Corporate Communication: A Guide to Theory and Practice*, 6th Edition, SAGE Publications, 2020, ISBN 1526491982.

ii) Meenakshi Raman and Prakash Singh, *Business Communication*, 2nd Edition, Oxford University Press, 2012, ISBN 9780198077053.

iii) Shirley Taylor and V. Chandra, *Communication for Business: A Practical Approach*, 1st Edition, Pearson, 2010, ISBN 9788131727652.

| 5. | **Reference Book(s) and Other Required Material** |
|---|---|

i) Ashraf Rizvi, *Effective Technical Communication*, 2nd Edition, McGraw Hill Education, 2017, ISBN 9352605780.

ii) Courtland L. Bovee, John V. Thill, et al., *Business Communication Today*, 14th Edition, Pearson, 2018, ISBN 9789353062682.

iii) Mary Ellen Guffey and Dana Loewy, *Business Communication: Process and Product*, 10th Edition, South-Western College Publishing, 2021, ISBN 0357129237.

iv) Paul A. Argenti, *Corporate Communication*, 7th Edition, McGraw-Hill Education, 2016, ISBN 9814636193.

v) Sharon Gerson and Steven Gerson, *Technical Communication: Process and Product*, 8th Edition, Pearson Education India, 2014, ISBN 9332518599.

| 6. | **Evaluation Details:** |
|---|---|

a) Mid Semester Examination – 20 Marks

b) Teacher Defined Assessment – 20 Marks

c) End Semester Examination – 60 Marks

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | 3 | | | | |
| CO2 | | | | | | | | | 3 | | | | | |
| CO3 | | | | | | | 3 | | | 3 | 3 | | | |
| CO4 | | | | | | | | 3 | | | | | | |
| CO5 | | | | | | | | | | | | | | |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

Week 1. Ice Breaker
Week 2. Oral Presentation
Week 3. Listening Activity
Week 4. Role Play
Week 5. Group Discussion
Week 6. Writing Activities
Week 7. Peer Interview
Week 8. PPT Presentation
Week 9. Debate
Week 10. Corporate Meeting
Week 11. Case Study
Week 12. Interviewing Strangers

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MELA102 ENGINEERING DRAWING** | | |
| **Course Type:** | **ES** | | |
| **Name of the programme(s):** | **B. Tech** | | |
| **L – T – P** | **3-0-0** | **No. of Credits** | **03** |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

1. To understand the principles and methods of projections as per the National Standards.
2. To develop the visualization skills for the interpretation of the use of various objects like lines, planes, solids, sections of solids & development of lateral surfaces.
3. To acquire skills to interpret and convert multi-view drawings into single-view drawings and vice versa.
4. To understand and acquire basic skills in Computer-Aided Drafting.

| **2.** | **Course Outcomes:** |
|---|---|
| **CO1** | Students will be able to understand the conventions and standards for engineering drawing. |
| **CO2** | Students will be able to apply the knowledge of projections and methods to prepare the drawing for lines, planes, solids, sections of solids and development of lateral surfaces. |
| **CO3** | Students will be able to visualize and convert 2D to 3D drawing and vice versa. |
| **CO4** | Students will be able to understand and apply Computer Aided Drafting in real practice |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| Introduction to BIS SP-46-2003, Use of various drawing instruments, Concept of scales, Representative Fraction (RF) and dimensioning. | | CO1 | 01 |
| Conversion of Pictorial views to orthographic/ profile views | | CO3 | 02 |
| Projections of points, lines, plane on principle planes/Profile planes. | | CO2 | 03 |
| Projection of right regular solids inclined to both the planes. Section and development of surfaces of solids. (Preferably in normal position/ Inclined to one plane). | | CO2 | 03 |
| Drawing isometric views and projection from orthographic projection. | | CO3 | 02 |

| | | |
|---|---|---|
| Introduction to Computer Aided Drafting (CAD)- Basic commands for Setting, Drawing, Editing, Writing, Dimensioning and other features. | CO4 | 02 |

| 4. | **Text books** |
|---|---|

i) Bhatt, N. D., Panchal, V. M., & Ingle, P. R., *Engineering Drawing (Plane and Solid Geometry)*, 53rd Edition, Charotar Publishing House Pvt. Limited, 2013, ISBN 978-93-80358-83-3.

ii) Dhananjay, A. J., *Engineering Drawing: With An Introduction To Auto Cad*. Tata McGraw-Hill Education Private Limited, 2010, ISBN 978-0-07-064837-1.

| 5. | **Reference Book(s) and Other Required Material** |
|---|---|

i) Engineering Drawing Practices for School & Colleges SP46:2003, Bureau of Indian Standards, 2003, ISBN 81-7061-019-2

ii) Kuthe A.M., Computer Graphics including CAD, AutoCAD & C, 1st Edition, S.Chand, 2005, ISBN 9788121924610.

iii) Zeid I., CAD / CAM Theory & Practice, 3rd Edition, Tata McGraw-Hill, 1991, ISBN-0070728577.

| 6. | **Evaluation Details:** |
|---|---|

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %

b) Teacher Defined Assessment: 20 %

c) End Semester Exam: 50-60 %

| 7. | **Relationship of Course Outcomes to Program Outcomes:** |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | 1 | 2 | 1 | 3 | 1 | 3 | 3 | 3 | 2 |
| CO2 | 2 | 2 | 2 | 1 | 3 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO3 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO4 | 2 | 2 | 2 | 2 | 3 | 1 | 2 | 2 | 3 | 3 | 3 |
| CO5 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 2 | 3 | 3 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | **List of Indicative Laboratory Experiment (if applicable):** |
|---|---|

| Course Code & Course Title: | AMLA101 - ENGINEERING MECHANICS | | |
|---|---|---|---|
| Course Type: | ES | | |
| Name of the programme(s): | B. Tech. in Mechanical Engineering | | |
| L – T – P | 3-0-0 | No. of Credits | 03 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

To expose the students to the basic concepts of mechanics such as force, moment, static equilibrium, etc. to analyse basic force systems, and introduce basic concept of stress and strain.

| 2. | Course Outcomes: |
|---|---|
| CO1 | Knowledge of basic theory and principles of forces and their engineering applications. |
| CO2 | Knowledge of equilibrium of structures. |
| CO3 | Ability to draw internal forces for beams with various boundary conditions under given set of loading. |
| CO4 | Knowledge of the concepts of stresses and strains and their importance for engineering analysis and design. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| Topics | | CO(s) Addressed | Duration in weeks |
| **Force Systems and Equilibrium:** 2-D Force System, Moment of a Force about a Point and about an Axis; Free Body Diagram, Reactions at Supports, Equilibrium of Planar Force System, Friction: inclined plane, wedge, ladder friction, Analysis of Statically Determinate Systems i.e. Beams and Trusses | | CO1 | 04 |
| **Properties of Area:** First (Centroid) and Second Moment of Areas, Parallel Axis Theorem, Perpendicular Axis Theorem | | CO2 | 02 |
| **Internal Forces in Member:** Determination of variation of Axial force (Axial Force Diagram), Shear Force (Shear Force Diagram), Bending Moment (Bending Moment Diagram) | | CO3 | 02 |
| **Concept of Stress and Strain:** Normal and Shear Stress and Strain, State of Stress at a Point, Stress Strain Curve, Hook's Law, | | CO2 | 04 |

| | | |
|---|---|---|
| Modulus of Elasticity, Poisson's Ratio, Modulus of Rigidity, Bulk Modulus, Thermal Stresses, Shear Stress and Bending Stress for Rectangular Section, Stresses in Circular shafts due to Torsion. | | |
| **Work and Energy:** Virtual Work and Potential Energy Principles | CO4 | 02 |

| **4.** | **Text books** |
|---|---|

i. Beer, F. P., Johnston, E. R., Jr., Cornwell, P. J., Mazurek, D. F., & Sanghi, S., Vector Mechanics for Engineers: Statics and Dynamics. 10th ed., McGraw-Hill Education, 2019.

ii. Beer, F.P., Johnston, E.R., DeWolf, J.T., and Mazurek, D.F., Mechanics of Materials. 6th ed., McGraw-Hill, 2012

| **5.** | **Reference Book(s) and Other Required Material** |
|---|---|

i. Hibbeler, R. C. Engineering Mechanics. 7th ed., Pearson Education, 2004.

ii. Meriam, J. L., and L. G. Kraige. Engineering Mechanics: Dynamics. 7th ed., John Wiley & Sons, 2012.

iii. Popov, E. P. Engineering Mechanics of Solids. Prentice Hall, 1990.

iv. Pytel, Andrew, and Ferdinand L. Singer. Strength of Materials. Harper & Row Publishers, 1987.

v. Shames, I. H. Engineering Mechanics: Statics and Dynamics. Pearson Education Asia Pvt. Ltd., 1996.

vi. Timoshenko, S. Strength of Materials, Part 1: Elementary Theory and Problems. CBS Publishers and Distributors, 2021.

| **6.** | **Evaluation Details:** |
|---|---|

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %
b) Teacher Defined Assessment: 20 %
c) End Semester Exam: 50-60 %

| **7.** | **Relationship of Course Outcomes to Program Outcomes:** |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | 2 | | | 1 | | | 2 | | | 1 | 2 | 1 | |
| CO2 | 2 | 1 | 1 | 1 | 1 | 1 | | | 2 | | | 2 | 2 | 2 | |
| CO3 | 2 | 2 | 1 | 1 | 1 | 1 | | | 2 | | | 1 | 1 | 1 | |
| CO4 | | | | | | 1 | | 1 | 1 | 2 | | 3 | 2 | 2 | |

*High - 3; Medium – 2; Low – 1;*

| **8.** | **List of Indicative Laboratory Experiment (if applicable):** |
|---|---|

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **CHPA102 – CHEMISTRY** | | |
| **Course Type:** | **BS** | | |
| **Name of the programme(s):** | **B. Tech.** | | |
| **L – T – P** | **0-0-2** | **No. of Credits** | **1** |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objectives:** |
|---|---|

i) To develop skills and capabilities of students in applying knowledge of chemistry for practically solving real life problems.
ii) Provide thorough understanding of the subject as many experiments are based on theory course.

| **2.** | **Course Outcomes:** |
|---|---|
| **CO1** | Knows the proper procedures and regulations for safe handling and use of chemicals, and can follow the proper procedures and regulations for the safe handling when using chemicals. |
| **CO2** | Are able to design, carry out, record and analyze the results of chemical experiments. Are skilled in problem solving, critical thinking and analytical reasoning. |
| **CO3** | Ability to use modern instrumentation for chemical analysis and measurements. |
| **CO4** | Are able to communicate the results of their work to chemists and non-chemists. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| **Water and waste water analysis:** Determination of<br>i. Hardness<br>ii. Alkalinity<br>iii. Dissolved oxygen and free chlorine<br>iv. Chloride, fluorides and COD<br>v. Trace metal in water using Ion –selective electrodes, arsenic, lead, mercury | | CO1, CO2, CO4 | 3 |
| Determination of capacity of ion exchange resin | | CO1, CO2, CO4 | 1 |
| **Analysis of ores and alloys:**<br>i. Determination of copper in brass<br>ii. Calcium in limestone and dolomite. | | CO1, CO2, CO4 | 2 |

| | | |
|---|---|---|
| **Demonstration experiments on instrumental methods of analysis:**<br>i. pH-metric and conductometric titration<br>ii. Colorimetric determination<br>iii. Turbidity by nephelometer<br>iv. Flame photometry<br>v. Flashpoint of lubricants<br>vi. Viscosity of lubricants<br>vii. Calorific value of solid fuels<br>viii. Proximate analysis of coal | CO1, CO2, CO3, CO4 | 4 |
| **Chemical kinetics / Adsorption:**<br>**i.** Determination of rate constant.<br>**ii.** Verify Freundlich Adsorption isotherm (study adsorption of acetic acid on activated charcoal) | CO1, CO2, CO4 | 2 |
| Synthesis of paracetamol and aspirin, and its characterization. | CO1, CO2, CO4 | 2 |

## 4. Text books

i) Dara, S.S. and S.S. Umare, A Text Book on Experiments and calculations in Engineering Chemistry (Ninth edition); S. Chand, 2015. ISBN-13: 978-8121908641

## 5. Reference Book(s) and Other Required Material

i) Shashi Chawla, Essentials of Experimental Engineering Chemistry, (Fourth Edition); Dhanpat Rai & Co. ISBN: 9788177000160.

## 6. Evaluation Details:

Continuous Evaluation: 100 Marks *(Till Mid Term: 60 Marks, Till End Term: 40 Marks)*

## 7. Relationship of Course Outcomes to Program Outcomes:

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | 1 | 2 | 2 | 1 | 1 | - | 1 |
| CO2 | 3 | 2 | 2 | 3 | 1 | 1 | 2 | 2 | 1 | 1 | - |
| CO3 | 2 | 1 | 2 | 3 | 1 | 1 | - | - | 1 | - | 1 |
| CO4 | 1 | 1 | 1 | 1 | 1 | - | 1 | 1 | 2 | 1 | 1 |

*High - 3; Medium – 2; Low – 1;*

## 8. List of Indicative Laboratory Experiment (if applicable):

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEPA102 - ENGINEERING DRAWING** | | |
| **Course Type:** | **ES** | | |
| **Name of the programme(s):** | **B. Tech** | | |
| **L – T – P** | **0-0-2** | **No. of Credits** | **01** |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i. To understand the principles and methods of projections as per the National Standards.

ii. To develop the visualization skills for the interpretation of the use of various objects like lines, planes, solids, sections of solids and the development of lateral surfaces.

iii. To acquire skills to interpret and convert multi-view drawings into single-view drawings and vice versa.

iv. To understand and acquire basic skills in Computer-Aided Drafting.

| **2.** | **Course Outcomes:** |
|---|---|
| **CO1** | Students will be able to understand the conventions and standards for engineering drawing. |
| **CO2** | Students will be able to apply the knowledge of projections and methods to prepare the drawing for lines, planes, solids, sections of solids and development of lateral surfaces. |
| **CO3** | Students will be able to visualize and convert 2D to 3D drawing and vice versa. |
| **CO4** | Students will be able to understand and apply Computer Aided Drafting in real practice. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| Introduction to BIS SP-46-2003. Explanation of various drawing instruments, symbols, dimensioning, line types, concept of scales and Representative Fraction (RF). | | CO1 | 02 |
| Conversion of pictorial views to orthographic / profile views. | | CO3 | 01 |
| Projections of points and lines | | CO2 | 01 |
| Projections of planes | | CO2 | 01 |
| Projections of solids. | | CO2 | 01 |
| Section and development of solids. | | CO2 | 02 |
| Isometric Projections | | CO3 | 01 |
| Computer Aided Drafting (CAD) assignments. | | CO4 | 02 |

| 4. | Text books |
|---|---|

i) Bhatt, N. D., Panchal, V. M., & Ingle, P. R., *Engineering Drawing (Plane and Solid Geometry)*, 53rd Edition, Charotar Publishing House Pvt. Limited, 2013, ISBN 978-93-80358-83-3.

ii) Dhananjay, A. J., *Engineering Drawing: With An Introduction To Auto Cad*. Tata McGraw-Hill Education Private Limited, 2010, ISBN 978-0-07-064837-1.

| 5. | Reference Book(s) and Other Required Material |
|---|---|

i) Engineering Drawing Practices for School & Colleges SP46:2003, Bureau of Indian Standards, 2003, ISBN 81-7061-019-2

ii) Kuthe A.M., Computer Graphics including CAD, AutoCAD & C, 1st Edition, S.Chand, 2005, ISBN 9788121924610.

iii) Zeid I., CAD / CAM Theory & Practice, 3rd Edition, Tata McGraw-Hill, 1991, ISBN-0070728577.

| 6. | Evaluation Details: |
|---|---|

**Evaluation Weightage (%)**

a) Continuous Evaluation - I 30-35 %
b) Continuous Evaluation - II 30-40 %
c) Continuous Evaluation - III 25-40 %

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | 1 | 2 | 1 | 3 | 1 | 3 | 3 | 3 | 2 |
| CO2 | 2 | 2 | 2 | 1 | 3 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO3 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO4 | 2 | 2 | 2 | 2 | 3 | 1 | 2 | 2 | 3 | 3 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment: |
|---|---|

1. Orthographic Projection of objects
2. Projection of points and lines
3. Projections of planes
4. Projection of regular solids
5. Projection of sections of a solid
6. Development of the lateral surfaces of a solid
7. Isometric projection of objects.
8. Orthographic projections using AutoCAD.
9. Isometric Projections using AutoCAD.

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **AMPA101 - ENGINEERING MECHANICS** | | |
| **Course Type:** | **ES** | | |
| **Name of the programme(s):** | **B.Tech. in Mechanical Engineering** | | |
| **L – T – P** | **0-0-2** | **No. of Credits** | **1** |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

To expose the students to simple practical experiments based on fundamental concept of mechanics

| **2.** | **Course Outcomes:** |
|---|---|
| **After completion of this course, student shall acquire:** | |
| **CO1** | Knowledge of experimental verification of laws of mechanics. |
| **CO2** | Knowledge and ability to compare theoretical results with the experimental one. |
| **CO3** | Knowledge of frictional resistance between two surface and ability to determine coefficient of friction. |
| **CO4** | Knowledge of mechanical properties of metals and ability to obtain the same through experiment. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics (Any Eight)** | | **CO(s) Addressed** | **Duration in weeks** |
| Introduction to Engineering Mechanics | | CO1 | 1 |
| Proving the Law of Polygon of Forces | | CO1, CO2 | 1 |
| Verification of Lami's Theorem | | CO1, CO2 | 1 |
| Determination of forces in truss members by analytical and experimentally | | CO2 | 1 |
| Determination of Reactions of a Simply Supported Beam | | CO1, CO2 | 1 |
| Determination of Coefficient of Static Friction | | CO3 | 1 |
| Determination of centroid of Planar Figures | | CO1, CO2 | 1 |
| Tension Test on Metal Specimen | | CO1, CO4 | 1 |
| Bending Test on Wooden Beam | | CO1, CO4 | 1 |
| Shear test on metal specimen | | CO1, CO4 | 1 |

| 4. | Text books |
|---|---|

i. Beer, F. P., Johnston, E. R., Jr., Cornwell, P. J., Mazurek, D. F., & Sanghi, S., Vector Mechanics for Engineers: Statics and Dynamics. 10th ed., McGraw-Hill Education, 2019.

ii. Beer, F.P., Johnston, E.R., DeWolf, J.T., and Mazurek, D.F., Mechanics of Materials. 6th ed., McGraw-Hill, 2012

iii. Hibbeler, R. C. Engineering Mechanics. 7th ed., Pearson Education, 2004.

| 5. | Reference Book(s) and Other Required Material |
|---|---|

i. Meriam, J. L., and L. G. Kraige. Engineering Mechanics: Dynamics. 7th ed., John Wiley & Sons, 2012.

ii. Popov, E. P. Engineering Mechanics of Solids. Prentice Hall, 1990.

iii. Pytel, Andrew, and Ferdinand L. Singer. Strength of Materials. Harper & Row Publishers, 1987.

iv. Shames, I. H. Engineering Mechanics: Statics and Dynamics. Pearson Education Asia Pvt. Ltd., 1996.

v. Timoshenko, S. Strength of Materials, Part 1: Elementary Theory and Problems.

| 6. | Evaluation Details: |
|---|---|

**Evaluation Weightage (%)**

a) Continuous Evaluation - I 30-35 %
b) Continuous Evaluation - II 30-40 %
c) Continuous Evaluation - III 25-40 %

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | 2 | | | 1 | | | 2 | | | 1 | 2 | 1 | |
| CO2 | 2 | 1 | 1 | 1 | 1 | 1 | | | 2 | | | 2 | 2 | 2 | |
| CO3 | 2 | 2 | 1 | 1 | 1 | 1 | | | 2 | | | 1 | 1 | 1 | |
| CO4 | | | | | | 1 | | 1 | 1 | 2 | | 3 | 2 | 2 | |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): NA |
|---|---|

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEPA103 - WORKSHOP** | | |
| **Course Type:** | **DC** | | |
| **Name of the programme(s):** | **B. Tech.** | | |
| **L – T – P** | **0-0-4** | **No. of Credits** | **2** |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

The objectives of the course are

i. To make the students aware with various skills involved in basic engineering processes for manufacturing and assembly.

ii. To make students aware of various basic engineering processes like cutting, filing and joining and to have hands on experience for the same.

| **2.** | **Course Outcomes:** |
|---|---|
| **CO1** | Acquire skills in basic engineering practice. |
| **CO2** | Identify the hand tools and instruments. |
| **CO3** | Gain measuring skills. |
| **CO4** | Obtain practical skills in the various trades. |
| **CO5** | Enhance psycho motor skills and attitude |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| **Fitting:** Use and setting of fitting tools for chipping, cutting, filing, and marking, center punching, drilling, and tapping. Term work to include one job involving following operations: Filing to size, drilling and tapping. | | CO1 to CO5 | 02 |
| **Carpentry:** Use and setting of hand tools like hacksaws, Jack planes, chisels and gauges for construction of various joints, wood turning and modern wood turning methods. Term work to include one carpentry job involving a joint and report on demonstration of a job involving wood turning. | | CO1 to CO5 | 02 |

| | | |
|---|---|---|
| **Welding:** Use and setting of tools and equipments for edge preparation for welding jobs and Arc welding for Jobs like, Lap welding of two plates, butt welding of plates. | CO1 to CO5 | 02 |
| **Machining:** At least one metal turning job is to be demonstrated. | CO1 to CO5 | 01 |
| **CNC Machines:** One job on CNC Lathe and CNC Milling machine to be demonstrated. | CO1 to CO5 | 01 |
| **Foundry:** At least one demonstration of mould making. | CO1 to CO5 | 01 |
| **Sheet Metal Working:** Use and setting of tools like Shears, Stakes, Hammers, Snips, Punches, Riveting gun etc. and equipments for sheet metal working. At least one job/demonstration of making of an article from surface development drawings. | CO1 to CO5 | 01 |
| **Plumbing:** Use and setting of hand tools like hacksaws, Vices, V blocks, Taps, Tap wrenches, Pipe Course Book First Year B. Tech. (2024-2025) wrenches, Pipe threading dies, pipe bending dies, Pipe cutters, callipers etc for plumbing works. At least one job/ demonstration involving threading and joining of pipes. | CO1 to CO5 | 01 |
| **Assembly:** Using and setting various workshop tools like spanners, wrenches, screw drivers, torque wrenches, hammers, and pliers etc. to assemble and disassemble an engineering system (e.g. bicycle, etc.). At least one job/ demonstration of assembly/ disassembly of an engineering system. | CO1 to CO5 | 01 |

| **4.** | **Text books** |
|---|---|


i. Hajra Choudhury, S. K., Hajra Choudhury, A. K., & Roy, Nirjhar, *Elements of Workshop Technology (Volume I: Manufacturing Processes)*, 14th (or 16th revised) Edition, Media Promoters & Publishers (Mumbai, India), 2008 (revised); ISBN 978-8185099149.

ii. Hajra Choudhury, S. K., Hajra Choudhury, A. K., & Roy, Nirjhar, *Elements of Workshop Technology (Volume II: Machine Tools)*, 16th Edition (Revised & Enlarged), Media Promoters & Publishers Pvt. Limited, 2014, ISBN 978-8185099156


| **5.** | **Reference Book(s) and Other Required Material** |
|---|---|


i. Chapman, W. A. J., *Workshop Technology, Part I: Theoretical and Practical Workshop Technology*, 5th Edition, CBS Publishers & Distributors, 2001, ISBN 978-81-239-0401-6.

ii. Chapman, W. A. J., *Workshop Technology, Part II: Machine-Shop Practice and Workshop Calculations*, 3rd Edition, Edward Arnold (Publishers) Ltd., 1997, ISBN 978-0713134893.

iii. Chapman, W. A. J., *Workshop Technology, Part III: Special Workshop Practice*, 3rd Edition, Edward Arnold (Publishers) Ltd., 1961, ISBN 978-0713134992.

| 6. | Evaluation Details: |
|---|---|

**Evaluation Weightage (%)**

a) Continuous Evaluation - I 30-35 %
b) Continuous Evaluation - II 30-40 %
c) Continuous Evaluation - III 25-40 %

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 2 | 1 | 1 | 2 | 2 | 2 | 3 | 2 | 2 | | | |
| CO2 | 3 | 1 | 2 | 1 | 1 | 2 | 2 | 2 | 3 | 2 | 2 | | | |
| CO3 | 3 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 3 | 2 | 1 | | | |
| CO4 | 3 | 1 | 2 | 1 | 1 | 3 | 2 | 2 | 3 | 2 | 1 | | | |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

# Semester II

| Course Code & Course Title: | PHL1XX – PHYSICS FOR MECHANICAL ENGINEERING | | |
|---|---|---|---|
| Course Type: | BS | | |
| Name of the programme(s): | B Tech | | |
| L – T – P | 3-0-0 | No. of Credits | 3 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) To provide a strong foundation in physics in preparation for technical or scientific career.
ii) To develop skills that enables to function as productive, qualified engineering professionals in areas where traditional science and engineering disciplines overlap.
iii) Create awareness of the importance of continued professional development.

| 2. | Course Outcomes:<br>Student will be able to understand, apply and analyze: |
|---|---|
| CO1 | The concepts of quantum mechanics and its application |
| CO2 | Primitive crystal systems through packing density and Miller indices. |
| CO3 | The concepts of semiconductors based on band theory |
| CO4 | The physics of electronic devices |
| CO5 | The basics of LASERs and its applications, understanding of optical fibers |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| Topics | | CO(s) Addressed | Duration in weeks |
| **Quantum Mechanics:** Origin of quantum mechanics, Compton effect, Concept of matter waves, Davission and Germer's experiment, Heisenberg's Uncertainty principle, Schrodinger's Wave equation and its application and Quantization of energy | | CO1 | 8 |
| **Elementary crystal structure**: Unit cell and its characteristics in SC, BCC, FCC crystal structure, Miller indices, Bragg's Law, inter-planer spacing | | CO2 | 6 |
| **Semiconductor Physics:** Formation of energy bands in solid, classification of solids: intrinsic and extrinsic semiconductor, Fermi level in an intrinsic and extrinsic semiconductor, Hall effect | | CO3 | 9 |

| | | |
|---|---|---|
| **Device Physics:** V-I characteristics of p-n junction diode, zener diode, photo diode, LED, BJT, FET and MOSFET | CO4 | 8 |
| **LASER Optics**: Introduction to LASER, Spontaneous and Stimulated Emission, Different types of CW & Pulse lasers & their characteristics, Principle & characteristics of optical fibers, Different types of optical fibers | CO5 | 8 |

## 4. Text books

i) M N Avadhanulu, P. Kshirsagar, A Textbook of Engineering Physics, 2017, S Chand Publications ISBN 13: 9789352833993

## 5. Reference Book(s) and Other Required Material

i) A.J. Dekker, Solid State Physics, MacMillan, Student Edition (2000) ISBN-13. 9780333918333

ii) B.B. Laud, Lasers and nonlinear optics, New Age International limited (1991). ISBN-13. 978-9393159670.

iii) B. G. Streetman, Solid State Electronics, Prentice Hall India (2nd Edition) (1986) ISBN-13. 978-0134363790

iv) David J. Griffiths, Introduction to Quantum Mechanics, Cambridge India (2016) ISBN-13. 978-1107179868

v) Kenneth Krane; Modern Physics, John Wiley Eastern (2nd Edition); (1998) ISBN-13, 978-0471828723

vi) Resnick, Walker and Halliday, Fundamental of Physics, John Willey and Sons. Inc, 6th Edition (2005). ISBN · 9788126508235

vii) S.M. Sze Semiconductor devices (Physics and Technology), II Edition, Wiley India Pvt. Ltd. ISBN-13. 978-0470873670

## 6. Evaluation Details:

Mid Sem: 30 Marks,

End Sem: 50 Marks,

Quiz/Internal assessment: 20 Marks

## 7. Relationship of Course Outcomes to Program Outcomes:

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | | | | | | | | | | | |
| CO2 | 3 | 2 | 2 | | | | | | | | | | | |
| CO3 | 3 | 2 | 2 | | | | | | | | | | | |
| CO4 | 3 | 2 | 2 | | | | | | | | | | | |
| CO5 | 3 | 2 | 2 | | | | | | | | | | | |

*High - 3; Medium – 2; Low – 1;*

## 8. List of Indicative Laboratory Experiment (if applicable):

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MAL211: COMPLEX VARIABLES, INTEGRAL TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS** | | |
| **Course Type:** | **BS** | | |
| **Name of the programme(s):** | **B. Tech.** | | |
| **L – T – P** | **3-1-0** | **No. of Credits** | **4** |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

The objective of this subject is to expose students to understand the importance of complex variables. It also focuses on partial differential equations and its applications in science and engineering.

| **2.** | **Course Outcomes:** |
|---|---|
| **CO1** | Analyse complex variable function's continuity, differentiability, analyticity and can compute complex integrals. |
| **CO2** | know the fundamentals of Laplace transform, inverse Laplace transform and its properties. Apply the Laplace transform techniques to solve ordinary differential equations. |
| **CO3** | understand the fundamental of Fourier series expansion and Fourier transform. Explore the properties of Fourier series & Fourier transform and its applications in Science and Engineering. |
| **CO4** | expose the concepts of the solutions to the PDE over the bounded domain. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| | **Topics** | **CO(s) Addressed** | **Duration in weeks** |
| | **Complex Variable:** Functions of a complex variable - continuity, differentiability, analyticity. Zeros of an analytic function – singularities, Residue, Cauchy's residue theorem, complex integration - Cauchy's integral theorem (statement only), Cauchy's integral formula (statement only), Taylor's theorem - Laurent's theorem (statement only), contour integration. | CO1 | 4 |
| | **Laplace Transforms**: Definition of Laplace Transforms, Linearity property, condition for existence of Laplace transform, first and second shifting properties, transforms of derivatives and integrals, evaluation of integrals by Laplace transform. Inverse Laplace transform, convolution | CO2 | 3 |

| | | |
|---|---|---|
| theorem, Laplace transform of periodic functions, unit step function and Dirac delta function. Applications of Laplace transform to solve ordinary differential equations. | | |
| **Fourier Series and Fourier Transforms**: Fourier series, half range Sine and Cosine series expansions, exponential form of Fourier series. Fourier integral theorem, Fourier transform, Fourier Sine and Cosine Transforms, Linearity, scaling, frequency shifting and time shifting properties, convolution theorem. | CO3 | 3 |
| **Partial Differential Equations**: Classification of linear second order PDEs, method of separation of variables, Solution of One-dimensional wave equation, heat equation, Laplace equation (Cartesian and polar forms). | CO4 | 4 |

| **4.** | **Text books** |
|---|---|

i) J.W. Brown and R.V. Churchill, Complex Variables and Applications, McGraw Hill, 9th Edition, 2009, ISBN-13. 978-0073383170.

ii) R.K. Jain, and S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publishers, 2005, ISBN-13. 978-8184875607.

iii) E. Kreyszig, Advanced Engineering Mathematics, John Wiley publications, 10th Edition, 2011, ISBN: 978-0-470-45836-5.

| **5.** | **Reference Book(s) and Other Required Material** |
|---|---|

i) E.T. Copson, Theory of Complex Variables, Oxford University Press,1988.

| **6.** | **Evaluation Details** |
|---|---|

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %

b) Teacher Defined Assessment: 20 %

c) End Semester Exam: 50-60 %

| **7.** | **Relationship of Course Outcomes to Program Outcomes:** |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | | | | | | | | |
| CO2 | 3 | 2 | 1 | | | | | | | | |
| CO3 | 3 | 2 | 1 | | | | | | | | |
| CO4 | 3 | 2 | 1 | | | | | | | | |

*High - 3; Medium – 2; Low – 1;*

| **8.** | **List of Indicative Laboratory Experiment (if applicable): NA** |
|---|---|

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **CSL101 - COMPUTER PROGRAMMING** | | |
| **Course Type:** | **ES** | | |
| **Name of the programme(s):** | **B.Tech.** | | |
| **L – T – P** | **3-0-2** | **No. of Credits** | **4** |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

To develop students' proficiency in structured programming using C by teaching them essential constructs (variables, data types, operators, I/O, control flow), foundational problem-solving algorithms, modular and structured data handling (arrays, functions, structures), and basic file operations—empowering them to design, implement, and debug efficient, maintainable programs for real-world computational tasks.

| **2.** | **Course Outcomes:** |
|---|---|
| **CO1** | Remember and understand the fundamental programming constructs—such as program structure, data types, operators, expressions, and formatted I/O |
| **CO2** | Implement computational logic using decision structures and loops to solve problem |
| **CO3** | Analyze and modularize solutions using arrays, strings, and user-defined functions (including recursion) to implement algorithms |
| **CO4** | Apply and design structured data and persistent storage solutions by using C structures (including nested and arrays of structs) and basic file-handling operations (text and binary I/O). |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|

| | **Topics** | **CO(s) Addressed** | **Duration in weeks** |
|---|---|---|---|
| 1 | Introduction: Fundamentals of Computer programming, Program development and execution, basics of algorithms and flow charts and the software development lifecycle. | CO1 | 1.5 |
| **2** | Basic constructs of C programming: Structure of Programs, Keywords and Identifiers, Variables and Data Types, Operators | CO1 | 1.5 |

| | | | |
|---|---|---|---|
| | and Expressions (Precedence and Associativity, Type Conversions), Formatted Input/Output. | | |
| **3** | Control Flow: Decision Making and Branching (if, if-else), Loops (while, for). Algorithms such as swapping two variables, reversing digits, character-to-number conversion, generating primes, GCD, smallest divisor, factorial, and Fibonacci generation through loops, nested-loop pattern printing. | CO1, CO2 | 3 |
| 4 | Data Organization & Modularity: Arrays and Strings (1-D arrays, 2-D arrays, basic string operations), Functions (user-defined functions, scope and lifetime of variables, recursive functions); Algorithms like array reversal, finding maximum number in a set, factorial computation, fibonacci sequence generation, reversing the digits of an integer; sorting and searching techniques and comparison. | CO3 | 3 |
| 5 | Composite Data Types: structures, defining struct types, declaring instances, accessing members using the dot operator, memory layout and padding. Array of Structures: Declaring arrays whose elements are structures; Nested Structures: Embedding one struct type within another (either defined separately or inline), accessing nested members. | CO4 | 3 |
| 6 | File handling: Opening and creating files, Closing files, Text file reading, Text file writing, Binary file reading, Binary file writing. | CO4 | 2 |

| **4.** | **Text books (Theory and Practical):** |
|---|---|

i) The C Programming Language by Brian Kernighan and Dennis Ritchie. ISBN:9780131101630

ii) How to Solve It by Computer by R. G. Dromey. ISBN-13. 978-8120303881

| **5.** | **Reference Book(s) and Other Required Material** |
|---|---|

i) Algorithms in C by Robert Sedgewick ISBN-13:9780-0201314526

ii) Algorithms (4th Edition) by Robert Sedgewick & Kevin Wayne ISBN-13: 978-0321573513

iii) Introduction to Algorithms (commonly known as *CLRS*) by Cormen, Leiserson, Rivest & Stein ISBN-13: 978-0262033848

| **6.** | **Evaluation Details:** |
|---|---|

Mid Sem: 25 Marks, End Sem: 50 Marks, Quiz/Internal assessment: 10 Marks, Continuous Evaluation-I (Pr.): 7.5 Marks and Continuous Evaluation-II (Pr.): 7.5, Total 100 Marks,

| **7.** | **Relationship of Course Outcomes to Program Outcomes:** |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | | 2 | | 2 | | | 1 | 2 | | | 1 | | 2 |
| CO2 | 3 | 2 | 3 | | 1 | | 1 | 2 | | 2 | 2 | 3 | 2 | 3 |
| CO3 | 2 | 1 | 2 | 2 | 3 | 1 | | 3 | | | 3 | 2 | 1 | 2 |
| CO4 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 2 |

| 8. | **List of Indicative Laboratory Experiment (if applicable):** |
|---|---|

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **EEL1XX - ELECTRICAL ENGINEERING** | | |
| **Course Type:** | **ES** | | |
| **Name of the programme(s):** | **B.Tech.** | | |
| **L – T – P** | **3-0-0** | **No. of Credits** | **3** |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) To learn basic ideas and principles of Electrical Engineering

ii) Understanding the details of electrical machines.

| **2.** | **Course Outcomes: Students will be able to** |
|---|---|
| **CO1** | Understand the basics of electrical components and power system. |
| **CO2** | Calculate DC, AC, and magnetic circuits parameters using KCL and KVL. |
| **CO3** | Determine performance parameters of transformers. |
| **CO4** | Evaluate performance of electrical machines. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| **Electrical Circuits:** Circuit elements: resistance, inductance, and capacitance; voltage and current sources, definition, ideal and practical sources, source conversions, Kirchhoff's Laws and star-delta transformation. | | CO1 | 2 |
| **Magnetic Circuits:** Flux, MMF, reluctance; analogy with electric circuits; simple calculations for composite magnetic circuits. | | CO1 | 2 |
| **AC Circuits:** Periodic signals, average and R.M.S. values, phasor representation, steady-state analysis of ac circuits with sinusoidal excitation, reactance and impedance, series and parallel AC circuits, power factor, active, reactive and apparent power, series and parallel resonance, principle of generating single-phase and three-phase voltages, Balanced three-phase AC systems: Voltages, currents, and powers in star and delta connected load. | | CO2 | 3.5 |
| **Single phase Transformers:** Construction, types, basic principles, EMF equation, ideal and practical transformers, equivalent circuits, voltage regulation, and efficiency. | | CO3 | 2.5 |

| | | |
|---|---|---|
| **DC Motors:** Construction, types, applications, significance of Back EMF, Speed and Torque equations, speed control, and need of motor starter. | CO4 | 1.5 |
| **Induction Motors**: Three-phase induction motor—construction, types, applications, revolving magnetic field, principle of operation, synchronous speed, rotor speed, slip, power flow diagram, torque equation, and T-s characteristics. Block diagram of induction motor drive. Single-phase induction motors— principle of operation, types and applications. | CO4 | 1.5 |
| Introduction to Generation, Transmission and Distribution of Electricity | CO1 | 1 |

## 4. Textbooks


i) D. C. Kulshreshtha, Basic Electrical Engineering, Second Edition, McGraw-Hill, 2019, ISBN: 9353167213.

ii) S.K. Bhattacharya , Basic Electrical and Electronics Engineering, Second Edition, Pearson Education, 2017, ISBN: 9789332586505.


## 5. Reference Book(s) and Other Required Material


i) Edward Hughes, Electrical and Electronic Technology, Tenth Edition, Pearson Education, 2010, ISBN: 9788131733660.

ii) Kothari D.P. and Nagrath I.J., Basic Electrical Engineering, Fourth Edition, McGraw-Hill, 2019, ISBN: 9353165725.

iii) N. K. De, G. D. Roy, T. K. Bhattacharya, IIT Kharagpur, Basic Electrical Technology, Web course of NPTEL


## 6. Evaluation Details

Mid Sem: 20-30 Marks,

End Sem: 50-60 Marks,

Quiz/Internal assessment: 10-20 Marks,

Total 100 Marks

## 7. Relationship of Course Outcomes to Program Outcomes:

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 1 | 1 | 1 | | | 1 | 2 | | 3 |
| CO2 | 2 | 2 | 1 | 1 | 1 | | | 1 | 2 | | 3 |
| CO3 | 3 | 2 | 1 | 1 | 1 | | | 1 | 2 | | 3 |
| CO4 | 3 | 2 | 1 | 1 | 1 | | | 1 | 2 | | 3 |

## 8. List of Indicative Laboratory Experiment (if applicable):

| Course Code & Course Title: | ICL1XX - ENVIRONMENTAL STUDIES | | |
|---|---|---|---|
| Course Type: | IC | | |
| Name of the programme(s): | B. Tech | | |
| L – T – P | 2 – 0 - 0 | No. of Credits | 02 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) To introduce various natural resources, their importance and status.
ii) To introduce the concepts of ecosystem, their structure and functions.
iii) To introduce the concept of biodiversity conservation.
iv) To introduce possible causes of various forms of environmental pollution and their consequences, methods of prevention.
v) To introduce various social and climatic changes due to pollution

| 2. | Course Outcomes |
|---|---|
| CO1 | Understand about various natural resources, their importance and status. |
| CO2 | Understand the concepts of ecosystem and biodiversity, their structure, functions and conservation. |
| CO3 | Understand the causes of various forms of environmental pollution and their consequences, and methods of prevention. |
| CO4 | About the various changes in social and climate due to pollution and population and the environment. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| Topics | | CO(s) Addressed | Duration in weeks |
| **Natural resources:** Forest resources, Water resources, Mineral resources, Food resources, Energy resources, Land resources. | | CO1 | 04 |
| **Ecosystem:** Concept of an ecosystem, Structure and functions of an ecosystem, Producers, consumers and decomposers, Food chain, food webs and pyramids.<br>**Biodiversity and its conservation:** Introduction, definitions: genetics, species and diversity, Value of biodiversity, Biodiversity at global, national and local level, India as a mega-diversity nation, Hot-spot of | | CO2 | 03 |

| | | |
|---|---|---|
| biodiversity, Threat to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, Conservation of biodiversity: in-situ and ex-situ conservation. | | |
| **Environmental pollution:** Definition, Causes, effects and control measures of: Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards, Solid waste management: Causes, effects and control measures of urban and industrial wastes. | CO3 | 06 |
| **Social issues and environment:** Sustainable development, Water conservation, Rain water harvesting, Watershed management, Climate change, Global warming, Acid rain, Ozone layer depletion, Nuclear accident, Environmental rules and regulations.<br>**Human population and environment:** Population growth, Environment and human health, Human rights, Value education, Role of information technology in environment and human health. | CO4 | 02 |

| 4. | **Text books** |
|---|---|

i) Rajgopalan R., Environmental Studies, 3rd Edition, Oxford University Press, 2023. ISBN: 13. 9789354978944

ii) Benny Joseph, Environmental Studies, 3rd Edition, McGraw Hill, 2017. ISBN: 10. 9352605179

iii) Erach Barucha, Environmental Studies, 3rd Edition, Universities press (India), 2025, ISBN: 9789389211788

| 5. | **Reference Book(s) and Other Required Material** |
|---|---|

i) Rao M.N. and Rao H.V.N., Air Pollution, 1st Edition, McGraw-Hill Publishing Company Limited, 2007. ISBN: 13, 978-0074518717.

ii) Rao C.S., Environmental Pollution Control Engineering, 3rd Edition, Wiley Eastern Limited, New Age International Limited, 1995. ISBN: 13. 978-9386649898.

| 6. | **Evaluation Details:** |
|---|---|

a) Mid Term Examination: 30 Marks
b) Continuous Assessment (Seminars): 10 Marks
c) End Term Examination: 60 Marks
Total Marks: 100

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 3 | 1 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO2 | 3 | 1 | 3 | 1 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO3 | 3 | 1 | 3 | 1 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO4 | 3 | 1 | 3 | 1 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Course Code & Course Title: | PHP1XX - PHYSICS LAB FOR MECHANICAL ENGINEERING | | |
|---|---|---|---|
| Course Type: | BS | | |
| Name of the programme(s): | B. Tech. | | |
| L – T – P | 0-0-2 | No. of Credits | 1 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

1. The Objective of this course is to make the students gain practical knowledge to co-relate with the theoretical studies.
2. To achieve perfectness in experimental skills and the study of practical applications will bring more confidence and ability to develop and fabricate engineering and technical equipment.
3. Design of circuits using new technology and latest components and to develop practical applications of engineering materials and use of principle in the right way to implement the modern technology.

| 2. | Course Outcomes: |
|---|---|
| CO1 | Demonstrate experimental skills, analyze and interpret the results obtained. |
| CO2 | Acquire written communication skill to write reports of experiments performed in the lab. |
| CO3 | Understand basic concepts of Physics and develop oral communication skills. |
| CO4 | Enhance understanding of concepts in physics by performing practicals. |
| CO5 | Function effectively as an individual and as a member of a team. |

| 3. | Detailed Description of the Course: | | |
|---|---|---|---|
| List of experiments | | CO(s) Addressed | Duration in weeks |
| 1. To study the characteristics of Photocell and to determine the work function of the cathode material.<br>2. To calibrate an electromagnet and to study the dependence of Hall voltage on magnetic field and current through the sample.<br>3. To study the I/P, O/P and transfer characteristics and to determine 'α' of transistor in common base mode. | | | |

| | | |
|---|---|---|
| 4. To study I-V characteristics of conventional p-n junction diode and Zener diode<br>5. To determine the energy band gap in a semiconductor using reverse biased p-n junction diode.<br>6. Study of voltage regulation using Zener diode.<br>7. Study of output characteristics and transfer characteristics of FET.<br>8. To determine numerical aperture of the optical fibers<br>9. To determine wavelength of He-Ne LASER | | |

## 4. Text books

i) M N Avadhanulu, P. Kshirsagar, A Textbook of Engineering Physics, 2017, S Chand Publications ISBN 13: 9789352833993

## 5. Reference Book(s) and Other Required Material

i) A.J. Dekker, Solid State Physics, MacMillan, Student Edition (2000) ISBN-13. 9780333918333

ii) B.B. Laud, Lasers and nonlinear optics, New Age International limited (1991). ISBN-13. 978-9393159670.

iii) B. G. Streetman, Solid State Electronics, Prentice Hall India (2nd Edition) (1986) ISBN-13. 978-0134363790

iv) David J. Griffiths, Introduction to Quantum Mechanics, Cambridge India (2016) ISBN-13. 978-1107179868

v) Kenneth Krane; Modern Physics, John Wiley Eastern (2nd Edition); (1998) ISBN-13, 978-0471828723

vi) Resnick, Walker and Halliday, Fundamental of Physics, John Willey and Sons. Inc, 6th Edition (2005). ISBN · 9788126508235

vii) S.M. Sze Semiconductor devices (Physics and Technology), II Edition, Wiley India Pvt. Ltd. ISBN-13. 978-0470873670

## 6. Evaluation Details:

**Evaluation Weightage (%)**

a) Continuous Evaluation - I 30-35 %
b) Continuous Evaluation - II 30-40 %
c) Continuous Evaluation - III 25-40 %

## 7. Relationship of Course Outcomes to Program Outcomes:

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | | | | | | 1 | 1 | | | | |
| CO2 | 3 | 2 | 2 | | | | | | 1 | 1 | | | | |
| CO3 | 3 | 2 | 2 | | | | | | 1 | 1 | | | | |
| CO4 | 3 | 2 | 2 | | | | | | 1 | 1 | | | | |
| CO5 | 3 | 2 | 2 | | | | | | 1 | 1 | | | | |

*High - 3; Medium – 2; Low – 1;*

## 8. List of Indicative Laboratory Experiment (if applicable):

| Course Code & Course Title: | EEP1XX - ELECTRICAL ENGINEERING | | |
|---|---|---|---|
| Course Type: | ES | | |
| Name of the programme(s): | B.Tech. | | |
| L – T – P | 0-0-2 | No. of Credits | 1 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) To verify basic ideas and principles of various Electrical Circuits.

ii) Understanding the principle and operation of electrical machines.

| 2. | Course Outcomes: Students will be able to |
|---|---|
| CO1 | Understand behaviour of R, L, C circuit elements, voltage and current sources. |
| CO2 | Appreciate and analyse magnetic circuits. |
| CO3 | Familiar with various machines operations |
| CO4 | Verify various parameters of three phase circuits. |

| 3. | Detailed Description of the Course | |
|---|---|---|
| Topics (List of Experiments) | CO(s) Addressed | Duration in Weeks |
| 1. Study and verification of Kirchhoff's Laws applied to direct current circuit. | CO1 | 1 |
| 2. Determination of B-H curve of a magnetic material | CO2 | 1 |
| 3. Study of AC series circuits. | CO1 | 1 |
| 4. Study of AC Parallel circuits. | CO1 | 1 |
| 5. To determine Voltage regulation and efficiency of a single-phase transformer by direct loading. | CO3 | 1 |
| 6. Reversal of direction of rotation of a three-phase induction motor. | CO3 | 1 |
| 7. To study balanced three phase circuit- star connection. | CO4 | 1 |
| 8. To study balanced three phase circuit- delta connection. | CO4 | 1 |
| 9. Speed control of a DC motor by varying:-<br>a. Field current with armature voltage kept constant | CO3 | 1 |

| | | |
|---|---|---|
| b. Armature voltage with field current kept constant. | | |
| 10. Assessment 1 + Assessment 2 + Quiz / Viva | All COs | 5 |

| 4. | Textbooks |
|---|---|

i) B.S. Umre and D. P. Kothari, Laboratory Manuals for Electrical Machines, 2nd Edition, I. K. International, 2018, ISBN: 978-93-85909-75-7

ii) S. G. Tarnekar and P. K. Kharbanda, Laboratory Courses in Electrical Engineering, 3rd Edition, S. Chand, ISBN: 9788121901048.

| 5. | Reference Book(s) and Other Required Material |
|---|---|

i) D. C. Kulshreshtha, Basic Electrical Engineering, Second Edition, McGraw-Hill, 2019, ISBN: 9353167213.

ii) P. Tiwari & S. Gairola, Electrical Engineering Laboratory Practice, First Edition, S.K. Kataria & Sons, 2012, ISBN: 978-81-89757-89-2.

| 6. | Evaluation Details: |
|---|---|

Continuous Evaluation, Total 100 Marks

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | | 2 | 1 | 2 | | 3 | 3 | | 2 |
| CO2 | 3 | 1 | | 2 | 1 | 2 | | 3 | 3 | | 2 |
| CO3 | 2 | | 2 | 2 | 1 | 2 | | 3 | 3 | | 2 |
| CO4 | 2 | | 2 | 2 | 1 | 2 | | 3 | 3 | | 2 |

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

# Semester III

| Course Code & Course Title: | MELA201: MANUFACTURING PROCESS-I | | |
|---|---|---|---|
| Course Type: | DC | | |
| Name of the programme(s): | B. Tech. Mechanical Engineering | | |
| L – T – P | 3-0-0 | No. of Credits | 3 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) Able to understand the behavior and properties of materials as they are affected by manufacturing processes.
ii) Able to apply knowledge of manufacturing processes and the skills to develop and manipulate the operating parameters for a given process.
iii) Able to examine the principles associated with basic operations involving the forming and welding of engineering materials.
iv) Able to analyze the basic processes used in mechanical working of metals and welding operations on engineering materials.

| 2. | Course Outcomes |
|---|---|
| CO1 | Explain the fundamental principles, terminology, materials, and operations involved in casting, moulding, mechanical working, and metal forming processes. |
| CO2 | Apply appropriate manufacturing processes for producing engineering components based on material and functional requirements. |
| CO3 | Analyze defects, limitations, and process parameters in casting, forging, welding, and forming operations to suggest suitable corrective measures or process improvements. |
| CO4 | Select and justify suitable manufacturing and joining processes for given engineering applications considering material properties, production volume, quality, and cost. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| Topics | | CO(s) Addressed | Duration in weeks |
| **Moulding & Casting:** Casting Processes, Pattern making, pattern materials, Types of pattern, Removable and disposable pattern, pattern allowances, color codes of pattern. Moulding Sands: Types of moulding sands, properties of moulding sand. Moulding: Types of Moulds, Tools used in moulding, Procedure for making moulds, Moulding process, Types of moulding operations. Cores: Properties of cores, types of cores, core making, chaplets. | | CO1, CO2 | 03 |

| | | |
|---|---|---|
| Casting: Elements of gating system, Types of gating, risering, Melting and pouring of metals, Melting Furnaces: Electric arc furnace, Cupola furnace, Induction furnace, oil fired tilting furnace. Defects in sand casting: blowholes, shrinkage defect, hot tears. Mis-runs, cold shut, and pour short, Inclusions. Special casting processes: Plaster mould casting processes, shell moulding casting processes, permanent mould casting processes, die casting processes, continues casting processes, centrifugal casting processes, Advantages and limitations of casting processes, selection of casting process. CO2 moulding, Investment casting. | | |
| **Mechanical Working of Metals:** Hot rolling, hot spinning, wire drawing. Metal Forming Process: Rolling Processes, rolling operation, terminology used in rolling, rolling mills, thread rolling, Extrusion Process: Types of extrusion, extrusion pressure in direct and indirect extrusion. Forging Processes: Forging materials, classification of forging operations, types of forging operations. Power forging, Impression die forging, press forging, roll-die forging, and defects in forging, Rotary swaging. Defects in forging. Surface Coating of Metals: Cleaning methods of metals, buffing, and electroplating, anodizing, plastic coating. | CO1, CO3 | 03 |
| **Sheet Metal & Press Working:** Introduction, Punches and dies, sheet metal working operations: piercing and punching, blanking, notching, beading, flanging, hemming, seaming, perforating, slitting, lancing, mechanism of blanking, drawing, coining, embossing, wire drawing, metal spinning. Press working: Die cutting operation, classification, types of presses, press terminology, introduction to shaping operations, bending forming & drawing. | CO2, CO3 | 02 |
| **Applied Metallurgy**: Classification of materials, Classification and application of steels, Steel making process, Effect of alloying elements, Carbon steel, Tool steel, Mild Steel, Stainless Steel, Specification of some commonly used steels for Engineering applications, Cast iron & Non-ferrous alloys, Heat Treatment, annealing, normalizing, hardening, Powder metallurgy- mixing of powders, compaction, sintering, secondary operation, advantages and limitation of powder metallurgy. | CO2, CO3 | 02 |
| **Processing of Plastic**: Introduction, general properties and applications, types of plastic, thermosetting plastic, thermo-plastic plastics. Forms of raw plastic material: Powder form, laminated sheets and rods, fibers, resins, Methods of processing plastics: compression molding, injection molding, extrusion, Calendaring, wire drawing. | CO2, CO4 | 02 |
| **Joining Processes:** Introduction, classification of joining processes. Welding process: Types of welding processes, pre-welding requirements, and welding, welding technique, types of welding joints, edge preparation for welding, welding techniques. Arc welding: electron theory of arc | CO2, CO4 | 02 |

| | | |
|---|---|---|
| columns, arc-welding process, weld penetration, Gas welding: Gas welding process, Types of flames, fluxes, filler material. Resistance Welding: Spot welding, seam welding, Tungsten Inert Gas (TIG) welding, Metal Inert Gas welding (MIG). Soldering and brazing, Thermit welding. Mechanical Fasteners: Threaded fasteners, non-threaded fasteners. | | |

## 4. Text books

i) Rao, P. N., Manufacturing Technology: Metal Cutting and Machine Tools, 3rd Edition, McGraw Hill Education (India) Pvt. Ltd., 2013, ISBN: 978-1259006784.

ii) Ghosh, A., Malik, A. K., Manufacturing Science, 1st Edition, Affiliated East-West Press Pvt. Ltd., 2001, ISBN: 978-8176710466.

iii) Hajra Choudhury, H., Workshop Technology (Vol. I & II), 13th Edition, Media Promoters & Publishers Pvt. Ltd., 2010, ISBN: 978-8186735558.

iv) Kalpakjian, S., Schmid, S. R., Manufacturing Engineering and Technology, 4th Edition, Pearson Education Asia, 2000, ISBN: 978-0201361315

## 5. Reference Book(s) and Other Required Material

i) Krar, S. F., Oswald, J. W., Technology of Machine Tools, 1st Edition, McGraw Hill Book Company, New York, 1976, ISBN: 978-0070353572.

ii) Begeman, M. L., Amstead, B. H., Ostwald, P. F., Manufacturing Processes, 1st Edition, John Wiley & Sons / Texas Publication (commonly referenced), 1956, ISBN: 978-0471065999.

iii) HMT Ltd., Production Technology, 1st Edition, Tata McGraw Hill Publishing Company Ltd., 1980, ISBN: 978-0070964433.

iv) Bawa, H. S., Workshop Technology, 1st Edition, Tata McGraw Hill Publishing Company Ltd., 2001, ISBN: 978-0074630358.

v) Avner, S. H., Introduction to Physical Metallurgy, 2nd Edition, Tata McGraw Hill Publishing Company Ltd., 2001, ISBN: 978-0074624234.

## 6. Evaluation Details:

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %

b) Teacher Defined Assessment: 20 %

c) End Semester Exam: 50-60 %

## 7. Relationship of Course Outcomes to Program Outcomes:

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 3 | 3 | 1 | 1 |
| CO2 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 3 | 2 | 3 | 2 |
| CO3 | 3 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 |
| CO4 | 3 | 1 | 1 | 2 | 1 | 2 | 2 | 1 | 2 | 1 | 3 | 3 | 2 | 2 |

*High - 3; Medium – 2; Low – 1;*

## 8. List of Indicative Laboratory Experiment (if applicable):

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MELA202: ENGINEERING THERMODYNAMICS** | | |
| **Course Type:** | **DC** | | |
| **Name of the programme(s):** | **B. Tech. Mechanical Engineering** | | |
| **L – T – P** | **3-1-0** | **No. of Credits** | 4 |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) To introduce the basic fundamental terms like properties, state, process, system etc. and laws of thermodynamics

ii) To understand the concepts of energy transformation/ conversion such as heat into work

iii) To be acquainted with the understanding the heat engines, entropy and its calculations

iv) To understand the behaviour of pure substance and analyse the power cycles

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Able to understand the fundamental of the first and second laws of thermodynamics and their application to a wide range of thermal systems. |
| **CO2** | Able to analyze the work and heat interactions associated with a prescribed process path, and to perform a first law analysis of a flow system. |
| **CO3** | Able to evaluate entropy changes in a wide range of processes and determine the reversibility or irreversibility of a process from such calculations. |
| **CO4** | Able to use and apply volume-temperature and pressure- volume phase diagrams and the steam tables in the analysis of engineering devices and systems. |
| **CO5** | Familiar with formulation of the fundamental of the vapour power cycles, air standard cycles and their applications. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| | **Topics** | **CO(s) Addressed** | **Duration in weeks** |
| | **Basic Concepts**<br>Introduction to Thermodynamics, Basic concept of thermodynamics, Closed and open systems, Forms of energy, Properties of system, State and equilibrium, processes and cycles, Temperatures and Zeroth law of thermodynamics. Introduction to First law of Thermodynamics (Law of conservation of Energy), Heat and work, Mechanical forms of work, non- | CO1, CO2 | 02 |

| | | |
|---|---|---|
| mechanical forms of work (Electrical, Magnetic etc.), Ideal gas equation of states, Difference between Gas and vapor, compressibility Factor, Internal energy and specific heats of gases, Universal Gas constant. | | |
| **First Law of Thermodynamics**<br>First Law of thermodynamics, closed system (control mass system), work done, change in Internal energy, heat transferred during various thermodynamic processes, P-V diagrams. Open system (control mass system), Thermodynamic analysis of control volume Conservation of energy principle, flow work and enthalpy. The steady flow process applied to (i) Nozzles and Diffuser (ii) Turbines and Compressor, (iii) Throttle valve Unsteady flow process (Simple system like Charging & Discharging of tanks) | CO1, CO2 | 03 |
| **Second Law of Thermodynamics**<br>Second law of Thermodynamics Introduction (Law of degradation of Energy) Thermal Energy reservoir, Kelvin-Plank and Clausius Statement, Heat engine, Refrigerator and Heat pump, Perpetual motion machines, Reversible and Irreversible processes, Carnot cycle, Thermodynamic temperature scale. Entropy: The Clausius inequality, Entropy Principle of increase of entropy, Change in entropy for Closed and steady flow open systems. Second law analysis of engineering system, Availability, reversible work and Irreversibility. | CO1, CO3 | 03 |
| **Properties of Steam**<br>Critical state, sensible heat, Latent heat, Super Heat, Wet Steam, Dryness fraction, Internal energy of steam External work done during evaporation, T-S diagram Mollier Chart. Work and heat transfer during various thermodynamic processes with steam as working fluid Determination of dryness fraction using various calorimeters. | CO4 | 02 |
| **Air Standard Cycle**<br>Air standard cycle: Otto cycle Sterling and Ericsson cycle, Brayton cycle Vapor cycle: Simple and Modified Rankine cycle with reheat and regeneration. | CO5 | 02 |
| **I.C. Engines and Compressors**<br>Introduction to Internal combustion engine e.g. Two stroke, Four stroke cycle, engine components, their comparison, Wankel engine, and their efficiencies, Introduction to Single stage reciprocating compressor and its efficiencies | CO5 | 02 |

| 4. | Text books |
|---|---|

i) Nag, P. K., Engineering Thermodynamics, 7th Edition, Tata McGraw Hill Education (India) Pvt. Ltd., 2025, ISBN: 978-9355324894.

ii) Joel, R., Engineering Thermodynamics, 5th Edition, Addison Wesley Longman Ltd., 1999, ISBN: 978-0582236066.

iii) Arora, C. P., Thermodynamics, Tata McGraw Hill Education (India) Pvt. Ltd., 2017, ISBN: 978-1259006791.

| 5. | Reference Book(s) and Other Required Material |
|---|---|

i) Çengel, Y. A., Boles, M. A., Thermodynamics: An Engineering Approach, 7th Edition, Tata McGraw Hill Education (India) Pvt. Ltd., 2017, ISBN: 978-9339219895.

| 6. | Evaluation Details: |
|---|---|

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %

b) Teacher Defined Assessment: 20 %

c) End Semester Exam: 50-60 %

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | - | - | - |
| CO2 | 1 | 0 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | - | - |
| CO3 | 2 | 3 | 3 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 2 | 2 | - | - |
| CO4 | 2 | 2 | 2 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 1 | - |
| CO5 | 1 | 2 | 2 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 2 | 1 | - | - |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MELA203: THEORY OF MACHINE – I** | | |
| **Course Type:** | **DC** | | |
| **Name of the programme(s):** | **B. Tech. Mechanical Engineering** | | |
| **L – T – P** | **3-1-0** | **No. of Credits** | 4 |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) The objective of this course is to introduce students to the fundamental principles of kinematics and mechanisms used in machines.

ii) The course aims to develop the ability to analyze motion, velocity, and acceleration characteristics of mechanical systems and to understand the functioning of commonly used machine elements and mechanisms

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Understand basic concepts of kinematics, links, pairs, and mechanisms used in machines. |
| **CO2** | Analyze displacement, velocity, and acceleration of planar mechanisms using graphical and analytical methods. |
| **CO3** | Apply kinematic principles to study cams, followers, gears, and gear trains. |
| **CO4** | Evaluate motion transmission characteristics in mechanical systems such as linkages and mechanisms. |
| **CO5** | Develop problem-solving skills related to kinematic analysis of machines. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| **Basics:** Basic concepts of mechanisms, links, kinematic pairs, kinematic chain, mechanisms and machines. Types of mechanisms. Degree of freedom of link and planar mechanisms. | | CO1 | 2 |
| **Analysis of Mechanisms:** Classification of four-bar chain (Class I and Class II). Inversion of four-bar chain, slider crank chain and double slider crank chain with gross motion analysis. Velocity and acceleration analysis of planar mechanisms by graphical method using relative velocity and acceleration. Concept of velocity and acceleration images. Coriolis component of acceleration. Instantaneous centre of velocity method. | | CO1, CO5 | 3 |

| | | |
|---|---|---|
| **Synthesis of Mechanisms:** Synthesis of four-bar and slider-crank mechanisms for gross motion. Input–output coordination and quick return ratio. Transmission angle. | CO2, CO5 | 2 |
| **Cam Mechanisms:** Types of cams and followers and their applications. Synthesis of cam for different follower motions such as constant velocity, parabolic motion, SHM and cycloidal motion. Construction of eccentric cam, tangent cam and circular arc cam. Analysis of follower motion for cams with specified contours like eccentric, tangent and circular arc cams. | CO3 | 2 |
| **Gears:** Types of gears and gear tooth terminology. Concept of conjugate action and law of gearing. Kinematics of involute gear tooth pairs during contact. Number of pairs of teeth in contact, path of approach and path of recess. Interference and undercutting in involute profile teeth. Introduction to cycloidal profile. Types of gear trains. Kinematic analysis of gear trains including simple epicyclic and double epicyclic gear trains. | CO3 | 2 |
| **Friction Devices:** Ratio of belt tensions and initial tension for flat and V-belts. Theory of friction. Efficiency and torque required to raise and lower load in nut and screw mechanisms. Types of brakes and braking torque relations. Dynamometers. Types of pivots and clutches along with torque transmission relations. | CO4 | 2 |
| **Friction Devices:** Ratio of belt tensions and initial tension for flat and V-belts. Theory of friction. Efficiency and torque required to raise and lower load in nut and screw mechanisms. Types of brakes and braking torque relations. Dynamometers. Types of pivots and clutches along with torque transmission relations. | CO4 | 2 |

## 4. Text books


i) Shigley, J. E., Uicker, J. J., *Theory of Machines and Mechanisms*, 1st Edition, McGraw-Hill International, 1985, ISBN: 978-0070569324.

ii) Bevan, T., *Theory of Machines*, 3rd Edition, CBS Publishers & Distributors, 1984, ISBN: 978-8123900179.

iii) Rao, J. S., Dukkipati, R. V., *Mechanism and Machine Theory*, 2nd Edition, New Age International Publishers, 1998, ISBN: 978-8122404265.


## 5. Reference Book(s) and Other Required Material


i) Ghosh, A., Mallik, A. K., *Theory of Mechanisms and Machines*, 3rd Edition, Affiliated East-West Press Pvt. Ltd., 1998, ISBN: 978-8176710817.

ii) Rattan, S. S., *Theory of Machines*, 2nd Edition, Tata McGraw Hill Education, 1995, ISBN: 978-0074630464.

iii) Sandor, G. N., Erdman, A. G., *Advanced Mechanism Design: Analysis and Synthesis*, 1st Edition, Prentice Hall Publications, 1984, ISBN: 978-0130116840.

| 6. | Evaluation Details: |
|---|---|

**Evaluation is continuous. Components are**

a) Mid Semester Examination: Conducted after 40% syllabus completion, Weightage: 20–30%

b) Teacher Defined Assessment: Includes assignments, tutorials, quizzes, tests, presentations, etc. Must consist of minimum two components- One before Mid-Sem, One after Mid-Sem, Weightage: 20%

c) End Semester Examination: Comprehensive exam covering full syllabus, Weightage: 50–60%

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | – | – | – | – | – | – | – | – | 2 | 2 | 1 |
| CO2 | 3 | 3 | 2 | 2 | – | – | – | – | – | – | – | 3 | 2 | 1 |
| CO3 | 2 | 3 | 3 | 2 | – | – | – | – | – | – | – | 3 | 3 | 1 |
| CO4 | 2 | 2 | 3 | 3 | – | – | – | – | – | – | – | 3 | 3 | 1 |
| CO5 | 2 | 2 | 2 | 3 | – | – | – | – | – | – | – | 2 | 2 | 1 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Course Code & Course Title: | MELA204: COMPUTATIONAL METHODS IN MECHANICAL ENGINEERING | | |
|---|---|---|---|
| Course Type: | DC | | |
| Name of the programme(s): | B. Tech. in Mechanical Engineering | | |
| L – T – P | 3-1-0 | No. of Credits | 4 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) Develop a foundation in numerical error analysis and the convergence of computational algorithms.

ii) Provide systematic tools for solving complex systems of linear and nonlinear algebraic equations.

iii) Equip students with techniques for data approximation, curve fitting, and interpolation of experimental results.

iv) Train students in numerical schemes for differentiation and integration where analytical solutions are unavailable.

v) Introduce computational approaches for solving ordinary and partial differential equations (ODEs/PDEs) relevant to mechanical systems.

| 2. | Course Outcomes |
|---|---|
| CO1 | Explain the trade-offs between accuracy, precision, and stability when choosing a numerical scheme for a specific engineering problem. |
| CO2 | Analyze sources of error to validate the reliability of numerical results in mechanical modeling. |
| CO3 | Formulate engineering problems into systems of equations and their solution |
| CO4 | Apply regression and interpolation techniques to characterize and approximate experimental data for engineering design. |
| CO5 | Apply Runge-Kutta and finite difference methods to solve dynamic systems governed by ordinary or partial differential equations. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| | **Topics** | **CO(s) Addressed** | **Duration in weeks** |
| | **Mathematical Modeling and Error Analysis**<br>Mathematical modeling of mechanical systems, conservation laws in engineering, significant figures, accuracy and precision, sources of numerical errors, truncation and round-off errors, Taylor series expansion, conditioning of problems, stability and convergence of numerical methods | CO1, CO3 | 1 |

| | | |
|---|---|---|
| **Roots of Equations**<br>Graphical methods, bracketing methods, open methods, roots of polynomials, roots of transcendental equations, systems of nonlinear equations, Newton–Raphson method for single and multiple equations, convergence behavior and failure modes | CO1, CO2 | 2 |
| **Linear Algebra and Eigenvalue Problems**<br>Mathematical background, systems of linear algebraic equations, Gauss elimination and pivoting, iterative methods for linear systems, matrix decomposition techniques, eigenvalue and eigenvector problems, physical interpretation in mechanical systems, special matrices arising in engineering applications, case studies | CO3 | 3 |
| **Curve Fitting and Approximation**<br>Least-squares regression, polynomial and non-polynomial fitting, interpolation techniques, errors in interpolation, Fourier approximation and spectral interpretation, engineering data fitting case studies | CO4 | 2 |
| **Numerical Differentiation and Integration**<br>Finite difference approximations, numerical differentiation, numerical integration techniques, accuracy and stability of integration schemes, integration of engineering equations, case studies from mechanics and heat transfer | CO1, CO2 | 3 |
| **Ordinary Differential Equations**<br>Initial value problems, Runge–Kutta methods, multi-step methods, stiffness in ODEs, explicit and implicit integration schemes, time-step selection, boundary value problems, eigenvalue problems, physical interpretation of solutions, engineering case studies.<br>Introduction to PDEs: Classification of PDEs, elliptic, parabolic and hyperbolic equations, physical origin in engineering problems | CO5 | 3 |

## 4. Text books


i) Strang, G., *Introduction to Linear Algebra*, 5th Edition, Wellesley-Cambridge Press, 2016, ISBN: 978-0980232776.

ii) Sastry, S. S., *Introductory Methods of Numerical Analysis*, 5th Edition, PHI Learning Pvt. Ltd., 2012, ISBN: 978-8120345928.

iii) Chapra, S. C., Canale, R. P., *Numerical Methods for Engineers*, 7th Edition, McGraw-Hill Education, 2015, ISBN: 978-0073397924.


## 5. Reference Book(s) and Other Required Material


i) Epperson, J. F., *An Introduction to Numerical Methods and Analysis*, 2nd Edition, John Wiley & Sons, 2013, ISBN: 978-1118367599.

ii) Butcher, J. C., *Numerical Methods for Ordinary Differential Equations*, 2nd Edition, John Wiley & Sons, 2008, ISBN: 978-0470753751.

| 6. | Evaluation Details: |
|---|---|

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %
b) Teacher Defined Assessment: 20 %
c) End Semester Exam: 50-60 %

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 1 | 2 |
| CO2 | 3 | 3 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 2 | 2 |
| CO3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 2 |
| CO4 | 2 | 2 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 |
| CO5 | 3 | 3 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 2 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Course Code & Course Title: | MELA205 SOLID MECHANICS | | |
|---|---|---|---|
| Course Type: | DC | | |
| Name of the programme(s): | B.Tech. in Mechanical Engineering | | |
| L – T – P | 3-0-0 | No. of Credits | 3 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) To introduce the fundamental concepts of stress, strain, and mechanical behavior of engineering materials under various loading conditions.

ii) To develop the ability to analyze stresses, deformations, and stability of structural and machine components subjected to axial, torsional, bending, and combined loads.

iii) To provide an understanding of stress transformation, principal stresses, and theories of failure for safe and reliable mechanical design.

iv) To familiarize students with deflection, buckling, and energy-based methods used in the analysis of elastic structures.

| 2. | Course Outcomes |
|---|---|
| CO1 | Explain the mechanical behavior of engineering materials using stress–strain relationships, elastic constants, hardness, toughness, and basic structure–property concepts. |
| CO2 | Analyze stresses and deformations in bars, shafts, and beams subjected to axial loading, torsion, bending, and transverse shear using classical solid mechanics principles. |
| CO3 | Evaluate combined stress states and determine principal stresses and maximum shear stresses using stress transformation techniques and Mohr's circle. |
| CO4 | Apply appropriate theories of failure to assess the safety of components made of ductile and brittle materials under combined loading conditions. |
| CO5 | Formulate mathematical models to compute beam deflections, column buckling loads, and strain energy using differential equations and energy-based methods. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| **Fundamentals of Materials and Mechanical Behavior**<br>Classification of engineering materials, crystalline nature of metals, concept of microstructure and qualitative structure: property relationship, engineering stress-strain curve and true stress-strain curve, elastic and plastic behavior of materials, Hooke's law, proportional limit, yield strength and ultimate tensile strength, ductility and brittleness, toughness and resilience, strain energy in elastic range, hardness as a mechanical property, Brinell Vickers and Rockwell hardness tests, qualitative correlation between hardness and strength, relevance of mechanical behavior in engineering design | | CO1 | 1 |
| **Stress, Strain and Elastic Constants**<br>Concept of normal and shear stress, direct and simple shear, strain and types of strain, Poisson's ratio, volumetric strain, elastic constants Young's modulus shear modulus and bulk modulus, relations between elastic constants, uniaxial stress-strain response, thermal strain and thermal stress, thermal stresses in statically determinate and indeterminate members | | CO2 | 1 |
| **Axial Loading of Bars**<br>Normal stress and deformation of axially loaded members, bars of uniform and varying cross section, stepped bars, composite bars, statically indeterminate axial members, temperature effects in axial members, strain energy in axially loaded bars | | CO2 | 1.5 |
| **Torsion of Circular Shafts**<br>Assumptions of torsion theory, derivation of torsion equation, torsional shear stress distribution, angle of twist, indeterminate shafts, torsion of solid and hollow circular shafts, composite shafts, power transmission by shafts, strength and rigidity criteria | | CO2 | 1 |
| **Pure Bending of Beams**<br>Types of beams and types of loading, shear force and bending moment diagrams for simple cases, theory of simple bending, assumptions of bending theory, derivation of bending equation, bending stress distribution, neutral axis, second moment of area, section modulus, flexural strength of beams, unsymmetrical bending of beams | | CO2 | 2 |
| **Transverse Shear Stress in Beams** | | CO2 | 1 |

| | | |
|---|---|---|
| Concept of transverse shear stress, derivation of shear stress formula, shear stress distribution in rectangular circular and I-sections, shear flow, shear center, significance of shear stress in beam design | | |
| **Combined Stresses and Stress Concentration**<br>Combined axial and bending stresses, combined bending and torsion in shafts, eccentric loading and stress distribution, introduction to stress concentration, causes of stress concentration, stress concentration factor, qualitative effect of geometry and material on stress concentration, need for stress concentration consideration in design | CO3 | 1 |
| **Plane Stress and Stress Transformation**<br>Plane stress concept and assumptions, plane stress state in thin members, stress components on an inclined plane, transformation of normal and shear stresses, principal stresses and principal planes, maximum (in-plane and absolute) shear stress, Mohr's circle for plane stress representation, physical interpretation of plane stress results. | CO3 | 1 |
| **Theories of Failure**<br>Failure modes in ductile and brittle materials, factor of safety, maximum principal stress theory, maximum principal strain theory, maximum shear stress theory (Tresca), distortion energy theory (von Mises), comparison and applicability of failure theories under plane stress conditions, application to simple combined stress states, case study. | CO4 | 1 |
| **Deflection of Beams**<br>Differential equation of elastic curve, slope and deflection of beams, Method of sections, Macaulay's method, area-moment method, deflection of beams under common loading conditions, indeterminate beams, significance of deflection limits in design. | CO5 | 1.5 |
| **Columns and Struts**<br>Short and long columns, slenderness ratio, Euler's buckling theory and assumptions, effective length and end conditions, critical buckling load, limitations of Euler theory, Johnson's parabolic formula, influence of material properties on buckling behavior | CO5 | 1 |
| **Energy Methods**<br>Strain energy due to axial load bending and torsion, resilience, Castigliano's theorem (introductory applications), deflection using energy methods for simple cases, suddenly applied and impact loads (introductory), relation between energy absorption and material toughness | CO5 | 1 |

| 4. | Text books |
|---|---|

i) Hibbeler, R. C., Mechanics of Materials, 10th Edition, Pearson Education, 2017, ISBN: 978-0134319650.

ii) Beer, F. P., Johnston, E. R., DeWolf, J. T., Mazurek, D. F., Mechanics of Materials, 7th Edition, McGraw Hill Education, 2015, ISBN: 978-0073398235.

iii) Gere, J. M., Goodno, B. J., Mechanics of Materials, 9th Edition, Cengage Learning, 2018, ISBN: 978-1337093347.

| 5. | Reference Book(s) and Other Required Material |
|---|---|

i) Popov, E. P., Mechanics of Materials, 2nd Edition, Prentice Hall, 1976, ISBN: 978-0135713563.

ii) Belyaev, N. M., Strength of Materials (Translated by N. K. Mehta), Mir Publishers, Moscow, 1979, ISBN: 978-5030006220.

iii) Shames, I. H., Introduction to Solid Mechanics, 2nd Edition, Prentice Hall of India (PHI), 1997, ISBN: 978-8120307858.

iv) Timoshenko, S. P., Young, D. H., Elements of Strength of Materials, 5th Edition, Princeton / East-West Press, 1968, ISBN: 978-0442040994

| 6. | Evaluation Details: |
|---|---|

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %

b) Teacher Defined Assessment: 20 %

c) End Semester Exam: 50-60 %

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO2 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 3 | 2 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEPA201: MANUFACTURING PROCESSES – I** | | |
| **Course Type:** | **DC** | | |
| **Name of the programme(s):** | **B. Tech. Mechanical Engineering** | | |
| **L – T – P** | **0-0-2** | **No. of Credits** | 1 |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) Impart knowledge of foundry and pattern making tools.
ii) Develop skills in green sand moulding.
iii) Train in arc and gas welding.
iv) Enable gas cutting practices.
v) Facilitate selection of shop-specific materials and tools.

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Identify and understand tools, joints, allowances, sands, furnaces, and patterns used in pattern making and foundry. |
| **CO2** | Demonstrate preparation of a green sand mould and basic pattern making practices. |
| **CO3** | Perform electric arc welding, gas welding, gas cutting following safety protocols. |
| **CO4** | Select appropriate foundry sands, welding methods, and tools based on material properties and application requirements. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| **Pattern Making Shop:**<br>1. Execute various joints used in carpentry.<br>2. Operate different wood working machines.<br>3. Use and handle various tools used in pattern making.<br>4. Apply various pattern allowances.<br>Practice and fabricate a pattern. | | CO1 | 04 |
| **Foundry Shop:**<br>1. Study of different furnaces (i.e. Cupola, Electric arc, Induction, Tilting etc.) | | | 04 |

| | | |
|---|---|---|
| 2. Identify and classify different types of patterns.<br>3. Identify and use of different types of Foundry tools.<br>4. Use of different types of moulding sands and identify their properties.<br>Practice of making green sand mould. | CO1, CO2 | |
| **Welding Shop:**<br>1. Perform manual metal arc welding, and demonstrate MIG and TIG welding processes.<br>2. Perform gas welding.<br>Perform gas cutting. | CO3, CO4 | 04 |

| 4. | **Text books** |
|---|---|

i) Rao, P. N., Manufacturing Technology: Metal Cutting and Machine Tools, 3rd Edition, McGraw Hill Education (India) Pvt. Ltd., 2013, ISBN: 978-1259006784.

ii) Ghosh, A., Malik, A. K., Manufacturing Science, 1st Edition, Affiliated East-West Press Pvt. Ltd., 2001, ISBN: 978-8176710466.

iii) Hajra Choudhury, H., Workshop Technology, 13th Edition, Media Promoters & Publishers Pvt. Ltd., 2010, ISBN: 978-8186735558.

iv) Kalpakjian, S., Schmid, S. R., Manufacturing Engineering and Technology, 4th Edition, Pearson Education Asia, 2000, ISBN: 978-0201361315.

| 5. | **Reference Book(s) and Other Required Material** |
|---|---|

i) Krar, S. F., Oswald, J. W., *Technology of Machine Tools*, 1st Edition, McGraw-Hill Book Company, New York, 1976, ISBN: 978-0070353572.

ii) Begeman, M. L., Amstead, B. H., Ostwald, P. F., *Manufacturing Processes*, 1st Edition, John Wiley & Sons, 1956, ISBN: 978-0471065999.

iii) HMT Ltd., *Production Technology*, 1st Edition, Tata McGraw-Hill Publishing Company Ltd., 1980, ISBN: 978-0070964433.

iv) Bawa, H. S., *Workshop Technology*, 1st Edition, Tata McGraw-Hill Publishing Company Ltd., 2001, ISBN: 978-0074630358.

v) Avner, S. H., *Introduction to Physical Metallurgy*, 2nd Edition, Tata McGraw-Hill Publishing Company Ltd., 2001, ISBN: 978-0074624234.

| 6. | **Evaluation Details:** |
|---|---|

Continuous evaluation based on job performance, practical involvement, journal submission, quizzes, assignment, viva-voce, etc.

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 2 | 2 | 2 | 1 | 1 |
| CO2 | 3 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 2 | 2 | 2 | 3 | 2 | 2 |
| CO3 | 3 | 1 | 2 | 1 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 3 | 2 | 2 |
| CO4 | 1 | 1 | 2 | 1 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Topics | Duration in weeks |
|---|---|
| **Pattern Making Shop:**<br>1. Execute various joints used in carpentry.<br>2. Operate different wood working machines.<br>3. Use and handle various tools used in pattern making.<br>4. Apply various pattern allowances.<br>Practice and fabricate a pattern. | 04 |
| **Foundry Shop:**<br>1. Study of different furnaces (i.e. Cupola, Electric arc, Induction, Tilting etc.)<br>2. Identify and classify different types of patterns.<br>3. Identify and use of different types of Foundry tools.<br>4. Use of different types of moulding sands and identify their properties.<br>Practice of making green sand mould. | 04 |
| **Welding Shop:**<br>1. Perform manual metal arc welding, and demonstrate MIG and TIG welding processes.<br>2. Perform gas welding.<br>Perform gas cutting. | 04 |

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEPA205 SOLID MECHANICS** | | |
| **Course Type:** | **DC** | | |
| **Name of the programme(s):** | **B.Tech. in Mechanical Engineering** | | |
| **L – T – P** | **0-0-2** | **No. of Credits** | 1 |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i. To acquaint students with laboratory experiments related to strength of materials/solid mechanics
ii. To develop the ability to experimentally determine material properties and structural response under various loads.
iii. To develop ability in measurement, instrumentation, and data analysis
iv. To demonstrate the connection between the solid mechanics theory and engineering.

| **2.** | **Course Outcomes:** |
|---|---|
| **CO1** | Determine the mechanical properties of materials through tensile, compressive, hardness, and impact tests. |
| **CO2** | Investigate the response of beams, shafts, springs, and columns under bending, torsion, stiffness, and buckling conditions. |
| **CO3** | Measure and interpret strain, deformation, and stress using strain gauges and related experimental tools. |
| **CO4** | Examine stress distribution phenomena using photoelasticity and identify shear center in structural sections. |
| **CO5** | Process laboratory data, validate theoretical relations, and communicate findings through structured technical reports. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| Tensile test on ductile and brittle materials | | CO1, CO5 | 1 |
| Compression test on ductile and brittle materials | | CO1, CO5 | 1 |
| Hardness test | | CO1, CO5 | 1 |
| Impact test | | CO1, CO5 | 1 |

| | | |
|---|---|---|
| Torsion test on circular shaft | CO2, CO5 | 1 |
| Bending test on simply supported beam | CO2, CO5 | 1 |
| Deflection of beams under point | CO2, CO5 | 1 |
| Load and UDL | CO2, CO5 | 1 |
| Spring stiffness test | CO2, CO5 | 1 |
| Buckling of columns | CO2, CO5 | 1 |
| Measurement of strain using strain gauges | CO3, CO5 | 1 |
| Photo elasticity to visualize stress concentration and principal stresses | CO4, CO5 | 1 |
| Determination of shear center | CO4, CO5 | 1 |

## 4. Text books


i) Hibbeler, R. C., Mechanics of Materials, 10th Edition, Pearson Education, 2017, ISBN: 978-0134319650.

ii) Beer, F. P., Johnston, E. R., DeWolf, J. T., Mazurek, D. F., Mechanics of Materials, 7th Edition, McGraw Hill Education, 2015, ISBN: 978-0073398235.

iii) Gere, J. M., Goodno, B. J., Mechanics of Materials, 9th Edition, Cengage Learning, 2018, ISBN: 978-1337093347.


## 5. Reference Book(s) and Other Required Material


i) Popov, E. P., Mechanics of Materials, 2nd Edition, Prentice Hall, 1976, ISBN: 978-0135713563.

ii) Belyaev, N. M., Strength of Materials (Translated by N. K. Mehta), Mir Publishers, Moscow, 1979, ISBN: 978-5030006220.

iii) Shames, I. H., Introduction to Solid Mechanics, 2nd Edition, Prentice Hall of India (PHI), 1997, ISBN: 978-8120307858.

iv) Timoshenko, S. P., Young, D. H., Elements of Strength of Materials, 5th Edition, Princeton / East-West Press, 1968, ISBN: 978-0442040994.


## 6. Evaluation Details:

**Evaluation Weightage (%)**

a) Continuous Evaluation - I 30-35 %
b) Continuous Evaluation - II 30-40 %
c) Continuous Evaluation - III 25-40 %

| 7 | **Relationship of Course Outcomes to Program Outcomes:** |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO2 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 3 | 2 |

*High - 3; Medium – 2; Low – 1;*

| 8. | **List of Indicative Laboratory Experiment (if applicable):** |
|---|---|

| **Topic** | **Duration in weeks** |
|---|---|
| 1. Tensile test on ductile and brittle materials | 1 |
| 2. Compression test on ductile and brittle materials | 1 |
| 3. Hardness test | 1 |
| 4. Impact test | 1 |
| 5. Torsion test on circular shaft | 1 |
| 6. Bending test on simply supported beam | 1 |
| 7. Deflection of beams under point | 1 |
| 8. Load and UDL | 1 |
| 9. Spring stiffness test | 1 |
| 10. Buckling of columns | 1 |
| 11. Measurement of strain using strain gauges | 1 |
| 12. Photo elasticity to visualize stress concentration and principal stresses | 1 |
| 13. Determination of shear center | 1 |

| Course Code & Course Title: | MEPA206: COMPUTER AIDED DRAFTING AND MODELLING | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B. Tech | | |
| L – T – P | 0-1-2 | No. of Credits | 2 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) Understand the basic structure and working of CAD systems
ii) Apply 3D modeling concepts to engineering components
iii) Create engineering drawings and design documentation
iv) Develop long-term CAD skills through hands-on, project-based learning.

| 2. | Course Outcomes |
|---|---|
| CO1 | Create accurate 2D and 3D drawings of engineering components using CAD |
| CO2 | Model assemblies and generate sectional views using CAD tools |
| CO3 | Produce standard design documentation suitable for manufacturing |
| CO4 | Demonstrate practical CAD proficiency through project-based learning |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| Topics | | CO(s) Addressed | Duration in weeks |
| Introduction to CAD Systems: Evolution from manual drafting to CAD. Components of a CAD system (hardware, software, input/output devices). Overview of CAD software interface and coordinate systems. Relevance of CAD in interdisciplinary engineering domains | | CO1 | 1 |
| Revision of Manual Drafting Concepts: Orthographic projection principles. First- angle and third-angle projections. Isometric projections and views. Transition from manual drafting to CAD environment. | | CO1 | 1 |
| Intersection of Solids: Types of solid intersections (prism–prism, cylinder–cylinder, cone–cylinder). Visualization techniques. Manual interpretation and CAD-based representation | | CO1 | 1 |

| | | |
|---|---|---|
| CAD Basics – 2D Drafting Tools: Drawing setup: units, limits, grids, layers. Basic drawing commands (line, circle, arc, polyline). Modify commands (trim, extend, offset, fillet, chamfer) | CO1 | 1 |
| Computer Aided Drafting of Engineering Curves: Construction of engineering curves using CAD, Involute, Cycloid, Helix. Applications of curves in engineering components. | CO1 | 1 |
| Drafting of Planes and Regular Solids: CAD drafting of planes. Regular solids, Prism, Pyramid, Cylinder, Cone. True shape and orientation using CAD tools. | CO1 | 1 |
| Advanced Solid Drafting: Frustum of cone and pyramid. Truncated solids. Visualization and dimensioning standards. | CO1, CO3 | 1 |
| Introduction to 3D Solid Modelling: Difference between wireframe, surface, and solid modelling. 3D coordinate systems. Feature-based modeling approach | CO2 | 1 |
| 3D Modelling of Regular Solids: Creation of 3D solids using Extrude, Revolve, Sweep, Loft, etc. Parametric modeling concepts. | CO2 | 1 |
| Modelling of Engineering Components: 3D modeling of simple mechanical components, Brackets, Flanges, Shafts, Housings. Design intent and feature sequencing. | CO2 | 1 |
| Computer Aided Assembly Modelling: Assembly constraints and relationships. Bottom-up and top-down assembly approaches. Interference and fit checking. | CO2, CO3 | 1 |
| Sectioning and Exploded Views: Full, half, and sectional views of assemblies. Exploded assembly views. Bill of Materials (BOM) generation. | CO3 | 1 |
| 2D Drawing Generation from 3D Models: Creation of orthographic views from solid models. Dimensioning and tolerancing standards. Title blocks, annotations, and drafting conventions. | CO3 | 1 |
| Project-Based Learning & Design Documentation: Mini project / case study (individual or group). Complete workflow with Problem definition, 3D modelling, Assembly, 2D drawings. Submission of design documentation. Presentation and peer review. | CO4 | 1 |

| 4. | **Text books** |
|---|---|


i) Goetsch, D. L., *Engineering Drawing with CAD Applications*, 1st Edition, McGraw-Hill Education, 1998, ISBN: 978-0028010441.

ii) Venugopal, K., Prabhu Raja, V., *Engineering Drawing and Design*, 1st Edition, New Age International Publishers, 2008, ISBN: 978-8122421934.

iii) Raghuwanshi, B. S., Deshmukh, S. K., *Computer Aided Engineering Drawing*, 1st Edition, Pearson Education India, 2009, ISBN: 978-8131720288.

| 5. | **Reference Book(s) and Other Required Material** |
|---|---|

i) Bhatt, N. D., Panchal, V. M., Engineering Drawing, 53rd Edition, Charotar Publishing House Pvt. Ltd., 2014, ISBN: 978-9380358963.

ii) Bethune, J. D., Engineering Design Graphics with CAD Applications, 1st Edition, Pearson Education, 2000, ISBN: 978-0139553127.

iii) Shah, M. B., Rana, B. C., Engineering Drawing with CAD Applications, 1st Edition, Pearson Education India, 2009, ISBN: 978-8131720318.

iv) AutoCAD / SolidWorks / Fusion 360 / Creo (any one)

v) NPTEL: Engineering Drawing with CAD

vi) Manufacturer tutorials & online CAD repositories

| 6. | **Evaluation Details:** |
|---|---|

| **Assessment Component** | **Weightage (%)** |
|---|---|
| Continuous Assessment (CAD exercises) | 20 |
| Mid-Semester Practical Exam | 20 |
| End-Semester Practical / Theory Exam | 30 |
| Project-Based Learning (Model + Drawings) | 20 |
| Viva-Voce / Presentation | 10 |
| **Total** | **100** |

| 7. | **Relationship of Course Outcomes to Program Outcomes:** |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | – | 3 | – | – | – | – | 1 | – | 3 | 2 | 3 |
| CO2 | 3 | 2 | 3 | – | 3 | – | – | – | 1 | 1 | – | 3 | 3 | 2 |
| CO3 | 2 | 2 | 3 | – | 3 | – | – | – | – | 2 | – | 2 | 3 | 3 |
| CO4 | 2 | 3 | 3 | 1 | 3 | – | – | – | 3 | 2 | 2 | 3 | 3 | 3 |
| CO5 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |

*High - 3; Medium – 2; Low – 1;*

| 8. | **List of Indicative Laboratory Experiment (if applicable):** |
|---|---|

# Semester IV

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEL202 FLUID MECHANICS** | | |
| **Course Type:** | **DC** | | |
| **Name of the programme(s):** | **B. Tech. in Mechanical Engineering** | | |
| **L – T – P** | **3-0-0** | **No. of Credits** | **3** |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) To understand fundamental principles of fluid mechanics.
ii) To analyze fluid flow problems using the principles of conservation of mass and momentum.
iii) To use potential flow theory to analyze and solve ideal fluid flow problems.
iv) To perform dimensional analysis and similitude for solving and modeling fluid mechanics problems.
v) To understand the fundamentals of laminar and turbulent boundary layers.

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Explain the fundamental principles of fluid mechanics. |
| **CO2** | Analyze fluid flow systems using conservation of mass and momentum principles. |
| **CO3** | Employ potential flow concepts to determine flow characteristics of ideal fluids. |
| **CO4** | Perform dimensional analysis and similitude to model. |
| **CO5** | Explain the fundamentals of laminar and turbulent boundary layers |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| **Introduction:** Continuum concept, properties of fluids, Newtonian and Non-Newtonian fluids. | | CO1 | 01 |
| **Fluid Statics:** Pascal's law, hydrostatic pressure, Forces on plane and curved surfaces, centre of pressure, equilibrium of submerged and floating bodies, buoyancy, metacentric height, Fluids subjected to constant linear acceleration and to constant rotation. | | CO1 | 02 |
| **Kinematics of Fluid:** Types of flow, Lagrangian and Eulerian approach, Continuity equation, stream line, stream function, and potential function; Deformation of fluid elements, vorticity and circulation. | | CO1, CO2 | 01 |

| | | |
|---|---|---|
| **Dynamics of Inviscid Flow:** Reynolds transport theorem; Conservation equations of mass, and momentum, Euler and Bernoulli equations; Forces due to fluid flow over flat plates, curved vanes and in the bends, applications of Bernoulli equation. | CO1, CO2 | 02 |
| **Dynamics of Viscous Flow:** Reynold's experiment, laminar and turbulent flow, plane Poiseuille flow, Couette flow, Hagen-Poiseuille flow; Friction factor and Moody's diagram, losses in pipes and pipe fittings; Pipes in series and parallel; Flow over aerofoil, lift and drag, flow separation. | CO2, CO5 | 02 |
| **Ideal Fluid Flow:** Ideal flow identities, flow over half body, Rankine oval, stationary and rotating cylinders, Magnus effect, d'Alembert's paradox. | CO3 | 02 |
| **Dimensional Analysis:** Basic and derived quantities, similitude and dimensional analysis, Buckingham $\pi$-theorem, non-dimensional parameters, model testing. | CO4 | 01 |
| **Flow Measurement:** Flow measuring devices, Pitot tube, obstruction flow meters, principles of hot-wire anemometry and particle image velocimetry. | CO4 | 01 |
| **Compressible Flow:** Propagation of sound waves, Mach number, isentropic flow and stagnation properties, one dimensional convergent-divergent nozzle flow, normal shock. | CO1, CO2 | 02 |

## 4. Text books

i) Som, S. K., Biswas, G., Chakraborty, S., *Introduction to Fluid Mechanics and Fluid Machines*, 3rd Edition, McGraw Hill Education (India) Pvt. Ltd., 2017, ISBN: 978-9339221645.

ii) Munson, B. R., Young, D. F., Okiishi, T. H., Rothmayer, A. P., *Fundamentals of Fluid Mechanics*, 7th Edition, John Wiley & Sons, 2013, ISBN: 978-1118116135.

## 5. Reference Book(s) and Other Required Material

i) White, F. M., *Fluid Mechanics*, 8th Edition, McGraw Hill Education, 2016, ISBN: 978-0073398273.

ii) Schlichting, H., Gersten, K., *Boundary-Layer Theory*, 8th Edition, McGraw Hill, 2000, ISBN: 978-3540662709.

## 6. Evaluation Details:

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %

b) Teacher Defined Assessment: 20 %

c) End Semester Exam: 50-60 %

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 2 | 2 | 2 |
| CO2 | 3 | 3 | 3 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 3 | 2 | 3 |
| CO3 | 3 | 3 | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 1 | 1 |
| CO4 | 3 | 3 | 2 | 2 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 2 | 2 |
| CO5 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 2 | 2 | 2 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEL 301: THEORY OF MACHINE – II** | | |
| **Course Type:** | **DC** | | |
| **Name of the programme(s):** | **B. Tech. in Mechanical Engineering** | | |
| **L – T – P** | **3-0-0** | **No. of Credits** | **3** |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) The objective of this course is to introduce the principles of machine dynamics, including inertia forces, balancing, flywheel dynamics, gyroscopic effects, and vibration of mechanical systems.

ii) The course aims to develop analytical skills required to study dynamic behavior and stability of machines

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Understand static force relationships, inertia forces, and their effects in machine elements. |
| **CO2** | Analyze the dynamics and motion of flywheels and gyroscopic systems in machines. |
| **CO3** | Perform balancing of rotating and reciprocating masses and analyze vibration characteristics and critical speeds of mechanical systems. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| Machine Dynamics: Concepts of machine element dynamics, D'Alembert's principle, inertia forces, unbalance forces and moments in rotor–disc assemblies, static and dynamic balancing using analytical and graphical methods, field balancing using vector diagrams and influence coefficient method. | | CO1 | 3 |
| Balancing of Reciprocating Masses: Dynamic force analysis of reciprocating mechanisms, primary and secondary inertia forces, balancing of inertia forces in single-cylinder and multi-cylinder engines, balancing in reciprocating machines such as punching presses, selection of flywheel inertia parameters. | | CO2, CO3 | 3 |
| Balancing of Multi-cylinder Engines and Gyroscopic Effects: Balancing of inertia forces and couples in multi-cylinder engines, selection of firing order and crank diagrams, analysis of radial engines and V-twin engines, | | CO2, CO3 | 2 |

| | | |
|---|---|---|
| gyroscopic effects in machines such as ships, vehicles, grinding mills, and rotating machinery. | | |
| Vibration of Mechanical Systems: Mathematical modeling of discrete vibratory systems, free body diagrams, Rayleigh energy method, Lagrange's equation, Laplace transform and transfer function derivation, free vibration of single degree-of-freedom systems, estimation of damping. | CO1, CO3 | 2 |
| Forced Vibration and Multi-DOF Systems: Forced vibration under harmonic excitation, impulse and step response, modeling and analysis of two degree-of-freedom vibratory systems. | CO1, CO3 | 2 |

## 4. Text books

i) Rao, J. S., Dukkipati, R. V., *Mechanism and Machine Theory*, 2nd Edition, Wiley Eastern Ltd., 1992, ISBN: 978-8122404265.

ii) Ghosh, A., Malik, A. K., *Theory of Mechanisms and Machines*, 3rd Edition, Affiliated East-West Press Pvt. Ltd., 2006, ISBN: 978-8176710817.

## 5. Reference Book(s) and Other Required Material

i) Thomson, W. T., Dahleh, M. D., *Theory of Vibration with Applications*, 5th Edition, Pearson Education, 1998, ISBN: 978-0136514640.

ii) Den Hartog, J. P., *Mechanical Vibrations*, 4th Edition, McGraw-Hill Book Company, 1956, ISBN: 978-0486647852.

## 6. Evaluation Details:

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %

b) Teacher Defined Assessment: 20 %

c) End Semester Exam: 50-60 %

## 7. Relationship of Course Outcomes to Program Outcomes:

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | – | – | – | – | – | – | – | 3 | 2 | 1 |
| CO2 | 3 | 2 | 3 | 2 | – | – | – | – | – | – | – | 3 | 2 | 1 |
| CO3 | 2 | 3 | 3 | 3 | – | – | – | – | – | – | – | 3 | 3 | 2 |

*High - 3; Medium – 2; Low – 1;*

## 8. List of Indicative Laboratory Experiment (if applicable):

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEL303 ENERGY CONVERSION-I** | | |
| **Course Type:** | **DC** | | |
| **Name of the programme(s):** | **B. Tech in Mechanical Engineering** | | |
| **L – T – P** | **3-0-0** | **No. of Credits** | **3** |
| **Pre-requisites: Course Code(s) & Name(s)** | **MEL203- Engineering Thermodynamics** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) Understand the principles, classification, and operation of various steam generators and their performance parameters.

ii) Analyze the principles of draught and design considerations for efficient boiler operation.

iii) Understand steam flow through nozzles, determine critical pressure ratios, and account for frictional effects.

iv) Comprehend the working of steam turbines, evaluate energy losses, and calculate performance parameters including efficiency and work done.

v) Design and analyze steam condensers, cooling towers, and associated air removal systems.

vi) Understand simple steam engine operation and the modified Rankine cycle for thermal power plants

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Explain the principles and classification of steam generators and their performance characteristics. Analyze and calculate draught requirements, chimney height, and efficiency for boilers. |
| **CO2** | Evaluate steam nozzle performance, including adiabatic expansion, critical pressure ratios, and friction effects. |
| **CO3** | Differentiate between impulse and reaction turbines, and compute work done, thrust, and efficiency using velocity diagrams. |
| **CO4** | Design steam condensers and cooling towers, calculate cooling water requirements, and manage air removal. |
| **CO5** | Illustrate the operation of steam engines and modified Rankine cycles, assessing thermal efficiency. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| **Steam Generators**<br>Principles of steam generation, Classification of Steam Generators, Fire tubes and Water tubes Steam Generators, High Pressure and Super critical Steam Generators, Boiler Mountings and Accessories. | | CO1 | 02 |
| **Performance of Steam Generators**: Evaporative Capacity, Equivalent Evaporation, Factor of Evaporation, Boiler Efficiency, Energy balance. | | CO1 | 01 |
| **Draught**<br>Draught and its classification, Chimney height, Chimney Efficiency, Condition for maximum discharge. | | CO1 | 02 |
| **Steam Nozzles**: Adiabatic expansion in nozzles, Maximum Discharge, Critical Pressure Ratio and effects of Friction, Calculation of throats and exit area, Super Saturated flow, Wilson's line. | | CO2 | 02 |
| **Steam Turbines**: Principles of Working of Steam Turbines, Classifications of Steam Turbine, Comparison of Impulse and Reaction Turbines, Simple and Compound Steam Turbines. Energy losses in Steam Turbines, Flow of steam through Turbine blading, Actual Reheat factor, Velocity diagrams, Graphical and analytical Methods, Work done, Thrust and Power, Dimensions and Proportioning of the Blades, Steam Turbine, Efficiencies, Condition for Maximum Efficiency, Reheat and Regenerative cycles, Governing of Steam Turbine. | | CO3 | 04 |
| **Steam Condensers and Cooling Towers**<br>Steam Condensers and Cooling Towers: Types of Condensers, Classification of Condenser, Quantity of cooling water Required, Design Calculations for Surface Condenser, Daltons Law of Partial Pressures, Sources of Air Leakage and Air Removal. Wet and Dry Pumps, Air Ejectors, Cooling Towers, Cooling Ponds. | | CO4 | 02 |
| **Steam Engines**<br>Introduction to Simple Steam Engine. Modified Rankine Cycle. | | CO5 | 01 |

| 4. | Text books |
|---|---|


i) Domkundwar, S., Domkundwar, K., Khajuria, A., *Thermal Engineering*, 4th Edition, Dhanpat Rai & Sons, 1996, ISBN: 978-8187433484.

ii) Ballaney, P. L., *Thermal Engineering*, 24th Edition, Khanna Publishers, 2003, ISBN: 978-8174090348.

iii) Rogers, G. F. C., Mayhew, Y. R., *Engineering Thermodynamics: Work and Heat Transfer*, 4th Edition, Longman Group Ltd., London, 1992, ISBN: 978-0582045668.

| 5. | **Reference Book(s) and Other Required Material** |
|---|---|

i) Kearton, W. J., *Steam Turbines*, 1st Edition, The English Language Book Society, London, 1961, ISBN: 978-0273400516.

ii) Thombre, S. B., Roy, H., *A Data Book on Thermal Engineering*, 1st Edition, Green Brains Publication, 2003, ISBN: 978-8190125408.

| 6. | **Evaluation Details:** |
|---|---|

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %
b) Teacher Defined Assessment: 20 %
c) End Semester Exam: 50-60 %

| 7. | **Relationship of Course Outcomes to Program Outcomes:** |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 1 | - | - | - | - | - | - | - | - | - | - |
| **CO2** | 3 | 3 | 3 | 2 | - | - | - | - | - | - | - | - | - | - |
| **CO3** | 3 | 3 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | - |
| **CO4** | 3 | 2 | 2 | 2 | 1 | - | - | - | - | - | - | - | - | - |
| **CO5** | 3 | 2 | 2 | 1 | - | - | - | - | - | - | - | - | - | - |

*High - 3; Medium – 2; Low – 1;*

| 8. | **List of Indicative Laboratory Experiment (if applicable):** |
|---|---|

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEL304 MACHINE DESIGN – I** | | |
| **Course Type:** | **DC** | | |
| **Name of the programme(s):** | **B. Tech. in Mechanical Engineering** | | |
| **L – T – P** | **3-0-0** | **No. of Credits** | **3** |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) The objective of this course is to develop a systematic understanding of mechanical design principles for machine elements under static, dynamic, and fatigue loading.

ii) The course emphasizes failure prevention, material selection, manufacturability, application of design standards, and reliability considerations, with exposure to modern engineering practices and industrial relevance.

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Explain design philosophy and process, identify failure modes, and perform material selection for machine elements considering loading, service conditions, and manufacturability. |
| **CO2** | Analyse and design machine elements subjected to direct, bending, torsional, and combined stresses using appropriate failure theories. |
| **CO3** | Design mechanical joints, fastening, and power transmission elements such as bolted and welded joints, screws, and springs under static and fatigue loading. |
| **CO4** | Design thin and thick cylindrical pressure vessels subjected to internal pressure using appropriate assumptions and introductory design codes. |
| **CO5** | Design machine elements for fatigue and cyclic loading, and validate analytical designs using basic computational tools and applicable standards. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| Design Philosophy and Material Selection: Definition and scope of machine design; types of design; design process and iterations; feasibility study; failure modes (yielding, fracture, fatigue, wear, corrosion); factor of safety and reliability (introductory); design for manufacturability and assembly; tolerances and surface finish; cost considerations. Material | | CO1, CO2 | 3 |

| | | |
|---|---|---|
| selection based on mechanical properties, temperature effects, and service conditions; ferrous and non-ferrous alloys; polymers and composite materials (introductory); material standards (ISI/ISO); concept of Ashby material selection charts; sustainability and life-cycle considerations (introductory). | | |
| Design of Mechanical Joints: Design of bolted joints: types of bolts, preload, joint stiffness, uniformly loaded and eccentrically loaded joints, fatigue considerations in bolts. Design of welded joints: types of welds, static and fatigue loading of welded joints, design considerations as per standards (introductory). Design of pin joints, levers, knuckle joints, and cotter joints (conceptual emphasis). Shrink and press fits. Riveted joints – principles and applications (conceptual only). | CO3 | 3 |
| Design of Power Transmission Elements: Design of power screws; forms of threads; efficiency, self-locking, and applications; design of screw jack and compound screws. Design of helical springs under static and fatigue loading; stress and deflection analysis. Design of leaf springs (introductory). | CO4 | 3 |
| Design of Pressure Vessels: Classification of pressure vessels; thin and thick cylindrical pressure vessels; stresses due to internal pressure; design of shells, heads, and cover plates; limitations of thin cylinder theory; introduction to pressure vessel design philosophy and relevant codes (ASME Section VIII – introductory). | CO4 | 2 |
| Design for Fatigue and Cyclic Loading: Fatigue failure mechanism; S–N curves; endurance limit; stress concentration and fatigue stress concentration factors; effects of surface finish, size, reliability, and temperature. Design for variable and fluctuating loads; mean stress correction theories (Goodman, Gerber, and Soderberg); comparison and limitations; cumulative fatigue damage and Miner's rule (introductory). | CO5 | 2 |
| Design Integration and Mini Design Exercise: Integrated design of a simple machine element or subassembly (e.g., bolted flange, screw jack, spring assembly) involving load estimation, material selection, application of standards, and basic validation using CAD. | CO5 | 1 |

| 4. | **Text books** |
|---|---|


i) Shigley, J. E., Budynas, R. G., Nisbett, J. K., *Mechanical Engineering Design*, 10th Edition, McGraw-Hill Education, 2015, ISBN: 978-0073398204.

ii) ii) Bhandari, V. B., *Design of Machine Elements*, 4th Edition, Tata McGraw Hill Education (India) Pvt. Ltd., 2017, ISBN: 978-9352601851.

| 5. | Reference Book(s) and Other Required Material |
|---|---|


i) Norton, R. L., *Machine Design: An Integrated Approach*, 5th Edition, Pearson Education, 2013, ISBN: 978-0133356717.

ii) Maleev, V. L., Hartman, J. B., *Mechanical Design of Machines*, 2nd Edition, CBS Publishers & Distributors, 1984, ISBN: 978-8123903439.

iii) PSG College of Technology, *Design Data Book*, Latest Edition, Kalaikathir Achchagam / PSG Tech Publications, Coimbatore, 2014, ISBN: 978-8192058476.

iv) Ashby, M. F., *Materials Selection in Mechanical Design*, 4th Edition, Butterworth-Heinemann (Elsevier), 2011, ISBN: 978-1856176637.


| 6. | Evaluation Details: |
|---|---|

Evaluation is continuous. Components are;

i) Mid-Semester Examination: 25% (After ~40% syllabus completion)

ii) Teacher Defined Assessment: 20% (Assignments, tutorials, quizzes, design exercise; minimum two components)

iii) End-Semester Examination: 45% (Comprehensive)

iv) Mini Design Exercise: 10%

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 1 | 1 | – | – | – | – | – | – | 3 | 2 | 1 |
| CO2 | 3 | 3 | 2 | 2 | 1 | – | – | – | – | – | – | 3 | 2 | 1 |
| CO3 | 3 | 3 | 3 | 2 | 2 | – | – | – | – | – | – | 3 | 3 | 1 |
| CO4 | 3 | 3 | 2 | 3 | 2 | – | – | – | – | – | – | 3 | 2 | 1 |
| CO5 | 2 | 3 | 3 | 3 | 3 | – | – | – | 2 | 2 | 2 | 3 | 2 | 2 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEL313 MACHINE DRAWING** | | |
| **Course Type:** | **DC** | | |
| **Name of the programme(s):** | **B. Tech. in Mechanical Engineering** | | |
| **L – T – P** | 2-0-0 | **No. of Credits** | 2 |
| **Pre-requisites: Course Code(s) & Name(s)** | NIL | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) The objective of this course is to develop the ability to interpret and prepare machine drawings using standard conventions.

ii) The course aims to enable students to understand geometry, fits, tolerances, symbols, and assembly principles required for manufacturing and production drawings.

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Understand and apply principles of engineering drawing as a standardized technical communication tool, Apply BIS standards, conventions, symbols, and dimensioning practices in machine drawings. |
| **CO2** | Interpret symbols related to machining, welding, surface finish, and heat treatment. |
| **CO3** | Apply principles of fits, tolerances, and assembly requirements in machine drawings. |
| **CO4** | Prepare assembly drawings and understand assembly and dismantling principles. |
| **CO5** | Prepare production drawings with complete manufacturing specifications. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| Engineering drawing standards and conventions: drawing sheets and formats, scales, title and revision blocks, types of lines and their applications, dimensioning rules and best practices, limits, fits and tolerances, allowance and interchangeability, surface finish symbols and functional interpretation, machining, welding and heat treatment symbols, materials, manufacturing instructions and general notes | | CO1 | 1.5 |
| Orthographic projection and visualization: principles of orthographic projection, first angle and third angle projection, multiple views, sectional and auxiliary views, missing views and interpretation of | | CO1 | 1.5 |

| | | |
|---|---|---|
| incomplete drawings, cross-sections, reference planes, alignments, dimensioning strategies for clarity and manufacturability | | |
| Standard machine elements and representation: threads and standards, fasteners such as bolts, nuts, washers and rivets, keys and keyways, splines, rigid and flexible couplings, standard practices for drawing, specification and annotation | CO2 | 1.5 |
| Fits, tolerances and assembly considerations: types of fits and applications, selection of tolerances for functional requirements, tolerance charts and interpretation, surface finish requirements for mating parts, manufacturing considerations for assembly, assembly and dismantling tools and practices | CO2 | 1 |
| Assembly drawings and production documentation: component, subassembly and full assembly drawings, exploded views and part identification, bill of materials, name plates and revision control, principles of production drawing, process sheets, manufacturing workflow, reading and interpretation of industrial drawings | CO3 | 1.5 |
| CAD-based engineering drawing concepts: role of CAD in modern engineering practice, comparison of 2D drafting and 3D parametric modeling, associativity between model and drawings, constraints and degrees of freedom in assemblies, introduction to interference checking and motion validation | CO3, CO4 | 1 |
| Reverse engineering in mechanical design: objectives and applications, product redesign and benchmarking, measurement tools and accuracy considerations, feature identification and functional decomposition, tolerances and uncertainty in reverse engineering, ethical and intellectual property considerations | CO4, CO5 | 1 |

| 4. | **Text books** |
|---|---|


i) Narayana, K. L., Kannaiah, P., Venkata Reddy, K., *Machine Drawing*, 3rd Edition, New Age International Publishers, 2006, ISBN: 978-8122416015.

ii) Narayana, K. L., Kannaiah, P., Venkata Reddy, K., *Production Drawing*, 2nd Edition, New Age International Publishers, 2006, ISBN: 978-8122414653.

iii) Bhatt, N. D., *Machine Drawing*, 43rd Edition, Charotar Publishing House Pvt. Ltd., 2013, ISBN: 978-9380358093.


| 5. | **Reference Book(s) and Other Required Material** |
|---|---|


i) PSG College of Technology, *Design Data Book*, Latest Edition, DPV Printers / Kalaikathir Achchagam, Coimbatore, 2014, ISBN: 978-8192058476.

ii) Bureau of Indian Standards (BIS), *Engineering Drawing Practice for Schools and Colleges*, 1st Edition, Bureau of Indian Standards, New Delhi, 1992, ISBN: 978-8170610335.

| 6. | Evaluation Details: |
|---|---|

a) Mid Semester Examination: Conducted after 40% syllabus completion, Weightage: 20–30%

b) Teacher Defined Assessment: Includes assignments, tutorials, quizzes, tests, presentations, etc. Must consist of minimum two components- One before Mid-Sem, One after Mid-Sem, Weightage: 20%

c) End Semester Examination: Comprehensive exam covering full syllabus, Weightage: 50–60

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | – | – | 1 | 3 | – | 3 | 2 | 3 | 2 | 3 | 1 |
| CO2 | 3 | 3 | 3 | – | – | 1 | 3 | – | 3 | 2 | 3 | 2 | 3 | 1 |
| CO3 | 3 | 3 | 3 | – | – | 1 | 3 | – | 3 | 2 | 3 | 1 | 3 | 1 |
| CO4 | 3 | 3 | 3 | – | – | 1 | 3 | – | 3 | 2 | 3 | 3 | 3 | 1 |
| CO5 | 3 | 3 | 3 | – | – | 1 | 3 | – | 3 | 2 | 3 | 3 | 3 | 2 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Course Code & Course Title: | MEP202 FLUID MECHANICS | | |
|---|---|---|---|
| Course Type: | DC | | |
| Name of the programme(s): | B. Tech. in Mechanical Engineering | | |
| L – T – P | 0-0-2 | No. of Credits | 1 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) To provide hands-on experience with fundamental fluid mechanics concepts.
ii) To familiarize students with standard fluid mechanics laboratory equipment.
iii) To develop skills in experimental data acquisition, and result interpretation.
iv) To enhance the ability to correlate theoretical knowledge with practical observations.

| 2. | Course Outcomes |
|---|---|
| CO1 | Apply fundamental fluid mechanics principles through hands-on laboratory experiments. |
| CO2 | Identify and operate standard fluid mechanics laboratory equipment safely and effectively. |
| CO3 | Acquire, analyze, and interpret experimental data to evaluate fluid flow behavior. |
| CO4 | Correlate theoretical fluid mechanics concepts with experimental observations and results. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| Topics | | CO(s) Addressed | Duration in weeks |
| 1. Determination of viscosity of a fluid | | CO1 – CO4 | 1 |
| 2. Determination of metacentric height of a ship model | | CO1 – CO4 | 1 |
| 3. Measurement of free and forced vortex motion | | CO1 – CO4 | 2 |
| 4. Verification of Bernoulli's equation | | CO1 – CO4 | 1 |
| 5. Determination of coefficient of discharge of a venturi meter | | CO1 – CO4 | 1 |
| 6. Determination of coefficient of discharge of an orifice meter | | CO1 – CO4 | 1 |

| | | |
|---|---|---|
| 7. Measurement of major and minor losses in flow through pipes and fittings | CO1 – CO4 | 1 |
| 8. Identification of laminar and turbulent flow using Reynold's experiment | CO1 – CO4 | 1 |
| 9. Determination of drag and lift coefficients | CO1 – CO4 | 1 |
| 10. Visualization of flow patterns around a bluff body | CO1 – CO4 | 1 |

## 4. Text books

i) Som, S. K., Biswas, G., Chakraborty, S., *Introduction to Fluid Mechanics and Fluid Machines*, 3rd Edition, McGraw Hill Education (India) Pvt. Ltd., 2017, ISBN: 978-9339221645.

ii) Munson, B. R., Young, D. F., Okiishi, T. H., Rothmayer, A. P., *Fundamentals of Fluid Mechanics*, 7th Edition, John Wiley & Sons, 2013, ISBN: 978-1118116135.

## 5. Reference Book(s) and Other Required Material

i) White, F. M., *Fluid Mechanics*, 8th Edition, McGraw Hill Education, 2016, ISBN: 978-0073398273.

ii) Schlichting, H., Gersten, K., *Boundary-Layer Theory*, 8th Edition, McGraw Hill, 2000, ISBN: 978-3540662709.

## 6. Evaluation Details:

**Evaluation Weightage (%)**

a) Continuous Evaluation - I 30-35 %
b) Continuous Evaluation - II 30-40 %
c) Continuous Evaluation - III 25-40 %

## 7. Relationship of Course Outcomes to Program Outcomes:

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 3 |
| CO2 | 2 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 2 | 1 | 3 |
| CO3 | 2 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 3 | 2 | 2 |
| CO4 | 2 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 3 | 1 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Topics | Duration in weeks |
|---|---|
| 1. Determination of viscosity of a fluid | 1 |
| 2. Determination of metacentric height of a ship model | 1 |
| 3. Measurement of free and forced vortex motion | 2 |
| 4. Verification of Bernoulli's equation | 1 |
| 5. Determination of coefficient of discharge of a venturi meter | 1 |
| 6. Determination of coefficient of discharge of an orifice meter | 1 |
| 7. Measurement of major and minor losses in flow through pipes and fittings | 1 |
| 8. Identification of laminar and turbulent flow using Reynold's experiment | 1 |
| 9. Determination of drag and lift coefficients | 1 |
| 10. Visualization of flow patterns around a bluff body | 1 |

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEP 301: THEORY OF MACHINE – II** | | |
| **Course Type:** | **DC** | | |
| **Name of the programme(s):** | **B. Tech. in Mechanical Engineering** | | |
| **L – T – P** | **0-0-2** | **No. of Credits** | 1 |
| **Pre-requisites: Course Code(s) & Name(s)** | NIL | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) The objective of this laboratory course is to provide hands-on understanding of machine dynamics through experiments on inertia forces, flywheel behavior, balancing, vibrations, and critical speeds.

ii) The course helps students correlate theoretical concepts of Theory of Machines–II with practical dynamic behavior of mechanical systems.

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Students will be able to perform experiments to determine inertia forces, flywheel characteristics, and balancing requirements of rotating and reciprocating systems. |
| **CO2** | Students will be able to analyze free and forced vibration behavior of single and multi degree of freedom systems, including estimation of natural frequency, damping, and transmissibility. |
| **CO3** | Students will be able to experimentally evaluate critical speeds, gyroscopic effects, and dynamic response of mechanical components and mechanisms. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| Determination of jump-off speed of a cam–follower system | | CO1 | 1 |
| Dynamic balancing of rotating masses | | CO1 | 1 |
| Balancing of reciprocating mechanisms | | CO1 | 1 |
| Determination of critical speed of shafts | | CO3 | 1 |
| Study of gyroscopic effect | | CO3 | 1 |
| Free vibration analysis of single degree of freedom spring–mass system | | CO2 | 1 |
| Free vibration analysis of two degree of freedom spring–mass system | | CO2 | 1 |
| Determination of natural frequency of a cantilever beam | | CO2 | 1 |

| 4. | Text books |
|---|---|

i) Rao, J. S., Dukkipati, R. V., *Mechanism and Machine Theory*, 2nd Edition, Wiley Eastern Ltd., 1992, ISBN: 978-8122404265.

ii) Ghosh, A., Malik, A. K., *Theory of Mechanisms and Machines*, 3rd Edition, Affiliated East-West Press Pvt. Ltd., 2006, ISBN: 978-8176710817.

| 5. | Reference Book(s) and Other Required Material |
|---|---|

i) Thomson, W. T., Dahleh, M. D., *Theory of Vibration with Applications*, 5th Edition, Pearson Education, 1998, ISBN: 978-0136514640.

ii) Den Hartog, J. P., *Mechanical Vibrations*, 4th Edition, McGraw-Hill Book Company, 1956, ISBN: 978-0486647852.

| 6. | Evaluation Details: |
|---|---|

**i)** Continuous Eval-I: 30–35%

**ii)** Continuous Eval-II: 30–40%

**iii)** Continuous Eval-III: 25–40%

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 1 | 2 | 3 | – | 1 | – | 1 | 1 | 2 | 3 | 2 |
| CO2 | 3 | 3 | 3 | 2 | 3 | 3 | – | 1 | – | 1 | 2 | 3 | 2 | 2 |
| CO3 | 2 | 3 | 3 | 2 | 3 | 3 | – | 1 | – | 2 | 2 | 3 | 3 | 2 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Experiment No | Title of Experiment | Duration in weeks |
|---|---|---|
| 1. | Determination of jump-off speed of a cam–follower system | 1 |
| 2. | Dynamic balancing of rotating masses | 1 |
| 3. | Balancing of reciprocating mechanisms | 1 |
| 4. | Determination of critical speed of shafts | 1 |
| 5. | Study of gyroscopic effect | 1 |
| 6. | Free vibration analysis of single degree of freedom spring–mass system | 1 |
| 7. | Free vibration analysis of two degree of freedom spring–mass system | 1 |
| 8. | Determination of natural frequency of a cantilever beam | 1 |

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEP313 MACHINE DRAWING** | | |
| **Course Type:** | **DC** | | |
| **Name of the programme(s):** | **B. Tech. in Mechanical Engineering** | | |
| **L – T – P** | **0-0-2** | **No. of Credits** | **1** |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

To develop the ability to communicate engineering ideas through accurate machine drawings by applying standard drawing conventions, reading and interpreting drawings, and preparing production drawings and basic process plans using manual and computer-aided techniques.

| **2.** | **Course Outcomes:** |
|---|---|
| **CO1** | Prepare accurate orthographic, component, and assembly drawings using standard machine drawing conventions. |
| **CO2** | Read, interpret, and analyze machine drawings, including dimensions, tolerances, and symbols used in engineering practice. |
| **CO3** | Develop production drawings and basic process plans for machine components using manual drafting and computer graphics tools. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| Orthographic Projection using CAD (2 sheets) | | CO1 | 1 |
| CAD Drafting of Standard Machine Components | | CO1 | 1 |
| Assembly Modeling using 3D CAD | | CO1 | 1 |
| Exploded Assembly Drawing and Bill of Materials | | CO1 | 1 |
| Kinematic Validation of Assembly | | CO2 | 1 |
| Production Drawing from 3D CAD Model (2 Sheets) | | CO3 | 1 |
| Reverse Engineering of a Mechanical Component | | CO2 | 1 |
| Process Planning for Components | | CO3 | 1 |
| Reading and Interpretation of Industrial Drawings | | CO2 | 1 |

| | | |
|---|---|---|
| Integrated CAD Assignment: One complete assembly and its components modelled and documented using CAD tools | CO1, CO3 | 1 |

## 4. Text books

i) Narayana, K. L., Kannaiah, P., Venkata Reddy, K., *Machine Drawing*, 3rd Edition, New Age International Publishers, 2006, ISBN: 978-8122416015.

ii) Narayana, K. L., Kannaiah, P., Venkata Reddy, K., *Production Drawing*, 2nd Edition, New Age International Publishers, 2006, ISBN: 978-8122414653.

iii) Bhatt, N. D., *Machine Drawing*, 43rd Edition, Charotar Publishing House Pvt. Ltd., 2013, ISBN: 978-9380358093.

## 5. Reference Book(s) and Other Required Material

i) PSG College of Technology, *Design Data Book*, Latest Edition, DPV Printers / Kalaikathir Achchagam, Coimbatore, 2014, ISBN: 978-8192058476.

ii) Bureau of Indian Standards (BIS), *Engineering Drawing Practice for Schools and Colleges*, 1st Edition, Bureau of Indian Standards, New Delhi, 1992, ISBN: 978-8170610335.

## 6. Evaluation Details:

Evaluation is continuous. Components are

**i)** Continuous Eval-I: 30–35%

**ii)** Continuous Eval-II: 30–40%

**iii)** Continuous Eval-III: 25–40%

## 7. Relationship of Course Outcomes to Program Outcomes:

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | – | – | 1 | 3 | – | 3 | – | 3 | 2 | 3 | 2 |
| CO2 | 3 | 3 | 2 | – | – | 1 | 3 | – | 3 | – | 3 | 2 | 3 | 1 |
| CO3 | 3 | 2 | 3 | – | – | 1 | 2 | – | 3 | 2 | 3 | 3 | 3 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Sr. No | List of Sheets | Duration in weeks |
|---|---|---|
| 1. | Orthographic Projection using CAD (2 sheets) | 1 |
| 2. | CAD Drafting of Standard Machine Components | 1 |
| 3. | Assembly Modeling using 3D CAD | 1 |
| 4. | Exploded Assembly Drawing and Bill of Materials | 1 |
| 5. | Kinematic Validation of Assembly | 1 |
| 6. | Production Drawing from 3D CAD Model (2 Sheets) | 1 |
| 7. | Reverse Engineering of a Mechanical Component | 1 |
| 8. | Process Planning for Components | 1 |
| 9. | Reading and Interpretation of Industrial Drawings | 1 |
| 10 | Integrated CAD Assignment: One complete assembly and its components modelled and documented using CAD tools | 1 |

# Semester V

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEL302 HEAT TRANSFER** | | |
| **Course Type:** | **DC** | | |
| **Name of the programme(s):** | **B. Tech in Mechanical Engineering** | | |
| **L – T – P** | **3-1-0** | **No. of Credits** | 4 |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) Build a rigorous foundation in the mechanisms and governing laws of heat transfer (conduction, convection, radiation, and phase change) relevant to thermal systems

ii) Develop proficiency to formulate heat transfer problems (geometry, assumptions, boundary conditions) and solve them using standard analytical methods (resistance networks, dimensionless analysis, correlations)

iii) Enable students to evaluate and design thermal components/systems such as insulation, extended surfaces, and heat exchangers, including practical effects (contact resistance, fouling, overall heat transfer coefficient)

iv) Train students to select appropriate engineering correlations and design approaches (LMTD/NTU, convection correlations, view-factor methods) for realistic thermal calculations and performance estimation

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Explain the fundamental principles, mechanisms, and governing laws of heat transfer (conduction, convection, and radiation). |
| **CO2** | Formulate and solve one-dimensional steady conduction problems, including composite systems, thermal resistance networks, contact resistance and fouling effects, overall heat transfer coefficient, and critical insulation thickness. |
| **CO3** | Estimate convection heat transfer coefficients for forced and natural convection, and standard empirical correlations for external flows and internal duct flows. |
| **CO4** | Analyze phase-change heat transfer processes (filmwise/dropwise condensation) and perform heat exchanger performance/design calculations. |
| **CO5** | Compute radiative heat exchange using radiation laws, black/gray body concepts, emissivity, and view (shape) factors, including radiation exchange between two gray surfaces. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| Introduction to heat transfer: modes of heat transfer and physical mechanisms | | CO1 | 1 |
| Fourier law of conduction; thermal conductivity and thermal diffusivity; General heat conduction equation (physical meaning and applications) | | CO2 | 2 |
| One-dimensional, steady-state conduction (without heat generation); Thermal resistance concept and electrical analogy; Conduction through composite systems: plane wall (slab), cylinder, and sphere | | CO2 | 2 |
| Contact resistance and fouling factor; overall heat transfer coefficient (U); Critical thickness of insulation; | | CO2 | 1 |
| Extended surfaces (fins/spines): longitudinal fins of rectangular profile; fin heat transfer and performance parameters; Transient conduction (lumped capacitance method): applicability and calculations | | CO2 | 1 |
| External forced convection: flow over a flat plate; Hydrodynamic and thermal boundary layers; Dimensionless numbers: Reynolds (Re), Prandtl (Pr), Nusselt (Nu); Local and average heat transfer coefficient; Empirical correlations for external flows; Internal forced convection: flow through ducts/pipes and related correlations | | CO3 | 2 |
| Natural convection mechanism and buoyancy-driven flow; Natural convection from a vertical plate; Dimensionless numbers: Grashof (Gr) (and Rayleigh concept if needed for correlation use); Empirical correlations for natural convection from common bodies/surfaces. | | CO3 | 1 |
| Condensation: film-wise and drop-wise condensation; Nusselt theory for film-wise condensation on a vertical plate; Boiling: pool boiling curve and boiling regimes | | CO4 | 1 |
| Radiation fundamentals and laws of thermal radiation; Black body, gray body, and colored body concepts; emissivity; Black-body radiation relations; Shape factor (view factor): definition, properties, and evaluation concepts; Radiation exchange between two gray surfaces. | | CO5 | 2 |
| Classification of heat exchangers and flow arrangements; LMTD method for parallel-flow and counter-flow heat exchangers; Effectiveness–NTU method for parallel-flow and counter-flow heat exchangers; Design and performance considerations (selection of configuration, overall-U based sizing concepts) | | CO4 | 1 |

| 4. | Text books |
|---|---|

i) Çengel, Y. A., Heat and Mass Transfer: A Practical Approach, 3rd Edition, Tata McGraw-Hill Education (India) Pvt. Ltd., New Delhi, 2007, ISBN: 978-0070630543.

ii) Holman, J. P., Heat Transfer, 8th Edition, McGraw-Hill Education, 2003, ISBN: 978-0073529363.

iii) Sukhatme, S. P., A Textbook on Heat Transfer, 3rd Edition, Orient Longman Ltd., Bombay, 1985, ISBN: 978-0863111938.

| 5. | Reference Book(s) and Other Required Material |
|---|---|

i) Incropera, F. P., DeWitt, D. P., Fundamentals of Heat and Mass Transfer, 4th Edition, John Wiley & Sons, 1996, ISBN: 978-0471304609.

| 6. | Evaluation Details: |
|---|---|

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %
b) Teacher Defined Assessment: 20 %
c) End Semester Exam: 50-60 %

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 1 | 1 | - | - | - | - | 1 | - | 3 | 1 | 1 |
| CO2 | 3 | 3 | 2 | 1 | 1 | - | - | - | - | 1 | - | 3 | 1 | 1 |
| CO3 | 3 | 3 | 1 | 2 | 2 | - | - | - | - | 1 | 1 | 3 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 2 | - | - | - | - | 1 | 1 | 3 | 2 | 2 |
| CO5 | 3 | 3 | 2 | 1 | 1 | - | - | - | - | 1 | - | 3 | 1 | 1 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Course Code & Course Title: | MEL305: MANUFACTURING PROCESSES – II | | |
|---|---|---|---|
| Course Type: | DC | | |
| Name of the programme(s): | B. Tech. Mechanical Engineering | | |
| L – T – P | 3-0-0 | No. of Credits | 3 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) Understand the fundamental principles of metal cutting, chip formation, cutting forces, and energy requirements in conventional machining processes.

ii) Explain and compare the construction, working mechanisms, and applications of common machine tools such as lathe, drilling, milling, shaping, and grinding machines.

iii) Analyze the influence of cutting tool materials, geometry, cutting fluids, and machining parameters on tool life, surface quality, power consumption, and machining economics.

iv) Apply theoretical concepts of machining to solve numerical problems related to cutting forces, power estimation, surface roughness, and tool life.

v) Familiarize students with advanced and non-traditional manufacturing processes, CNC machining, additive manufacturing, and recent trends to support modern industrial practices

| 2. | Course Outcomes |
|---|---|
| CO1 | Explain the mechanics of metal cutting, chip formation, heat generation, and cutting forces in conventional machining processes. |
| CO2 | Apply principles of machining and machine tools to solve numerical problems related to cutting speed, feed, depth of cut, power requirement, and tool life. |
| CO3 | Analyze and select appropriate machining processes, cutting tools, coolants, and finishing methods based on surface finish, productivity, cost, and application requirements. |
| CO4 | Compare and evaluate finishing, non-traditional, CNC, and additive manufacturing processes for modern manufacturing applications |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| Topics | | CO(s) Addressed | Duration in weeks |
| **Fundamentals of Machining:** Mechanics of metal cutting, Workpiece-cutting tool-chip, chip formation, Machining parameters- cutting speed, feed and depth of cut, orthogonal and oblique cutting, shear plane, shear stress, strain and cutting forces, Merchant's circle, Cutting force | | CO1, CO2 | 03 |

| | | |
|---|---|---|
| calculation & measurement, determination of power requirement for various operations. | | |
| **Basic machining processes and machine tools**: Lathe, shaper, planer, drilling (including reaming, tapping, etc.), milling, etc. Construction, main parts, accessories and essential mechanism of each machine, Work holding devices- jigs & fixtures, Common operations on these machines, Heat generation and temperature measurement in cutting, Numerical problems related to machining operations. | CO1, CO3 | 03 |
| **Cutting tools, Coolants & Tool Life:** Essential properties of tool materials, Common tool materials and their usages, Tool geometry, Single point vs multi-point cutting tools, Cutting fluid properties, Common cutting fluids & application methods (such as flood application, minimum quantity lubrication, cryogenic machining, etc.), Tool life & tool wear, Effect of tool geometry, cutting fluids, and machining parameters on power requirement and tool life, Economics of machining. | CO2, CO3 | 03 |
| **Special machining processes:** Broaching, Form tools and form cutting, Gear hobbing, Gear shaving, etc. | CO3 | 01 |
| **Finishing Processes:** Surface roughness and its measurement**,** grinding process and machines, basic principles, types of grinding, grinding wheels, Fine finishing operations such as lapping, honing, polishing and buffing. | CO3, CO4 | 01 |
| **Non-Traditional Machining & Recent Trends:** Introduction to NTM, classification, Water Jet Machining (WJM), Chemical Machining (CHM), Electro Chemical Machining ECM), Electrical Discharge Machining (EDM), etc., Additive manufacturing (including micro/nano 3D printing), Hybrid manufacturing, Micromachining, CNC machines-part programming, tooling and control system | CO4 | 03 |

| **4.** | **Text books** |
|---|---|


i) Groover, M. P., Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, 5th Edition, John Wiley & Sons, 2010, ISBN: 978-0470467008.

ii) Boothroyd, G., Knight, W. A., Fundamentals of Machining and Machine Tools, 3rd Edition, CRC Press (Taylor & Francis Group), 2006, ISBN: 978-1574446593.

iii) Trent, E. M., Wright, P. K., Metal Cutting, 4th Edition, Butterworth-Heinemann (Elsevier), 2000, ISBN: 978-0750647069.

| 5. | Reference Book(s) and Other Required Material |
|---|---|


i) Ghosh, A., Mallik, A. K., *Manufacturing Science*, 1st Edition, Affiliated East-West Press Pvt. Ltd., 2001, ISBN: 978-8176710466.

ii) Smid, P., *CNC Programming Handbook*, 3rd Edition, Industrial Press Inc., 2017, ISBN: 978-0831133474.

iii) Gibson, I., Rosen, D. W., Stucker, B., *Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping and Direct Digital Manufacturing*, 2nd Edition, Springer, 2015, ISBN: 978-1493921126.


| 6. | Evaluation Details: |
|---|---|

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %

b) Teacher Defined Assessment: 20 %

c) End Semester Exam: 50-60 %

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 1 | 1 |
| CO2 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 3 | 2 | 2 |
| CO3 | 3 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 2 | 2 |
| CO4 | 3 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 2 | 1 | 3 | 2 | 3 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEL307 FLUID MACHINES** | | |
| **Course Type:** | **DC** | | |
| **Name of the programme(s):** | **B. Tech in Mechanical Engineering** | | |
| **L – T – P** | **3-0-0** | **No. of Credits** | **3** |
| **Pre-requisites: Course Code(s) & Name(s)** | **MEL202 - Fluid Mechanics** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) Understand the fundamental principles governing the dynamic action of fluid jets and apply the impulse–momentum principle to analyze forces on stationary and moving vanes and plates.

ii) Study the working principles, classification, and performance parameters of hydraulic turbines and pumps used in energy conversion systems.

iii) Analyze velocity triangles for turbines and pumps to evaluate work done, power, and efficiencies.

iv) Explain the construction, operation, and design considerations of impulse and reaction turbines and various types of pumps.

v) Evaluate performance characteristics of turbines and pumps using characteristic curves, specific speed, and model testing.

**vi)** Identify operational issues such as cavitation and losses in hydraulic machines and understand methods to minimize their effects.

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Apply the impulse–momentum principle to determine forces exerted by fluid jets on fixed and moving flat plates, curved vanes, and hinged plates. Construct and analyze velocity triangles for jets, turbines, and pumps to compute work done, power output, and efficiencies |
| **CO2** | Classify hydraulic machines and explain the working, components, and performance of impulse turbines (Pelton turbine) and reaction turbines (Francis and Kaplan turbines). |
| **CO3** | Analyze the performance characteristics of hydraulic turbines, including specific speed, model testing, draft tube performance, and cavitation phenomena. |
| **CO4** | Explain the working principles, construction, and performance analysis of centrifugal pumps, including head, efficiencies, NPSH, and characteristic curves. |
| **CO5** | Evaluate the operation and performance of reciprocating pumps, including discharge, slip, indicator diagrams, air vessels, and cavitation effects. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| **Impact of jet:**<br>Impulse-momentum principle, dynamic action of jet on fixed and moving flat plate and curved vanes, force exerted by jet on vanes of plates and vanes, force exerted by jet on a hinged plate, velocity triangles and their analysis, principle and classification of hydraulic machines, elements of hydroelectric power plants. | | CO1 | 03 |
| **Hydraulic Turbines:**<br>**Impulse Turbine**<br>Classification of hydraulic turbines, head and efficiencies of turbines, Impulse Turbine like Pelton turbine, main parts of Pelton turbine, velocity triangles, work done and efficiency of Pelton turbine, design aspects of Pelton turbine. | | CO2 | 02 |
| **Reaction Turbines** like Francis turbine, propeller turbine and Kaplan turbine, main components of Francis turbine, power and efficiency of Francis turbine, main components of Kaplan turbine, Power & efficiency of Kaplan turbine, Draft tube, efficiency of draft tube, Types of draft tube. | | CO2 | 02 |
| **Performance of Turbine**, specific speed of turbine, model testing of turbine, cavitation in turbine, performance characteristics of turbines, main characteristic of curves, operating characteristic curve, isoefficiency Curve. | | CO3 | 02 |
| **Hydraulic Pumps:**<br>**Rotodynamic pump** like centrifugal pump, main parts of centrifugal pump, classification of centrifugal pumps, head of pump, fundamental equation of centrifugal pump, velocity triangle and efficiency of centrifugal pump, vane shape, head-Capacity relation, power-discharge relation, pump losses and efficiencies, multistage centrifugal pump, specific speed of pump, centrifugal pump, model testing of centrifugal pump, NPSH, Cavitation in centrifugal pump, Performance characteristics of centrifugal pump, main Characteristic curves, operating characteristic curve, constant efficiency curve. | | CO4 | 03 |
| **Positive displacement pump** like reciprocating pump, main parts of reciprocating pump, working of single acting reciprocating pump, and double acting reciprocating pump, discharge, workdone and power required to drive single acting and double acting reciprocating pump, Coefficient of discharge and slip, indicator diagram, effect of acceleration on indicator diagram, effect of friction on indicator diagram, air vessels, work done against friction with and without air vessels, cavitation in reciprocating pump. | | CO5 | 02 |

| 4. | Text books |
|---|---|

i) Lal, J., *Centrifugal Pumps and Blowers*, 1st Edition, Metropolitan Book Company Pvt. Ltd., New Delhi, 1983, ISBN: 978-8123901251.

ii) Massey, B. S., *Turbines, Compressors and Fans*, 2nd Edition, Van Nostrand Reinhold Company, 1970, ISBN: 978-0442204761.

iii) Church, A. H., Lal, J., *Centrifugal Pumps and Blowers*, 2nd Edition, Metropolitan Book Company Pvt. Ltd., New Delhi, 1995, ISBN: 978-8123901251.

iv) Vasandani, V. P., *Hydraulic Machines: Theory and Practice*, 1st Edition, Khanna Publishers, 1998, ISBN: 978-8174090645.

| 5. | Reference Book(s) and Other Required Material |
|---|---|

i) Bansal, R. K., *Fluid Mechanics and Hydraulic Machines*, 10th Edition, Laxmi Publications Pvt. Ltd., 2010, ISBN: 978-8131808153.

ii) Rajput, R. K., *Hydraulic Machines*, 1st Edition, S. Chand & Company Ltd., 2008, ISBN: 978-8121926171.

iii) Kumar, D. S., *Fluid Mechanics and Fluid Machines*, 1st Edition, S. K. Kataria & Sons, 2013, ISBN: 978-9350142776.

| 6. | Evaluation Details: |
|---|---|

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %

b) Teacher Defined Assessment: 20 %

c) End Semester Exam: 50-60 %

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | - | - | - | - | - | - | - | - | - | - | - | - |
| CO2 | 3 | 3 | - | - | 2 | - | - | - | - | - | - | - | - | - |
| CO3 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | - | - | - |
| CO4 | 2 | 3 | - | 2 | 2 | - | - | - | - | - | - | - | - | - |
| CO5 | 2 | 3 | - | 2 | 3 | - | - | - | - | - | - | - | - | - |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEL 308: ENERGY CONVERSION-II** | | |
| **Course Type:** | **DC** | | |
| **Name of the programme(s):** | **B.Tech. in Mechachanical Engineering** | | |
| **L – T – P** | **3-0-0** | **No. of Credits** | 3 |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) Student should understand the basics and mathematical treatment of reciprocating air compressors and evaluate their performance.

ii) Student should understand basics and mathematical treatment of I. C. Engines and evaluate their performance.

iii) Student should understand the basics and mathematical treatment of Gas turbines and Jet propulsion engines and evaluate their performance.

iv) Student should understand the basics and mathematical treatment of refrigeration and air conditioning systems and evaluate their performances.

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Student should be able to understand the basics and mathematical treatment of reciprocating air compressors and evaluate their performance. |
| **CO2** | Student should be able to understand basics and mathematical treatment of I. C. Engines and evaluate their performance. |
| **CO3** | Student should be able to understand the basics and mathematical treatment of Gas turbines and Jet propulsion engines and evaluate their performance. |
| **CO4** | Student should be able to understand the basics and mathematical treatment of refrigeration and air conditioning systems and evaluate their performances. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| **I.C. Engines:** Air standard and fuel air cycles, parts of I.C. engines, two stroke and four stroke I.C. engines, SI and CI engines, combustion in SI and CI engines, detonation, carburetion and diesel injection. Measurement of power: indicated, friction and brake power, fuel and air consumption, indicated, brake, volumetric and mechanical efficiency, | | CO2 | 4 |

| | | |
|---|---|---|
| percentage of excess air, heat balance sheet, performance characteristics & factors influencing the performance of I.C. engines. | | |
| **Gas Turbines & Jet Propulsion:** Ideal cycles, small stage efficiency, pressure losses, intercooling, reheat & regeneration, fuel-air ratio, combustion efficiency, performance calculations, open cycle and closed cycle gas turbines. Working of turbojet, turboprop, ramjet & pulsejet, performance. | CO3 | 4 |
| **Positive displacement and Dynamic compressors:** Various parts, operations, work done during isothermal, polytropic & adiabatic compression process, PV diagram, isothermal, volumetric and mechanical efficiency, effect of clearance.<br>Multistage compressor, condition for minimum work input, capacity control, actual indicator diagram. | CO1 | 3 |
| **Refrigeration And Air Conditioning:** Vapor compression refrigeration system, analysis, actual refrigerating cycle, effect of subcooling& superheating, C.O.P., performance calculation, psychometric chart and processes such as heating cooling, humidification & dehumidification. | CO4 | 3 |

| **4.** | **Text books** |
|---|---|

i) Ballaney, P. L., *Thermal Engineering*, 24th Edition, Khanna Publishers, 2003, ISBN: 978-8174090348.

ii) Heywood, J. B., *Internal Combustion Engine Fundamentals*, 2nd Edition, McGraw-Hill Education, 2018, ISBN: 978-1260116106.

iii) Yadav, R., *Steam and Gas Turbines*, 7th Edition, Central Publishing House, 2001, ISBN: 978-8173810527.

| **5.** | **Reference Book(s) and Other Required Material** |
|---|---|

i) Arora, C. P., Refrigeration and Air Conditioning, 3rd Edition, McGraw Hill Education (India) Pvt. Ltd., 2019, ISBN: 978-9353160937.

ii) Yahya, S. M., Turbines, Compressors and Fans, 4th Edition, McGraw Hill Education (India) Pvt. Ltd., 2011, ISBN: 978-0070707023.

| **6.** | **Evaluation Details:** |
|---|---|

**Evaluation Weightage (%)**

i) Mid Semester Exam: 20-30 %

ii) Teacher Defined Assessment: 20 %

iii) End Semester Exam: 50-60 %

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 1 | 1 | - | 1 | - | 2 | 1 | - | 2 | 2 | 2 | 1 |
| CO2 | 3 | 2 | 1 | 1 | 1 | 1 | - | 2 | 1 | - | 2 | 2 | 2 | 1 |
| CO3 | 3 | 2 | 2 | 1 | 3 | - | - | 2 | 1 | - | 2 | 2 | 1 | 1 |
| CO4 | 3 | 2 | 1 | 1 | 2 | - | - | 1 | 1 | - | 1 | 2 | 1 | 1 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEP 302: THERMAL** | | |
| **Course Type:** | **DC** | | |
| **Name of the programme(s):** | **B. Tech in Mechanical Engineering** | | |
| **L – T – P** | **0-0-2** | **No. of Credits** | 1 |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) Build experimental competence in thermal measurements: Safely set up and operate thermal laboratory equipment; acquire reliable steady and transient temperature/flow data using standard instruments and procedures.

ii) Develop capability to evaluate major heat-transfer modes: Investigate conduction, convection, and radiation through experiments and connect observed trends with governing laws and physical mechanisms.

iii) Strengthen thermal system performance analysis: Analyze heat-exchanger operation and performance using engineering parameters such as heat duty, LMTD, overall heat-transfer coefficient, and (where applicable) effectiveness.

iv) Enhance engineering data reduction and reporting: Perform systematic calculations, interpret results using standard correlations/models, identify error sources (uncertainty awareness), and prepare technically sound laboratory reports.

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Determine the thermal conductivity of a metal rod and an unknown powder, and analyze unsteady (transient) heat conduction using appropriate conduction models and systematic experimental data reduction. |
| **CO2** | Estimate heat-transfer coefficients for free convection, forced convection, and condensation (filmwise/dropwise), and relate performance to governing parameters and expected trends. |
| **CO3** | Determine emissivity of an unknown surface and evaluate radiative heat-transfer relations, including estimation/verification of the Stefan–Boltzmann constant within experimental limits. |
| **CO4** | Evaluate heat exchanger performance under different configurations and analyze unsteady (transient) heat-transfer behavior using suitable first-principles formulations and data interpretation. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| A) Conduction / Thermal Conductivity<br>1. To determine thermal conductivity of metal rods.<br>2. To Determine Thermal Conductivity of Metal Rod. *(duplicate title retained; typically one rod-conduction experiment)*<br>3. To Determine Thermal Conductivity of Unknown Powder. | | CO1 | 3 |
| B) Convection + Condensation<br>1. To Determine Heat Transfer Coefficient for Free Convection.<br>2. To Determine Heat Transfer Coefficient for Force(d) Convection.<br>3. To determine heat transfer coefficient under filmwise / dropwise condensation. | | CO2 | 3 |
| C) Radiation<br>1. To Determine Emissivity of Unknown Surface.<br>2. To Determine Stefan Boltzmann Constant. | | CO3 | 2 |
| D) Heat Exchanger + Transient/Unsteady<br>1. To compare performance of HX in parallel & counter flow mode.<br>2. To Determine Heat Transfer Parameter of Shell and Tube Type Heat Exchanger.<br>3. To Determine Unsteady State of Heat Transfer. | | CO4 | 3 |

| 4. | Text books |
|---|---|

i) Çengel, Y. A., Heat and Mass Transfer: A Practical Approach, 3rd Edition, Tata McGraw-Hill Education (India) Pvt. Ltd., New Delhi, 2007, ISBN: 978-0070630543.

ii) Holman, J. P., Heat Transfer, 8th Edition, McGraw-Hill Education, 2003, ISBN: 978-0073529363.

iii) Sukhatme, S. P., A Textbook on Heat Transfer, 3rd Edition, Orient Longman Ltd., Bombay, 1985, ISBN: 978-0863111938.

| 5. | Reference Book(s) and Other Required Material |
|---|---|

i) Incropera, F. P., DeWitt, D. P., Fundamentals of Heat and Mass Transfer, 4th Edition, John Wiley & Sons, 1996, ISBN: 978-0471304609.

| 6. | Evaluation Details: |
|---|---|

**Evaluation Weightage (%)**

a) Continuous Evaluation - I 30-35 %
b) Continuous Evaluation - II 30-40 %
c) Continuous Evaluation - III 25-40 %

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 1 | 1 | - | - | - | - | 1 | - | 3 | 1 | 1 |
| CO2 | 3 | 3 | 2 | 1 | 1 | - | - | - | - | 1 | - | 3 | 1 | 1 |
| CO3 | 3 | 3 | 1 | 2 | 2 | - | - | - | - | 1 | 1 | 3 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 2 | - | - | - | - | 1 | 1 | 3 | 2 | 2 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

1. To determine thermal conductivity of metal rods.
2. To Determine Thermal Conductivity of Metal Rod. *(duplicate title retained; typically one rod-conduction experiment)*
3. To Determine Thermal Conductivity of Unknown Powder.
4. To Determine Heat Transfer Coefficient for Free Convection.
5. To Determine Heat Transfer Coefficient for Force(d) Convection.
6. To determine heat transfer coefficient under filmwise / dropwise condensation.
7. To Determine Emissivity of Unknown Surface.
8. To Determine Stefan Boltzmann Constant.
9. To compare performance of HX in parallel & counter flow mode.
10. To Determine Heat Transfer Parameter of Shell and Tube Type Heat Exchanger.
11. To Determine Unsteady State of Heat Transfer.

| Course Code & Course Title: | MEP305: MANUFACTURING PROCESSES – II | | |
|---|---|---|---|
| Course Type: | DC | | |
| Name of the programme(s): | B. Tech. in Mechanical Engineering | | |
| L – T – P | 0-0-2 | No. of Credits | 1 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) Impart knowledge of basic machining operations.
ii) Develop hands-on skills in machine tool usage.
iii) Enable selection of optimal machining parameters.
iv) Familiarize students with CNC programming basics.
v) Introduce additive manufacturing techniques.

| 2. | Course Outcomes |
|---|---|
| CO1 | Explain basic machining operations such as turning, drilling, and shaping, including their principles and applications. |
| CO2 | Perform basic machining operations on machine tools, following standard safety and operational procedures. |
| CO3 | Select appropriate machining parameters (e.g., speed, feed, depth of cut) for a given workpiece material and tool combination to achieve desired outcomes. |
| CO4 | Demonstrate fundamental CNC programming and additive manufacturing processes through hands-on execution. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| Topics | | CO(s) Addressed | Duration in weeks |
| Demonstration of lathe | | CO1 | 01 |
| Perform specified machining operations on Lathe (such as turning, facing, tapper turning, step turning, threading, etc.) | | CO2, CO3 | 03 |
| Demonstration of shaping, drilling, milling machine | | CO1 | 01 |
| Perform specified machining operations on shaping machine, drilling machine, milling machine, etc. | | CO2, CO3 | 03 |

| | | |
|---|---|---|
| Demonstration of CNC machine with G, M, S, F, T codes | CO4 | 01 |
| Part programming for specific operations & job preparation on CNC machine | CO4 | 02 |
| Demonstration of additive manufacturing (3D printing) | CO4 | 01 |
| Perform specific job on 3D printing machine | CO4 | 02 |

## 4. Text books

i) Groover, M. P., Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, 5th Edition, John Wiley & Sons, 2010, ISBN: 978-0470467008.

ii) Boothroyd, G., Knight, W. A., Fundamentals of Machining and Machine Tools, 3rd Edition, CRC Press (Taylor & Francis Group), 2006, ISBN: 978-1574446593.

iii) Trent, E. M., Wright, P. K., Metal Cutting, 4th Edition, Butterworth-Heinemann (Elsevier), 2000, ISBN: 978-0750647069.

## 5. Reference Book(s) and Other Required Material

i) Ghosh, A., Mallik, A. K., *Manufacturing Science*, 1st Edition, Affiliated East-West Press Pvt. Ltd., 2001, ISBN: 978-8176710466.

ii) Smid, P., *CNC Programming Handbook*, 3rd Edition, Industrial Press Inc., 2017, ISBN: 978-0831133474.

iii) Gibson, I., Rosen, D. W., Stucker, B., *Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping and Direct Digital Manufacturing*, 2nd Edition, Springer, 2015, ISBN: 978-1493921126.

## 6. Evaluation Details:

**Evaluation Weightage (%)**

a) Continuous Evaluation - I 30-35 %
b) Continuous Evaluation - II 30-40 %
c) Continuous Evaluation - III 25-40 %

## 7. Relationship of Course Outcomes to Program Outcomes:

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 1 | --- | --- | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 1 | 1 |
| CO2 | 3 | 1 | 1 | --- | --- | 3 | 1 | 1 | 2 | 2 | 2 | 3 | 2 | 2 |
| CO3 | 3 | 1 | 2 | --- | --- | 2 | 2 | 1 | 2 | 2 | 2 | 3 | 2 | 2 |
| CO4 | 1 | 1 | 2 | --- | --- | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Experiment | Duration in weeks |
|---|---|
| Demonstration of lathe | 01 |
| Perform specified machining operations on Lathe (such as turning, facing, tapper turning, step turning, threading, etc.) | 03 |
| Demonstration of shaping, drilling, milling machine | 01 |
| Perform specified machining operations on shaping machine, drilling machine, milling machine, etc. | 03 |
| Demonstration of CNC machine with G, M, S, F, T codes | 01 |
| Part programming for specific operations & job preparation on CNC machine | 02 |
| Demonstration of additive manufacturing (3D printing) | 01 |
| Perform specific job on 3D printing machine | 02 |

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEP 307: FLUID MACHINES** | | |
| **Course Type:** | **DC** | | |
| **Name of the programme(s):** | **B. Tech in Mechanical Engineering** | | |
| **L – T – P** | **0-0-2** | **No. of Credits** | 1 |
| **Pre-requisites: Course Code(s) & Name(s)** | **MEP202 FLUID MECHANICS** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) To provide hands-on experience in the operation and performance evaluation of different turbines and pumps.

ii) To understand the characteristics and efficiencies of hydro turbines and pumps.

iii) To develop skills in measuring and analyzing fluid machine parameters like head, discharge, efficiency, and power.

iv) To demonstrate practical knowledge of pump connections in series and parallel and hydraulic ram operation.

v) To bridge the gap between theoretical fluid mechanics and real-world applications.

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Analyze the performance of Pelton, Francis, and Kaplan turbines under varying load conditions. |
| **CO2** | Evaluate the performance characteristics of centrifugal and reciprocating pumps. |
| **CO3** | Compare pump performance in series and parallel arrangements. |
| **CO4** | Examine the working and efficiency of a hydraulic ram. |
| **CO5** | Correlate theoretical knowledge with experimental observations for fluid machines. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| 1. Study of Hydroelectric power plant | | CO5 | 1 |
| 2. Performance analysis of Pelton Turbine | | CO1 | 1 |
| 3. Performance analysis of Francis Turbine | | CO1 | 1 |
| 4. Performance analysis of Kaplan Turbine | | CO1 | 1 |

| | | |
|---|---|---|
| 5. Performance analysis of Centrifugal Pump | CO2 | 1 |
| 6. Performance analysis of Reciprocating Pump | CO2 | 1 |
| 7. Performance analysis of Pumps in series and parallel | CO3 | 1 |
| 8. Performance analysis of Hydraulic Ram | CO4 | 1 |

| 4. | **Text books** |
|---|---|

i) Bansal, R. K., *Fluid Mechanics and Hydraulic Machines*, 10th Edition, Laxmi Publications Pvt. Ltd., 2010, ISBN: 978-8131808153.

ii) ii) Rajput, R. K., *Hydraulic Machines*, 1st Edition, S. Chand & Company Ltd., 2008, ISBN: 978-8121926171.

iii) iii) Kumar, D. S., *Fluid Mechanics and Fluid Machines*, 1st Edition, S. K. Kataria & Sons, 2013, ISBN: 978-9350142776.

iv) iv) Vasandani, V. P., *Hydraulic Machines: Theory and Practice*, 1st Edition, Khanna Publishers, 1998, ISBN: 978-8174090645.

| 5. | **Reference Book(s) and Other Required Material** |
|---|---|

i) Lal, J., *Centrifugal Pumps and Blowers*, 1st Edition, Metropolitan Book Company Pvt. Ltd., New Delhi, 1983, ISBN: 978-8123901251.

ii) vi) Massey, B. S., *Turbines, Compressors and Fans*, 2nd Edition, Van Nostrand Reinhold Company, 1970, ISBN: 978-0442204761.

iii) vii) Church, A. H., Lal, J., *Centrifugal Pumps and Blowers*, 2nd Edition, Metropolitan Book Company Pvt. Ltd., New Delhi, 1995, ISBN: 978-8123901251.

| 6. | **Evaluation Details:** |
|---|---|

**Evaluation Weightage (%)**

a) Continuous Evaluation - I 30-35 %
b) Continuous Evaluation - II 30-40 %
c) Continuous Evaluation - III 25-40 %

| 7. | **Relationship of Course Outcomes to Program Outcomes:** |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | - | 2 | 3 | 3 | - | - | - | - | - | - | - | - |
| CO2 | 3 | 3 | - | 2 | 3 | - | - | - | - | - | - | - | - | - |
| CO3 | 3 | 3 | - | 2 | 3 | - | - | - | - | - | - | - | - | - |
| CO4 | 3 | 3 | - | 2 | 3 | 3 | - | - | - | - | - | - | - | - |
| CO5 | 3 | 3 | - | 3 | 3 | - | - | - | - | - | 2 | - | - | - |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Topics | Duration in weeks |
|---|---|
| 1. Study of Hydroelectric power plant | 1 |
| 2. Performance analysis of Pelton Turbine | 1 |
| 3. Performance analysis of Francis Turbine | 1 |
| 4. Performance analysis of Kaplan Turbine | 1 |
| 5. Performance analysis of Centrifugal Pump | 1 |
| 6. Performance analysis of Reciprocating Pump | 1 |
| 7. Performance analysis of Pumps in series and parallel | 1 |
| 8. Performance analysis of Hydraulic Ram | 1 |

# Semester VI

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEL309 MACHINE DESIGN II** | | |
| **Course Type:** | **DC** | | |
| **Name of the programme(s):** | **B. Tech. in Mechanical Engineering** | | |
| **L – T – P** | **3-0-0** | **No. of Credits** | **3** |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) The objective of this course is to impart comprehensive knowledge of the design of machine elements subjected to static, dynamic, and fatigue loading.

ii) The course emphasizes systematic design procedures for power transmission and motion control components, considering strength, wear, lubrication, thermal effects, and industrial standards, to enable students to design reliable mechanical systems for practical engineering applications

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Design bearings and rotating machine elements by considering friction, lubrication, wear, load capacity, and service life. |
| **CO2** | Design and analyze mechanical couplings and flywheels based on energy fluctuation, stress analysis, and operational requirements. |
| **CO3** | Design belt, chain, and friction drive systems for efficient power transmission under specified operating conditions. |
| **CO4** | Design spur, helical, and bevel gear drives by applying gear geometry, force analysis, and strength equations. |
| **CO5** | Design worm gear drives and basic hoisting systems by considering strength, wear, thermal limits, and motor selection criteria. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| Surface finish, friction and wear, lubrication systems, oil seals, design of journal bearings for radial and thrust loads, selection of ball and roller bearings, failures of antifriction bearings, design of hydrostatic thrust bearings (circular step thrust bearing), bearing housing design. | | CO1 | 3 |

| | | |
|---|---|---|
| Types of shaft couplings, design of rigid and flexible couplings (flange and bush pin type), flywheel fundamentals, coefficient of fluctuation of energy and speed, energy stored in flywheel, stresses in flywheel, design of flywheel. | CO2 | 2 |
| Types of belts and belt materials, belt tension analysis, condition for maximum power transmission, design of flat belt and pulley, V-belt drives and pulley design, chain drive fundamentals, velocity ratio, chain length, chain design, sprocket tooth profile and dimensions. | CO3 | 3 |
| Review of gear kinematics and terminology, interference and tooth profiles, formative number of teeth, Buckingham equation, design of spur and helical gear drives, bevel gears—types, proportions, force analysis, and design of bevel gear drive. | CO4 | 3 |
| Worm and worm gear types and proportions, force analysis, beam strength, dynamic and wear loads, thermal rating, design of worm gear drive, introduction to haulage systems, design of wire ropes, sheaves and drums, electric motor rating, characteristics and selection of AC and DC motors. | CO5 | 3 |

## 4. Text books

i) Maleev, V. L., Hartman, J. B., *Mechanical Design of Machines*, 2nd Edition, CBS Publishers & Distributors, 1983, ISBN: 978-8123903439.

ii) Shigley, J. E., *Mechanical Engineering Design*, 8th Edition, Tata McGraw Hill Education (India) Pvt. Ltd., 2008, ISBN: 978-0070611412.

## 5. Reference Book(s) and Other Required Material

i) Black, P. H., Adams, O. E., *Machine Design*, 3rd Edition, Tata McGraw Hill Publishing Company Ltd., 1968, ISBN: 978-0070055971.

## 6. Evaluation Details:

a. Mid Semester Examination: Conducted after 40% syllabus completion, Weightage: 20–30%

b. Teacher Defined Assessment: Includes assignments, tutorials, quizzes, tests, presentations, etc. Must consist of minimum two components- One before Mid-Sem, One after Mid-Sem, Weightage: 20%

c. End Semester Examination: Comprehensive exam covering full syllabus, Weightage: 50–60%

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 1 | 3 | 3 | 3 | 2 | – | 3 | 3 | 2 | 3 | 2 | 1 |
| CO2 | 2 | 3 | 3 | – | 3 | – | – | 2 | – | – | 3 | 3 | 2 | 1 |
| CO3 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 | – | 2 | 3 | 3 | 3 | 1 |
| CO4 | 2 | 1 | 2 | 2 | – | 3 | – | – | 3 | 2 | – | 3 | 2 | 1 |
| CO5 | 1 | 2 | 3 | 2 | 1 | 3 | – | – | 2 | 2 | 3 | 3 | 3 | 2 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Course Code & Course Title: | MEL 311- METROLOGY AND QUALITY ASSURANCE | | |
|---|---|---|---|
| Course Type: | DC | | |
| Name of the programme(s): | B. Tech. Mechanical Engineering | | |
| L – T – P | 3-0-0 | No. of Credits | 3 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) Provide fundamental knowledge of metrology, measurement systems, errors, and standards used in engineering practice.

ii) Familiarize students with precision measuring instruments and methods for form, surface, and angular measurements.

iii) Develop understanding of gauge design, limits, fits, tolerances, and calibration techniques.

iv) Introduce optical metrology, surface finish measurement, and machine tool metrology.

v) Equip students with principles of statistical quality control, acceptance sampling, and quality standards used in industry.

| 2. | Course Outcomes |
|---|---|
| CO1 | Explain fundamental concepts of metrology, measurement systems, standards, and errors. |
| CO2 | Apply precision and optical measurement techniques for dimensional and form measurements. |
| CO3 | Analyze gauge design, calibration procedures, surface finish, and machine tool metrology. |
| CO4 | Apply statistical quality control tools, acceptance sampling techniques, and quality standards to manufacturing processes. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| **Fundamentals of Metrology**<br>Metrology and measurements, Errors in measurement and standards, Precision<br>measuring instruments, Straightness, flatness, squareness, roundness measurement, Angular measurement, Principles of comparators | | CO1, CO2 | 3 |
| **Gauges, Limits and Fits**<br>Calibration of measuring instruments, Principles of gauge design, Types of gauges<br>Taylor's principle of gauge design, Limits, fits and tolerances | | CO3 | 3 |
| **Optical Metrology (CO2 – 10 Lectures)**<br>Interferometer: principle and sources of light, Optical flat: fringe patterns, Calibration and applications of optical flat, Tool maker's microscope, Profile projector | | CO2 | 3 |
| **Surface Finish and Machine Tool Metrology**<br>Surface texture terminology, Measurement of surface roughness and instruments, Alignment and performance tests of lathe, milling and drilling machines, Metrology of screw threads and Spur Gear. | | CO3 | 2 |
| **Statistical Quality Control and Quality Standards**<br>Basic statistics: mean, mode, standard deviation, frequency distribution, Control charts for variables and attributes, Process capability, Acceptance sampling: OC curve, AQL, LTPD, AOQL, Producer's and consumer's risk, Quality standards: ISO<br>9000:2001, Six Sigma. | | CO4 | 3 |

| 4. | Text books |
|---|---|


i) Gupta, I. C., *Engineering Metrology*, 1st Edition, Dhanpat Rai & Sons, 2000, ISBN: 978-8187433538.

ii) Jain, R. K., *Engineering Metrology*, 20th Edition, Khanna Publishers, 2013, ISBN: 978-8174091611.

iii) Mahajan, M., *Statistical Quality Control*, 1st Edition, Dhanpat Rai Publishers, 2012, ISBN: 978-8189928735.

| 5. | Reference Book(s) and Other Required Material |
|---|---|


i) Montgomery, D. C., Introduction to Statistical Quality Control, 7th Edition, John Wiley & Sons, 2013, ISBN: 978-1118146811.

ii) Juran, J. M., Gryna, F. M., Juran's Quality Handbook, 5th Edition, McGraw-Hill Education, 1998, ISBN: 978-0070340039.

iii) Smith, R., Engineering Metrology and Measurements, 1st Edition, McGraw-Hill Education, 2010, ISBN: 978-0070146891.


| 6. | Evaluation Details: |
|---|---|

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %

b) Teacher Defined Assessment: 20 %

c) End Semester Exam: 50-60 %

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | – | – | – | – | – | – | – | – | 2 | 1 | - |
| CO2 | 3 | 3 | 2 | 1 | 1 | – | – | – | – | – | – | 3 | 2 | - |
| CO3 | 3 | 3 | 3 | 2 | 2 | – | – | – | – | – | – | 3 | 3 | - |
| CO4 | 2 | 3 | 2 | 2 | 2 | – | – | – | – | – | 1 | 2 | 3 | - |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Course Code & Course Title: | MEL312 MECHANICAL MEASUREMENTS | | |
|---|---|---|---|
| Course Type: | DC | | |
| Name of the programme(s): | B. Tech. in Mechanical Engineering | | |
| L – T – P | 3-0-0 | No. of Credits | 3 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

**i)** The objective of this course is to introduce the principles, techniques, and instruments used for measurement of mechanical quantities.

**ii)** The course aims to develop understanding of sensor characteristics, measurement systems, error analysis, signal conditioning, and data acquisition for mechanical engineering applications.

| 2. | Course Outcomes |
|---|---|
| CO1 | Understand basic concepts of measurement systems, standards, errors, and calibration techniques. |
| CO2 | Identify and explain working principles of sensors and transducers used for measurement of mechanical quantities. |
| CO3 | Measure displacement, velocity, acceleration, force, torque, pressure, and flow using appropriate instruments. |
| CO4 | Analyze dynamic characteristics of measurement systems and apply signal conditioning techniques. |
| CO5 | Apply data acquisition and processing techniques for experimental measurements in mechanical systems. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| | **Topics** | **CO(s) Addressed** | **Duration in weeks** |
| | **Introduction to Measurements:** Measurement standards, units, accuracy, precision, errors, sensitivity, resolution, repeatability, hysteresis, static and dynamic characteristics of instruments, calibration methods. | CO1 | 3 |
| | **Sensors and Transducers:** Classification of sensors, mechanical, electrical, optical and smart sensors, resistive, inductive and capacitive transducers, strain gauges, Wheatstone bridge circuits. | CO2 | 2 |

| | | |
|---|---|---|
| **Measurement of Mechanical Quantities:** Measurement of displacement, velocity, acceleration, force, torque, pressure, and vibration using mechanical and electrical instruments. | CO3 | 2 |
| **Thermal and Flow Measurements:** Measurement of temperature (thermocouples, RTDs, thermistors), flow measurement techniques, pressure measurement devices. | CO4 | 3 |
| **Signal Conditioning and Data Acquisition:** Signal amplification, filtering, noise reduction, analog and digital data acquisition systems, basic introduction to computer-based measurement systems. | CO5 | 2 |

## 4. Text books

i) Raghuwanshi, B. P., *Mechanical Measurements and Instrumentation*, 1st Edition, Dhanpat Rai & Sons, 2005, ISBN: 978-8187433637.

ii) Doebelin, E. O., Manik, D. N., *Measurement Systems: Application and Design*, 5th Edition, McGraw-Hill Education, 2004, ISBN: 978-0072426323.

iii) Beckwith, T. G., Marangoni, R. D., Lienhard, J. H., *Mechanical Measurements*, 6th Edition, Pearson Education, 2007, ISBN: 978-8131700839.

## 5. Reference Book(s) and Other Required Material

i) Bentley, J. P., *Principles of Measurement Systems*, 4th Edition, Pearson Education, 2005, ISBN: 978-0130430281.

## 6. Evaluation Details:

a) Mid Semester Examination: Conducted after 40% syllabus completion, Weightage: 20–30%

b) Teacher Defined Assessment: Includes assignments, tutorials, quizzes, tests, presentations, etc. Must consist of minimum two components- One before Mid-Sem, One after Mid-Sem, Weightage: 20%

c) End Semester Examination: Comprehensive exam covering full syllabus, Weightage: 50–60%

## 7. Relationship of Course Outcomes to Program Outcomes:

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 2 | – | – | – | – | – | – | – | 2 | 2 | 1 |
| CO2 | 3 | 3 | 2 | 2 | – | – | – | – | – | – | – | 2 | 3 | 2 |
| CO3 | 2 | 3 | 2 | 2 | – | – | – | – | – | – | – | 2 | 3 | 2 |
| CO4 | 2 | 3 | 3 | 3 | – | – | – | – | – | – | – | 3 | 2 | 2 |
| CO5 | 2 | 2 | 3 | 3 | – | – | – | – | – | – | – | 2 | 3 | 3 |

*High - 3; Medium – 2; Low – 1;*

## 8. List of Indicative Laboratory Experiment (if applicable):

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEP314 MECHANICAL MEASUREMENT AND METROLOGY** | | |
| **Course Type:** | **DC** | | |
| **Name of the programme(s):** | **B. Tech. in Mechanical Engineering** | | |
| **L – T – P** | **0-0-2** | **No. of Credits** | 1 |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

To enable students to understand the standards, concepts and terminology of mechanical measurement and metrology, principles of measurements of linear, angular, surface parameters and other mechanical parameters on the shop floor, as well as mechanical properties

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Make students to apply the standards, concepts and terminology of mechanical metrology and principles of linear and angular measurements and instrumentation. |
| **CO2** | Able to apply and analyse the production drawings for dimensional and geometrical tolerances and the concepts of Surface roughness and machine tool metrology, and to apply the statistical quality control concepts and control charts for manufacturing. |
| **CO3** | Make students apply the concepts and terminology of mechanical measurement and the principles of various property measurement systems |
| **CO4** | Analyse and calibrate various mechanical measurement systems |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| | **Topics** | **CO(s) Addressed** | **Duration in weeks** |
| A. Experiments in Metrology lab (Any 7)<br>1. To perform Linear Measurements using Vernier calliper, Vernier Depth gauge, Vernier Height gauge, Micrometre etc.<br>2. To perform Angle measurements using Bevel Protractor & Sine bar.<br>3. Testing and calibration of Dial Gauge using Dial Calibration Tester.<br>4. Testing and calibration of Dial Gauge using Slip Gauges. | | | 7 |

| | | |
|---|---|---|
| 5. Calibration of Micrometre and Vernier Calliper using Slip Gauges.<br>6. Circularity Estimation using Dial Gauge<br>7. Study and use of optical flat for flatness testing.<br>8. To measure Major Diameter, Minor Diameter, Pitch and Thread Angle using<br>(a) Tool Makers Microscope and (b) Profile Projector.<br>9. Statistical Quality Control, Experimentation and Analysis using Minitab. | | |
| B. Experiments in Mechanical Measurements lab (Any 7)<br>1. Force Measurement using a load cell<br>2. Torque Measurement using a load cell<br>3. Displacement Measurement using Potentiometer (Linear/Angular)<br>4. Speed Measurement using Photo-Electric Transducer<br>5. Speed Measurement using Variable Reluctance Magnetic Pickup<br>6. Linear displacement measurement using inductive pick-up<br>7. Study of Dead Weight Pressure Tester<br>8. Temperature measurement using (a) RTD (b)Thermistor<br>9. Liquid level measurement using an ultrasonic transducer | | 7 |

| 4. | **Text books** |
|---|---|

i) Doebelin, E. O., Manik, D. N., *Measurement Systems: Application and Design*, 5th Edition, McGraw-Hill Education, 2004, ISBN: 978-0072426323.

ii) Gupta, I. C., *Engineering Metrology*, 1st Edition, Dhanpat Rai & Sons, 2000, ISBN: 978-8187433538.

| 5. | **Reference Book(s) and Other Required Material** |
|---|---|

i) Raghuwanshi, B. P., *Mechanical Measurements and Instrumentation*, 1st Edition, Dhanpat Rai & Sons, 2005, ISBN: 978-8187433637.

ii) Jain, R. K., *Engineering Metrology*, 20th Edition, Khanna Publishers, 2013, ISBN: 978-8174091611.

| 6. | **Evaluation Details:** |
|---|---|

Evaluation is continuous. Components are

i) Mid Semester Examination: Conducted after 40% experiments are completed, Weightage: 30%

ii) End Semester Examination: Comprehensive exam covering full syllabus, Weightage: 50%

Teacher Defined Assessment for (a) and (b): Includes quizzes, tests, performing any practical by an individual, viva, etc. Must consist of a minimum of two components- One before Mid-Sem, One after Mid-Sem, Weightage: 20%

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | - | 3 | 2 | 1 |
| CO2 | 3 | 2 | 3 | 2 | - | - | - | - | - | - | - | 3 | 2 | 1 |
| CO3 | 3 | 2 | 3 | 2 | - | - | - | - | - | - | - | 3 | 3 | 1 |
| CO4 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | - | 3 | 2 | 1 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| List of Experiments | Duration in weeks |
|---|---|
| A. Experiments in Metrology lab (Any 7)<br>1. To perform Linear Measurements using Vernier calliper, Vernier Depth gauge, Vernier Height gauge, Micrometre etc.<br>2. To perform Angle measurements using Bevel Protractor & Sine bar.<br>3. Testing and calibration of Dial Gauge using Dial Calibration Tester.<br>4. Testing and calibration of Dial Gauge using Slip Gauges.<br>5. Calibration of Micrometre and Vernier Calliper using Slip Gauges.<br>6. Circularity Estimation using Dial Gauge<br>7. Study and use of optical flat for flatness testing.<br>8 To measure Major Diameter, Minor Diameter, Pitch and Thread Angle using (a) Tool Makers Microscope and (b) Profile Projector.<br>9. Statistical Quality Control, Experimentation and Analysis using Minitab. | 7 |
| B. Experiments in Mechanical Measurements lab (Any 7)<br>1. Force Measurement using a load cell<br>2. Torque Measurement using a load cell<br>3. Displacement Measurement using Potentiometer (Linear/Angular)<br>4. Speed Measurement using Photo-Electric Transducer<br>5. Speed Measurement using Variable Reluctance Magnetic Pickup<br>6. Linear displacement measurement using inductive pick-up<br>7. Study of Dead Weight Pressure Tester<br>8. Temperature measurement using (a) RTD (b)Thermistor<br>9. Liquid level measurement using an ultrasonic transducer | 7 |

# Departmental Electives

# List of Electives: For Odd Semester

| Sr. No. | Course Code | Course Title | L–T–P | Credits | Course Type |
|---|---|---|---|---|---|
| 1 | MEL317 | Mobile Robotics | 3-0-0 | 3 | |
| 2 | MEL402 | Surface Engineering | 3-0-0 | 3 | Theory |
| 3 | MEL403 | Operation Research | 3-0-0 | 3 | Theory |
| 4 | MEL406 | Dynamics of Mechanical System | 3-0-0 | 3 | Theory |
| 5 | MEL407 | Bio Mechanics | 3-0-0 | 3 | Theory |
| 6 | MEL408 | Supply Chain Management | 3-0-0 | 3 | Theory |
| 7 | MEL410 | Computer Aided Design | 3-0-0 | 3 | Theory |
| 8 | MEP410 | | 0-0-2 | 1 | Practical |
| 9 | MEL412 | Air Conditioning | 3-0-0 | 3 | Theory |
| 10 | MEL414 | Tribology | 3-0-0 | 3 | Theory |
| 11 | MEL417 | Power Plant Engineering | 3-0-0 | 3 | Theory |
| 12 | MEL420 | Finite Element Method | 3-0-0 | 3 | Theory |
| 13 | MEP420 | | 0-0-2 | 1 | Practical |
| 14 | MEL425 | Reliability and Maintenance Engineering | 3-0-0 | 3 | Theory |
| 15 | MEL428 | Machine Tool Design | 3-0-0 | 3 | Theory |
| 16 | MEL431 | Advanced Mechanism | 3-0-0 | 3 | Theory |
| 17 | MEL433 | Design for Manufacturing and Assembly | 3-0-0 | 3 | Theory |
| 18 | MEL435 | Computational Fluid Dynamics | 3-0-0 | 3 | Theory |
| 19 | MEP435 | | 0-0-2 | 1 | Practical |
| 20 | MEL436 | Mechatronics | 3-0-0 | 3 | Theory |
| 21 | MEP436 | | 0-0-2 | 1 | Practical |
| 22 | MEL437 | Composite Materials | 3-0-0 | 3 | Theory |
| 23 | MEL439 | Product Design and Development | 3-0-0 | 3 | Theory |
| 24 | MEL440 | Machine Vision & Its Application | 3-0-0 | 3 | Theory |
| 25 | MEL452 | Advanced Machining Processes | 3-0-0 | 3 | Theory |
| 26 | MEL458 | Aerial Robotics | 3-0-0 | 3 | Theory |
| 27 | MEL4XX | Vehicle Dynamics | 3-0-0 | 3 | Theory |

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEL317 MOBILE ROBOTICS** | | |
| **Course Type:** | **DE** | | |
| **Name of the programme(s):** | **B. Tech. in Mechanical Engineering** | | |
| **L – T – P** | **3-0-0** | **No. of Credits** | **3** |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

**i)** The objective of this course is to provide students with a strong foundation in the principles, models, and algorithms of mobile robotics.

**ii)** The course aims to develop an understanding of mobile robot locomotion, kinematics, dynamics, sensing, localization, mapping, and motion planning.

**iii)** Emphasis is placed on enabling students to analyze, model, and simulate mobile robot behavior and to design autonomous navigation and obstacle avoidance solutions for real-world environments using computational tools.

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Explain the architecture, classification, and applications of mobile robotic systems, including locomotion mechanisms and system-level components. |
| **CO2** | Model and analyze the kinematics and motion of wheeled mobile robots using coordinate transformations, mobility constraints, and odometry principles. |
| **CO3** | Formulate and simulate the dynamic behavior of mobile robots using Newton–Euler and Lagrange–Euler methods, accounting for actuator and interaction effects. |
| **CO4** | Analyze and integrate sensing and perception systems for mobile robots, including sensor characteristics, noise modeling, calibration, and basic sensor fusion. |
| **CO5** | Design and implement autonomous navigation frameworks incorporating probabilistic localization, mapping (SLAM), motion planning, and obstacle avoidance using modern computational tools. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| | **Topics** | **CO(s) Addressed** | **Duration in weeks** |
| | Introduction to Mobile Robotics: Evolution of mobile robots; applications in industry, logistics, service robotics, agriculture, defense, | CO1 | 2 |

| | | |
|---|---|---|
| and healthcare; classification of mobile robots and mobile manipulators; system-level architecture of a mobile robot including sensing, computation, actuation, and control; principles of locomotion and terrain interaction | | |
| Locomotion and Kinematics of Mobile Robots: Types of locomotion mechanisms; kinematics of wheeled mobile robots; degrees of freedom, mobility and maneuverability; generalized wheel model; wheel–ground contact constraints; common wheel configurations (differential, Ackermann, omnidirectional); holonomic vs non-holonomic systems; forward and inverse kinematics | CO2 | 2 |
| State Representation and Motion Modeling: Coordinate frames and transformations; homogeneous transformations; robot pose representation; velocity kinematics; motion models for mobile robots; uncertainty modeling in motion; odometry and dead-reckoning | CO4 | 1 |
| Dynamics of Mobile Robots: Dynamic modeling using Newton–Euler and Lagrange–Euler formulations; force and torque analysis; actuator modeling; friction and slip effects; stability considerations; computer-based numerical simulation of mobile robot dynamics | CO3 | 2 |
| Sensors and Perception for Mobile Robots: Proprioceptive and exteroceptive sensors; position and inertial sensors (encoders, IMU, gyroscope, accelerometer); range sensors (ultrasonic, infrared, LiDAR); vision sensors (monocular, stereo); sensor characteristics, noise models, calibration, and sensor fusion basics | CO4 | 2 |
| Localization and Mapping: Problem formulation of localization; probabilistic state estimation; error propagation models; Bayesian filtering concepts; Kalman filter and particle filter overview; map representations; autonomous map building; simultaneous localization and mapping (SLAM) principles | CO5 | 2 |
| Motion Planning and Navigation: Configuration space; path planning vs trajectory planning; graph-based and sampling-based planners (conceptual overview); collision-free path planning; local planning; sensor-based obstacle avoidance; reactive vs deliberative navigation strategies | CO5 | 1.5 |
| Integrated Mobile Robot Navigation Framework: End-to-end navigation pipeline; interaction between perception, localization, planning, and control; case study on warehouse mobile robots; implementation of obstacle avoidance and navigation algorithms using MATLAB Robotics Toolbox | CO5 | 1.5 |

| 4. | Text books |
|---|---|

i) Siegwart, R., Nourbakhsh, I. R., Scaramuzza, D., *Introduction to Autonomous Mobile Robots*, 2nd Edition, MIT Press, USA, 2011, ISBN: 978-0262015356.

ii) Tzafestas, S. G., *Introduction to Mobile Robot Control*, 1st Edition, Elsevier (Academic Press), USA, 2014, ISBN: 978-0124170995.

iii) Kelly, A., *Mobile Robotics: Mathematics, Models, and Methods*, 1st Edition, Cambridge University Press, USA, 2013, ISBN: 978-1107031159.

| 5. | Reference Book(s) and Other Required Material |
|---|---|

i) Thrun, S., Burgard, W., Fox, D., *Probabilistic Robotics*, 1st Edition, MIT Press, USA, 2005, ISBN: 978-0262201629.

ii) Dudek, G., Jenkin, M., *Computational Principles of Mobile Robotics*, 2nd Edition, Cambridge University Press, USA, 2010, ISBN: 978-0521692120.

| 6. | Evaluation Details: |
|---|---|

Evaluation is continuous. Components are

a) Mid Semester Examination : Conducted after 40% syllabus completion, Weightage: 20–30%

b) Teacher Defined Assessment : Includes assignments, tutorials, quizzes, tests, presentations, etc. Must consist of minimum two components- One before Mid-Sem , One after Mid-Sem, Weightage: 20%

c) End Semester Examination : Comprehensive exam covering full syllabus, Weightage: 50–60%

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 1 | 2 | – | – | – | – | – | – | 2 | 2 | 1 |
| CO2 | 3 | 3 | 2 | 2 | 2 | – | – | – | – | – | – | 3 | 2 | 1 |
| CO3 | 3 | 3 | 2 | 3 | 2 | – | – | – | – | – | – | 3 | 2 | 2 |
| CO4 | 2 | 3 | 2 | 2 | 3 | – | – | – | – | – | – | 2 | 2 | 2 |
| CO5 | 2 | 3 | 3 | 3 | 3 | – | – | – | 2 | 2 | 2 | 3 | 2 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Course Code & Course Title: | MEL402 SURFACE ENGINEERING | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B. Tech. Mechanical Engineering | | |
| L – T – P | 3-0-0 | No. of Credits | 3 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) To introduce the need, classification, and surface preparation methods in surface engineering.

ii) To impart knowledge of surface hardening, thermochemical, mechanical, friction-based, hard-facing, and thermal spray techniques.

iii) To familiarize students with PVD, CVD, and advanced coating processes, including CVD diamond.

iv) To develop capability in characterization and application-based selection of surface engineering methods.

| 2. | Course Outcomes |
|---|---|
| CO1 | Explain fundamentals of surface engineering, surface preparation, PVD, CVD, and characterization techniques. |
| CO2 | Describe surface hardening, thermochemical diffusion, mechanical, friction-based, hard-facing, and thermal spray processes. |
| CO3 | Evaluate surface-engineered materials using microstructural, mechanical, and degradation characterization techniques. |
| CO4 | Select appropriate surface engineering techniques for specific engineering applications. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| | Topics | CO(s) Addressed | Duration in weeks |
| | Need for surface engineering, Classification of surface engineering methods and Surface Preparation. Surface Hardening without modification of surface chemistry. By changing surface metallurgy - Induction hardening, Flame hardening, Laser beam hardening and Electron beam hardening. Thermo Chemical Diffusion Treatments - Carburizing, nitriding and boriding techniques. | CO1, CO2 | 3 |

| | | |
|---|---|---|
| Mechanical treatments - Cold working, Shot peening and SMAT processes and Laser peening. Friction based - friction surfacing and friction stir processing techniques. | CO2, CO4 | 2 |
| Hard facing - selection of hard facing materials and techniques. Laser cladding and laser surface alloying. Thermal spraying techniques – Flame spraying, Oxy-fuel powder spraying, D-gun spraying, HVOF coating, Plasma spraying, Cold/kinetic spraying and Emerging Techniques such as liquid precursor spraying etc. | CO2, CO4 | 3 |
| Physical vapour deposition – PVD system, Thermal evaporation, Sputtering, Pulsed laser deposition, Electron beam deposition. Chemical Vapour Deposition (CVD) – CVD system, Hot wall and Cold wall reactors, Thermally activated and Plasma assisted CVD techniques. CVD diamond – A case study. | CO1, CO4 | 2 |
| Structural, microstructural and mechanical characterization techniques with focus on surface engineering – Metallography, Optical microscopy, SEM, EDS, XRD, Raman Spectroscopy, Microhardness, Coating Adhesion Strength, Evaluation of Degradation Performance of the Coatings. | CO1, CO3 | 2 |

## 4. Text books

i) Budinski, K. G., *Surface Engineering for Wear Resistance*, 1st Edition, Prentice Hall, Englewood Cliffs, 1988, ISBN: 978-0138779450.

ii) Ohring, M., *The Materials Science of Thin Films*, 2nd Edition, Academic Press Inc. (Elsevier), 2002, ISBN: 978-0125249751.

## 5. Reference Book(s) and Other Required Material

i) Morton, P. H., *Surface Engineering and Heat Treatment*, 1st Edition, Brookfield Press, 1991, ISBN: 978-0946943517.

## 6. Evaluation Details:

Continuous Evaluation: 20 Marks, Mid-exam: 30 Marks, End-exam: 50 Marks

## 7. Relationship of Course Outcomes to Program Outcomes:

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | – | 3 | – | – | 3 | 3 | 3 | – | 3 | | | |
| CO2 | 3 | 3 | 3 | 3 | – | 1 | 3 | 3 | 3 | – | 1 | | | |
| CO3 | 3 | 2 | 1 | 3 | – | – | 3 | 1 | 3 | 3 | 2 | | | |
| CO4 | 2 | 2 | 1 | 3 | – | 1 | 3 | 2 | 3 | – | 1 | | | |

*High - 3; Medium – 2; Low – 1;*

## 8. List of Indicative Laboratory Experiment (if applicable):

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEL 403: OPERATIONS RESEARCH** | | |
| **Course Type:** | **DE** | | |
| **Name of the programme(s):** | **B. Tech in Mechanical Engineering** | | |
| **L – T – P** | **3-0-0** | **No. of Credits** | 3 |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) To recognize the importance and value of Operations Research and mathematical modeling in solving practical problems in industry.

ii) To formulate a managerial decision problem into a mathematical model.

iii) To understand various Operations Research models and apply them to real-life problems,

iv) To use computer tools to solve a mathematical model for a practical problem.

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Students will be understood the history and importance of Operation Research for industrial applications. |
| **CO2** | Students will be able analyze and formulate real world problems into the mathematical model. |
| **CO3** | Students will be able solve complex decision making problems using mathematical tools of Operation Research. |
| **CO4** | Students will be able to develop and use computer programs for real world problems. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| Introduction to OR & basic OR models, definition, characteristics and limitations of OR. | | CO1 | 1 |
| Linear programming: solutions of LPP by graphical method and simplex method, formulation of dual of LPP. | | CO1, CO2 | 2 |
| Assignment model, travelling salesman problem by, Transportation Problems, transshipment model. | | CO1, CO2 | 2 |

| | | |
|---|---|---|
| Dynamic programming, structure and characteristics of dynamic programming, application of dynamic programming to resource allocation, inventory control & linear programming. | CO2, CO3 | 1 |
| Project management: drawing of network, CPM & PERT, Probability of completion of project, cost analysis of project, allocation and updating of networks. | CO2, CO3 | 3 |
| Replacement models: concept of equivalent, interest rate, present worth, economic evaluation of alternatives, group replacement models. Inventory control models, analysis of single product deterministic models. | CO2, CO3 | 2 |
| Waiting line situations, queuing theory and models (no derivations expected). Simulation concept and its application in waiting line situations, inventory and networks | CO4 | 2 |

## 4. Text books

i) Taha, H. A., *Operations Research: An Introduction*, 7th Edition, Prentice Hall, 2002, ISBN: 978-0130488084.

ii) Hillier, F. S., Lieberman, G. J., *Introduction to Operations Research*, 7th Edition, Tata McGraw Hill Education, 2002, ISBN: 978-0070449213.

iii) Ravindran, A., Phillips, D. T., Solberg, J. J., *Operations Research: Principles and Practice*, 2nd Edition, John Wiley & Sons, 2009, ISBN: 978-0470258835.

## 5. Reference Book(s) and Other Required Material

i) Mittal, K. V., Mohan, C., *Optimization Methods in Operations Research and Systems Analysis*, 1st Edition, New Age International Publishers, 2003, ISBN: 978-8122414912.

ii) Mohan, C., Deep, K., *Optimization Techniques*, 1st Edition, New Age International Publishers, 2009, ISBN: 978-8122420869.

iii) Chandra, S., Jayadeva, Mehra, A., *Numerical Optimization with Applications*, 1st Edition, Narosa Publishing House, 2009, ISBN: 978-8173199455.

## 6. Evaluation Details:

a) Mid Term Examination 30%
b) Continuous Evaluation 20%
c) End Term Examination 50%

## 7. Relationship of Course Outcomes to Program Outcomes:

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 3 | 3 | 3 | | | |
| CO2 | 2 | 3 | 3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 3 | | | |
| CO3 | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 3 | | | |
| CO4 | 2 | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 3 | 3 | 3 | | | |

*High - 3; Medium – 2; Low – 1;*

## 8. List of Indicative Laboratory Experiment (if applicable):

| Course Code & Course Title: | MEL 406: DYNAMICS OF MECHANICAL SYSTEM | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B. Tech. in Mechanical Engineering | | |
| L – T – P | 3-0-0 | No. of Credits | 3 |
| Pre-requisites: Course Code(s) & Name(s) | MEL301 | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

**i)** The objective of this course is to develop a strong foundation in the dynamics of mechanical systems using energy-based and analytical methods.

**ii)** The course aims to enable students to model, analyze, and predict the dynamic response of mechanical systems subjected to various forces and motions.

| 2. | Course Outcomes |
|---|---|
| CO1 | Understand fundamental principles of particle and rigid body dynamics using Newtonian and energy methods. |
| CO2 | Apply kinematics and kinetics concepts to analyze planar motion of rigid bodies. |
| CO3 | Formulate equations of motion for mechanical systems using work–energy and Lagrange's methods. |
| CO4 | Analyze free and forced vibration behavior of mechanical systems. |
| CO5 | Evaluate dynamic response and stability of single and multi-degree-of-freedom mechanical systems. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| Topics | | CO(s) Addressed | Duration in weeks |
| Review of Engineering Dynamics: Particle dynamics, kinematics and kinetics, Newton's laws, D'Alembert's principle, work and energy, impulse and momentum. | | CO1 | 2 |
| Dynamics of Rigid Bodies: Kinematics of rigid bodies in plane motion, instantaneous center of rotation, kinetic energy of rigid bodies, equations of motion for rigid bodies. | | CO2 | 2 |

| | | |
|---|---|---|
| Energy Methods and Equations of Motion: Principle of virtual work, generalized coordinates, Lagrange's equations, formulation of equations of motion for mechanical systems. | CO3 | 3 |
| Vibration Analysis: Free vibration of undamped and damped single degree-of-freedom systems, forced vibration, resonance, vibration isolation, response to harmonic excitation. | CO4 | 3 |
| Multi-Degree-of-Freedom Systems: Modeling of two degree-of-freedom systems, natural frequencies and mode shapes, introduction to continuous systems and stability concepts. | CO5 | 3 |

## 4. Text books

i) Rao, S. S., *Mechanical Vibrations*, 5th Edition, Pearson Education, 2011, ISBN: 978-0132128193.

ii) Meriam, J. L., Kraige, L. G., *Engineering Mechanics: Dynamics*, 7th Edition, John Wiley & Sons, 2012, ISBN: 978-0470614815.

iii) Meirovitch, L., *Methods of Analytical Dynamics*, 1st Edition, McGraw-Hill Book Company, 1970, ISBN: 978-0486647838.

## 5. Reference Book(s) and Other Required Material

i) Thomson, W. T., Dahleh, M. D., *Theory of Vibration with Applications*, 5th Edition, Pearson Education, 1998, ISBN: 978-0136514640.

## 6. Evaluation Details:

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %
b) Teacher Defined Assessment: 20 %
c) End Semester Exam: 50-60 %

## 7. Relationship of Course Outcomes to Program Outcomes:

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | – | – | – | – | – | – | – | – | 3 | 2 | 1 |
| CO2 | 3 | 3 | 2 | 2 | – | – | – | – | – | – | – | 3 | 2 | 1 |
| CO3 | 2 | 3 | 3 | 3 | – | – | – | – | – | – | – | 3 | 2 | 1 |
| CO4 | 2 | 3 | 2 | 3 | – | – | – | – | – | – | – | 3 | 2 | 2 |
| CO5 | 2 | 2 | 3 | 3 | – | – | – | – | – | – | – | 3 | 3 | 2 |

*High - 3; Medium – 2; Low – 1;*

## 8. List of Indicative Laboratory Experiment (if applicable):

| Course Code & Course Title: | MEL 407: BIO MECHANICS | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B. Tech. in Mechanical Engineering | | |
| L – T – P | 3-0-0 | No. of Credits | 3 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

The objective of this course is to introduce mechanical engineering principles applied to biological systems. The course aims to develop understanding of biomechanics of human body structures, movement, loading, material behavior of biological tissues, and analysis of bio-mechanical systems using engineering approaches.

| 2. | Course Outcomes |
|---|---|
| CO1 | Understand basic concepts of biomechanics and mechanical behavior of biological tissues. |
| CO2 | Analyze forces, stresses, and motions in human musculoskeletal systems. |
| CO3 | Apply kinematics and kinetics to study human movement and gait. |
| CO4 | Analyze biomechanics of joints, bones, muscles, and soft tissues under physiological loading. |
| CO5 | Apply engineering analysis to design and evaluation of biomedical devices and assistive systems. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| Topics | | CO(s) Addressed | Duration in weeks |
| Introduction to Biomechanics: Scope and applications of biomechanics, review of anatomy and physiology relevant to mechanical analysis, mechanical properties of biological tissues. | | CO1 | 2 |
| Biomechanics of Bone and Connective Tissues: Structure and mechanical behavior of bone, cartilage, ligaments and tendons, anisotropy and viscoelasticity of biological tissues. | | CO1, CO2 | 2 |
| Muscle Mechanics: Types of muscles, muscle contraction mechanisms, force–length and force–velocity relationships, modeling of muscle behavior. | | CO1, CO4 | 2 |

| | | |
|---|---|---|
| Kinematics and Kinetics of Human Motion: Analysis of human movement, joint kinematics, kinetics, free body diagrams of limbs, inverse dynamics. | CO3 | 3 |
| Gait and Posture Analysis: Walking and running mechanics, ground reaction forces, balance, posture control, ergonomics considerations. | CO4, CO5 | 2 |
| Biomechanics Applications: Orthopedic implants, prosthetics, orthotics, rehabilitation devices, sports biomechanics, introduction to injury biomechanics. | CO4, CO5 | 1 |

## 4. Text books

i) Fung, Y. C., *Biomechanics: Mechanical Properties of Living Tissues*, 2nd Edition, Springer, 1993, ISBN: 978-0387979472.

ii) Nordin, M., Frankel, V. H., *Basic Biomechanics of the Musculoskeletal System*, 3rd Edition, Lippincott Williams & Wilkins, 2001, ISBN: 978-0683302479.

iii) Winter, D. A., *Biomechanics and Motor Control of Human Movement*, 4th Edition, John Wiley & Sons, 2009, ISBN: 978-0470398180.

## 5. Reference Book(s) and Other Required Material

i) McGinnis, P. M., *Biomechanics of Sport and Exercise*, 3rd Edition, Human Kinetics, 2013, ISBN: 978-1450434188.

## 6. Evaluation Details:

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %
b) Teacher Defined Assessment: 20 %
c) End Semester Exam: 50-60 %

## 7. Relationship of Course Outcomes to Program Outcomes:

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | – | – | – | – | – | – | – | – | 2 | 2 | 1 |
| CO2 | 3 | 3 | 2 | 2 | – | – | – | – | – | – | – | 3 | 2 | 1 |
| CO3 | 2 | 3 | 2 | 3 | – | – | – | – | – | – | – | 3 | 2 | 1 |
| CO4 | 2 | 3 | 3 | 3 | – | – | – | – | – | – | – | 3 | 2 | 1 |
| CO5 | 2 | 2 | 3 | 3 | – | – | – | – | – | – | – | 3 | 3 | 2 |

*High - 3; Medium – 2; Low – 1;*

## 8. List of Indicative Laboratory Experiment (if applicable):

| Course Code & Course Title: | MEL408 SUPPLY CHAIN MANAGEMENT | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B.Tech. in Mechanical Engineering | | |
| L – T – P | 3-0-0 | No. of Credits | 3 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) Develop a system-level understanding of supply chains as interconnected networks of nodes and flows.
ii) Enable students to identify, model, and analyze relationships among suppliers, manufacturers, distributors, and customers.
iii) Introduce strategic, tactical, and operational decisions in supply chain management and their performance implications.
iv) Equip students with the ability to apply supply chain practices to real-life and simulated industrial scenarios.
v) Foster analytical skills to compare alternative supply chain structures and drivers under varying business contexts

| 2. | Course Outcomes |
|---|---|
| CO1 | Create and define supply chain nodes and their relationships in a network |
| CO2 | Outline supply chain structures for dedicated applications |
| CO3 | Identify basic elements of SCM and their roles |
| CO4 | Apply SCM practices to real-life or simulated networks |
| CO5 | Compare and evaluate multiple determinants of supply chain nodes |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| Topics | | CO(s) Addressed | Duration in weeks |
| Introduction to Supply Chains & Networks: Definition of Supply Chain and Supply Chain Networks. Evolution of SCM: From logistics to network competition. Supply chains as systems of nodes and links. Examples: Automotive, FMCG, E-commerce, Healthcare. Activity: Identify nodes in a familiar product supply chain | | CO1 | 1 |

| | | |
|---|---|---|
| Strategic View of Supply Chains: Role of SCM in: Economy, Organization, Competitive advantage. SCM challenges: cost, responsiveness, sustainability. Strategic vs operational decisions in SCM. Outcome Focus: Role of nodes at strategic level | CO1, CO2 | 1 |
| Supply Chain Strategy & Performance: Efficient vs Responsive supply chains. Performance measures: Cost, Service level, Flexibility, Risk. Strategy–performance alignment: Case snippet: Amazon vs Traditional Retail | CO3, CO4 | 1 |
| Push–Pull View & Production Strategies: Build-to-Stock (BTS), Build-to-Order (BTO), Push–Pull boundary and decoupling point. Impact on: Inventory, Lead time, Customer responsiveness. Network Mapping Exercise | CO3, CO4 | 1 |
| Supply Chain Key drivers: Inventory, Transportation, Facilities, Information, Sourcing, Pricing. Role of each driver at different nodes. Comparison Task: Driver dominance across industries. | CO5 | 1 |
| Supply Chain Metrics: Fill rate, OTIF, Inventory Metrics (Turns, DOS), Speed Metrics (Lead time, Cycle time), Financial Metrics (Cash-to-Cash cycle), Bad metrics and local optimization. Trade-off curves. Numerical illustrations | CO5 | 1 |
| Bullwhip Effect & Outsourcing: Causes, Consequences, Measurement. Bullwhip metrics. Outsourcing decisions: Cost, Capacity, Competency. Simulation / Spreadsheet demo | CO4, CO5 | 1 |
| Managing Material Flow: Inventory, Role of inventory in SCM. Types of inventories: Raw material, WIP, Finished goods. Inventory policies (conceptual overview). Inventory positioning in networks. Case-based discussion | CO3, CO4 | 1 |
| Managing Material Flow: Transportation & Facilities. Transportation modes and trade-offs. Network design fundamentals. Facility location decisions. Centralized vs decentralized networks. Design Exercise: Facility placement for a region. | CO3, CO4 | 1 |
| Managing Information Flow: Role of information in supply chains. Demand forecasting fundamentals. Forecast errors and their impact. Information distortion. Mini Activity: Forecast comparison | CO3, CO4 | 1 |
| Information Technology & SCM Software: Role of IT in SCM coordination. Overview of SCM software: ERP, APS, WMS, TMS. Visibility and data-driven SCM. Industry demonstration / video-based learning. | CO3, CO4 | 1 |
| Supply Chain Innovation & Integration: Internal and External. Cross-functional drivers. Agile and responsive supply chains. Supply chain restructuring. Industry Case Discussion | CO2, CO3 | 1 |
| Internet, Pricing & B2B Integration: Internet-enabled supply chains. E-SCM and digital platforms. Pricing and revenue management. B2B integration and collaboration. Case: Digital-first supply chains. | CO3, CO4 | 1 |
| Case Studies: National & International: End-to-end supply chain case analysis: Network design, Performance metrics, Drivers, Bullwhip | CO4, CO5 | 1 |

| | | |
|---|---|---|
| effect, Inventory & transportation planning. Comparison of: National vs International supply chains.<br>Final Assessment: Group presentation / report | | |

| 4. | **Text books** |
|---|---|

i) Chopra, S., Meindl, P., *Supply Chain Management: Strategy, Planning, and Operation*, 6th Edition, Pearson Education, 2016, ISBN: 978-0134731889.

ii) Simchi-Levi, D., Kaminsky, P., Simchi-Levi, E., *Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies*, 3rd Edition, McGraw-Hill Education, 2007, ISBN: 978-0073341521.

| 5. | **Reference Book(s) and Other Required Material** |
|---|---|

i) Christopher, M., *Logistics and Supply Chain Management*, 4th Edition, Pearson Education, 2016, ISBN: 978-1292083797.

ii) Heizer, J., Render, B., *Operations Management*, 11th Edition, Pearson Education, 2014, ISBN: 978-0132921145.

iii) Watson, M., Lewis, S., Cacioppi, P., Jayaraman, J., *Supply Chain Network Design: Applying Optimization and Analytics to the Global Supply Chain*, 1st Edition, Prentice Hall (Pearson Education), 2012, ISBN: 978-0133015461.

| 6. | **Evaluation Details:** |
|---|---|

a) CO-1 & CO-2 are strongly assessed through conceptual and design-oriented exam questions.

b) CO-3 is evaluated via theory-based questions and tutorials.

c) CO-4 is primarily assessed through assignments, simulations, and case studies.

d) CO-5 is emphasized through comparative, analytical, and application-based problems.

| 7. | **Relationship of Course Outcomes to Program Outcomes:** |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 1 | 1 | – | – | – | – | – | – | 3 | 2 | – |
| CO2 | 3 | 2 | 3 | 1 | 1 | 1 | – | – | – | – | – | 3 | 2 | – |
| CO3 | 2 | 1 | – | – | – | 1 | – | – | – | – | – | 2 | 1 | – |
| CO4 | 2 | 3 | 3 | 3 | 2 | 1 | – | – | 2 | 2 | 2 | 3 | 3 | – |
| CO5 | 2 | 3 | 2 | 2 | 1 | 1 | 1 | – | – | – | 1 | 3 | 2 | – |

*High - 3; Medium – 2; Low – 1;*

| 8. | **List of Indicative Laboratory Experiment (if applicable):** |
|---|---|

| Course Code & Course Title: | MEL410 COMPUTER AIDED DESIGN | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B. Tech. in Mechanical Engineering | | |
| L – T – P | 3-0-0 | No. of Credits | 3 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) The objective of this course is to introduce computer-aided techniques for geometric modeling, drafting, and design of mechanical components.

ii) The course aims to develop the ability to use CAD tools for creating 2D drawings, 3D solid models, assemblies, and engineering documentation used in product design and manufacturing.

| 2. | Course Outcomes |
|---|---|
| CO1 | Understand the fundamentals of computer-aided design and CAD system architecture. |
| CO2 | Create and modify 2D engineering drawings using standard CAD tools and conventions. |
| CO3 | Develop 3D solid and surface models of mechanical components. |
| CO4 | Create assembly models and generate engineering drawings from 3D models. |
| CO5 | Apply CAD tools for visualization, interference checking, and basic design validation. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| Topics | | CO(s) Addressed | Duration in weeks |
| Introduction to CAD: Evolution of CAD, CAD hardware and software, CAD system architecture, coordinate systems, geometric modeling concepts. | | CO1 | 2 |
| 2D Drafting and Detailing: Drawing entities, editing commands, layers, dimensioning, tolerances, fits, text, blocks, standard drafting practices. | | CO2 | 3 |
| 3D Solid Modeling: Wireframe, surface and solid modeling concepts, feature-based modeling, parametric modeling, constraints, sketching techniques. | | CO3 | 3 |

| | | |
|---|---|---|
| Assembly Modeling: Assembly constraints, bottom-up and top-down assembly approaches, interference and collision checking, exploded views. | CO4 | 2 |
| Engineering Documentation and Applications: Generation of part and assembly drawings, bill of materials, visualization, introduction to CAD–CAM–CAE integration. | CO5 | 2 |

## 4. Text books

i) Zeid, I., Sivasubramanian, R., *CAD/CAM: Theory and Practice*, 2nd Edition, McGraw-Hill Education, 2009, ISBN: 978-0070152489.

ii) Groover, M. P., Zimmers, E. W., *CAD/CAM: Computer-Aided Design and Manufacturing*, 1st Edition, Pearson Education, 1984, ISBN: 978-0131227064.

iii) Radhakrishnan, P., Subramanyan, S., Raju, V., *CAD/CAM/CIM*, 3rd Edition, New Age International Publishers, 2008, ISBN: 978-8122412482.

## 5. Reference Book(s) and Other Required Material

i) Onkar, S. N., Pande, S. S., *CAD/CAM: Principles and Applications*, 1st Edition, McGraw-Hill Education (India) Pvt. Ltd., 2008, ISBN: 978-0070152496.

## 6. Evaluation Details:

Evaluation is continuous. Components are

a) Mid Semester Examination : Conducted after 40% syllabus completion, Weightage: 20–30%

b) Teacher Defined Assessment : Includes assignments, tutorials, quizzes, tests, presentations, etc. Must consist of minimum two components- One before Mid-Sem , One after Mid-Sem, Weightage: 20%

c) End Semester Examination : Comprehensive exam covering full syllabus, Weightage: 50–60%

## 7. Relationship of Course Outcomes to Program Outcomes:

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | – | 2 | – | – | – | – | – | – | 2 | 2 | 2 |
| CO2 | 2 | 3 | 2 | – | 3 | – | – | – | – | – | – | 2 | 3 | 3 |
| CO3 | 2 | 3 | 3 | 2 | 3 | – | – | – | – | – | – | 3 | 3 | 3 |
| CO4 | 2 | 2 | 3 | 3 | 3 | – | – | – | – | – | – | 3 | 3 | 3 |
| CO5 | 2 | 2 | 3 | 3 | 3 | – | – | – | – | – | – | 3 | 2 | 3 |

*High - 3; Medium – 2; Low – 1;*

## 8. List of Indicative Laboratory Experiment (if applicable):

| Course Code & Course Title: | MEP410 COMPUTER AIDED DESIGN | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B. Tech. in Mechanical Engineering | | |
| L – T – P | 0-0-2 | No. of Credits | 1 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

To develop hands-on skills in computer-aided design by using graphics software, programming techniques, and finite element methods for modeling, analysis, optimization, and practical design of mechanical elements and systems

| 2. | Course Outcomes |
|---|---|
| CO1 | Use computer-aided design software and graphics programming techniques to create, transform, and manipulate engineering drawings and models. |
| CO2 | Develop and apply finite element–based programs and customized FEM software to analyze one-dimensional elements and stress problems in mechanical components. |
| CO3 | Perform design optimization and practical CAD applications using programming methods and standard drafting software tools such as AutoCAD and Pro-Engineer. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| Topics | | CO(s) Addressed | Duration in weeks |
| Development of software for design of any mechanical element and system. | | CO3 | 1 |
| Development of menu driven software for graphics using output primitives. | | CO1 | 1 |
| Development of software for transformation using scaling, rotation, reflection. | | CO1 | 1 |
| Development of software for clipping of graphical entities. | | CO2 | 1 |
| Development of software for analysis of one-dimensional element using FEM technique. | | CO2 | 1 |
| Software operation of customized FEM software. | | CO2 | 1 |

| | | |
|---|---|---|
| Development of computer program for analysis of mechanical element using FEM for user input values. | CO2 | 1 |
| Development of software for analysis of stress problem using FEM. | CO2 | 1 |
| Development of software for design optimization of mechanical element using Johnson method. | CO3 | 1 |
| Use of commands of any computer aided drafting software viz. AutoCAD, Pro-Engineer. | CO1, CO3 | 1 |

## 4. Text books

i) Zeid, I., Sivasubramanian, R., *CAD/CAM: Theory and Practice*, 2nd Edition, McGraw-Hill Education, 2009, ISBN: 978-0070152489.

ii) Groover, M. P., Zimmers, E. W., *CAD/CAM: Computer-Aided Design and Manufacturing*, 1st Edition, Pearson Education, 1984, ISBN: 978-0131227064.

iii) Radhakrishnan, P., Subramanyan, S., Raju, V., *CAD/CAM/CIM*, 3rd Edition, New Age International Publishers, 2008, ISBN: 978-8122412482.

## 5. Reference Book(s) and Other Required Material

i) Onkar, S. N., Pande, S. S., *CAD/CAM: Principles and Applications*, 1st Edition, McGraw-Hill Education (India) Pvt. Ltd., 2008, ISBN: 978-0070152496.

## 6. Evaluation Details:

Evaluation is continuous. Components are

**i)** Continuous Eval-I: 30–35%

**ii)** Continuous Eval-II: 30–40%

**iii)** Continuous Eval-III: 25–40%

## 7. Relationship of Course Outcomes to Program Outcomes:

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 3 | – | – | 1 | 2 | – | 2 | 3 | 3 | 2 | 2 | 3 |
| CO2 | 3 | 3 | 2 | – | – | 1 | 2 | – | 2 | 3 | 3 | 3 | 2 | 3 |
| CO3 | 3 | 2 | 3 | – | – | 1 | 2 | – | 3 | 3 | 3 | 3 | 3 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| List Experiments | Duration in weeks |
|---|---|
| Development of software for design of any mechanical element and system. | 1 |
| Development of menu driven software for graphics using output primitives. | 1 |
| Development of software for transformation using scaling, rotation, reflection. | 1 |
| Development of software for clipping of graphical entities. | 1 |
| Development of software for analysis of one-dimensional element using FEM technique. | 1 |
| Software operation of customized FEM software. | 1 |
| Development of computer program for analysis of mechanical element using FEM for user input values. | 1 |
| Development of software for analysis of stress problem using FEM. | 1 |
| Development of software for design optimization of mechanical element using Johnson method. | 1 |
| Use of commands of any computer aided drafting software viz. AutoCAD, Pro-Engineer. | 1 |

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEL412 AIR CONDITIONING** | | |
| **Course Type:** | **DE** | | |
| **Name of the programme(s):** | **B. Tech Mechanical Engineering** | | |
| **L – T – P** | **3-0-0** | **No. of Credits** | **3** |
| **Pre-requisites: Course Code(s) & Name(s)** | **MEL203: Engineering Thermodynamics**<br>**MEL302: Heat Transfer** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) The student should understand various definitions and theoretical concepts related to air conditioning like psychrometrics and psychrometric processes etc to meet UG level requirement.

ii) The student should understand the concepts related to comfort and its measurement, effective temperature, comfort chart and its use, methods of cooling load calculations, design process for summer /monsoon/winter air conditioning and duct design

iii) The student should understand working of various equipment/systems used in air conditioning like air washers, fans, pumps, pan humidifiers and room/package/central type air conditioners from undergraduate perspective.

**iv)** The student should understand and apply mathematical treatment to various problems related to psychrometrics, psychrometric processes, design of summer/ winter/monsoon air conditioning and duct design to reasonable correctness.

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | The student should be able to understand various definitions and theoretical concepts related to air conditioning like psychrometrics and psychrometric processes etc to meet UG level requirement. |
| **CO2** | The student should be able to understand the concepts related to comfort and its measurement, effective temperature, comfort chart and its use, methods of cooling load calculations, design process for summer /monsoon/winter air conditioning and duct design |
| **CO3** | The student should be able to understand working of various equipment/systems used in air conditioning like air washers, fans, pumps, pan humidifiers and room/package/central type air conditioners from undergraduate perspective. |
| **CO4** | The student should be able to understand and apply mathematical treatment to various problems related to psychrometrics, psychrometric processes, design of summer/ winter/monsoon air conditioning and duct design to reasonable correctness. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| **Fundamentals of Air conditioning**: Introduction to air conditioning, psychrometrics, important terms and definitions, enthalpy of air, adiabatic saturation temperature, measurement of properties, psychrometric chart, its construction and use. | | CO1, CO2 | 3 |
| **Psychrometric processes:** Mixing, mixing with condensation, sensible heating and cooling, humidification and dehumidification, bypass factor and its role, evaporative cooling, drying process, working of air-washer. | | CO1 | 2 |
| **Air-conditioning System Design:** Sensible heat factor, design of summer air conditioning system, calculation of dehumidified air quantity and apparatus dew point, ERSHF method, air-conditioning systems for monsoon and winter, air conditioning systems using all fresh air. | | CO2, CO3 | 3 |
| **Comfort and Cooling load Estimation**: Comfort and its requirements, mechanism of body heat loss, effect of heat on body and body defence mechanism, effective temperature, factors affecting human comfort, comfort chart and its use, Cooling load estimation, components of cooling load, sensible and latent loads, ASHRAE and CARRIER methods of load estimation. | | CO2, CO3 | 2 |
| **Industrial practices in Air conditioning:** General layout of central air conditioning Plant. Fans, types and characteristics, commissioning and testing of air conditioning systems. Applications of air conditioning, working of room air-conditioner and split air-conditioner and packaged air-conditioner. | | CO3, CO4 | 2 |
| **Air Distribution and duct design**: Components of air handling systems, principles of air distribution, types of supply and return air openings and related definitions, considerations for selection and location of supply and return air openings. Duct design: General duct design, rules, principles of duct design, equivalent diameter of ducts, ducting materials, frictionchart and its use, methods of duct design. | | CO3, CO4 | 2 |

| 4. | Text books |
|---|---|


i) Arora, C. P., *Refrigeration and Air Conditioning*, 3rd Edition, Tata McGraw Hill Education (India) Pvt. Ltd., 2016, ISBN: 978-9351343349.

ii) Ballaney, P. L., *Refrigeration and Air Conditioning*, 16th Edition, Khanna Publishers, 2013, ISBN: 978-8174091925.

iii) Domkundwar, S., *A Course in Refrigeration and Air Conditioning*, 1st Edition, Dhanpat Rai & Sons, 1980, ISBN: 978-8187433569.

iv) Ananthanarayanan, P. N., *Basic Refrigeration and Air Conditioning*, 4th Edition, McGraw Hill Education (India) Pvt. Ltd., 2013, ISBN: 978-0070150447.

| 5. | **Reference Book(s) and Other Required Material** |
|---|---|

i) Pita, E. G., *Air Conditioning Principles and Systems*, 4th Edition, Prentice Hall, 2001, ISBN: 978-0130925891.

ii) ASHRAE, *ASHRAE Handbook: Fundamentals*, SI Edition, ASHRAE Publications, 2017, ISBN: 978-1939200570.

iii) ASHRAE, *ASHRAE Handbook: HVAC Systems and Equipment*, SI Edition, ASHRAE Publications, 2016, ISBN: 978-1939200488.

iv) Carrier Corporation, *Handbook of Air Conditioning System Design*, 1st Edition, McGraw Hill, 1965, ISBN: 978-0070106635.

| 6. | **Evaluation Details:** |
|---|---|

One Mid sem exam of 30 Marks, two Class tests of 10 marks each (best of 10) and End sem exam of 60 marks.

| 7. | **Relationship of Course Outcomes to Program Outcomes:** |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 |
| CO3 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | **List of Indicative Laboratory Experiment (if applicable):** |
|---|---|

| Course Code & Course Title: | MEL414 TRIBOLOGY | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B. Tech. in Mechanical Engineering | | |
| L – T – P | 3-0-0 | No. of Credits | 3 |
| Pre-requisites: Course Code(s) & Name(s) | MEL202, MEL206 | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) The objective of this course is to introduce the science and engineering of interacting surfaces in relative motion.

ii) The course aims to develop understanding of friction, wear, lubrication mechanisms, and surface engineering concepts for design and analysis of machine elements.

| 2. | Course Outcomes |
|---|---|
| CO1 | Understand fundamental concepts of tribology, friction, wear, and lubrication mechanisms. |
| CO2 | Analyze frictional behavior of contacting surfaces under different operating conditions. |
| CO3 | Evaluate wear mechanisms and predict wear behavior of machine components. |
| CO4 | Apply principles of lubrication and hydrodynamic theory to bearing design and analysis. |
| CO5 | Select suitable materials, surface treatments, and lubricants for tribological applications. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| Topics | | CO(s) Addressed | Duration in weeks |
| Introduction to Tribology: Historical background, scope and importance of tribology, surface roughness, surface topography, real area of contact, adhesion and deformation. | | CO1 | 2 |
| Friction: Laws of friction, mechanisms of friction, friction of metals and non-metals, rolling friction, friction in machine elements, friction measurement techniques. | | CO2 | 2 |
| Wear: Types of wear—adhesive, abrasive, erosive, corrosive and fatigue wear, wear mechanisms, Archard's wear law, wear testing methods. | | CO3 | 3 |

| | | |
|---|---|---|
| Lubrication Theory: Types of lubrication, hydrodynamic lubrication theory, Reynolds equation, slider and journal bearings, hydrostatic and elastohydrodynamic lubrication. | CO4 | 3 |
| Tribological Materials and Applications: Lubricants and additives, solid lubricants, bearing materials, surface engineering and coatings, tribology in machine design applications. | CO5 | 2 |

## 4. Text books

i) Bhushan, B., *Introduction to Tribology*, 2nd Edition, John Wiley & Sons, 2013, ISBN: 978-1118403228.

ii) Stachowiak, G. W., Batchelor, A. W., *Engineering Tribology*, 4th Edition, Butterworth-Heinemann (Elsevier), 2013, ISBN: 978-0123970473.

iii) Hamrock, B. J., Schmid, S. R., Jacobson, B. O., *Fundamentals of Fluid Film Lubrication*, 2nd Edition, CRC Press (Taylor & Francis), 2004, ISBN: 978-0824753719.

## 5. Reference Book(s) and Other Required Material

i) Neale, M. J., *The Tribology Handbook*, 2nd Edition, Butterworth-Heinemann, 1995, ISBN: 978-0750611985.

## 6. Evaluation Details:

Evaluation is continuous. Components are;

i) Mid Semester Examination: Conducted after 40% syllabus completion, Weightage: 20–30%

ii) Teacher Defined Assessment: Includes assignments, tutorials, quizzes, tests, presentations, etc. Must consist of minimum two components- One before Mid-Sem, One after Mid-Sem, Weightage: 20%

iii) End Semester Examination: Comprehensive exam covering full syllabus, Weightage: 50–60%

## 7. Relationship of Course Outcomes to Program Outcomes:

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | – | – | – | – | – | – | – | – | 2 | 3 | 1 |
| CO2 | 3 | 3 | 2 | 2 | – | – | – | – | – | – | – | 3 | 2 | 1 |
| CO3 | 2 | 3 | 3 | 2 | – | – | – | – | – | – | – | 3 | 2 | 1 |
| CO4 | 2 | 3 | 3 | 3 | – | – | – | – | – | – | – | 3 | 3 | 1 |
| CO5 | 2 | 2 | 3 | 3 | – | – | – | – | – | – | – | 2 | 3 | 2 |

*High - 3; Medium – 2; Low – 1;*

## 8. List of Indicative Laboratory Experiment (if applicable):

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEL417 POWER PLANT ENGINEERING** | | |
| **Course Type:** | **DE** | | |
| **Name of the programme(s):** | **B. Tech** | | |
| **L – T – P** | **3-0-0** | **No. of Credits** | **3** |
| **Pre-requisites: Course Code(s) & Name(s)** | **MEL203, MEL302, MEL303, MEL429** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) Understand the classification, layout, and operating principles of conventional and modern power plants in the Indian and global context.

ii) Analyze fuel properties, combustion processes, boiler performance, and thermal efficiency of power generation systems.

iii) Apply thermodynamic principles to the analysis and performance evaluation of coal- and gas-based power plants, including combined cycles.

iv) Understand the fundamentals, safety aspects, and regulatory requirements of nuclear power generation.

v) Analyze renewable energy–based power plants with emphasis on emerging technologies, grid integration, sustainability, and techno-economic considerations.

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Explain power plant classifications, components, and Indian and global power generation scenarios. Analyze fuel properties, combustion processes, and boiler performance. |
| **CO2** | Analyze coal and gas-based power plants, thermodynamic cycles, and combined cycle performance. Evaluate power plant components and systems for efficient operation and design. |
| **CO3** | Explain nuclear power generation principles, safety, and regulatory aspects. |
| **CO4** | Analyze renewable energy–based power plants and advanced operational technologies. |
| **CO5** | Evaluate sustainability, life cycle, grid integration, and policy aspects of power plants. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| **Introduction and fundamentals:** Leading industries in India, classifications, leading power-generating states, global power generation | | CO1 | 3 |

| | | |
|---|---|---|
| scenario, selection factors for a particular type of power plant, advantages and disadvantages of each power plant type, boiler accessories, material flow networks, major areas of a power plant, etc. | | |
| **Fuels and combustion:** Properties of fuel, calorific value of fuel, analysis of combustion product by mass and by volume, analysis of flue gas, heat balance for the boiler, boiler efficiency, etc. | CO1, CO2 | 2 |
| **Coal and gas-based power plants:** Increasing cycle efficiencies, steam turbines, steam generator, Rankine cycle, Brayton cycle, transition piece, liner, shrouds, condensers, cooling system, thermodynamic analysis for optimum design, advantages and performance of combined cycles, economics of combined cycle, problem solving, etc. | CO2, CO5 | 3 |
| **Nuclear power plant:** Fundamentals of nuclear power generation, fission & role of neutron energy, neutron multiplication factor, different control mechanisms & various effects, hydrogen fusion reactions, regulatory requirements, nuclear safety, etc. | CO3, CO5 | 2 |
| **Renewable energy-based power plants:** hybrid renewable power plants, floating solar power plants, Agrivoltaic solar power plants, green hydrogen–based power plants, AI and digital twins for power plant performance, autonomous operation of renewable power plants, grid integration of renewable power plants, net-zero energy power plants, life cycle assessment of renewable power plants, sustainability of renewable power plants, policy, economics, and carbon markets, etc. | CO4, CO5 | 4 |

| 4. | **Text books** |
|---|---|


i) Nag, P. K., *Power Plant Engineering*, 4th Edition, Tata McGraw Hill Education (India) Pvt. Ltd., New Delhi, 2014, ISBN: 978-1259005275.

ii) Domkundwar, A. S., *Power Plant Engineering*, 6th Edition, Dhanpat Rai & Sons, New Delhi, 2000, ISBN: 978-8187433897.

iii) Drbal, L. F., Westra, K. L., Boston, P. G. (Eds.), *Power Plant Engineering*, 2nd Edition, Springer Science & Business Media, 2012, ISBN: 978-1461304234.


| 5. | **Reference Book(s) and Other Required Material** |
|---|---|


i) Sarkar, D., *Thermal Power Plant: Design and Operation*, 1st Edition, Elsevier (Academic Press), 2015, ISBN: 978-0128015759.

ii) NTPC Ltd., NPTI, BHEL, *Power Plant Engineering Training Manual*, 1st Edition, NTPC / NPTI / BHEL Publications, India, 2010.

| 6. | Evaluation Details: |
|---|---|

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %
b) Teacher Defined Assessment: 20 %
c) End Semester Exam: 50-60 %

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 3 | 2 | 1 |
| CO2 | 3 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 2 | 1 |
| CO3 | 3 | 2 | 3 | 1 | 3 | 1 | 1 | 2 | 1 | 1 | 2 | 3 | 3 | 1 |
| CO4 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 1 | 1 | 2 | 2 | 3 | 2 |
| CO5 | 2 | 1 | 2 | 1 | 2 | 1 | 3 | 2 | 1 | 1 | 2 | 1 | 2 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Course Code & Course Title: | MEL420 FINITE ELEMENT METHOD | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B. Tech. in Mechanical Engineering | | |
| L – T – P | 3-0-0 | No. of Credits | 3 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) The objective of this course is to introduce the finite element method as a numerical technique for solving complex engineering problems.

ii) The course aims to develop the ability to discretize physical systems, formulate element equations, assemble global matrices, and interpret numerical solutions for structural, thermal, and mechanical engineering applications.

| 2. | Course Outcomes |
|---|---|
| CO1 | Explain the fundamentals, formulation steps, and applications of the finite element method. |
| CO2 | Formulate finite element equations for one-dimensional structural and thermal problems. |
| CO3 | Apply finite element formulation to two-dimensional problems using appropriate elements and shape functions. |
| CO4 | Analyze structural and thermal problems using FEM concepts and interpret numerical results. |
| CO5 | Use commercial FEM software for modeling, analysis, and validation of engineering problems. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| Topics | | CO(s) Addressed | Duration in weeks |
| Introduction to Finite Element Method: need for numerical methods, basic concepts, terminology, steps in FEM, discretization, types of elements, degrees of freedom | | CO1 | 2 |
| Mathematical preliminaries and FEM formulation: matrix algebra review, interpolation functions, weighted residual methods, variational formulation, Rayleigh–Ritz and Galerkin methods, assembly of global equations, boundary conditions. | | CO2 | 3 |

| | | |
|---|---|---|
| One-dimensional finite element analysis: axial bar elements, beam elements, formulation of stiffness matrix, displacement and stress computation, one-dimensional heat conduction problems | CO2 | 2 |
| Two-dimensional finite element analysis: plane stress and plane strain problems, triangular and quadrilateral elements, isoparametric formulation, numerical integration, convergence and error estimation | CO3, CO4 | 3 |
| Applications of FEM and FEM software: structural and thermal applications, preprocessing, meshing, post-processing, result interpretation, validation and limitations | CO4, CO5 | 2 |

## 4. Text books

i) Reddy, J. N., *An Introduction to the Finite Element Method*, 3rd Edition, McGraw-Hill Education, 2006, ISBN: 978-0072466850.

ii) Chandrupatla, T. R., Belegundu, A. D., *Introduction to Finite Elements in Engineering*, 4th Edition, Pearson Education, 2012, ISBN: 978-0132162749.

## 5. Reference Book(s) and Other Required Material

i) Cook, R. D., Malkus, D. S., Plesha, M. E., Witt, R. J., *Concepts and Applications of Finite Element Analysis*, 4th Edition, John Wiley & Sons, 2001, ISBN: 978-0471356059.

ii) Logan, D. L., *A First Course in the Finite Element Method*, 5th Edition, Cengage Learning, 2011, ISBN: 978-0495668251.

## 6. Evaluation Details:

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %

b) Teacher Defined Assessment: 20 %

c) End Semester Exam: 50-60 %

## 7. Relationship of Course Outcomes to Program Outcomes:

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 3 | 2 | – | – | – | 2 | 2 | 3 | 3 | 2 | 1 |
| CO2 | 3 | 3 | 2 | 3 | 2 | – | – | – | 2 | 2 | 3 | 3 | 2 | 1 |
| CO3 | 3 | 3 | 3 | 3 | 2 | – | – | – | 2 | 2 | 3 | 3 | 2 | 2 |
| CO4 | 3 | 2 | 3 | 3 | 2 | – | – | – | 2 | 2 | 3 | 3 | 3 | 2 |
| CO5 | 2 | 2 | 3 | 2 | 3 | – | – | – | 2 | 2 | 3 | 2 | 2 | 3 |

*High - 3; Medium – 2; Low – 1;*

## 8. List of Indicative Laboratory Experiment (if applicable):

| Course Code & Course Title: | MEP420 FINITE ELEMENT METHOD | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B. Tech. in Mechanical Engineering | | |
| L – T – P | 0-0-2 | No. of Credits | 1 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

To develop the ability to model, analyze, and interpret structural and thermal engineering problems using the Finite Element Method by understanding discretization strategies, formulation of element and global matrices, solution of linear and nonlinear systems, and validation of numerical results through analytical solutions and commercial FEM tools such as ANSYS.

| 2. | Course Outcomes |
|---|---|
| CO1 | Formulate and solve structural and thermal problems using the Finite Element Method, including trusses, beams, frames, and heat conduction systems. |
| CO2 | Analyze the effects of discretization strategies, element formulations, and matrix assembly techniques on accuracy, convergence, and deformation or stress predictions. |
| CO3 | Implement FEM solutions for linear, nonlinear, and modal analysis problems using numerical coding approaches and commercial software tools such as ANSYS-APDL and ANSYS-Workbench. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| Topics | | CO(s) Addressed | Duration in weeks |
| Effect of h-type and p-type refinement on convergence in numerical approximation of area under a curve | | CO2 | 1 |
| Series and Parallel Spring Systems: Assembly of Global Stiffness Matrix and Visualization of Deformation | | CO1, CO2 | 1 |
| Axial Bar with Non-linear Taper | | CO1 | 1 |
| Analysis of a 2D truss using penalty method | | CO1 | 1 |
| Beam Deflection using Finite Element Method (FEM) and Comparison with Analytical Solution | | CO1 | 1 |

| | | |
|---|---|---|
| Modal Analysis: Discrete and Continuous systems with consistent matrix and lumped matrix formulation approach | CO2, CO3 | 1 |
| Deformation and stress analysis of a real structure using frame elements | CO1, CO3 | 1 |
| Heat conduction problem using 2D FEM | CO1 | 1 |
| Implementation of selected problems in ANSYS-APDL | CO3 | 1 |
| Implementation of selected problems in ANSYS-Workbench | CO3 | 1 |

## 4. Text books

i) Reddy, J. N., *An Introduction to the Finite Element Method*, 3rd Edition, McGraw-Hill Education, 2006, ISBN: 978-0072466850.

ii) Chandrupatla, T. R., Belegundu, A. D., *Introduction to Finite Elements in Engineering*, 4th Edition, Pearson Education, 2012, ISBN: 978-0132162749.

## 5. Reference Book(s) and Other Required Material

i) Cook, R. D., Malkus, D. S., Plesha, M. E., Witt, R. J., *Concepts and Applications of Finite Element Analysis*, 4th Edition, John Wiley & Sons, 2001, ISBN: 978-0471356059.

ii) Logan, D. L., *A First Course in the Finite Element Method*, 5th Edition, Cengage Learning, 2011, ISBN: 978-0495668251.

## 6. Evaluation Details:

Evaluation is continuous. Components are;

1. Continuous Eval-I: 30–35%,
2. Continuous Eval-II: 30–40%,
3. Continuous Eval-III: 25–40%

## 7. Relationship of Course Outcomes to Program Outcomes:

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | 3 | – | 1 | – | 2 | 3 | 3 | 3 | 3 | 2 |
| CO2 | 3 | 2 | 2 | 3 | 3 | – | 1 | – | 3 | 2 | 3 | 3 | 2 | 2 |
| CO3 | 3 | 2 | 3 | 2 | 2 | – | 1 | – | 3 | 3 | 3 | 3 | 2 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| | |
|---|---|
| Effect of h-type and p-type refinement on convergence in numerical approximation of area under a curve | 1 |
| Series and Parallel Spring Systems: Assembly of Global Stiffness Matrix and Visualization of Deformation | 1 |
| Axial Bar with Non-linear Taper | 1 |
| Analysis of a 2D truss using penalty method | 1 |
| Beam Deflection using Finite Element Method (FEM) and Comparison with Analytical Solution | 1 |
| Modal Analysis: Discrete and Continuous systems with consistent matrix and lumped matrix formulation approach | 1 |
| Deformation and stress analysis of a real structure using frame elements | 1 |
| Heat conduction problem using 2D FEM | 1 |
| Implementation of selected problems in ANSYS-APDL | 1 |
| Implementation of selected problems in ANSYS-Workbench | 1 |

| Course Code & Course Title: | MEL 425: RELIABILITY AND MAINTENANCE ENGINEERING | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B. Tech. Mechanical Engineering | | |
| L – T – P | 3-0-0 | No. of Credits | 3 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) Plan, design, and execute effective maintenance strategies and practices in various industries.

ii) Apply Reliability-Centered Maintenance (RCM)–based tools to analyze and prioritize defects and failures.

iii) Use state-of-the-art condition monitoring technologies and instrumentation.

iv) Apply essential reliability theory and engineering concepts.

v) Develop, implement, and enhance reliability programs for improved system performance.

| 2. | Course Outcomes |
|---|---|
| CO1 | Understand reliability, maintainability, and availability concepts. |
| CO2 | Analyze failures using FTA, FMEA, downtime, and breakdown analysis. |
| CO3 | Select appropriate maintenance strategies. Plan and manage maintenance activities and documentation. |
| CO4 | Apply condition monitoring techniques. |
| CO5 | Evaluate reliability-based maintenance using models and indices. Apply reliability concepts in design and manufacturing. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| **Unit I: Introduction to Reliability and Maintainability:** Engineering reliability: definition and concepts, Reliability assurance, Reliability through redundancy<br>Maintainability: definition and importance, Maintainability improvement techniques Maintainability *vis-à-vis* maintenance | | CO1, CO5 | 2 |
| **Unit II: Maintenance Techniques and Defect / Failure Analysis:** Dismantling and assembling, Inspection and adjustment, Lubrication and maintenance cleaning, Welding, metal spraying, metal stitching, Defect recording and failure analysis Downtime analysis and breakdown analysis, Fault Tree Analysis (FTA), Failure Modes and Effects Analysis (FMEA) | | CO2, CO3 | 3 |
| **Unit III: Maintenance Systems and Condition Monitoring:** Planned and unplanned maintenance, Breakdown, corrective, opportunistic, routine maintenance, Preventive and predictive maintenance, Condition-based maintenance systems, Design-out maintenance, Selection of maintenance systems, Online and offline monitoring, Visual, temperature, leakage, vibration monitoring, Ferrography and spectrography, Crack, corrosion, noise/sound, smell/odour monitoring, Condition monitoring of lubrication systems, hydraulic systems, and cross-country pipelines | | CO3, CO4 | 3 |
| **Unit IV: Maintenance Planning, Scheduling and Documentation:** Maintenance planning concepts, Job planning and job manuals, Long-term and short- term maintenance plans, Overhauls and renovation, Machine Replacement Analysis, Codification and cataloguing, Equipment history cards, Instruction and operation manuals, Maintenance work orders and work permits, Maintenance records: benefits, procedures, and steps | | CO3 | 2 |
| **Unit V: Reliability-Based Maintenance and Reliability Models:** Reliability-based maintenance (RBM) concepts, Evaluation of RBM programs, Failure rate and reliability indices, MTTF, MTBF, MTTR, MTBM, MTBS, Hazard models, Weibull distribution, Constant and linearly increasing hazard rate models System reliability, Logic diagrams, Markov models, Boolean algebra and De Morgan's theorem | | CO5 | 3 |
| **Unit VI: Reliability in Design and Manufacturing:** Reliability considerations in design and manufacturing, Design analysis methods, FMECA and HAZOPS, Parts, Materials, and Process (PMP) review, Software reliability concepts, Reliability and quality management approaches | | CO5 | 1 |

| 4. | Text books |
|---|---|

i) Ebeling, C. E., *An Introduction to Reliability and Maintainability Engineering*, 1st Edition, Tata McGraw-Hill Education, New Delhi, 2000, ISBN: 978-0071160209.

ii) Balagurusamy, E., *Reliability Engineering*, 1st Edition, Tata McGraw-Hill Education, New Delhi, 1984, ISBN: 978-0074511282.

iii) Shrivastava, S. K., *Industrial Maintenance Management*, 1st Edition, S. Chand & Company Ltd., New Delhi, 2004, ISBN: 978-8121924702.

iv) Ramesh, M., *Maintenance and Plant Engineering*, 1st Edition, New Age International Publishers, New Delhi, 2004, ISBN: 978-8122415476.

| 5. | Reference Book(s) and Other Required Material |
|---|---|

i) Kapoor, K. C., Lamberson, L. R., *Reliability in Engineering Design*, 1st Edition, John Wiley & Sons, 1977, ISBN: 978-0471021179.

ii) O'Connor, P. D. T., Kleyner, A., *Practical Reliability Engineering*, 5th Edition, John Wiley & Sons, 2012, ISBN: 978-0470979822.

iii) Billinton, R., Allan, R. N., *Reliability Evaluation of Engineering Systems: Concepts and Techniques*, 2nd Edition, Plenum Press / Springer, 1992, ISBN: 978-0306440632.

| 6. | Evaluation Details: |
|---|---|

Continuous Evaluation: 20 Marks, Mid-exam: 30 Marks, End-exam: 50 Marks

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | – | – | – | – | – | – | – | – | – | 2 | – | |
| CO2 | 3 | 3 | 2 | 2 | – | – | – | – | – | – | – | 2 | 2 | |
| CO3 | 3 | 3 | 3 | 2 | – | – | – | – | – | – | – | 3 | 2 | |
| CO4 | 2 | 2 | 2 | 2 | 3 | – | – | – | – | – | – | 2 | 3 | |
| CO5 | 2 | 2 | – | – | 2 | 2 | – | – | 2 | 2 | 3 | 2 | – | |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Course Code & Course Title: | MEL428 MACHINE TOOL DESIGN | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B. Tech. in Mechanical Engineering | | |
| L – T – P | 3-0-0 | No. of Credits | 3 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) Know basic principles of design of machine tools.
ii) Establish the design criteria for different systems in machine tools.
iii) Design the various systems in machine tools.
iv) Apply principles of ergonomics in machine tool design.
v) Select appropriate standards for testing of machine tools.

| 2. | Course Outcomes |
|---|---|
| CO1 | Understand functions of basic systems in machine tools and principles of their design |
| CO2 | Select appropriate design criteria for machine tool elements |
| CO3 | Design basic systems in machine tools like structures, speed/feed drives, guideways etc. |
| CO4 | Apply ergonomic principles in the design of machine tool controls |
| CO5 | Select testing procedures and standards for machine tools |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| Topics | | CO(s) Addressed | Duration in weeks |
| Introduction and Principles of Machine Tool Design | | CO1 | 1 |
| Design of Machine Tool Structures | | CO1, CO2, CO3 | 3 |
| Regulation of Speeds and Feeds | | CO1, CO2, CO3 | 3 |
| Design of Spindles and Spindle Supports | | CO1, CO2, CO3 | 1 |
| Design of Guide ways | | CO1, CO2, CO3 | 1 |
| Machine Tool Dynamics and Vibration Behaviour | | CO3 | 3 |
| Ergonomics and Controls in Machine Tools | | CO4 | 1 |

| | | |
|---|---|---|
| Testing of Machine Tools | CO5 | 1 |

| 4. | Text books |
|---|---|

i) Mehta, N. K., *Machine Tool Design and Numerical Control*, 1st Edition, Tata McGraw Hill Education, 2017, ISBN: 978-0074637425.

ii) Basu, S. K., Pal, D. K., *Design of Machine Tools*, 5th Edition, Oxford & IBH Publishing Company Pvt. Ltd., New Delhi, 2011, ISBN: 978-8120417040.

iii) Lisitsyn, N., Kudryashov, A. V., Trifonov, O., *Machine Tool Design*, 4th Edition, University Press of the Pacific, 2000, ISBN: 978-0898754711.

iv) Boothroyd, G., Knight, W. A., *Fundamentals of Machining and Machine Tools*, 3rd Edition, CRC Press (Taylor & Francis Group), New Delhi, 2006, ISBN: 978-1574446593.

| 5. | Reference Book(s) and Other Required Material |
|---|---|

i) Central Manufacturing Technology Institute (CMTI), *Machine Tool Design Handbook*, 1st Edition, Kojo Press, 2024

ii) Joshi, P. H., *Machine Tools Handbook: Design and Operation*, 1st Edition, McGraw Hill Education, 2007, ISBN: 978-0070964150.

| 6. | Evaluation Details: |
|---|---|

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %

b) Teacher Defined Assessment: 20 %

c) End Semester Exam: 50-60 %

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 3 | 2 | 3 | 3 | 2 | 3 |
| CO2 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 1 | 3 | 3 | 3 | 3 | 2 | 2 |
| CO3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 2 | 1 | 1 | 1 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 2 | 2 |
| CO5 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 1 | 3 | 3 | 3 | 3 | 2 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEL431 ADVANCED MECHANISM** | | |
| **Course Type:** | **DE** | | |
| **Name of the programme(s):** | **B. Tech. in Mechanical Engineering** | | |
| **L – T – P** | **3-0-0** | **No. of Credits** | **3** |
| **Pre-requisites: Course Code(s) & Name(s)** | **MEL313** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) The objective of this course is to provide students with a strong theoretical foundation in the kinematics of mechanisms and in the analysis and synthesis of mechanical systems.

ii) The course aims to familiarize students with both basic and advanced computer-based engineering tools used for the analysis and design of linkages, and to develop the ability to apply theoretical concepts and practical engineering tools effectively in carrying out a comprehensive mechanism design project.

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Explain fundamental concepts of kinematics, types of mechanisms, mobility criteria, and kinematic chains using Grashof and Grübler criteria. |
| **CO2** | Apply graphical and analytical synthesis techniques for position generation problems including two-, three-, and four-position synthesis and Burmester theory. |
| **CO3** | Apply function generation techniques using relative pole, inversion, overlay methods, and evaluate errors using Chebyshev spacing and Freudenstein's equation. |
| **CO4** | Analyze and synthesize path generation problems using graphical, complex number, and infinitesimal position methods, including coupler curves and cognate linkages. |
| **CO5** | Apply advanced synthesis methods for planar and spatial mechanisms, including optimal synthesis techniques, least-square method, and kinematic analysis of robot arms using D-H notation. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| Introduction to Kinematics and Mechanism Fundamentals: Introduction to kinematics, types of mechanisms, kinematic synthesis, science of relative motion, tasks of kinematic synthesis, degree of freedom, class-I | | CO1 | 2 |

| | | |
|---|---|---|
| and class-II chains, Harding's notation, Grashof criterion, Grübler's criterion | | |
| Position Generation – Graphical Methods: Introduction to position generation problem, concept of pole, two- and three-position synthesis, pole triangle, relationship between moving and fixed pivots, four-position synthesis, opposite pole quadrilateral, center-point and circle-point curves, Burmester's point | CO2 | 2 |
| Position Generation – Analytical Methods: Matrix method for position generation problems, rotation matrix, displacement matrix | CO2 | 1 |
| Function Generation: Introduction to function generation problem, coordination of input–output link motion, relative pole technique, inversion technique, overlay technique, graphical synthesis of quick-return mechanisms, optimum transmission angle, types of errors, accuracy points, Chebyshev spacing, Freudenstein's equation | CO3 | 2 |
| Path Generation – Graphical Methods: Introduction to path generation problem, synthesis for path generation with and without prescribed timing using graphical methods, coupler curves, cognate linkages, Robert's law of cognate linkages | CO4 | 2 |
| Path Generation – Analytical and Advanced Methods: Complex number method for path generation (three precision points), synthesis for infinitesimally separated positions, concept of polode and centrod, Euler–Savary equation, inflection circle, Bobillier and Hartmann constructions | CO4 | 2 |
| Optimal and Spatial Mechanism Synthesis: Optimal synthesis of planar mechanisms, least square method, introduction to spatial mechanisms, Denavit–Hartenberg (D-H) notation, introduction to kinematic analysis of robot arms | CO5 | 1 |

| 4. | **Text books** |
|---|---|


i) Tad, D. C., *Applied Linkage Synthesis*, 1st Edition, Addison-Wesley Publishing Company, 1964, ISBN: 978-0201072556.

ii) ii) Sandor, G. N., Erdman, A. G., *Advanced Mechanism Design: Analysis and Synthesis*, 1st Edition, Prentice Hall Inc., 1984, ISBN: 978-0130116840.


| 5. | **Reference Book(s) and Other Required Material** |
|---|---|


i) Suh, C. H., Radcliffe, C. W., *Kinematics and Mechanisms Design*, 1st Edition, John Wiley & Sons, 1978, ISBN: 978-0471041719.

| 6. | Evaluation Details: |
|---|---|

Evaluation is continuous. Components are;

i) Mid Semester Examination: Conducted after 40% syllabus completion, Weightage: 20–30%

ii) Teacher Defined Assessment: Includes assignments, tutorials, quizzes, tests, presentations, etc. Must consist of minimum two components- One before Mid-Sem, One after Mid-Sem, Weightage: 20%

iii) End Semester Examination: Comprehensive exam covering full syllabus, Weightage: 50–60%

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 2 | 1 | 3 | – | – | – | 2 | 2 | – | 3 | 2 | 1 |
| CO2 | 3 | 1 | 3 | 1 | 3 | – | – | – | 2 | 2 | – | 3 | 2 | 1 |
| CO3 | 3 | 1 | 3 | 1 | 3 | – | – | – | 2 | 2 | – | 3 | 2 | 1 |
| CO4 | 3 | 1 | 2 | 1 | 3 | – | – | – | 2 | 3 | – | 3 | 2 | 1 |
| CO5 | 3 | 2 | 3 | 2 | 3 | – | – | – | 2 | 3 | – | 3 | 2 | 2 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEL433 DESIGN FOR MANUFACTURING AND ASSEMBLY** | | |
| **Course Type:** | **DE** | | |
| **Name of the programme(s):** | **B. Tech. Mechanical Engineering** | | |
| **L – T – P** | **3-0-0** | **No. of Credits** | 3 |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

Students will be able to,

i) Understand the difference between DFMA and conventional design process

ii) Select appropriate materials and processes for product design

iii) Know basic principles of DFMA

iv) Analyse products to minimise number of parts and simplification of product

v) Apply design features according to manufacturing processes

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Differentiate between conventional design and DFMA procedures |
| **CO2** | Select appropriate material, processes and features for a product design |
| **CO3** | Design products which are easy for assembly. |
| **CO4** | Design products which are easy for manufacturing |
| **CO5** | Evaluate the design for simplification and alternatives of manufacturing |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| Introduction – Definition, History, Advantages and Impact of DFMA | | CO1 | 1 |
| Selection of materials and processes – General requirements, process capabilities, Systematic selection of processes and materials | | CO2 | 1 |
| Product design for manual assembly – General guidelines, systematic design for assembly, effect of various design features on manufacturing, design examples | | CO3, CO5 | 2.5 |

| | | |
|---|---|---|
| Design for high-speed automatic and robotic assembly – Design for high-speed feeding and orientating, High speed inspection, Analysis of assembly, design examples | CO3, CO5 | 2.5 |
| Design for Manufacturing.<br>Design for machining – Design for single point / multi point / abrasive machining, assembly of components, accuracy and surface finish, cost estimating, Design examples.<br>Design for injection moulding – Injection moulding materials, moulding cycles, estimation of optimum number of cavities, Design examples.<br>Design for sheet metal working – Dies and Press working, Press selection, Design rules.<br>Design for sand casting, die casting, investment casting – Materials, Basic characteristics of process and mould features, cost estimating, Design rules for different castings.<br>Design for forging – characteristics, cost estimation and Design rules | CO4, CO5 | 7 |

| 4. | Text books |
|---|---|

i) Boothroyd, G., Dewhurst, P., Knight, W. A., Product Design for Manufacturing and Assembly, 3rd Edition, CRC Press, 2011, ISBN: 978-1420089271.

ii) Allen, C. W., Simultaneous Engineering – Integrating Manufacturing and Design, 1st Edition, Society of Manufacturing Engineers (SME), 1990, ISBN: 978-0872633629.

| 5. | Reference Book(s) and Other Required Material |
|---|---|

i) Bralla, J. G., Design for Manufacturability Handbook, 2nd Edition, McGraw-Hill, 2004, ISBN: 978-0071416580.

ii) Anderson, D. M., Design for Manufacturability and Concurrent Engineering: How to Design for Low Cost, Design in High Quality, Design for Lean Manufacture, and Design Quickly for Fast Production, 2nd Edition, CIM Press, 2010, ISBN: 978-1878072160

| 6. | Evaluation Details: |
|---|---|

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %

b) Teacher Defined Assessment: 20 %

c) End Semester Exam: 50-60 %

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 3 | 3 | 2 | 2 |
| CO2 | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 3 | 3 | 2 | 2 |
| CO3 | 3 | 1 | 3 | 2 | 1 | 2 | 2 | 2 | 2 | 1 | 3 | 3 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 1 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 2 |
| CO5 | 3 | 1 | 3 | 2 | 1 | 2 | 2 | 2 | 2 | 1 | 3 | 3 | 2 | 2 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Course Code & Course Title: | MEL435 COMPUTATIONAL FLUID DYNAMICS | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B.Tech. | | |
| L – T – P | 3-0-0 | No. of Credits | 3 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) Develop a strong understanding of governing equations of fluid flow, their derivation and appropriate boundary and initial conditions.
ii) Provide the fundamental of discretization, various discretization schemes and their numerical stability.
iii) Provide the fundamentals of finite difference, finite volume, and finite element methods to solve fluid dynamics problems.
iv) Enable students to analyse and solve convection–diffusion and Navier–Stokes equations using appropriate numerical schemes and solution algorithms.
v) Introduce turbulence modelling concepts and modern CFD solution strategies for engineering applications.

| 2. | Course Outcomes |
|---|---|
| CO1 | Explain, analyze and mathematically model the physical problems involving fluid flow and heat transfer phenomenon. |
| CO2 | Derive, classify and discretize the governing equations of fluid flow and apply appropriate initial and boundary conditions. |
| CO3 | Formulate and analyse Finite Difference Method (FDM) to solve fluid flow and heat transfer problems. |
| CO4 | Apply the finite volume method to discretize and solve convection–diffusion and Navier–Stokes equations using algorithms such as SIMPLE, SIMPLER, and SIMPLEC. |
| CO5 | Explain and apply turbulence modeling approaches, including Reynolds-averaged Navier–Stokes equations in CFD simulations. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| **Basic concepts:** Introduction to Computational Fluid Dynamics: Importance and its applications, Eulerian and Lagrangian methods of describing fluid flow motion, acceleration and deformation of fluid particles, vorticity. | | CO1 | 1 |
| **Governing Equations, Boundary conditions and their characteristics:** Laws governing fluid motion, Continuity, Navier-Stokes, and energy equations. Equations derived from NS equations: Boundary layer equation, Euler equation, Potential flow equation, Bernoulli's equation and vorticity transport equation. Initial and boundary conditions. Physical and Mathematical classifications of Partial Differential Equations – Hyperbolic, Parabolic and Elliptic. | | CO2 | 3 |
| **Finite Difference Method (FDM):** Elementary finite difference coefficients, basic aspect of finite difference equations, consistency, errors and stability. Stability analysis of elliptic and hyperbolic type problems, Fundamental of fluid flow modeling-conservative property, Finite difference applications in heat transfer – conduction, convection. | | CO3 | 3 |
| **Finite Volume Method (FVM):** Introduction, Conservative and Non-conservative form of equations, General form of Convection-diffusion equation, Application of FVM in convection-diffusion problems. Solution of discretised equations using TDMA. Finite volume methods for unsteady problems – explicit schemes, implicit schemes. Upwind schemes, higher order upwind schemes, QUICK scheme. Calculation of Fluid Flow: NS equations – staggered grid, collocated grid, SIMPLE, SIMPLER and SIMPLEC algorithm. | | CO4 | 4 |
| **Introduction to mathematical modelling of turbulent flow:** Derivation of Reynolds Averaged Navier-Stokes Equation, Fundamental of Closure problem, Various turbulent flow models.<br>**Finite Element Method:** Introduction, weighted residual and variational formulations, Application of FEM to 1D 2D problems in fluid flow and heat transfer. Grid transformation for complex geometry. | | CO5 | 3 |

| 4. | Text books |
|---|---|

i) Anderson, J. D., Jr., *Computational Fluid Dynamics: The Basics with Applications*, 1st Edition, McGraw-Hill Inc., 1995, ISBN: 978-0070016859.

ii) Patankar, S. V., *Numerical Heat Transfer and Fluid Flow*, 1st Edition, Hemisphere Publishing Corporation / Taylor & Francis, 1980, ISBN: 978-0891165224.

iii) Versteeg, H. K., Malalasekera, W., *An Introduction to Computational Fluid Dynamics: The Finite Volume Method*, 2nd Edition, Pearson Education, 2007, ISBN: 978-0131274983.

| 5. | Reference Book(s) and Other Required Material |
|---|---|

iii) Ferziger, J. H., Perić, M., *Computational Methods for Fluid Dynamics*, 3rd Edition, Springer-Verlag Berlin Heidelberg, 2002, ISBN: 978-3540420743.

iv) Muralidhar, K., Sundararajan, T., *Computational Fluid Flow and Heat Transfer*, 2nd Edition, Alpha Science International Ltd., 2003, ISBN: 978-1842651728.

| 6. | Evaluation Details: |
|---|---|

**Evaluation Weightage (%)**

d) Mid Semester Exam: 20-30 %

e) Teacher Defined Assessment: 20 %

f) End Semester Exam: 50-60 %

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 1 | 1 | 1 | - | - | 2 | 1 | 1 | 3 | 2 | 2 | 1 |
| CO2 | 2 | 2 | 2 | 1 | 1 | 1 | - | 1 | 1 | - | 3 | 2 | 1 | 1 |
| CO3 | 2 | 2 | 3 | 2 | 3 | 2 | - | 2 | 1 | 1 | 3 | 3 | 2 | 1 |
| CO4 | 2 | 2 | 3 | 2 | 3 | 3 | - | 1 | 1 | 1 | 3 | 3 | 2 | 2 |
| CO5 | 1 | 1 | 2 | 1 | 2 | - | - | 1 | 1 | 1 | 2 | 2 | 1 | 1 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Course Code & Course Title: | MEP435 COMPUTATIONAL FLUID DYNAMICS LABORATORY | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B.Tech. | | |
| L – T – P | 0-0-2 | No. of Credits | 1 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) To provide students with the necessary skills to use commercial CFD software.
ii) To perform numerical simulation of variety of steady and unsteady flow problems in fluid flow and heat transfer applications.
iii) To motivate the students to carry out research using CFD simulations.
iv) To evaluate the understanding and knowledge of students through mini-project.

| 2. | Course Outcomes |
|---|---|
| CO1 | Explain the importance of CFD software packages in research. |
| CO2 | Solve fluid flow and heat transfer problems through numerical simulations. |
| CO3 | Carry out post-processing of the numerical results of the problems. |
| CO4 | Develop the skills to prepare the technical report to explain the numerical results in terms of physical behaviours. |
| CO5 | Identify and solve industrial problems through numerical simulations and suggest possible solutions. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| Topics | | CO(s) Addressed | Duration in weeks |
| **Introduction of the software:** Introduction of numerical simulation software ANSYS and its various modules, Importance and alternatives. Tutorials on how to use the software and introduce them about various functionality. | | | 2 |
| **Numerical simulation of problems:** To solve convection-diffusion problem from basic to advance level using ANSYS fluent software. Problems such as<br>**Steady state problem:** | | | 6 |

| | | |
|---|---|---|
| 1. 2D/3D heat conduction in a slab with and without volumetric heat generation.<br>2. Two-dimensional lid driven cavity flow problem.<br>3. Rayleigh-Benard convection to observe the transition from conduction to convection.<br>4. Natural convection in a differentially heated square cavity.<br>5. Conjugate natural convection heat transfer phenomenon in a plate/ enclosure.<br>**Unsteady State Problem**<br>6. Flow over a circular cylinder observing the vortex shedding phenomenon. | | |
| **User Defined Function (UDF)**<br>7. Natural convection in a square cavity with sinusoidal temperature variation at heated wall.<br>8. Effect of variable thermo-physical properties on connection heat transfer.<br>**Turbulent Flow Simulation**<br>9. Turbulent fluid flow simulation over a flat plate<br>10. Turbulent fluid flow simulation in an enclosure. | | 4 |
| 11. **ICEM** software module for modelling (Geometry + Meshing) | | 2 |

| 4. | Text books |
|---|---|

i) Anderson, J. D., Jr., *Computational Fluid Dynamics: The Basics with Applications*, 1st Edition, McGraw-Hill Inc., 1995, ISBN: 978-0070016859.

ii) Patankar, S. V., *Numerical Heat Transfer and Fluid Flow*, 1st Edition, Hemisphere Publishing Corporation / Taylor & Francis, 1980, ISBN: 978-0891165224.

iii) Versteeg, H. K., Malalasekera, W., *An Introduction to Computational Fluid Dynamics: The Finite Volume Method*, 2nd Edition, Pearson Education, 2007, ISBN: 978-0131274983.

| 5. | Reference Book(s) and Other Required Material |
|---|---|

i) Ferziger, J. H., Perić, M., *Computational Methods for Fluid Dynamics*, 3rd Edition, Springer-Verlag Berlin Heidelberg, 2002, ISBN: 978-3540420743.

ii) Muralidhar, K., Sundararajan, T., *Computational Fluid Flow and Heat Transfer*, 2nd Edition, Alpha Science International Ltd., 2003, ISBN: 978-1842651728.

| 6. | Evaluation Details: |
|---|---|

**Evaluation Weightage (%)**

a) Continuous Evaluation - I 30-35 %
b) Continuous Evaluation - II 30-40 %
c) Continuous Evaluation - III 25-40 %

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | - | 2 | 2 | 3 | 1 | 1 | 2 | 1 | 1 | 3 | 1 | 1 | 2 |
| CO2 | 3 | 2 | 2 | 2 | 3 | - | 1 | 2 | - | - | 3 | 3 | 1 | 1 |
| CO3 | 3 | 2 | 3 | 3 | 3 | - | 1 | 2 | 1 | 1 | 2 | 2 | 1 | 1 |
| CO4 | 2 | 2 | 1 | 1 | 2 | - | 1 | 2 | 3 | 1 | 3 | 3 | 1 | 1 |
| CO5 | 3 | 2 | 2 | 2 | 3 | - | 1 | 2 | 1 | 1 | 3 | 2 | 1 | 1 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Course Code & Course Title: | MEL436 MECHATRONICS | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B. Tech. in Mechanical Engineering | | |
| L – T – P | 3-0-0 | No. of Credits | 3 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) The objective of this course is to provide mechanical engineering students with an understanding of mechatronic systems through the integration of mechanical components, sensors, actuators, and control elements.

ii) The course aims to develop the ability to model, analyze, and implement automated mechanical systems using industrial automation tools such as PLC and SCADA.

| 2. | Course Outcomes |
|---|---|
| CO1 | Explain the key elements of mechatronic systems and model mechanical, electrical, and electromechanical systems using appropriate analogies and simulation concepts. |
| CO2 | Select and apply suitable sensors and measurement systems for position, force, motion, and condition monitoring in mechanical and robotic applications. |
| CO3 | Analyze and select actuators and drive systems, including electrical, pneumatic, and smart actuators, based on mechanical load, motion, and power requirements. |
| CO4 | Develop PLC-based control logic using ladder programming for sequencing, interlocking, and automation of mechanical processes. |
| CO5 | Integrate PLC, SCADA, and HMI systems to monitor, control, and visualize automated mechanical and manufacturing systems. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| | **Topics** | **CO(s) Addressed** | **Duration in weeks** |
| | **Introduction to Mechatronic Systems:** Mechatronics key elements; comparison of conventional and mechatronic systems; role of pneumatic and hydraulic subsystems in integrated mechatronic systems; mechatronic system design process and design issues; overview of modeling and simulation of physical systems. | CO1 | 2 |

| | | |
|---|---|---|
| **Modeling of Mechanical and Electromechanical Systems:** Modeling of electrical systems; mechanical translational and rotational systems; electromechanical coupling; lumped-parameter modeling of pneumatic and hydraulic actuators; modeling of motion transmission elements such as ball screws, electronic cams, and indexing mechanisms. | CO1 | 2 |
| **Sensors and Measurement Systems:** Sensor characteristics and classification; position and proximity sensors; load cells; piezoelectric sensors; gas sensors; accelerometers; gyroscopes; inclinometers; wearable sensors for robotic applications; pressure, flow, and level sensors for fluid power systems; basics of signal conditioning and data conversion. | CO2 | 2 |
| **Actuators and Drive Systems:** DC motors and drives; stepper motors and drives; servo motors and drives; piezoelectric actuators; MEMS actuators; shape memory alloy actuators; pneumatic and hydraulic actuators including cylinders, motors, and valves; selection of electric, pneumatic, and hydraulic actuators; power and torque estimation of actuators. | CO3 | 2 |
| **Industrial Automation and PLC Systems:** Industrial revolutions; basic components of automation; PLC commissioning and installation; PLC hardware architecture; PLC programming techniques; ladder logic programming; advanced PLC instructions; PLC-based control of electro-pneumatic and electro-hydraulic systems; introduction to programmable automation controllers (PAC). | CO4 | 2 |
| **SCADA and HMI Systems:** SCADA components and features; graphical animation; SCADA scripting; PLC networking and communication; Open Platform Communication (OPC); monitoring and supervision of pneumatic and hydraulic systems; introduction to Human–Machine Interface (HMI) design. | CO5 | 2 |

| **4.** | **Text books** |
|---|---|


i) Bolton, W., *Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering*, 3rd Edition (Indian Reprint), Pearson Education Asia, 2001, ISBN: 978-8131700624.

ii) Alciatore, D. G., Histand, M. B., *Introduction to Mechatronics and Measurement Systems*, 3rd Edition, Tata McGraw Hill Education, 2007, ISBN: 978-0070669338.

iii) Mahalik, N. P., *Mechatronics: Principles, Concepts and Applications*, 1st Edition (Indian Reprint), McGraw Hill Education, 2014, ISBN: 978-0070482937.

| 5. | Reference Book(s) and Other Required Material |
|---|---|

i) Hackworth, J. R., Hackworth, F. D., Jr., *Programmable Logic Controllers: Programming Methods and Applications*, 1st Edition, Pearson Education, 2004, ISBN: 978-0130607188.

| 6. | Evaluation Details: |
|---|---|

Evaluation is continuous. Components are;

a. Mid Semester Examination: Conducted after 40% syllabus completion, Weightage: 20–30%
b. Teacher Defined Assessment: Includes assignments, tutorials, quizzes, tests, presentations, etc. Must consist of minimum two components- One before Mid-Sem, One after Mid-Sem, Weightage: 20%
c. End Semester Examination: Comprehensive exam covering full syllabus, Weightage: 50–60%

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 2 | 1 | 3 | – | – | – | 2 | 2 | – | 3 | 2 | 2 |
| CO2 | 3 | 2 | 2 | 1 | 3 | – | – | – | 2 | 2 | – | 2 | 3 | 2 |
| CO3 | 3 | 1 | 3 | 1 | 3 | – | – | – | 2 | 2 | – | 3 | 3 | 2 |
| CO4 | 3 | 2 | 3 | 2 | 3 | – | – | – | 2 | 3 | – | 2 | 3 | 3 |
| CO5 | 3 | 2 | 3 | 2 | 2 | – | – | – | 2 | 3 | – | 2 | 3 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEP 436: MECHATRONICS** | | |
| **Course Type:** | **DE** | | |
| **Name of the programme(s):** | **B. Tech. in Mechanical Engineering** | | |
| **L – T – P** | **0-0-2** | **No. of Credits** | 1 |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

**i)** To provide students with a practical understanding of mechatronic systems by integrating sensors, actuators, PLCs, drives, and pneumatic/hydraulic systems using Siemens automation platforms, enabling them to design, program, and monitor industrial automation systems through PLC, HMI, and SCADA applications.

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Identify and integrate sensors, actuators, and motion transmission elements in a mechatronic system and configure their interfacing with Siemens PLC hardware. |
| **CO2** | Develop and implement PLC programs using TIA Portal for controlling electromechanical and electro-pneumatic/hydraulic systems, including analog processing, sequencing, and interlocks. |
| **CO3** | Design and deploy HMI and SCADA applications for monitoring, visualization, data logging, and supervision of automated mechatronic systems using WinCC and OPC communication. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| Study of a mechatronic system using a Siemens PLC setup involving identification of sensors, signal conditioning, PLC, actuators, and HMI with preparation of the system block diagram. | | CO1 | 1 |
| Implementation of basic dynamic behavior of a mechanical system using PLC logic such as timers, counters, and ramps and observation of system response through WinCC trends. | | CO2 | 1 |
| Control and monitoring of an electromechanical system such as a DC, servo, or stepper motor using Siemens PLC including speed and direction control with an HMI interface. | | CO1, CO2 | 1 |

| | | |
|---|---|---|
| Study and control of motion transmission elements such as a ball screw, cam, or indexing mechanism using sensors and PLC-based sequencing and positioning logic. | CO1, CO2 | 1 |
| Calibration and scaling of analog sensors such as position sensors, load cells, and pressure, flow, or level sensors using PLC analog input modules and scaling blocks in TIA Portal. | CO2 | 1 |
| Signal conditioning, analog value conversion, and data visualization using PLC function blocks, data blocks, and HMI trend displays. | CO2, CO3 | 1 |
| Measurement and monitoring of inertial or motion-related sensors such as accelerometers or IMU signals using PLC inputs and visualization through WinCC trends. | CO1, CO3 | 1 |
| Actuator drive control using Siemens PLC for stepper or servo motors including estimation of power and torque based on load and operating conditions. | CO1, CO2 | 1 |
| Control of an electro-pneumatic or electro-hydraulic system using Siemens PLC through sequencing of cylinders or actuators with ladder logic, interlocks, timers, and sensors. | CO2 | 1 |
| Integrated PLC, HMI, and SCADA application development using TIA Portal and WinCC including screen development, alarms, trends, recipes, user management, and OPC-based communication. | CO3 | 1 |

## 4. Text books


i) Bolton, W., *Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering*, 3rd Edition (Indian Reprint), Pearson Education Asia, 2001, ISBN: 978-8131700624.

ii) Alciatore, D. G., Histand, M. B., *Introduction to Mechatronics and Measurement Systems*, 3rd Edition, Tata McGraw Hill Education, 2007, ISBN: 978-0070669338.

iii) Mahalik, N. P., *Mechatronics: Principles, Concepts and Applications*, 1st Edition (Indian Reprint), McGraw Hill Education, 2014, ISBN: 978-0070482937.


## 5. Reference Book(s) and Other Required Material


i) Hackworth, J. R., Hackworth, F. D., Jr., *Programmable Logic Controllers: Programming Methods and Applications*, 1st Edition, Pearson Education, 2004, ISBN: 978-0130607188.


## 6. Evaluation Details:

Evaluation is continuous. Components are;

1. Continuous Eval-I: 30–35%,
2. Continuous Eval-II: 30–40%,
3. Continuous Eval-III: 25–40%

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | 3 | 1 | 1 | 1 | 2 | 1 | 3 | 2 | 3 | 3 |
| CO2 | 3 | 3 | 3 | 2 | 3 | 1 | 1 | 1 | 2 | 1 | 3 | 2 | 3 | 3 |
| CO3 | 2 | 2 | 3 | 2 | 3 | 1 | 1 | 1 | 3 | 2 | 3 | 2 | 3 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEL437 COMPOSITE MATERIALS** | | |
| **Course Type:** | **DE** | | |
| **Name of the programme(s):** | **B. Tech. in Mechanical Engineering** | | |
| **L – T – P** | **3-0-0** | **No. of Credits** | **3** |
| **Pre-requisites: Course Code(s) & Name(s)** | **MEL206** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) The objective of this course is to introduce composite materials with emphasis on their structure, properties, and mechanical behavior.

ii) The course aims to develop an understanding of orthotropic material behavior, mechanics of composite lamina and laminates under different loading conditions, and to enable students to apply strength theories and laminate design concepts for optimized engineering applications.

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Explain the characteristics, classification, and applications of composite materials with emphasis on orthotropic behavior. |
| **CO2** | Evaluate mechanical properties of composite laminae and analyze their behavior under uniaxial and compressive loading. |
| **CO3** | Analyze stress–strain behavior of orthotropic and angle-ply laminae under bi-axial stress conditions using elasticity concepts. |
| **CO4** | Apply failure theories and strength criteria to predict failure of composite laminae and laminates. |
| **CO5** | Design and optimize composite laminates for specific engineering applications considering stiffness, strength, thermal, and hygroscopic effects. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| Introduction to Composite Materials: Evolution and applications of composite materials in engineering, characteristics and classification of composites (fibrous, laminated, particulate), basic terminologies (volume fraction, weight fraction), laminae and laminates, fibres and matrix materials with their properties, advantages and limitations of polymer, metal, and ceramic matrix composites | | CO1, CO2 | 2 |

| | | |
|---|---|---|
| Mechanical Properties of Unidirectional Composite Lamina: Longitudinal and transverse Young's modulus, shear modulus, Poisson's ratio, Halpin–Tsai empirical relations, longitudinal and transverse strength, behavior of composites under compressive loading | CO2 | 2 |
| Orthotropic and Angle-Ply Lamina Behavior: Properties of angle-ply lamina, transformation of elastic constants, coupling coefficients, general and special orthotropic materials, Tsai–Pagano invariants | CO3 | 2 |
| Strength and Failure Theories for Composites: Strength of orthotropic lamina, biaxial strength theories, maximum stress theory, maximum strain theory, Tsai–Hill maximum work theory, Tsai–Wu tensor theory, applications to pressure vessels and composite shafts | CO4 | 2 |
| Analysis of Laminated Composites: Codes and engineering representation of laminates, micromechanical behavior of laminates, laminate stiffness matrices, symmetric, antisymmetric, and cross-ply laminates, stress distribution in individual laminae | CO5 | 2 |
| Laminate Design and Failure Mechanisms: Design of laminates for special properties, failure mechanisms in composite laminates, first ply failure (FPF) and total failure, hygroscopic and thermal stresses | CO5 | 2 |

| 4. | **Text books** |
|---|---|

i) Mallick, P. K., *Fiber-Reinforced Composites: Materials, Manufacturing, and Design*, 3rd Edition, CRC Press, New York, 2007, ISBN: 978-0849334344.

ii) Agarwal, B. D., Broutman, L. J., Chandrashekhara, K., *Analysis and Performance of Fiber Composites*, 3rd Edition, John Wiley & Sons, New York, 2006, ISBN: 978-0471267669.

| 5. | **Reference Book(s) and Other Required Material** |
|---|---|

i) Jones, R. M., *Mechanics of Composite Materials*, 2nd Edition, McGraw-Hill Education, New Delhi, 1999, ISBN: 978-1560327127.

| 6. | **Evaluation Details:** |
|---|---|

Evaluation is continuous. Components are;

a. Mid Semester Examination: Conducted after 40% syllabus completion, Weightage: 20–30%
b. Teacher Defined Assessment: Includes assignments, tutorials, quizzes, tests, presentations, etc. Must consist of minimum two components- One before Mid-Sem, One after Mid-Sem, Weightage: 20%
c. End Semester Examination: Comprehensive exam covering full syllabus, Weightage: 50–60%

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 2 | 1 | 2 | – | – | – | 2 | 2 | – | 2 | 3 | 1 |
| CO2 | 3 | 2 | 2 | 1 | 3 | – | – | – | 2 | 2 | – | 3 | 2 | 1 |
| CO3 | 3 | 1 | 2 | 1 | 3 | – | – | – | 2 | 2 | – | 3 | 2 | 1 |
| CO4 | 3 | 2 | 3 | 1 | 3 | – | – | – | 2 | 2 | – | 3 | 2 | 2 |
| CO5 | 3 | 1 | 3 | 2 | 3 | – | – | – | 2 | 2 | – | 3 | 3 | 2 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Course Code & Course Title: | MEL439 PRODUCT DESIGN AND DEVELOPMENT | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B. Tech. in Mechanical Engineering | | |
| L – T – P | 3-0-0 | No. of Credits | 3 |
| Pre-requisites: Course Code(s) & Name(s) | MEL313 | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) The objective of this course is to provide students with a comprehensive understanding of engineering product development by introducing product planning, design methodologies, and development processes from concept to commercialization.

ii) The course aims to develop the ability to integrate engineering knowledge, management strategies, and cross-functional teamwork to analyze, design, and deliver commercially viable engineering products through structured product development and case studies.

| 2. | Course Outcomes |
|---|---|
| CO1 | Explain the fundamentals of engineering product development, including design cycles, redesign, DFMA considerations, standardization, and commercialization processes. |
| CO2 | Apply structured new product development strategies to convert a conceptual product idea into an engineered prototype using cost, time, and quality considerations. |
| CO3 | Integrate engineering knowledge, tools, and cross-functional team inputs to develop, validate, and refine engineering products through multiple development generations. |
| CO4 | Analyze engineering products using case studies covering concept review, prototyping, testing, validation, gate reviews, and market seeding stages. |
| CO5 | Evaluate product performance, cost targets, and customer feedback to support decision-making during product launch, seeding, and lifecycle management. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| | **Topics** | **CO(s) Addressed** | **Duration in weeks** |
| | Engineering Product and Design Fundamentals: Engineering product definition, design cycle, types of design and redesign, processing of designs for commercialization, concurrent engineering, materials and process considerations, DFMA, standardization in design, redesigning components to suit production facilities and systems | CO1 | 2 |

| | | |
|---|---|---|
| New Product Development (NPD) Process: Concept level development, cost vs time evaluation, necessity of new products, organizational strategies for NPD, management approaches to engineering design, emergence of engineering product development, market research, formation of cross-functional teams, quality function deployment, product briefs, business case preparation and clearance | CO2 | 2 |
| Product Planning and Management: Budget planning, product costing, roles and responsibilities of cross-functional team members, stakeholder meetings, concept gate review | CO2 | 2 |
| Generation–I Product Development: First-generation aggregate and prototype build, tooling of exclusive components (limited quantity), 3D modeling of components, validation through CAE routes, laboratory testing (fatigue testing, engine testing, etc.), testing of sheet metal and structural components, field testing, issue capturing and resolution, Generation–I gate review | CO3 | 2 |
| Generation–II Product Development: Corrections from Generation–I, scaled-up tooling, second-generation prototype and aggregate build, capital budget outflow, proprietary parts treatment, pre-production approval process, manufacturing location involvement, jury panel evaluation, validation progress, virtual 3D modeling through virtual assembly line, Generation–II gate review | CO4 | 2 |
| Product Seeding and Commercialization: Product seeding, batch size determination, implementation of QFD, monitoring product performance at customer end, budget utilization, role of marketing, customer care, quality assurance and product development teams, cost vs target monitoring, issue resolution process, seeding gate review | CO5 | 2 |

## 4. Text books


i) Crawford, C. M., Di Benedetto, C. A., *New Products Management*, 10th Edition, Irwin/McGraw-Hill, 2010, ISBN: 978-0073381541.

ii) Moore, W. I., Pessemier, E. A., *Product Planning and Management: Designing and Delivering Value*, 1st Edition, McGraw-Hill International Edition, 2009, ISBN: 978-0071263382.

iii) Cross, N., *Engineering Design Methods: Strategies for Product Design*, 4th Edition, John Wiley & Sons, 2008, ISBN: 978-0470519273.


## 5. Reference Book(s) and Other Required Material


i) Ulrich, K. T., Eppinger, S. D., *Product Design and Development*, 5th Edition, McGraw-Hill Education, 2015, ISBN: 978-0078029066.

| 6. | Evaluation Details: |
|---|---|

Evaluation is continuous. Components are;

a. Mid Semester Examination: Conducted after 40% syllabus completion, Weightage: 20–30%
b. Teacher Defined Assessment: Includes assignments, tutorials, quizzes, tests, presentations, etc. Must consist of minimum two components- One before Mid-Sem, One after Mid-Sem, Weightage: 20%
c. End Semester Examination: Comprehensive exam covering full syllabus, Weightage: 50–60%

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 2 | – | 2 | 2 | 3 | 2 | 3 | 2 | – | 2 | 3 | 2 |
| CO2 | 2 | – | 3 | – | 2 | 2 | 2 | – | 2 | 2 | – | 3 | 3 | 2 |
| CO3 | 2 | – | 3 | – | 2 | 2 | 2 | – | 2 | 1 | – | 3 | 3 | 2 |
| CO4 | 2 | – | 2 | – | 2 | 2 | 2 | – | 1 | 1 | – | 2 | 3 | 1 |
| CO5 | 2 | – | 2 | – | 2 | 2 | 2 | – | 2 | 1 | – | 2 | 3 | 1 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Course Code & Course Title: | MEL440 MACHINE VISION & ITS APPLICATION | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B. Tech. in Mechanical Engineering | | |
| L – T – P | 3-0-0 | No. of Credits | 3 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

**i)** The objective of this course is to introduce students to the principles and practical aspects of machine vision, extending beyond basic image processing to advanced computer vision and deep learning techniques.

**ii)** The course aims to develop the ability to design, implement, and apply vision-based systems for mechanical engineering applications such as inspection, quality control, robotics, autonomous systems, and biomedical imaging.

| 2. | Course Outcomes |
|---|---|
| CO1 | Explain the fundamentals of computer vision including image formation, camera models, geometric transformations, and vision system design. |
| CO2 | Apply image processing and classical computer vision techniques such as filtering, feature extraction, segmentation, calibration, motion analysis, and 3D vision. |
| CO3 | Analyze motion, pose estimation, tracking, modeling, and registration techniques for autonomous and industrial vision systems. |
| CO4 | Apply deep learning techniques for machine vision including CNNs, object detection, segmentation, vision transformers, and GAN-based image generation. |
| CO5 | Design and evaluate machine vision solutions for mechanical engineering applications such as inspection, surface metrology, robot guidance, autonomous systems, and biomedical imaging. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| | **Topics** | **CO(s) Addressed** | **Duration in weeks** |
| | Fundamentals of Computer Vision: Nature of images, image representation, homogeneous transformations, quaternions, geometrical and optical image formation, perspective projection, camera technologies, vision system design. | CO1 | 2 |

| | | |
|---|---|---|
| Image Processing for Vision Systems: Image filtering, edge detection, feature detection, contour extraction, image segmentation, morphological operators. | CO2 | 2 |
| Camera Models and Calibration: Camera models, intrinsic and extrinsic parameters, camera calibration techniques, calibration accuracy and error sources. | CO2 | 2 |
| Motion Analysis and 3D Vision: Motion detection, optical flow, object tracking, epipolar geometry, stereoscopic vision, active range imaging, structured lighting | CO3 | 2 |
| Pose Estimation, Modeling and Registration: Pose estimation and tracking of objects and human body parts, action recognition in complex production environments, modeling techniques for autonomous systems, data fusion, uncertainty mapping, registration | CO3, CO4 | 2 |
| Deep Learning in Machine Vision and Applications: CNNs, transfer learning, pretrained models (ResNet,EfficientNet), object detection (YOLO, SSD, Faster R-CNN), image segmentation (U-Net, Mask R-CNN), vision transformers, GANs, depth estimation for 3D vision, applications in quality control, surface metrology, inspection, robot guidance, autonomous systems, biomedical imaging | CO4, CO5 | 3 |

| 4. | **Text books** |
|---|---|


i) Gonzalez, R. C., Woods, R. E., *Digital Image Processing*, 4th Edition, Pearson Education, 2018, ISBN: 978-0133356724.

ii) Wöhler, C., *3D Computer Vision: Efficient Methods and Applications*, 1st Edition, Springer, 2013, ISBN: 978-1447140634.

iii) Hartley, R., Zisserman, A., *Multiple View Geometry in Computer Vision*, 2nd Edition, Cambridge University Press, 2004, ISBN: 978-0521540513.


| 5. | **Reference Book(s) and Other Required Material** |
|---|---|


i) Elgendy, M., *Deep Learning for Vision Systems*, 1st Edition, Manning Publications, 2020, ISBN: 978-1617296192.

| 6. | Evaluation Details: |
|---|---|

Evaluation is continuous. Components are

(a) Mid Semester Examination : Conducted after 40% syllabus completion, Weightage: 20–30%

(b) Teacher Defined Assessment : Includes assignments, tutorials, quizzes, tests, presentations, etc. Must consist of minimum two components- One before Mid-Sem , One after Mid-Sem, Weightage: 20%

(c) End Semester Examination : Comprehensive exam covering full syllabus, Weightage: 50–60%

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 2 | 1 | 3 | – | – | – | 2 | 2 | – | 2 | 1 | 2 |
| CO2 | 3 | 2 | 2 | 1 | 3 | – | – | – | 2 | 2 | – | 3 | 2 | 2 |
| CO3 | 3 | 2 | 2 | 2 | 3 | – | – | – | 2 | 2 | – | 3 | 2 | 2 |
| CO4 | 2 | 1 | 3 | 1 | 2 | – | – | – | 2 | 3 | – | 2 | 1 | 3 |
| CO5 | 2 | 1 | 3 | 2 | 2 | – | – | – | 2 | 3 | – | 3 | 3 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Course Code & Course Title: | MEL452: ADVANCED MACHINING PROCESSES | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B.Tech. Mechanical Engineering | | |
| L – T – P | 3-0-0 | No. of Credits | 3 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) Introduction of oblique cutting process and their effect on cutting forces modeling.

ii) To introduce fundamental concepts and classification of non-conventional machining processes (based on type of energy).

iii) Understand the physics and the mechanisms of material removal in processes like USM, ECM, EDM, LBM, AWJM.

iv) Introduce the knowledge of advanced finishing techniques like AFM, MAF and the latest trends using Laser and Electron Beam.

v) Highlight the importance of parametric selection for machining difficult to cut materials particularly used in Aerospace and Medical application involving complex geometries.

| 2. | Course Outcomes |
|---|---|
| CO1 | Evaluate and choose suitable advanced machining processes for specific applications and materials. |
| CO2 | Describe the working, parameters, and limitations of various non-conventional processes. |
| CO3 | Distinguish between conventional and unconventional machining methods in view of the application. |
| CO4 | Apply theoretical knowledge to solve practical problems in manufacturing using these techniques. To understand the role of oblique cutting in machining operations. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| Topics | | CO(s) Addressed | Duration in weeks |
| **Advanced Metal Cutting:** Modeling of cutting process; Review of cutting mechanism; Cutting force model; Oblique Cutting; Temperature analysis (Finite Difference Method) | | CO1, CO-4 | 04 |

| | | |
|---|---|---|
| **Non-conventional Machining Processes:** Abrasive Jet Machining (AJM); Water Jet Cutting (WJC), Abrasive Water Jet Machining (AWJM); Ultrasonic Machining (USM); Electric Discharge Machining (EDM); Electron Beam Machining (EBM); Plasma Arc Machining (PAM); Laser Beam Machining (LBM); Electro-Chemical Machining (ECM); Chemical Machining (CHM) | CO2, CO3, CO4 | 06 |
| **Finishing Processes:** Grinding force model; Wheel life model; Introduction of finishing processes like Honing, Lapping, Super finishing, etc | CO2, CO3, CO4 | 02 |
| **Non-Conventional Finishing Processes:** Advanced finishing techniques like AFM, MAF; latest trends using Laser and Electron Beam. | CO2, CO3, CO4 | 02 |

## 4. Text books

i) Boothroyd, G., Knight, W. A., *Fundamentals of Machining and Machine Tools*, 3rd Edition, CRC Press (Taylor & Francis Group), 2005, ISBN: 978-1574446593.

ii) ii) Benedict, G. F., *Nontraditional Manufacturing Processes*, 1st Edition, Marcel Dekker Inc., New York, 1987, ISBN: 978-0824773526.

iii) iii) Pandey, P. C., Shan, H. S., *Modern Machining Processes*, 1st Edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1980, ISBN: 978-0070965539.

## 5. Reference Book(s) and Other Required Material

i) McGeough, J. A., *Advanced Methods of Machining*, 1st Edition, Chapman and Hall, London, 1988, ISBN: 978-0412319709.

## 6. Evaluation Details:

Continuous Evaluation: 20 Marks, Mid-Sem: 25 Marks, End-Sem: 55 Marks

## 7. Relationship of Course Outcomes to Program Outcomes:

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | **3** | **2** | **1** | - | - | - | - | - | - | - | - | | | |
| CO2 | **2** | **3** | - | **1** | - | - | - | - | - | - | - | | | |
| CO3 | - | - | **3** | **2** | - | - | **1** | - | - | - | - | | | |
| CO4 | **3** | **3** | - | - | **2** | - | **1** | - | - | - | - | | | |

*High - 3; Medium – 2; Low – 1;*

## 8. List of Indicative Laboratory Experiment (if applicable):

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEL458 AERIAL ROBOTICS** | | |
| **Course Type:** | **DE** | | |
| **Name of the programme(s):** | **B. Tech. in Mechanical Engineering** | | |
| **L – T – P** | **3-0-0** | **No. of Credits** | **3** |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

The objective of this course is to provide students with a comprehensive understanding of aerial robotic systems, with emphasis on the geometry, mechanics, dynamics, and control of quadrotor and multi-rotor UAVs. The course aims to develop the ability to model and analyze aerial robot motion, design planning and control strategies for three-dimensional environments, and address sensing and state estimation under uncertainty. It also seeks to introduce concepts of multi-aerial-robot coordination, enabling students to design, simulate, and evaluate autonomous aerial robotic systems for real-world applications.

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Explain the architecture, classification, and applications of aerial robotic systems, including operational constraints and safety considerations. |
| **CO2** | Model and analyze the geometry, kinematics, and dynamics of aerial robots using appropriate coordinate representations and rigid-body motion principles. |
| **CO3** | Design and analyze control and guidance strategies for aerial robots to achieve stable flight and trajectory tracking in three-dimensional environments. |
| **CO4** | Analyze sensing systems and apply probabilistic state estimation techniques, including Kalman-filter-based methods, for reliable aerial robot navigation under uncertainty. |
| **CO5** | Develop and evaluate autonomous single- and multi-aerial-robot systems incorporating planning, coordination, and collision avoidance using simulation-based tools. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| Introduction to Aerial Robotics: Evolution of aerial robots; classification of UAVs (fixed-wing, rotary-wing, hybrid VTOL); quadrotor configurations; applications in surveillance, inspection, agriculture, logistics, and disaster response; system architecture of aerial robots including airframe, propulsion, sensing, onboard computation, | | CO1 | 2 |

| | | |
|---|---|---|
| communication, and control; operational constraints and safety considerations | | |
| Geometry and Mechanics of Flight: Coordinate frames and reference systems; rotation representations (Euler angles, rotation matrices, quaternions); rigid-body kinematics; transformation between coordinate frames; forces and moments acting on aerial vehicles; aerodynamic effects; thrust and torque generation; equations of motion of quadrotor UAVs | CO2 | 2 |
| Dynamics and Control of Aerial Robots: Dynamic modeling of quadrotors using Newton–Euler and Lagrange formulations; linearization of nonlinear dynamics; stability analysis; attitude and position control; PID and model-based control strategies; cascade and hierarchical control structures; trajectory tracking in three-dimensional space | CO3 | 2 |
| Planning and Guidance: Motion planning in 3D environments; waypoint generation; trajectory generation and smoothing; constraint handling (velocity, acceleration, and thrust limits); guidance laws; obstacle avoidance strategies; interaction between planning and control layers | CO4 | 2 |
| Sensing and State Estimation: Proprioceptive and exteroceptive sensors for aerial robots; IMU, GPS, magnetometer, barometer, range and vision sensors; sensor noise and uncertainty modeling; Bayesian state estimation; Kalman filter and Extended Kalman Filter (EKF) for attitude and position estimation; sensor fusion for robust navigation | CO4 | 2 |
| Navigation and Autonomous Flight: Localization in GPS-denied and cluttered environments; map representations; visual-inertial navigation; coupling of perception, estimation, planning, and control; fault tolerance and robustness considerations | CO5 | 1 |
| Control of Multiple Aerial Robots: Multi-UAV system architectures; centralized and decentralized control; formation control; consensus and coordination strategies; collision avoidance among multiple aerial robots; communication constraints and scalability issues | CO5 | 2 |
| Integrated Case Studies and Applications: Real-world case studies in aerial inspection, warehouse monitoring, and cooperative missions; simulation-based implementation of control, estimation, and coordination algorithms using MATLAB/Simulink or equivalent tools | CO4, CO5 | 1 |

| 4. | Text books |
|---|---|

i) Etkin, B., Reid, L. D., *Dynamics of Flight: Stability and Control*, 3rd Edition, John Wiley & Sons, New York, 1995, ISBN: 978-0471034181.

ii) Nelson, R. C., *Flight Stability and Automatic Control*, 2nd Edition, McGraw-Hill, Boston, 1997, ISBN: 978-0070462730.

iii) Cook, M. V., *Flight Dynamics Principles*, 1st Edition, Arnold Publishers, London, 1997, ISBN: 978-0340632000.

| 5. | Reference Book(s) and Other Required Material |
|---|---|

i) Perkins, C. D., Hage, R. E., *Airplane Performance Stability and Control*, 1st Edition, John Wiley & Sons, New York, 1949, ISBN: 978-0471680463.

| 6. | Evaluation Details: |
|---|---|

Evaluation is continuous. Components are

(a) Mid Semester Examination : Conducted after 40% syllabus completion, Weightage: 20–30%

(b) Teacher Defined Assessment : Includes assignments, tutorials, quizzes, tests, presentations, etc. Must consist of minimum two components- One before Mid-Sem , One after Mid-Sem, Weightage: 20%

(c) End Semester Examination : Comprehensive exam covering full syllabus, Weightage: 50–60%

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 1 | 2 | – | – | – | – | – | – | 2 | 2 | 1 |
| CO2 | 3 | 3 | 2 | 2 | 2 | – | – | – | – | – | – | 3 | 2 | 1 |
| CO3 | 3 | 3 | 3 | 2 | 2 | – | – | – | – | – | – | 3 | 2 | 2 |
| CO4 | 2 | 3 | 2 | 3 | 3 | – | – | – | – | – | – | 3 | 2 | 2 |
| CO5 | 2 | 3 | 3 | 3 | 3 | – | – | – | 2 | 2 | 2 | 3 | 2 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEL4XX VEHICLE DYNAMICS** | | |
| **Course Type:** | **DE** | | |
| **Name of the programme(s):** | **B.Tech. in Mechanical Engineering** | | |
| **L – T – P** | **3-0-0** | **No. of Credits** | **3** |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) The course aims to introduce the fundamental principles governing the motion of road vehicles and to explain the role of vehicle dynamics in automotive design and performance.

ii) It develops an understanding of tire–road interaction and its influence on longitudinal, lateral, and vertical vehicle behavior.

iii) The course focuses on analyzing vehicle responses during acceleration, braking, cornering, and ride excitation using simplified mathematical models.

iv) It also familiarizes students with vehicle stability concepts, handling characteristics, and real-world automotive case studies

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Describe and model the longitudinal, lateral, and vertical motions of a vehicle using appropriate coordinate systems and assumptions. |
| **CO2** | Explain the generation of tire forces and evaluate vehicle behavior under traction, braking, and cornering conditions. |
| **CO3** | Analyze ride comfort, handling characteristics, and load transfer effects using simplified vehicle models. |
| **CO4** | Interpret vehicle stability phenomena and assess the influence of suspension, tires, and control systems on overall vehicle performance. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| | **Topics** | **CO(s) Addressed** | **Duration in weeks** |
| | **Introduction and Fundamentals of Vehicle Motion**<br>Role of vehicle dynamics in automotive engineering, classification of vehicle motions, degrees of freedom of a road vehicle, planar and spatial vehicle motion, coordinate systems and sign conventions, inertial and | CO1 | 2 |

| | | |
|---|---|---|
| body-fixed reference frames, kinematic description of longitudinal, lateral and yaw motion, basic assumptions used in vehicle dynamics modeling | | |
| **Tyre - Road Interaction and Tire Models**<br>Mechanics of tire–road contact, contact patch concept, generation of longitudinal and lateral tire forces, slip ratio and longitudinal slip, slip angle and lateral slip, cornering force and cornering stiffness, friction limits and adhesion, combined longitudinal and lateral slip, linear tire models, limitations of linear tire models, qualitative introduction to nonlinear tire behavior | CO2 | 2 |
| **Longitudinal Vehicle Dynamics**<br>Forces acting on a moving vehicle, rolling resistance, aerodynamic drag and lift, traction forces and power limitation, vehicle acceleration performance, braking forces and deceleration, stopping distance, load transfer during acceleration and braking, brake force distribution, stability considerations during braking | CO3, CO4 | 2.5 |
| **Lateral Vehicle Dynamics**<br>Steady-state cornering behavior, single-track (bicycle) model, yaw rate and lateral acceleration, understeer, oversteer and neutral steer characteristics, handling diagrams, influence of vehicle speed and tire properties on handling behavior, load transfer during cornering, transient response in steering maneuvers, basic concepts of vehicle handling stability | CO3, CO4 | 2.5 |
| **Vertical Vehicle Dynamics**<br>Vehicle suspension systems and functions, sprung and unsprung mass, quarter-car and half-car models, road excitation inputs, natural frequencies of vehicle systems, suspension stiffness and damping effects, ride comfort criteria, frequency ranges relevant to ride comfort, trade-off between ride comfort and road holding | CO3 | 2 |
| **Vehicle Stability and Control Concepts**<br>Vehicle stability definitions, rollover tendency and stability limits, interaction of braking and cornering, combined longitudinal and lateral dynamics, basic concepts of anti-lock braking systems, traction control systems and electronic stability control, role of sensors and actuators in vehicle stability, limitations of passive vehicle dynamics | CO4 | 2 |
| **Integrated Vehicle Dynamics and Case Studies**<br>Coupling of longitudinal, lateral and vertical vehicle dynamics, influence of road conditions and driving maneuvers, interpretation of real-world vehicle behavior, basic vehicle dynamics simulations | CO4 | 1 |

| 4. | Text books |
|---|---|

i) Gillespie, T. D., *Fundamentals of Vehicle Dynamics*, 1st Edition, SAE International, 1992, ISBN: 978-1560911999.

ii) Wong, J. Y., *Theory of Ground Vehicles*, 4th Edition, John Wiley & Sons, 2008, ISBN: 978-0470170380.

| 5. | Reference Book(s) and Other Required Material |
|---|---|

i) Pacejka, H. B., *Tire and Vehicle Dynamics*, 3rd Edition, Butterworth-Heinemann (Elsevier), 2012, ISBN: 978-0080970165.

ii) Jazar, R. N., *Vehicle Dynamics: Theory and Application*, 2nd Edition, Springer, 2017, ISBN: 978-3319534312.

| 6. | Evaluation Details: |
|---|---|

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %
b) Teacher Defined Assessment: 20 %
c) End Semester Exam: 50-60 %

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 1 | 1 | 1 | – | – | – | – | - | 1 | 3 | 2 | 1 |
| CO2 | 3 | 3 | 2 | 2 | 2 | 3 | 1 | – | – | 1 | 2 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 2 | 2 | 2 | 2 | 1 | – | – | 1 | 2 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 3 | 3 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 1. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

# List of Electives: For Even Semester

| Sr. No. | Course Code | Course Title | L–T–P | Credits | Course Type |
|---|---|---|---|---|---|
| 1 | MEL310 | Manufacturing Processes Automation | 3-0-0 | 3 | Theory |
| 2 | MEP310 | | 0-0-2 | 1 | Practical |
| 3 | MEL318 | Two Phase Flow and Heat Transfer | 3-0-0 | 3 | Theory |
| 4 | MEP318 | | 0-0-2 | 1 | Practical |
| 5 | MEL401 | Control Systems | 3-0-0 | 3 | Theory |
| 6 | MEL405 | Optimization | 3-0-0 | 3 | Theory |
| 7 | MEL409 | Advanced Mechanics of Solids | 3-0-0 | 3 | Theory |
| 8 | MEL413 | Fracture Mechanics | 3-0-0 | 3 | Theory |
| 9 | MEL415 | Mechanical Vibration | 3-0-0 | 3 | Theory |
| 10 | MEL416 | Industrial Robotics | 3-0-0 | 3 | Theory |
| 11 | MEL418 | Advanced Stress Analysis | 3-0-0 | 3 | Theory |
| 12 | MEL421 | Computational Methods in Engineering | 3-0-0 | 3 | Theory |
| 13 | MEL422 | Automobile Engineering | 3-0-0 | 3 | Theory |
| 14 | MEP422 | Automobile Engineering | 0-0-2 | 1 | Practical |
| 15 | MEL424 | Industrial Engineering & Management | 3-0-0 | 3 | Theory |
| 16 | MEL426 | Refrigeration & Cryogenics | 3-0-0 | 3 | Theory |
| 17 | MEP426 | | 0-0-2 | 1 | Practical |
| 18 | MEL429 | Renewable Energy Sources | 3-0-0 | 3 | Theory |
| 19 | MEL430 | Advanced IC Engines | 3-0-0 | 3 | Theory |
| 20 | MEP430 | | 0-0-2 | 1 | Practical |
| 21 | MEL432 | Computer Graphics and Solid Modelling | 3-0-0 | 3 | Theory |
| 22 | MEP432 | | 0-0-2 | 1 | Practical |
| 23 | MEL438 | Adv Refrigeration and Air Conditioning | 3-0-0 | 3 | Theory |
| 24 | MEP438 | | 0-0-2 | 1 | Practical |
| 25 | MEL443 | Air Pollution Control | 3-0-0 | 3 | Theory |
| 26 | MEL444 | Solar Energy Utilization | 3-0-0 | 3 | Theory |
| 27 | MEL448 | Artificial Intelligence in Manufacturing | 3-0-0 | 3 | Theory |
| 28 | MEL449 | Advanced Turbo Machinery | 3-0-0 | 3 | Theory |
| 29 | MEP452 | Machine System Design | 0-1-4 | 3 | Practical |
| 30 | MEL456 | Design of Fixtures in Manufacturing | 3-0-0 | 3 | Theory |
| 31 | MEL4XX | Smart Manufacturing and Quality 4.0 | 3-0-0 | 3 | Theory |
| 32 | MEL4XX | Noise Vibration and Harshness | 3-0-0 | 3 | Theory |

| Course Code & Course Title: | MEL310 MANUFACTURING PROCESS AUTOMATION | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B Tech Mechanical engineering | | |
| L – T – P | 3-0-0 | No. of Credits | 3 |
| Pre-requisites: Course Code(s) & Name(s) | MEL207; MEL305 | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i. This course introduces the principles and applications of automation in manufacturing, covering CNC machines, PLCs, industrial robots, and control systems.

ii. It aims to develop the ability to analyze, program, and integrate automated manufacturing systems to improve productivity, quality, and flexibility.

iii. The course also provides exposure to smart manufacturing and Industry 4.0 concepts used in modern industrial environments.

| 2. | Course Outcomes |
|---|---|
| CO1 | Able to demonstrate a thorough understanding of the principles and theoretical bases of modern manufacturing techniques, automation, and production processes. |
| CO2 | Competent to identify appropriate manufacturing systems for different production requirements, and describe their performance using appropriate analytical and modelling methods. |
| CO3 | Able to understand Industrial Revolution 4.0 and its implications and application challenges. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| Topics | | CO(s) Addressed | Duration in weeks |
| **Overview of Manufacturing**<br>Manufacturing Operations, Manufacturing Industries and Products, Manufacturing Operations, Production Facilities, Product/Production Relationships, Manufacturing Metrics and economics, Production Performance Metrics, Manufacturing Costs | | CO1 | 01 |
| **Basic Elements of an Automated System**<br>Power to Accomplish the Automated Process, Program of Instructions, Control System, Advanced Automation Functions, Safety, Monitoring, | | CO1 | 01 |

| | | |
|---|---|---|
| Maintenance and Repair Diagnostics, Error Detection and Recovery, Levels of Automation | | |
| **Automation and Control Technologies**<br>System, Advanced Automation Functions, Levels of Automation, Industrial Control Systems, Process Industries versus Discrete Manufacturing Industries, Continuous versus Discrete Control, Computer Process Control, Hardware Components for Automation and Process Control, Sensors, Actuators, Analog–Digital Conversions, Input/Output Devices for Discrete Data, Computer Numerical Control | CO1 | 02 |
| **Industrial Robotics**<br>Robot Anatomy and Related Attributes, Robot Control Systems, End Effectors, Applications of Industrial Robots, Robot Programming, Robot Accuracy and Repeatability, Discrete Control and Programmable Logic Controllers, Discrete Process Control, Ladder Logic Diagrams, Programmable Logic Controllers | CO1 | 02 |
| **Material Handling and Identification**<br>Material Transport Systems, Overview of Material Handling, Material Transport Equipment, Analysis of Material Transport Systems, Storage Systems, Introduction to Storage Systems, Conventional Storage Methods and Equipment, Automated Storage Systems, Analysis of Storage Systems, Automatic Identification and Data Capture, Overview of Automatic Identification Methods, Bar Code Technology, Radio Frequency Identification, Other AIDC Technologies | CO2 | 02 |
| **Manufacturing Systems**<br>Overview of Manufacturing Systems, Components of a Manufacturing System, Types of Manufacturing Systems, Single-Station Manufacturing Cells, Single-Station Manned Cells, Single-Station Automated Cells, Applications of Single-Station Cells, Analysis of Single-Station Cells, Manual Assembly Lines, Fundamentals of Manual Assembly Lines, Analysis of Single-Model Assembly Lines, Line Balancing Algorithms, Workstation Details, Other Considerations in Assembly Line Design, Alternative Assembly Systems, Batch-Model and Mixed-Model Lines, Automated Production Lines, Fundamentals of Automated Production Lines, Applications of Automated Production Lines, Analysis of Transfer Lines, Automated Assembly Systems, Fundamentals of Automated Assembly Systems, Analysis of Automated Assembly Systems, Group Technology and Cellular Manufacturing, Part Families and Machine Groups, Cellular Manufacturing<br>Manufacturing, Applications of Group Technology, Analysis of Cellular Manufacturing, Opitz Parts Classification and Coding System, Flexible Manufacturing Cells and Systems, FMC/FMS Components, FMS Application Considerations, Analysis of Flexible Manufacturing Systems, Alternative Approaches to Flexible Manufacturing | CO2 | 04 |

| | | |
|---|---|---|
| **Industrial Revolution**<br>Introduction to Industry 4.0, History of Industry 4.0, Industrial Internet, First stages of maturity, Next maturity stages, Society 5.0, Breaking down 5 walls, Augmented Reality, Digital Transformation, Innovative examples of Industry 4.0 and digital transformation, Architecture of smart factory | CO3 | 02 |

| 4. | **Text books** |
|---|---|

i) Groover, M. P., *Automation, Production Systems, and Computer-Integrated Manufacturing*, 4th Edition, Pearson Education, 2015, ISBN: 978-0133499612.

| 5. | **Reference Book(s) and Other Required Material** |
|---|---|

i) Gilchrist, A., *Industry 4.0: The Industrial Internet of Things*, 1st Edition, Apress, 2016, ISBN: 978-1484220467.

| 6. | **Evaluation Details:** |
|---|---|

a) Continuous Evaluation: 20 Marks
b) Mid-Sem: 25-30 Marks
c) End-Sem: 50-55 Marks

| 7. | **Relationship of Course Outcomes to Program Outcomes:** |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 1 | 2 | – | – | – | – | – | – | 3 | 3 | 2 |
| CO2 | 3 | 3 | 2 | 2 | 2 | – | – | – | – | – | 2 | 3 | 3 | 2 |
| CO3 | 2 | 2 | 2 | 1 | 3 | 2 | 2 | – | – | – | 2 | 2 | 3 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | **List of Indicative Laboratory Experiment (if applicable):** |
|---|---|

| Course Code & Course Title: | MEP310 MANUFACTURING PROCESS AUTOMATION | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B Tech Mechanical Engineering | | |
| L – T – P | 0-0-2 | No. of Credits | 1 |
| Pre-requisites: Course Code(s) & Name(s) | MEL207; MEL305 | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) The course aims to introduce students to the principles and components of manufacturing process automation, including CNC machines, PLCs, robotics, and integrated production systems.

ii) It also aims to develop the ability to analyze, design, and apply appropriate automation solutions to improve productivity, quality, and flexibility in modern manufacturing.

| 2. | Course Outcomes |
|---|---|
| CO1 | Apply industrial robot programming techniques using offline simulation tools and teach pendants to program, simulate, and validate robotic welding and automation tasks. |
| CO2 | Develop and execute CNC machining programs and PLC-based control logic using industrial controllers and software tools for automated manufacturing systems. |
| CO3 | Model, simulate, and analyze smart manufacturing systems using digital factory tools to evaluate layout, process flow, human ergonomics, and overall system performance. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| Topics | | CO(s) Addressed | Duration in weeks |
| To study the architecture, work cell setup, and basic operations of ABB industrial robots using RobotStudio software. | | CO1 | 1 |
| To program an ABB spot welding robot using RobotStudio by defining tools, work objects, weld points, and simulating the welding sequence. | | CO1 | 1 |
| To program an ABB arc welding robot using RobotStudio by generating welding paths, setting process parameters, and validating the program through simulation. | | CO1 | 1 |
| To write, simulate, and verify CNC lathe programs using SINUMERIK controller for basic turning operations such as facing, straight turning, taper turning, and threading. | | CO2 | 1 |

| | | |
|---|---|---|
| To write, simulate, and verify CNC milling programs using SINUMERIK controller for contouring, pocketing, drilling, and multi-tool machining operations. | CO2 | 1 |
| To study the components and working of a smart manufacturing system, including automation hierarchy, data integration, and Industry 4.0 concepts. | CO3 | 1 |
| To develop and simulate PLC programs using TIA Portal for basic automation tasks involving digital inputs, outputs, timers, and counters. | CO2 | 1 |
| To develop and test PLC programs using Siemens S7-300 / S7-1200 PLC systems for sequential control, interlocking, and analog signal processing. | CO2 | 1 |
| To create and analyze a plant layout simulation using Technomatix Plant Simulation for studying material flow, throughput, and system bottlenecks. | CO3 | 1 |
| To simulate and validate manufacturing and robotic processes using Technomatix Process Simulate, including cycle time analysis and collision detection. | CO3 | 1 |

## 4. Text books

i) Groover, M. P., *Automation, Production Systems, and Computer-Integrated Manufacturing*, 4th Edition, Pearson Education, 2015, ISBN: 978-0133499612

## 5. Reference Book(s) and Other Required Material

i) Gilchrist, A., *Industry 4.0: The Industrial Internet of Things*, 1st Edition, Apress, 2016, ISBN: 978-1484220467.

## 6. Evaluation Details:

Evaluation is continuous. Components are

a) Continuous Eval-I: 30–35%
b) Continuous Eval-II: 30–40%
c) Continuous Eval-III: 25–40%

## 7. Relationship of Course Outcomes to Program Outcomes:

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | 3 | 1 | 1 | 1 | 2 | 1 | 3 | 2 | 3 | 3 |
| CO2 | 3 | 3 | 3 | 2 | 3 | 1 | 1 | 1 | 2 | 1 | 3 | 2 | 3 | 3 |
| CO3 | 2 | 2 | 3 | 2 | 3 | 1 | 1 | 1 | 3 | 2 | 3 | 2 | 3 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Topics | Duration in weeks |
|---|---|
| To study the architecture, work cell setup, and basic operations of ABB industrial robots using RobotStudio software. | 1 |
| To program an ABB spot welding robot using RobotStudio by defining tools, work objects, weld points, and simulating the welding sequence. | 1 |
| To program an ABB arc welding robot using RobotStudio by generating welding paths, setting process parameters, and validating the program through simulation. | 1 |
| To write, simulate, and verify CNC lathe programs using SINUMERIK controller for basic turning operations such as facing, straight turning, taper turning, and threading. | 1 |
| To write, simulate, and verify CNC milling programs using SINUMERIK controller for contouring, pocketing, drilling, and multi-tool machining operations. | 1 |
| To study the components and working of a smart manufacturing system, including automation hierarchy, data integration, and Industry 4.0 concepts. | 1 |
| To develop and simulate PLC programs using TIA Portal for basic automation tasks involving digital inputs, outputs, timers, and counters. | 1 |
| To develop and test PLC programs using Siemens S7-300 / S7-1200 PLC systems for sequential control, interlocking, and analog signal processing. | 1 |
| To create and analyze a plant layout simulation using Technomatix Plant Simulation for studying material flow, throughput, and system bottlenecks. | 1 |
| To simulate and validate manufacturing and robotic processes using Technomatix Process Simulate, including cycle time analysis and collision detection. | 1 |

| Course Code & Course Title: | MEL318: TWO PHASE FLOW AND HEAT TRANSFER | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B. Tech. in Mechanical Engineering | | |
| L – T – P | 3-0-0 | No. of Credits | 3 |
| Pre-requisites: Course Code(s) & Name(s) | MEL 202 Fluid Mechanics; MEL302 Heat Transfer | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) To introduce the basic mechanism involved in Two-Phase flow and heat transfer.
ii) To differentiate among different types of Two-phase flows, including gas-liquid, liquid-liquid, and gas-solid flows.
iii) To analyse flows for industrial applications, such as chemical, petroleum, power generation, and refrigeration industries.
iv) To interpret the results of two-phase flow analysis in different cases.

| 2. | Course Outcomes |
|---|---|
| CO1 | Understand the basic mechanism involved in Two-Phase flow and heat transfer. |
| CO2 | Analyze different types of Two-phase flows, including gas-liquid, liquid-liquid, and gas-solid flows. |
| CO3 | Evaluate two-phase flow for industrial applications, such as chemical, petroleum, power generation, and refrigeration industries. |
| CO4 | Interpret the two-phase flow analysis results |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| Topics | | CO(s) Addressed | Duration in weeks |
| **Introduction:** Types of flow; volumetric concentration; void fraction; flow regimes; flow maps; superficial and phase velocities; response times; stokes number. | | CO1, CO2 | 1 |
| **Homogeneous Flow:** One dimensional steady homogeneous equilibrium flow; homogeneous friction factor; turbulent flow friction factor. | | CO1, CO2 | 1 |
| **Separated Flow:** Slip; Lockhart-Martinelli method for pressure drop calculation; pressure drop for flow with boiling; flow with phase change. | | CO2, CO3 | 2 |

| | | |
|---|---|---|
| **The Drift-Flux Model:** General theory; gravity flows with no wall shear; correction to simple theory. | CO2, CO3 | 2 |
| **Interfacial Phenomena:** Thermodynamics of the interfaces; surface tension; wetting phenomena and contact angles; cavitation. | CO1, CO2 | 1 |
| **Fluid-Particle Flow and Heat Transfer:** Size distribution of particles; gas-particle systems- fluidized bed, pneumatic transport, cyclone separator; liquid-particle systems- slurry transportation, nanofluids. | CO3, CO4 | 3 |
| **Boiling:** Regimes of boiling; nucleation; gas nucleation in bulk liquid; growth of bubbles; motion at a heating surface; heat transfer rates in pool boiling; forced convection boiling; heat transfer correlations; maximum heat flux or burnout; metal boiling. | CO1, CO3, CO4 | 2 |
| **Condensation:** Nusselt theory; boundary layer treatment of laminar film condensation; experimental results for vertical and horizontal tubes; condensation inside a horizontal tube, condensation outside a horizontal tube. | CO1, CO3, CO4 | 2 |

| 4. | **Text books** |
|---|---|

i) Brennen, C. E., *Fundamentals of Multiphase Flow*, 1st Edition, Cambridge University Press, 2005, ISBN: 978-0521848046.

ii) Wallis, G. B., *One-Dimensional Two-Phase Flow*, 1st Edition, McGraw-Hill, 1969, ISBN: 978-0070679427.

iii) Faghri, A., and Zhang, Y., *Fundamentals of Multiphase Heat Transfer and Flow*, 1st Edition, Springer, 2020, ISBN: 978-3030221393.

| 5. | **Reference Book(s) and Other Required Material** |
|---|---|

i) Mills, D., *Pneumatic Conveying Design Guide*, 3rd Edition, Elsevier (Butterworth-Heinemann), 2016, ISBN: 978-0750654715.

ii) Michaelides, E. E., Crowe, C. T., and Schwarzkopf, J. D. (Editors), *Multiphase Flow Handbook*, 2nd Edition, CRC Press (Taylor & Francis Group), 2017, ISBN: 978-1498701006

| 6. | **Evaluation Details:** |
|---|---|

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %

b) Teacher Defined Assessment: 20 %

c) End Semester Exam: 50-60 %

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 3 | 1 |
| CO2 | 2 | 3 | 2 | 2 | 3 | 1 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 |
| CO3 | 3 | 2 | 3 | 2 | 3 | 1 | 2 | 3 | 2 | 2 | 1 | 3 | 2 | 2 |
| CO4 | 3 | 2 | 3 | 2 | 3 | 1 | 2 | 3 | 2 | 2 | 1 | 2 | 2 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Course Code & Course Title: | MEP318: TWO PHASE FLOW AND HEAT TRANSFER | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B. Tech. in Mechanical Engineering | | |
| L – T – P | 0-0-2 | No. of Credits | 1 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) To measure the pressure drop in the pipeline for the two-phase flow.
ii) To study the measure the volume fraction of secondary phase for the two-phase flow.
iii) To study the flow regime maps for the two-phase flow.
iv) To do characterization of particles and bubbles based on their shape and size.

| 2. | Course Outcomes |
|---|---|
| CO1 | Measure pressure drop in pipelines for two-phase flow. |
| CO2 | Determine the volume fraction of the secondary phase in two-phase flow systems. |
| CO3 | Develop flow regime maps for two-phase flow. |
| CO4 | Characterize particles based on their size and shape. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| Topics | | CO(s) Addressed | Duration in weeks |
| Determination of pressure drop for the gas-liquid flow through vertical pipe. | | CO1 | 1 |
| Measurement of void fraction for the gas-liquid flow through vertical pipe using quick valve closing method. | | CO2 | 1 |
| Measurement of void fraction for the gas-liquid flow through vertical pipe using conductivity probe. | | CO2 | 1 |
| Measurement of pressure drop in a pipeline for the solid-liquid flow. | | CO1 | 1 |
| Development of flow regime maps for the gas-liquid flow through vertical pipe. | | CO3 | 1 |
| Measurement of the heat transfer coefficient of the fluidized bed. | | CO1 | 1 |

| | | |
|---|---|---|
| Rise of Taylor Bubble through vertical pipe. | CO3 | 1 |
| Bubble generation, growth and departure from a submerged orifice. | CO3 | 1 |
| Measurement of viscosity of different types of slurries. | CO1 | 1 |
| Determination of particle size distribution and shape. | CO4 | 1 |

## 4. Text books

i) Brennen, C. E., *Fundamentals of Multiphase Flow*, 1st Edition, Cambridge University Press, 2005, ISBN: 978-0521848046.

ii) Wallis, G. B., *One-Dimensional Two-Phase Flow*, 1st Edition, McGraw-Hill, 1969, ISBN: 978-0070679427.

iii) Faghri, A., and Zhang, Y., *Fundamentals of Multiphase Heat Transfer and Flow*, 1st Edition, Springer, 2020, ISBN: 978-3030221393.

## 5. Reference Book(s) and Other Required Material

i) Mills, D., *Pneumatic Conveying Design Guide*, 3rd Edition, Elsevier (Butterworth-Heinemann), 2016, ISBN: 978-0750654715.

ii) Michaelides, E. E., Crowe, C. T., and Schwarzkopf, J. D. (Editors), *Multiphase Flow Handbook*, 2nd Edition, CRC Press (Taylor & Francis Group), 2017, ISBN: 978-1498701006

## 6. Evaluation Details:

**Evaluation Weightage (%)**

a) Continuous Evaluation - I 30-35 %
b) Continuous Evaluation - II 30-40 %
c) Continuous Evaluation - III 25-40 %

## 7. Relationship of Course Outcomes to Program Outcomes:

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 2 | 3 | 2 | 2 | 1 | 3 |
| CO2 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 2 | 3 | 1 | 3 | 2 | 2 |
| CO3 | 2 | 3 | 2 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 |
| CO4 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| |
|---|
| Determination of pressure drop for the gas-liquid flow through vertical pipe. |
| Measurement of void fraction for the gas-liquid flow through vertical pipe using quick valve closing method. |
| Measurement of void fraction for the gas-liquid flow through vertical pipe using conductivity probe. |
| Measurement of pressure drop in a pipeline for the solid-liquid flow. |
| Development of flow regime maps for the gas-liquid flow through vertical pipe. |
| Measurement of the heat transfer coefficient of the fluidized bed. |
| Rise of Taylor Bubble through vertical pipe. |
| Bubble generation, growth and departure from a submerged orifice. |
| Measurement of viscosity of different types of slurries. |
| Determination of particle size distribution and shape. |

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEL401 CONTROL SYSTEMS** | | |
| **Course Type:** | **DE** | | |
| **Name of the programme(s):** | **B. Tech. in Mechanical Engineering** | | |
| **L – T – P** | **3-0-0** | **No. of Credits** | **3** |
| **Pre-requisites: Course Code(s) & Name(s)** | **MEL 313** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) The objective of this course is to introduce the fundamental concepts of control systems and feedback theory.

**ii)** The course aims to develop the ability to model physical systems, analyze system behavior, and assess stability and performance of control systems using time-domain and frequency-domain techniques.

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Understand basic concepts, terminology, and components of open-loop and closed-loop control systems. |
| **CO2** | Develop mathematical models of physical systems using differential equations, transfer functions, and block diagrams. |
| **CO3** | Analyze time-domain response characteristics of control systems and evaluate system stability. |
| **CO4** | Analyze frequency-domain characteristics using Bode plots, Nyquist plots, and root locus techniques. |
| **CO5** | Apply stability criteria and performance measures to assess and improve control system behavior. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| Introduction to Control Systems: Basic concepts, open-loop and closed-loop systems, feedback, examples of control systems in mechanical engineering, control system components. | | CO1 | 2 |

| | | |
|---|---|---|
| Mathematical Modeling of Systems: Differential equation models of mechanical, electrical, and electromechanical systems, transfer functions, block diagram algebra, signal flow graphs. | CO2 | 3 |
| Time-Domain Analysis: Standard test signals, time response of first- and second-order systems, transient and steady-state response, steady-state error, system type. | CO3 | 2 |
| Stability Analysis: Concept of stability, Routh–Hurwitz stability criterion, relative stability, root locus technique and its applications. | CO5 | 3 |
| Frequency-Domain Analysis: Frequency response, Bode plots, Nyquist criterion, gain margin and phase margin, correlation between time and frequency response. | CO4 | 2 |

## 4. Text books

i) Ogata, K., *Modern Control Engineering*, 5th Edition, Pearson Education, 2010, ISBN: 978-0136156734.

ii) Nagrath, I. J., and Gopal, M., *Control Systems Engineering*, 5th Edition, New Age International Publishers, 2007, ISBN: 978-8122430783.

## 5. Reference Book(s) and Other Required Material

i) Kuo, B. C., and Golnaraghi, F., *Automatic Control Systems*, 9th Edition, Wiley India, 2010, ISBN: 978-8126521333.

ii) Dorf, R. C., and Bishop, R. H., *Modern Control Systems*, 13th Edition, Pearson Education, 2017, ISBN: 978-0134407623.

## 6. Evaluation Details:

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %
b) Teacher Defined Assessment: 20 %
c) End Semester Exam: 50-60 %

## 7. Relationship of Course Outcomes to Program Outcomes:

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | – | – | – | – | – | – | – | – | 2 | 2 | 1 |
| CO2 | 3 | 3 | 2 | 2 | – | – | – | – | – | – | – | 3 | 2 | 1 |
| CO3 | 2 | 3 | 2 | 3 | – | – | – | – | – | – | – | 3 | 2 | 1 |
| CO4 | 2 | 3 | 3 | 3 | – | – | – | – | – | – | – | 3 | 2 | 2 |
| CO5 | 2 | 2 | 3 | 3 | – | – | – | – | – | – | – | 3 | 2 | 2 |

*High - 3; Medium – 2; Low – 1;*

## 8. List of Indicative Laboratory Experiment (if applicable):

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEL405 OPTIMIZATION** | | |
| **Course Type:** | **DE** | | |
| **Name of the programme(s):** | **B. Tech in Mechanical Engineering** | | |
| **L – T – P** | **3-0-0** | **No. of Credits** | **3** |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

1. To understand the classical optimization techniques for getting solutions to mechanical engineering related problems.
2. To understand the various numerical methods for getting solutions of constrained and unconstrained problems of mechanical engineering.
3. To develop the skills for the formulation of mathematical models and application of software tools such as Matlab for designing a system operating within a realistic constraints.

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Students will be able to understand and implement the classical optimization techniques to solve the problems of mechanical systems. |
| **CO2** | Students will be able to understand and implement the numerical methods for solving the constrained and unconstrained problems of mechanical engineering. |
| **CO3** | Students will be able to formulate the mathematical model for various engineering system for robust design. |
| **CO4** | Students will be able to develop the own codes in Matlab® for the optimization of the system response. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| Introduction to Optimization Techniques, Statement of an Optimization problem – design vector – design constraints – constraint surface – objective function –objective function surfaces – classification of Optimization problems, Graphical Method. | | CO1 | 2 |
| Classical Optimization Techniques. Single variable Optimization – multi variable Optimization without constraints – necessary and sufficient conditions for minimum/maximum – multivariable, Optimization with | | CO1, CO2 | 3 |

| | | |
|---|---|---|
| equality constraints. Solution by method of Lagrange multipliers – multivariable Optimization with inequality constraints. Kuhn-Tucker Conditions, Constraint Qualification. | | |
| Unconstrained optimization Techniques, Introduction; Standard form of the problem and basic terminology; Direct search method- Simplex method, Random search method, Univariate and pattern search method, Indirect search method-Steepest Descent (Cauchy) method, Conjugate gradient method, Newton's method, Application to engineering problems. | CO2, CO3 | 3 |
| Constrained Optimization Introduction; Standard form of the problem and basic terminology; Direct method; Linear Programming (Simplex); Sequential Linear Programming; Generalized reduced gradient method, Methods of feasible direction Indirect method: Penalty function method, Interior and exterior penalty function method, Convex programming problem, Check for Convergence. Application to engineering problems. | CO2, CO3 | 3 |
| Introduction to non- traditional methods, Genetic Algorithm: Introduction, Representation of design variables, Objective function and constraints, Genetic operators and numerical results. Introduction to Neural network based optimization. | CO3, CO4 | 2 |

| 4. | **Text books** |
|---|---|

i) Rao, S. S., *Engineering Optimization: Theory and Practice*, 4th Edition, John Wiley & Sons, 2009, ISBN: 978-0470183526.

ii) Arora, J. S., *Introduction to Optimum Design*, 3rd Edition, Academic Press (Elsevier), 2011, ISBN: 978-0123813756.

| 5. | **Reference Book(s) and Other Required Material** |
|---|---|

i) Deb, K., *Optimization for Engineering Design: Algorithms and Examples*, 2nd Edition, PHI Learning Private Limited, New Delhi, 2012, ISBN: 978-8120349889.

| 6. | **Evaluation Details:** |
|---|---|

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %
b) Teacher Defined Assessment: 20 %
c) End Semester Exam: 50-60 %

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | 2 | 3 | 3 | | | |
| CO2 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | | | |
| CO3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 2 | 3 | | | |
| CO4 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 2 | 2 | 2 | | | |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Course Code & Course Title: | MEL409 ADVANCED MECHANICS OF SOLIDS | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B. Tech. in Mechanical Engineering | | |
| L – T – P | 3-0-0 | No. of Credits | 3 |
| Pre-requisites: Course Code(s) & Name(s) | MEL206 | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1 | Course Objective: |
|---|---|

i) The objective of this course is to extend the fundamentals of solid mechanics to advanced stress analysis, elasticity theory, and complex deformation behavior of solids.

ii) The course aims to equip students with the ability to analyze stresses, strains, and displacements in elastic bodies using analytical and energy-based methods.

| 2 | Course Outcomes |
|---|---|
| CO1 | Understand advanced concepts of stress, strain, and constitutive relations in elastic solids. |
| CO2 | Analyze two-dimensional stress and strain problems using elasticity theory. |
| CO3 | Apply energy methods to solve problems in elasticity and structural mechanics. |
| CO4 | Analyze torsion, bending, and combined loading in non-circular and advanced structural members. |
| CO5 | Evaluate stress concentration, contact stresses, and failure behavior in solid bodies. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| Topics | | CO(s) Addressed | Duration in weeks |
| Review of Elasticity and Stress–Strain Relations: Generalized stress and strain, constitutive equations, generalized Hooke's law, plane stress and plane strain conditions. | | CO1 | 2 |
| Two-Dimensional Elasticity: Equilibrium equations, compatibility conditions, stress functions, Airy stress function, solution of plane elasticity problems. | | CO2 | 3 |
| Energy Methods in Solid Mechanics: Strain energy, Castigliano's theorems, principle of minimum potential energy, Rayleigh–Ritz method, applications to structural problems. | | CO3 | 2 |

| | | |
|---|---|---|
| Advanced Bending and Torsion: Torsion of non-circular sections, thin-walled open and closed sections, warping torsion, combined bending and torsion. | CO4 | 3 |
| Stress Concentration and Contact Mechanics: Stress concentration factors, notch effects, contact stresses (Hertzian contact), introduction to fracture and failure considerations. | CO5 | 2 |

## 4. Text books

i) Timoshenko, S. P., and Goodier, J. N., *Theory of Elasticity*, 3rd Edition, McGraw-Hill, 1970, ISBN: 978-0070647206.

ii) Boresi, A. P., and Schmidt, R. J., *Advanced Mechanics of Materials*, 6th Edition, John Wiley & Sons, 2002, ISBN: 978-0471438816.

## 5. Reference Book(s) and Other Required Material

i) Sadd, M. H., *Elasticity: Theory, Applications, and Numerics*, 3rd Edition, Academic Press (Elsevier), 2014, ISBN: 978-0124081369.

ii) Ugural, A. C., and Fenster, S. K., *Advanced Mechanics of Materials and Applied Elasticity*, 5th Edition, Pearson, 2019, ISBN: 978-0134859286

## 6. Evaluation Details:

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %
b) Teacher Defined Assessment: 20 %
c) End Semester Exam: 50-60 %

## 7. Relationship of Course Outcomes to Program Outcomes:

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | – | – | – | – | – | – | – | – | 3 | 2 | 1 |
| CO2 | 3 | 3 | 2 | 3 | – | – | – | – | – | – | – | 3 | 2 | 1 |
| CO3 | 2 | 3 | 3 | 3 | – | – | – | – | – | – | – | 3 | 2 | 1 |
| CO4 | 2 | 3 | 3 | 2 | – | – | – | – | – | – | – | 3 | 3 | 1 |
| CO5 | 2 | 2 | 3 | 3 | – | – | – | – | – | – | – | 3 | 3 | 2 |

*High - 3; Medium – 2; Low – 1;*

## 8. List of Indicative Laboratory Experiment (if applicable):

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEL413 FRACTURE MECHANICS** | | |
| **Course Type:** | **DE** | | |
| **Name of the programme(s):** | **B. Tech. in Mechanical Engineering** | | |
| **L – T – P** | **3-0-0** | **No. of Credits** | **3** |
| **Pre-requisites: Course Code(s) & Name(s)** | **MEL206** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) The objective of this course is to introduce the principles of fracture mechanics for analysis of crack initiation, crack growth, and failure of engineering materials.

**ii)** The course aims to develop the ability to assess structural integrity of components under static and cyclic loading using fracture-based design concepts.

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Understand the fundamentals of fracture, failure mechanisms, and limitations of strength-based design. |
| **CO2** | Analyze stress fields near cracks and apply linear elastic fracture mechanics concepts. |
| **CO3** | Evaluate fracture toughness and crack growth behavior under static loading. |
| **CO4** | Analyze fatigue crack growth and failure under cyclic loading conditions. |
| **CO5** | Apply fracture mechanics concepts to engineering design and life prediction of components. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| Introduction to Fracture: Types of fracture, brittle and ductile fracture, fracture surfaces, Griffith theory, energy balance approach, limitations of conventional design criteria. | | CO1 | 2 |
| Stress Analysis Near Cracks: Stress concentration at cracks, crack tip stress fields, stress intensity factors, modes of crack opening (Mode I, II, III). | | CO2 | 3 |

| | | |
|---|---|---|
| Linear Elastic Fracture Mechanics (LEFM): Fracture toughness, critical crack length, fracture toughness testing methods, crack instability, mixed-mode fracture. | CO2, CO3 | 2 |
| Fatigue and Crack Growth: Fatigue crack initiation and propagation, Paris law, crack growth rate curves, effect of mean stress and environment, threshold stress intensity factor. | CO4 | 3 |
| Applications of Fracture Mechanics: Fracture control, damage tolerance design, life prediction, introduction to elastic-plastic fracture mechanics concepts, engineering case studies. | CO5 | 2 |

## 4. Text books

i) Anderson, T. L., *Fracture Mechanics: Fundamentals and Applications*, 3rd Edition, CRC Press (Taylor & Francis Group), 2005, ISBN: 978-0849316562.

ii) Broek, D., *Elementary Engineering Fracture Mechanics*, 4th Edition, Martinus Nijhoff Publishers (now Springer), 1986, ISBN: 978-9024732586.

## 5. Reference Book(s) and Other Required Material

i) Kanninen, M. F., and Popelar, C. H., *Advanced Fracture Mechanics*, 1st Edition, Oxford University Press, 1985, ISBN: 978-0195035179.

ii) Hertzberg, R. W., *Deformation and Fracture Mechanics of Engineering Materials*, 5th Edition, John Wiley & Sons, 2012, ISBN: 978-0470527801.

## 6. Evaluation Details:

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %

b) Teacher Defined Assessment: 20 %

c) End Semester Exam: 50-60 %

## 7. Relationship of Course Outcomes to Program Outcomes:

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | – | – | – | – | – | – | – | – | 3 | 2 | 1 |
| CO2 | 3 | 3 | 2 | 3 | – | – | – | – | – | – | – | 3 | 2 | 1 |
| CO3 | 2 | 3 | 3 | 3 | – | – | – | – | – | – | – | 3 | 2 | 1 |
| CO4 | 2 | 3 | 2 | 3 | – | – | – | – | – | – | – | 3 | 3 | 1 |
| CO5 | 2 | 2 | 3 | 3 | – | – | – | – | – | – | – | 3 | 3 | 2 |

*High - 3; Medium – 2; Low – 1;*

## 8. List of Indicative Laboratory Experiment (if applicable):

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEL415 MECHANICAL VIBRATION** | | |
| **Course Type:** | **DE** | | |
| **Name of the programme(s):** | **B. Tech. in Mechanical Engineering** | | |
| **L – T – P** | **3-0-0** | **No. of Credits** | **3** |
| **Pre-requisites: Course Code(s) & Name(s)** | **MEL301** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) The objective of this course is to introduce the principles of vibration analysis of mechanical systems.

ii) The course aims to develop the ability to model, analyze, and predict vibration behavior of single and multi-degree-of-freedom systems under free and forced excitation, with emphasis on engineering applications and vibration control.

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Understand fundamental concepts and terminology related to mechanical vibrations. |
| **CO2** | Analyze free vibration of single degree-of-freedom systems with and without damping. |
| **CO3** | Analyze forced vibration of single degree-of-freedom systems and resonance behavior. |
| **CO4** | Model and analyze multi-degree-of-freedom vibration systems and determine natural frequencies and mode shapes. |
| **CO5** | Apply vibration analysis concepts to practical engineering problems including vibration measurement and control. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| Fundamentals of vibrations: definition and classification of vibration, free and forced vibration, transient and steady-state response, degrees of freedom, lumped and distributed parameter systems, physical idealization and mathematical modeling of vibrating systems, examples from mechanical and structural systems | | CO1 | 1 |
| Free vibration of single degree of freedom systems: undamped free vibration, natural frequency and stiffness–mass relationship, damped free vibration, underdamped, critically damped and overdamped systems, | | CO2 | 1.5 |

| | | |
|---|---|---|
| logarithmic decrement, decay of motion, energy methods for free vibration, physical interpretation of damping effects | | |
| Models of damping and energy dissipation: physical sources of damping, viscous damping model, Coulomb (dry friction) damping, structural or hysteretic damping, viscoelastic damping, frequency-dependent behavior, equivalent viscous damping, comparison of damping models and engineering relevance | CO2 | 1 |
| Forced vibration of single degree of freedom systems: harmonic excitation, steady-state response, resonance phenomenon, magnification factor, frequency response function, phase angle variation, effect of damping on resonance and bandwidth, vibration due to rotating unbalance, practical implications in machinery | CO3 | 1.5 |
| Base excitation and vibration isolation: vibration due to base motion, modeling of base-excited SDOF systems, response to harmonic base excitation, displacement and force transmissibility, vibration isolation criteria, isolator design considerations, applications in machine foundations, vehicles and equipment mounting | CO3 | 1 |
| Multi-degree of freedom systems: modeling of two and multi-DOF systems, matrix formulation of equations of motion, free vibration of undamped systems, natural frequencies and mode shapes, physical interpretation of modes, orthogonality of mode shapes, modal coordinates, introduction to modal superposition method | CO4 | 1.5 |
| Continuous systems: need for continuous system modeling, vibration of stretched strings, longitudinal vibration of bars, transverse vibration of beams using Euler–Bernoulli beam theory, governing differential equations, boundary conditions, natural frequencies and mode shapes, comparison with lumped parameter models | CO4 | 1.5 |
| Response spectrum method: concept of response spectra, transient and base excitation response of SDOF systems, maximum response, construction and interpretation of response spectra, effect of damping, application to multi-degree of freedom systems using modal participation, limitations and engineering interpretation | CO4 | 1 |
| Engineering applications and case studies: vibration problems in mechanical and structural systems, resonance-induced failures, vibration fatigue and serviceability issues, vibration control strategies, tuned mass dampers, damping treatments, overview of experimental vibration measurement techniques, time-domain and frequency-domain response interpretation | CO5 | 1 |
| **4.** | **Text books** | |

i) Rao, S. S., *Mechanical Vibrations*, 6th Edition, Pearson Education, 2017, ISBN: 978-9332584563.

ii) Thomson, W. T., and Dahleh, M. D., *Theory of Vibration with Applications*, 5th Edition, Pearson Education, 1998, ISBN: 978-0136510680.

| 5. | **Reference Book(s) and Other Required Material** |
|---|---|

i) Den Hartog, J. P., *Mechanical Vibrations*, Revised Edition, McGraw-Hill, 1956, ISBN: 978-0486607542.

ii) Inman, D. J., *Engineering Vibration*, 4th Edition, Pearson Education, 2014, ISBN: 978-0132871693.

| 6. | **Evaluation Details:** |
|---|---|

Evaluation is continuous. Components are

a) Mid Semester Examination: Conducted after 40% syllabus completion, Weightage: 20–30%

b) Teacher Defined Assessment: Includes assignments, tutorials, quizzes, tests, presentations, etc. Must consist of minimum two components- One before Mid-Sem, One after Mid-Sem, Weightage: 20%

c) End Semester Examination: Comprehensive exam covering full syllabus, Weightage: 50–60%

| 7 | **Relationship of Course Outcomes to Program Outcomes:** |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | – | – | – | – | – | – | – | – | 2 | 1 | 1 |
| CO2 | 3 | 3 | 2 | 2 | – | – | – | – | – | – | – | 3 | 2 | 1 |
| CO3 | 2 | 3 | 2 | 3 | – | – | – | – | – | – | – | 3 | 2 | 1 |
| CO4 | 2 | 3 | 3 | 3 | – | – | – | – | – | – | – | 3 | 2 | 2 |
| CO5 | 2 | 2 | 3 | 3 | – | – | – | – | – | – | – | 2 | 3 | 2 |

*High - 3; Medium – 2; Low – 1;*

| 8. | **List of Indicative Laboratory Experiment (if applicable):** |
|---|---|

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEL416 INDUSTRIAL ROBOTICS** | | |
| **Course Type:** | **DE** | | |
| **Name of the programme(s):** | **B. Tech. in Mechanical Engineering** | | |
| **L – T – P** | **3-0-0** | **No. of Credits** | **3** |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) The objective of this course is to develop a comprehensive understanding of industrial robotics by introducing the mechanical structure of industrial robots, along with kinematic and dynamic analysis techniques.

**ii)** The course aims to enable students to understand path and trajectory planning for robots during specific industrial applications and to develop the ability to analyze and design grippers and end-effector systems based on application requirements, supported by relevant analytical computations.

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Analyze the mechanical structure of industrial robots, including manipulators, actuators, drives, and sensor systems. |
| **CO2** | Apply forward kinematics, inverse kinematics, and Jacobian-based methods to analyze motion of industrial robotic manipulators. |
| **CO3** | Analyze path planning and trajectory generation techniques for industrial robots under kinematic and dynamic constraints. |
| **CO4** | Evaluate static and dynamic behavior of robotic manipulators, including force/torque relationships and manipulability characteristics. |
| **CO5** | Identify, select, and design appropriate end effectors and grippers for specific industrial applications considering payload, force, and operational requirements. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| Fundamentals of Robotics: evolution, characteristics, configurations, coordinate systems, precision, accuracy, applications | | CO1 | 2 |
| Frame Transformations: coordinate frames, rotation properties, homogeneous transformations, Euler and axis–angle representations | | CO1, CO2 | 2 |

| | | |
|---|---|---|
| Forward Kinematics: DH and modified DH conventions, homogeneous transformation matrices | CO2 | 2 |
| Inverse Kinematics: workspace analysis, singularities, IK approaches, spherical and non-spherical wrists | CO2 | 2 |
| Path Planning and Trajectory Generation: point-to-point and continuous paths, quaternions, splines, Jacobian-based velocity analysis | CO3 | 2 |
| Statics, Dynamics and End-Effectors: Jacobian-based force analysis, manipulability, dynamic modeling overview, gripper and end-effector design | CO4, CO5 | 3 |

## 4. Text books

i) Craig, J. J., *Introduction to Robotics: Mechanics and Control*, 3rd Edition, Pearson Prentice Hall, 2005, ISBN: 978-0201543612.

ii) Mittal, R. K., and Nagrath, I. J., *Robotics and Control*, 1st Edition, McGraw-Hill Education (India), 2003, ISBN: 978-0070482935.

iii) Niku, S. B., *Introduction to Robotics: Analysis, Control, Applications*, 2nd Edition, John Wiley & Sons, 2011, ISBN: 978-0470604465.

## 5. Reference Book(s) and Other Required Material

i) Lynch, K. M., and Park, F. C., *Modern Robotics: Mechanics, Planning, and Control*, 1st Edition, Cambridge University Press, 2017, ISBN: 978-1107156302.

ii) Jazar, R. N., *Theory of Applied Robotics: Kinematics, Dynamics, and Control*, 2nd Edition, Springer, 2010, ISBN: 978-1441917492.

## 6. Evaluation Details:

Evaluation is continuous. Components are

a) Mid Semester Examination : Conducted after 40% syllabus completion, Weightage: 20–30%

b) Teacher Defined Assessment : Includes assignments, tutorials, quizzes, tests, presentations, etc. Must consist of minimum two components- One before Mid-Sem , One after Mid-Sem, Weightage: 20%

c) End Semester Examination : Comprehensive exam covering full syllabus, Weightage: 50–60%

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 1 | 2 | – | – | – | – | – | – | 3 | 3 | 2 |
| CO2 | 3 | 3 | 2 | 1 | 2 | – | – | – | – | – | – | 3 | 2 | 2 |
| CO3 | 3 | 3 | 2 | 2 | 2 | – | – | – | – | – | – | 3 | 2 | 2 |
| CO4 | 3 | 3 | 2 | 2 | 2 | – | – | – | – | – | – | 3 | 2 | 2 |
| CO5 | 2 | 2 | 3 | 1 | 2 | – | – | – | 2 | 1 | 2 | 3 | 3 | 2 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEL418: ADVANCED STRESS ANALYSIS** | | |
| **Course Type:** | **DE** | | |
| **Name of the programme(s):** | **B. Tech. in Mechanical Engineering** | | |
| **L – T – P** | **3-0-0** | **No. of Credits** | **3** |
| **Pre-requisites: Course Code(s) & Name(s)** | **MEL206** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

**i)** The objective of this course is to provide an in-depth understanding of advanced stress analysis by developing the ability to analyze complex stress–strain relationships and elastic behavior of materials.

**ii)** The course aims to enable students to apply analytical and experimental methods for two-dimensional stress analysis using Cartesian and polar coordinate systems, evaluate thermal stresses in structural components, and use experimental techniques such as photoelasticity and strain-gauge measurements for stress determination and failure assessment in engineering components.

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Explain fundamental concepts of stress, strain, elasticity, elastic constants, and distinguish between plane stress and plane strain conditions. |
| **CO2** | Analyze two-dimensional stress problems in Cartesian coordinate systems using equilibrium equations, compatibility conditions, and Airy's stress function. |
| **CO3** | Analyze stress distributions in polar coordinate systems and evaluate stresses due to thermal loading in components such as circular discs, thin plates, and long cylinders. |
| **CO4** | Apply experimental stress analysis techniques including strain gauges, strain rosettes, brittle coating, and Moiré fringe methods to determine stresses and detect cracks. |
| **CO5** | Interpret photoelastic fringe patterns and apply photoelasticity techniques, including three-dimensional photoelasticity, for stress analysis and failure assessment. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| Fundamentals of stress and strain, stress–strain relationship, elastic constants, plane stress and plane strain | | CO1 | 2 |

| | | |
|---|---|---|
| Two-dimensional stress analysis in Cartesian coordinate system: equilibrium equations, boundary conditions, compatibility equation, Airy's stress function | CO2 | 3 |
| Two-dimensional stress analysis in polar coordinate systems: general equations, stress distribution about symmetric axis, pure bending of curved beams, effect of holes in plates | CO3 | 3 |
| Thermal stresses: circular disc, thin plate, long cylinder | CO3 | 1 |
| Photoelasticity: polarized light, wave plates, plane and circular polariscope, isochromatic and isoclinic fringes, compensation and separation techniques, fringe analysis, introduction to 3-D photoelasticity | CO5 | 2 |
| Strain gauge techniques: strain gauge circuits, recording instruments, data analysis, strain rosette, brittle coating technique, failure theories, crack patterns and detection, Moiré fringe techniques | CO4 | 1 |

| 4. | **Text books** |
|---|---|

i) Timoshenko, S. P., and Goodier, J. N., *Theory of Elasticity*, 3rd Edition, McGraw-Hill Book Company, 1970, ISBN: 978-0070647206.

ii) Dally, J. W., and Riley, W. F., *Experimental Stress Analysis*, 3rd Edition, McGraw-Hill, 1991, ISBN: 978-0070152182.

| 5. | **Reference Book(s) and Other Required Material** |
|---|---|

i) Dove, R. C., and Adams, A. M., *Experimental Stress Analysis and Motion Measurement*, 1st Edition, Prentice-Hall of India, 1965.

| 6. | **Evaluation Details:** |
|---|---|

Evaluation is continuous. Components are

a) Mid Semester Examination : Conducted after 40% syllabus completion, Weightage: 20–30%

b) Teacher Defined Assessment : Includes assignments, tutorials, quizzes, tests, presentations, etc. Must consist of minimum two components- One before Mid-Sem , One after Mid-Sem, Weightage: 20%

c) End Semester Examination : Comprehensive exam covering full syllabus, Weightage: 50–60%

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 2 | 3 | – | – | – | 3 | 2 | 3 | 3 | 2 | 1 |
| CO2 | 3 | 3 | 2 | 3 | 3 | – | – | – | 3 | 3 | 3 | 3 | 2 | 1 |
| CO3 | 3 | 2 | 2 | 3 | 3 | – | – | – | 2 | 3 | 3 | 3 | 3 | 1 |
| CO4 | 3 | 3 | 3 | 2 | 2 | – | – | – | 3 | 2 | 3 | 2 | 3 | 3 |
| CO5 | 3 | 2 | 3 | 2 | 3 | – | – | – | 2 | 3 | 3 | 2 | 3 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Course Code & Course Title: | MEL422: AUTOMOBILE ENGINEERING | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B. Tech Mechanical Engineering | | |
| L – T – P | 3-0-0 | No. of Credits | 3 |
| Pre-requisites: Course Code(s) & Name(s) | Solid Mechanics | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) To provide a comprehensive detail about the working principle of various system in vehicle

ii) To provide a comprehensive overview of the construction, operation, and maintenance of automobiles.

iii) To impart knowledge on vehicle layouts, power transmission, control systems (steering, braking, suspension), electrical systems, and recent technological advancements in the automotive industry.

| 2. | Course Outcomes |
|---|---|
| CO1 | Explain the anatomy of automobile layouts, chassis types, and the working principles of Internal Combustion (I.C.) engines including fuel, cooling, and lubrication systems |
| CO2 | Analyze the power transmission train, distinguishing the functions and operations of clutches, gearboxes (manual/automatic), propeller shafts, and differentials. |
| CO3 | Evaluate the mechanisms of vehicle control systems, specifically steering geometry, suspension types, and braking systems to determine their impact on vehicle stability and safety. |
| CO4 | Apply the principles of automotive electrical systems to explain the operation of batteries, ignition systems, lighting, and air-conditioning. |
| CO5 | Familiar with formulation of maintenance procedures for vehicle overhauling and discuss the integration of modern advancements like ABS, Power steering etc. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| Introduction: Automobile history and development Present scenario of automobiles in India and Abroad. Chassis, articulated and rigid vehicles and vehicles layout. | | CO1 | 2 |
| Steering & Suspension Systems: Steering systems, principle of steering, centre point steering, steering linkages, steering geometry and wheel alignment, power Steering, special steering systems.<br>Tyres, tyres specification, factors affecting tyre performance, Special tyres, wheel balancing, suspension system- Function of Spring and shock absorber, conventional and Independent Suspension System, Telescopic shock absorber, linked suspension systems, | | CO3 | 3 |
| Transmission Systems: Clutch - Necessity, requirements of a clutch system. Types of Clutches, size of clutch, centrifugal clutch, wet clutch, fluid Clutch.<br>Transmission, Necessity of transmission, principle, types of transmission, sliding mesh, constant mesh, synchromesh, Transfer gear box, Gear Selector mechanism, lubrication and control. Overdrive, Automatic Transmission.<br>Propeller shaft, Universal joint, constant velocity joint, Hotchkiss drive, and torque tube drive. Differential - Need and types Rear Axles and Front Axles. | | CO2 | 3 |
| Brakes: Need, types, Mechanical, hydraulic, Pneumatic brakes, Electrical Brakes, Engine Exhaust brakes, Drum and Disc brakes, Comparison. Details of components, Brake adjustment. | | CO3 | 2 |
| Electrical systems: Construction. Operation and maintenance of Lead acid batteries, battery charging system, Principles and Operation of cutout and regulators, Starter motor, Battery Ignition and magneto ignition systems ignition timing. Lighting and electrical accessories Automobile air- conditioning, Panel board instruments. | | CO4 | 2 |
| Maintenance & Testing: Maintenance, Trouble shooting and service, procedures, Overhauling, Engine tune up, Tools and equipment for repair and Overhaul. Testing equipment. Inspection, laboratory and road testing of automobiles. Safety Considerations in automobiles Recent Advances in automobiles such as ABS, Electronic Power Steering, and Steer by wire | | CO5 | 2 |

| 4. | Text books |
|---|---|

i) Singh, K., *Automobile Engineering, Vol. I and Vol. II*, Standard Publishers and Distributors, New Delhi, 2012, ISBN: 978-8180141713.

ii) Ramalingam, K. K., *Automobile Engineering*, Scitech Publications (India) Pvt. Ltd., 2011, ISBN: 978-8189757243.

iii) Srinivasan, S., *Automotive Engines*, Tata McGraw-Hill Education, 2009, ISBN: 978-0070700411.

| 5. | Reference Book(s) and Other Required Material |
|---|---|

i) Crouse, W. H., and Anglin, D. L., *Automotive Mechanics*, 10th Edition, Tata McGraw-Hill Education, 2004, ISBN: 978-0070582932.

| 6. | Evaluation Details: |
|---|---|

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %

b) Teacher Defined Assessment: 20 %

c) End Semester Exam: 50-60 %

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | - | - | - | - | - | - | - | - | 1 | - | - | - |
| CO2 | 3 | 3 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | - |
| CO3 | 3 | 3 | 2 | 2 | - | 1 | - | - | - | - | 1 | 1 | - | - |
| CO4 | 3 | 2 | 1 | - | 2 | | - | - | - | - | 1 | - | 1 | - |
| CO5 | 2 | 2 | - | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | - | 2 | 1 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Course Code & Course Title: | MEP422 AUTOMOBILE ENGINEERING | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B. Tech in Mechanical Engineering | | |
| L – T – P | 0-0-2 | No. of Credits | 1 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) To provide hands-on exposure to vehicle layouts, chassis configurations, and the physical arrangement of transmission and steering systems.

ii) To correlate the theoretical concepts of automobile engineering (mechanics, thermodynamics, and machine design) with actual vehicle components and performance.

iii) To develop the ability to calculate and analyze critical performance parameters such as maximum speed, stopping distance, turning radius, and tractive effort.

iv) To impart skills in designing and verifying the safety of critical mechanical components like gearbox shafts and suspension springs under load.

**v)** To understand the systems responsible for passenger safety (braking, steering) and comfort (air conditioning, suspension).

| 2. | Course Outcomes |
|---|---|
| **CO1** | Identify different vehicle categories, interpret technical specifications, and explain the layout of chassis and transmission systems. |
| **CO2** | Apply design procedures to determine the dimensions of gearbox shafts and verify the stiffness and safety of suspension springs. |
| **CO3** | Calculate vehicle speed across different gears, analyze gear shift patterns, and estimate the tractive power required to overcome resistance forces. |
| **CO4** | Assess the steering and braking systems by determining the Turning Circle Radius (TCR), stopping distance, and dynamic weight transfer. |
| **CO5** | Explain the working principles, components, and maintenance requirements of automobile air conditioning systems. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| Selection of Vehicle and measurement of vehicle dimensions | | CO1 | 1 |
| Demonstration of vehicle system with cut section automobile chassis | | CO1 | 1 |
| Determining maximum speed of selected vehicle in all forward gears | | CO3 | 1 |
| Graphical representation of gear shift pattern and effect of transmission efficiency for the selected vehicle | | CO3 | 1 |
| Measurement of steering system parameters and determining TCR of vehicle. | | CO4 | 1 |
| Design of input shaft diameter of gearbox based on engine characteristics of selected vehicle | | CO2 | 1 |
| Determine stopping distance of vehicle and weight transfer to front wheels | | CO4 | 1 |
| Calculation of tractive power based on engine and transmission system of selected vehicle | | CO3 | 1 |
| Verifying suspension system spring design | | CO2 | 1 |
| Heat Load calculation of selected automobile air conditioning system | | CO5 | 1 |

| 4. | Text books |
|---|---|

i) Singh, K., *Automobile Engineering, Vol. I and Vol. II*, Standard Publishers and Distributors, New Delhi, 2012, ISBN: 978-8180141713.

ii) Ramalingam, K. K., *Automobile Engineering*, Scitech Publications (India) Pvt. Ltd., 2011, ISBN: 978-8189757243.

**iii)** Srinivasan, S., *Automotive Engines*, Tata McGraw-Hill Education, 2009, ISBN: 978-0070700411.

| 5. | Reference Book(s) and Other Required Material |
|---|---|

i) Crouse, W. H., and Anglin, D. L., *Automotive Mechanics*, 10th Edition, Tata McGraw-Hill Education, 2004, ISBN: 978-0070582932.

| 6. | Evaluation Details: |
|---|---|

**Evaluation Weightage (%)**

a) Continuous Evaluation - I 30-35 %
b) Continuous Evaluation - II 30-40 %
c) Continuous Evaluation - III 25-40 %

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | - | 1 | 1 | - | - | - | - | - |
| CO2 | 3 | 3 | 3 | 2 | - | - | - | 1 | 1 | - | - | 1 | - | - |
| CO3 | 3 | 3 | - | 2 | - | - | - | 1 | 1 | - | - | - | 2 | 2 |
| CO4 | 3 | 3 | - | 2 | - | 1 | - | 1 | 1 | - | - | - | - | - |
| CO5 | 3 | - | - | - | - | - | - | 1 | 1 | - | 1 | - | 2 | - |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Topics | Duration in weeks |
|---|---|
| Selection of Vehicle and measurement of vehicle dimensions | 1 |
| Demonstration of vehicle system with cut section automobile chassis | 1 |
| Determining maximum speed of selected vehicle in all forward gears | 1 |
| Graphical representation of gear shift pattern and effect of transmission efficiency for the selected vehicle | 1 |
| Measurement of steering system parameters and determining TCR of vehicle. | 1 |
| Design of input shaft diameter of gearbox based on engine characteristics of selected vehicle | 1 |
| Determine stopping distance of vehicle and weight transfer to front wheels | 1 |
| Calculation of tractive power based on engine and transmission system of selected vehicle | 1 |
| Verifying suspension system spring design | 1 |
| Heat Load calculation of selected automobile air conditioning system | 1 |

| Course Code & Course Title: | MEL424: INDUSTRIAL ENGINEERING & MANAGEMENT | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B.Tech. Mechanical Engineering | | |
| L – T – P | 3-0-0 | No. of Credits | 03 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) Understand the core Industrial Engineering concepts and their role in system optimization.
ii) Develop skills to enhance process design and its improvement.
iii) To undertake master techniques for productivity enhancement and reduction in waste.
iv) Implement methods of forecasting, inventory control and strategic manufacturing principles.
v) Highlight the importance of resource management including material, machine and finance in an organization.

| 2. | Course Outcomes |
|---|---|
| CO1 | To design efficient layouts, production plans and control systems. |
| CO2 | Use different models for better allocation of resources and forecasting. |
| CO3 | Introduce different techniques to streamline different work flow in the production lines. |
| CO4 | Apply theoretical knowledge to solve onsite practical problems in the plant using qualitative and quantitative methods. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| Topics | | CO(s) Addressed | Duration in weeks |
| **Principles of management:** Concepts of management, scientific principles of management by Fredric Taylor; functions such as planning organizing, staffing, leading motivating, communicating, controlling, decision making, span of control. | | CO1 | 02 |
| **Personal management:** Functions of personal management, manpower planning, collective bargaining, wages & salary administration, labour welfare, training, trade unions, industrial factories Act, industrial boilers Act, Trade union act. | | CO3, CO4 | 02 |

| | | |
|---|---|---|
| **Plant management:** Plant location and plant layout; types of maintenance like break down, predictive and preventive maintenance; stores of management, industrial safety, accident causes, production planning and control; types of production. | CO2, CO4 | 04 |
| **Marketing management:** Definition; selling and modern concept of marketing, market research, new product development, product life cycle; product launching, sales promotion, pricing, channels of distribution, advertising, market segmentation, marketing mix. | CO4 | 02 |
| **Material management:** Importance of material management, classification, codification, forecasting, necessity of inventory. | CO2, CO3 | 02 |
| **Financial management:** Sources of finance, financing organizations, types of capital, elements of costs and allocation; cost control, break even analysis, budgetary control; equipment replacement policy; balance sheet, profit-ratio analysis and statement. | CO1 | 02 |

## 4. Text books

i) Koontz, H., O'Donnell, C., *Principles of Management*, 5th Edition, McGraw Hill Book Company, 1984, ISBN: 978-0070350557.

ii) Kuchhal, S. C., *Financial Management*, 1st Edition, Chaitanya Publishing House, 1996, ISBN: 978-8170419570.

iii) Banga, T. R., Sharma, S. C., *Industrial Organization and Engineering Economics*, 25th Edition, Khanna Publishers, 2010, ISBN: 978-8174091666.

## 5. Reference Book(s) and Other Required Material

i) Kotler, P., Stanton, W. J., *Principles of Marketing Management*, 5th Edition, Prentice Hall, 1985, ISBN: 978-0137098240.

## 6. Evaluation Details:

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %
b) Teacher Defined Assessment: 20 %
c) End Semester Exam: 50-60 %

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 3 | 2 | 2 | 1 | - | - | - | - | - | | | |
| CO2 | 2 | 3 | 3 | 1 | - | - | - | - | 2 | - | - | | | |
| CO3 | 3 | 2 | 2 | 1 | - | - | - | - | | - | - | | | |
| CO4 | 3 | 2 | 3 | - | 1 | 2 | - | - | - | - | - | | | |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Course Code & Course Title: | MEL426: REFRIGERATION & CRYOGENICS | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B. Tech in Mechanical Engineering | | |
| L – T – P | 3-0-0 | No. of Credits | 3 |
| Pre-requisites: Course Code(s) & Name(s) | MEL203: Engineering Thermodynamics | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) The student should understand, conceptualize and analyze simple and multistage vapour compression refrigeration systems and cryogenic systems

ii) The student should understand, conceptualize and analyze alternate refrigeration systems like steam jet/vapour absorption/thermoelectric/vortex tube/air cycle refrigeration.

iii) The student should understand functions and working of various components of refrigeration machine and types of refrigerants used.

iv) The student should understand and practice the mathematical treatment related to vapour compression, multistage and Air cycle refrigeration systems

| 2. | Course Outcomes |
|---|---|
| CO1 | The student should be able to understand, conceptualize and analyze simple and multistage vapour compression refrigeration systems and cryogenic systems |
| CO2 | The student should be able to understand, conceptualize and analyze alternate refrigeration systems like steam jet/vapour absorption/thermoelectric/vortex tube/air cycle refrigeration. |
| CO3 | The student should be able to understand functions and working of various components of refrigeration machine and types of refrigerants used. |
| CO4 | The student should be able to understand and practice the mathematical treatment related to vapour compression, multistage and Air cycle refrigeration systems. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| Topics | | CO(s) Addressed | Duration in weeks |
| **Vapor Compression Refrigeration System:** Introduction to refrigeration, applications of refrigeration, development of simple saturated Vapour compression refrigeration cycle, effect of change in evaporator and condenser pressure, effect of pressure drops, polytropic | | CO1, CO4 | 3 |

| | | |
|---|---|---|
| compression, methods of improvement in the performance of the cycle like sub cooling, superheating, use of heat exchanger etc. | | |
| **Components of Vapor Compression Refrigeration System and Refrigerants**: Classification, construction and application of various components used in refrigeration technology like compressors, condensers, evaporators, expansion devices, controls, cooling towers etc. Refrigerants: Types and classification, properties and nomenclature, Azeotropes and alternate environment friendly refrigerants. | CO3 | 2 |
| **Alternate Refrigeration Systems:** Vapor absorption systems ($NH_3$-$H_20$, LiBr- $H_2O$, Three fluid), Steam jet refrigeration systems, Thermoelectric refrigeration, Vortex tube refrigeration. | CO2 | 3 |
| **Multistage Refrigeration Systems:** Working and analysis of multistage systems, multi- evaporator, multi-compressor vapour compression systems. | CO1, CO4 | 2 |
| **Gas Cycle Refrigeration:** Reversed Brayton /Joules/Bell Coleman cycle, aircraft refrigeration, simple, boot strap, reduced ambient and regenerative cycle. | CO2, CO4 | 2 |
| **Cryogenics:** Introduction and applications of cryogenics, cascade refrigeration, Joules Thomson coefficient, methods of air liquefaction, Linde's and Claude's cycle, adiabatic demagnetization, cryogenic insulation. | CO1 | 2 |

| 4. | Text books |
|---|---|


i) Arora, C. P., *Refrigeration and Air Conditioning*, 3rd Edition, Tata McGraw Hill Education (India) Pvt. Ltd., 2016, ISBN: 978-9351343349.

ii) Ballaney, P. L., *Refrigeration and Air Conditioning*, 16th Edition, Khanna Publishers, 2013, ISBN: 978-8174091925.

iii) Domkundwar, S., *A Course in Refrigeration and Air Conditioning*, 1st Edition, Dhanpat Rai & Sons, 1980, ISBN: 978-8187433569.

iv) Ananthanarayanan, P. N., *Basic Refrigeration and Air Conditioning*, 4th Edition, McGraw Hill Education (India) Pvt. Ltd., 2013, ISBN: 978-0070150447.


| 5. | Reference Book(s) and Other Required Material |
|---|---|


i) Dossat, R. J., *Principles of Refrigeration*, 4th Edition, Pearson Education, 2009, ISBN: 978-8131725375.

ii) ASHRAE, *ASHRAE Handbook: Fundamentals*, SI Edition, ASHRAE Publications, 2017, ISBN: 978-1939200570.

iii) ASHRAE, *ASHRAE Handbook: HVAC Systems and Equipment*, SI Edition, ASHRAE Publications, 2016, ISBN: 978-1939200488.

iv) Carrier Corporation, *Handbook of Air Conditioning System Design*, 1st Edition, McGraw Hill Book Company, 1965, ISBN: 978-0070106635.

v) Barron, R. F., *Cryogenic Systems*, 2nd Edition, Oxford University Press / Tata McGraw Hill, 1985, ISBN: 978-0195037739.

| 6. | **Evaluation Details:** |
|---|---|

a) One Mid sem exam of 30 Marks,

b) Two Class tests of 10 marks each (best of 10)

c) End sem exam of 60 marks

| 7. | **Relationship of Course Outcomes to Program Outcomes:** |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 |
| CO3 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | **List of Indicative Laboratory Experiment (if applicable):** |
|---|---|

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEP426: REFRIGERATION AND CRYOGENICS** | | |
| **Course Type:** | **DE** | | |
| **Name of the programme(s):** | **B. Tech in Mechanical Engineering** | | |
| **L – T – P** | **0-0-2** | **No. of Credits** | **1** |
| **Pre-requisites: Course Code(s) & Name(s)** | **With MEL426 REFRIGERATION & CRYOGENICS** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) The student should understand various theoretical and practical concepts related to single stage refrigeration and for alternate refrigeration systems like, vortex tube and thermoelectric refrigeration to meet UG level requirement.

ii) The student should understand practical application of concepts of psychrometrics / psychrometric processes to actual air conditioning machine to meet UG level requirement.

iii) The student should understand working of various equipment/systems used in refrigeration and air conditioning like compressors, condensers, evaporators, expansion devices, controls, refrigerator, air conditioner etc. from under graduate perspective.

iv) The student should understand and apply mathematical treatment to energy efficiency calculations for refrigeration and air conditioning machines to reasonable correctness

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | The student should be able to understand practical application of concepts of psychrometrics / psychrometric processes to actual air conditioning machine to meet UG level requirement. |
| **CO2** | The student should be able to understand practical application of concepts of psychrometrics / psychrometric processes to actual air conditioning machine to meet UG level requirement. |
| **CO3** | The student should be able to understand working of various equipment/systems used in refrigeration and air conditioning like compressors, condensers, evaporators, expansion devices, controls, refrigerator, air conditioner etc. from under graduate perspective |
| **CO4** | The student should be able to understand and apply mathematical treatment to energy efficiency calculations for refrigeration and air conditioning machines to reasonable correctness |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| Experiment on Determination of COP of Refrigeration trainer | | CO1, CO4 | 1 |
| Experiment on Determination of COP of Heat pump | | CO1, CO4 | 1 |
| Experiment on Determination of COP of air conditioning trainer-1 | | CO1, CO4 | 1 |
| Experiment on Determination of COP of air conditioning trainer-1I | | CO1, CO4 | 1 |
| Experiment on Determination of COP of Room air conditioner | | CO1, CO4 | 1 |
| Experiment on Determination of COP of Thermoelectric Refrigeration | | CO2, CO4 | 1 |
| Demonstration of frost free refrigerator | | CO3 | 1 |
| Demonstration of conventional Refrigerator | | CO3 | 1 |
| Study and demonstration of types of compressors | | CO3 | 1 |
| Study and demonstration of types of condensers | | CO3 | 1 |
| Study and demonstration of types of evaporators | | CO3 | 1 |
| Study and demonstration of types of expansion devices | | CO3 | 1 |

## 4. Text books


i) Arora, C. P., *Refrigeration and Air Conditioning*, 3rd Edition, Tata McGraw Hill Education (India) Pvt. Ltd., 2016, ISBN: 978-9351343349.

ii) Ballaney, P. L., *Refrigeration and Air Conditioning*, 16th Edition, Khanna Publishers, 2013, ISBN: 978-8174091925.

iii) Domkundwar, S., *A Course in Refrigeration and Air Conditioning*, 1st Edition, Dhanpat Rai & Sons, 1980, ISBN: 978-8187433569.

iv) Ananthanarayanan, P. N., *Basic Refrigeration and Air Conditioning*, 4th Edition, McGraw Hill Education (India) Pvt. Ltd., 2013, ISBN: 978-0070150447.


## 5. Reference Book(s) and Other Required Material


i) Dossat, R. J., *Principles of Refrigeration*, 4th Edition, Pearson Education, 2009, ISBN: 978-8131725375.

ii) ASHRAE, *ASHRAE Handbook: Fundamentals*, SI Edition, ASHRAE Publications, 2017, ISBN: 978-1939200570.

iii) ASHRAE, *ASHRAE Handbook: HVAC Systems and Equipment*, SI Edition, ASHRAE Publications, 2016, ISBN: 978-1939200488.

iv) Carrier Corporation, *Handbook of Air Conditioning System Design*, 1st Edition, McGraw Hill Book Company, 1965, ISBN: 978-0070106635.

v) Barron, R. F., *Cryogenic Systems*, 2nd Edition, Oxford University Press / Tata McGraw Hill, 1985, ISBN: 978-0195037739.

| 6. | Evaluation Details: |
|---|---|

a) First evaluation 20 marks,
b) Second Evaluation 20 marks,
c) Final evaluations 40 marks,
d) Journal 20 marks

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 |
| CO3 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Course Code & Course Title: | MEL429 RENEWABLE ENERGY SOURCES | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B. Tech IN Mechanical Engineering | | |
| L – T – P | 3–0–0 | No. of Credits | 3 |
| Pre-requisites: Course Code(s) & Name(s) | MEL202, MEL302 | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

After completion of this course, students will be able to

a) Understand the fundamentals and role of renewable energy sources in global and Indian energy systems.
b) Assess wind and solar energy resources using standard measurement and analysis techniques.
c) Analyze the working and performance of wind energy conversion systems.
d) Design and evaluate solar photovoltaic systems for practical applications.
e) Analyze the performance and applications of solar thermal and hydro energy systems.
f) Understand the principles of biomass, ocean, geothermal, and green hydrogen energy systems.
g) Appreciate emerging trends and research directions in renewable energy technologies

| 2. | Course Outcomes |
|---|---|
| CO1 | Explain the fundamentals of renewable energy systems and analyze global and Indian energy scenarios along with emerging trends in renewable energy technologies. |
| CO2 | Assess wind and solar resources using standard measurement and data analysis methods. |
| CO3 | Analyze wind energy conversion systems and evaluate wind turbine performance under varying operating conditions. |
| CO4 | Design and evaluate solar photovoltaic systems for standalone and grid-connected applications. |
| CO5 | Analyze the performance and applications of hydro, biomass, ocean, geothermal, and hydrogen-based energy systems. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| Topics | | CO(s) Addressed | Duration in weeks |
| **Fundamentals of renewable energy sources:** Overview of renewable energy resources and their role in sustainable development. Global and | | CO1 | 1.5 |

| | | |
|---|---|---|
| Indian renewable energy scenarios. Decarbonisation of power. Long-term environmental sustainability is driving the global energy transition, etc. | | |
| **Renewable energy resource measurements and assessment:** Measurement analysis of wind speed and direction, wind shear and turbulence characterization, long-term wind data extrapolation, estimation of wind energy. Solar radiation geometry. Advancements in ground-based solar radiation measurement techniques; importance and objectives of the Indian solar radiation atlas; solar atlas specifications and applications; measurement and estimation of solar radiation; atmospheric effects on solar radiation; radiation data analysis and long-term solar resource assessment, etc. | CO2 | 1.5 |
| **Wind energy conversion systems:** Wind characteristics and resource assessment. Aerodynamics of wind turbines. Horizontal and vertical axis wind turbines. Power curves, control strategies, and structural aspects. Small wind turbine technologies and applications. Performance assessment of wind turbine systems under varying wind conditions, etc., from an undergraduate perspective. | CO3 | 2 |
| **Solar photovoltaic systems:** Solar PV cell physics and characteristics. Types of PV technologies. PV system design, sizing, and performance evaluation. Grid-connected and standalone PV systems. Solar PV home system design. | CO4 | 2 |
| **Solar thermal energy systems:** Working principles of flat plate and concentrating collectors. Solar water heating systems. Solar air heaters. Design considerations and applications of solar thermal systems. | CO4 | 1 |
| **Hydro energy systems:** Hydrological cycle and water resource assessment. Classification of hydro power plants. Turbine types and selection criteria. Various types of hydropower systems. Plant operation, performance, and environmental considerations. | CO5 | 1.5 |
| **Green hydrogen:** Background, objectives, production, storage & transportation, safety, etc. | CO5 | 1.5 |
| **Ocean and geothermal energy:** Tidal energy, wave energy, ocean thermal energy conversion, principles and technologies. Geothermal resources, power generation methods, direct heat applications, advantages and limitations. | CO5 | 1 |
| **Biomass and bioenergy conversion**: Biomass resources and properties. Thermochemical conversion: combustion, gasification, and pyrolysis. Biomass energy systems design, performance analysis, etc. | CO5 | 1.5 |
| **Future trends and research opportunities in renewable energy sources** | CO1 | 0.5 |

| 4. | Text books |
|---|---|

i) Kothari, D. P., Ranjan, R., Singal, K. C., *Renewable Energy Sources and Emerging Technologies*, 3rd Edition, PHI Learning Pvt. Ltd., 2022, ISBN: 978-9391818752.

ii) Sukhatme, S. P., Nayak, J. K., *Solar Energy: Principles of Thermal Collection and Storage*, 3rd Edition, Tata McGraw Hill Education (India) Pvt. Ltd., 2003, ISBN: 978-0070260641.

iii) Kalogirou, S. A., *Solar Energy Engineering: Processes and Systems*, 3rd Edition, Elsevier / Academic Press, 2023, ISBN: 978-0128196106.

iv) Manwell, J. F., McGowan, J. G., Rogers, A. L., *Wind Energy Explained: Theory, Design and Application*, 2nd Edition, John Wiley & Sons, 2010, ISBN: 978-0470015001.

| 5. | Reference Book(s) and Other Required Material |
|---|---|

i) Wood, D., *Small Wind Turbines*, 1st Edition, Springer, Berlin Heidelberg, 2011, ISBN: 978-3642229947.

ii) Wagner, H. J., Mathur, J., *Introduction to Hydro Energy Systems: Basics, Technology and Operation*, 1st Edition, Springer, 2011, ISBN: 978-3642207365.

iii) Basu, P., *Biomass Gasification, Pyrolysis and Torrefaction: Practical Design and Theory*, 2nd Edition, Academic Press (Elsevier), 2013, ISBN: 978-0123964885.

| 6. | Evaluation Details: |
|---|---|

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %

b) Teacher Defined Assessment: 20 %

c) End Semester Exam: 50-60 %

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 3 | 1 | 2 |
| CO2 | 3 | 1 | 2 | 1 | 2 | 1 | 2 | 2 | 2 | 1 | 2 | 3 | 2 | 2 |
| CO3 | 2 | 1 | 3 | 1 | 3 | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 3 | 1 |
| CO4 | 1 | 1 | 2 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 3 | 1 |
| CO5 | 2 | 1 | 3 | 1 | 3 | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 3 | 2 |

*High - 3; Medium – 2; Low – 1;*

| 8 | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEL430 ADVANCED IC ENGINES** | | |
| **Course Type:** | **DE** | | |
| **Name of the programme(s):** | **B. Tech. in Mechanical Engineering** | | |
| **L – T – P** | **3-0-0** | **No. of Credits** | **3** |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) To provide fundamental knowledge of internal combustion engine types, components, operating cycles, and mechanical losses.

ii) To develop understanding of engine fuels and combustion principles using thermodynamic laws.

iii) To explain combustion, fuel injection, and performance enhancement techniques in SI and CI engines.

iv) To analyze engine performance, emissions, and testing methods with emphasis on pollutant control.

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Explain the working, classification, components, and losses in internal combustion engines. |
| **CO2** | Apply thermodynamic and combustion principles to evaluate engine fuels and combustion processes. |
| **CO3** | Analyze SI and CI engine combustion characteristics, injection systems, and performance enhancement techniques. |
| **CO4** | Assess engine performance and emission characteristics. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| **Introduction**<br>Engines types and their operation, Introduction and Historical Perspective, Engine classifications, Engine operating cycles, Engine components, Engine friction, lubrication and cooling, lubrication systems. Frictional losses, blow by losses, pumping loss, Factors affecting mechanical friction | | CO1 | 02 |

| | | |
|---|---|---|
| **Fuels**<br>Fluid, Solid, gaseous, liquid fuels, SI Engine fuels characteristics, C.I. Engine fuels, characteristics, Rating of engine fuels, I.C. engine fuels - petrol, diesel ENG, LPG, Alcohol, Vegetable oils, Combustion, Combustion stoichiometry - The first low of thermodynamics and combustion, Enthalpies of formation, Heating values combustion efficiency. The second law of thermodynamics applied to combustions. Maximum work, chemical equilibrium, theoretical flame temperature. | CO2 | 02 |
| **SI Engine**<br>S. I. Engine fuel requirements, carburetors, factors attesting carburetion, moderns carburetors, metering systems, choke, altitude compensation, fuel injection systems, multipoint port injection, feedback systems, charge motion within the cylinder swirl, squish, combustion stages, flame propagation cyclic variations in combustion, ignition fundamentals, conventional ignition system, abnormal combustion, knock and surface ignition, knock fundamentals, turbo charging, supercharging and scavenging in engines. | CO3 | 02 |
| **C. I. Engines**<br>Essential features of the process, combustion systems. Combustion in direct and indirect injection, fuel spray behavior. Fuel injection systems, fuel pumps, fuel injectors, atomization, combustion in C. I. Engines, ignition delay, certain number, auto ignition. Factors affecting delay. Effects of fuel properties. Abnormal combustion, supercharging and turbo charging in engines. | CO3 | 02 |
| **Pollutant formation & Control**<br>Nature and extent of problem, Nitrogen oxides Kinetics of NO formation, formation of NO2 NO formation in S. I. Engines NOx formation in C. I. Engine Carbon monoxide and unearned hydrocarbon emissions in S.I. and C.I. engines, EGR Particulate emissions, measurement technique. Catalytic converters, particulate traps. | CO4 | 02 |
| **Engine Design and Operating Parameters**<br>Important engine characteristics, Geometrical properties of Reciprocating engines, Brake, Torque & Power, Indicated work per cycle, Mechanical efficiency, Road load power, Mean effective pressure, Specific fuel consumption and efficiency, Air/Fuel and Fuel/Air ratios, Volumetric efficiency, Engine specific weight and specific volume, Correction factors for power and efficiency, Specific emission and emission index, Relationship between performance parameters | CO4 | 02 |
| **Measurement and Testing**<br>Measurement of friction 'power indicated power, Brake power, Fuel consumption, Air consumption, Performance parameters and | CO4 | 02 |

| | | |
|---|---|---|
| characteristics: Engine Power, Engine efficiencies, Engine performance characteristics, Variables affecting performance characteristics | | |

| 4. | **Text books** |
|---|---|

i) Heywood, J. B., *Internal Combustion Engine Fundamentals*, 1st Edition, McGraw-Hill Book Company, 1988, ISBN: 978-0071004992.

ii) Obert, E. F., *Internal Combustion Engines and Air Pollution*, 1st Edition, Intext Educational Publishers, 1974, ISBN: 978-0700224135.

iii) Ganesan, V., *Internal Combustion Engines*, 6th Edition, Tata McGraw Hill Education (India) Pvt. Ltd., 2012, ISBN: 978-1259006197.

| 5. | **Reference Book(s) and Other Required Material** |
|---|---|

i) Domkundwar, V. M., Domkundwar, S., *Internal Combustion Engines*, 1st Edition, Dhanpat Rai & Sons, 2009, ISBN: 978-8187433668.

ii) Mathur, M. L., Sharma, R. P., *Internal Combustion Engines*, 8th Edition, Dhanpat Rai & Sons, 2003, ISBN: 978-8187433385.

| 6. | **Evaluation Details:** |
|---|---|

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %

b) Teacher Defined Assessment: 20 %

c) End Semester Exam: 50-60 %

| 7. | **Relationship of Course Outcomes to Program Outcomes:** |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 3 | 2 | 1 | 2 |
| CO2 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 2 |
| CO3 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 1 | 2 | 1 | 2 | 3 | 1 | 2 |
| CO4 | 2 | 1 | 2 | 3 | 3 | 3 | 2 | 1 | 2 | 1 | 1 | 1 | 2 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | **List of Indicative Laboratory Experiment (if applicable):** |
|---|---|

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEP430: ADVANCE I.C. ENGINE** | | |
| **Course Type:** | **DE** | | |
| **Name of the programme(s):** | **B. Tech in Mechanical Engineering** | | |
| **L – T – P** | **0-0-2** | **No. of Credits** | **1** |
| **Pre-requisites: Course Code(s) & Name(s)** | **Nil** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) To familiarize students with the construction, components, and working principles of IC engines.

ii) To enable performance evaluation of single and multi-cylinder IC engines under varying operating conditions.

iii) To analyze combustion, heat balance, and indicated power characteristics using experimental techniques.

iv) To assess engine emissions, alternative fuels (bio-diesel), and variable compression ratio effects on engine performance.

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Identify and explain the function of major parts of single and multi-cylinder IC engines. |
| **CO2** | Conduct and analyze performance tests of IC engines to determine efficiency. |
| **CO3** | Evaluate combustion characteristics, heat balance, and indicated power using indicator diagrams and Morse test. |
| **CO4** | Analyze exhaust emissions and assess the impact of bio-diesel and compression ratio variation on engine performance. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| 1. Study of different parts of single cylinder diesel engine | | CO1 | 1 |
| 2. Performance test on single cylinder 4-stroke diesel engine | | CO2 | 1 |
| 3. Performance test on multi-cylinder 4-stroke petrol engine | | CO2 | 1 |
| 4. Morse test on multi-cylinder 4-stroke engine | | CO3 | 1 |
| 5. Heat balance test on IC engine | | CO3 | 1 |

| | | |
|---|---|---|
| 6. Indicator diagram of IC engine and indicated power calculation | CO3 | 1 |
| 7. Exhaust gas analysis of IC engine | CO4 | 1 |
| 8. Variable compression ratio (VCR) engine performance test | CO4 | 1 |
| 9. Bio-Diesel formation and property evaluation | CO4 | 1 |
| 10. Performance test of diesel engine using bio-diesel | CO4 | 1 |

## 4. Text books

i) Heywood, J. B., *Internal Combustion Engine Fundamentals*, 1st Edition, McGraw-Hill Book Company, 1988, ISBN: 978-0071004992.

ii) Obert, E. F., *Internal Combustion Engines and Air Pollution*, 1st Edition, Intext Educational Publishers, 1974, ISBN: 978-0700224135.

iii) Ganesan, V., *Internal Combustion Engines*, 6th Edition, Tata McGraw Hill Education (India) Pvt. Ltd., 2012, ISBN: 978-1259006197.

## 5. Reference Book(s) and Other Required Material

i) Domkundwar, V. M., Domkundwar, S., *Internal Combustion Engines*, 1st Edition, Dhanpat Rai & Sons, 2009, ISBN: 978-8187433668.

ii) Mathur, M. L., Sharma, R. P., *Internal Combustion Engines*, 8th Edition, Dhanpat Rai & Sons, 2003, ISBN: 978-8187433385.

## 6. Evaluation Details:

**Evaluation Weightage (%)**

a) Continuous Evaluation - I 30-35 %
b) Continuous Evaluation - II 30-40 %
c) Continuous Evaluation - III 25-40 %

## 7. Relationship of Course Outcomes to Program Outcomes:

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 2 | 3 | 2 | 1 | 1 | 2 |
| CO2 | 3 | 2 | 2 | 3 | 2 | 2 | 1 | 1 | 2 | 3 | 1 | 1 | 2 | 2 |
| CO3 | 2 | 3 | 2 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 |
| CO4 | 2 | 2 | 3 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Topics | Duration in weeks |
|---|---|
| 1. Study of different parts of single cylinder diesel engine | 1 |
| 2. Performance test on single cylinder 4-stroke diesel engine | 1 |
| 3. Performance test on multi-cylinder 4-stroke petrol engine | 1 |
| 4. Morse test on multi-cylinder 4-stroke engine | 1 |
| 5. Heat balance test on IC engine | 1 |
| 6. Indicator diagram of IC engine and indicated power calculation | 1 |
| 7. Exhaust gas analysis of IC engine | 1 |
| 8. Variable compression ratio (VCR) engine performance test | 1 |
| 9. Bio-Diesel formation and property evaluation | 1 |
| 10. Performance test of diesel engine using bio-diesel | 1 |

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEL432: COMPUTER GRAPHICS AND SOLID MODELLING** | | |
| **Course Type:** | **DE** | | |
| **Name of the programme(s):** | **B. Tech. in Mechanical Engineering** | | |
| **L – T – P** | **3-0-0** | **No. of Credits** | **3** |
| **Pre-requisites: Course Code(s) & Name(s)** | **MEL313** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) The objective of this course is to introduce the fundamentals of computer graphics, including graphic devices, display systems, graphical user interfaces, transformations, and clipping techniques.

ii) The course also aims to develop the ability to model, represent, and analyze curves, surfaces, and solids using parametric and advanced modeling techniques for engineering design and visualization applications.

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Explain the fundamentals of computer graphics including graphic devices, display systems, input–output devices, and graphical user interface concepts. |
| **CO2** | Apply clipping algorithms, scan conversion techniques, and geometric transformations for two-dimensional and three-dimensional graphical objects. |
| **CO3** | Analyze and generate curves using parametric and non-parametric representations such as spline, B-spline, Bezier, and Hermite curves. |
| **CO4** | Apply surface and solid modeling techniques including boundary representation, sweep representation, constructive solid geometry, and spatial enumeration. |
| **CO5** | Develop and visualize complex geometric models using advanced modeling and rendering techniques such as procedural modeling, volume rendering, and grammar-based systems. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| Introduction to Computer Graphics and Graphic Systems: Applications of computer graphics, graphic devices, display systems, refresh CRT, | | CO1 | 2 |

| | | |
|---|---|---|
| raster scan and random scan displays, color monitors, VGA, flat panel displays, LED and LCD, input and output devices | | |
| Graphical User Interface and Viewing: GUI concepts, types of GUI, widgets and components, user-centered design, event-driven programming, principles of good GUI design, windows and viewport, clipping concepts, point and line clipping, Sutherland–Cohen line clipping algorithm, midpoint subdivision algorithm | CO1, CO2 | 2 |
| Scan Conversion and Output Primitives: Scan conversion concepts, DDA algorithm, Bresenham line drawing algorithm, midpoint circle and ellipse algorithms, polygon filling techniques | CO2 | 2 |
| Geometric Transformations: Two-dimensional and three-dimensional transformations, homogeneous matrix representation, translation, rotation, scaling, reflection, shearing, successive and composite transformations | CO2 | 2 |
| Solid and Surface Modeling: Solid modeling versus surface modeling, spatial enumeration, cell decomposition, boundary representation, sweep representation, primitive instancing, constructive solid geometry, advanced modeling techniques, procedural modeling, multi-particle rendering, volume rendering, grammar-based systems | CO4, CO5 | 2 |
| Curves and Surfaces: Curve representation, parametric and non-parametric forms, interpolation and approximation, blending functions, space curves, spline and cubic spline, B-spline, Bezier and Hermite curves, properties and comparison of curves, three-dimensional surfaces, super-quadric surfaces, blobby objects | CO3 | 2 |

| 4. | **Text books** |
|---|---|

i) Angel, E., Shreiner, D., *Interactive Computer Graphics: A Top-Down Approach Using OpenGL*, 7th Edition, Addison-Wesley (Pearson Education), 2014, ISBN: 978-0133574845.

ii) Hearn, D., Baker, M. P., *Computer Graphics with OpenGL*, 4th Edition, Pearson Education, 2011, ISBN: 978-0132316811.

| 5. | **Reference Book(s) and Other Required Material** |
|---|---|

i) ISRD Group, *Computer Graphics*, 1st Edition, McGraw-Hill Education (India) Pvt. Ltd., 2006, ISBN: 978-0070634213.

| 6. | **Evaluation Details:** |
|---|---|

Evaluation is continuous. Components are

a) Mid Semester Examination : Conducted after 40% syllabus completion, Weightage: 20–30%

b) Teacher Defined Assessment : Includes assignments, tutorials, quizzes, tests, presentations, etc. Must consist of minimum two components- One before Mid-Sem , One after Mid-Sem, Weightage: 20%

c) End Semester Examination : Comprehensive exam covering full syllabus, Weightage: 50–60%

| 7. | **Relationship of Course Outcomes to Program Outcomes:** |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 2 | 1 | 2 | – | – | – | 2 | 2 | – | 2 | 1 | 2 |
| CO2 | 3 | 2 | 3 | 2 | 3 | – | – | – | 2 | 3 | – | 3 | 1 | 2 |
| CO3 | 3 | 1 | 2 | 1 | 3 | – | – | – | 2 | 2 | – | 3 | 1 | 2 |
| CO4 | 3 | 1 | 3 | 2 | 3 | – | – | – | 2 | 3 | – | 3 | 2 | 2 |
| CO5 | 2 | 1 | 3 | 2 | 2 | – | – | – | 2 | 3 | – | 3 | 2 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | **List of Indicative Laboratory Experiment (if applicable):** |
|---|---|

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEP432: COMPUTER GRAPHICS AND SOLID MODELLING** | | |
| **Course Type:** | **DE** | | |
| **Name of the programme(s):** | **B. Tech. in Mechanical Engineering** | | |
| **L – T – P** | **0-0-2** | **No. of Credits** | **1** |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

To develop practical skills in computer graphics and solid modeling by creating 2D sketches and 3D models, building and constraining assemblies, and performing basic simulation and static analysis of mechanical components and systems using CAD tools

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Create and transform 2D sketches and 3D solid/surface models of mechanical components using appropriate computer graphics and modeling commands. |
| **CO2** | Develop, assemble, and constrain complex mechanical assemblies from individual parts and perform simulation and animation of their motion. |
| **CO3** | Apply basic static analysis tools to evaluate and visualize the mechanical behavior of assembled components. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| Demonstration of computer graphics interface, tools, and commands. | | CO1 | 1 |
| Creating different sketches on 2D planes and performing transformations. | | CO1 | 1 |
| Transformation of objects in 2D plane and 3D space without distortion. | | CO1 | 1 |
| Use of solid modeling commands such as protrusion, extrusion, cut, draft, etc. | | CO1 | 1 |
| Use of surface modeling commands such as blue surf, project curve, blend, etc. | | CO1 | 1 |
| Use of Boolean operations: union, subtraction, and intersection. | | CO1 | 1 |

| | | |
|---|---|---|
| Conversion of surface and hollow objects into solid objects using stitch and thicken commands. | CO1 | 1 |
| Creation of part copy files for assembly environment. | CO2 | 1 |
| Use of assembly environment commands and application of different types of constraints. | CO2 | 1 |
| Creation of complex assemblies from basic parts. | CO2 | 1 |
| Simulation and animation of assemblies. | CO2 | 1 |
| Performing basic static analysis on assemblies. | CO3 | 1 |

## 4. Text books

i) Angel, E., Shreiner, D., *Interactive Computer Graphics: A Top-Down Approach Using OpenGL*, 7th Edition, Addison-Wesley (Pearson Education), 2014, ISBN: 978-0133574845.

ii) Hearn, D., Baker, M. P., *Computer Graphics with OpenGL*, 4th Edition, Pearson Education, 2011, ISBN: 978-0132316811.

## 5. Reference Book(s) and Other Required Material

ISRD Group, *Computer Graphics*, 1st Edition, McGraw-Hill Education (India) Pvt. Ltd., 2006, ISBN: 978-0070634213.

## 6. Evaluation Details:

Evaluation is continuous. Components are

**a)** Continuous Eval-I: 30–35%

**b)** Continuous Eval-II: 30–40%

**c)** Continuous Eval-III: 25–40%

## 7. Relationship of Course Outcomes to Program Outcomes:

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 3 | – | – | 1 | 2 | – | 2 | 3 | 3 | 2 | 2 | 3 |
| CO2 | 3 | 2 | 3 | – | – | 1 | 2 | – | 3 | 3 | 3 | 3 | 3 | 3 |
| CO3 | 3 | 3 | 2 | – | – | 1 | 2 | – | 2 | 3 | 3 | 3 | 2 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): | |
|---|---|---|
| **Sr. No** | **List of Experiments** | **Duration in weeks** |
| 1. | Demonstration of computer graphics interface, tools, and commands. | 1 |
| 2. | Creating different sketches on 2D planes and performing transformations. | 1 |
| 3. | Transformation of objects in 2D plane and 3D space without distortion. | 1 |
| 4. | Use of solid modeling commands such as protrusion, extrusion, cut, draft, etc. | 1 |
| 5. | Use of surface modeling commands such as blue surf, project curve, blend, etc. | 1 |
| 6. | Use of Boolean operations: union, subtraction, and intersection. | 1 |
| 7. | Conversion of surface and hollow objects into solid objects using stitch and thicken commands. | 1 |
| 8. | Creation of part copy files for assembly environment. | 1 |
| 9. | Use of assembly environment commands and application of different types of constraints. | 1 |
| 10. | Creation of complex assemblies from basic parts. | 1 |
| 11. | Simulation and animation of assemblies. | 1 |
| 12. | Performing basic static analysis on assemblies. | 1 |

| Course Code & Course Title: | MEL438: ADVANCED REFRIGERATION AND AIR CONDITIONING | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B. Tech. in Mechanical Engineering | | |
| L – T – P | 3-0-0 | No. of Credits | 3 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) Student should understand various theoretical and practical concepts related to single stage refrigeration and for alternate refrigeration systems like vapour absorption, vortex tube and thermoelectric refrigeration to meet PG level requirement.

ii) Student should understand practical application of concepts of psychrometrics / psychrometric processes to actual air conditioning machine to meet PG level requirement

iii) Student should understand working of various equipment/systems used in refrigeration and air conditioning like compressors, condensers, evaporators, expansion devices, controls, refrigerator, air conditioner etc. from post graduate perspective.

iv) Student should understand and apply mathematical treatment to energy efficiency calculations for refrigeration and air conditioning machines to reasonable correctness.

| 2. | Course Outcomes |
|---|---|
| CO1 | Student should be able to understand various definitions and theoretical concepts related to single stage/ multistage refrigeration, air cycle refrigeration, cryogenics and for alternate refrigeration systems like vapour absorption, steam jet, vortex tube and thermoelectric refrigeration and cryogenics to meet PG level requirement. |
| CO2 | Student should be able to understand various concepts related to air conditioning like psychrometrics / psychrometric processes, comfort and its measurement, effective temperature, comfort chart and its use, method of cooling load calculation, design process for summer/monsoon/winter Air conditioning and duct design to meet PG level requirement |
| CO3 | Student should be able to understand working of various equipments/systems used in refrigeration and air conditioning like compressors, condensers, evaporators, expansion devices, controls, Air washers, AHU's cooling towers, refrigerator, air conditioner etc. from post graduate perspective. |
| CO4 | Student should be able to understand and apply mathematical treatment to various problems related to single/multistage, vapour absorption, air cycle and refrigeration, |

| | |
|---|---|
| | psychrometrics, psychrometric processes, design of summer/ winter/monsoon air conditioning and duct design to reasonable correctness. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| 1. Single and Multistage Refrigeration: Introduction to refrigeration, applications of refrigeration, development of simple saturated Vapour compression refrigeration cycle, effect of pressure drops, polytropic compression, methods of improvement in the performance of the cycle like sub cooling, superheating, use of heat exchanger etc and working/analysis of multistage systems, multiple evaporator and multiple compressor refrigeration systems. | | CO1, CO4 | 3 |
| 2. Other Refrigeration Systems: Design and working of Vapor absorption systems (NH3- H20, LiBr- H2O), Steam jet refrigeration systems, Thermoelectric refrigeration, Vortex tube refrigeration. | | CO1, CO4 | 2 |
| 3. Gas Cycle Refrigeration and Cryogenics: Reversed Brayton /Joules/Bell Coleman cycle, aircraft refrigeration, simple cycle, boot strap cycle, reduced ambient cycle, regenerative cycle. Introduction and applications of cryogenics, cascade refrigeration, Joules Thomson coefficient, methods of air liquefaction, Linde's and Claude's cycle, adiabatic demagnetization. | | CO1, CO4 | 2 |
| 4. Air conditioning: Introduction to air conditioning, psychrometrics, psychrometric processes, comfort and its requirements, comfort chart. | | CO2, CO4 | 2 |
| 5. Air-conditioning System and duct Design: design of summer air conditioning calculation of dehumidified air quantity and apparatus dew point, ERSHF method, air-conditioning systems for monsoon and winter, principles and methods of duct design. | | CO2, CO4 | 3 |
| 6. Components in refrigeration and air conditioning system: compressors, condensers, evaporators, expansion devices, Refrigerants, Air washers, AHU etc, Applications of air conditioning, working of room air-conditioner and split air-conditioner and packaged air-conditioner. | | CO3 | 2 |

| 4. | Text books |
|---|---|

i) Arora, C. P., *Refrigeration and Air Conditioning*, 3rd Edition, Tata McGraw Hill Education (India) Pvt. Ltd., 2016, ISBN: 978-9351343349.

ii) Ballaney, P. L., *Refrigeration and Air Conditioning*, 16th Edition, Khanna Publishers, 2013, ISBN: 978-8174091925.

iii) Domkundwar, S., *A Course in Refrigeration and Air Conditioning*, 1st Edition, Dhanpat Rai & Sons, 1980, ISBN: 978-8187433569.

iv) Ananthanarayanan, P. N., *Basic Refrigeration and Air Conditioning*, 4th Edition, McGraw Hill Education (India) Pvt. Ltd., 2013, ISBN: 978-0070150447.

| 5. | Reference Book(s) and Other Required Material |
|---|---|

i) Pita, E. G., *Air Conditioning Principles and Systems*, 4th Edition, Prentice Hall, 2001, ISBN: 978-0130925891.

ii) Barron, R. F., *Cryogenic Systems*, 2nd Edition, Oxford University Press / Tata McGraw Hill, 1985, ISBN: 978-0195037739.

iii) ASHRAE, *ASHRAE Handbook: Fundamentals*, SI Edition, ASHRAE Publications, 2017, ISBN: 978-1939200570.

iv) ASHRAE, *ASHRAE Handbook: HVAC Systems and Equipment*, SI Edition, ASHRAE Publications, 2016, ISBN: 978-1939200488.

v) Carrier Corporation, *Handbook of Air Conditioning System Design*, 1st Edition, McGraw Hill, 1965, ISBN: 978-0070106635.

| 6. | Evaluation Details: |
|---|---|

One Mid sem exam of 30 Marks, two Class tests of 10 marks each(best of 10) and End sem exam of 60 marks

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 |
| CO3 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Course Code & Course Title: | MEP438 ADVANCED REFRIGERATION AND AIR CONDITIONING | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B. Tech. in Mechanical Engineering | | |
| L – T – P | 0-0-2 | No. of Credits | 1 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) Student should understand various theoretical and practical concepts related to single stage refrigeration and for alternate refrigeration systems like vapour absorption, vortex tube and thermoelectric refrigeration to meet PG level requirement.

ii) Student should understand practical application of concepts of psychrometrics / psychrometric processes to actual air conditioning machine to meet PG level requirement

iii) Student should understand working of various equipment/systems used in refrigeration and air conditioning like compressors, condensers, evaporators, expansion devices, controls, refrigerator, air conditioner etc. from post graduate perspective.

iv) Student should understand and apply mathematical treatment to energy efficiency calculations for refrigeration and air conditioning machines to reasonable correctness

| 2. | Course Outcomes |
|---|---|
| CO1 | Student should be able to understand various theoretical and practical concepts related to single stage refrigeration and for alternate refrigeration systems like vapour absorption, vortex tube and thermoelectric refrigeration to meet PG level requirement. |
| CO2 | Student should be able to understand practical application of concepts of psychrometrics / psychrometric processes to actual air conditioning machine to meet PG level requirement. |
| CO3 | Student should be able to understand working of various equipments/systems used in refrigeration and air conditioning like compressors, condensers, evaporators, expansion devices, controls, refrigerator, air conditioner etc. from post graduate perspective. |
| CO4 | Student should be able to understand and apply mathematical treatment to energy efficiency calculations for refrigeration and air conditioning machines to reasonable correctness. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| 1. Experiment on Determination of COP of Refrigeration trainer- | | CO1, CO4 | 1 |
| 2. Experiment on Determination of COP for Heat pump- | | CO1, CO4 | 1 |
| 3. Experiment of Determination of COP for Vapour absorption Refrigeration- | | CO1, CO4 | 1 |
| 4. Experiment of Determination of COP for Thermoelectric Refrigeration- | | CO1, CO4 | 1 |
| 5. Experiment on Determination of COP for Room air conditioner- | | CO3, CO4 | 1 |
| 6. Experiment on Determination of COP for Refrigerator- | | CO3, CO4 | 1 |
| 7. Demonstration of frost free refrigerator | | CO3 | 1 |
| 8. Demonstration of conventional Refrigerator- | | CO3 | 1 |
| 9. Study and demonstration of types of compressors- | | CO3 | 1 |
| 10. Study and demonstration of types of condensers- | | CO3 | 1 |
| 11. Study and demonstration of types of evaporators- | | CO3 | 1 |
| 12. Study and demonstration of types of expansion devices – | | CO3 | 1 |

| 4. | Text books |
|---|---|

i) Arora, C. P., *Refrigeration and Air Conditioning*, 3rd Edition, Tata McGraw Hill Education (India) Pvt. Ltd., 2016, ISBN: 978-9351343349.

ii) Ananthanarayanan, P. N., *Basic Refrigeration and Air Conditioning*, 4th Edition, McGraw Hill Education (India) Pvt. Ltd., 2013, ISBN: 978-0070150447.

| 5. | Reference Book(s) and Other Required Material |
|---|---|

Carrier Corporation, *Handbook of Air Conditioning System Design*, 1st Edition, McGraw Hill Book Company, 1965, ISBN: 978-0070106635.

| 6. | Evaluation Details: |
|---|---|

**Evaluation Weightage (%)**

a) Continuous Evaluation - I 30-35 %
b) Continuous Evaluation - II 30-40 %
c) Continuous Evaluation - III 25-40 %

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 |
| CO3 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEL443 AIR POLLUTION CONTROL** | | |
| **Course Type:** | **DE** | | |
| **Name of the programme(s):** | **B. Tech. in Mechanical Engineering** | | |
| **L – T – P** | **3-0-0** | **No. of Credits** | **03** |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) To introduce conventional energy conversion methods using fossil fuels and analyze their environmental impacts, including thermal and particulate pollution.

ii) To explain combustion processes in petrol and diesel engines, sources of emissions, and methods for emission control using alternative fuels and additives.

iii) To provide knowledge of engine control systems, noise pollution, and environmental standards for effective pollution monitoring and control.

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Analyze pollution caused by thermal power plants and internal combustion engines |
| **CO2** | Explain combustion phenomena in petrol and diesel engines, classify primary and secondary pollutants, and assess the impact of alternative fuels and additives on emissions. |
| **CO3** | Apply concepts of conventional and microprocessor-based engine control systems and noise control techniques in compliance with environmental pollution standards. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| Introduction<br>Conventional energy conversion methods using fossil fuels. Their environmental aspects, Pollution from the thermal power plants, thermal and particulate pollution and its control. | | CO1 | 4 |
| IC Engines<br>Combustion in petrol and diesel engines. Emissions from I.C. Engines and its control. Primary and Secondary Pollutants. Use of various alternative fuels, additives and their effect on pollution | | CO1, CO2 | 4 |
| Conventional and microprocessor-based control of Air/Fuel ratio, ignition and injection timing, speed and emissions from I. C. Engines. | | CO3 | 3 |

| | | |
|---|---|---|
| Noise pollution<br>Noise pollution and noise control. Standardization for environmental control pollution | CO3 | 3 |

| 4. | Text books |
|---|---|

i) Rao, M. N., Rao, H. V. N., *Air Pollution*, 7th Edition, Tata McGraw Hill Publishing Company Ltd., 2001, ISBN: 978-0074636602.

ii) Obert, E. F., *Internal Combustion Engines and Air Pollution*, 1st Edition, Harper & Row Publishers, 1979, ISBN: 978-0060441845.

| 5. | Reference Book(s) and Other Required Material |
|---|---|

i) Reston Publishing Company, *Automotive Pollution Control*, 1st Edition, Reston Publishing Co., 1984, ISBN: 978-0835921213.

ii) Prabhakar, V. K., *Air Pollution Monitoring and Control*, 1st Edition, Anmol Publications Pvt. Ltd., 2001, ISBN: 978-8174883209.

| 6. | Evaluation Details: |
|---|---|

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %

b) Teacher Defined Assessment: 20 %

c) End Semester Exam: 50-60 %

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| CO2 | 2 | 3 | 1 | 2 | 3 | 1 | 1 | 2 | 1 | 3 | 1 | 1 | 3 | 2 |
| CO3 | 2 | 2 | 3 | 2 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 2 | 2 | 1 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEL444: SOLAR ENERGY UTILIZATION** | | |
| **Course Type:** | **DE** | | |
| **Name of the programme(s):** | **B.Tech. in Mechanical Engineering** | | |
| **L – T – P** | **3-0-0** | **No. of Credits** | **3** |
| **Pre-requisites: Course Code(s) & Name(s)** | **MEL 302 Heat transfer** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) To learn solar radiation geometry; Locating Sun's position in the sky using various angles.
ii) To learn how to build mathematical model for a solar thermal system and analyse its performance
iii) To learn how to design a solar PV system
iv) To learn how to analyse a thermal storage system
v) To understand economics of solar systems

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | The students will be able to estimate solar radiation on a tilted surface on any given day and time of a year. |
| **CO2** | The students will be able to analyse a solar thermal system using appropriate performance indicators |
| **CO3** | The students will be able to design and analyse a solar PV system for an establishment |
| **CO4** | The students will be able to analyse a storage system for a process requirement |
| **CO5** | The students will be able to carry out economic analysis of a solar system |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| **Solar energy option**<br>Solar radiation: Beam, Diffuse, Global; Measurement and empirical equations;<br>Estimation of solar radiation incident on a tilted surface.<br>Transmissivity-absorptivity product for a glass cover - absorber system | | CO1 | **3** |
| **Solar Thermal systems**<br>Performance analysis of Liquid flat plate collectors, Solar Air heaters, Concentrating collectors. Estimation of overall loss coefficient for a | | CO2 | 4 |

| | | |
|---|---|---|
| collector. HWB equation. Testing Procedures as per Indian Standards.<br>**Self-study:**<br>Solar Cookers, Solar Pond, Solar Stills, Solar Dryers, etc. Construction, working & Basic calculations | | |
| **Solar PV systems**<br>Solar PV panels: rated output, estimation of actual output under given operating conditions. Design of stand-alone solar PV systems; Roof-top solar PV system | CO3 | 3 |
| **Thermal storage:** Sensible heat, latent heat and thermochemical storage, Modelling and analysis, simulation in process design; testing procedures. | CO4 | 2 |
| **Economic Analysis**: Initial cost, annual cost, annual savings, subsidies available, depreciation, life span, salvage value, inflation, discount rate, present worth, EMI calculation, payback period, Internal rate of return, etc | CO5 | 2 |

## 4. Text books

i) Sukhatme, S. P., Nayak, J. K., *Solar Energy: Principles of Thermal Collection and Storage*, 3rd Edition, Tata McGraw Hill Education (India) Pvt. Ltd., 2012, ISBN: 978-0070260641.

ii) Parulekar, B. B., Rao, S., *Energy Technology*, 3rd Edition, Khanna Publishers, 1995, ISBN: 978-8174090423.

## 5. Reference Book(s) and Other Required Material

i) Duffie, J. A., Beckman, W. A., *Solar Engineering of Thermal Processes*, 2nd Edition, John Wiley & Sons, New York, 1991, ISBN: 978-0471510567.

## 6. Evaluation Details:

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %
b) Teacher Defined Assessment: 20 %
c) End Semester Exam: 50-60 %

## 7. Relationship of Course Outcomes to Program Outcomes:

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 0 |
| CO2 | 2 | 3 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 3 | 0 |
| CO3 | 2 | 2 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 2 | 2 | 0 |
| CO4 | 3 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 2 | 0 |
| CO5 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 3 | 0 | 0 | 0 | 0 |

*High - 3; Medium – 2; Low – 1;*

## 8. List of Indicative Laboratory Experiment (if applicable):

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEL448: ARTIFICIAL INTELLIGENCE IN MANUFACTURING** | | |
| **Course Type:** | **DE** | | |
| **Name of the programme(s):** | **B. Tech. in Mechanical Engineering** | | |
| **L – T – P** | **3-0-0** | **No. of Credits** | **3** |
| **Pre-requisites: Course Code(s) & Name(s)** | **NIL** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) The objective of this course is to introduce artificial intelligence techniques relevant to manufacturing engineering and to develop an understanding of learning-based and data-driven approaches for solving engineering decision-making problems.

ii) The course aims to enable students to apply machine learning, fuzzy logic, genetic algorithms, and neural network techniques to real-life manufacturing and engineering problems

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Explain fundamental concepts of artificial intelligence, its evolution, application areas, advantages, limitations, and relevance to manufacturing systems. |
| **CO2** | Apply supervised, unsupervised, and semi-supervised machine learning techniques to solve manufacturing and engineering problems. |
| **CO3** | Design and apply fuzzy logic systems and genetic algorithms for decision-making and optimization in manufacturing applications. |
| **CO4** | Analyze and implement artificial neural networks and deep learning approaches for engineering and manufacturing problems. |
| **CO5** | Select and apply appropriate artificial intelligence techniques for data-driven analysis and problem-solving in real-life manufacturing scenarios. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| Overview of Artificial Intelligence: introduction to AI, evolution, application areas in manufacturing, advantages, limitations, and future applications | | CO1 | 2 |

| | | |
|---|---|---|
| Machine Learning Algorithms: supervised, unsupervised and semi-supervised learning techniques and their applications to manufacturing problems | CO2 | 3 |
| Fuzzy Logic Systems: sources of uncertainty, membership functions, Type-I and Type-II fuzzy logic systems, applications in engineering and manufacturing | CO3 | 2 |
| Genetic Algorithms: random heuristic search, simple genetic algorithm (selection, crossover, mutation, mixing), single-objective multi-constraint optimization | CO3 | 3 |
| Artificial Neural Networks and Deep Learning: single and multilayer neural networks, supervised and unsupervised learning, deep learning concepts, physics- informed neural networks, reinforcement learning | CO4, CO5 | 3 |

## 4. Text books

i) Mitchell, T. M., *Machine Learning*, 1st Edition, McGraw-Hill Education (Indian Edition), 2017, ISBN: 978-1259096952.

ii) Ross, T. J., *Fuzzy Logic with Engineering Applications*, 3rd Edition, John Wiley & Sons, 2010, ISBN: 978-0470743768.

## 5. Reference Book(s) and Other Required Material

i) Deb, K., *Genetic Algorithms in Search, Optimization and Machine Learning*, 1st Edition, John Wiley & Sons, 2010, ISBN: 978-0471873396.

## 6. Evaluation Details:

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %
b) Teacher Defined Assessment: 20 %
c) End Semester Exam: 50-60 %

## 7. Relationship of Course Outcomes to Program Outcomes:

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 2 | 2 | 3 | – | – | – | 1 | 2 | – | – | – | – |
| CO2 | 3 | 3 | 2 | 2 | 3 | – | – | – | 3 | 2 | – | – | – | – |
| CO3 | 3 | 2 | 3 | 1 | 3 | – | – | – | 2 | 2 | – | – | – | – |
| CO4 | 3 | 2 | 2 | 1 | 3 | – | – | – | 2 | 2 | – | – | – | – |
| CO5 | 3 | 2 | 3 | 2 | 3 | – | – | – | 2 | 2 | – | – | – | – |

*High - 3; Medium – 2; Low – 1;*

## 8. List of Indicative Laboratory Experiment (if applicable):

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEL449 Advanced Turbo Machinery** | | |
| **Course Type:** | **DE** | | |
| **Name of the programme(s):** | **B.Tech.** | | |
| **L – T – P** | **3-0-0** | **No. of Credits** | **3** |
| **Pre-requisites: Course Code(s) & Name(s)** | **MEL307** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) Introduce the basic concepts of turbomachinery and dimensional analysis, performance characteristics.

ii) Develop an understanding of working principles, design, and performance of centrifugal fans, blowers, compressors, and turbines.

iii) Analyze flow behavior, losses, and performance characteristics in centrifugal and axial flow compressors.

iv) Provide knowledge of axial and radial flow turbines to carry out blade design, stage analysis, and performance evaluation.

v) Familiarize students with the application of CFD techniques for analysis and performance prediction of turbomachinery.

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Apply the principles of dimensional analysis to compare the performance of homologous fluid machines. |
| **CO2** | Identify, classify, and explain the role and physical significance of dimensionless numbers in fluid machines analysis. |
| **CO3** | Design and predict the performance of a prototype fluid machine from experimental model data. |
| **CO4** | Select appropriate fluid machines for specific engineering operations based on different flow parameters. |
| **CO5** | Design, analyze and evaluate positive displacement and rotor dynamic fluid machines. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| | **Topics** | **CO(s) Addressed** | **Duration in weeks** |
| | **Basic concepts:** Introduction to gas dynamics**,** Machinery, dimensionless parameters, specific speed, applications, stage velocity triangles, work and efficiency. | CO1, CO2 | 2 |

| | | |
|---|---|---|
| **Centrifugal fans and blowers:** Types, stage and design parameters, flow analysis in impeller blades-volute and diffusers, losses, characteristic curves and selection, fan drives and fan noise. | CO4 | 3 |
| **Centrifugal Compressor:** Construction details, impeller flow losses, slip factor, diffuser analysis, losses and performance curves. | CO3, CO5 | 3 |
| **Axial flow compressor:** Stage velocity diagrams, enthalpy-entropy diagrams, stage losses and efficiency, work done, stage design problems and performance characteristics | CO3, CO5 | 3 |
| **Axial and radial flow turbines:** Stage velocity diagrams, reaction stages, losses and coefficients, blade design principles, testing and performance characteristics.<br>CFD for Turbo machinery, General Aspects. | CO3, CO5 | 3 |

## 4. Text books

i) Yahya, S. M., *Turbines, Compressors and Fans*, 4th Edition, Tata McGraw-Hill Publishing Company Ltd., 2011, ISBN: 978-0070707023.

ii) Logan, E., *Handbook of Turbomachinery*, 2nd Edition, Marcel Dekker Inc., 2003, ISBN: 978-0824709747.

iii) Dixon, S. L., Hall, C. A., *Fluid Mechanics and Thermodynamics of Turbomachinery*, 6th Edition, Butterworth-Heinemann (Elsevier), 2010, ISBN: 978-1856177931.

## 5. Reference Book(s) and Other Required Material

i) Shepherd, D. G., *Principles of Turbomachinery*, 1st Edition, Macmillan Company, 1969, ISBN: 978-0024095008.

## 6. Evaluation Details:

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %
b) Teacher Defined Assessment: 20 %
c) End Semester Exam: 50-60 %

## 7. Relationship of Course Outcomes to Program Outcomes:

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 1 | 1 | 1 | - | - | 2 | 1 | 1 | 3 | 2 | 2 | 1 |
| CO2 | 2 | 2 | 2 | 1 | 1 | 1 | - | 1 | 1 | - | 3 | 2 | 1 | 1 |
| CO3 | 2 | 2 | 3 | 2 | 3 | 2 | - | 2 | 1 | 1 | 3 | 3 | 2 | 1 |
| CO4 | 2 | 2 | 3 | 2 | 3 | 3 | - | 1 | 1 | 1 | 3 | 3 | 2 | 2 |
| CO5 | 1 | 1 | 2 | 1 | 2 | - | - | 1 | 1 | 1 | 2 | 2 | 1 | 1 |

*High - 3; Medium – 2; Low – 1;*

## 8. List of Indicative Laboratory Experiment (if applicable):

| | | | |
|---|---|---|---|
| **Course Code & Course Title:** | **MEP452: MACHINE SYSTEM DESIGN** | | |
| **Course Type:** | **DE** | | |
| **Name of the programme(s):** | **B.Tech. in Mechanical Engineering** | | |
| **L – T – P** | **0-1-4** | **No. of Credits** | **3** |
| **Pre-requisites: Course Code(s) & Name(s)** | **Solid Mechanics, Theory of Machines, Machine Design** | | |
| **Course Equivalence: Course Code(s) & Name(s)** | **NIL** | | |

| **1.** | **Course Objective:** |
|---|---|

i) Identify the design specifications of machine systems.
ii) Apply kinematics and synthesis of mechanism for machine systems.
iii) Design power transmission systems for machines.
iv) Carry out force analysis of machine components.
v) Prepare design assemblies and production drawings.

| **2.** | **Course Outcomes** |
|---|---|
| **CO1** | Identify and define functional requirements, design specifications, and constraints for a complete machine or a major subsystem. |
| **CO2** | Synthesize suitable mechanisms and machine elements to meet the specified functional and performance requirements. |
| **CO3** | Design power transmission systems and select standard components considering strength, reliability, and manufacturing aspects. |
| **CO4** | Analyze forces and loads acting on machine components and evaluate their effect on safe and effective system operation. |
| **CO5** | Develop assembly drawings, subassembly drawings, and detailed production drawings using computer-aided design tools, along with specifications and bill of materials. |

| **3.** | **Detailed Description of the Course** | | |
|---|---|---|---|
| **Topics** | | **CO(s) Addressed** | **Duration in weeks** |
| Identification and selection of a complete small machine or a major subsystem of a large machine, formulation of design specifications, and consideration of manufacturing aspects | | CO1 | 2 |
| Design of machine components including power calculation and design of key components using standard design procedures | | CO2, CO3, CO4 | 4 |

| | | |
|---|---|---|
| Computer-aided design of machine components, subassemblies, and overall assembly using appropriate CAD tools | CO1, CO5 | 4 |
| Preparation of assembly and subassembly drawings with proper fits, tolerances, and manufacturing details | CO4, CO5 | 2 |
| Preparation of production drawings, specifications of standard components, and bill of materials, and compilation of complete design report | CO5 | 3 |

## 4. Text books

i) Narayana, K. L., Kannaiah, P., Reddy, K. V., *Machine Drawing*, 6th Edition, New Age International Publishers, 2019, ISBN: 978-9387788558.

ii) Narayana, K. L., Kannaiah, P., Reddy, K. V., *Production Drawing*, 3rd Edition, New Age International Publishers, 2014, ISBN: 978-8122430479.

iii) Bhandari, V. B., *Design of Machine Elements*, 5th Edition, McGraw Hill Education (India) Pvt. Ltd., 2021, ISBN: 978-9354245800.

## 5. Reference Book(s) and Other Required Material

Rattan, S. S., *Theory of Machines*, 4th Edition, McGraw Hill Education (India) Pvt. Ltd., 2017, ISBN: 978-9352601837.

## 6. Evaluation Details:

Evaluation is continuous. The final report is a single file consisting of various subsystems and machine elements such that the design is exhaustive, complete, giving details with production drawings. However, grading will be done in stages-

(a) Mid-Semester Examination: Conducted after 40% work completion. Teacher evaluation through viva and presentations on report, Weightage: 30%

(b) End Semester Examination: Comprehensive review of the design report the full system design, and other details through viva and presentations on the report by the course coordinator. Weightage: 70% Single file in the form of a design report, along with final presentation, shall be submitted before final evaluation. Unless the project is completed, students will not be given a passing grade.

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 1 | 3 | 1 | 1 | 1 | 2 | 1 | 2 | 3 | 2 | 1 |
| CO2 | 3 | 2 | 3 | 2 | 3 | 1 | 1 | 1 | 2 | 1 | 2 | 3 | 2 | 1 |
| CO3 | 3 | 2 | 3 | 2 | 3 | 1 | 1 | 1 | 2 | 1 | 2 | 3 | 2 | 1 |
| CO4 | 3 | 3 | 2 | 2 | 3 | 1 | 1 | 1 | 2 | 1 | 2 | 3 | 2 | 1 |
| CO5 | 2 | 1 | 3 | 2 | 3 | 1 | 1 | 1 | 3 | 2 | 3 | 3 | 3 | 3 |

High - 3; Medium – 2; Low – 1;

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Course Code & Course Title: | MEL456 DESIGN OF FIXTURES IN MANUFACTURING | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B. Tech. Mechanical Engineering | | |
| L – T – P | 3-0-0 | No. of Credits | 3 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) Develop an understanding of the importance of precision manufacturing and tool design in achieving dimensional accuracy and repeatability.
ii) Introduce the principles, elements, and design methodologies of jigs and fixtures used in manufacturing operations.
iii) Enable students to design and develop suitable jigs and fixtures for specific manufacturing applications.
iv) Familiarize students with appropriate material selection for jig and fixture elements, considering strength, wear resistance, and dimensional stability.

| 2. | Course Outcomes |
|---|---|
| CO1 | Explain the significance of precision manufacturing, part accuracy, and tool design concepts in modern manufacturing systems. |
| CO2 | Apply fundamental principles and design techniques of jigs and fixtures for various manufacturing operations. |
| CO3 | Design and develop appropriate jigs and fixtures for a given component considering functional and economic aspects. |
| CO4 | Select suitable materials for jig and fixture elements based on mechanical properties, wear resistance, heat treatment, and dimensional stability. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| Topics | | CO(s) Addressed | Duration in weeks |
| **Unit 1**: Precision Manufacturing: Part Accuracy, Geometric Dimensioning and Tolerancing (GD&T), Static Stiffness & Accuracy, Supporting Elements for Work Setting, Concept of Tool Design, Overview of Tool Design. | | CO1 | 2 |

| | | |
|---|---|---|
| **Unit 2**: Introduction to Jigs & Fixtures: Elements and their Function, Classification and Types of Jigs & Fixtures, Fundamental Principles of Jigs & Fixtures, Features: Locating/ Datum Surface, Loading/Unloading and Clamping, Tolerancing on Fixtures. | CO2 | 3 |
| **Unit 3**: Supporting, Locating and Clamping Principles: Referencing, Basic Rules for Locating, Fool Proofing, Planes of Movement and Restriction, Stability of Work, Locating Principles and Types, Locating from an External Profile, Rules of Clamping, Cutting and Clamping Forces, Types of Clamps, Non-mechanical Clamping, Clamping Accessories. | CO1, CO2 | 3 |
| **Unit 4**: Design of Jigs & Fixtures: Design Economics, Tool Design Parameters, Developing the Initial Design, Initial Drawing and Dimensioning, Limits and Critical Dimensions, Design of Milling Fixtures, Turning and Welding Fixtures, Sheet Metal Forming Fixtures, Case Studies. | CO2, CO3 | 2 |
| **Unit 5**: Materials for Jigs & Fixture Elements: Basic Properties Required for Jigs & Fixtures, Ferrous, Non-ferrous and Non-metallic Tool Materials, Designing with Relation to Heat Treatment, Dimensional Stability. Safety and Maintenance. | CO3, CO4 | 2 |

## 4. Text books

i) Hoffman, E. G., *Jig and Fixture Design*, 5th Edition, Delmar Cengage Learning, 2004, ISBN: 978-1401881214.

ii) Mehta, N. K., *Metal Cutting and Design of Cutting Tools, Jigs and Fixtures*, 2nd Edition, Tata McGraw-Hill Publishing Company Ltd., 1994, ISBN: 978-0070965539.

iii) Joshi, P. H., *Jigs and Fixtures*, 1st Edition, Tata McGraw-Hill Publishing Company Ltd., 2003, ISBN: 978-0074630358.

## 5. Reference Book(s) and Other Required Material

i) Grant, H. E., *Jigs and Fixtures: Non-Standard Clamping Devices*, 1st Edition, McGraw-Hill Book Company, 1950, ISBN: 978-0070249707.

ii) Donaldson, C., LeCain, G. H., Goold, V. C., *Tool Design*, 4th Edition, Tata McGraw-Hill Publishing Company Ltd., 2000, ISBN: 978-0071164559.

## 6. Evaluation Details:

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %

b) Teacher Defined Assessment: 20 %

c) End Semester Exam: 50-60 %

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | 2 | - | - | - | 2 | - | 1 | 2 | 1 | | | |
| CO2 | 2 | 2 | 3 | - | - | - | 2 | - | - | 2 | 3 | | | |
| CO3 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | - | 2 | 3 | 2 | | | |
| CO4 | 3 | 1 | 2 | 1 | - | - | 1 | - | 2 | 2 | 2 | | | |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Course Code & Course Title: | MEL4XX: SMART MANUFACTURING & QUALITY 4.0 | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B. Tech. Mechanical Engineering | | |
| L – T – P | 3-0-0 | No. of Credits | 3 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) **Explain** the concepts, evolution, and building blocks of Smart Manufacturing, Industry 4.0/5.0 and Quality 4.0.

ii) **Apply** data-centric approaches, IoT, digital twins, and analytics tools for modelling, and optimization of manufacturing systems.

iii) **Analyze** smart manufacturing systems using simulation, advanced process modelling, Lean, Six Sigma, and Quality 4.0 frameworks for decision support.

iv) **Evaluate** traditional and modern quality tools in the context of digitally connected manufacturing environments.

**v) Develop** integrated solutions or mini-projects incorporating smart manufacturing technologies and Quality 4.0 principles.

| 2. | Course Outcomes |
|---|---|
| CO1 | **Describe** the principles of Smart Manufacturing, Industry 4.0/5.0, Cyber-Physical Systems, IoT, and Digital Twins. |
| CO2 | **Apply** analytics, simulation and digital quality tools to model and improve manufacturing and quality systems. |
| CO3 | **Analyze** manufacturing and quality problems using Lean Six Sigma, traditional quality tools, and Quality 4.0 concepts to support data-driven decision making. |
| CO4 | **Design and evaluate** smart manufacturing or Quality 4.0 solutions through case studies or mini-projects addressing integration, scalability, human factors, and sustainability. |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| | **Topics** | **CO(s) Addressed** | **Duration in weeks** |
| | **Smart manufacturing paradigm:** Introduction to smart manufacturing, Principal concepts in smart manufacturing, Strategies & execution of smart manufacturing. Data centric view, Building blocks of smart | CO1 | 02 |

| | | |
|---|---|---|
| manufacturing, PLM in smart manufacturing, Advanced process modelling, Analytics for smart manufacturing, Parametric optimization and control (PAROC), Decision support framework for smart manufacturing, Lean production system, Manufacturing system simulation (process & plant simulation). | | |
| **Industry 4.0 in Smart Manufacturing:** Genesis of I4.0, Basic concepts & founding principles of I4.0, System integration, Drivers & barriers, Key technologies involved, Skills required, Industry 4.0 worldwide, Industry 5.0, India's readiness. Understanding Cyber-Physical Systems, Digital twins, Asset administration shell, IoT: Physical design of IoT, Logical design of IoT, IoT enabling technologies, Domain specific IoTs, physical devices (such as Raspberry Pi, Arduino, pcDuino, Beaglebone black, Cubieboard, etc.) | CO1, CO2 | 03 |
| **Megatrends & Communication in smart manufacturing:** Digitization & digitalization, 3D printing, Artificial intelligence, Machine Learning, Collaborative robots, Augmented / virtual reality, Sensor technology & data communication, Connected network, M2M communication, M2H communication, Communication protocols, Bluetooth, RFID, LoRaWAN, Xbee, ZigBee, etc., Cybersecurity. | CO2 | 02 |
| **Foundation of Quality 4.0:** Traditional quality engineering- QC, QM and QA. Quality evolution, Meaning & dimensions of quality, 7 old & 7 new quality tools, Kano model, Process capability, Lean Six Sigma (including DMAIC & DFSS) and other contemporaneous techniques such as JIT, Kanban, Kaizen, BPR, SMED, Poka-yoke, Kansei Engg., TQM, TPM & 5S, BPM, Cost of Quality, Q4.0 genesis (Q1.0, Q2.0, Q3.0 & Q4.0) | CO3 | 02 |
| **Quality 4.0 principles & elements:** Understanding Q4.0, Digital value chain, Principles of integration, Smart business perspectives, 11 axes of Q4.0, Technology-people-process perspective, Data centric decision making, Connectivity, Collaboration, Interfaces for quality, Scalability, EQMS, Compliance, Culture, Leadership, Competency, Traceability, Descriptive-diagnostic- predictive- prescriptive analytics, Human factors in Q4.0. | CO3, CO4 | 02 |
| **Traditional & Q4.0 tools and techniques:** FMEA, FTA, QFD, AD, DOE, ANOVA, SQC, SPC, TOC, Robust design, Taguchi techniques, Predictive quality- descriptive and diagnostic analytics, KPIs like, OEE, MTBF, MTTR, FPY, RTY, scrap, rework, COPQ, OTIF, etc., Realtime data acquision and analysis, Image processing, Other enabling technologies like, Shape memory alloys, Big data analysis, Cloud computing, Machine vision, Automated inspection, AI/ML-based defect detection, Agentic AI, Closed-loop quality control, Simulation, etc., Value-cocreation, QMS & ISO standards, Introduction to National & International Quality Awards, Skill-set for Q4.0, Future of Q4.0- quantum computing applications. Case studies/ Mini projects/ Group or individual exercises in smart manufacturing & Q4.0. | CO2, CO4 | 03 |

| 4. | Text books |
|---|---|

i) Soroush, M., Baldea, M., Edgar, T. F., *Smart Manufacturing: Concepts and Methods*, 1st Edition, Elsevier Science, 2020, ISBN: 978-0128186787.

ii) Gilchrist, A., *Industry 4.0: The Industrial Internet of Things*, 1st Edition, Apress (Springer Nature), 2016, ISBN: 978-1484220467.

iii) Tao, F., Qi, Q., Liu, A., Kusiak, A., *Digital Twin Driven Smart Manufacturing*, 1st Edition, Elsevier, 2019, ISBN: 978-0128176306.

| 5. | Reference Book(s) and Other Required Material |
|---|---|

i) Ibidapo, T. A., *From Industry 4.0 to Quality 4.0*, 1st Edition, Springer, 2022, ISBN: 978-3030912123.

ii) Yang, K., *Quality in the Era of Industry 4.0*, 1st Edition, John Wiley & Sons, 2024, ISBN: 978-1394171057.

iii) Sütőová, A., Vykydal, D., Wawak, S., *Introduction to Quality 4.0*, 1st Edition, Visegrad Fund Publication, 2024, ISBN: 978-8082071803

| 6. | Evaluation Details: |
|---|---|

**Evaluation Weightage (%)**

a) Mid Semester Exam: 20-30 %

b) Teacher Defined Assessment: 20 %

c) End Semester Exam: 50-60 %

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 2 | 3 |
| CO2 | 3 | 2 | 2 | 2 | 3 | 1 | 2 | 1 | 2 | 1 | 3 | 1 | 3 | 3 |
| CO3 | 3 | 3 | 1 | 1 | 2 | 1 | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 3 |
| CO4 | 3 | 1 | 2 | 2 | 1 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

| Course Code & Course Title: | MEL4XX: NOISE VIBRATIONS AND HARSHNESS | | |
|---|---|---|---|
| Course Type: | DE | | |
| Name of the programme(s): | B.Tech. in Mechanical Engineering | | |
| L – T – P | 3-0-2 | No. of Credits | 4 |
| Pre-requisites: Course Code(s) & Name(s) | NIL | | |
| Course Equivalence: Course Code(s) & Name(s) | NIL | | |

| 1. | Course Objective: |
|---|---|

i) This course aims to develop an understanding of the physical origins of noise, vibration, and harshness in mechanical and automotive systems. It focuses on the analysis of structural dynamic behavior through eigenvalue, harmonic, and transient response methods.

ii) The course emphasizes correlation of numerical simulation results with experimental measurements to ensure realistic and reliable analysis. It also introduces interpretation of NVH results from a human perception and comfort perspective.

iii) The course enables application of basic optimization concepts for improving NVH performance in engineering systems.

| 2. | Course Outcomes |
|---|---|
| CO1 | Understand fundamentals of Noise, Vibration, and Harshness (NVH), gain domain knowledge in NVH, and learn applications in automotive industry |
| CO2 | Formulate one-dimensional and two-dimensional finite elements for eigenvalue, frequency response, and transient dynamic problems |
| CO3 | Solve vibration problems using modal and direct frequency response approaches |
| CO4 | Simulate dynamic behavior of structures using FEA package and computational / programming tools for vibration attenuation and noise reduction |

| 3. | Detailed Description of the Course | | |
|---|---|---|---|
| Topics | | CO(s) Addressed | Duration in weeks |
| **NVH Fundamentals**<br>Fundamental concepts of NVH, structure-borne and air-borne noise, relationship between vehicle speed and excitation frequency, order of vibration and engine orders, RMS and average values of vibration signals, decibel scale and sound pressure level, octave and one-third octave bands, addition of sound pressure levels, psychoacoustics and human auditory system, A, B, C, and D weighted sound levels, loudness and sound power, time-domain and frequency-domain representation, industrial and automotive NVH examples | | CO1 | 2 |

| | | |
|---|---|---|
| **Finite Element Concepts for NVH**<br>Basic concepts of finite element modeling for dynamic problems, formulation of mass and stiffness matrices for simple one-dimensional elements, concept of eigenvalue problem in structural dynamics, natural frequencies and mode shapes, physical interpretation of modes, orthogonality of mode shapes, consistent and lumped mass matrices, rigid body modes, modal participation factor and effective mass, interpretation of FE modal results for automotive structures | CO2 | 3 |
| **Harmonic and Transient Response for NVH Applications**<br>Concept of forced vibration response, harmonic response and resonance, frequency response functions and physical interpretation, damping models used in NVH analysis including viscous, Rayleigh and structural damping, transient dynamic response and shock loading, base excitation and shaker-based excitation, modal superposition concept, cut-off frequency and mode truncation for low-frequency NVH problems, engineering interpretation of harmonic and transient response results | CO3, CO4 | 3 |
| **Experimental NVH Techniques**<br>NVH data acquisition systems, accelerometers and microphones, tachometer and speed measurement, impact hammer testing, measurement of natural frequencies, mode shapes and damping, shakers and modal testing, frequency response functions and point mobility, operational deflection shapes, order analysis and Campbell diagrams, correlation between vibration response and acoustic radiation, binaural noise measurement and human perception of NVH | CO4 | 3 |
| **Introduction to NVH Optimization**<br>Optimization concepts for NVH problems, objective functions and constraints, design variables for vibration and noise reduction, introduction to FE-based sizing, shape and topology optimization, bead optimization in automotive panels, interpretation of optimization results using commercial FE software | CO3, CO4 | 3 |

## 4. Text books


i) Seshu, P., *Textbook of Finite Element Analysis*, 1st Edition, Prentice Hall of India, 2003, ISBN: 978-8120323124.

ii) Thomson, W. T., Dahleh, M. D., Padmanabhan, C., *Theory of Vibration with Applications*, 5th Edition, Pearson Education, 1997, ISBN: 978-0136514640.

iii) Brandt, A., *Noise and Vibration Analysis: Signal Analysis and Experimental Procedures*, 1st Edition, John Wiley & Sons, 2011, ISBN: 978-0470746448.


## 5. Reference Book(s) and Other Required Material


i) Munjal, M. L., *Noise and Vibration Control*, Latest Edition, World Scientific Publishing, 2024, ISBN: 978-9811273872.

| 6. | Evaluation Details: |
|---|---|

**Evaluation Weightage (%)**

a) Mid Semester Exam. 20-30
b) End Semester Examination 50-60
c) Continuous Evaluation-I (Pr.) 05-10
d) Continuous Evaluation-II (Pr.) 05-10
e) Continuous Evaluation – III (Pr.) 05-10

| 7. | Relationship of Course Outcomes to Program Outcomes: |
|---|---|

***Mapping with POs (Departmental Reference)***

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 1 | – | 2 | – | – | 2 | – | 1 | 3 | 2 | 3 | 1 |
| CO2 | 3 | 2 | 2 | 1 | 3 | – | – | – | – | 2 | 3 | 3 | 2 | 2 |
| CO3 | 3 | 3 | 2 | 1 | 3 | – | – | – | – | 2 | 3 | 3 | 2 | 2 |
| CO4 | 2 | 3 | 3 | 2 | 2 | – | – | – | – | 3 | 3 | 3 | 2 | 3 |

*High - 3; Medium – 2; Low – 1;*

| 8. | List of Indicative Laboratory Experiment (if applicable): |
|---|---|

2. **Experimental modal testing**: impact hammer, measurement of natural frequencies, mode shapes and damping; conversion of acceleration response to velocity and displacement; correlation with finite element modal analysis.
3. **Signal processing for NVH applications**: FFT, windowing techniques, frequency resolution, orbit analysis, Campbell diagram and order analysis using vibration and noise data
4. Harmonic and base-excited vibration response
5. **Vibration damping treatments**: effect of dampers and viscoelastic materials on vibration amplitude and frequency response; comparison of vibration reduction and noise reduction
6. **Noise spectrum and octave band analysis**: 1/1, 1/2 and 1/3 octave analysis; comparison of unweighted and A-weighted sound pressure levels
7. **Binaural noise measurement and psychoacoustics**: measurement of sound pressure levels using head and torso simulator, loudness perception, left and right ear response, human-centric NVH interpretation.
8. **Noise intensity and sound radiation measurement**: directionality of noise sources and identification of dominant contributors.

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