NEW HORIZON COLLEGE OF ENGINEERING

# Department of Mechanical Engineering

## Academic Year 2025-26


## 3rd and 4th Semester

## Scheme & Syllabus

## BATCH: 2024-28

## CREDITS: 160

## NEW HORIZON COLLEGE OF ENGINEERING

### VISION

To emerge as an institute of eminence in the fields of engineering, technology and management in serving the industry and the nation by empowering students with a high degree of technical, managerial and practical competence.

### MISSION

- To strengthen the theoretical, practical and ethical dimensions of the learning process by fostering a culture of research and innovation among faculty members and students.
- To encourage long-term interaction between the academia and industry through their involvement in the design of curriculum and its hands-on implementation.
- To strengthen and mould students in professional, ethical, social and environmental dimensions by encouraging participation in co-curricular and extracurricular activities.

### QUALITY POLICY

To provide educational services of the highest quality both curricular and co-curricular to enable students integrate skills and serve the industry and society equally well at global level

### VALUES

- Academic Freedom
- Integrity
- Inclusiveness
- Innovation
- Professionalism
- Social Responsibility

## DEPARTMENT OF MECHANICAL ENGINEERING

### VISION

To create competent mechanical engineers capable of working in diversified disciplines for transformative impact on societal progressive development in the field of mechanical engineering through creative research and lifelong learning

### MISSION

- To impart excellent education by providing the state of art research facilities in the field of mechanical engineering.
- To develop alliances with industries and other organizations for excellence in teaching learning process, research and consultancy projects.
- To enhance the knowledge of students in intellectual, entrepreneurial and ethical challenges through active participation by critical thinking.

### PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

- **PEO 1**: The graduates will be able to apply the overall knowledge of Mechanical Engineering along with concepts of Mathematics, Science, Communication and Computing skills to understand specific problem areas and finding the optimal solutions for the same.

- **PEO 2**: The graduates will be able to implement ideas of Mechanical Engineering for the challenging tasks in the interdisciplinary areas like Electrical, Electronics, Computer Science, Civil, Bio-Technology and allied branches.

- **PEO 3**: The graduates will be widely talented in the fields of manufacturing, service and design industries, which will not only improve their employability but also aid in establishing the above said industries.

- **PEO 4**: The graduates will develop lifelong learning attitudes, ethics and values that will help their career employability and growth in engineering, academia, defence, state and central government sectors.

### PEO TO MISSION STATEMENT MAPPING

| Program Educational Objectives | M1 | M2 | M3 |
|---|---|---|---|
| **PEO 1** | 3 | 2 | 3 |
| **PEO 2** | 2 | 3 | 2 |
| **PEO 3** | 2 | 3 | 2 |
| **PEO 4** | 1 | 2 | 3 |

**KNOWLEDGE AND ATTITUDE PROFILE (WK)**

WK1: A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

WK2: Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

WK3: A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.

WK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

WK5: Knowledge, including efficient resource use, environmental impacts, whole-life cost, reuse of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

WK6: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.

WK7: Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.

WK8: Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

WK9: Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

## PROGRAM OUTCOMES (POs)

| Graduate Attributes | PO # | Program Outcomes |
|---|---|---|
| Engineering knowledge | 1 | Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems. |
| Problem Analysis | 2 | Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4) |
| Design Development of Solutions | 3 | Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5) |
| Conduct Investigations of Complex Problems | 4 | Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8). |
| Engineering Tool Usage | 5 | Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6) |
| The Engineer and The World | 6 | Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7). |
| Ethics | 7 | Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9) |
| Individual and Collaborative Team work | 8 | Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams |
| Communication | 9 | Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences |
| Project Management and Finance | 10 | Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments. |
| Life-Long Learning | 11 | Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8) |

## PROGRAM SPECIFIC OUTCOMES (PSOs)

After successful completion of mechanical Engineering Program, the graduates will be able to:

| | |
|---|---|
| PSO1 | Specify, fabricate, test and operate various machines along with essential documentations. |
| PSO2 | Analyze, design, develop and implement the concepts of mechanical systems and processes towards product development |

**NEW HORIZON COLLEGE OF ENGINEERING**
**B. E. in Mechanical Engineering**

| **III Semester** | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **S. No.** | **Course and Course Code** | | **Course Title** | **BoS** | **Credit Distribution** | | | | **Overall Credits** | **Contact Hours** | **Marks** | | |
| | | | | | **L** | **T** | **P** | **S** | | | **CIE** | **SEE** | **Total** |
| 1 | BSC | 24MAE31 | Numerical Methods and Transforms | BS | 2 | 1 | 0 | 0 | 3 | 4 | 50 | 50 | **100** |
| 2 | PCC | 24MEE32 | Mechanics of Materials | ME | 3 | 0 | 0 | 0 | 3 | 3 | 50 | 50 | **100** |
| 3 | PCCL | 24MEL32 | Mechanics of Materials Lab | ME | 0 | 0 | 1 | 0 | 1 | 2 | 50 | 50 | **100** |
| 4 | PCC | 24MEE33 | Fluid Mechanics | ME | 3 | 0 | 0 | 0 | 3 | 3 | 50 | 50 | **100** |
| 5 | PCCL | 24MEL33 | Fluid Mechanics Lab | ME | 0 | 0 | 1 | 0 | 1 | 2 | 50 | 50 | **100** |
| 6 | PCC | 24MEE34 | Material Science and Metallurgy | ME | 3 | 0 | 0 | 0 | 3 | 3 | 50 | 50 | **100** |
| 7 | PCC | 24MEE35 | Computer Aided Machine Drawing | ME | 2 | 0 | 1 | 0 | 3 | 3 | 50 | 50 | **100** |
| 8 | AEC | 24MEE36X | Ability Enhancement Course – III | ME | 1 | 0 | 0 | 0 | 1 | 1 | 50 | 50 | **100** |
| 9 | UHV | 24UHK37 | Universal Human Values and Life Skills | Any Dept | 1 | 0 | 0 | 0 | 1 | 2 | 50 | 50 | **100** |
| 10 | NCMC | 24NSS30 | National Service Scheme | - | 0 | 0 | 0 | 0 | 0 | 2 | 50 | -- | **50** |
| | | 24PED30 | Physical Education and Sports | - | | | | | | | | | |
| | | 24YOG30 | Yoga | - | | | | | | | | | |
| **Total** | | | | | | | | | **19** | **25** | **500** | **450** | **950** |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11 | NCMC | 24DMAT31* | Basic Applied Mathematics -I | BS | 0 | 0 | 0 | 0 | 0 | 2 | 50 | -- | **50** |

**BSC**: Basic Science Course, **PCC**: Professional Core Course, **PCCL**: Professional Core Course laboratory, **UHV**: Universal Human Value Course, **NCMC:** Non-Credit Mandatory Course, **AEC**: Ability Enhancement Course, **L:** Lecture, **T**: Tutorial, **P**: Practical **S: SDA**: Self Study for Skill Development, **K:** This letter in the course code indicates common to all the stream of engineering. **ESC:** Engineering Science Course, **ETC**: Emerging Technology Course, **PLC**: Programming Language Course, **CIE**: Continuous Internal Evaluation, **SEE**:Semester End Evaluation

**NCMC*:24DMAT31*:** This non-credit mandatory course to be offered to Lateral entry students.

| **Ability Enhancement Course – III (1-0-0-0)** | | | |
|---|---|---|---|
| 24MEE361 | Sustainable Manufacturing and Green Technologies | 24MEE364 | Instrumentation in Thermal Engineering |
| 24MEE362 | Tool Engineering | 24MEE365 | Bio Inspired Design and Innovation |
| 24MEE363 | Bioenergy and Biofuels | | |

**National Service Scheme /Physical Education/Yoga:** All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE) (Sports and Athletics), and Yoga (YOG) with the concerned coordinator of the course during the first week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, and Yoga activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of degree.

| **Credit Definition**: | |
|---|---|
| 1-hour Lecture (L) per week=1Credit<br>2-hoursTutorial(T) per week=1Credit<br>2-hours Practical / Drawing (P) per week=1Credit<br>2-hous Self Study for Skill Development (SDA) per week = 1 Credit | 03-Credits courses are to be designed for 40 hours in Teaching-Learning Session<br>02- Credits courses are to be designed for 25 hours of Teaching-Learning Session<br>01-Credit courses are to be designed for 15 hours of Teaching-Learning<br>Sessions |

**NEW HORIZON COLLEGE OF ENGINEERING**
**B. E. in Mechanical Engineering**

| **IV Semester** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **S. No.** | **Course and Course Code** | | **Course Title** | **BoS** | **Credit Distribution** | | | | **Overall Credits** | **Contact Hours** | **Marks** | | |
| | | | | | **L** | **T** | **P** | **S** | | | **CIE** | **SEE** | **Total** |
| 1 | BSC | 24MAE41 | Complex Analysis and Probability | BS | 2 | 1 | 0 | 0 | 3 | 4 | 50 | 50 | **100** |
| 2 | PCC | 24MEE42 | Engineering Thermodynamics | ME | 3 | 0 | 0 | 0 | 3 | 3 | 50 | 50 | **100** |
| 3 | PCCL | 24MEL42 | Engineering Thermodynamics Lab | ME | 0 | 0 | 1 | 0 | 1 | 2 | 50 | 50 | **100** |
| 4 | PCC | 24MEE43 | Manufacturing Technology | ME | 3 | 0 | 0 | 0 | 3 | 3 | 50 | 50 | **100** |
| 5 | PCCL | 24MEL43 | Manufacturing Technology Lab | ME | 0 | 0 | 1 | 0 | 1 | 2 | 50 | 50 | **100** |
| 6 | PCC | 24MEE44 | Mechanical Measurements and Metrology | ME | 3 | 0 | 0 | 0 | 3 | 3 | 50 | 50 | **100** |
| 7 | PCCL | 24MEL44 | Mechanical Measurements and Metrology Lab | ME | 0 | 0 | 1 | 0 | 1 | 2 | 50 | 50 | **100** |
| 8 | PEC | 24MEE45X | Professional Elective Course-I | ME | 3 | 0 | 0 | 0 | 3 | 3 | 50 | 50 | **100** |
| 9 | AEC | 24MEE46X | Ability Enhancement Course – IV | ME | 0 | 0 | 1 | 0 | 1 | 2 | 50 | 50 | **100** |
| 10 | UHV | 24DTK47 | Design Thinking and Fabrication | Any Dept | 1 | 0 | 0 | 0 | 1 | 1 | 50 | 50 | **100** |
| 11 | PROJ | 24MEE48 | Mini Project | ME | 0 | 0 | 1 | 0 | 1 | 2 | 50 | 50 | **100** |
| 12 | NCMC | 24NSS40 | National Service Scheme | - | 0 | 0 | 0 | 0 | 0 | 2 | 50 | -- | **50** |
| | | 24PED40 | Physical Education and Sports | - | | | | | | | | | |
| | | 24YOG40 | Yoga | - | | | | | | | | | |
| **Total** | | | | | | | | | **21** | **29** | **600** | **550** | **1150** |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13 | NCMC | 24DMAT41* | Basic Applied Mathematics-II | BS | 0 | 0 | 0 | 0 | 0 | 2 | 50 | -- | **50** |

**BSC**: Basic Science Course, **PCC**: Professional Core Course, **PCCL**: Professional Core Course laboratory, **UHV**: Universal Human Value Course, **NCMC:** Non-Credit Mandatory Course, **AEC**: Ability Enhancement Course, **PROJ**: Mini Project work, **L:** Lecture, **T**: Tutorial, **P**: Practical **S: SDA**: Self Study for Skill Development, **K:** This letter in the course code indicates common to all the stream of engineering. **ESC:** Engineering Science Course, **ETC**: Emerging Technology Course, **PLC**: Programming Language Course, **CIE**: Continuous Internal Evaluation, **SEE**:Semester End Evaluation.

**NCMC*:24DMAT41*:** This non-credit mandatory course to be offered to Lateral entry students.

**Mini-project work:** Mini Project is a laboratory-oriented/hands on course that will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications etc. Based on the ability/abilities of the student/s and recommendations of the mentor. A student can do mini project as

**(i)** A group of 2 if mini project work is single discipline (applicable to all IT allied branches)

**(ii)** A group of 2- 4 if mini project work is single discipline (applicable to all Core Branches)

(iii) A group of 2 - 4 students if the Mini Project work is a multidisciplinary (Applicable to all Branches)

**CIE procedure for Mini-project:**

**(i) Single discipline:** The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two faculty members of the Department, one of them being the Guide. The CIE marks awarded for the Mini-project work shall be based on the evaluation of the project report, project presentation skill, and question and answer session in the ratio of 50:25:25. The marks awarded for the project report shall be the same for all the batches mates.

**(ii) Interdisciplinary:** Continuous Internal Evaluation shall be group-wise at the college level with the participation of all the guides of the project.

The CIE marks awarded for the Mini-project, shall be based on the evaluation of the project report, project presentation skill, and question and answer session in the percentage ratio of 50:25:25. The marks awarded for the project report shall be the same for all the batch mates

| **Professional Elective Course-I** | | | |
|---|---|---|---|
| 24MEE451 | Introduction to Solar energy | 24MEE454 | Non Traditional Machining |
| 24MEE452 | Rotor Dynamics | 24MEE455 | Fundamentals of Nanotechnology |
| 24MEE453 | Aerospace propulsion System | | |

| **Ability Enhancement Course – IV (0-0-1-0)** | | | |
|---|---|---|---|
| 24MEE461 | MatLab for Mechanical Engineers | 24MEE464 | Air and Water Resources Engineering Lab |
| 24MEE462 | Energy management and auditing | 24MEE465 | Introduction to Augmented and Virtual Reality |
| 24MEE463 | Tools for Energy systems design and drafting | | |

**National Service Scheme /Physical Education/Yoga:** All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE) (Sports and Athletics), and Yoga (YOG) with the concerned coordinator of the course during the first week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, and Yoga activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of degree.

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# III Semester Syllabus

## NUMERICAL METHODS AND TRANSFORMS

| | | | |
|---|---|---|---|
| **Course Code** | **24MAE31** | **CIE Marks** | **50** |
| **L:T:P:S** | **2:1:0:0** | **SEE Marks** | **50** |
| **Hrs. / Week** | **4** | **Total Marks** | **100** |
| **Credits** | **3** | **Exam Hours** | **3** |

**Course outcomes:**
At the end of the course, the student will be able to:

| | |
|---|---|
| 24MAE31.1 | Use appropriate numerical methods to solve algebraic equations and transcendental equations. |
| 24MAE31.2 | Differentiate the physical problems numerically, evaluate a definite integral numerically and use appropriate numerical methods to solve boundary value problems in partial differential equations. |
| 24MAE31.3 | Justify Z-transforms method to solve continuous/discrete model problems. |
| 24MAE31.4 | Express the periodic functions as Fourier series expansion analytically and numerically. |
| 24MAE31.5 | Solve the continuous model problems using Fourier transform and Analyze the Fast Fourier transforms method to solve the discrete model problems. |

**Mapping of Course Outcomes to Program Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 24MAE31.1 | 3 | 3 | - | - | - | - | - | - | - | - | - |
| 24MAE31.2 | 3 | 3 | - | - | - | - | - | - | - | - | - |
| 24MAE31.3 | 3 | 3 | - | - | - | - | - | - | - | - | - |
| 24MAE31.4 | 3 | 3 | - | - | - | - | - | - | - | - | - |
| 24MAE31.5 | 3 | 3 | - | - | - | - | - | - | - | - | - |

| | | | |
|---|---|---|---|
| **MODULE-1** | **NUMERICAL SOLUTIONS AND INTERPOLATION** | **24MAE31.1** | **8 Hours** |

Numerical solution of algebraic and transcendental equations: Regula-falsi method and Newton-Raphson Method-Problems. Interpolation: Newton's forward and backward formulae for equal intervals, Newton divided difference, Lagrange's formula and Lagrange's inverse interpolation formula for unequal intervals (without proofs)-Problems.

| | |
|---|---|
| Text Book | Text Book 1: 28.2, 28.3, 29.6, 29.10, 29.12, 29.13, Text Book 3: 19.2, 19.3. |

| | | | |
|---|---|---|---|
| **MODULE-2** | **NUMERICAL DIFFERENTIATION AND INTEGRATION** | **24MAE31.2** | **8 Hours** |

Numerical Differentiation: Derivatives of first order and second order using Newton's forward differences and Newton's backward differences. Numerical solution of one-dimensional wave equation, heat equation and two-dimensional Laplace's equation. Numerical integration: Trapezoidal rule, Simpson's 1/3rd rule and Simpson's 3/8th rule (without proofs)-Problems. Application of numerical integration to velocity of a particle and volume of solids

| | |
|---|---|
| Text Book | Text Book 1: 30.2, 30.6, 30.7, 30.8, 33.5, 33.8, 33.10, Text Book 3: 19.5. |

| | | | |
|---|---|---|---|
| **MODULE-3** | **Z-TRANSFORMS** | **24MAE31.3** | **8 Hours** |

Definition, Z-transforms of some standard functions, properties, damping rule, shifting rule (without proof), initial and final value theorems. Inverse Z- transforms by partial fractions method. Convolution theorem (Statement only). Solution of difference equations using Z-transform

| | |
|---|---|
| Text Book | Text Book 1: 23.3, 23.4, 23.5, 23.6, 23.9, 23.15, 23.16. Text Book 2: 6.14.11, 6.14.12 |

| | | | |
|---|---|---|---|
| **MODULE-4** | **FOURIER SERIES** | **24MAE31.4** | **8 Hours** |

Periodic function, Dirichlet's conditions, Fourier series of periodic functions of period $2\pi$ and arbitrary period $2l$, Fourier series of full wave & half wave rectifiers, triangular wave, square wave and saw-toothed wave functions. Half range series-Problems. Practical harmonic analysis, variation of periodic current – problems.

| | |
|---|---|
| Text Book | Text Book 1: 10.2, 10.4, 10.5, 10.6, 10.7, 10.11, Text Book 3: 11.1 |

| | | | |
|---|---|---|---|
| **MODULE-5** | **FOURIER TRANSFORMS** | **24MAE31.5** | **8 Hours** |

Fourier Transforms: Infinite Fourier transforms, Fourier Sine and Cosine transforms, Inverse Fourier sine and cosine transforms. Convolution theorem (Statement only). Discrete Fourier Transform and Fast Fourier Transform: Definition of N-Point DFT, problems for 4-points and inverse DFT for four points only. FFT algorithm to compute the Fourier transforms 4-point only.

| Text Book | Text Book 1: 22.4, 22.5, Text Book 2:8.3, 8.4, 9.2, 9.3, Text Book 3: 11.8, 11.9 |
|---|---|

**List of Tutorial Contents**

| Sl. No. | Contents | COs |
|---|---|---|
| 1. | Use Newton's forward formula for equal interval problems. | 24MAE31.1 |
| 2. | Use Newton's backward formula for equal interval problems. | 24MAE31.1 |
| 3. | Uses of Simpson's rule | 24MAE31.2 |
| 4. | Numerical solution of one-dimensional heat equation and two-dimensional Laplace's equation. | 24MAE31.2 |
| 5. | Solve difference equations using Z-transform. | 24MAE31.3 |
| 6. | Solve difference equations using inverse Z-transform. | 24MAE31.3 |
| 7. | Practical harmonic analysis-Problems. | 24MAE31.4 |
| 8. | Practical harmonic analysis-Problems. | 24MAE31.4 |
| 9. | Uses of DFT in problems. | 24MAE31.5 |
| 10. | Uses of FFT in problems. | 24MAE31.5 |

**CIE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Marks Distribution | | |
|---|---|---|---|---|
| | | Theory Tests | AAT1 | AAT2 |
| | | 25 | 15 | 10 |
| L1 | Remember | 5 | - | - |
| L2 | Understand | 5 | 5 | - |
| L3 | Apply | 5 | - | 5 |
| L4 | Analyze | 5 | 5 | 5 |
| L5 | Evaluate | 5 | 5 | - |
| L6 | Create | - | - | - |

**SEE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| L1 | Remember | 5 |
| L2 | Understand | 10 |
| L3 | Apply | 10 |
| L4 | Analyze | 15 |
| L5 | Evaluate | 10 |
| L6 | Create | - |

**Suggested Learning Resources:**

**Text Books:**

1) B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, Forty fourth Edition, 2022, ISBN: 9788193328491.
2) Tarun Kumar Rawat, Digital Signal Processing, Oxford University Press, Wiley-India Publishers, Second impression, 2015, ISBN: 9780198081937.
3) Erwin Kreyszig, Advanced Engineering Mathematics, Wiley-India Publishers, Tenth Edition, Reprint 2016, ISBN: 9788126554232.

**Reference Books:**

1) Glyn James, Advanced Modern Engineering Mathematics, Pearson Education, Fourth Edition, 2015, ISBN: 9780273719236.
2) B. V. Ramana, Higher Engineering Mathematics, McGraw Hill Education (India) Private Limited, Fourth Edition, 2017, ISBN: 9780070634190.
3) H. K. Dass, Advanced Engineering Mathematics, S. Chand & Company Ltd., Twenty Second Edition, 2018, ISBN: 9789352533831.
4) N.P.Bali and Manish Goyal, A Text Book of Engineering Mathematics, Laxmi Publications (P) Ltd., Ninth Edition, 2014, ISBN: 9788131808320.

**Web links and Video Lectures (e-Resources):**

1)https://youtu.be/IgoJV4g_0LM?si=JO1_bkIvMR8xlC0V
2)https://youtu.be/mIFwzg11uO4?si=Xd13dh0eNlmIswPS
3)https://youtu.be/74g5_3TC-tQ?si=yB2PHVGr4hxIlqPo
4)https://youtu.be/QQFIWwDA9NM?si=3wJrtlm1NdPSbXmB
5)https://youtu.be/5817fLmsTGE?si=Y7ORyV2ETSCxZRAZ
6)https://youtu.be/XJRW6jamUHk?si=G_UTgCM622bz9yh4
7)https://youtu.be/QHH50jy8s_A?si=eNUoUXYLEvEZj3KM
8)https://youtu.be/m3mMeXLt2OQ?si=r9QXzwCRo0PC0ewz
9)https://youtu.be/aSu5Yde9Sfk?si=6kZbU3QRXEfEn2ua
10)https://www.youtube.com/live/tjBxcBLBe6I?si=v4RH4oqyttKhfaPd
11)https://youtu.be/-Y_0FY-IDrI?si=-ERIHGln3U2dr54J
12)https://youtu.be/zWRVxWdwXaw?si=Y78g7TogvDZIKhvs
13)https://youtu.be/nl9TZanwbBk?si=LdywSeCJ0EIt5zCx
14)https://youtu.be/E8HeD-MUrjY?si=JWwQzkQWfaTIqVhG

**Activity-Based Learning (Suggested Activities in Class)/Practical Based Learning:**

- Contents related activities (Activity-based discussions)
  - Problem solving Approach
  - Organizing Group wise discussions on related topics
  - Seminars

| MECHANICS OF MATERIALS | | | |
|---|---|---|---|
| **Course Code** | **24MEE32** | **CIE Marks** | **50** |
| **L:T:P:S** | **3:0:0:0** | **SEE Marks** | **50** |
| **Hrs / Week** | **03** | **Total Marks** | **100** |
| **Credits** | **03** | **Exam Hours** | **03** |

**Course outcomes:**

At the end of the course, the student will be able to:

| | |
|---|---|
| 24MEE32.1 | Apply the concepts of simple stresses and strains to determine the mechanical properties of materials for designing structural members |
| 24MEE32.2 | Identify the behavior of beams under various lateral loads, by determining the shear force and bending moments, and the shear force diagrams and bending moment diagrams and to evaluate the deflection of beams. |
| 24MEE32.3 | Analyze the effects of bending and shear loads on structural members. |
| 24MEE32.4 | Develop a working knowledge of the analytical methodologies used in column structural design. |
| 24MEE32.5 | Design circular shafts subjected to torsional loads and, compute the stresses and strains in thick and thin cylindrical pressure vessels. |
| 24MEE32.6 | Apply structural mechanics of deformable bodies to solve engineering problems. |

**Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24MEE32.1 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | 3 | 2 |
| 24MEE32.2 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | 3 | 2 |
| 24MEE32.3 | 3 | 3 | 2 | - | - | - | - | - | - | - | - | 3 | 2 |
| 24MEE32.4 | 3 | 3 | 2 | - | - | - | - | - | - | - | - | 3 | 2 |
| 24MEE32.5 | 3 | 3 | 2 | - | - | - | - | - | - | - | - | 3 | 2 |
| 24MEE32.6 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 3 | 2 |

| **MODULE-1** | **SIMPLE STRESS AND STRAIN** | **24MEE32.1, 24MEE32.6** | **8 Hours** |
|---|---|---|---|

Assumptions in MOM, stress, strain, mechanical properties of materials, Hooke's Law and Poisson's ratio, Stress-Strain curve for Mild steel, cast iron and Aluminum. Extension /Shortening of a bar, bars with cross section varying in steps, bars with continuously varying cross sections (circular and rectangular), Elongation due to self-weight, Principle of super position and numericals, Thermal Stresses (No numericals), elastic constants (only definitions). Definition of Indeterminate structures (No Numerical's).

| | |
|---|---|
| Self-study / Case Study | Study the mechanical properties of various materials and their applications |
| Text Book | Text Book 1: 2.1,2.2,2.4,2.5,2.6,2.7<br>Text Book 2: Page No. 1-90 |

| **MODULE-2** | **BENDING MOMENT AND SHEAR FORCE DIAGRAMS** | **24MEE32.2, 24MEE32.6** | **8 Hours** |
|---|---|---|---|

Introduction, Types of beams, loads and reactions, shear forces and bending moments, Rate of loading, sign conventions, relationship between shear force and bending moments. Shear force and bending moment diagrams for different beams subjected to concentrated loads, uniformly distributed load, (UDL) uniformly varying load (UVL) and couple for different types of beams, numericals.

| | |
|---|---|
| Self-study / Case Study | Study the various types of load acting on various structural members. |

| | | | |
|---|---|---|---|
| Text Book | Text Book 1:5.1,5.2,5.3, Text Book 2: Page No.160-282 | | |
| **MODULE-3** | **BENDING AND SHEAR STRESSES IN BEAMS** | **24MEE32.3, 24MEE32.6** | **8 Hours** |
| Introduction, Theory of simple bending, assumptions in simple bending. Bending stress equation, relationship between bending stress and radius of curvature, relationship between bending moment and radius of curvature. Moment carrying capacity of a section. Shearing stresses in beams, shear stress across rectangular, circular, symmetrical I and T sections. | | | |
| Self-study / Case Study | Study the importance of moment of inertia and kinds of cross sections for beams. | | |
| Text Book | Text Book 1:4.1,4.2,4.6,4.8,6.1,6.2,6.3<br>Text Book 2: Page No.283-333 | | |
| **MODULE-4** | **DEFLECTION OF BEAMS AND ELASTIC STABILITY OF COLUMNS** | **24MEE32.2 24MEE32.4 24MEE32.6** | **8 Hours** |
| Introduction, Differential equation for deflection. Equations for deflection, slope and bending moment. Double integration method for cantilever and simply supported beams for point load, UDL, UVL and Couple, Macaulay's method.<br>Elastic Stability of Columns**:** Introduction, Columns and struts, slenderness ratio, Classification of columns, buckling load or critical load, Sign conventions, Euler's theory of buckling, Effective length for various boundary conditions, Limitations of Euler's theory, Rankine formula, numericals. | | | |
| Self-study / Case Study | Study the importance of deflection of beams and slenderness ratio and applications of Euler's critical load in the design of long columns. | | |
| Text Book | Text Book 1: 9.1,9.2,9.3,10.1,10.2,10.3,10.4<br>Text Book 2:Page No.441-575 and 982-1010 | | |
| **MODULE-5** | **TORSION OF CIRCULAR SHAFTS, THICK AND THIN CYLINDERS** | **24MEE32.5 24MEE32.6** | **8 Hours** |
| Introduction, Pure torsion, assumptions, derivation of torsional equations, polar modulus, Torsional rigidity / stiffness of shafts. Power transmitted by solid and hollow circular shafts, numericals.<br>Stresses in thin cylinders, changes in dimensions of cylinder (diameter, length and volume). Thick cylinders - Lame's equation, Problems on Lame's equation. | | | |
| Self-study / Case Study | Study the importance of design parameters in the design of Boilers, Tanks and Gun Barrels etc. Also study the importance of design of shafts. | | |
| Text Book/Reference Book | Text Book 1:3.1,3.2<br>Text Book 2: Page No.759-798 and 945-981 | | |

**CIE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Marks Distribution | | |
|---|---|---|---|---|
| | | Test (s) | AAT1 | AAT2 |
| | | 25 | 15 | 10 |
| L1 | Remember | 5 | - | - |
| L2 | Understand | 5 | 5 | - |
| L3 | Apply | 10 | 5 | 5 |
| L4 | Analyze | 5 | 5 | 5 |
| L5 | Evaluate | - | - | - |
| L6 | Create | - | - | - |

**SEE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| **L1** | **Remember** | 10 |
| **L2** | **Understand** | 10 |
| **L3** | **Apply** | 20 |
| **L4** | **Analyze** | 10 |
| **L5** | **Evaluate** | -- |
| **L6** | **Create** | -- |

**Suggested Learning Resources:**

**Text Books:**


1) Ferdinand Beer & Russell Johston., 'Mechanics of Materials', McGraw Hill India, 7th Edition, 2016, ISBN: 9789339217624.
2) Ramamrutham S., 'Strength of Materials', Dhanpat Rai Publishing Co Pvt Ltd, 16th Edition, 2008, ISBN-81-27-433-54-X.


**Reference Books:**


1) R C Hibbeler., 'Mechanics of Materials', Pearson Education, 9th Edition, 2018, ISBN-(13 digits): 978- 9332584037; ISBN:9332584036.
2) James M. Gere, Barry J. Goodno., 'Mechanics of Materials', Cengage Learning, 8th Edition, 2014, ISBN: 9788131524749.
3) S S Rattan., 'Strength of Materials', McGraw Hill India, 2nd Edition, 2011, ISBN-(13 digits): 978-0071072564; ISBN: 007107256X.
4) Dr.R K Bansal 'Strength of Materials'6th Edition,Laxmi Publications India,ISBN: 978-81-318-0814-6


**Web links and Video Lectures (e-Resources):**

- **https://www.youtube.com/watch?v=La4UEa7hA7Q&list=PLJoALJA_KMOARYNi50T6b488kPUBbOIsX**
- **https://www.youtube.com/watch?v=GkFgysZC4Vc**
- **https://www.youtube.com/watch?v=aQf6Q8t1FQE&list=PLEYqyyrm-hQ3wtF34smyJSAOqUJqnf1ch**
- **https://www.youtube.com/watch?v=B9lyGZzb_6M&list=PLIhUrsYr8yHzft7ygw5THZo4aDcsxEadP**
- **https://www.youtube.com/watch?v=MFsirsHnQi4**

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Visit to any design department of manufacturing/aero/auto industry
- Demonstration of short, medium and long columns
- Video demonstration of finding the mechanical properties of materials.
- Contents related activities (Activity-based discussions)
  - Organizing Group wise discussions on issues
  - Seminars

| MECHANICS OF MATERIALS LAB | | | |
|---|---|---|---|
| **Course Code** | **24MEL32** | **CIE Marks** | **50** |
| **L:T:P:S** | **0:0:1:0** | **SEE Marks** | **50** |
| **Hrs / Week** | **2** | **Total Marks** | **100** |
| **Credits** | **01** | **Exam Hours** | **03** |

**Course outcomes:**
At the end of the course, the student will be able to:

| | |
|---|---|
| 24MEL32.1 | Examine the microstructure details of Ferrous and nonferrous materials. |
| 24MEL32.2 | Analyze the role and function of multidisciplinary teams in materials testing by examining stresses and strains in members subjected to axial, bending, and torsional loads |
| 24MEL32.3 | Determine the impact strength, hardness and wear rate of various materials. |
| 24MEL32.4 | Identify the surface defects through NDT techniques for ferrous and nonferrous materials. |

**Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24MEL32.1 | 3 | 2 | - | - | - | - | - | - | - | - | - | 3 | 1 |
| 24MEL32.2 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | - | 3 | 1 |
| 24MEL32.3 | 3 | - | - | - | - | - | - | - | - | - | - | 3 | 1 |
| 24MEL32.4 | 3 | 2 | - | - | - | - | - | - | - | - | - | 3 | 1 |

| Exp. No. / Pgm. No. | List of Experiments / Programs | Hours | COs |
|---|---|---|---|
| | **Prerequisite Experiments / Programs / Demo** | | |
| | **Demo:** To determine the wear rate of the given specimen using Pin on Disc apparatus. | 2 | NA |
| | **PART-A** | | |
| 1 | To determine the hardness number of aluminum specimen using Brinell hardness test. | 2 | 24MEL32.3 |
| 2 | Evaluating the hardness number of hardened steel specimen using Vickers'shardness test. | 2 | 24MEL32.3 |
| 3 | To determine the hardness number of mild steel/cast iron specimen usingRockwell hardness test. | 2 | 24MEL32.3 |
| 4 | To determine the impact energy and strength of notched specimen using Izod test. | 2 | 24MEL32.3 |
| 5 | To determine the impact energy and strength of notched specimen using Charpy test. | 2 | 24MEL32.3 |
| 6 | Metallographic examination and identification of microstructures of ferrous and non-ferrous materials materials. | 2 | 24MEL32.1 |
| | **PART-B** | | |
| 7 | Determination of cracks in given material using dye penetrant test. | 2 | 24MEL32.2 |
| 8 | To determine the ultimate shear strength of the given specimen in single and double shear using UTM. | 2 | 24MEL32.2 |
| 9 | To determine the moment of inertia, modulus of elasticity and maximum bending stress of wood specimen by conducting bending test. | 2 | 24MEL32.2 |
| 10 | To determine the compressive strength, modulus of elasticity, % | 2 | |

| | | | |
|---|---|---|---|
| | reduction in length and % increase in area of cast iron specimen by conducting compression test on universal testing machine. | | 24MEL32.2 |
| 11 | To determine the modulus of rigidity, Torsional strength and modulus of toughness of mild steel specimen using torsion test. | 2 | 24MEL32.2 |
| 12 | To determine the elastic strength, ultimate tensile strength, modulus of toughness and young's modulus of mild steel specimen by conducting tensile test on universal testing machine. | 2 | 24MEL32.2 |

**PART-C**

**Beyond Syllabus Virtual Lab Content (To be done during Lab but not to be included for CIE or SEE)**

**1.Izod Impact Test**
https://sm-nitk.vlabs.ac.in/exp/izod-impact-test/

**2. Charpy Impact Test**
https://sm-nitk.vlabs.ac.in/exp/charpy-impact-test/

**3. Brinell Hardness Test**
https://sm-nitk.vlabs.ac.in/exp/brinell-hardness-test/

**4. Rockwell Hardness Test**
https://sm-nitk.vlabs.ac.in/exp/rockwell-hardness-test/

**5. Vickers Hardness Test**

https://sm-nitk.vlabs.ac.in/exp/vickers-hardness-test/

**6. Tensile Test on Mild Steel**

https://sm-nitk.vlabs.ac.in/exp/tensile-test-mild-steel/

**7. Compression Test**

https://sm-nitk.vlabs.ac.in/exp/compression-test-cast-iron/
https://sm-nitk.vlabs.ac.in/exp/compression-test-mild-steel/

**8. Torsion Test on Mild Steel**

https://sm-nitk.vlabs.ac.in/exp/torsion-test-mild-steel/

**9.Shear Test**
https://sm-nitk.vlabs.ac.in/exp/direct-shear-test-timber/
https://sm-nitk.vlabs.ac.in/exp/direct-shear-test-steel-plate/

**CIE Assessment Pattern (50 Marks – Lab)**

| RBT Levels | | Test (s) | Weekly Assessment |
|---|---|---|---|
| | | 20 | 30 |
| L1 | Remember | - | - |
| L2 | Understand | 5 | 10 |
| L3 | Apply | 10 | 10 |
| L4 | Analyze | 5 | 10 |
| L5 | Evaluate | - | - |
| L6 | Create | - | - |

**SEE Assessment Pattern (50 Marks – Lab)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| L1 | Remember | 05 |
| L2 | Understand | 05 |
| L3 | Apply | 20 |
| L4 | Analyze | 20 |
| L5 | Evaluate | - |
| L6 | Create | - |

**Suggested Learning Resources:**

**Reference Books:**


1) R C Hibbeler., 'Mechanics of Materials', Pearson Education, 9th Edition, 2018, ISBN-(13 digits): 978- 9332584037; ISBN-(10 digits): 9332584036.
2) James M. Gere, Barry J. Goodno., 'Mechanics of Materials', Cengage Learning, 8th Edition, 2014, ISBN-(13 digits): 9788131524749.
3) S S Rattan., 'Strength of Materials', McGraw Hill India, 2nd Edition, 2011, ISBN-(13 digits): 978-0071072564; ISBN-(10 digits): 007107256X.
4) Dr.R K Bansal 'Strength of Materials'6th Edition, Laxmi Publications India,ISBN-978-81-318-0814-6

## FLUID MECHANICS

| | | | |
|---|---|---|---|
| **Course Code** | **24MEE33** | **CIE Marks** | **50** |
| **L:T:P:S** | **3:0:0:0** | **SEE Marks** | **50** |
| **Hrs / Week** | **03** | **Total Marks** | **100** |
| **Credits** | **03** | **Exam Hours** | **03** |

**Course outcomes:**

At the end of the course, the student will be able to:

| | |
|---|---|
| 24MEE33.1 | Understand the fundamental properties of fluids such as surface tension, viscosity, and capillarity to explain fluid behavior in practical scenarios |
| 24MEE33.2 | Apply principles of aerodynamics to compute lift, drag, and moment forces acting on simple aerodynamic profiles in inviscid and steady fluid flows |
| 24MEE33.3 | Apply concepts of fluid statics, kinematics, and dynamics to solve engineering problems in Aerodynamics, Hydraulics, Marine Engineering, and Gas Dynamics. |
| 24MEE33.4 | Analyze the causes of major and minor losses in pipe flows and assess their impact on fluid transport systems |
| 24MEE33.5 | Apply the Continuity and Bernoulli equations to model and solve real-time fluid flow problems in engineering systems |
| 24MEE33.6 | Evaluate various types of fluid flow and flow descriptions, and design an appropriate flow measuring device to assess discharge and performance. |

**Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24MEE33.1 | 2 | 1 | - | - | - | - | - | - | - | - | - | 1 | 3 |
| 24MEE33.2 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 1 | 3 |
| 24MEE33.3 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 1 | 3 |
| 24MEE33.4 | 3 | 3 | 2 | - | - | - | - | - | - | - | - | 1 | 3 |
| 24MEE33.5 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 1 | 3 |
| 24MEE33.6 | 3 | 3 | 2 | 1 | - | - | - | - | - | - | - | 1 | 3 |

| | | | |
|---|---|---|---|
| **MODULE-1** | **INTRODUCTION TO FLUID MECHANICS** | **24MEE33.1<br>24MEE33.3** | **8 Hours** |

Fluid Properties: Types of fluids, Mass Density, Specific Weight, Specific Gravity, Newton's Law of Viscosity, Dynamic Viscosity, Surface Tension, Capillarity, Compressibility, Vapour pressure , numericals
Fluid Statics: Pascal's law, Hydrostatic law , pressure variation in a static fluid in 2D.

| | |
|---|---|
| Case study | Case Study on vapour pressure and cavitation |
| Text Book | Text Book 1: 1.1, 1.2, 1.3, 1.6, 2.1, 2.2, 2.3, 4.1, 4.2, 4.3, 4.4, 4.5 Text Book 2: 1.1, 1.2,1.3, 1.4, 1.5, 1.6, 2.3, 4.1, 4.2, 4.3, 4.4 |

| | | | |
|---|---|---|---|
| **MODULE-2** | **FLUID KINEMATICS** | **24MEE33.3<br>24MEE33.5** | **8 Hours** |

Fluid Kinematics: Types of Flow- steady, unsteady, uniform, non-uniform, laminar, turbulent, one, two and three dimensional, compressible, incompressible, rotational, irrotational, stream lines, path lines, streak lines, Continuity equation in 2D and 3D (Cartesian Co-ordinates only), velocity and acceleration, velocity potential function and stream function (Numerical).

| | |
|---|---|
| Case Study | Case Study on Determination of metacentric height |
| Text Book | Text Book 1: 5.1, 5.2, 5.3,5.4,5.5, 5.7,5.8, 6.1,6.2,6.3,6.4, 7.1, 7.3 Text Book 2: 5.1, 5.3, 5.6, 6.1, |

| | | | |
|---|---|---|---|
| **MODULE-3** | **FLUID DYNAMICS** | **24MEE33.3<br>24MEE33.4<br>24MEE33.6** | **8 Hours** |

Fluid Dynamics: Introduction to Navier-Stroke's Equation, derivation of Euler equation of motion along a stream line, and Bernoulli's equation from Euler's equation and first principles (Numerical). Application of Bernoulli's equation to pitot tube, venturimeter, orifice meter (No Derivation of discharge equation).

| | |
|---|---|
| Case Study | Case study on flow measuring devices |
| Text Book | Text Book 1: 9.1, 9.2, 9.310.1, 10.2, 10.3 Text Book 2: 11.2, 11.2, 10.4, 10.5 |

| | | | |
|---|---|---|---|
| **MODULE-4** | **FLOW THROUGH PIPES** | **24MEE33.4** | **8 Hours** |

Flow Through Pipes: Energy losses through pipe, Major losses, Darcy- Weisbach equation, Chezy's Equation, Minor losses in pipes-sudden enlargement, sudden contraction, TEL, HGL, pipes in series and parallel, Siphons, Transmission of power. (Numerical).

Laminar And Turbulent Flow: Definition, Relation between pressure and shear stresses, Laminar flow through circular pipe, Fixed parallel plates, Turbulent flow and velocity distribution. (Numerical)

| | |
|---|---|
| Case Study | Case study on HGL and TEL |
| Text Book | Text Book 1: 19.1, 19.2, 19.3, 19.7, 19.9 Text Book 2: 3.1, 3.2, 3.3, 3.4, 3.5 |

| | | | |
|---|---|---|---|
| **MODULE-5** | **FLOW AROUND IMMERSED BODIES** | **24MEE33.3**<br>**24MEE33.2** | **8 Hours** |

Buoyancy: Buoyancy, centre of buoyancy, Archimedes' principle, principle of floatation, metacentre and metacentric height, stability of floating and submerged bodies, determination of Metacentric height by experimental method.(Numerical)

Flow around Immersed Bodies: -Force exerted by flowing fluid on stationary body, expression for Lift and Drag, Classification of Drag, Flow around circular cylinder and Aerofoil, Development of lift on Aerofoil. (Numerical)

| | |
|---|---|
| Self study | Self study on Lift and drag concepts |
| Text Book | Text Book : 18.1, 18.2, 18.5, 18.6 18.8, 18.10 Text Book 2: 2.1, 2.2, 2.3, 2.4 |

**CIE Assessment Pattern (50 Marks – Theory)**

| **RBT Levels** | | **Marks Distribution** | | |
|---|---|---|---|---|
| | | **Test (s)** | **AAT1** | **AAT2** |
| | | **25** | **15** | **10** |
| **L1** | **Remember** | 5 | - | - |
| **L2** | **Understand** | 5 | 5 | - |
| **L3** | **Apply** | 10 | 5 | 5 |
| **L4** | **Analyze** | 5 | 5 | 5 |
| **L5** | **Evaluate** | - | - | - |
| **L6** | **Create** | - | - | - |

**SEE Assessment Pattern (50 Marks – Theory)**

| **RBT Levels** | | **Exam Marks Distribution (50)** |
|---|---|---|
| **L1** | **Remember** | 10 |
| **L2** | **Understand** | 10 |
| **L3** | **Apply** | 20 |
| **L4** | **Analyze** | 10 |
| **L5** | **Evaluate** | -- |
| **L6** | **Create** | -- |

**Suggested Learning Resources:**

**Text Books:**


1) Bansal R.K., "Fluid Mechanics and Hydraulic Machines", 9th edition, Laxmi Publications (P)Ltd., New Delhi, 2018. ISBN 9788131808153
2) R.K.Rajput, "A Text Book of Fluid Mechanics and Hydraulic Machines", 6th edition, S. Chand, 2015. ISBN 9789385401374


**Reference Books:**


1) Yunus A. Cengel and John M. Cimbala., 'Fluid Mechanics', McGraw Hill, 4th Edition, 2017, ISBN-(13 digits): 978-9385401374
2) P.N.Modi and Seth, "Fluid Mechanics and Hydraulic Machines",22nd edition, Standard Book House, 2018.


**Web links and Video Lectures (e-Resources)**

- **https://archive.nptel.ac.in/courses/112/105/112105171/**
- **https://unacademy.com/content/gate/videos/mechanical-engineering/fluid-mechanics/#**
- **https://www.youtube.com/watch?v=clVwKynHpB0**
- **https://nptel.ac.in/courses/103102211**
- **https://nitsri.ac.in/Department/DisplayDeptPage.aspx?page=magee&ItemID=ocgkk&nDeptID=e**

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Visit to any Hydraulic power plant
- Demonstration on working of Pumps /Turbines
- Demonstration on Flow measuring Devices
- Contents related activities (Activity-based discussions)
  - For active participation of students, instruct the students to prepare Fluid Mechanics and Machinery related Flowcharts.
  - Organizing Group wise discussions on issues
  - Seminars

## FLUID MECHANICS LAB

| | | | |
|---|---|---|---|
| **Course Code** | **24MEL33** | **CIE Marks** | **50** |
| **L:T:P:S** | **0:0:1:0** | **SEE Marks** | **50** |
| **Hrs / Week** | **02** | **Total Marks** | **100** |
| **Credits** | **01** | **Exam Hours** | **03** |

**Course outcomes:**

At the end of the course, the student will be able to:

| | |
|---|---|
| 24MEL33.1 | Apply the flow measuring devices such as Venturi meter, orifice meter and Notches to predict the coefficient of discharge for flow through pipes |
| 24MEL33.2 | Investigate the friction and measure the frictional losses in fluid flow |
| 24MEL33.3 | Understand the working of impact of jet on various types of vanes |
| 24MEL33.4 | Analyze the performance of hydraulic turbine, pumps, Air blower under different working conditions |

**Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24MEL33.1 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 3 | 1 |
| 24MEL33.2 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | - | 3 | 1 |
| 24MEL33.3 | 2 | 2 | 1 | -- | - | - | - | - | - | - | - | 3 | 1 |
| 24MEL33.4 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | - | 3 | 1 |

| Exp. No. / Pgm. No. | List of Experiments / Programs | Hours | COs |
|---|---|---|---|
| | **Prerequisite Experiments / Programs / Demo** | | |
| | • Understand the properties of fluids<br>• Demonstration on pascal's law, hydrostatic law<br>• Demonstration on Buoyancy, determination of metacentric height. | 2 | NA |
| | **PART-A** | | |
| 1 | Calibration of given Venturi meter and plotting the suitable calibration curve | 2 | 24MEL33.1 |
| 2 | Calibration of given Orifice meter and plotting the suitable calibration curve | 2 | 24MEL33.1 |
| 3 | Calibration of given V-notch, rectangular notch and plotting the suitable calibration curve | 2 | 24MEL33.1 |
| 4 | Determination of coefficient of friction and Chezy's constant for turbulent flow in pipes. | 2 | 24MEL33.2 |
| 5 | Determination of minor losses coefficient in flow through pipes due to sudden contraction and sudden expansion | 2 | 24MEL33.2 |
| 6 | Determine the efficiency of air blower | 2 | 24MEL33.1 |
| | **PART-B** | | |
| 7 | Determination of the impact of jet on Flat Vanes | 2 | 24MEL33.3 |
| 8 | Determination of the impact of jet on hemispherical vanes | 2 | 24MEL33.4 |
| 9 | Determination of the impact of jet on Inclined Vanes | 2 | 24MEL33.4 |
| 10 | Investigate the Performance test on Pelton Wheel Turbine | 2 | 24MEL33.4 |
| 11 | Determination of performance characteristics of centrifugal pump | 2 | 24MEL33.4 |
| 12 | Investigate the Performance test on Kaplan Turbine | 2 | 24MEL33.4 |

## PART-C
## Beyond Syllabus Virtual Lab Content
## (To be done during Lab but not to be included for CIE or SEE)

**Reciprocating-pump**

- https://fmc-nitk.vlabs.ac.in/exp/reciprocating-pump/

**Francis-turbine**

- https://fmc-nitk.vlabs.ac.in/exp/francis-turbine/

**Reynolds Experiment**

- https://me.iitp.ac.in/Virtual-Fluid-Laboratory/reynolds/introduction.html

**Pitot Tube**

- https://me.iitp.ac.in/Virtual-Fluid-Laboratory/pitot/introduction.html

**Metacenter**

- https://me.iitp.ac.in/Virtual-FluidLaboratory/metacenter/introduction.html

**CIE Assessment Pattern (50 Marks – Lab)**

| RBT Levels | | Test (s) | Weekly Assessment |
|---|---|---|---|
| | | 20 | 30 |
| L1 | Remember | - | - |
| L2 | Understand | 5 | 10 |
| L3 | Apply | 10 | 10 |
| L4 | Analyze | 5 | 10 |
| L5 | Evaluate | - | - |
| L6 | Create | - | - |

**SEE Assessment Pattern (50 Marks – Lab)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| L1 | Remember | 05 |
| L2 | Understand | 05 |
| L3 | Apply | 20 |
| L4 | Analyze | 20 |
| L5 | Evaluate | - |
| L6 | Create | - |

**Suggested Learning Resources:**

**Reference Books:**

1) Bansal R.K., "Fluid Mechanics and Hydraulic Machines", 9th edition, Laxmi Publications (P)Ltd., New Delhi, 2018 ISBN 9788131808153

2) R.K. Rajput, "A Text Book of Fluid Mechanics and Hydraulic Machines", 6th edition, S. Chand, 2015, ISBN 9789385401374

## MATERIAL SCIENCE AND METALLURGY

| | | | |
|---|---|---|---|
| **Course Code** | **24MEE34** | **CIE Marks** | **50** |
| **L:T:P:S** | **3:0:0:0** | **SEE Marks** | **50** |
| **Hrs / Week** | **3** | **Total Marks** | **100** |
| **Credits** | **03** | **Exam Hours** | **03** |

**Course outcomes:**

At the end of the course, the student will be able to:

| | |
|---|---|
| 24MEE34.1 | Identify the properties of metals with respect to crystal structure and grain size. |
| 24MEE34.2 | Construct phase diagrams for various materials and analyze the phase transformations. |
| 24MEE34.3 | Analyze invariant reactions and various equilibrium diagrams for metals and alloys. |
| 24MEE34.4 | Identify suitable type of Heat treatment processes and Significance of properties vs microstructure. |
| 24MEE34.5 | Identify different types of cast irons, steels and nonferrous alloy for specific applications |
| 24MEE34.6 | Apply the concept of powder metallurgy in manufacturing ceramics. |

**Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24MEE34.1 | 2 | 2 | - | - | - | - | - | - | - | - | - | 3 | 1 |
| 24MEE34.2 | 3 | 2 | - | - | - | - | - | - | - | - | - | 3 | 1 |
| 24MEE34.3 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 3 | 1 |
| 24MEE34.4 | 2 | 2 | - | - | - | - | - | - | - | - | - | 3 | 1 |
| 24MEE34.5 | 2 | 2 | - | - | - | - | - | - | - | - | - | 3 | 1 |
| 24MEE34.6 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 3 | 1 |

| **MODULE-1** | **CRYSTAL STRUCTURE** | **24MEE34.1** | **8 Hours** |
|---|---|---|---|

Introduction to crystal structure, BCC, FCC and HCP Structures, coordination number and atomic packing factors, Derivation of APF for BCC, FCC & HCP structures, crystal imperfections - point line and surface imperfections. Simple problems. Atomic Diffusion: Phenomenon, Ficks laws of diffusion, factors affecting diffusion. Simple problems.

| | |
|---|---|
| Self-study | Study crystal structure and Diffusion. |
| Text Book | Text Book 1: 1.2, 1.3, 1.4, 1.13, 1.15, 1.16 |

| **MODULE-2** | **PHASE DIAGRAM** | **24MEE34.2** | **8 Hours** |
|---|---|---|---|

Phase Diagram I: Solid solutions, Hume Rothary rule, substitutional and interstitial solid solutions, intermediate phases, Gibbs phase rule.

Phase Diagram II: Construction of equilibrium diagrams involving complete and partial solubility, lever rule. Different types invariant reactions – Eutectic, Eutectoid, Peritectic, Peritectectoid reactions

| | |
|---|---|
| Case Study | Transformations in the solid state, allotropy, eutectoid, peritectoid reactions, phase rule, relationship between equilibrium diagrams and properties of alloys. |
| Text Book | Text Book 1: 2.2, 2.3, 2.4 to 2.15 |

| **MODULE-3** | **IRON CARBON EQUILIBRIUM DIAGRAM** | **24MEE34.3 24MEE34.4** | **8 Hours** |
|---|---|---|---|

Description of phases, solidification of steels and cast irons, invariant reactions. Heat treating of metals. TTT curves, continuous cooling curves, description of the following heat treatment processes with industrial applications: annealing and its types, normalizing, hardening, tempering, martempering, austempering, hardenability, surface hardening methods like carburizing, cyaniding, nitriding, flame hardening, induction hardening.

| | |
|---|---|
| Case Study | Influence of different phases of steel and cast iron on its properties and applications. |

| | | | |
|---|---|---|---|
| Text Book | Text Book 2: 3.1, 3.3, 3.5, 3.7, 3.10 | | |
| **MODULE-4** | **ADVANCED MATERIALS** | **24MEE34.5** | **8 Hours** |
| Engineering materials: Properties, Composition and Applications of Grey cast iron, White cast Iron, malleable iron, SG iron and steels, Copper & Aluminium alloys. Titanium and Magnesium alloys.<br>Composite materials: Introduction, Classification, Applications<br>Nanomaterials: History of nanomaterials, effect of size on properties, Synthesis of nanomaterials-physical nanofabrication techniques (PVD, MBE, CVD, self-assembly, lithographic techniques), Applications of nanomaterials. | | | |
| Self-study | Comparison of properties of engineering materials and nanomaterials. | | |
| Text Book | Text Book 1: 6.1, 6.3, 6.5, 6.7, Text Book 2: 10.1, 10.3, 10.5, 10.7 | | |
| **MODULE-5** | **CERAMICS AND POWDER METALLURGY** | **24MEE34.6** | **8 Hours** |
| Ceramics: Introduction to ceramics, nature of ceramics, types of ceramics, properties of ceramics materials, ceramic forming techniques, applications of ceramics.<br>Powder Metallurgy: Definition and concept, applications, powder metallurgy process, Production of metal powders, characteristics of metal powders, compacting, pre-sintering and sintering | | | |
| Applications | Powder Metallurgy applications in mechanical components. | | |
| Text Book | Text Book 2: 12.1 to 12.10, Ref. book 2: 20.1 to 20.5 | | |

**CIE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Marks Distribution | | |
|---|---|---|---|---|
| | | Test (s) | AAT1 | AAT2 |
| | | 25 | 15 | 10 |
| L1 | Remember | 5 | - | - |
| L2 | Understand | 5 | 5 | - |
| L3 | Apply | 10 | 5 | 5 |
| L4 | Analyze | 5 | 5 | 5 |
| L5 | Evaluate | - | - | - |
| L6 | Create | - | - | - |

**SEE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| L1 | Remember | 10 |
| L2 | Understand | 10 |
| L3 | Apply | 20 |
| L4 | Analyze | 10 |
| L5 | Evaluate | -- |
| L6 | Create | -- |

**Suggested Learning Resources:**

**Text Books:**

1) Introduction to Physical Metallurgy Sidney H Avner, Mcgraw Hill Education, 1997,ISBN 13: 978007463
2) Fundamentals of Material Science and Engineering David G Rethwisch William D Callister Jr. Rethwisch Callister , John Wiley & Sons Publishers, 4th Edition, 2012, ISNB13: 978111806160

**Reference Books:**

1) Materials Science and Engineering, V.RAGHAVAN, PHI Learning, 2004, ISBN: 9788120324558
2) Engineering Materials, Kenneth G. Budinski, Michael K. Budinski, Prentice Hall, 9 edition, 2010, ISBN: 978013712842

**Web links and Video Lectures (e-Resources):**

- https://www.youtube.com/watch?v=zGUGBegBgdk
- https://www.youtube.com/watch?v=CRPMDb0Xr1s&t=713s
- https://www.youtube.com/watch?v=ejg27ozbPA8
- https://www.youtube.com/watch?v=-YIGjX-jcMo
- https://www.youtube.com/watch?v=PaGJwOPg2kU
- https://www.youtube.com/watch?v=H50zsHuIgrU
- https://www.youtube.com/watch?v=OLa8DQkKlyU&t=21s
- https://www.youtube.com/watch?v=N4-kfSD6XJI

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Video demonstration of phase transformation
- Discussion based on collection of different mechanical components and materials.
- Contents related activities (Activity-based discussions)
  - For active participation of students, instruct the students to prepare Flowcharts and Handouts
  - Organizing Group wise discussions on issues
  - Seminars

## COMPUTER AIDED MACHINE DRAWING

| | | | |
|---|---|---|---|
| **Course Code** | **24MEE35** | **CIE Marks** | **50** |
| **L:T:P:S** | **2:0:1:0** | **SEE Marks** | **50** |
| **Hrs / Week** | **2** | **Total Marks** | **100** |
| **Credits** | **03** | **Exam Hours** | **03** |

**Course outcomes:**

At the end of the course, the student will be able to:

| | |
|---|---|
| 24MEE35.1 | Apply the principles of sectional views to interpret and represent engineering drawings effectively |
| 24MEE35.2 | Demonstrate knowledge of thread forms and riveted joints in engineering applications |
| 24MEE35.3 | Interpret and implement Geometric Dimensioning and Tolerancing (GD&T) for precise design and manufacturing. |
| 24MEE35.4 | Design and model sheet metal components using standard practices and tools |
| 24MEE35.5 | assemble machine components to meet functional and design requirements |
| 24MEE35.6 | Utilize CAD software efficiently for creating, modifying, analyzing, and optimizing engineering designs |

**Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24MEE35.1 | 2 | 2 | - | - | 2 | - | - | - | - | - | - | 3 | 2 |
| 24MEE35.2 | 3 | 2 | - | - | 2 | - | - | - | - | - | - | 3 | 2 |
| 24MEE35.3 | 3 | 2 | - | - | 2 | - | - | - | - | - | - | 3 | 2 |
| 24MEE35.4 | 3 | 2 | - | - | 2 | - | - | - | - | - | - | 3 | 2 |
| 24MEE35.5 | 2 | 2 | - | - | 2 | - | - | - | - | - | - | 3 | 2 |
| 24MEE35.6 | 2 | 2 | 2 | - | 2 | - | - | - | - | - | - | 3 | 2 |

| | | | |
|---|---|---|---|
| **MODULE-1** | **SECTIONS OF SOLIDS** | **24MEE35.1** | **8 Hours** |

Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases (No problems on axis inclinations, spheres and hollow solids), True shape of sections

| | |
|---|---|
| Case Study | Investigate the truncation, frustum of solids. |
| Text Book | Text Book 1; 1.1-1.13, |

| | | | |
|---|---|---|---|
| **MODULE-2** | **RIVETED JOINTS** | **24MEE35.2** | **8Hours** |

Thread Forms and proportions of rivet heads, Single and double riveted lap joints, butt joints with single/double cover straps

| | |
|---|---|
| Self-study | Make a report on the applications of riveted joints in the structural members. |
| Text Book | Text Book: 1; 2.1-2.13, |

| | | | |
|---|---|---|---|
| **MODULE-3** | **GEOMETRIC DIMENSIONING AND TOLERANCE** | **24MEE35.3** | **8Hours** |

Introduction to limits, fits and tolerances, dimensional and geometric tolerances, surface finish symbols. Practical examples using industrial drawings

| | |
|---|---|
| Self-study | Make a report on the application of Geometric dimensioning and tolerance for a given machine component. |
| Text Book | Text Book 1;10.1-10.8 |

| | | | |
|---|---|---|---|
| **MODULE-4** | **SHEET METAL MODELLING** | **24MEE35.4** | **8 Hours** |

Generation of 3D sheet metal components Tray, Brackets, Funnel, Belt Guards, Air filters, Housings, Transition Pieces etc.

| | |
|---|---|
| Case study | Develop the given sheet metal components using cardboard sheet. |
| Text Book | Text Book: 2: 5.6-5.10 |

| MODULE-5 | 3D GEOMETRIC MODELING AND ASSEMBLY | 24MEE35.5<br>24MEE35.6 | 8 Hours |
|---|---|---|---|

Machine components – Screw jack (Bottle type), Plummer block (Pedestal Bearing), Machine vice, I.C. Engine connecting rod, Rams Bottom Safety Valve, Tailstock of lathe, Tool Head of a shaper.

| | |
|---|---|
| Case Study | List the procedure for assembly and disassembly of the given machine assembly. |
| Text Book | Text Book 1; 9.1-9.5, |

**CIE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Marks Distribution | | |
|---|---|---|---|---|
| | | Test (s) | AAT1 | AAT2 |
| | | 25 | 15 | 10 |
| L1 | Remember | 5 | - | - |
| L2 | Understand | 5 | 5 | - |
| L3 | Apply | 10 | 5 | 5 |
| L4 | Analyze | 5 | 5 | 5 |
| L5 | Evaluate | - | - | - |
| L6 | Create | - | - | - |

**SEE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| L1 | Remember | 10 |
| L2 | Understand | 10 |
| L3 | Apply | 20 |
| L4 | Analyze | 10 |
| L5 | Evaluate | - |
| L6 | Create | - |

**Suggested Learning Resources:**

**TEXTBOOKS**


1. 'Machine Drawing', K.R. Gopala Krishna, Subhash Publication, 2017, ISBN-139789383214235
2. 'Machine Drawing' N. D. Bhat, V M Panchal, Charotar Publication House, 2014, ISBN: 9789385039232, 9385039237.


**Reference Books:**


1. 'Machine Drawing with Auto CAD', Goutam Pohit & Goutham Ghosh, 1st Indian print Pearson Education, 2005, ISBN: 13-978-8131706770
2. 'Machine Drawing', N. Siddeshwar, P. Kanniah, V.V.S. Sastri, published by Tata McGraw Hill,2014, ISBN**:** 007460337X / 9780074603376
3 'Machine Drawing' Junnarkar N. D., Pearson Education, 2007, ISBN: 8131706788
4 'Textbook of Machine Drawing' K. C. John, PHI, 2009, 1st Edition, ISBN-13 : 978-8120337213
5. 'A Textbook of Machine Drawing' P. S. Gill, S.K. Kataria & Sons, 2013 Edition, ISBN-13 : 978-9350144169


**Web links and Video Lectures (e-Resources):**

- Bureau of Indian Standards (BIS): SP-46, 2003
- NPTEL Web Course: https://nptel.ac.in/courses/112103019/
- NPTEL Video Course: https://nptel.ac.in/syllabus/112106075/

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Visit to any manufacturing/aero/auto industry/process industry/any power plant.
- Demonstration of design stages in the manufacturing or process industry.

| SUSTAINABLE MANUFACTURING AND GREEN TECHNOLOGIES | | | |
|---|---|---|---|
| **Course Code** | **24MEE361** | **CIE Marks** | **50** |
| **L:T:P:S** | **1:0:0:0** | **SEE Marks** | **50** |
| **Hrs / Week** | **01** | **Total Marks** | **100** |
| **Credits** | **01** | **Exam Hours** | **03** |

**Course outcomes:**

At the end of the course, the student will be able to:

| | |
|---|---|
| 24MEE361.1 | Understand the principles of sustainable manufacturing and its importance in modern industry. |
| 24MEE361.2 | Analyze and evaluate the environmental impacts of traditional manufacturing practices. |
| 24MEE361.3 | Investigate and apply green manufacturing technologies to reduce environmental impacts. |
| 24MEE361.4 | Design and implement energy-efficient solutions in manufacturing processes. |
| 24MEE361.5 | Critically assess sustainable supply chain practices and develop solutions for green logistics. |
| 24MEE361.6 | Analyze and apply policies, regulations, and future trends in sustainable manufacturing. |

**Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24MEE361.1 | 2 | 2 | - | - | - | - | - | - | - | - | - | 3 | 2 |
| 24MEE361.2 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 3 | 2 |
| 24MEE361.3 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 3 | 2 |
| 24MEE361.4 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 3 | 2 |
| 24MEE361.5 | 2 | 2 | - | - | - | - | - | - | - | - | - | 2 | 2 |
| 24MEE361.6 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 3 | 2 |

| **MODULE-1** | **INTRODUCTION TO SUSTAINABLE MANUFACTURING** | **24MEE361.1 24MEE361.2** | **3 Hours** |
|---|---|---|---|

Definition and Importance of Sustainable Manufacturing - Understanding sustainability in the context of manufacturing, Evolution and drivers of sustainability - Economic, Environmental, and Social factors, Global initiatives and frameworks: ISO 14001, Sustainable Development Goals (SDGs).
Environmental Impact of Traditional Manufacturing – Ecological footprints - Greenhouse gas emissions, air, and water pollution.

| | |
|---|---|
| Self-study | Study on Life Cycle Assessment (LCA) and Carbon footprint analysis. |
| Text Book | Text Book 1: 1 to 20, 45 to 90, |

| **MODULE-2** | **GREEN MANUFACTURING TECHNOLOGIES** | **24MEE361.3** | **3 Hours** |
|---|---|---|---|

Introduction to Green Technologies - Definition and benefits of green technologies in manufacturing,
Key principles - Eco-design, energy- efficient production, pollution prevention.
Advanced Manufacturing Processes - Additive manufacturing (3D printing) and its sustainability implications, Precision manufacturing and reducing material waste, Nanotechnology in sustainable manufacturing.

| | |
|---|---|
| Case Study | Study on Circular economy concepts. |
| Text Book | Text Book 2: 1 to 122 |

| **MODULE-3** | **ENERGY EFFICIENCY IN MANUFACTURING** | **24MEE361.4** | **3 Hours** |
|---|---|---|---|

Principles of Energy Efficiency - Understanding energy consumption in manufacturing processes, Methods for improving energy efficiency - Lean manufacturing, energy audits, process optimization.
Energy Management Systems - ISO 50001 Energy Management Standard, Smart energy monitoring and

| | | | |
|---|---|---|---|
| automation technologies, Role of Artificial Intelligence (AI) and Internet of Things (IoT) in energy optimization. | | | |
| Case Study | Study on Energy Efficiency in Industry | | |
| Text Book | Text Book 1: 145 to 170 | | |
| **MODULE-4** | **SUSTAINABLE SUPPLY CHAIN MANAGEMENT** | **24MEE361.5** | **3 Hours** |
| Sustainable Supply Chain Principles - The triple bottom line - People, Planet, Profit, Sustainable procurement - Sourcing materials responsibly, Environmental performance metrics across the supply chain. Green Logistics and Transportation, Green packaging solutions and their impact, Sustainable transportation technologies - Electric vehicles, hybrid fleets. | | | |
| Self-study | Study on Circular Supply Chains. | | |
| Text Book | Text Book 2: 2.1 to 2.35 | | |
| **MODULE-5** | **POLICY, REGULATIONS, AND FUTURE TRENDS IN SUSTAINABLE MANUFACTURING** | **24MEE361.6** | **3 Hours** |
| Government Policies and Regulations - Environmental regulations - Waste management, emissions standards, and pollution control, Policies promoting green technologies - Carbon taxes, incentives for renewable energy adoption, Compliance with environmental standards and the role of environmental certifications. | | | |
| Applications | Survey on Zero-emissions factories. | | |
| Text Book | Text Book 3: 164 - 180 | | |

**CIE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Marks Distribution | | |
|---|---|---|---|---|
| | | Test (s) | AAT1 | AAT2 |
| | | 25 | 15 | 10 |
| L1 | Remember | 5 | - | - |
| L2 | Understand | 5 | 5 | - |
| L3 | Apply | 10 | 5 | 5 |
| L4 | Analyze | 5 | 5 | 5 |
| L5 | Evaluate | - | - | - |
| L6 | Create | - | - | - |

**SEE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| L1 | Remember | 10 |
| L2 | Understand | 10 |
| L3 | Apply | 20 |
| L4 | Analyze | 10 |
| L5 | Evaluate | -- |
| L6 | Create | -- |

**Suggested Learning Resources:**

**Text Books:**

1) Sustainable Manufacturing: Concepts, Tools, Methods and Case Studies by S. Vinodh (CRC Press, 2021), ISBN-13: 9788176710107

2) Sustainable Manufacturing edited by Stark, Seliger & Bonvoisin (Springer, 2017), ISBN-13: 9788176710107.

**Reference Books:**

1) Smart and Sustainable Manufacturing Systems for Industry 4.0 (Manupati et al., CRC Press, 2023), ISBN-13: 9788174092030

2) Handbook of Intelligent and Sustainable Manufacturing (Kumar, Parveen et al., CRC Press, 2025), ISBN-13: 9781259097560

**Web links and Video Lectures (e-Resources):**

- **https://www.youtube.com/watch?v=IMdrfsTn8_M**
- **https://www.youtube.com/watch?v=WUl_tzsW8u4**
- **https://www.youtube.com/watch?v=doBcENHpRQQ**
- **https://www.youtube.com/watch?v=3VBzLrF6FvA**
- **https://www.youtube.com/watch?v=bIbWUfEK-Lc**

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- For active participation of students, instruct the students to prepare Flowcharts and Handouts
- Organizing Group wise discussions on issues
- Seminars

## TOOL ENGINEERING

| | | | |
|---|---|---|---|
| **Course Code** | **24MEE362** | **CIE Marks** | **50** |
| **L:T:P:S** | **1:0:0:0** | **SEE Marks** | **50** |
| **Hrs / Week** | **1** | **Total Marks** | **100** |
| **Credits** | **01** | **Exam Hours** | **03** |

**Course outcomes:**

At the end of the course, the student will be able to:

| | |
|---|---|
| 24MEE362.1 | Understand the basics concepts of Injection mould design. |
| 24MEE362.2 | Apply knowledge in Compression mold design. |
| 24MEE362.3 | Analyze the techniques and essential components involved in mold design to understand their interrelationships and functional roles |
| 24MEE362.4 | Evaluate various mold design techniques and components to determine their effectiveness and suitability for specific manufacturing applications |
| 24MEE362.5 | Analyze the basics of jigs and fixtures. |
| 24MEE362.6 | Apply the gained knowledge to practical applications. |

**Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24MEE362.1 | 2 | 1 | - | - | - | - | - | - | - | - | - | 3 | 2 |
| 24MEE362.2 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 3 | 2 |
| 24MEE362.3 | 2 | 1 | - | - | - | - | - | - | - | - | - | 3 | 2 |
| 24MEE362.4 | 2 | 1 | - | - | - | - | - | - | - | - | - | 3 | 2 |
| 24MEE362.5 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 3 | 2 |
| 24MEE362.6 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 3 | 2 |

| **MODULE-1** | **INJECTION MOULDING** | **24MEE362.1 24MEE362.3 24MEE362.6** | **3 Hours** |
|---|---|---|---|

Plastics product design Concepts, factors, process variables, product design. Uniform and symmetrical wall thickness, Draft angle Rib & Radius Bosses Holes, metal inserts parting line Tolerances.

| | |
|---|---|
| Applications | Injection Moulding areas of industrial applications. |
| Text Book | Text Book 1: 1.1, 1.2, 1.3, 1.4, 1.5 |

| **MODULE-2** | **GENERAL MOLUDING CONSTRUCTION** | **24MEE362.1 24MEE362.3 24MEE362.6** | **3 Hours** |
|---|---|---|---|

Introduction , Mold design concepts, mold elements parting line and parting surface construction of core and cavities Bolsters mold alignment, Feed system, Sprue, runner, gate & position of gate runner & gate balancing.

| | |
|---|---|
| Case Study | Moulding construction case study. |
| Text Book | Text Book 1: 2.1, 2.2, 2.3, 2.4, 2.5 |

| **MODULE-3** | **COMPRESSION MOULDING** | **24MEE362.2 24MEE362.3 24MEE362.4** | **3 Hours** |
|---|---|---|---|

Types of compression mold, open flash, semi-positive type, positive, displacement molds, types of loading chambers, flash thickness, pot design, projected area, compression pressure, clamping force.

| | |
|---|---|
| Applications | Compression Moulding areas of industrial applications. |
| Text Book | Text Book 1: 4.1, 4.2, 4.3, 4.4, 4.5 |

| **MODULE-4** | **PRESS TOOLS** | **24MEE362.4 24MEE362.6** | **3 Hours** |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Types of presses, types of dies, Clearance, die sets, materials of die sets, cutting force, punch design, punch holder and die support, stripper plate, die springs, die wear. | | | |
| Applications | Press tools areas of industrial applications. | | |
| Text Book | Text Book 1: 5.1, 5.2, 5.3, 5.4, 5.5 | | |
| **MODULE-5** | **JIGS AND FIXTURES** | **24MEE362.5 24MEE362.6** | **3 Hours** |
| Production devices, Elements of jigs and fixtures, Advantages of jigs and fixtures, Inspection devices, Materials used presentation of work piece. | | | |
| Case Study | Jigs and fixtures industrial applications and case studies of the same. | | |
| Text Book | Text Book 2: 1.1, 1.2, 1.3, 1.4,1.5, 1.6 | | |

**CIE Assessment Pattern (50 Marks – Theory) –**

| RBT Levels | | Marks Distribution | | |
|---|---|---|---|---|
| | | Test (s) | AAT1 | AAT2 |
| | | 25 | 15 | 10 |
| L1 | Remember | 5 | - | - |
| L2 | Understand | 5 | 5 | - |
| L3 | Apply | 10 | 5 | 5 |
| L4 | Analyze | 5 | 5 | 5 |
| L5 | Evaluate | - | - | - |
| L6 | Create | - | - | - |

**SEE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| L1 | Remember | 10 |
| L2 | Understand | 10 |
| L3 | Apply | 20 |
| L4 | Analyze | 10 |
| L5 | Evaluate | - |
| L6 | Create | - |

**Suggested Learning Resources:**

**Text Books:**

1) Injection Mould Design An Introduction And Design For The Thermoplastics, Publisher: Affiliated East-West Press Pvt. Ltd. ISBN-13: 9788176710107.

2) Jigs and fixtures design manual by P.H.Joshi Publication Tata McGraw Hill Education Private Limited. ISBN-13**:** 9780071405560

**Reference Books:**

1) Press Tools Design and Construction, 2012, by Joshi P.H. (Author), S.Chand and publications. ISBN-13**:** 9788121929387
2) A Textbook of Production Engineering, 11/e, by P.C.Sharma, S. Chand Publishing. ISBN-13**:** 9788121901482
3) Tool Engineering and design by G.R. Nagpal., Khanna Publishers. ISBN-13**:** 9788174092030
4) Fundamentals of Plastics Mould Design- Sanjay K Nayak , Pratap Chandra Padhi, Y. Hidayathullah, Publication Tata McGraw Hill Education Private Limited . ISBN-13**:** 9781259097560
5) Injection mold design engineering, David O Kazmer, 2nd edition Hanser publications ISBN-13**:** 9781569905708

**Web links and Video Lectures (e-Resources):**

- **https://www.youtube.com/watch?v=I71YrXafg0o**
- **https://www.youtube.com/watch?v=l-7ivFEAzw8**
- **https://www.youtube.com/watch?v=0t_kie_sBLw**
- **https://www.youtube.com/watch?v=uOYIoX3srbw**

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Case Study & Alternative Assignments
- Visit to any manufacturing/aero/auto industry
- Video demonstration of latest trends in Tool Engineering
- Contents related activities (Activity-based discussions)
  - For active participation of students, instruct the students for tool construction
  - Organizing Group wise discussions on tool engineering issues
  - Seminars
  - Presentation

| BIOENERGY AND BIOFUELS | | | |
|---|---|---|---|
| **Course Code** | **24MEE363** | **CIE Marks** | **50** |
| **L:T:P:S** | **1:0:0:0** | **SEE Marks** | **50** |
| **Hrs / Week** | **01** | **Total Marks** | **100** |
| **Credits** | **01** | **Exam Hours** | **03** |

**Course outcomes:**

At the end of the course, the student will be able to:

| | |
|---|---|
| 24MEE363.1 | Understand the importance of energy from biomass and biofuels. |
| 24MEE363.2 | Explain the various energy conversion technologies on biomass and biogas. |
| 24MEE363.3 | Analyze the alternative energy requirement for meeting the current Scenario. |
| 24MEE363.4 | Analyze the fuel preparation and storage systems. |
| 24MEE363.5 | Apply the testing on the fuel with required engine modification. |
| 24MEE363.6 | Implement modified fuels on transport systems for sustainable development. |

**Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24MEE363.1 | 2 | 1 | - | - | - | - | - | - | - | - | - | 2 | 3 |
| 24MEE363.2 | 3 | 2 | - | - | - | - | - | - | - | - | - | 2 | 3 |
| 24MEE363.3 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 2 | 3 |
| 24MEE363.4 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 2 | 3 |
| 24MEE363.5 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 2 | 3 |
| 24MEE363.6 | 2 | 2 | 1 | - | - | - | - | - | - | - | - | 2 | 3 |

| **MODULE-1** | **BIOMASS AND CONVERSION TECHNOLOGIES** | **24MEE363.1 24MEE363.2** | **3 Hours** |
|---|---|---|---|

Biomass and Conversion Technologies - Introduction, Biomass as a sources of energy, Biomass conversion Technologies - Wet Processes, Dry Processes, Photosynthesis, Biogas Generation, Energy Plantation, advantages of Energy Plantation, Plants proposed for energy plantation, methods for energy from biomass, Thermal gasification process, classification, chemistry and applications of gasifier and Pyrolysis.

| | |
|---|---|
| Self-study / Case Study | Study the Problems in Development of gasifiers. |
| Text Book | Text Book 1: 7.313, 7.385, 7.414 |

| **MODULE-2** | **BIOGAS AND PRODUCTION TECHNOLOGIES** | **24MEE363.1 24MEE363.2** | **3 Hours** |
|---|---|---|---|

Biogas and Production Technologies **-** Biogas Generation, Factors affecting Biodigestion or Generation of gas, Classification of biogas plants, advantages and disadvantages of Floating Drum Plant and Fixed dome type Plant. Types of biogas plants, Constructional Details of the plants, biogas from plant waste, Community biogas plants, material used for biogas generation, site selection, digester design consideration, methods for maintaining biogas production and utilization of biogas.

| | |
|---|---|
| Case Study | Case study on fuel properties of biogas. |
| Text Book | Text Book 1: 7.327, 7.381 |

| **MODULE-3** | **ALTERNATIVE FUELS AND BIOFUEL** | **24MEE363.3 24MEE363.4 24MEE363.5 24MEE363.6** | **3 Hours** |
|---|---|---|---|

Alternative Fuels **-**Introduction, Classification, Scenario of conventional auto fuels, oils reserves of the world, Fuel quality aspects related to emissions, technological upgradations required, need for alternative fuels.

Biofuel - Methanol – Introduction, history of methanol, Methanol properties. Production, applications, advantages and disadvantages, health hazards and economics of Methanol. Methanol storage and

| | | | |
|---|---|---|---|
| dispensing system, Methanol vehicles worldwide, Methanol combustions and emissions. | | | |
| Applications | Application of Methanol for fuel cells. | | |
| Text Book | Text Book 2: 1.9, 10.176 | | |
| **MODULE-4** | **ETHANOL AND BUTANOL FUEL** | **24MEE363.4<br>24MEE363.5<br>24MEE363.6** | **3 Hours** |
| Ethanol – Introduction, history, Properties and Production of ethanol, dry milling process, second generation bio-ethanol, Material compatibility of ethanol, storage, Transportation and Dispensing of ethanol, Piping for ethanol, advantages and disadvantages, health and environmental effects of Ethanol. Ethanol diesel blends (E-diesel), Ethanol gasoline blends (gasohol), Engine modifications for ethanol Combustions of ethanol, Emissions from ethanol, Flex fuel vehicles with ethanol, Standards for ethanol. Butanol - Introduction, history, Production and of Butanol, Butanol as an automotive fuel, Advantages and disadvantages of butanol, Storage and material compatibility and Health hazards of butanol. | | | |
| Self-study / Case Study | Study on Ethanol vehicles worldwide, Ethanol worldwide Scenario, Ethanol Scenario in India. | | |
| Text Book | Text Book 2: 11.185, 12.204 | | |
| **MODULE-5** | **STRAIGHT VEGETABLE OIL (SVO) AND BIODIESEL** | **24MEE363.4<br>24MEE363.5<br>24MEE363.6** | **3 Hours** |
| Straight Vegetable Oil (SVO) - Introduction, Feedstock selection and iodine value for SVO, history of SVO, SVO as diesel engine fuel, Properties and production of SVO, SVO from algae, Degumming, Storage, Dispensing, Material compatibility, advantages and disadvantages of SVO, SVO engine modifications, SVO fuel kits, SVO twin tank or dual fuel system, SVO fuel treatment and combustion. Emissions from SVO vehicles, SVO standards. Biodiesel - Introduction, history and biodiesel feedstock selection, raw materials for biodiesel production, Biodiesel production. Properties, storage, dispensing, material compatibility, standards, transportation, advantages and disadvantages and hazards of biodiesel. Second generation biodiesel, Engine modifications for biodiesel, Biodiesel combustion and emissions and Biodiesel vehicles. | | | |
| Self-study / Case Study | Study on SVO vehicles worldwide and SVO Scenario in India.<br>Case study on Ethanol Scenario in India. | | |
| Text Book | Text Book 2: 13.209, 14.229 | | |

**CIE Assessment Pattern (50 Marks – Theory) –**

| RBT Levels | | Marks Distribution | | |
|---|---|---|---|---|
| | | Test (s) | AAT1 | AAT2 |
| | | 25 | 15 | 10 |
| L1 | Remember | 5 | - | - |
| L2 | Understand | 5 | 5 | - |
| L3 | Apply | 10 | 5 | 5 |
| L4 | Analyze | 5 | 5 | 5 |
| L5 | Evaluate | - | - | - |
| L6 | Create | - | - | - |

**SEE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| L1 | Remember | 10 |
| L2 | Understand | 10 |
| L3 | Apply | 10 |
| L4 | Analyze | 10 |
| L5 | Evaluate | 10 |
| L6 | Create | -- |

**Suggested Learning Resources:**

**Text Books:**

1) Non-Conventional Energy Sources, G.D.Rai, Khanna Publishers, ISBN.: 81.7409-073-8.
2) Alternative Fuels – Concepts, Technologies and Developments, S.S.Thipse, JAICO Publishing house, ISBN :978-81-8495-078-6

**Reference Books:**

1) Fuels and Combustion, Samir Sarkar, Universities Press,Third Edition 2009, Reprinted 2010, ISBN-13: 978-0070647763

2)Biodiesel – A Realistic Fuel Alternative for Diesel Engines, Ayhan Demirbas, Springer International Edition, Reprint 2012. ISBN-13: 978-0582068025

**Web links and Video Lectures (e-Resources):**

- **https://www.youtube.com/watch?v=H1hrkC--dto**
- **https://www.youtube.com/watch?v=ymCQWxwatuk**
- **https://www.youtube.com/watch?v=rjbq_Q0yEbo**
- **https://www.youtube.com/watch?v=xnr70DQVHr8**
- **https://www.youtube.com/watch?v=HCBa7te1thk**

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Visit to fuel preparation and testing industry
- Video demonstration of latest trends in fuel preparation and testing technologies
- Contents related activities (Activity-based discussions)
  - For active participation of students, instruct the students to collect fuel preparation and testing technologies.
  - Organizing Group wise discussions on issues in fuel preparation and testing technologies.
  - Seminars

## INSTRUMENTATION IN THERMAL ENGINEERING

| | | | |
|---|---|---|---|
| **Course Code** | **24MEE364** | **CIE Marks** | **50** |
| **L:T:P:S** | **1:0:0:0** | **SEE Marks** | **50** |
| **Hrs / Week** | **01** | **Total Marks** | **100** |
| **Credits** | **01** | **Exam Hours** | **03** |

**Course outcomes:**

At the end of the course, the student will be able to:

| | |
|---|---|
| 24MEE364.1 | Understand the thermal engineering measuring devices, utilization of computers in measurement applications and advanced measuring systems. |
| 24MEE364.2 | Analyze Instrumentation related to thermal system |
| 24MEE364.3 | Apply general concept of measurement, statistical analysis of experimental data and performance analysis of a measuring system |
| 24MEE364.4 | Evaluate given experimental requirement and recommend a correct measurement procedure and device pertaining to kinetic and thermo-physical measurement4.Understand the integration of digital to analog way of measurement |
| 24MEE364.5 | Develop skills to analyze and interpret measurement data, understanding its significance in the context of thermal engineering applications. |
| 24MEE364.6 | Design and implement instrumentation systems for monitoring and controlling thermal processes, ensuring efficient and reliable operation. |

**Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24MEE364.1 | 3 | 1 | 1 | - | - | - | - | - | - | - | - | 1 | 2 |
| 24MEE364.2 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 1 | 2 |
| 24MEE364.3 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 1 | 2 |
| 24MEE364.4 | 3 | 3 | 2 | - | - | - | - | - | - | - | - | 1 | 2 |
| 24MEE364.5 | 3 | 3 | 2 | - | - | - | - | - | - | - | - | 1 | 2 |
| 24MEE364.6 | 3 | 3 | 2 | - | - | - | - | - | - | - | - | 1 | 2 |

| | | | |
|---|---|---|---|
| **MODULE-1** | **MEASUREMENT CHARACTERISTICS** | **24MEE364.1<br>24MEE364.4<br>24MEE364.6** | **3 Hours** |

Instrument Classification, Characteristics of Instruments – Static and dynamic, experimental error analysis, Systematic and random errors, Statistical analysis, Uncertainty, Experimental planning and selection of measuring instruments, Reliability of instruments.

| | |
|---|---|
| Case Study | Case Studies on Performance and emission characteristics of IC engine |
| Text Book | Text Book 1: 1.1,1.2,1.3 |

| | | | |
|---|---|---|---|
| **MODULE-2** | **MEASUREMENT OF PHYSICAL QUANTITIES** | **24MEE364.2** | **3 Hours** |

Measurement of thermo-physical properties, instruments for measuring temperature, pressure and flow, use of sensors for physical variables.

| | |
|---|---|
| Applications | Investigate the applications of air standard cycles and Rankine cycle |
| Text Book | Text Book 1: 2.1,2.2,2.3 |

| | | | |
|---|---|---|---|
| **MODULE-3** | **MICROPROCESSORS AND COMPUTERS IN MEASUREMENT** | **24MEE364.3<br>24MEE364.4<br>24MEE364.6** | **3 Hours** |

| | | | |
|---|---|---|---|
| Data logging and acquisition – use of sensors for error reduction, elements of microcomputer interfacing, intelligent instruments in use. | | | |
| Applications | Analyze the Applications of gas turbine cycles | | |
| Text Book | Text Book 1: 3.1,3.2,3.3 | | |
| **MODULE-4** | **MEASURING DEVICES AND INSTRUMENDATION** | **24MEE364.5 24MEE364.6** | **3 Hours** |
| Thermal expansion method: Liquid-in-glass thermometer, pressure thermometer, bimetal type thermometer. Resistance Thermometer: RTD, Thermistor. Thermocouple, quartz thermometer, radiation thermometer. Boiler power plant instrumentation, air conditioning plant control, industrial robotics system | | | |
| Case Study/Applications | Case study and practical applications of reversed Carnot cycle, vapor absorption cycles | | |
| Text Book | Text Book 2: 5.1,5.2,5.3,5.4 | | |
| **MODULE-5** | **ADVANCE MEASUREMENT TECHNIQUES** | **24MEE364.5 24MEE364.6** | **3 Hours** |
| Shadowgraph, Schlieren, Interferometer, Laser Doppler Anemometer, Hot wire Anemometer, heat flux sensors, Telemetry in measurement | | | |
| Applications | Investigate the applications of Psychometric Chart | | |
| Text Book | Text Book 1: 8.1,8.2,8.3 | | |

**CIE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Marks Distribution | | |
|---|---|---|---|---|
| | | Test (s) | AAT1 | AAT2 |
| | | 25 | 15 | 10 |
| L1 | Remember | 5 | - | - |
| L2 | Understand | 5 | 5 | - |
| L3 | Apply | 10 | 5 | 5 |
| L4 | Analyze | 5 | 5 | 5 |
| L5 | Evaluate | - | - | - |
| L6 | Create | - | - | - |

**SEE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| L1 | Remember | 10 |
| L2 | Understand | 10 |
| L3 | Apply | 20 |
| L4 | Analyze | 10 |
| L5 | Evaluate | -- |
| L6 | Create | -- |

**Suggested Learning Resources:**

**Text Books:**

1. Holman J.P., Experimental methods for engineers, 7 edition (1 July 2017) McGraw-Hill, ISBN-13: 978-0070647763
2. Bolton.W, Industrial Control & Instrumentation, Universities Press, Second Edition, 2001, ISBN-13: 978-0582068025

**Reference Books:**

1. Intelligent Instrumentation, Prentice Hall of India, 1988, ISBN-13: 978-0134682167
2. Nakra, B.C., Choudhry K.K., Instrumentation, Measurements and Analysis Tata McGraw Hill, New Delhi, Fourth edition (1 August 2016), ISBN-13: 978-9385880629
3. John G Webster, The measurement, Instrumentation and sensors Handbook, CRC and IEE Press, 2008. ISBN-13: 978-0849383472

**Web links and Video Lectures (e-Resources)**

- **https://www.learnthermo.com/T1-tutorial/ch01/lesson-A/pg01.php**
- **http://www.freeonlinecoursesforall.com/2017/01/01/10-free-online-courses-on-thermodynamics/**
- **https://archive.nptel.ac.in/courses/112/105/112105123/**
- **http://www.digimat.in/nptel/courses/video/112105123/L13.html**

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Thermocouple Calibration and Temperature Measurement
- Pressure Measurement Using Bourdon Tube and Manometer
- Video demonstration on Temperature Measuring Instruments
- Contents related activities (Activity-based discussions)
  - For active participation of students, instruct the students to prepare thermodynamics related Flowcharts and Handouts
  - Organizing Group wise discussions on issues
  - Seminars

## BIO INSPIRED DESIGN AND INNOVATION

| | | | |
|---|---|---|---|
| **Course Code** | **24MEE365** | **CIE Marks** | **50** |
| **L:T:P:S** | **1:0:0:0** | **SEE Marks** | **50** |
| **Hrs / Week** | **01** | **Total Marks** | **100** |
| **Credits** | **01** | **Exam Hours** | **02** |

**Course outcomes:**
At the end of the course, the student will be able to:

| | |
|---|---|
| 24MEE365.1 | Apply the biomimetics principles for real life challenges |
| 24MEE365.2 | Investigate novel bioengineering initiatives by evaluating design and development principles |
| 24MEE365.3 | Apply the bio computing optimization through research and experiential learning. |
| 24MEE365.4 | Review the fundamental biological ideas through pertinent industrial applications and case studies |

**Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24MEE365.1 | 3 | 3 | 3 | 3 | 2 | - | - | - | 1 | 1 | - | 3 | 3 |
| 24MEE365.2 | 3 | 3 | 3 | 3 | 2 | - | - | - | 1 | 1 | - | 3 | 3 |
| 24MEE365.3 | 3 | 3 | 3 | 3 | 2 | - | - | - | 1 | 1 | - | 3 | 3 |
| 24MEE365.4 | 3 | 3 | 3 | 3 | 2 | - | - | - | 1 | 1 | - | 3 | 3 |

| | | | |
|---|---|---|---|
| **MODULE-1** | **BIO-INSPIRED DESIGN AND ENGINEERING** | **24MEE365.1** | **3 Hours** |

Bio-Inspired Engineering and design, History, Need for Bio-Inspired Designs. Bio inspired Additive manufacturing techniques, (self-healing, self-assembly).

| | |
|---|---|
| Self-study | Investigate the Challenges of Bio inspired design, Compare with traditional areas of science and engineering. |
| Text Book | Text Book 1: 1.2, 1.3, 1.4, 1.13, 1.15, 1.16 |

| | | | |
|---|---|---|---|
| **MODULE-2** | **BIO MATERIALS AND BIO HEALTHCARE DESIGN** | **24MEE365.2** | **3 Hours** |

Biomaterials, Design of Forms- (Hexagonal unit cells, Intrinsic disorder, anisotropy), Bio- Mechanics, Applications of Biomaterials and Bio systems in Health care design (Human Prosthetics, Parasitic, Wasp-Inspired Needle)

| | |
|---|---|
| Case Study | Investigate Bio-Compatible and health care applications. |
| Text Book | Text Book 1: 2.2, 2.3, 2.4 to 2.15 |

| | | | |
|---|---|---|---|
| **MODULE-3** | **BIO SUSTAINABLE DEVELOPMENT** | **24MEE365.3, 24MEE365.4** | **3 Hours** |

Innovations in Energy (Termite mound inspired shopping malls), Innovations in Resource-Air purification, filtration), Dew water collection systems, water purification, desalination.

| | |
|---|---|
| Self-study / Case Study / Applications | Explore the Bio inspired environmental constructions and development. |
| Text Book | Text Book 2: 3.1, 3.3, 3.5, 3.7, 3.10 |

| | | | |
|---|---|---|---|
| **MODULE-4** | **BIO COMPUTING AND OPTIMISATION** | **24MEE365.5** | **3 Hours** |

No Free Lunch Theorem, Bat Algorithm, Flower Pollination Algorithm, Genetic Algorithm, Ant Colony Optimisation (ACO), Swam Intelligence- Particle Swam Optimisation (PSO).

| | |
|---|---|
| Self-study | Scrutinize the Different types of Optimization techniques, genetic research. |
| Text Book | Text Book 1: 6.1, 6.3, 6.5, 6.7, Text Book 2: 10.1, 10.3, 10.5, 10.7 |

| | | | |
|---|---|---|---|
| **MODULE-5** | **APPLICATIONS OF BIO-INSPIRED INNOVATIONS** | **24MEE365.6** | **3 Hours** |

| | |
|---|---|
| Bioinspired innovations in– Automotive, Automation, Materials and Manufacturing, Carbon Neutral Solutions (Coral Reefs, Eco-cements), Carbon Free Solutions (Lotus leaf inspired paints), Eco-restorations (Eco-friendly pesticide). | |
| Case Study | Survey on Bio inspired Innovations, design, applications and case studies of the same. |
| Text Book | Text Book 2: 12.1 to 12.10 |

**CIE Assessment Pattern (50 Marks – Theory) –**

| RBT Levels | | Marks Distribution | | |
|---|---|---|---|---|
| | | Test (s) | AAT1 | AAT2 |
| | | 25 | 15 | 10 |
| L1 | Remember | 5 | - | - |
| L2 | Understand | 5 | - | - |
| L3 | Apply | 5 | 5 | 5 |
| L4 | Analyze | 5 | 5 | 5 |
| L5 | Evaluate | 5 | 5 | - |
| L6 | Create | - | - | - |

**SEE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| L1 | Remember | 10 |
| L2 | Understand | 10 |
| L3 | Apply | 10 |
| L4 | Analyze | 10 |
| L5 | Evaluate | 10 |
| L6 | Create | -- |

**Suggested Learning Resources:**

**Text Books:**


1) Helena Hashemi Farzaneh, Udo Lindemann, "A Practical Guide to Bio-inspired Design", Springer Vieweg, 1st edition 2019, ISBN-10 : 366257683X, ISBN-13 : 978-3662576830
2) Torben A. Lenau, Akhlesh Lakhtakia," Biologically Inspired Design: A Primer (Synthesis Lectures on Engineering, Science, and Technology)", Publisher: Morgan & Claypool Publishers, 2021, ISBN-10: 1636390471, ISBN-13: 978-1636390475


**Reference Books:**


1) French M, "Invention and evolution: Design in nature and engineering", Publisher: Cambridge University
Press, 2020
2) Pan L., Pang S., Song T. and Gong F. eds, "Bio-Inspired Computing: Theories and Applications", 15th International Conference, BIC-TA 2020, Qingdao, China, October 23-25, 2020, Revised Selected Papers (Vol. 1363). Springer Nature, 2021
3) Wann D, "Bio Logic: Designing with nature to protect the environment", Wiley Publisher, 1994


**Web links and Video Lectures (e-Resources) :**

- https://onlinecourses.nptel.ac.in/noc22_ge24/preview
- https://biodesign.berkeley.edu/bioinspired-design-course/
- https://nsf-gov-resources.nsf.gov/2023-03/Bio-inspired%20Design%20Workshop%20Report_2232327_October%202022_Final.508.pdf

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Bio Materials printing using 3D Printing
- Flipped class room
- Organizing Group wise discussions on sub topics
- Student presentations

## UNIVERSAL HUMAN VALUES AND LIFE SKILLS

| | | | |
|---|---|---|---|
| **Course Code** | **24UHK37** | **CIE Marks** | **50** |
| **L:T:P:S** | **1:0:0:0** | **SEE Marks** | **50** |
| **Hrs / Week** | **2** | **Total Marks** | **100** |
| **Credits** | **01** | **Exam Hours** | **02** |

**Course outcomes:**

At the end of the course, the student will be able to:

| | |
|---|---|
| 24UHK37 | Understand the concept and significance of life skills and universal human values. |
| 24UHK37 | Develop Self-awareness and Self-management skills to promote personal growth. |
| 24UHK37 | Apply Critical and Creative thinking and ethical decision-making skills in various contexts. |
| 24UHK37 | Promote teamwork and collaboration while respecting diversity and inclusivity. |

**Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24UHK37 | - | - | - | - | - | 3 | 1 | 2 | - | 2 | 2 | - | 1 |
| 24UHK37 | - | - | - | - | - | 1 | 2 | 3 | 1 | 2 | 3 | - | 1 |
| 24UHK37 | - | - | - | - | - | 3 | 1 | 2 | 1 | 3 | 2 | - | 1 |
| 24UHK37 | - | - | - | - | - | 2 | 2 | 3 | 2 | 2 | 1 | - | 1 |

| | | | |
|---|---|---|---|
| **MODULE-1** | **Self-Awareness and Self-Management** | **24UHK37.1 24UHK37.2** | **3 Hours** |

Emotional Intelligence, Techniques of self-awareness: SWOT and JOHARI WINDOWS, Stress management and coming out of comfort zone, managing failure, Time Management to recalibrate priorities.
Self-Exploration as a process of Value Education, the basic human Aspirations: Prosperity and Happiness, understanding infatuation.

| | |
|---|---|
| Self-study / Role play | Understand qualities of Role Models, explore self and do SWOT analysis for growth; participate in role play and presentations to come out of comfort zone |

| | | | |
|---|---|---|---|
| **MODULE-2** | **Towards Yourself** | **24UHK37.3** | **3 Hours** |

Exploring opportunities, understanding expectations and self for right fitment in profession, Goal Setting - Personal and Professional, aligning Personal and Professional goals for greater achievement, Mind-Maps as a tool for Goal Setting

| | |
|---|---|
| Self-study / Mind Maps | Understand industry expectations to set professional goals; realizing connection between personal and professional goals for peaceful living |

| | | | |
|---|---|---|---|
| **MODULE-3** | **Leading self to lead others** | **24UHK37.3, 24UHK37.4** | **3 Hours** |

Quality analysis of leader and self-evaluation, Critical thinking, Creative thinking and Ethical decision making, Critical thinking and Creative thinking for contribution to technical world, Six thinking hats, Exploring ethical decision-making frameworks and principles.

| | |
|---|---|
| Case study | Case studies for Critical thinking and activities for Creative thinking |

| | | | |
|---|---|---|---|
| **MODULE-4** | **Ownership towards Family and Society** | **24UHK37.2, 24UHK37.3 24UHK37.4** | **3 Hours** |

Responsibility, Diversity and Inclusivity:
Understanding personal and social responsibility; Appreciating diversity and managing inclusivity, promoting teamwork and collaboration while respecting differences.

| | |
|---|---|
| Self-study / | Working on Task bar; team building activities; Interviewing Corporate experts to |

| | | | |
|---|---|---|---|
| Interview with corporate people | understand expectations | | |
| **MODULE-5** | **Towards Nature and Industry** | **24UHK37.3, 24UHK37.4** | **3 Hours** |

Personal code of conduct for harmony between self and nature, resisting external pressures, negotiation and conflict resolution, assertiveness and empathy, change management

| | |
|---|---|
| Role play | Role play to understand contributions to nature and industry. |

**CIE Assessment Pattern (50 Marks – Theory) –**

| RBT Levels | | Marks Distribution | | |
|---|---|---|---|---|
| | | Test (s) | AAT1 | AAT2 |
| | | 25 | 15 | 10 |
| L1 | Remember | - | - | - |
| L2 | Understand | 5 | - | 5 |
| L3 | Apply | 10 | 5 | 5 |
| L4 | Analyze | 10 | 5 | - |
| L5 | Evaluate | - | 5 | - |
| L6 | Create | - | - | - |

**SEE Assessment Pattern (50 Marks – Group Discussion)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| L1 | Remember | 10 |
| L2 | Understand | 10 |
| L3 | Apply | 20 |
| L4 | Analyze | 10 |
| L5 | Evaluate | -- |
| L6 | Create | -- |

**Suggested Learning Resources:**

**REFERENCE BOOKS:**


1. The 7 Habits of Highly Effective People, Stephen R Covey, Neha publishers.
2. Seven Habits of Highly Effective Teens, Convey Sean, New York, Fireside Publishers, 1998.
3. Emotional Intelligence, Daniel Coleman, Bantam Book, 2006.
4. How to win friends and influence people, Dale Carnegie.
5. BHAGAVADGITA for college students, Sandeepa Guntreddy.


**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Conduct interviews with HR personnel of corporates to understand expectations in terms of Soft Skills and Values
- Participate in role plays and presentations to come out of comfort zone
- Talk to industry people to understand opportunities available
- Make a short movie to display creativity
- Use Mind maps to plan successful completion of semester
- Actively participate in Group Discussions and JAM sessions

## BASIC APPLIED MATHEMATICS-I

| | | | |
|---|---|---|---|
| **Course Code** | **24DMAT31** | **CIE Marks** | **50** |
| **L:T:P:S** | **0:0:0:0** | **SEE Marks** | **--** |
| **Hrs. / Week** | **2** | **Total Marks** | **50** |
| **Credits** | **0** | **Exam Hours** | **--** |

**Course outcomes:**
At the end of the course, the student will be able to:

| | |
|---|---|
| 24DMAT31.1 | Know the principles of engineering mathematics through calculus |
| 24DMAT31.2 | Determine the power series expansion of a function |
| 24DMAT31.3 | Find the definite integrals with standard limits and also develop the ability to solve different types of differential equations |
| 24DMAT31.4 | Apply ideas from linear algebra in solving systems of linear equations and determine the Eigen values and Eigen vectors of a matrix |

**Mapping of Course Outcomes to Program Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 24DMAT31.1 | 3 | 3 | - | - | - | - | - | - | - | - | - |
| 24DMAT31.2 | 3 | 3 | - | - | - | - | - | - | - | - | - |
| 24DMAT31.3 | 3 | 3 | - | - | - | - | - | - | - | - | - |
| 24DMAT31.4 | 3 | 3 | - | - | - | - | - | - | - | - | - |

| | | | |
|---|---|---|---|
| **MODULE-1** | **DIFFERENTIAL CALCULUS** | 24DMAT31.1<br>24DMAT31.2 | **8 Hours** |
| Polar Curves-Problems on angle between the radius vector and tangent, Angle between two curves-Problems, Pedal equation for polar curves-Problems. Maclaurin's theorem for function of one variable (statement only)-Problems. | | | |
| Text Book | Text Book 1: 4.4, 4.7, 4.8, Text Book 2: 15.4 | | |
| **MODULE-2** | **PARTIAL DIFFERENTIATION** | 24DMAT31.1 | **8 Hours** |
| Definition and Simple problems, Euler's theorem for Homogeneous function (NO Derivation and NO extended theorem)-Problems, Jacobians of order two - definition and problems. | | | |
| Text Book | Text Book 1: 5.4, 5.7, | | |
| **MODULE-3** | **INTEGRAL CALCULUS AND DIFFERENTIAL EQUATIONS** | 24DMAT31.3 | **8 Hours** |
| Problems on evaluation of sin n x and cos n x integrals with standard limits (0 to $\pi/2$). Solution of first order and first-degree differential equations-Variable separable, Linear and Exact differential equations. | | | |
| Text Book | Text Book 1: 6.2, 11.6, 11.9, 11.11, Text Book 2: 1.3, 1.4, 1.5 | | |
| **MODULE-4** | **LINEAR ALGEBRA-1** | 24DMAT31.4 | **8 Hours** |
| Problems on rank of a matrix by elementary transformations, Solution of system of linear equations by Gauss elimination method-Problems. | | | |
| Text Book | Text Book 1: 2.7, 28.6, Text Book 2: 7.3, 7.4 | | |
| **MODULE-5** | **LINEAR ALGEBRA-2** | 24DMAT31.4 | **8 Hours** |
| Linear transformation, Eigen values and Eigen Vectors of square matrix-Problems. | | | |
| Text Book | Text Book 1: 2.11, 2.13, Text Book 2: 7.9, 8.1. | | |

**CIE Assessment Pattern (50 X 2=100 Marks – Theory)**

| RBT Levels | | Marks Distribution | | |
|---|---|---|---|---|
| | | Theory Tests | AAT1 | AAT2 |
| | | 25 | 15 | 10 |
| L1 | Remember | 5 | - | - |
| L2 | Understand | 5 | 5 | - |
| L3 | Apply | 5 | - | 5 |
| L4 | Analyze | 5 | 5 | 5 |
| L5 | Evaluate | 5 | 5 | - |
| L6 | Create | - | - | - |

**Suggested Learning Resources:**

**Text Books:**


1) B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, Forty fourth Edition, 2022, ISBN: 9788193328491.
2) Erwin Kreyszig, Advanced Engineering Mathematics, Wiley-India Publishers, Tenth Edition, Reprint 2016, ISBN: 9788126554232.


**Reference Books:**


1) Glyn James, Advanced Modern Engineering Mathematics, Pearson Education, Fourth Edition, 2015, ISBN: 9780273719236.
2) B. V. Ramana, Higher Engineering Mathematics, McGraw Hill Education (India) Private Limited, Fourth Edition, 2017, ISBN: 9780070634190.
3) H. K. Dass, Advanced Engineering Mathematics, S. Chand & Company Ltd., Twenty Second Edition, 2018, ISBN: 9789352533831.
4) N.P.Bali and Manish Goyal, A Text Book of Engineering Mathematics, Laxmi Publications (P) Ltd., Ninth Edition, 2014, ISBN: 9788131808320.


**Web links and Video Lectures (e-Resources):**

1)https://youtu.be/IUV0_Nj4d1s?si=eO3s7keCbCO1_jcz
2)https://youtu.be/VzUcs7aiqgg?si=YLtTUGr4Xp88KGY3
3)https://youtu.be/LDBnS4c7YbA?si=udUOdJ-u0ZxFmBAW
4)https://youtu.be/palSdK9P-ns?si=7A8_VSxEI4lGvksB
5)https://youtu.be/Bw5yEqwMjQU?si=jzbklZmVev1w8K2S
6)https://youtu.be/LBqdGn1r_fQ?si=DWcAIiFnosT7zikY
7)https://youtu.be/N5YCGOyTSuU?si=Wsf75V5fkUpfVVxr
8)https://youtu.be/gd1FYn86P0c?si=7drzBEqVFSv6sQeZ
9)https://youtu.be/cSj82GG6MX4?si=4QN1DFXEqaJoUBn7
10)https://youtu.be/0c3yq9btr3A?si=jIoz8eu5TgV7mh8G
11)https://youtu.be/PhfbEr2btGQ?si=HVK1uk65oHph0t8G

**Activity-Based Learning (Suggested Activities in Class)/Practical Based Learning:**

- Contents related activities (Activity-based discussions)
  - Problem solving Approach
  - Organizing Group wise discussions on related topics
  - Seminars

# IV Semester Syllabus

## COMPLEX ANALYSIS AND PROBABILITY

| | | | |
|---|---|---|---|
| **Course Code** | **24MAE41** | **CIE Marks** | **50** |
| **L:T:P:S** | **2:1:0:0** | **SEE Marks** | **50** |
| **Hrs. / Week** | **4** | **Total Marks** | **100** |
| **Credits** | **3** | **Exam Hours** | **3** |

**Course outcomes:**
At the end of the course, the student will be able to:

| | |
|---|---|
| 24MAE41.1 | Solve initial value problems using appropriate numerical methods |
| 24MAE41.2 | Apply the concepts of Complex variables, Transformations and Complex integration to solve Engineering Problems |
| 24MAE41.3 | Demonstrate the idea of Linear Dependence and Independence of sets in the vector space. |
| 24MAE41.4 | Gain ability to use probability distributions to analyze and solve real time problems |
| 24MAE41.5 | Apply the concept of sampling distribution to solve engineering problems and Use the concepts to analyze the data to make decision about the hypothesis |

**Mapping of Course Outcomes to Program Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 24MAE41.1 | 3 | 3 | - | - | - | - | - | - | - | - | - |
| 24MAE41.2 | 3 | 3 | - | - | - | - | - | - | - | - | - |
| 24MAE41.3 | 3 | 3 | - | - | - | - | - | - | - | - | - |
| 24MAE41.4 | 3 | 3 | - | - | - | - | - | - | - | - | - |
| 24MAE41.5 | 3 | 3 | - | - | - | - | - | - | - | - | - |

| | | | |
|---|---|---|---|
| **MODULE-1** | **NUMERICAL SOLUTIONS TO DIFFERENTIAL EQUATIONS** | **24MAE41.1** | **8 Hours** |

Numerical solution of ordinary differential equations of first order and of first degree: Taylor's series method, Modified Euler's method and Runge-Kutta method of fourth-order-Problems. Milne's predictor and corrector methods-Problems. Numerical Solution of second order ordinary differential equations by Runge-Kutta method of fourth-order-Problems.

| | |
|---|---|
| Text Book | Text Book 1: 32.3, 32.5, 32.7, 32.9, 32.12, Text Book 2: 21.1. |

| | | | |
|---|---|---|---|
| **MODULE-2** | **COMPLEX ANALYSIS** | **24MAE41.2** | **8 Hours** |

Functions of complex variables, Analytical functions, Cauchy-Riemann Equations in Cartesian and Polar forms, Harmonic functions and Construction of analytic functions-Problems using Milne-Thompson's method. Applications of Flow Problems-Velocity potential, Stream functions and complex potential functions. Conformal Transformations of $W = z^2$ and $W = e^z$. Cauchy's Theorem (with proof), Generalized Cauchy's integral formula

| | |
|---|---|
| Text Book | Text Book 1: 20.2, 20.4, 20.5, 20.6, 20.10, 20.14, Text Book 2: 13.1, 13.2, 13.3, 13.4. |

| | | | |
|---|---|---|---|
| **MODULE-3** | **VECTOR SPACES AND LINEAR TRANSFORMATIONS** | **24MAE41.3** | **8 Hours** |

Vector Space definition and examples, Subspaces and Spanning sets, Linear Dependence and Independence, Linear Independence and Spanning Sets, Bases: Orthogonal and Orthonormal bases and Dimension. Introduction to Linear Transformations and Basic Problems

| | |
|---|---|
| Text Book | Text Book 3: 4.1, 4.2, 4.3, 4.4, 4.5. |

| | | | |
|---|---|---|---|
| **MODULE-4** | **PROBABILITY DISTRIBUTIONS** | **24MAE41.4** | **8 Hours** |

Random variables (discrete and continuous), probability density functions, Discrete Probability distributions: Binomial and Poisson Distributions-Problems. Continuous Probability distributions: Exponential and Normal Distributions-Problems. Joint Probability Distribution-Problems.

| | |
|---|---|
| Text Book | Text Book 1: 26.7, 26.8, 26.9, 26.12, 26.14, 26.15, 26.16. |

| | | | |
|---|---|---|---|
| **MODULE-5** | **SAMPLING THEORY** | **24MAE41.5** | **8 Hours** |

Sampling, Sampling distributions, test of hypothesis of large samples for means and proportions, Inferences for variance and proportion. Central limit theorem (without proof), Confidence limits for means, Student's t-distribution, F-distribution and Chi-Square test for test of goodness of fit for small samples.

| Text Book | Text Book 1: 27.2, 27.3, 27.4, 27.5, 27.6, 27.7, 27.8, 27.9, 27.10, 27.11, 27.12, 27.14, 27.15, 27.16, 27.17, 27.19. |
|---|---|

**List of Tutorial Contents**

| Sl. No. | Contents | COs |
|---|---|---|
| 1. | Use Runge-Kutta method of fourth-order to solve first order and of first-degree ordinary differential equations. | 24MAE41.1 |
| 2. | Use Runge-Kutta method of fourth-order to solve second order ordinary differential equations. | 24MAE41.1 |
| 3. | Applications of Flow Problems-Velocity potential, Stream functions | 24MAE41.2 |
| 4. | Find the images/regions in the w-plane bounded regions under the transformation $W = z^2$. $W = e^z$ | 24MAE41.2 |
| 5. | Use Wronskian to test a set of solutions of a linear homogeneous differential equation for linear independence. | 24MAE41.3 |
| 6. | Usage of linear transformation for scale rotate and manipulate images | 24MAE41.3 |
| 7. | Use of Binomial Distribution in real life problems. | 24MAE41.4 |
| 8. | Use of Normal Distribution in real life problems. | 24MAE41.4 |
| 9. | Use Student's t-distribution to test goodness of fit for small samples. | 24MAE41.5 |
| 10. | Use Chi-square distribution to test goodness of fit for small samples. | 24MAE41.5 |

**CIE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Marks Distribution | | |
|---|---|---|---|---|
| | | Theory Tests | AAT1 | AAT2 |
| | | 25 | 15 | 10 |
| L1 | Remember | 5 | - | - |
| L2 | Understand | 5 | 5 | - |
| L3 | Apply | 5 | - | 5 |
| L4 | Analyze | 5 | 5 | 5 |
| L5 | Evaluate | 5 | 5 | - |
| L6 | Create | - | - | - |

**SEE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| L1 | Remember | 5 |
| L2 | Understand | 10 |
| L3 | Apply | 10 |
| L4 | Analyze | 15 |
| L5 | Evaluate | 10 |
| L6 | Create | - |

**Suggested Learning Resources:**

**Text Books:**


1) B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, Forty fourth Edition, 2022, ISBN: 9788193328491.
2) Erwin Kreyszig, Advanced Engineering Mathematics, Wiley-India Publishers, Tenth Edition, Reprint 2016, ISBN: 9788126554232.
3) David C Lay, Linear Algebra and its applications, Addison-Wesley Publishers, Fourth Edition, 2012, ISBN: 9780321385178.

**Reference Books:**

1) Glyn James, Advanced Modern Engineering Mathematics, Pearson Education, Fourth Edition, 2015, ISBN: 9780273719236.
2) B. V. Ramana, Higher Engineering Mathematics, McGraw Hill Education (India) Private Limited, Fourth Edition, 2017, ISBN: 9780070634190.
3) H. K. Dass, Advanced Engineering Mathematics, S. Chand & Company Ltd., Twenty Second Edition, 2018, ISBN: 9789352533831.
4) N.P.Bali and Manish Goyal, A Text Book of Engineering Mathematics, Laxmi Publications (P) Ltd., Ninth Edition, 2014, ISBN: 9788131808320.

**Web links and Video Lectures (e-Resources):**

1)https://youtu.be/4lCiEnuhbA4?si=My95pvqwAMRDfjid
2)https://youtu.be/QQFIWwDA9NM?si=3wJrtlm1NdPSbXmB
3)https://youtu.be/bI46OqXUtd8?si=_Po-jfjq_94X4p_O
4)https://youtu.be/NqZUHJgitHk?si=Y6viSg1DFA4hgM9u
5)https://youtu.be/oPPJNoKYCro?si=A5zWC_vQQaHY7HlQ
6)https://youtu.be/hll0DAilhoA?si=2dN3KfJMBy9ZGxjD
7)https://youtu.be/x6X1P8rGXXs?si=YcmH8nxx1iQwq8mA
8) https://youtu.be/q3xj16shDuw?si=ewdlKAC8UEc6oRQV
9) https://youtu.be/89Z0tOvHjNU?si=3jT-oriJZaC1kSzx
10) https://youtu.be/dOr0NKyD31Q?si=dMBU-BXGdGL6jIZy
11) https://youtu.be/BR1nN8DW2Vg?si=melzz97SqhK3wr--
12)https://youtu.be/z0Ry_3_qhDw?si=6IG2a65BZgdbaKsn
13)https://youtu.be/36cAE1Ovpq4?si=jfR8gkFmMOCkWNZ_
14)https://youtu.be/vFz2FG65HBc?si=SCHi3Y1XuHWg-pPT
15)https://youtu.be/2Dsz1lZBJ3Y?si=8ATLUE-mkJSMewO3

**Activity-Based Learning (Suggested Activities in Class)/Practical Based Learning:**

- Contents related activities (Activity-based discussions)
  - Problem solving Approach
  - Organizing Group wise discussions on related topics
  - Seminars

## ENGINEERING THERMODYNAMICS

| | | | |
|---|---|---|---|
| **Course Code** | **24MEE42** | **CIE Marks** | **50** |
| **L:T:P:S** | **3:0:0:0** | **SEE Marks** | **50** |
| **Hrs / Week** | **03** | **Total Marks** | **100** |
| **Credits** | **03** | **Exam Hours** | **03** |

**Course outcomes:**

At the end of the course, the student will be able to:

| | |
|---|---|
| 24MEE42.1 | Understand basic concepts of thermodynamics like systems, equilibrium, process etc. and its applications |
| 24MEE42.2 | Apply the laws of thermodynamics to solve engineering, problems |
| 24MEE42.3 | Identify the different types of work and heat transfer mechanisms |
| 24MEE42.4 | Analyze reversible and irreversible process using second law and entropy concepts |
| 24MEE42.5 | Apply the quantities used to describe the composition of a gas mixture, such as mass fraction, mole fraction, and volume fraction |
| 24MEE42.6 | Understand the behavior of real gases at various conditions |

**Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24MEE42.1 | 2 | 2 | - | - | - | - | - | - | - | - | - | 1 | 3 |
| 24MEE42.2 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 1 | 3 |
| 24MEE42.3 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 1 | 3 |
| 24MEE42.4 | 3 | 2 | 2 | | - | - | | - | - | - | - | 1 | 3 |
| 24MEE42.5 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 1 | 3 |
| 24MEE42.6 | 2 | 2 | - | - | - | - | - | - | - | - | - | 1 | 3 |

| | | | |
|---|---|---|---|
| **MODULE-1** | **FUNDAMENTAL CONCEPTS & DEFINITIONS** | **24MEE42.1 24MEE42.2** | **8 Hours** |

**Fundamental Concepts & Definitions:** Microscopic and Macroscopic approaches. System and its types, Surroundings, boundary, Thermodynamic properties: definition and units, Intensive and extensive properties, quasi-static process. Thermodynamic equilibrium: definition and conditions, Zeroth law of thermodynamics.
**Temperature:** concept, two-point scales and one-point scale, International fixed points. Temperature measurements, Numerical on temperature scales

| | |
|---|---|
| Applications | Analyze the Practical Applications of zeroth law of thermodynamics and temperature concepts. |
| Text Book | Text Book 1: 1.1, 1.2, 1.3, 1.4,1.5, 2.1,2.2, 2.3 Text Book 2: 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, |

| | | | |
|---|---|---|---|
| **MODULE-2** | **WORK AND HEAT AND FIRST LAW OF THERMODYNAMICS:** | **24MEE42.1 24MEE42.2 24MEE42.3** | **8 Hours** |

**Work and Heat:** Mechanics definition of work and its limitations. Thermodynamic definition of work; examples, sign convention. Displacement work explanation, expressions for displacement work in various processes through p-V diagrams, Problems on work transfer and heat transfer.
**First Law of Thermodynamics:** Joules experiment, equivalence of heat and work. Statement of the First law of thermodynamics, Internal energy, prove energy is a property of the system, steady state-steady flow energy equation, Assumptions for SFEE and some important applications. Numerical on open and closed systems

| | |
|---|---|
| Applications | Investigate the applications of steady flow energy equation |
| Text Book | Text Book 1: 3.1, 3.2, 3.5, 3.6 , 4.1, 4.2, 4.3 , 5.1, 5.2 Text Book 2: 2.1, 2.2, 2.3, 3.1, 3.2, 3.3 |

| | | | |
|---|---|---|---|
| **MODULE-3** | **SECOND LAW OF THERMODYNAMICS:** | **24MEE42.2 24MEE42.4** | **8 Hours** |

**Second Law of Thermodynamics:** Thermal reservoirs. Direct heat engine; schematic representation and efficiency. Reversed heat engine, schematic representation, coefficients of performance. Kelvin - Planck and Clausius statement; PMM I and PMM II, Equivalence of the two statements; Reversible and irreversible processes; factors that make a process irreversible, reversible heat engines, Carnot cycle, Numerical

| | |
|---|---|
| Applications | Analyze the Application of second law of thermodynamics |
| Text Book | Text Book 1: 6.3, 6.4, 6.5, 6.6, 6.7, 6.8 Text Book 2: 4.1, 4.2, 4.3, 4.4, 4.5, 4.6 |

| | | | |
|---|---|---|---|
| **MODULE-4** | **ENTROPY AND PURE SUBSTANCES** | **24MEE42.4** | **8 Hours** |

**Entropy:** Clausius theorem, Clausius inequality; Statement, proof, application to a reversible cycle. Entropy; definition, a property, change of entropy for irreversible process, principle of increase in entropy of the universe, entropy as a quantitative test for irreversibility, Numerical

**Pure Substances:** P-T and P-V diagrams, triple point and critical points. Sub cooled liquid, saturated liquid, mixture of saturated liquid and vapour, saturated vapour and superheated vapour states of pure substance with water as example. Enthalpy of change of phase (Latent heat). Dryness fraction (quality), T-S and H-S diagrams, Numerical.

| | |
|---|---|
| Case Study/Applications | Case study and practical applications of Entropy and pure substance concepts |
| Text Book | Text Book 1: 7.4, 7.6, 7.7, 7.8, 9.1, 9.2, 9.7 Text Book 2: 5.1, 5.6, 5.7, 5.8, 7.1, 7.2, 7.3 |

| | | | |
|---|---|---|---|
| **MODULE-5** | **IDEAL GAS MIXTURES AND REAL GASES** | **24MEE42.5 24MEE42.6** | **8 Hours** |

**Ideal gas mixtures:** Ideal gas mixture; Dalton's laws of partial pressures, Amagat's law of additive volumes, evaluation of mass fractions, mole fractions, Expressions for $C_P$,$C_V$ and Gas constant of the mixture. Numerical on mixtures.

**Real Gases:** Introduction. Van-der Waal's Equation of state, Van-der Waal's constants in terms of critical properties, Law of corresponding states, compressibility factor; compressibility chart. Numerical on real gases.

| | |
|---|---|
| Applications | Investigate the applications of Ideal and Real gas mixtures |
| Text Book | Text Book 1: 10.1,10.2,10.3, 10.4, 10.5 Text Book 2: 8.1, 8.2, 8.3, 8.5. |

**CIE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Marks Distribution | | |
|---|---|---|---|---|
| | | Test (s) | AAT1 | AAT2 |
| | | 25 | 15 | 10 |
| L1 | Remember | 5 | - | - |
| L2 | Understand | 5 | 5 | - |
| L3 | Apply | 10 | 5 | 5 |
| L4 | Analyze | 5 | 5 | 5 |
| L5 | Evaluate | - | - | - |
| L6 | Create | - | - | - |

**SEE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| L1 | Remember | 10 |
| L2 | Understand | 10 |
| L3 | Apply | 20 |
| L4 | Analyze | 10 |
| L5 | Evaluate | -- |
| L6 | Create | -- |

**Suggested Learning Resources:**

**Text Books:**

1) Basic and Applied Thermodynamics, P.K.Nag, Tata McGraw Hill Publication, 2nd edition, 2017, ISBN: 9780070151314.
2) Basic Thermodynamics, B.K Venkanna, Swati B. Wadavadagi, PHI Learning Private Limited, 2020, ISBN 13 – 9788120341128.

**Reference Books:**

1) Fundamentals of Engineering Thermodynamics, Moran J Shapiro., John wiley Pub.2015, ISBN – 9780470032091.

2)Thermodynamics, An Engineering Approach, YunusA.Cenegal and Michael A.Boles, Tata McGraw Hill publications, 2016, ISBN – 9780073305370

3) Fundamentals of Thermodynamics, Claus Borgnakke, Richard Edwin Sonntag, 8th Edition,WILEY, ISBN – 9781306947732, 2012

**Web links and Video Lectures (e-Resources)**

- **https://www.learnthermo.com/T1-tutorial/ch01/lesson-A/pg01.php**
- **http://www.freeonlinecoursesforall.com/2017/01/01/10-free-online-courses-on-thermodynamics/**
- **https://archive.nptel.ac.in/courses/112/105/112105123/**
- **http://www.digimat.in/nptel/courses/video/112105123/L13.html**

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Visit to any Thermal power plant
- Demonstration of working of IC engine/refrigerator
- Video demonstration on Laws of thermodynamics
- Contents related activities (Activity-based discussions)
  - For active participation of students, instruct the students to prepare thermodynamics related Flowcharts and Handouts
  - Organizing Group wise discussions on issues
  - Seminars

## ENGINEERING THERMODYNAMICS LAB

| | | | |
|---|---|---|---|
| **Course Code** | **24MEL42** | **CIE Marks** | **50** |
| **L:T:P:S** | **0:0:1:0** | **SEE Marks** | **50** |
| **Hrs / Week** | **02** | **Total Marks** | **100** |
| **Credits** | **01** | **Exam Hours** | **03** |

**Course outcomes:**

At the end of the course, the student will be able to:

| | |
|---|---|
| 24MEL42.1 | Conduct tests to determine the properties of fuels and oils |
| 24MEL42.2 | Analyze the area of irregular and regular surfaces using planimeter |
| 24MEL42.3 | Investigate the viscosity of given liquid using different viscometers. |
| 24MEL42.4 | Determine the Calorific value of solid, liquid and gaseous fuels and cloud point, pour point of the given sample |

**Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24MEL42.1 | 3 | 3 | 2 | - | - | - | - | - | - | - | - | 3 | 2 |
| 24MEL42.2 | 3 | 3 | 2 | 1 | - | - | - | - | - | - | - | 3 | 2 |
| 24MEL42.3 | 3 | 3 | 2 | 1 | - | - | - | - | - | - | - | 3 | 2 |
| 24MEL42.4 | 2 | 1 | - | - | - | - | - | - | - | - | - | 3 | 2 |

| Exp. No. | List of Experiments | Hours | COs |
|---|---|---|---|
| | **Prerequisite Experiments / Demo** | | |
| | • Understand the properties of fluids<br>• Demonstration on working of 2-stroke engine and 4-stroke engine. | 2 | NA |
| | **PART-A** | | |
| 1 | Determination flash point and fire point using Abel's Apparatus | 2 | 24MEL42.1 |
| 2 | Determination flash point and fire point using Pensky Marten's Apparatus | 2 | 24MEL42.1 |
| 3 | Determination flash point and fire point using Cleveland's Apparatus | 2 | 24MEL42.1 |
| 4 | Determination of area of irregular surface using Planimeter | 2 | 24MEL42.2 |
| 5 | Determination of Calorific value of solid and liquid fuels | 2 | 24MEL42.4 |
| 6 | Determination of Calorific value of gaseous fuels | 2 | 24MEL42.4 |
| | **PART-B** | | |
| 7 | Determination of viscosity of given lubricating oil using Saybolt Viscometer. | 2 | 24MEL42.1, 24MEL42.3 |
| 8 | Determination of viscosity of given lubricating oil using Redwood Viscometer. | 2 | 24MEL42.1, 24MEL42.3 |
| 9 | Determination of viscosity of given lubricating oil using Torsion Viscometer. | 2 | 24MEL42.1, 24MEL42.3 |
| 10 | Determination of cloud point of the given sample | 2 | 24MEL42.4 |
| 11 | Determination of Pour point of the given sample | 2 | 24MEL42.4 |
| 12 | Determination of property values for common refrigerants using tables | 2 | 24MEL42.4 |

## PART-C
## Beyond Syllabus Virtual Lab Content
## (To be done during Lab but not to be included for CIE or SEE)

- http://htv-au.vlabs.ac.in/heat-thermodynamics/Thermo_Couple_Seebeck_Effect/
- http://htv-au.vlabs.ac.in/heat-thermodynamics/Characteristics_of_Thermistor/
- http://vlabs.iitkgp.ernet.in/rtvlas/#
- https://mv-iitkgp.vlabs.ac.in/exp/assmann-psychrometer/

**CIE Assessment Pattern (50 Marks – Lab)**

| RBT Levels | | Test (s) | Weekly Assessment |
|---|---|---|---|
| | | 20 | 30 |
| L1 | Remember | - | - |
| L2 | Understand | 5 | 10 |
| L3 | Apply | 10 | 10 |
| L4 | Analyze | 5 | 10 |
| L5 | Evaluate | - | - |
| L6 | Create | - | - |

**SEE Assessment Pattern (50 Marks – Lab)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| L1 | Remember | - |
| L2 | Understand | 10 |
| L3 | Apply | 20 |
| L4 | Analyze | 20 |
| L5 | Evaluate | - |
| L6 | Create | - |

**Suggested Learning Resources:**

**Reference Books:**

1) Engineering Thermodynamics, P.K.Nag, Tata McGraw Hill Publication, 6th edition, 2017, ISBN: 9789352606429

2) Engineering Thermodynamics, R.K Rajput, Lakshmi Publications , 2019, ISBN 9788131800584.2016.

## MANUFACTURING TECHNOLOGY

| | | | |
|---|---|---|---|
| **Course Code** | **24MEE43** | **CIE Marks** | **50** |
| **L:T:P:S** | **3:0:0:0** | **SEE Marks** | **50** |
| **Hrs / Week** | **03** | **Total Marks** | **100** |
| **Credits** | **03** | **Exam Hours** | **03** |

**Course outcomes:**
At the end of the course, the student will be able to:

| | |
|---|---|
| 24MEE43.1 | Understand the selection of suitable moulding and casting processes |
| 24MEE43.2 | Apply various concepts of forging and joining techniques for required materials. |
| 24MEE43.3 | Analyze the tool life and tool failure during machining process |
| 24MEE43.4 | Select the appropriate machine tools and machining operations to manufacture the components |
| 24MEE43.5 | Apply Indexing the number of divisions on the work using various indexing techniques during gear cutting operations |
| 24MEE43.6 | Investigate on special Moulding processes & Machines |

**Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24MEE43.1 | 2 | 2 | - | - | - | - | - | - | - | - | - | 2 | 2 |
| 24MEE43.2 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 2 | 2 |
| 24MEE43.3 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 2 | 2 |
| 24MEE43.4 | 2 | 2 | 1 | - | - | - | - | - | - | - | - | 2 | 2 |
| 24MEE43.5 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 2 | 2 |
| 24MEE43.6 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 2 | 2 |

| **MODULE-1** | **CASTING & MOULDING TECHNOLOGY** | **24MEE43.1** | **8 Hours** |
|---|---|---|---|

Casting by Moulding sand: Introduction to Casting process & steps involved. Mixture ingredients for different sand mixtures. Method used for sand moulding, such as Greensand, dry sand and skin dried moulds.
Patterns & Cores: Definition, Need, Types, Material. Method of making patterns, cores, Binders & additives used in sand moulding. Concept of Gating &Risers: Principle and types.
Casting defects: Types & methods to avoid

| | |
|---|---|
| Self-study / Case Study | Make a typical pattern by suitable software supported tool. |
| Text Book | Text Book 1: chapter1.1,1.2,2.1,2.2,2.3,2.4,2.5,2.6 |

| **MODULE-2** | **SPECIAL MOULDING PROCESSES** | **24MEE43.2** | **8 Hours** |
|---|---|---|---|

Special moulding Process: Study of important moulding processes, No bake moulds, Flask less moulds, Sweep mould, CO2 mould, Shell mould, Investment mould. Metal moulds: Gravity die-casting, Pressure die casting, Centrifugal casting, Squeeze Casting, Slush casting, Thixo-casting and Continuous Casting Processes. Moulding Machines: Jolt type, Squeeze type, Jolt & Squeeze type and Sand slinger, classifications of Melting Furnaces.

| | |
|---|---|
| Self-study / Case Study | Make a typical Sand/Metal mould by suitable moulding machine. |
| Text Book | Text Book 1: chapter3.11, 3.13, 5.2 |

| **MODULE-3** | **MACHINES FOR MANUFACTURING** | **24MEE43.3, 24MEE43.4** | **8 Hours** |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Theory of metal cutting: Single point cutting tool nomenclature, types of metal cutting, Mechanism of chip formation, types of chips. Tool wear and tool failure, tool life. Effects of cutting parameters on tool life. Tool failure criteria, Taylors tool life equations, numericals on tool life.<br>Turning (lathe): classifications, Work holding devices, constructional features of turret and capstan lathe, tool layout.<br>Milling machines: classification,, constructional features, milling cutters nomenclature, milling operations, up milling and down milling concept. Various milling operations, Indexing: simple, compound, differential and angular indexing calculations<br>Drilling machine: classification, constructional features, drilling & related operations. Types of drill & drill bit nomenclature, drill materials, reaming, boring, tapping | | | |
| Self-study / Case Study | Make a typical work piece using all the Computer Numerical Controlled machining processes. | | |
| Text Book | Text Book 2: Chapters 2.12,2.19,4.5,4.8,4.11,4.12,4.13<br>Text Book 3: Chapters 12.1,12.2,12.6,12.12,12.39,16.2,16.3,16.4,16.15,16.17,16.27,18.4,18.7 | | |
| **MODULE-4** | **WELDING & JOINING TECHNIQUES** | **24MEE43.5** | **8 Hours** |
| Welding process: Principle of welding, classification, application advantages and disadvantages, welding terminology, edge preparation.<br>Arc welding: Arc welding process, Metal arc welding(MAW) or Flux shielded metal arc welding(FSMAW), Tungsten inert gas welding(TIG), Metal inert gas welding(MIG), Submerged arc welding(SAW), Atomic hydrogen welding(AHW).<br>Friction Stir Welding: Types, principle of working Advantages and Applications<br>Soldering and Brazing: Surface cleaning and soldering flux, Types of soldering, advantages and disadvantages, types of brazing, advantages and disadvantages. | | | |
| Self-study / Case Study | Make a typical special welded/brazed model by suitable welding/brazing process. | | |
| Text Book | Text Book 1: chapter 23.1, 23.2, 23.3, 23.4, 23.5, 23.6, 23.7 | | |
| **MODULE-5** | **FORGING TECHNOLOGY** | **24MEE43.6** | **8 Hours** |
| Forging: Introduction, Classification of forging processes. Forging machines & equipment. Forging pressure and load in open die forging and closed die forging, concepts of friction hill and factors affecting it. Die- design parameters. Material flow lines in forging. Forging defects, Residual stresses in forging. Advantages and disadvantages of forging. Simple problems. | | | |
| Self-study / Case Study | Make a typical die forged model by suitable die forging process. | | |
| Text Book | Text Book 4: Chapters 3.3,3.7,3.9,3.14,3.16,3.17 | | |

**CIE Assessment Pattern (50 Marks – Theory)**

| **RBT Levels** | | **Marks Distribution** | | |
|---|---|---|---|---|
| | | **Test (s)** | **AAT1** | **AAT2** |
| | | **25** | **15** | **10** |
| **L1** | **Remember** | 5 | - | - |
| **L2** | **Understand** | 5 | 5 | - |
| **L3** | **Apply** | 10 | 5 | 5 |
| **L4** | **Analyze** | 5 | 5 | 5 |
| **L5** | **Evaluate** | - | - | - |
| **L6** | **Create** | - | - | - |

**SEE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| **L1** | **Remember** | - |
| **L2** | **Understand** | 10 |
| **L3** | **Apply** | 20 |
| **L4** | **Analyze** | 20 |
| **L5** | **Evaluate** | - |
| **L6** | **Create** | - |

Suggested Learning Resources:

**Text Books:**


1) Manufacturing Process-I, Dr.K.Radhakrishna, Sapna Book House, 5th Revised Edition 2017. ISBN:978- 8128002076
2) Hazara Choudhry, 'Work shop Technology', Vol – II, Media promoters and publishers Pvt. Ltd. 2018, ISBN:9788185099156
3) R.K.Jain, 'Production Technology', Khanna Publishers-Delhi , 2017, ISBN:9788174090997
4) Manufacturing Process-III, Dr.K.Radhakrishna, Sapna Book House, 5th Revised Edition 2017. ISBN:978- 8128010439


**Reference Books:**


1) Fundamentals of Metal machining and machine tools, G. Boothroyd , McGraw Hill, 2015, ISBN:978- 1574446593
2) HMT, 'Production Technology', HMT, Tata McGraw Hill, 2017. ISBN:978-0070964433


**Web links and Video Lectures (e-Resources):**

- https://www.google.com/search?q=non+destructive+testing+videos&rlz=1C1CHBF_enIN959IN959&oq=non+destructive+testing+videos&aqs=chrome..69i57j0i22i30j0i390i650l3.17238j0j4&sourceid=c hrome&ie=UTF-8
- https://www.youtube.com/watch?v=uTGXHxgcHCo
- https://www.youtube.com/watch?v=kZ7YfWW-rg0
- https://www.slideshare.net/anishadevarashetty/non-destructive-testing-ppt

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Visit to any manufacturing/aero/auto industry or any power plant
- Demonstration of lathe/milling/drilling/CNC operations
- Demonstration of working of IC engine/refrigerator
- Demonstration of metal joining process
- Video demonstration of latest trends in mobility/robotics
- Contents related activities (Activity-based discussions)
  - For active participation of students, instruct the students to prepare Flowcharts and Handouts
  - Organizing Group wise discussions on issues
  - Seminars

## MANUFACTURING TECHNOLOGY LAB

| | | | |
|---|---|---|---|
| **Course Code** | **24MEL43** | **CIE Marks** | **50** |
| **L:T:P:S** | **0:0:1:0** | **SEE Marks** | **50** |
| **Hrs / Week** | **02** | **Total Marks** | **100** |
| **Credits** | **01** | **Exam Hours** | **03** |

Course outcomes:
At the end of the course, the student will be able to:

| | |
|---|---|
| 24MEL43.1 | Analyze the properties of sand by determining various values from the sand tests and develop the skill towards metal joining techniques |
| 24MEL43.2 | Apply Utilization of the patterns of different geometrical shapes for mold making and volumetric calculation in forging processes |
| 24MEL43.3 | Apply the various lathe operations to manufacture cylindrical components |
| 24MEL43.4 | Apply the various drilling & milling operations to machine components and make holes |

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24MEL43.1 | 3 | 3 | 2 | - | - | - | - | - | - | - | - | 3 | 2 |
| 24MEL43.2 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 3 | 2 |
| 24MEL43.3 | 3 | 2 | 1 | - | 2 | - | - | - | - | - | - | 3 | 2 |
| 24MEL43.4 | 3 | 2 | 1 | - | 2 | - | - | - | - | - | - | 3 | 2 |

| Exp. No. | List of Experiments | Hours | COs |
|---|---|---|---|
| | **PART-A** | | |
| 1 | Foundry Models:<br>Model 1- Preparation of moulds using two moulding boxes with pattern | 2 | 24MEL43.2 |
| 2 | Model 2- Preparation of moulds using two moulding boxes without pattern | 2 | 24MEL43.2 |
| 3 | Permeability test and Sieve analysis test | 2 | 24MEL43.1 |
| 4 | Clay content test and Moisture content test | 2 | 24MEL43.1 |
| 5 | Forging Models:<br>Model 1- Converting round rod to square rod | 2 | 24MEL43.2 |
| 6 | Joining Models: Model 1- Soldering, Model 2- Brazing, Model 3- Electric Arc & gas welding | 2 | 24MEL43.1 |
| | **PART-B** | | |
| 7 | Preparation of models on lathe involving facing, plain turning, step turning, taper turning, knurling and thread cutting. | 2 | 24MEL43.3 |
| 8 | Cutting of v groove/ dovetail/ rectangular groove/gear teeth using milling/Shaping | 2 | 24MEL43.4 |
| 9 | Preparation of models on drilling involving reaming, boring and internal thread cutting. | 2 | 24MEL43.4 |
| 10 | Grinding of a surface using a surface grinding machine | 2 | 24MEL43.4 |
| 11 | Milling of surfaces using both horizontal & vertical milling machines | 2 | 24MEL43.4 |
| 12 | Demonstration of melting, pouring for casting and CNC turning and milling centres | 2 | 24MEL43.2, 24MEL43.3 |

**PART-C**

**Beyond Syllabus Virtual Lab Content**

**(To be done during Lab but not to be included for CIE or SEE)**

- https://smfe-iiith.vlabs.ac.in/exp/permeability/simulation.html
- https://ms-nitk.vlabs.ac.in/exp/fineness-modulus-of-aggregates/simulation.html
- http://vlabs.iitkgp.ac.in/psac/newlabs2020/vlabiitkgpAM/exp1/Webpage/index.html
- http://vlabs.iitkgp.ac.in/psac/newlabs2020/vlabiitkgpAM/exp2/webpage/index.html
- http://msvsdei.vlabs.ac.in/mem103/Unit3Simulations.php?MEM103/Unit3/Simulations/Casting .m p4

**CIE Assessment Pattern (50 Marks – Lab)**

| RBT Levels | | Test (s) | Weekly Assessment |
|---|---|---|---|
| | | 20 | 30 |
| L1 | Remember | - | - |
| L2 | Understand | 5 | 10 |
| L3 | Apply | 10 | 10 |
| L4 | Analyze | 5 | 10 |
| L5 | Evaluate | - | - |
| L6 | Create | - | - |

**SEE Assessment Pattern (50 Marks – Lab)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| L1 | Remember | - |
| L2 | Understand | 10 |
| L3 | Apply | 20 |
| L4 | Analyze | 20 |
| L5 | Evaluate | - |
| L6 | Create | - |

**Suggested Learning Resources:**

**Text Books:**

1. Manufacturing Process-I, Dr.K.Radhakrishna, Sapna Book House, 5th Revised Edition 2017.ISBN:978-8128002076
2. Hazara Choudhry, 'Work shop Technology', Vol – II, Media promoters and publishers Pvt. Ltd. 2018, ISBN:9788185099156
3. R.K.Jain, 'Production Technology', Khanna Publishers-Delhi , 2017, ISBN:9788174090997
4. Manufacturing Process-III, Dr.K.Radhakrishna, Sapna Book House, 5th Revised Edition 2017.ISBN:978-8128010439

## MECHANICAL MEASUREMENTS AND METROLOGY

| | | | |
|---|---|---|---|
| **Course Code** | **24MEE44** | **CIE Marks** | **50** |
| **L:T:P:S** | **3:0:0:0** | **SEE Marks** | **50** |
| **Hrs / Week** | **03** | **Total Marks** | **100** |
| **Credits** | **03** | **Exam Hours** | **03** |

**Course outcomes:**

At the end of the course, the student will be able to:

| | |
|---|---|
| 24MEE44.1 | Identify the suitable standards for measurement and calibration of end bars. |
| 24MEE44.2 | Design the gauges for engineering components using the concepts of Limits, fits, geometric dimensioning and tolerances (GD&T) |
| 24MEE44.3 | Understand the working principle of various linear measuring instruments and principles of interference |
| 24MEE44.4 | Analyze the various types of screw threads and gear tooth used in various applications and its measuring instruments |
| 24MEE44.5 | Investigate appropriate measuring instruments for measurement of force, torque, pressure, temperature and nano metrology. |
| 24MEE44.6 | Evaluate the surface properties of components |

**Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24MEE44.1 | 3 | 2 | - | - | - | - | - | - | - | - | - | 1 | 3 |
| 24MEE44.2 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | - | 1 | 3 |
| 24MEE44.3 | 2 | 1 | - | - | - | - | - | - | - | - | - | 1 | 3 |
| 24MEE44.4 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | - | 1 | 3 |
| 24MEE44.5 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | - | 1 | 3 |
| 24MEE44.6 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 1 | 3 |

| **MODULE-1** | **STANDARDS OF MEASUREMENT** | **24MEE44.1** | **8 Hours** |
|---|---|---|---|

**Introduction**: Definition and Objectives of metrology, Material standards-International Prototype meter, Imperial standard yard, Airy points, Wave length standard, subdivision of standards, line and end standard, calibration of end bars, Indian Standards (M-87, M- 112) of Slip gauges, Wringing phenomena, Numerical problems on building of slip gauges.

**Measurements and measurement systems**: Generalized measurement system, basic definitions, Errors in measurement, classification of errors.

| | |
|---|---|
| Text Book | Text Book 1: 1.1, 1.2, 1.4, 1.5, 1.6 ,1.7, 1.8, 1.10, 1.11, 1.12,5.5, 5.7, 5.8, 5.9 |
| Case Study / Applications | Case Study on primary standards |

| **MODULE-2** | **LIMITS, FITS, TOLERANCE AND GAUGE** | **24MEE44.2** | **8 Hours** |
|---|---|---|---|

Definition of tolerance, Specification in assembly, Principle of interchangeability and selective assembly limits of size, Indian standards, concept of limits of size and tolerances, compound tolerances, accumulation of tolerances, definition of fits, types of fits and their designation (IS 919-1963), geometrical tolerance, hole basis system, shaft basis system, classification of gauges, design of gauges (Taylor's principles), Wear allowance on gauges, Types of gauges- plain plug gauge, ring gauge, and gauge materials, numericals

| | |
|---|---|
| Text Book | Text Book 1: 2.1 to 2.11, 2.14 to 2.29 |

| | | | |
|---|---|---|---|
| Case Study / Applications | Applications : Applications of gauges in industry | | |
| **MODULE-3** | **COMPARATORS** | **24MEE44.3, 24MEE44.4** | **8 Hours** |
| Introduction to comparators, characteristics, classification of comparators, Johnson's Mikrokator, Sigma comparator, Dial gauge, Ziess ultra-optimeter, Solex pneumatic gauge. Principles of interference, concept of flatness, flatness testing, optical flats, optical interferometer and laser interferometer. Principle of sine bar, sine center, angle gauges, numericals on building of angles. | | | |
| Text Book | Text Book 2: 3.1 to 3.8, 3.3, 3.5, 3.7, 3.10, 3.13 to 3.16 | | |
| Self-study / Applications | Self-study on Electrical and electronic comparators. | | |
| **MODULE-4** | **SURFACE METROLOGY AND FORM MEASUREMENT** | **24MEE44.5** | **8 Hours** |
| **Surface Texture Measurement** - Importance of surface conditions, roughness and waviness, surface roughness standards for terminology and symbols, surface roughness measuring instruments – Tomlinson and Taylor Hobson versions.<br>**Form Measurement:** Terminology of screw threads, measurement of major diameter, minor diameter and effective diameter of screw threads by 2-wire and 3-wire methods, best size wire. Tool maker's microscope, gear tooth terminology, gear tooth vernier caliper. | | | |
| Text Book | Text Book 1: 4.7, to 4.20 Text Book 3: 11.1, 11.2, 11.3, 11.11, 11.12. | | |
| Case Study / Applications | Case Study on roughness of different materials | | |
| **MODULE-5** | **MEASUREMENT OF FORCE, TORQUE, PRESSURE AND TEMPERATURE** | **24MEE44.6** | **8 Hours** |
| **Measurement of force, torque, pressure:** Principle of analytical balance, platform balance, proving ring. Torque measurement - Prony brake, hydraulic dynamometer. Pressure measurements- McLeod gauge, Pirani gauge.<br>**Measurement of Temperature**: Resistance thermometers, thermocouple, laws of thermocouple.<br>**Advanced Metrology:** Introduction to Nanometrology, Principles of XRD, Coordinate measuring machines: Structure, Modes of Operation, Probe, autocollimator | | | |
| Text Book | Text Book 1: 7.1 to 7.6 ,7.14, 7.15 ,8.4 to 8.7, Reference text book 3: 17.1 to17.5.4 | | |
| Case Study / Applications | Nanometrology applications | | |

**CIE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Marks Distribution | | |
|---|---|---|---|---|
| | | Test (s) | AAT1 | AAT2 |
| | | 25 | 15 | 10 |
| L1 | Remember | 5 | - | - |
| L2 | Understand | 5 | 5 | 5 |
| L3 | Apply | 10 | 5 | 5 |
| L4 | Analyze | 5 | 5 | - |
| L5 | Evaluate | - | - | - |
| L6 | Create | - | - | - |

**SEE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| **L1** | **Remember** | - |
| **L2** | **Understand** | 10 |
| **L3** | **Apply** | 20 |
| **L4** | **Analyze** | 20 |
| **L5** | **Evaluate** | -- |
| **L6** | **Create** | -- |

**Suggested Learning Resources:**

**Text Books:**

1) Dr. T Chandrashekar, 'Metrology and Measurement', Subhas publication, 2017, ISBN: 9789383214198.
2) N V Raghavendra and Krishnamurthy, 'Engineering Metrology and Measurement', Oxford University Press, 2013, ISBN: 9780198085492..
3) R.K. Jain, 'Engineering Metrology', Khanna Publishers, 2017, ISBN-13: 978-8174091536.

**Reference Books:**

1) I.C. Gupta, 'Engineering Metrology', Dhanpat Rai Publications, Delhi, 8th Edition, 2018, ISBN 13: 9788189928452.
2) R.K. Jain, 'Mechanical and Industrial Measurements', Khanna Publishers, 2008, ISBN: 9788174091918. 3) Anand K. Bewoor & Vinay A. Kulkarni, 'Metrology & Measurement', Tata McGraw Hill Pvt. Ltd., New Delhi, 2009, ISBN: 9781259081323.
3) Beckwith Marangoni and Lienhard, 'Mechanical Measurements', Pearson Education, 7th Edition, 2015, ISBN 13: 978-8131717189

**Web links and Video Lectures (e-Resources):**

- https://archive.nptel.ac.in/courses/112/104/112104250/
- https://archive.nptel.ac.in/courses/112/106/112106138/
- https://www.youtube.com/watch?v=BqAmLOI8uzs
- https://www.youtube.com/watch?v=X8KPNVZhvmo
- https://www.youtube.com/watch?v=z0dvKCGRny0
- https://www.youtube.com/watch?v=vzr1IAvm-wU
- https://www.youtube.com/watch?v=v8gaEqHa1r0

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Visit to any manufacturing/aero/auto industry.
- Demonstration of inspection tool used for manufacturing processes
- Demonstration of sensors.
- Video demonstration of latest trends in Comparators
  - For active participation of students, instruct the students to prepare Flowcharts and Handouts
  - Case study and presentations

## MECHANICAL MEASUREMENTS AND METROLOGY LAB

| | | | |
|---|---|---|---|
| **Course Code** | **24MEL44** | **CIE Marks** | **50** |
| **L:T:P:S** | **0:0:1:0** | **SEE Marks** | **50** |
| **Hrs / Week** | **2** | **Total Marks** | **100** |
| **Credits** | **01** | **Exam Hours** | **03** |

**Course outcomes:**
At the end of the course, the student will be able to:

| | |
|---|---|
| 24MEL44.1 | Investigate the measuring instruments such as micrometer, pressure gauge, LVDT, load cell, thermocouple, strain gauge etc. |
| 24MEL44.2 | Evaluate the taper angle, surface roughness and alignment of machined components |
| 24MEL44.3 | Analyze the screw thread and gear tooth parameters of the specimens |
| 24MEL44.4 | Compute the forces and torque measurement using different dynamometers |

**Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 22MEL44.1 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 1 | 2 |
| 22 MEL44.2 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | - | 1 | 2 |
| 22 MEL44.3 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 1 | 2 |
| 22 MEL44.4 | 3 | 2 | - | - | - | - | - | - | - | - | - | 1 | 2 |

| Exp. No. | List of Experiments | Hours | COs |
|---|---|---|---|
| | **Prerequisite Experiments / Demo** | | |
| | • Demonstration on measuring devices like vernier caliper, screw gauge, height gauge etc.<br>• Measurement of limits, fits using standard gauges. | 2 | NA |
| | **PART-A** | | |
| 1 | Calibration of load cell using standard weights | 2 | 24MEL44.1 |
| 2 | Calibration of micrometer using slip gauge | 2 | 24MEL44.1 |
| 3 | Calibration of LVDT using micrometer | 2 | 24MEL44.1 |
| 4 | Calibration of pressure gauge | 2 | 24MEL44.1 |
| 5 | Angular measurement using sine bar and bevel protractor | 2 | 24MEL44.2 |
| 6 | Measurement of surface roughness and Circularity / Roundness using of a component using mechanical comparator | 2 | 24MEL44.2 |
| | **PART-B** | | |
| 7 | Measurement of a screw thread parameters using floating carriage micrometer by 2-wire method | 2 | 24MEL44.3 |
| 8 | Measurement of gear parameters using gear tooth vernier | 2 | 24MEL44.3 |
| 9 | Measurement of alignment of surface plate using roller set | 2 | 24MEL44.2 |
| 10 | Comparison and measurement of temperature using thermocouple and RTD | 2 | 24MEL44.1 |
| 11 | • Measurement of cutting forces and torque using lathe/ drill tool Dynamometer<br>• Measurement of fluid flow using mechanical, electrical and hydraulic dynamomter. | 2 | 24MEL44.4 |

| | | | |
|---|---|---|---|
| 12 | Determination of young s modulus using strain gauge. | 2 | 24MEL44.1 |

**PART-C**

**Beyond Syllabus Virtual Lab Content**

**(To be done during Lab but not to be included for CIE or SEE)**

1) https://sl-coep.vlabs.ac.in/List%20of%20experiments.html
2) https://kcgcollege.ac.in/Virtual-Lab/Mechanical/Exp-3/theory.html
3) https://virtual-labs.github.io/exp-measurement-gear-tooth-vernier-iitkgp/
4) https://virtual-labs.github.io/exp-measurement-screw-threads-iitkgp/
5) https://virtual-labs.github.io/exp-measurement-displacement-lvdt-iitkgp/
6) http://vlabs.iitkgp.ac.in/metro/Exp1/index.html

**CIE Assessment Pattern (50 Marks – Lab)**

| RBT Levels | | Test (s) | Weekly Assessment |
|---|---|---|---|
| | | 20 | 30 |
| L1 | Remember | - | - |
| L2 | Understand | 5 | 10 |
| L3 | Apply | 10 | 10 |
| L4 | Analyze | 5 | 10 |
| L5 | Evaluate | - | - |
| L6 | Create | - | - |

**SEE Assessment Pattern (50 Marks – Lab)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| L1 | Remember | 10 |
| L2 | Understand | 10 |
| L3 | Apply | 20 |
| L4 | Analyze | 10 |
| L5 | Evaluate | - |
| L6 | Create | - |

**Suggested Learning Resources:**

**Reference Books:**

1) I.C. Gupta, 'Engineering Metrology', Dhanpat Rai Publications, Delhi, 8th Edition, 2018, ISBN 13: 9788189928452.
2) R.K. Jain, 'Mechanical and Industrial Measurements', Khanna Publishers, 2008, ISBN: 9788174091918.
3) Anand K. Bewoor & Vinay A. Kulkarni, 'Metrology & Measurement', Tata McGraw Hill Pvt. Ltd., New Delhi, 2009, ISBN: 9781259081323.
4) N V Raghavendra and Krishnamurthy, 'Engineering Metrology and Measurement', Oxford University Press, 2013, ISBN: 9780198085492.

## INTRODUCTION TO SOLAR ENERGY

| | | | |
|---|---|---|---|
| **Course Code** | **24MEE451** | **CIE Marks** | **50** |
| **L:T:P:S** | **3:0:0:0** | **SEE Marks** | **50** |
| **Hours / Week** | **3** | **Total Marks** | **100** |
| **Credits** | **03** | **Exam Hours** | **03** |

**Course outcomes:**

At the end of the course, the student will be able to:

| | |
|---|---|
| 24MEE451.1 | Describe the Energy sources and Fundamental concept of solar Energy |
| 24MEE451.2 | Study the Atmospheric effects of solar radiation and equipments to measure the available radiation data. |
| 24MEE451.3 | Interpret the solar Radiation data at various Inclinations. |
| 24MEE451.4 | Evaluate the performances of various Solar Thermal and PV Devices. |
| 24MEE451.5 | Interpret the parameters of PV modules and their connections to form arrays |
| 24MEE451.6 | Outline the technologies that are used to harness the power of solar energy |

**Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24MEE451.1 | 2 | 2 | - | - | - | - | - | - | - | - | - | 1 | 2 |
| 24MEE451.2 | 2 | 2 | - | - | - | - | - | - | - | - | - | 1 | 2 |
| 24MEE451.3 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 1 | 2 |
| 24MEE451.4 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | - | 1 | 2 |
| 24MEE451.5 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 1 | 2 |
| 24MEE451.6 | 2 | 2 | - | - | - | - | - | - | - | - | - | 1 | 2 |

| | | | |
|---|---|---|---|
| **MODULE-1** | **INTRODUCTION** | **24MEE451.1 24MEE451.3** | **8 Hours** |

Energy sources: Classification of Energy sources, renewable energy sources, renewable energy potential and achievements in India, General characteristics of solar energy; the Sun, solar spectrum, Solar constant.

| | |
|---|---|
| Text Book | Text Book 1: Chapters 1,2 |

| | | | |
|---|---|---|---|
| **MODULE-2** | **SOLAR RADIATION MEASURING INSTRUMENTS** | **24MEE451.2** | **8 Hours** |

Solar radiation outside the earth's Atmosphere, Atmospheric Attenuation of solar radiation, beam, diffuse and global radiation. Solar radiation data of India. Measurement of solar radiation. Pyronometer, pyrheliometer, sunshine recorder (schematic diagram and working principles of the devices.)

| | |
|---|---|
| Text Book | Text Book 1: Chapter 2 |

| | | | |
|---|---|---|---|
| **MODULE-3** | **SOLAR RADIATION DATA** | **24MEE451.2 24MEE451.3** | **8 Hours** |

Sun earth angles- latitude, declination, hour angle, zenith, solar altitude angle, surface azimuth angle, solar azimuth angle, Local apparent time, solar time, apparent motion of sun, day length, and numerical examples. Flux on a plane surface, Solar radiation on a inclined surface- Beam, diffuse, reflected radiation on a tilted surface, expression for flux on a tilted surfaces .Numerical examples.

| | |
|---|---|
| Text Book | Text Book 1: Chapter 3 |

| | | | |
|---|---|---|---|
| **MODULE-4** | **SOLAR CELLS, PV MODULES AND ARRAYS** | **24MEE451.4 24MEE451.5** | **8 Hours** |

| | | | |
|---|---|---|---|
| P-n junction diode, Working principle of Silicon Solar cell, Characteristics, Factors affecting Electricity generated from a Solar Cell, Solar PV Modules–Ratings, and Module Parameters. Measuring Module Parameters, Solar PV Module Arrays - Connection of Modules in Series, in Parallel and in Combination. | | | |
| Case Study | Case Study of a Solar PV System, Environmental considerations of PV Systems | | |
| Text Book | Text Book 2: Chapter 4 | | |
| **MODULE-5** | **HARNESSING THE SOLAR ENERGY** | **24MEE451.4, 24MEE451.6** | **8 Hours** |
| Application of solar thermal energy: water heating, space heating, space cooling, active and passive cooling systems. Various power generation methods; Solar furnace, Refrigeration, Distillation, Solar ponds; theory, working principles (Sketches, principle of working). ,<br>Application of solar PV Systems : Domestic and Street lighting, Water pumping, Solar PV building heating, solar vehicles, solar PV systems in space and Solar green houses. | | | |
| Text Book | Text Book 1: Chapter 5 , Text Book 2: Chapter 6 | | |

**CIE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Marks Distribution | |
|---|---|---|---|
| | | Test (s) | AAT1 |
| | | 25 | 25 |
| **L1** | **Remember** | 5 | - |
| **L2** | **Understand** | 5 | 5 |
| **L3** | **Apply** | 10 | 10 |
| **L4** | **Analyze** | 5 | 10 |
| **L5** | **Evaluate** | - | - |
| **L6** | **Create** | - | - |

**SEE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| **L1** | **Remember** | 10 |
| **L2** | **Understand** | 10 |
| **L3** | **Apply** | 20 |
| **L4** | **Analyze** | 10 |
| **L5** | **Evaluate** | -- |
| **L6** | **Create** | -- |

**Suggested Learning Resources:**

**Text Books:**


1) Solar Energy : Principles of thermal collection and storage by P.S Sukhatme and J K Nayak,3rd Edition 2008, Tata MC Graw Hill Publishing Company Limited, Print Book ISBN : 0070142963, eBook ISBN : 978-0070142961
2) Chetan Singh Solanki ,Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers, PHI Learning Publications, 3rd Edition, 2015, Print Book ISBN : 9788120347113


**Reference Books:**


1. Solar Engineering of Thermal Processes : Fourth Edition,April 2013 by John A Duffie ,William A Beckman, WILEY Publications, ISBN : 0470873663


**Web links and Video Lectures (e-Resources):**

- https://www.sku.ac.ir/Datafiles/BookLibrary/45/John%20A.%20Duffie,%20William%20A.%20Beckman(auth.)-Solar%20Engineering%20of%20Thermal%20Processes,%20Fourth%20Edition%20(2013).pdf
- **https://www.youtube.com/watch?v=px239v5o6xU**
- **https://archive.nptel.ac.in/courses/115/107/115107116/**

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Visit to any solar PV industry or power plant
- Demonstration of PV module, panel in the institution.
- Seminars

## ROTOR DYNAMICS

| | | | |
|---|---|---|---|
| **Course Code** | **24MEE452** | **CIE Marks** | **50** |
| **L:T:P:S** | **3:0:0:0** | **SEE Marks** | **50** |
| **Hrs / Week** | **03** | **Total Marks** | **100** |
| **Credits** | **03** | **Exam Hours** | **03** |

**Course outcomes:**

At the end of the course, the student will be able to:

| | |
|---|---|
| 24MEE452.1 | Apply basic concepts of Fluid Mechanics to conceptualize working of positive displacement machines and turbo machines |
| 24MEE452.2 | Analyze energy transfer through graphical and analytical methods in turbo machines |
| 24MEE452.3 | Determine various equipment sizing / design aspects of turbo machines based on engineering requirement. |
| 24MEE452.4 | Apply appropriate engineering techniques/methods to characterize the steam-based turbo machines and its thermodynamic analysis. |
| 24MEE452.5 | Investigate the concepts as a member of a team and make an effective presentation on the application of suitable turbo machines under / within the specified conditions. |
| 24MEE452.6 | Design and analysis of turbo machines by applying the knowledge to practical engineering problems for better sustainable solutions and staying updated with the latest developments. |

**Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24MEE452.1 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 3 | 1 |
| 24MEE452.2 | 3 | 3 | 2 | 1 | - | - | - | - | - | - | - | 3 | 1 |
| 24MEE452.3 | 2 | 1 | - | - | - | - | - | - | - | - | - | 3 | 1 |
| 24MEE452.4 | 3 | 3 | 2 | - | - | - | - | - | - | - | - | 3 | 1 |
| 24MEE452.5 | 3 | 3 | 2 | 1 | - | - | - | - | - | - | - | 3 | 1 |
| 24MEE452.6 | 3 | 3 | 2 | 1 | - | - | - | - | - | - | - | 3 | 1 |

| **MODULE-1** | **INTRODUCTION TO TURBO MACHINERY** | **24MEE452.1 24MEE452.2** | **8 Hours** |
|---|---|---|---|

**Introduction:** Definition of turbo machine, parts of turbo machines, Comparison with positive displacement machines, Classification, Unit and specific quantities, model studies. Efficiencies of turbo machines. Problems.
**Energy exchange in power generating machines:** Euler's turbine equation, Alternate form of Euler's turbine equation, Velocity triangles for different values of degree of reaction, Components of energy transfer, Degree of Reaction, utilization factor, Relation between degree of reaction and Utilization factor, Problems.

| | |
|---|---|
| Case study | Case Study on Performance of turbines |
| Text Book | Text Book 1: 1.1, 1.2, 1.3, 1.6, 2.1, 2.2, 2.3, 4.1, 4.2, 4.3, 4.4, 4.5 Text Book 2: 1.1, 1.2,1.3, 1.4, 1.5, 1.6, 2.3, 4.1, 4.2, 4.3, 4.4 |

| **MODULE-2** | **ENERGY EXCHANGE IN POWER ABSORBING MACHINES** | **24MEE452.3** | **8 Hours** |
|---|---|---|---|

**Energy exchange in power absorbing machines:** Radial flow compressors and pumps– general analysis, Expression for degree of reaction, velocity triangles, General analysis of axial flow pumps and compressors, degree of reaction, velocity triangles, Turbomachine Problems.
**Centrifugal Pumps:** Classification and parts of centrifugal pump, different heads and efficiencies of centrifugal pump, head capacity relationship, Minimum speed for starting the flow, Net positive suction head, Cavitation's, Need for priming. Problems.

| | |
|---|---|
| Case Study | Case Study on axial flow pumps |
| Text Book | Text Book 1: 5.1, 5.2, 5.3,5.4,5.5, 5.7,5.8, 6.1,6.2,6.3,6.4, 7.1, 7.3 Text Book 2: 5.1, 5.3, 5.6, 6.1, |

| **MODULE-3** | **CENTRIFUGAL COMPRESSORS** | **24MEE452.4** | **8 Hours** |
|---|---|---|---|

**Centrifugal Compressors:** Stage velocity triangles, slip factor, power input factor, Stage work, Pressure developed, stage efficiency, surging problems.
**Axial flow Compressors:** Expression for pressure ratio developed in a stage, work done factor, efficiencies, and stalling. Problems. Steam nozzles:- definition, types of nozzles, steady flow energy equation in nozzles, nozzle efficiency, throat pressure for maximum discharge in nozzle flow or choked flow simple problems on nozzles.

| | | | |
|---|---|---|---|
| Case Study | Case study on Steam nozzles | | |
| Text Book | Text Book 1: 9.1, 9.2, 9.310.1, 10.2, 10.3 Text Book 2: 11.2, 11.2, 10.4, 10.5 | | |
| **MODULE-4** | **STEAM TURBINES** | **24MEE452.4** | **8 Hours** |

**Steam Turbines:** Classification of steam turbines, Single stage impulse turbine, condition for maximum blade efficiency, stage efficiency, Need and methods of compounding, Multi-stage impulse turbine, expression for maximum utilization factor.

| | | | |
|---|---|---|---|
| Case Study | Case study on performance of Multi-stage impulse turbine | | |
| Text Book | Text Book 1: 19.1, 19.2, 19.3, 19.7, 19.9 Text Book 2: 3.1, 3.2, 3.3, 3.4, 3.5 | | |
| **MODULE-5** | **HYDRAULIC TURBINES** | **24MEE452.5**<br>**24MEE452.6** | **8 Hours** |

**Hydraulic Turbines:** Classification, Different efficiencies, Pelton turbine – velocity triangles, design parameters, Maximum efficiency. Francis turbine- velocity triangles, design parameters, runner shapes for different blade speeds. Draft tubes- Types and functions. Kaplan and Propeller turbines - velocity triangles, design parameters. Performance Charts Problems.

| | |
|---|---|
| Self study | Self study on Hydrualic Turbines |
| Text Book | Text Book : 18.1, 18.2, 18.5, 18.6 18.8, 18.10 Text Book 2: 2.1, 2.2, 2.3, 2.4 |

**CIE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Marks Distribution | |
|---|---|---|---|
| | | Test (s) | AAT1 |
| | | 25 | 25 |
| L1 | Remember | 5 | - |
| L2 | Understand | 5 | 5 |
| L3 | Apply | 10 | 10 |
| L4 | Analyze | 5 | 10 |
| L5 | Evaluate | - | - |
| L6 | Create | - | - |

**SEE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| L1 | Remember | 10 |
| L2 | Understand | 10 |
| L3 | Apply | 10 |
| L4 | Analyze | 10 |
| L5 | Evaluate | 10 |
| L6 | Create | -- |

**Suggested Learning Resources:**

**Text Books:**

1) An Introduction to Energy Conversion, Volume III, Turbo machinery, V. Kadambi and Manohar Prasad, New Age International Publishers, 2nd Ed, ISBN : 978-81- 224-3189- 6
2) R.K.Rajput, "A Text Book of Fluid Mechanics and Hydraulic Machines", 6th edition, S. Chand, 2015. ISBN 9789385401374

**Reference Books:**

1) An Introduction to Energy Conversion, Volume III, Turbo machinery, V. Kadambi and Manohar Prasad, New Age International Publishers, 2nd Ed, ISBN : 978-81- 224-3189- 6
2) Textbook of Turbo machines, M. S. Govinde Gowda and A. M. Nagaraj, M. M. Publications, 4Th Ed, 2008, , ISBN : 978-81- 224-3189- 6

**Web links and Video Lectures (e-Resources)**

- **https://archive.nptel.ac.in/courses/112/105/112105171/**
- **https://unacademy.com/content/gate/videos/mechanical-engineering/fluid-mechanics/#**
- **https://www.youtube.com/watch?v=clVwKynHpB0**
- **https://nptel.ac.in/courses/103102211**
- **https://nitsri.ac.in/Department/DisplayDeptPage.aspx?page=magee&ItemID=ocgkk&nDeptID=e**

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Visit to any Hydraulic power plant
- Demonstration on working of Pumps /Turbines
- Demonstration on Flow measuring Devices
- Contents related activities (Activity-based discussions)
  - For active participation of students, instruct the students to prepare Fluid Mechanics and Machinery related Flowcharts.
  - Organizing Group wise discussions on issues
  - Seminars

| AEROSPACE PROPULSION SYSTEM | | | |
|---|---|---|---|
| **Course Code** | **24MEE453** | **CIE Marks** | **50** |
| **L:T:P:S** | **3:0:0:0** | **SEE Marks** | **50** |
| **Hrs / Week** | **3** | **Total Marks** | **100** |
| **Credits** | **03** | **Exam Hours** | **03** |

**Course outcomes:**

At the end of the course, the student will be able to:

| | |
|---|---|
| 24MEE453.1 | Understand atmospheric properties relevant to propulsion and identify and classify propulsive devices |
| 24MEE453.2 | Outline procedures and equipment for handling and treating liquid fuels and it systems |
| 24MEE453.3 | Analyze the performance and matching of gas turbine modules using aerothermal principles and efficiency concepts |
| 24MEE453.4 | Apply dimensional analysis for performance scaling, and describe key engine health monitoring techniques to ensure reliable operation. |
| 24MEE453.5 | Explain rocket propulsion fundamentals, discuss fuel & combustion processes, and outline basics of space missions and fuel cells. |
| 24MEE453.6 | Estimate performance of solid & liquid propellant rockets, describe grain design and burn behavior for solid rockets |

**Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24MEE453.1 | 2 | 2 | 1 | - | - | - | - | - | - | - | - | 3 | 3 |
| 24MEE453.2 | 2 | 2 | 1 | - | - | - | - | - | - | - | - | 3 | 3 |
| 24MEE453.3 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | - | 3 | 3 |
| 24MEE453.4 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | 3 | 3 |
| 24MEE453.5 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 3 | 3 |
| 24MEE453.6 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 3 | 3 |

| **MODULE-1** | **INTRODUCTION TO PROPULSIVE DEVICES AND GAS TURBINE ENGINES** | **24MEE453.1** | **8 Hours** |
|---|---|---|---|

Introduction to Propulsive Devices and Gas Turbine Engines: Atmospheric Properties. Turbojet, Turbofan, Turboprop, Turbo-shaft Engine Construction and Nomenclature, theory and performance, introduction to compressors, turbines, combustors and after burners for aircraft engines.

| | |
|---|---|
| Self-study | Understand the to jet engines and its working principle of it for different aircraft |
| Text Book | Text Book 3: 4.3-4.5 Text Book 2: 3.1 to 3.7. |

| **MODULE-2** | **GAS TURBINE ENGINE FUEL AND FUEL SYSTEMS** | **24MEE453.2** | **8 Hours** |
|---|---|---|---|

Gas Turbine Engine Fuel and Fuel Systems: Fuel specification, fuel properties, liquid fuel handling and treatment, heavy fuels, fuel gas handling and treatment, equipment for removal of particulate and liquids from fuel gas systems, fuel heating, cleaning of turbine components, fuel economics, operating experience, heat tracing of piping systems. Types of heat tracing systems, storage of liquids.

| | |
|---|---|
| Case Study | Basic of fuel used in the jet engines and its systems |
| Text Book | Text Book 6: page no. 411-436 |

| **MODULE-3** | **ENGINE PERFORMANCE AND HEALTH MONITORING** | **24MEE453.3, 24MEE453.4** | **8 Hours** |
|---|---|---|---|

Engine Performance and Health Monitoring: Performance and Matching of modules of gas turbines-turbomachine aerothermodynamics, aerothermal equations, efficiencies, dimensional analysis, compressor performance characteristic, turbine performance characteristics, Engine health monitoring techniques.

| | |
|---|---|
| Self-study / Case Study / | To understand the engine performances and monitoring system and its techniques. |

| | | | |
|---|---|---|---|
| Text Book | Text Book 1: 3.1, 3.3, 3.5, 3.7, 3.10 | | |
| **MODULE-4** | **ROCKET PROPULSION AND SPACE MISSION** | **24MEE453.5** | **8 Hours** |
| Engine Air Frame Integration: Engine Performance theory, Propeller theory – pusher and tractor mode. Thrust vectoring nozzles. Introduction to Rocket Propulsion and Space Mission: Classification and fundamentals. Fuels and propellants. Rocket combustion processes. Introduction to Space mission. Fuel cells for space mission. | | | |
| Self-study | Know the propulsion system in the rocket engine and vectoring of nozzles | | |
| Text Book | Text Book 4: 2.1 to 2.10. & 4.4.5-4.4.6 | | |
| **MODULE-5** | **PROPELLANT ROCKET** | **24MEE453.6** | **8 Hours** |
| Solid Propellant Rocket Description: Performance Estimation, Flame spread and Ignition transient. Mechanical characterization of propellants. Grain design. Burn rate estimation. Liquid Propellant Rocket Description: Performance estimation. Injectors. Cooling systems. Combustion instabilities. | | | |
| Case Study / Applications | Applications and case studies of burn rate estimation and cooling system rocket. | | |
| Text Book | Text Book 5: 12.1-12.10 | | |

**CIE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Marks Distribution | |
|---|---|---|---|
| | | Test (s) | AAT1 |
| | | 25 | 25 |
| L1 | Remember | 5 | - |
| L2 | Understand | 5 | 5 |
| L3 | Apply | 10 | 10 |
| L4 | Analyze | 5 | 10 |
| L5 | Evaluate | - | - |
| L6 | Create | - | - |

**SEE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| L1 | Remember | 10 |
| L2 | Understand | 10 |
| L3 | Apply | 20 |
| L4 | Analyze | 10 |
| L5 | Evaluate | -- |
| L6 | Create | -- |

**Suggested Learning Resources:**

**TEXT BOOKS:**

1 . R. D. Flack, Fundamentals of Jet Propulsion with Applications, Cambridge University Press, 2005. ISBN 9781133430211

2 . H. Cohen, G.F.C. Rogers, and H. I. H. Saravanamuttoo, Gas Turbine Theory, Pearson, 2001. ISBN 9781401872402

**REFERENCE BOOKS:**

1. N. A. Cumpsty, Jet Propulsion, Cambridge University Press, 2003. ISBN : 0070142963
2. Mattingly, Elements of Gas Turbine Propulsion, McGraw Hill Publications, 1996. ISBN : 978-81- 224-3189- 6

**Web links and Video Lectures (e-Resources):**

- https://iitg.ac.in/mech/academics/masters/aerodynamics-propulsion/latest/sem-2/aircraft-propulsion/
- https://archive.nptel.ac.in/courses/112/103/112103281/
- https://www.youtube.com/watch?v=1-BsZDKtH_o
- https://www.youtube.com/watch?v=25i0AzTa5rw
- https://www.youtube.com/watch?v=PcPBYh6Cfao

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Video demonstration of latest trends in Industrial Robotics
- Contents related activities (Activity-based discussions)
  - For active participation of students, instruct the students to prepare Flowcharts and Handouts
  - Organizing Group wise discussions on issues
  - Seminars

## NON TRADITIONAL MACHINING

| | | | |
|---|---|---|---|
| **Course Code** | **24MEE454** | **CIE Marks** | **50** |
| **L:T:P:S** | **3:0:0:0** | **SEE Marks** | **50** |
| **Hrs / Week** | **03** | **Total Marks** | **100** |
| **Credits** | **03** | **Exam Hours** | **03** |

**Course outcomes:**

At the end of the course, the student will be able to:

| | |
|---|---|
| 24MEE454.1 | Identify the uses of Nontraditional machines for modern manufacturing industries. |
| 24MEE454.2 | Understand the uses of chemical & electro chemical process. |
| 24MEE454.3 | Apply the modern finishing process in NTM. |
| 24MEE454.4 | Evaluate the methods of hybrid non- traditional machining. |
| 24MEE454.5 | Analyze the process of Laser beam machining. |
| 24MEE454.6 | Develop the suitable applications of traditional NTM, Nano, and laser beam machining for NTM. |

**Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24MEE454.1 | 2 | 2 | - | - | - | - | - | - | - | - | - | 2 | 2 |
| 24MEE454.2 | 2 | 2 | - | - | - | - | - | - | - | - | - | 2 | 2 |
| 24MEE454.3 | 3 | 2 | - | - | - | - | - | - | - | - | - | 2 | 2 |
| 24MEE454.4 | 3 | 3 | 2 | - | - | - | - | - | - | - | - | 2 | 2 |
| 24MEE454.5 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 2 | 2 |
| 24MEE454.6 | 3 | 3 | 2 | - | - | - | - | - | - | - | - | 2 | 2 |

| | | | |
|---|---|---|---|
| **MODULE-1** | **INTRODUCTION NON TRADITIONAL MACHINING** | **24MEE454.1** | **8 Hours** |

Introduction to Non-traditional machining, Need for Non-traditional machining process, Comparison between traditional and non-traditional machining, general classification Nontraditional machining processes, classification based on nature of energy employed in machining, selection of non-traditional machining processes, Specific advantages, limitations and applications of non-traditional machining processes.

| | |
|---|---|
| Self Study | Study about nontraditional machining |
| Text Book | Text Book 1: Ch. 1, 2 |

| | | | |
|---|---|---|---|
| **MODULE-2** | **CHEMICAL AND ELECTRO-CHEMICAL ENERGY-BASED PROCESSES** | **24MEE454.2, 24MEE454.3** | **8 Hours** |

Principles, equipment's, effect of process parameters, applications, advantages and limitations of Chemical machining, Electro-chemical machining, Electrochemical honing, Electrochemical grinding, Electro chemical deburring.

| | |
|---|---|
| Case-study | Electro chemical energy process |
| Text Book | Text Book 3 Ch.3,4,5 |

| | | | |
|---|---|---|---|
| **MODULE-3** | **NANO FINISHING PROCESSES** | **24MEE454.3, 24MEE454.4** | **8 Hours** |

Principles, equipment's, effect of process parameters, applications, advantages and limitations of Abrasive flow machining – Chemo mechanical polishing, Magnetic abrasive finishing, Magnetorheological finishing, Magneto rheological abrasive flow finishing.

| | |
|---|---|
| Self-study | Study the nano finishing equipment's |
| Text Book | Text Book 3,4: Ch. 3-4,5: 4-5,6 |

| | | | |
|---|---|---|---|
| **MODULE-4** | **HYBRID NON-TRADITIONAL MACHINING PROCESSES** | **24MEE454.4** | **8Hours** |

Introduction – Various hybrid non-traditional machining processes, their working principles, equipments, effect of process parameters, applications, advantages and limitations. Selection and comparison of different non-traditional machining processes.

| | | | |
|---|---|---|---|
| Applications | Study the applications of Hybrid NTM Machines | | |
| Text Book | Text Book 3,4: Ch. 3-8,9 : 4-7,8 | | |
| **MODULE-5** | **LASER BEAM MACHINING** | **24MEE454.5, 24MEE454.6** | **8Hours** |

LASER BEAM MACHINING (LBM): Introduction, generation of LASER, Equipment and mechanism of metal removal, LBM parameters and characteristics, Applications, Advantages & limitations. ELECTRON BEAM MACHINING (EBM): Introduction, Principle, equipment and mechanism of metal removal, applications, advantages and limitations.

| | |
|---|---|
| Self Study | Study the process of Laser beam machining |
| Text Book | Text Book 2: Ch.10 |

**CIE Assessment Pattern (50 Marks – Theory) –**

| RBT Levels | | Marks Distribution | |
|---|---|---|---|
| | | Test (s) | AAT1 |
| | | 25 | 25 |
| L1 | Remember | 5 | - |
| L2 | Understand | 5 | 5 |
| L3 | Apply | 10 | 10 |
| L4 | Analyze | 5 | 10 |
| L5 | Evaluate | - | - |
| L6 | Create | - | - |

**SEE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| L1 | Remember | 10 |
| L2 | Understand | 10 |
| L3 | Apply | 20 |
| L4 | Analyze | 10 |
| L5 | Evaluate | -- |
| L6 | Create | -- |

**Suggested Learning Resources:**

**TEXT BOOKS:**


1)Modern Machining Process by P.C Pandey and H S Shah Mc Graw Hill Education India Pvt. Ltd. ISBN-13 978-0070965539, 2013

Production technology HMT McGraw Hill Education India Pvt. Ltd 2015.

2)Adithan. M., "Unconventional Machining Processes", Atlantic, New Delhi, India, 2009. ISBN 13: 9788126910458.

3)Anand Pandey, "Modern Machining Processes", Ane Books Pvt. Ltd., New Delhi, India, 2019.


**REFERENCE BOOKS:**


1) Benedict, G.F., "Non-traditional Manufacturing Processes", Marcel Dekker Inc., New York 1987. ISBN-13: 978-0824773526.

2) Carl Sommer, "Non-Traditional Machining Handbook", Advance Publishing., United States, 2000, ISBN-13: 978-1575373256.

3) Golam Kibria, Bhattacharyya B. and Paulo Davim J., "Non-traditional Micromachining

Processes: Fundamentals and Applications", Springer International Publishing., Switzerland, 2017, ISBN:978-3- 319-52008-7.
4) Jagadeesha T., "Non-Traditional Machining Processes", I.K. International Publishing House Pvt. Ltd., New Delhi, India, 2017, ISBN-13: 978-9385909122.
5) Kapil Gupta, Neelesh K. Jain and Laubscher R.F., "Hybrid Machining Processes: Perspectives on Machining and Finishing", 1st edition, Springer International Publishing., Switzerland, 2016, ISBN 13: 978-3319259208.

**Web links and Video Lectures (e-Resources):**

- https://in.video.search.yahoo.com/yhs/search?fr=yhs-sz-002&ei=UTF-8&hsimp=yhs-002&hspart=sz&param1=2486481154&p=non+traditional+machining+video+links+youtube&vm=r&type=type80160-848365615#id=0&vid=059506308eba0918daad1037ea08844a&action=click
- https://in.video.search.yahoo.com/yhs/search?fr=yhs-sz-002&ei=UTF-8&hsimp=yhs-002&hspart=sz&param1=2486481154&p=non+traditional+machining+video+links+youtube
- https://in.video.search.yahoo.com/yhs/search?fr=yhs-sz-002&ei=UTF-8&hsimp=yhs-002&hspart=sz&param1=2486481154&p=non+traditional+machining+video+links+youtube

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Visit the manufacturing Industry and study about the usage of modern machines.
- Visit any industrial exhibition centre and know about the modern machines.
- Conver any manufacturing operated machines into CNC machines by developing codes or use of AI code.

## FUNDAMENTALS OF NANOTECHNOLOGY

| | | | |
|---|---|---|---|
| **Course Code** | **24MEE455** | **CIE Marks** | **50** |
| **L:T:P:S** | **3:0:0:0** | **SEE Marks** | **50** |
| **Hrs / Week** | **3** | **Total Marks** | **100** |
| **Credits** | **03** | **Exam Hours** | **03** |

**Course outcomes:** At the end of the course, the student will be able to:

| | |
|---|---|
| 24MEE455.1 | Explain the physical, chemical, mechanical, and electrical properties of nanomaterials and their deviation from bulk counterparts. |
| 24MEE455.2 | Explain the physical, chemical, mechanical, and electrical properties of nanomaterials and their deviation from bulk counterparts. |
| 24MEE455.3 | Identify and compare various top-down and bottom-up synthesis techniques for nanomaterial fabrication. |
| 24MEE455.4 | Demonstrate knowledge of key nanomaterial characterization tools such as SEM, TEM, XRD, and AFM. |
| 24MEE455.5 | Analyze the potential applications of nanotechnology across electronics, energy, healthcare, environment, and consumer products. |
| 24MEE455.6 | Discuss the application of nanotechnology to all emerging domains |

**Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24MEE455.1 | 3 | 3 | - | - | 2 | - | - | - | - | - | - | 2 | 2 |
| 24MEE455.2 | 3 | 3 | - | - | 2 | - | - | - | - | - | - | 2 | 2 |
| 24MEE455.3 | 3 | 3 | - | - | 2 | - | - | - | - | - | - | 2 | 2 |
| 24MEE455.4 | 3 | 3 | - | - | 2 | - | - | - | - | - | - | 2 | 2 |
| 24MEE455.5 | 3 | 3 | - | - | 2 | - | - | - | - | - | - | 2 | 2 |
| 24MEE455.6 | 3 | 3 | - | - | 2 | - | - | - | - | - | - | 2 | 2 |

| | | | |
|---|---|---|---|
| **MODULE-1** | **INTRODUCTION TO NANOSCIENCE AND NANOTECHNOLOGY** | **24MEE455.1** | **8 Hours** |

Introduction: Definition, history, and evolution of nanotechnology, Nanoscale dimension and quantum confinement effects, Top-down and bottom-up approaches, Classification of nanomaterials: zero-, one-, two-, and three-dimensional, Societal impact and ethical issues in nanotechnology.

| | |
|---|---|
| Self-study | Self-study of different Nano material synthesis techniques. |
| Text Book | Text Book 1: 2.1 |

| | | | |
|---|---|---|---|
| **MODULE-2** | **PROPERTIES OF NANOMATERIALS** | **24MEE455.2** | **8 Hours** |

Mechanical, electrical, optical, magnetic, and thermal properties, Quantum size effects and surface-to-volume ratio, Surface energy and reactivity, Comparison with bulk materials, Role of defects and grain boundaries.

| | |
|---|---|
| Case Study | Case study in use of different nanomaterial characterization Techniques for different applications. |
| Text Book | Text Book 1: 3.4,3.7,3.8,5.1,5.2,5.3,5.4 |

| | | | |
|---|---|---|---|
| **MODULE-3** | **SYNTHESIS OF NANOMATERIALS** | **24MEE455.3** | **8 Hours** |

Physical methods: Ball milling, Sputtering, Evaporation, Laser ablation, Chemical methods: Sol-gel, Hydrothermal, Chemical vapor deposition (CVD), Biological methods: Microbial and plant-based synthesis, Self-assembly and templating techniques, Green nanotechnology synthesis routes.

| | |
|---|---|
| Case Study | Case study on the functions of nanomaterials. |
| Text Book | Text Book 1: 6.1,6.2,6.3,6.4,6.5,6.6,7.1,7.2,7.3,11.1,11.3,11.4,11.5,11.6 |

| MODULE-4 | CHARACTERIZATION TECHNIQUES | 24MEE455.4 | 8 Hours |
|---|---|---|---|
| X-ray Diffraction (XRD), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), UV-Vis, FTIR, and Raman spectroscopy for nanomaterial analysis. | | | |
| Case Study | Case studies on the fabrication of nano materials. | | |
| Text Book | Text Book 1: 8.1,8.2,8.4,8.7,9.1, 15.1,15.2,15.3,15.5,15.7,15.8 | | |
| **MODULE-5** | **APPLICATIONS OF NANOTECHNOLOGY** | **24MEE455.5, 24MEE455.6** | **8 Hours** |
| Nanotechnology in electronics, energy (solar cells, batteries), and environment,  Biomedical applications: drug delivery, imaging, diagnostics, Nano in agriculture and food industry, Textiles, coatings, and consumer goods, Emerging trends and future directions. | | | |
| Applications | Visiting the facility which uses applications of Nanotechnology | | |
| Text Book | Text Book 1: 14.1,14.2,18.1,18.2,18.3,18.4,20.1,20.2,20.3,20.4 | | |

**CIE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Marks Distribution | |
|---|---|---|---|
| | | Test (s) | AAT1 |
| | | 25 | 25 |
| L1 | Remember | 5 | - |
| L2 | Understand | 5 | 5 |
| L3 | Apply | 10 | 10 |
| L4 | Analyze | 5 | 10 |
| L5 | Evaluate | - | - |
| L6 | Create | - | - |
| | | | |

**SEE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| L1 | Remember | 10 |
| L2 | Understand | 10 |
| L3 | Apply | 10 |
| L4 | Analyze | 10 |
| L5 | Evaluate | 10 |
| L6 | Create | -- |

**Suggested Learning Resources:**

**Text Books:**

1. Gabor L. Hornyak, Fundamentals of Nanotechnology, CRC Press
2. Charles P. Poole Jr. & Frank J. Owens, Introduction to Nanotechnology, Wiley
3. M.S. Ramachandra Rao and Shubra Singh, Nanoscience and Nanotechnology: Fundamentals to Frontiers, Wiley

**Reference Books:**

1. Introduction to Nanoscience and Nanotechnology, Gabor L. Hornyak et al., CRC Pr I Llc; Illustrated edition, 2008
2. Nanotechnology, M. Ratner and D. Ratner, Prentice Hall, 2003
3. Nanotechnology, M. Wildon, K. Kannagara, G. Smith, M. Simmons and B. Raguse, CRC Press, 2002

**Web links and Video Lectures (e-Resources):**

https://www.youtube.com/watch?v=PNElByWIGNc https://www.youtube.com/watch?v=qUEbxTkPIWI
https://www.youtube.com/watch?v=lFYs3XDu4fQ
https://www.youtube.com/watch?v=Lpju0DTY8_g
https://www.youtube.com/watch?v=G6MIQlIIozg
https://www.youtube.com/watch?v=-gdILnzYZEg

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Visit to any Nano Technology implemented manufacturing/assembly industry
- Demonstration of Nano material synthesis operations
- Demonstration of working of Nano material synthesis machines
- Demonstration of Nano material synthesis applied to a typical case study
- Video demonstration of latest trends in nanotechnology
- Contents related activities (Activity-based discussions)
- ✓ For active participation of students, instruct the students to prepare Flowcharts and Handouts Organizing Group wise discussions on issues
- ✓ Seminars

## MATLAB FOR MECHANICAL ENGINEERS

| | | | |
|---|---|---|---|
| **Course Code** | **24MEE461** | **CIE Marks** | **50** |
| **L:T:P:S** | **0:0:1:0** | **SEE Marks** | **50** |
| **Hrs / Week** | **02** | **Total Marks** | **100** |
| **Credits** | **01** | **Exam Hours** | **03** |

**Course outcomes:**
At the end of the course, the student will be able to:

| | |
|---|---|
| 24MEE461.1 | Analyze Matrices, Differential equations, Integration, System of Linear Equations using MATLAB. |
| 24MEE461.2 | Solve engineering problems using MATLAB to develop the proficiency in variational calculus. |
| 24MEE461.3 | Solve Mechanical Engineering problems like Airfoil, Engineering mechanics, Truss, Vibration using MATLAB |
| 24MEE461.4 | Understand the Plots using MATLAB software. |

**Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24MEE461.1 | 3 | 3 | 2 | 3 | 2 | - | - | - | - | - | - | 3 | 3 |
| 24MEE461.2 | 3 | 2 | 2 | 2 | 2 | - | - | - | - | - | - | 3 | 3 |
| 24MEE461.3 | 3 | 2 | 2 | 2 | 2 | - | - | - | - | - | - | 3 | 3 |
| 24MEE461.4 | 2 | 1 | 3 | - | 2 | - | - | - | - | - | - | 3 | 3 |

| Exp. No. | List of Experiments | Hours | COs |
|---|---|---|---|
| | **Prerequisite Experiments / Programs / Demo** | | |
| | • Engineering Mathematics | | |
| | **PART-A** | | |
| 1 | Introduction to Matlab codes | 2 | 22MEE461.1 |
| 2 | Solving Matrices Problems, System of Linear Equations using MATLAB Codes. | 2 | 22MEE461.1 |
| 3 | Solving Trigonometric problems using MATLAB Code. | 2 | 22MEE461.1 |
| 4 | Solving Logorithemic Equations using MATLAB Code. | 2 | 22MEE461.2 |
| 5 | Solving Differential Equations using MATLAB Code. | 2 | 22MEE461.2 |
| 6 | Solving Differentiation and Integration Problems Using MATLAB Code | 2 | 22MEE461.2 |
| | PART-B | | |
| 7 | Solving Mechanical Engineering Problems - Engineering mechanics ,Truss problems | 2 | 22MEE461.3 |
| 8 | Solving Mechanical Engineering problems - Airfoil | 2 | 22MEE461.3 |
| 9 | Mechanical Vibration problems- Beats | 2 | 22MEE461.3 |
| 10 | Generating Overlay plots using plot command, Hold command, Line commands | 2 | 22MEE461.4 |
| 11 | Solving the Bode plots using Mat Lab code | 2 | 22MEE461.4 |
| 12 | Solving the Heat Transfer Problems using Mat Lab Code-Heat conduction problem | 2 | 22MEE461.4 |

**PART-C**

- https://www.mathworks.com/videos/virtual-labs-with-matlab-and-simulink-1605544954052.html
- https://www.mathworks.com/academia/educators/resources.html
- https://www.mathworks.com/academia/courseware/mass-spring-damper-systems.html
- https://www.mathworks.com/academia/courseware/heat-transfer.html

**CIE Assessment Pattern (50 Marks – Lab)**

| RBT Levels | | Test (s) | Weekly Assessment |
|---|---|---|---|
| | | 20 | 30 |
| L1 | Remember | - | - |
| L2 | Understand | 5 | 10 |
| L3 | Apply | 10 | 10 |
| L4 | Analyze | 5 | 10 |
| L5 | Evaluate | - | - |
| L6 | Create | - | - |

**SEE Assessment Pattern (50 Marks – Lab)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| L1 | Remember | 10 |
| L2 | Understand | 10 |
| L3 | Apply | 20 |
| L4 | Analyze | 10 |
| L5 | Evaluate | -- |
| L6 | Create | -- |

**Reference Books:**


1) Rao V Dukkipatti : Matlab for Mechanical Engineers, New Age Science,2009, ISBN 9788170374886
2) Y kirani singh, B. B. chaudhuri : Matlab Programming, PHI Learning Edition June 2007, ISBN 9788120333084

| ENERGY MANAGEMENT AND AUDITING | | | |
|---|---|---|---|
| **Course Code** | **24MEE462** | **CIE Marks** | **50** |
| **L:T:P:S** | **0:0:1:0** | **SEE Marks** | **50** |
| **Hrs / Week** | **2** | **Total Marks** | **100** |
| **Credits** | **01** | **Exam Hours** | **03** |

**Course outcomes:**

At the end of the course, the student will be able to:

| | |
|---|---|
| 24MEE462.1 | Analyze the demand-supply gap of energy in specific applications within educational buildings |
| 24MEE462.2 | Apply appropriate methods to conduct an energy audit for applications in industries or organizations |
| 24MEE462.3 | Understand and interpret the energy flow in an application by creating diagrams and analyzing energy losses |
| 24MEE462.4 | Evaluate the energy usage of an application through auditing and recommend appropriate conservation measures |

**Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24MEE462.1 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 3 | 3 |
| 24MEE462.2 | 3 | 1 | 1 | - | - | - | - | - | - | - | - | 3 | 3 |
| 24MEE462.3 | 2 | 1 | - | - | - | - | - | - | - | - | - | 3 | 3 |
| 24MEE462.4 | 3 | 3 | 2 | - | - | - | - | - | - | - | - | 3 | 3 |

| Exp. No. / Pgm. No. | List of Experiments / Programs | Hours | COs |
|---|---|---|---|
| | **Prerequisite Experiments / Programs / Demo** | | |
| | • Understand the concept of energy management and auditing in engineering field.<br>• Demonstration on energy management on various Industrial applications.<br>• Demonstration on energy auditing on various applications on different sectors. | 2 | NA |
| | **PART-A** | | |
| 1 | Determination of demand supply gap of energy in HPC lab. | 2 | 24MEE462.1 |
| 2 | Determination of demand supply gap of energy in Cooling Towers. | 2 | 24MEE462.1 |
| 3 | Determination of energy management values on Solar Collector. | 2 | 24MEE462.1 |
| 4 | Determination the efficiency of waste heat recovery system in engine setup. | 2 | 24MEE462.3 |
| 5 | Calibration on solar heating system. | 2 | 24MEE462.2 |
| 6 | Determination the Co efficient of Performance on refrigeration systems. | 2 | 24MEE462.2 |
| | **PART-B** | | |
| 7 | Investigate the energy consumption, management and audit on forced convection apparatus.. | 2 | 24MEE462.4 |
| 8 | Conduct the energy audit waste heat recovery in engine setup | 2 | 24MEE462.3 |
| 9 | Conduct the energy audit on Solar panel power generation. | 2 | 24MEE462.4 |
| 10 | Calibration of performance of cooling tower. | 2 | 24MEE462.2 |
| 11 | Conduct the energy audit on wind power generation. | 2 | 24MEE462.4 |

| | | | |
|---|---|---|---|
| 12 | Conduct the energy audit on VCR and VAR system | 2 | 24MEE462.4 |

**PART-C**
**Beyond Syllabus Virtual Lab Content**
**(To be done during Lab but not to be included for CIE or SEE)**

- http://vlabs.iitkgp.ernet.in/hm/?sub=HM01
- http://vlabs.iitb.ac.in/vlabs-dev/labs/thermodynamics/applied_thermodynamics/index.php
- http://vlab.amrita.edu/index.php%3Fsub%3D1%26brch%3D201
- http://vlabs.iitb.ac.in/vlabs-dev/labs/thermodynamics/chemical_thermodynamics/index.php
- http://vlab.amrita.edu/index.php?sub=1&brch=201
- http://vlabs.iitb.ac.in/vlabs-dev/labs/thermodynamics/refrigeration_air_conditioning/index.php

**CIE Assessment Pattern (50 Marks – Lab)**

| RBT Levels | | Test (s) | Weekly Assessment |
|---|---|---|---|
| | | 20 | 30 |
| L1 | Remember | - | - |
| L2 | Understand | 5 | 10 |
| L3 | Apply | 10 | 10 |
| L4 | Analyze | 5 | 10 |
| L5 | Evaluate | - | - |
| L6 | Create | - | - |

**SEE Assessment Pattern (50 Marks – Lab)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| L1 | Remember | - |
| L2 | Understand | 10 |
| L3 | Apply | 20 |
| L4 | Analyze | 20 |
| L5 | Evaluate | - |
| L6 | Create | - |

**Suggested Learning Resources:**

**Reference Books:**

1) Y P Abbi and Shashank Jain , Hand book on Energy Audit and Environment Management, TERI, New Delhi,2006, ISBN 9788179931013.

**Reference Books:**

1) Trivedi, PR, Jolka KR, Energy Management, Commonwealth Publication, New Delhi, 1997. ISBN-13: 978-8171694235
2) Ursala Eicker, "Solar Technologies for buildings", Wiley publications, 2003. ISBN-13: 978-0-471-48637-4

## TOOLS FOR ENERGY SYSTEM DESIGN AND DRAFTING

| | | | |
|---|---|---|---|
| **Course Code** | **24MEE463** | **CIE Marks** | **50** |
| **L:T:P:S** | **0:0:1:0** | **SEE Marks** | **50** |
| **Hrs / Week** | **2** | **Total Marks** | **100** |
| **Credits** | **01** | **Exam Hours** | **03** |

**Course outcomes:**
At the end of the course, the student will be able to:

| | |
|---|---|
| 24MEE463.1 | Understand the Indian Standards in modelling practices. |
| 24MEE463.2 | Apply energy concepts on simple mechanical elements (2D). |
| 24MEE463.3 | Create flow concepts on the practical applications (3D) using CBE comfort tool. |
| 24MEE463.4 | Visualize concepts on creating simple mechanical elements. |

**Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24MEE463.1 | 3 | 2 | 2 | - | 3 | - | - | - | 1 | 1 | - | 2 | 1 |
| 24MEE463.2 | 3 | 3 | 2 | - | 3 | - | - | - | 1 | 1 | - | 2 | 1 |
| 24MEE463.3 | 3 | 3 | 2 | - | 3 | - | - | - | 1 | 1 | - | 2 | 1 |
| 24MEE463.4 | 3 | 2 | 2 | - | 3 | - | - | - | 1 | 1 | - | 2 | 1 |

| Exp. No. / Pgm. No. | List of Experiments / Programs | Hours | COs |
|---|---|---|---|
| | **Prerequisite Experiments / Programs / Demo** | | |
| | • Computer Aided Engineering Drawing<br>• Computer Aided Machine Drawing | 2 | NA |
| | **PART-A** | | |
| 1 | Introduction to modelling software | 2 | 24MEE463.1 |
| 2 | Introduction to the different commands used in CATIA | 2 | 24MEE463.1 |
| 3 | Design of modelling solid and hallow mechanical elements | 2 | 24MEE463.1 |
| 4 | Introduction to 2D Energy tool | 2 | 24MEE463.1 |
| 5 | Experimentation on application of 2D energy tool to solid and hallow mechanical elements | 2 | 24MEE463.2 |
| 6 | Experimentation on the behavior of thermo mechanical structures. | 2 | 24MEE463.2 |
| | **PART-B** | | |
| 7 | Introduction to Predicted mean vote (PMV) and standard effective temperature (SET) | 2 | 24MEE463.2 |
| 8 | Experimentation on CBE Thermal Comfort Tool in the study of thermal comfort in buildings | 2 | 24MEE463.2 |
| 9 | Experimentation on modelling the comfort effects of short-wave solar radiation indoors | 2 | 24MEE463.3 |
| 10 | Introduction to Google sketcher and its uses | 2 | 24MEE463.3 |
| 11 | Design of modelling solid and hallow mechanical elements using sketcher. | 2 | 24MEE463.4 |

## PART-C

- https://www.youtube.com/watch?v=pAElciOJLIU
- https://shorturl.at/0pFGa
- https://shorturl.at/foXMC
- https://www.youtube.com/watch?v=Khyv_r4nlHY

**CIE Assessment Pattern (50 Marks – Lab)**

| RBT Levels | | Test (s) | Weekly Assessment |
|---|---|---|---|
| | | 20 | 30 |
| L1 | Remember | - | - |
| L2 | Understand | - | 5 |
| L3 | Apply | 5 | 10 |
| L4 | Analyze | 5 | 5 |
| L5 | Evaluate | 5 | 5 |
| L6 | Create | 5 | 5 |

**SEE Assessment Pattern (50 Marks – Lab)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| L1 | Remember | - |
| L2 | Understand | 05 |
| L3 | Apply | 10 |
| L4 | Analyze | 20 |
| L5 | Evaluate | 10 |
| L6 | Create | 05 |

**Suggested Learning Resources:**

**Reference Books:**

1) Franco Landriscina, Simulation and Learning: A Model-Centered Approach, Springer, 2013, ISBN-13: 978-1-4614-1953-2

2) Shyy, W., Thakur, S. S. , Ouyang, H., Liu, J., and Blosch, E., 1997, Computational Techniques for Complex Transport Phenomena, Cambridge University Press, Cambridge. ISBN-13: 978-0521592680

## AIR AND WATER RESOURCES ENGINEERING LAB

| | | | |
|---|---|---|---|
| **Course Code** | **24MEE464** | **CIE Marks** | **50** |
| **L:T:P:S** | **0:0:1:0** | **SEE Marks** | **50** |
| **Hrs / Week** | **02** | **Total Marks** | **100** |
| **Credits** | **01** | **Exam Hours** | **03** |

**Course outcomes:**

At the end of the course, the student will be able to:

| | |
|---|---|
| 24MEE464.1 | Apply the knowledge of mathematics, science, and environmental engineering principles to analyze and interpret air and water quality data. |
| 24MEE464.2 | Analyze the appropriate techniques, resources, and modern instruments such as pH meters, spectrophotometers, high-volume samplers, etc., for analyzing air and water samples. |
| 24MEE464.3 | Evaluate the research-based knowledge and laboratory methods to design experiments, conduct tests, analyze data, and draw valid conclusions about environmental quality. |
| 24MEE464.4 | Understand the impact of air and water pollution on ecosystems and human health, and apply this knowledge in the context of sustainable environmental practices. |

**Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24MEE464.1 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 3 | 2 |
| 24MEE464.2 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | - | 3 | 2 |
| 24MEE464.3 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | - | 3 | 2 |
| 24MEE464.4 | 2 | 2 | - | - | - | - | - | - | - | - | - | 3 | 2 |

| Exp. No. / Pgm. No. | List of Experiments / Programs | Hours | COs |
|---|---|---|---|
| | **PART-A** | | |
| 1 | Calibration of pH Measurement and Ambient Air Quality Monitoring. | 2 | 24MEE464.1 |
| 2 | Calibration of given Orifice meter and plotting the suitable calibration curve. | 2 | 24MEE464.1 |
| 3 | Determination of Dissolved Oxygen (DO) in given solution. | 2 | 24MEE464.1 |
| 4 | Determination of Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD). | 2 | 24MEE464.2 |
| 5 | Determination of Hardness of Water and Chloride Content. | 2 | 24MEE464.2 |
| 6 | Measurement of NOx, SOx, and CO | 2 | 24MEE464.2 |
| | **PART-B** | | |
| 7 | Calibration of Stack Monitoring Techniques. | 2 | 24MEE464.3 |
| 8 | Determination of Noise Level Measurement. | 2 | 24MEE464.3 |
| 9 | Determination of Total Suspended Solids (TSS). | 2 | 24MEE464.3 |
| 10 | Calibration of Gas Sampling Techniques. | 2 | 24MEE464.4 |
| 11 | Calibration of Coliform Count (MPN Method) | 2 | 24MEE464.4 |
| 12 | Preparation Wind Rose Diagram Preparation | | |

**PART-C**

- https://www.youtube.com/watch?v=LzE-cwRFuoA
- https://www.youtube.com/shorts/btIg2E5By9I
- https://www.youtube.com/shorts/qH5FAoCalnE
- https://www.youtube.com/shorts/JJDxtVywRyU

- https://www.youtube.com/watch?v=K-tzydTuGeg

**CIE Assessment Pattern (50 Marks – Lab)**

| RBT Levels | | Test (s) | Weekly Assessment |
|---|---|---|---|
| | | 20 | 30 |
| L1 | Remember | - | - |
| L2 | Understand | 5 | 10 |
| L3 | Apply | 10 | 10 |
| L4 | Analyze | 5 | 10 |
| L5 | Evaluate | - | - |
| L6 | Create | - | - |

**SEE Assessment Pattern (50 Marks – Lab)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| L1 | Remember | - |
| L2 | Understand | 10 |
| L3 | Apply | 10 |
| L4 | Analyze | 20 |
| L5 | Evaluate | - |
| L6 | Create | - |

**Suggested Learning Resources:**

**Reference Books:**

1) Warren Viessman Jr. & Mark J. Hammer., "Water Supply and Pollution Control", 9th edition, Pearson Education, 2018 ISBN 9788131808153

2) Nelson L. Nemerow, "Environmental Engineering: Water, Wastewater, Soil and Groundwater Treatment and Remediation", 6th edition, Wiley Publishers, ISBN 9789385401374

## INTRODUCTION TO AUGMENTED AND VIRTUAL REALITY

| | | | |
|---|---|---|---|
| **Course Code** | **24MEE465** | **CIE Marks** | **50** |
| **L:T:P:S** | **0:0:1:0** | **SEE Marks** | **50** |
| **Hrs / Week** | **2** | **Total Marks** | **100** |
| **Credits** | **01** | **Exam Hours** | **03** |

**Course outcomes:**

At the end of the course, the student will be able to:

| | |
|---|---|
| 24MEE465.1 | Investigate digital product creation technology and Set up platform technology for VR and AR experiences. |
| 24MEE465.2 | Implement controls for virtual object interactions also apply instantiation and related features for gaming objects. |
| 24MEE465.3 | Design an interactive UI with control tools. |
| 24MEE465.4 | Develop an interactive gaming app using available assets. |

**Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24MEE465.1 | 3 | 2 | 1 | - | 3 | - | - | - | - | - | - | 3 | 2 |
| 24MEE465.2 | 3 | 2 | - | - | 3 | - | - | - | - | - | - | 3 | 2 |
| 24MEE465.3 | 3 | 3 | 2 | - | 3 | - | - | - | 3 | - | - | 3 | 2 |
| 24MEE465.4 | 3 | 3 | 2 | - | 3 | - | - | - | 3 | - | - | 3 | 2 |

| Exp. No. / Pgm. No. | List of Experiments / Programs | Hours | COs |
|---|---|---|---|
| | **Prerequisite Experiments / Programs / Demo** | | |
| | Proficiency in programming languages like C# or C++,<br>Knowledge of 3D graphics and game development | 2 | NA |
| | **PART-A** | | |
| 1. | Build a Metaverse Avatar: Create your own Metaverse avatars using Metaverse platforms like Roblox or VR Chat. Also customize their avatars' appearance and experiment with different virtual identities. | 2 | 24MEE465.1 |
| 2. | Virtual World Exploration: Explore a Metaverse platform of your choice. Document the experiences, noting features, interactions, and any challenges which are encountered. | 2 | 24MEE465.1 |
| 3. | Get started with Unity: Install and configure your development environment. Craft and customize sprites for your game's visual elements. | 2 | 24MEE465.1 |
| 4. | Manage and optimize internal game assets efficiently. Control the game flow by saving and loading scenes seamlessly | 2 | 24MEE465.2 |
| 5. | Generate a character featuring Rigid Body and Collider components. Develop a script for nuanced control over acceleration, deceleration, and character movement. | 2 | 24MEE465.2 |
| 6. | Utilize ray casting to establish grounded status, permitting jumps exclusively when the character is on solid ground.<br>Incorporate customizable parameters for jump height, movement speed, and more | 2 | 24MEE465.2 |
| | **PART-B** | | |
| 7 | Craft a game object, tailor its attributes, and enhance it with various components. Craft a script that spawns a game object precisely at the mouse click location. | 2 | 24MEE465.3 |

| | | | |
|---|---|---|---|
| 8 | Develop a coroutine for a gradual, time-based transformation of a game object's color. | 2 | 24MEE465.3 |
| 9 | Construct a script deliberately containing errors (e.g., attempting to access a non-existent component) to explore error message outputs in the console | 2 | 24MEE465.3 |
| 10 | Create a Canvas object by right-clicking in the Hierarchy and selecting "UI" > "Canvas," then configure its Render Mode to "Screen Space - Overlay. | 2 | 24MEE465.4 |
| 11 | Craft a straightforward material for an object within the scene, such as a sphere, and experiment with various shader options, including properties like color, emission, and transparency. | 2 | 24MEE465.4 |
| 12 | Access the Unity Asset Store through Unity's Window menu, and explore available free or trial assets that can enhance your scene, such as UI elements, shaders, particle effects, or 3D models. | 2 | 24MEE465.4 |

## PART-C
## Beyond Syllabus Virtual Lab Content

- https://learn.unity.com/course/create-with-vr
- https://www.lncc.br/~jauvane/papers/RelatorioTecnicoLNCC-0603
- https://mv-iitkgp.vlabs.ac.in/List%20of%20experiments.html
- https://mv-iitkgp.vlabs.ac.in/exp/pitot-tube/

**CIE Assessment Pattern (50 Marks – Lab)**

| RBT Levels | | Test (s) | Weekly Assessment |
|---|---|---|---|
| | | 20 | 30 |
| L1 | Remember | - | - |
| L2 | Understand | 5 | 10 |
| L3 | Apply | 10 | 10 |
| L4 | Analyze | 5 | 10 |
| L5 | Evaluate | - | - |
| L6 | Create | - | - |

**SEE Assessment Pattern (50 Marks – Lab)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| L1 | Remember | - |
| L2 | Understand | 10 |
| L3 | Apply | 20 |
| L4 | Analyze | 20 |
| L5 | Evaluate | - |
| L6 | Create | - |

**Suggested Learning Resources:**

**Text Books:**

1) Unity in Action: Multiplatform Game Development in C#, By Joe Hocking, Manning Publications, 2015, ISBN: 978-1617292323.
2) Unity Animation Essentials by Alan Thorn, Packt Publishers, 2015, ISBN: 978-1782174813.

**Reference Books:**

1) Unity Artificial Intelligence Programming" by Dr. Davide Aversa, Packt, 2022, ISBN: 9781803238531.

**Web links and Video Lectures (e-Resources):**

- https://onlinecourses.nptel.ac.in/noc22_ge24/preview
- https://biodesign.berkeley.edu/bioinspired-design-course/
- https://www.youtube.com/watch?v=cwxXY9Qe8ss
- https://www.youtube.com/watch?v=V2GvQXvjhLA

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- **VR Game Jam:** Practice a VR game jam where students have a limited time (e.g., 48 hours) to design and develop a complete VR game. They provide a theme or specific constraints to make it more challenging.
- **Cross-Platform Compatibility:** Challenges to develop a VR app that works seamlessly across multiple VR platforms (e.g., Oculus Rift, HTC Vive, and mobile VR).
- **Immersive Storytelling:** Create an immersive VR storytelling experience with interactive elements and branching narratives.

## DESIGN THINKING AND FABRICATION

| | | | |
|---|---|---|---|
| **Course Code** | **24DTK47** | **CIE Marks** | **50** |
| **L:T:P:S** | **1:0:0:0** | **SEE Marks** | **50** |
| **Hrs / Week** | **01** | **Total Marks** | **100** |
| **Credits** | **01** | **Exam Hours** | **02** |

**Course outcomes:**

At the end of the course, the student will be able to:

| | |
|---|---|
| 24DTK47.1 | Identify innovation opportunities through real-world problem analysis and observation. |
| 24DTK47.2 | Propose a product or service idea using technical knowledge and feasibility insights. |
| 24DTK47.3 | Demonstrate empathy and creative thinking in the ideation and concept generation stages. |
| 24DTK47.4 | Design, prototype, and test functional models using appropriate tools and fabrication |

**Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24DTK47.1 | 3 | - | - | - | - | - | - | - | - | - | - | 2 | 1 |
| 24DTK47.2 | 3 | 3 | 2 | - | - | - | - | - | - | - | - | 2 | 1 |
| 24DTK47.3 | 3 | 3 | 2 | - | - | - | - | - | - | - | - | 3 | 1 |
| 24DTK47.4 | 3 | 3 | 2 | 1 | 2 | - | - | - | - | - | 2 | 3 | 1 |

| | | | |
|---|---|---|---|
| **MODULE-1** | **INTRODUCTION TO DESIGN THINKING** | **24DTK47.1 24DTK47.3** | **3 Hours** |

Definition, origin, and key features of Design Thinking. Role of a Design Thinker in organisations. Core principles and stages of the Design Thinking process. Collaborative design thinking with examples of MVPS or prototyping

| | |
|---|---|
| Self-study | Smart Agricultural Monitoring System |
| Text Book: | Text Book 1: 2.1,2.2,2.4,2.5,2.6,2.7<br>Text Book 2: Page No. 1-90 |

| | | | |
|---|---|---|---|
| **MODULE-2** | **DESIGN THINKING METHODOLOGY** | **24DTK47.3** | **3 Hours** |

Design Thinking Methodology: The 5 Stages of the Design Thinking Process- Empathise, define (the problem), Ideate, Prototype, and Test.

| | |
|---|---|
| Self-study | Autonomous Drone for Aerial Surveillance |
| Text Book | Text Book 1:5.1,5.2,5.3<br>Text Book 2: Page No.100-124 |

| | | | |
|---|---|---|---|
| **MODULE-3** | **TOOLS FOR DESIGN THINKING** | **24DTK47.1** | **3 Hours** |

Ideation tools & exercises. Sample Design Challenge, Introduction to the Design Challenge Themes, Storytelling and Tools for Innovation.

| | |
|---|---|
| Self-study | Smart Home Automation System |
| Text Book | Text Book 1:4.1,4.2,4.6,4.8,6.1,6.2,6.3, Text Book 2: Page No.125-138 |

| | | | |
|---|---|---|---|
| **MODULE-4** | **EMPATHY MAPS** | **24DTK47.3** | **3 Hours** |

Empathise-Understand customers, Empathy Maps, Empathise-Step into customers' shoes, Customer Journey Maps, Define- Analysis & Drawing Inferences from Research.

| | |
|---|---|
| Self-study | Custom Drone with Payload Integration for Search and Rescue |
| Text Book | Text Book 1: 9.1,9.2,9.3,10.1,10.2,10.3,10.4<br>Text Book 2:Page No.139-146 |

| | | | |
|---|---|---|---|
| **MODULE-5** | **DESIGN CHALLENGE AND PROTOTYPING** | **24DTK47.2 24DTK47.4** | **3 Hours** |

The Design Challenge: Define the Design Challenge, Prototyping & Iteration- Feasibility Study, Testing, Documentation, and the Pitching.

| | |
|---|---|
| Self-study | Automated PCB Inspection System |
| Text Book | Text Book 1:3.1,3.2<br>Text Book 2: Page No.147 and 189 |

**CIE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Marks Distribution | | |
|---|---|---|---|---|
| | | Test (s) | AAT1 | AAT2 |
| | | 25 | 15 | 10 |
| L1 | Remember | 5 | - | - |
| L2 | Understand | 5 | - | - |
| L3 | Apply | 10 | - | - |
| L4 | Analyze | 5 | 5 | - |
| L5 | Evaluate | - | 5 | 5 |
| L6 | Create | - | 5 | 5 |

**SEE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| L1 | Remember | 10 |
| L2 | Understand | 10 |
| L3 | Apply | 10 |
| L4 | Analyze | 10 |
| L5 | Evaluate | 10 |
| L6 | Create | - |

**Suggested Learning Resources:**

**Text Books:**


1) Christian Mueller-Roterberg, Handbook of Design Thinking - Tips & Tools for how to design thinking. ISBN-13: 978-1790435371
2) John. R. Karsnitz, Stephen O'Brien and John P. Hutchinson, "Engineering Design", Cengage learning (International edition) Second Edition, 2013. ISBN-13: 978-1111645823


**Reference Books:**


1) Roger Martin, "The Design of Business: Why Design Thinking is the Next Competitive Advantage", Harvard Business Press, 2009. ISBN-13: 978-1422177808
2) Hasso Plattner, Christoph Meinel and Larry Leifer (eds), "Design Thinking: Understand – Improve - Apply", Springer, 2011, ISBN-13: 978-3-642-13756-3
3) Yousef Haik and Tamer M. Shahin, "Engineering Design Process", Cengage Learning, Second Edition, 2011. 48 , ISBN-13: 978-0495668145
4) Book - Solving Problems with Design Thinking - Ten Stories of What Works (Columbia Business School Publishing) Hardcover – 20 Sep 2013 by Jeanne Liedtka (Author), Andrew King (Author), Kevin Bennett (Author), ISBN-13: 978-0231163569


**Web links and Video Lectures (e-Resources)**

- https://www.ibm.com/design/thinking/
- https://www.ideou.com/pages/design-thinking

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Ergonomic Kitchen Tool Handle: Reverse Engineering and Redesign
- Customizable Modular Furniture System: From Concept to Prototype
- Rapid PCB Prototyping for Bluetooth Applications
- CNC Milling for Custom Circuit Board Fabrication
- Smart Motion Detection System Using Microprocessor

- IoT-Based Smart Home Automation System Using Microprocessor
- Design and Fabrication of Rotary Milling Fixture
- Design and Fabrication of Milling Vise Attachment on Lathe Machine
- AI-Driven Drone for Search and Rescue Operations
- Autonomous Drone for Wildfire Detection and Monitoring
- Drone-Based Delivery System for Emergency Medical Supplies

## MINI PROJECT

| | | | |
|---|---|---|---|
| **Course Code** | **24MEE48** | **CIE Marks** | **50** |
| **L: T:P:S** | **0:0:1:0** | **SEE Marks** | **50** |
| **Hrs / Week** | **2** | **Total Marks** | **100** |
| **Credits** | **01** | **Exam Hours** | **03** |

**Course outcomes:**

At the end of the course, the student will be able to:

| | |
|---|---|
| 24MEE48.1 | Identify an open ended problem in area of mechanical engineering |
| 24MEE48.2 | Identify the methods and materials required for the project work |
| 24MEE48.3 | Apply the theoretical concepts to solve industrial problems with teamwork and multidisciplinary approach. |
| 24MEE48.4 | Formulate and implement innovative ideas for social and environmental benefit |
| 24MEE48.5 | Analyze the results to come out with concrete solutions |
| 24MEE48.6 | Demonstrate professionalism with ethics; present effective communication skills and relate engineering issues to broader societal context |

**MAPPING OF CO WITH POS**

| CO'S | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24MEE48.1 | 2 | 3 | 3 | 2 | | _ | 1 | _ | 3 | 1 | 2 | 1 | _ |
| 24MEE48.2 | 2 | 1 | 2 | 3 | 2 | _ | _ | _ | 2 | 2 | 2 | 2 | _ |
| 24MEE48.3 | 2 | 2 | 3 | 2 | 1 | _ | _ | _ | 3 | 1 | 3 | 2 | _ |
| 24MEE48.4 | 2 | 3 | 2 | 3 | 2 | _ | 2 | _ | 2 | 2 | 2 | _ | 3 |
| 24MEE48.5 | 1 | 2 | 3 | 2 | 2 | _ | _ | _ | 3 | 2 | 3 | _ | 3 |
| 24MEE48.6 | 2 | 2 | 2 | 1 | 2 | _ | _ | _ | 2 | 1 | 2 | _ | 2 |

**Mini Project Roadmap:**

**Project Overview:**

- Clearly define the project's scope, objectives, and expected outcomes.
- Provide a brief description of the problem the project aims to solve or the functionality it should implement.

**Project Milestones:**

- Set clear project milestones and deadlines for various phases, such as planning, design, implementation, testing, and presentation.

**Project Requirements:**

- List the specific features or functionality that students need to implement in their projects.
- Clearly state any constraints or limitations they should be aware of during development.

**Testing and Quality Assurance:**

- Incorporate testing practices into their development process.
- Specify the types of testing (e.g., unit testing, integration testing)

**Collaboration and Communication:**

- If the project involves teamwork, outline expectations for collaboration, including communication channels and responsibilities within the team.

**Documentation:**

- Emphasize the importance of thorough documentation throughout the project.
- Require students to maintain documentation for code, design, and usage instructions.

**Presentation:**

- Require students to present their projects to the class, explaining their design choices, challenges faced, and how they overcame them.

**CIE Assessment Pattern (50 Marks – Reviews as per the rubric statements defined)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| L1 | Remember | - |
| L2 | Understand | - |
| L3 | Apply | 20 |
| L4 | Analyze | 10 |
| L5 | Evaluate | 10 |
| L6 | Create | 10 |

**SEE Assessment Pattern (50 Marks – Theory)**

| RBT Levels | | Exam Marks Distribution (50) |
|---|---|---|
| L1 | Remember | - |
| L2 | Understand | - |
| L3 | Apply | 20 |
| L4 | Analyze | 10 |
| L5 | Evaluate | 10 |
| L6 | Create | 10 |

**Suggested Learning Resources:**

**Text Books:**

**1.** Kothari, C.R., 2018. Research Methodology: Methods and Techniques. New Age International. ISBN-13: 978-8122436235

2) Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2015, An introduction to Research Methodology, RBSA Publishers. ISBN-13: 978-8176111652

3) Ranjithkumar, 2014, research methodology, saga publications,4th edition ISBN-13- 978- 9351501336

**Reference Books:**

1.Anderson, T. W., 2011, An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi. ISBN-13: 978-8126524488

2) Montgomary, Douglas C. &Runger, George C. (2016) 6/e, Applied Statistics & probability for Engineers (Wiley India) ISBN-13: 978-1118539712

**Web links and Video Lectures (e-Resources):**

- https://www.youtube.com/watch?v=YScxVF6ZcYI
- https://www.youtube.com/watch?v=9WMgaulAJ-0

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

These challenging mini project activities can provide students with opportunities to think critically, apply their knowledge, and develop problem-solving skills in a practical context.

**Interdisciplinary Projects**:

- Encourage collaboration among students from different disciplines to work on projects that require diverse expertise.

**Prototype Development**:

- Challenge students to create a prototype of a product or device.

**Simulation and Modelling**:

- Task students with creating computer simulations or mathematical models to solve complex problems or simulate real-world scenarios.

**Humanitarian and Social Impact Projects**:

- Challenge students to develop projects that address social or humanitarian issues, such as providing clean water solutions, designing low-cost healthcare devices, or improving education in underserved communities.

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**Environmental Sustainability Projects**:

- Challenge students to propose and implement sustainability initiatives or renewable energy projects.

**Scientific Research Projects**:

- Assign students to conduct scientific research experiments, gather data, and present findings.

| NATIONAL SERVICE SCHEME | | | |
|---|---|---|---|
| **Course Code** | **24NSS30, 24NSS40, 24NSS50, 24NSS60** | **CIE Marks (each Semester)** | **50** |
| **L:T:P:S** | **0:0:0:0** | **SEE Marks** | **--** |
| **Hrs / Week** | **2** | **Total Marks** | **50 x 4 = 200** |
| **Credits** | **00** | **Exam Hours** | **02** |

**Course outcomes:**
At the end of the course, the student will be able to:

| | |
|---|---|
| 24NSSX0.1 | Understand the importance of his / her responsibilities towards society. |
| 24NSSX0.2 | Analyse the environmental and societal problems/issues and will be able to design solutions for the same. |
| 24NSSX0.3 | Evaluate the existing system and to propose practical solutions for the same for sustainable development. Implement government or self-driven projects effectively in the field. |
| 24NSSX0.4 | Develop capacity to meet emergencies and natural disasters & practice national integration and social harmony in general. |

**Mapping of Course Outcomes to Program Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 24NSSX0.1 | - | - | - | - | - | 3 | 3 | 2 | - | - | 1 |
| 24NSSX0.2 | - | - | - | - | - | 3 | 3 | 2 | - | - | 1 |
| 24NSSX0.3 | - | - | - | - | - | 3 | 3 | 2 | - | - | 1 |
| 24NSSX0.4 | - | - | - | - | - | 3 | 3 | 2 | - | - | 1 |

| Semester/ Course Code | CONTENT | COs | HOURS |
|---|---|---|---|
| **3RD 24NSS30** | 1. Organic farming, Indian Agriculture (Past, Present and Future) Connectivity for marketing<br>2. Waste management–Public, Private and Govt organization, 5R's.<br>3. Setting of the information imparting club for women leading to contribution in social and economic issues. | 24NSS30.1, 24NSS30.2, 24NSS30.3, 24NSS30.4 | 30 HRS |
| **4TH 24NSS40** | 4. Water conservation techniques – Role of different stakeholders– Implementation.<br>5. Preparing an actionable business proposal for enhancing the village income and approach forimplementation.<br>6. Helping local schools to achieve good results and enhance their enrolment in Higher/ technical/ vocational education. | 24NSS40.1, 24NSS40.2, 24NSS40.3, 24NSS40.4 | 30 HRS |
| **5TH 24NSS50** | 7. Developing Sustainable Water management system for rural areas and implementationapproaches.<br>8. Contribution to any national level initiative of Government of India. Foreg. Digital India, Skill India, Swachh Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme, Skill developmentprograms etc.<br>9. Spreading public awareness under rural outreach programs. (minimum 5 programs). | 24NSS50.1, 24NSS50.2, 24NSS50.3, 24NSS50.4 | 30 HRS |
| **6TH 24NSS60** | 10. Organize National integration and social harmony events / workshops / seminars. (Minimum TWO programs).<br>11. Govt. school Rejuvenation and helping them to achieve good infrastructure. | 24NSS60.1, 24NSS60.2, 24NSS60.3, 24NSS60.4 | 30 HRS |

**CIE Assessment Pattern (50 Marks – Activity based) –**

| CIE component for every semester | Marks |
|---|---|
| Presentation - 1<br>Selection of topic, PHASE - 1 | 10 |
| Commencement of activity and its progress - PHASE - 2 | 10 |
| Case study-based Assessment Individual performance | 10 |
| Sector wise study and its consolidation | 10 |
| Video based seminar for 10 minutes by each student at the end of semester with Report. | 10 |
| **Total marks for the course in each semester** | **50** |

- Implementation strategies of the project (NSS work).
- The last report should be signed by NSS Officer, the HOD and principal.
- At last report should be evaluated by the NSS officer of the institute.
- Finally, the consolidated marks sheet should be sent to the university and also to be made available at LIC visit.

**Suggested Learning Resources:**

**Reference Books:**

1. NSS Course Manual, Published by NSS Cell, VTU Belagavi.
2. Government of Karnataka, NSS cell, activities reports and its manual.
3. Government of India, NSS cell, Activities reports and its manual.

**Pre-requisites to take this Course:**

1. Students should have a service-oriented mindset and social concern.
2. Students should have dedication to work at any remote place, anytime with available resources and proper time management for the other works.
3. Students should be ready to sacrifice some of the time and wishes to achieve service-oriented targets on time.

**Pedagogy:**

- In every semester from 3rd semester to 6th semester, each student should do activities according to the scheme and syllabus.
- At the end of every semester student performance has to be evaluated by the NSS officer for the assigned activity progress and its completion.
- At last, in 6th semester consolidated report of all activities from 3rd to 6th semester, compiled report should be submitted as per the instructions.
- State the need for NSS activities and its present relevance in the society and provide real-life examples.
- Support and guide the students for self-planned activities.
- NSS coordinator will also be responsible for assigning homework, grading assignments and quizzes, and documenting students' progress in real activities in the field.
- Encourage the students for group work to improve their creative and analytical skills.

## Plan of Action:

- Student/s in individual or in a group Should select any one activity in the beginning of each semester till end of that respective semester for successful completion as per the instructions of NSS officer with the consent of HOD of the department.
- At the end of every semester, activity report should be submitted for evaluation.
- Practice Session Description:

- Lecture session by NSS Officer
- Students Presentation on Topics
- Presentation - 1, Selection of topic, PHASE – 1
- Commencement of activity and its progress - PHASE – 2
- Execution of Activity
- Case study-based Assessment, Individual performance
- Sector/ Team wise study and its consolidation
- Video based seminar for 10 minutes by each student at the end of semester with Report.

| Sl No | Topic | Groupsize | Location | Activity execution | Reporting | Evaluation of the Topic |
|---|---|---|---|---|---|---|
| 1. | Organic farming, IndianAgriculture (Past, Present and Future) Connectivity for marketing. | May be individual or team | Farmers land/Villages/ roadside / Community area / College campus | Site selection /proper consultation/ Continuous monitoring/ Information board | Report should be submitted byindividual to the concerned evaluation authority | Evaluation as per the rubrics of scheme and syllabus by NSS officer |
| 2. | Waste management– Public, Private and Govtorganization, 5 R's. | May be individual or team | Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus | Site selection /proper consultation/ Continuous monitoring/ Information board | Report should be submitted byindividual to the concerned evaluation authority | Evaluation as per the rubrics of scheme and syllabus by NSS officer |
| 3. | Setting of the information imparting club for women leading to contributionin social and economic issues. | May be individual or team | Women empowerment groups/ Consulting NGOs & Govt Teams / College campus | Group selection/proper consultation/ Continuous monitoring/ Information board | Report should be submitted byindividual to the concerned evaluation authority | Evaluation as per the rubrics of scheme and syllabus by NSS officer |
| 4. | Water conservation techniques – Role of different stakeholders– Implementation. | May be individual or team | Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus | site selection / proper consultation/ Continuous monitoring/ Information board | Report should be submitted byindividual to the concerned evaluation authority | Evaluation as per the rubrics of scheme and syllabus by NSS officer |

| | | | | | | |
|---|---|---|---|---|---|---|
| 5. | Preparing an actionable business proposal for enhancing the village income and approach for implementation. | May be individual or team | Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus | Group selection/proper consultation/ Continuous monitoring/ Information board | Report should be submitted byindividual to the concerned evaluation authority | Evaluation as per the rubrics of scheme and syllabus by NSS officer |
| 6. | Helping local schools toachieve good results and enhance their enrolment in Higher/ technical/ vocational education. | May be individual or team | Local government / private/ aided schools/Government Schemes officers | School selection/proper consultation/ Continuous monitoring/ Information board | Report should be submitted byindividual to the concerned evaluation authority | Evaluation as per the rubrics of scheme and syllabus by NSS officer |
| 7. | Developing SustainableWater management system for rural areas and implementation approaches. | May be individual or team | Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus | site selection/proper consultation/ Continuous monitoring/ Information board | Report should be submitted byindividual to the concerned evaluation authority | Evaluation as per the rubrics of scheme and syllabus by NSS officer |
| 8. | Contribution to any national level initiative of Government of India.For eg. Digital India, Skill India, Swachh Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme,Skill development programs etc. | May be individual or team | Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus | Group selection/proper consultation/ Continuous monitoring / Information board | Report should be submitted byindividual to the concerned evaluation authority | Evaluation as per the rubrics of scheme and syllabus by NSS officer |

| | | | | | | |
|---|---|---|---|---|---|---|
| 9. | Spreading public awareness under ruraloutreach programs. (minimum5 programs) | May be individual or team | Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus | Group selection/pro per consultation/ Continuous monitoring / Information board | Report should be submitted byindividual to the concerned evaluation authority | Evaluation as per the rubrics of scheme and syllabus by NSS officer |
| 10. | Organize National integration and socialharmony events / workshops / seminars. (Minimum 02 programs). | May be individual or team | Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus | Place selection/pro per consultation/ Continuous monitoring / Information board | Report should be submitted byindividual to the concerned evaluation authority | Evaluation as per the rubrics of scheme and syllabus by NSS officer |
| 11. | Govt. school Rejuvenation and helping them to achieve good infrastructure. | May be individual or team | Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus | Place selection/pro per consultation/ Continuous monitoring / Information board | Report should be submitted byindividual to the concerned evaluation authority | Evaluation as per the rubrics of scheme and syllabus by NSS officer |

## PHYSICAL EDUCATION AND SPORTS

| | | | |
|---|---|---|---|
| **Course Code** | **24PED30, 24PED40, 24PED50, 24PED60** | **CIE Marks (each semester)** | **50** |
| **L:T:P:S** | **0:0:0:0** | **SEE Marks** | **--** |
| **Hrs / Week** | **2** | **Total Marks** | **50 x 4= 200** |
| **Credits** | **00** | **Exam Hours** | **02** |

**Course outcomes:**

At the end of the course, the student will be able to:

| | |
|---|---|
| 24PEDX0.1 | Understand the fundamental concepts and skills of Physical Education, Health, Nutrition and Fitness |
| 24PEDX0.2 | Create consciousness among the students on Health, Fitness and Wellness in developing and maintaining a healthy lifestyle |
| 24PEDX0.3 | Perform in the selected sports or athletics of student's choice and participate in the competition at regional/state / national / international levels. |
| 24PEDX0.4 | Understand the roles and responsibilities of organization and administration of sports and games |

**Mapping of Course Outcomes to Program Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24PEDX0.1 | - | - | - | - | - | 2 | - | 3 | 3 | - | 2 | |
| 24PEDX0.2 | - | - | - | - | - | 2 | - | 3 | 3 | - | 2 | |
| 24PEDX0.3 | - | - | - | - | - | 2 | - | 3 | 3 | - | 2 | |
| 24PEDX0.4 | - | - | - | - | - | 2 | - | 3 | 3 | - | 2 | |

| Semester | CONTENT | COs | HOURS |
|---|---|---|---|
| 3RD 24PED30 | **Module 1: Orientation**<br>A. Lifestyle,<br>B. Fitness<br>C. Food & Nutrition<br>D. Health & Wellness<br>E. Pre-Fitness test. | 24PED30.1, 24PED30.2 | 5 HRS |
| | **Module 2: General Fitness & Components of Fitness**<br>A. Warming up (Free Hand exercises)<br>B. Strength – Push-up / Pull-ups<br>C. Speed – 30 Mtr Dash<br>D. Agility – Shuttle Run<br>E. Flexibility – Sit and Reach<br>F. Cardiovascular Endurance – Harvard step Test | 24PED30.2, 24PED30.3 | 15 HRS |
| | **Module 3: Recreational Activities**<br>A. Postural deformities.<br>B. Stress management.<br>C. Aerobics.<br>D. Traditional Games. | 24PED30.3, 24PED30.4 | 10 HRS |
| 4TH 24PED40 | **Module 1: Ethics and Moral Values**<br>A. Ethics in Sports<br>B. Moral Values in Sports and Games | 24PED40.1, 24PED40.2 | 5 HRS |
| | **Module 2: Specific Games (Anyone to be selected by the** | 24PED40.3 | 20 HRS |

| | | | |
|---|---|---|---|
| | **student)**<br>A. Volleyball – Attack, Block, Service, Upper Hand Pass and Lower hand Pass.<br>B. Throwball – Service, Receive, Spin attack, Net Drop & Jump throw.<br>C. Kabaddi – Hand touch, Toe Touch, Thigh Hold, Ankle hold and Bonus.<br>D. Kho-Kho – Giving Kho, Single Chain, Pole dive, Pole turning, 3-6 Up.<br>E. Table Tennis – Service (Fore Hand & Back Hand), Receive (Fore Hand & Back Hand), Smash.<br>F. Athletics (Track / Field Events) – Any event as per availability of Ground. | | |
| | **Module 3: Role of Organization and administration** | 24PED40.4 | 5 HRS |
| **5TH**<br>**24PED50** | **Fitness Components:** Meaning and Importance, Fit India Movement, Definition of fitness, Components of fitness, Benefits of fitness, Types of fitness and Fitness tips.<br>**Practical Components:** Speed, Strength, Endurance, Flexibility, and Agility<br>**Athletics**:<br>1. Track -Sprints:<br>• Starting Techniques: Standing start and Crouch start (its variations) use of Starting Block.<br>• Acceleration with proper running techniques.<br>• Finishing technique: Run Through, Forward Lunging and Shoulder Shrug.<br>2. Jumps- Long Jump: Approach Run, Take-off, Flight in the air (Hang Style/Hitch Kick)and Landing<br>3. Throws- Shot Put: Holding the Shot, Placement, Initial Stance, Glide, Delivery Stance and Recovery (Perry O'Brien Technique)<br>**Handball OR Ball Badminton**<br>**Handball:**<br>A. Fundamental Skills<br>1. Catching, Throwing and Ball control,<br>2. Goal Throws: Jumpshot, Centershot, Diveshot, Reverseshot.<br>3. Dribbling: High and low.<br>4. Attack and counter attack, simple counter attack, counter attack from two wings and center.<br>5. Blocking, Goal Keeping and Defensive skills.<br>6. Game practice with application of Rules and Regulations.<br>B. Rules and their interpretations and duties of officials<br>**Ball badminton:**<br>A. Fundamental Skills<br>1. Basic Knowledge: Various parts of the Racket and Grip.<br>2. Service: Short service, Long service, Long-high service.<br>3. Shots: Overhead shot, Defensive clearshot, Attacking clearshot, Dropshot, Netshot, Smash.<br>4. Game practice with application of Rules and Regulations.<br>B. Rules and their interpretation and duties of officials. | 24PED50.1,<br>24PED50.2,<br>24PED50.3,<br>24PED50.4 | Total 30 Hrs/ Semester<br><br>2 Hrs/week |

| | | | |
|---|---|---|---|
| **6TH 24PED60** | **Athletics**:<br>1. Track -110 Mtrs and 400Mtrs:<br>• Hurdling Technique: Lead leg Technique, Trail leg Technique, Side Hurdling, Over the Hurdles<br>• Crouch start (its variations) use of Starting Block.<br>• Approach to First Hurdles, In Between Hurdles, Last Hurdles to Finishing.<br>2. Jumps- High jump: Approach Run, Take-off, Bar Clearance (Straddle) and Landing.<br>3. Throws- Discus Throw: Holding the Discus, Initial Stance Primary Swing, Turn, Release and Recovery (Rotation in the circle).<br><br>**Football OR Hockey**<br>**Football:**<br>A. Fundamental Skills<br>1. Kicking: Kicking the ball with inside of the foot, Kicking the ball with Full Instep of the foot, Kicking the ball with Inner Instep of the foot, Kicking the ball with Outer Instep of the foot and Lofted Kick.<br>2. Trapping: Trapping- the Rolling ball, and the Bouncing ball with sole of the foot.<br>3. Dribbling: Dribbling the ball with Instep of the foot, Dribbling the ball with Inner and Outer Instep of the foot.<br>4. Heading: In standing, running and jumping condition.<br>5. Throw-in: Standing throw-in and Running throw-in.<br>6. Feinting: With the lower limb and upper part of the body.<br>7. Tackling: Simple Tackling, Slide Tackling.<br>8. Goal Keeping: Collection of Ball, Ball clearance-kicking, throwing and deflecting.<br>9. Game practice with application of Rules and Regulations.<br><br>A. Rules and their interpretation and duties of officials.<br><br>**Hockey:**<br>A. Fundamental Skills<br>1. Passing: Short pass, Longpass, pushpass, hit<br>2. Trapping.<br>3. Dribbling and Dozing<br>4. Penalty stroke practice.<br>5. Penalty corner practice.<br>6. Tackling: Simple Tackling, Slide Tackling.<br>7. Goal Keeping, Ball clearance- kicking, and deflecting.<br>8. Game practice with application of Rules and Regulations.<br>B. Rules and their interpretation and duties of officials | 24PED60.1, 24PED60.2, 24PED60.3, 24PED60.4 | Total 30 Hrs/ Semester<br><br>2 Hrs/week |
| | | | |

**CIE Assessment Pattern (50 Marks – Practical) –**

CIE to be evaluated every semester end based on practical demonstration of Sports and Athletics activities learnt in the semester.

| CIE | Marks |
|---|---|
| Participation of student in all the modules | 10 |
| Quizzes – 2, each of 7.5 marks | 15 |
| Final presentation / exhibition / Participation in competitions/ practical on specific tasks assigned to the students | 25 |
| **Total** | **50** |

**Suggested Learning Resources:**

**Reference Books:**


1. Saha, A.K. Sarir Siksher Ritiniti, Rana Publishing House, Kalyani.
2. Bandopadhyay, K. Sarir Siksha Parichay, Classic Publishers, Kolkata.
3. Petipus, et.al., Athlete's Guide to Career Planning, Human Kinetics.
4. Dharma, P.N. Fundamentals of Track and Field, Khel Sahitya Kendra, New Delhi.
5. Jain, R. Play and Learn Cricket, Khel Sahitya Kendra, New Delhi.
6. Vivek Thani, Coaching Cricket, Khel Sahitya Kendra, New Delhi.
7. Saha, A.K. Sarir Siksher Ritiniti, Rana Publishing House, Kalyani.
8. Bandopadhyay, K. Sarir Siksha Parichay, Classic Publishers, Kolkata
9. Naveen Jain, Play and Learn Basketball, Khel Sahitya Kendra, New Delhi.
10. Dubey H.C., Basketball, Discovery Publishing House, New Delhi.
11. Rachana Jain, Teach Yourself Basketball, Sports Publication.
12. Jack Nagle, Power Pattern Offences for Winning basketball, Parker Publishing Co., New York.
13. Renu Jain, Play and Learn Basketball, Khel Sahitya Kendra, New Delhi.
14. SallyKus, Coaching Volleyball Successfully, Human Kinetics.

| YOGA | | | |
|---|---|---|---|
| **Course Code** | **24YOG30, 24YOG40, 24YOG50, 24YOG60** | **CIE Marks** | **50** |
| **L:T:P:S** | **0:0:0:0** | **SEE Marks** | **--** |
| **Hrs / Week** | **2** | **Total Marks** | **50 x 4 = 200** |
| **Credits** | **00** | **Exam Hours** | **02** |

**Course outcomes:**
At the end of the course, the student will be able to:

| | |
|---|---|
| 24YOGX0.1 | Understanding the origin, history, aim and objectives of Yoga |
| 24YOGX0.2 | Become familiar with an authentic foundation of Yogic practices |
| 24YOGX0.3 | Practice different Yogic methods such as Suryanamaskara, Pranayama and some of the Shat |
| 24YOGX0.4 | Use the teachings of Patanjali in daily life. |

**Mapping of Course Outcomes to Program Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 24YOGX0.1 | - | - | - | - | - | 3 | - | - | - | - | 1 |
| 24YOGX0.2 | - | - | - | - | - | 3 | - | - | - | - | 1 |
| 24YOGX0.3 | - | - | - | - | - | 3 | - | - | - | - | 1 |
| 24YOGX0.4 | - | - | - | - | - | 3 | - | - | - | - | 1 |

| Semester / Course Code | CONTENT | COs | HOURS |
|---|---|---|---|
| 3rd 24YOG30 | **Introduction of Yoga:** Aim and Objectives of yoga, Prayer: Yoga, its origin, history and development. Yoga, its meaning, definitions. Different schools of yoga, importance of prayer<br>**Brief introduction of yogic practices for common man:** Yogic practices for common man to promote positive health<br>**Rules and regulations:** Rules to be followed during yogic practices by practitioner<br>**Misconceptions of yoga:** Yoga its misconceptions, Difference between yogic and non-yogic practices.<br>**Suryanamaskara:**<br>1. Suryanamaskar prayer and its meaning, Need, importance and b of Suryanamaskar.<br>2. Suryanamaskar 12 count,2rounds<br>**Different types of Asanas**:<br>1. Sitting: Padmasana, Vajrasana, Sukhasana<br>2. Standing: Vrikshana, Trikonasana, Ardhakati Chakrasana<br>3. Prone line: Bhujangasana, Shalabhasana<br>4. Supineline: Utthitadvipadasana, Ardhahalasana, Halasana | 24YOG30.1, 24YOG30.2, 24YOG30.3, 24YOG30.4 | Total 32 Hrs/ Semester 2 Hrs/week |

| | | | |
|---|---|---|---|
| **4TH 24YOG40** | **Suryanamaskara:** Suryanamaskar 12 count,4rounds<br>**Brief introduction and importance of:**<br>**Kapalabhati:** Revision of Kapalabhati -40strokes/min3rounds<br>**Different types of Asanas**:<br>1. Sitting: Paschimottanasana, Ardha Ushtrasana, Vakrasana, Aakarna Dhanurasana<br>2. Standing: Parshva Chakrasana, Urdhva Hastothanasana, Hastapadasana<br>3. Prone line: Dhanurasana<br>4. Supine line: Karna Peedasana, Sarvangasana, Chakraasana<br>**Patanjali's Ashtanga Yoga**: Asana, Pranayama<br>**Pranayama:** Chandra Bhedana, Nadishodhana, Surya Bhedana | 24YOG40.1, 24YOG40.2, 24YOG40.3, 24YOG40.4 | Total 32 Hrs/ Semester 2 Hrs/week |
| **5TH 24YOG50** | **Kapalabhati:** Revision of Kapalabhati - 60strokes/min3rounds<br>**Brief introduction and importance of:**<br>**Different types of Asanas**:<br>1. Sitting: Yogamudra in Padmasana, Vibhakta Paschimottanasana, Yogamudra in Vajrasana<br>2. Standing: Parivritta Trikonasana, Utkatasana, Parshvakonasana<br>3. Prone line: Padangushtha Dhanurasana, Poorna Bhujangasana / Rajakapotasana<br>4. Supine line: Navasana/Noukasana, Pavanamuktasana, Sarvanga<br>**Patanjali's Ashtanga Yoga**: Pratyahara, Dharana<br>**Pranayama:** Ujjayi, Sheetali, Sheektari | 24YOG50.1, 24YOG50.2, 24YOG50.3, 24YOG50.4 | Total 32 Hrs/ Semester 2 Hrs/week |
| **6TH 24YOG60** | **Kapalabhati:** Revision of Kapalabhati – 80 strokes/min3rounds<br>**Brief introduction and importance of:**<br>**Different types of Asanas**:<br>1. Sitting: Bakasana, Hanumanasana, Ekapada Rajakapotasana<br>2. Standing: Parivritta Trikonasana, Utkatasana, Parshvakonasana<br>3. Supine line: Setubandhasana, Shavasanaa (Relaxation posture)<br>4. Balancing: Sheershasana<br>**Patanjali's AshtangaYoga**: Dhyana (Meditation), Samadhi<br>**Pranayama:** Bhastrika, Bhramari, Ujjai<br>**Shat Kriyas:** Jalaneti and sutraneti, Sheetkarma Kapalabhati | 24YOG60.1, 24YOG60.2, 24YOG60.3, 24YOG60.4 | Total 32 Hrs/ Semester 2 Hrs/week |

**CIE Assessment Pattern (50 Marks – Practical)**

CIE to be evaluated every semester based on practical demonstration of Yogasana learnt in the semester and internal tests (objective type)

| CIE | Marks |
|---|---|
| Avg of Test 1 and Test 2 | 25 |
| Demonstration of Yogasana | 25 |
| **Total** | **50** |

**Suggested Learning Resources:**

**Reference Books:**

1.Swami Kuvulyananda: Asma (Kavalyadhama, Lonavala)
2.Tiwari, O P: Asana Why and How
3.Ajitkumar: Yoga Pravesha (Kannada)
4.Swami Satyananda Saraswati: Asana Pranayama, Mudra, Bandha (Bihar School of yoga, Munger)
5.Swami Satyananda Saraswati: Surya Namaskar (Bihar School of yoga, Munger)

6.Nagendra H R: The art and science of Pranayama
7.Tiruka: Shatkriyegalu (Kannada)
8.Iyengar B K S: Yoga Pradipika (Kannada)
9.Iyengar B K S: Light on Yoga (English)

**Web links and Video Lectures (e-Resources):**

- **https://youtu.be/KB-TYlgd1wE**
- **https://youtu.be/aa-TG0Wg1Ls**

## BASIC APPLIED MATHEMATICS-II

| | | | |
|---|---|---|---|
| **Course Code** | **24DMAT41** | **CIE Marks** | **50** |
| **L:T:P:S** | **0:0:0:0** | **SEE Marks** | **--** |
| **Hrs. / Week** | **2** | **Total Marks** | **50** |
| **Credits** | **00** | **Exam Hours** | **--** |

**Course outcomes:**
At the end of the course, the student will be able to:

| | |
|---|---|
| 24DMAT41.1 | Gain knowledge of basic operations of vectors |
| 24DMAT41.2 | Use curl and divergence of a vector function in three dimensions |
| 24DMAT41.3 | Develop the ability to solve higher order Linear differential equations |
| 24DMAT41.4 | Know the basic concepts of Laplace transform to solve the Periodic functions and also solve initial and boundary value problems using Laplace transform method. |

**Mapping of Course Outcomes to Program Outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 24DMAT41.1 | 3 | 3 | - | - | - | - | - | - | - | - | - |
| 24DMAT41.2 | 3 | 3 | - | - | - | - | - | - | - | - | - |
| 24DMAT41.3 | 3 | 3 | - | - | - | - | - | - | - | - | - |
| 24DMAT41.4 | 3 | 3 | - | - | - | - | - | - | - | - | - |

| | | | |
|---|---|---|---|
| **MODULE-1** | **VECTORS** | 24DMAT31.1 | **8 Hours** |

Definition of scalar and vector, Vector addition, Subtraction and Multiplication-Dot product, Cross product, Scalar triple product. Orthogonal, Co-planar and Angle between vectors-Problems.

| | |
|---|---|
| Text Book | Text Book 1: 3.1, 3.5, 3.6, 3.9, Text Book 2: 7.1, 9.2, 9.3, 9.4. |

| | | | |
|---|---|---|---|
| **MODULE-2** | **VECTOR DIFFERENTIATION** | 24DMAT31.2 | **8 Hours** |

Vector differential operator-Gradient of a scalar function, Divergence of a vector function, Curl of vector functior Problems. Solenoidal and irrotational vector fields-Problems.

| | |
|---|---|
| Text Book | Text Book 1: 8.5, 8.6, 8.7, Text Book 2: 9.7, 9.8, 9.9. |

| | | | |
|---|---|---|---|
| **MODULE-3** | **LINEAR DIFFERENTIAL EQUATIONS WITH CONSTANT COEFFICIENTS** | 24DMAT31.3 | **8 Hours** |

Solution of initial and boundary value problems, Inverse differential operator techniques for the functions-$e^{ax}$, $\sin(ax + b)$ and $\cos(ax + b)$.

| | |
|---|---|
| Text Book | Text Book 1: 13.3, 13.4, 13.5, 13.6, |

| | | | |
|---|---|---|---|
| **MODULE-4** | **LAPLACE TRANSFORM** | 24DMAT31.4 | **8 Hours** |

Definition and Laplace transforms of elementary functions-Problems. Properties of Laplace transforms (Shifting property-without proof), Periodic functions (without proof)-problems.

| | |
|---|---|
| Text Book | Text Book 1: 21.3, 21.4, 21.5, Text Book 2: 6.1. |

| | | | |
|---|---|---|---|
| **MODULE-5** | **INVERSE LAPLACE TRANSFORM** | 24DMAT31.4 | **8 Hours** |

Inverse Laplace Transform by partial fractions-Problems. Solution of linear differential equations using Laplace Transforms-Problems.

| | |
|---|---|
| Text Book | Text Book 1: 21.12, 21.15, Text Book 2: 6.4. |

**CIE Assessment Pattern (50 X 2=100 Marks – Theory)**

| RBT Levels | | Marks Distribution | | |
|---|---|---|---|---|
| | | Theory Tests | AAT1 | AAT2 |
| | | 25 | 15 | 10 |
| L1 | Remember | 5 | - | - |
| L2 | Understand | 5 | 5 | - |
| L3 | Apply | 5 | - | 5 |
| L4 | Analyze | 5 | 5 | 5 |
| L5 | Evaluate | 5 | 5 | - |
| L6 | Create | - | - | - |

**Suggested Learning Resources:**

**Text Books:**


1) B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, Forty fourth Edition, 2022, ISBN: 9788193328491.
2) Erwin Kreyszig, Advanced Engineering Mathematics, Wiley-India Publishers, Tenth Edition, Reprint 2016, ISBN: 9788126554232.


**Reference Books:**


1) Glyn James, Advanced Modern Engineering Mathematics, Pearson Education, Fourth Edition, 2015, ISBN: 9780273719236.
2) B. V. Ramana, Higher Engineering Mathematics, McGraw Hill Education (India) Private Limited, Fourth Edition, 2017, ISBN: 9780070634190.
3) H. K. Dass, Advanced Engineering Mathematics, S. Chand & Company Ltd., Twenty Second Edition, 2018, ISBN: 9789352533831.
4) N.P.Bali and Manish Goyal, A Text Book of Engineering Mathematics, Laxmi Publications (P) Ltd., Ninth Edition, 2014, ISBN: 9788131808320.


**Web links and Video Lectures (e-Resources):**

1)https://youtu.be/SaNDPSk1UVM?si=FRxMnRi1btCUIscK
2)https://youtu.be/HxrLu-qRJKc?si=pKc9XOCllBx-H4Wp
3)https://youtu.be/ma1QmE1SH3I?si=Hoo3_cjiIds203os
4)https://youtu.be/TKBXey91Gc4?si=JjZfQvJxdxN8I6YQ
5)https://youtu.be/1THkFmuIPXM?si=pc9VvmZ-9cQe_Wr_
6)https://youtu.be/m7jH0jfRf2I?si=OOEWttfQhieJ9wih
7)https://youtu.be/qFnoRfZknBY?si=BeMrhMF3LML4hBGa
8)https://youtu.be/n9XP6pljtw8?si=3gU-XKgt5JIZe9LE

**Activity-Based Learning (Suggested Activities in Class)/Practical Based Learning:**

- Contents related activities (Activity-based discussions)
  - Problem solving Approach
  - Organizing Group wise discussions on related topics
  - Seminars

**Appendix A: List of Assessment Patterns**

| S.NO | Pattern of Assessments |
|---|---|
| 1 | Assignments |
| 2 | Group Discussions |
| 3 | Case Study / Caselets |
| 4 | Practical-Orientation on Design Thinking |
| 5 | Participatory & Industry-Integrated Learning |
| 6 | Practical Activities / Problem Solving Exercises |
| 7 | Class Presentations |
| 8 | Analysis of Industry / Technical / Business Reports |
| 9 | Reports on Industrial Visit |
| 10 | Industrial / Social / Rural Projects |
| 11 | Participation in external seminars / Workshops |
| 12 | Any Other Academic Activity |
| 13 | Online / Offline Quizzes |

## APPENDIX B: Outcome Based Education

**Outcome-based education (OBE)** is an educational theory that bases each part of an educational system around goals (outcomes). By the end of the educational experience each student should have achieved the goal. There is no specified style of teaching or assessment in OBE; instead classes, opportunities, and assessments should all help students achieve the specified outcomes.

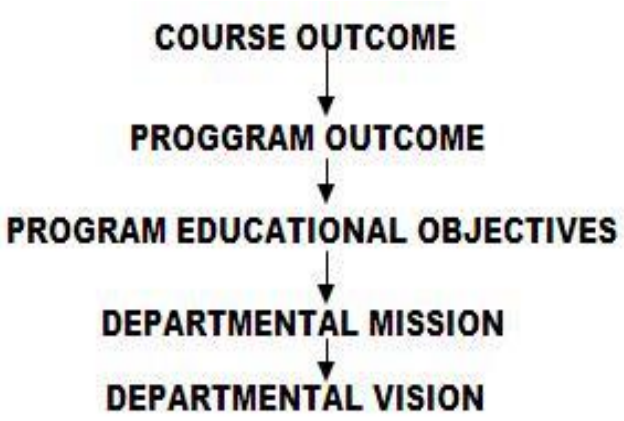
There are three educational Outcomes as defined by the National Board of Accreditation:

**Program Educational Objectives:** The Educational objectives of an engineering degree program are the statements that describe the expected achievements of graduate in their career and also in particular what the graduates are expected to perform and achieve during the first few years after graduation. [nbaindia.org]

**Program Outcomes:** What the student would demonstrate upon graduation. Graduate attributes are separately listed in Appendix C

**Course Outcome:** The specific outcome/s of each course/subject that is a part of the program curriculum. Each subject/course is expected to have a set of Course Outcomes

**Mapping of Outcomes**



## APPENDIX C: The Graduate Attributes of NBA

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

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

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

**Conduct investigations of complex problems**: The problems that cannot be solved by straightforward application of knowledge, theories and techniques applicable to the engineering discipline that may not have a unique solution. For example, a design problem can be solved in many ways and lead to multiple possible solutions that require consideration of appropriate constraints/requirements not explicitly given in the problem statement (like: cost, power requirement, durability, product life, etc.) which need to be defined (modeled) within appropriate mathematical framework that often require use of modern computational concepts and tools.

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

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

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

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

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

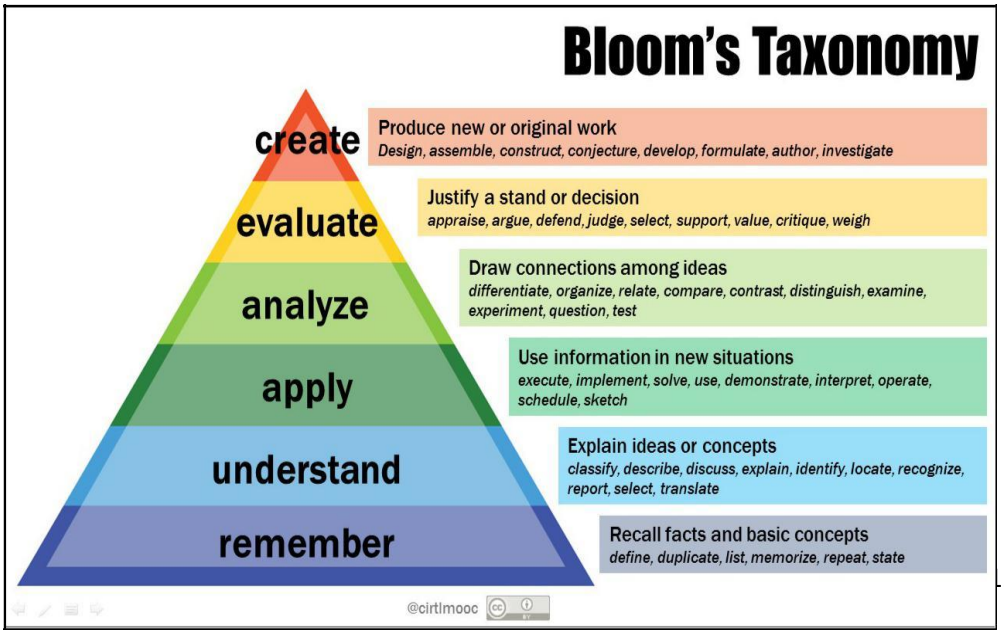
**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

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

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

## APPENDIX D: BLOOM'S TAXONOMY

**Bloom's taxonomy** is a classification system used to define and distinguish different levels of human cognition—i.e., thinking, learning, and understanding. Educators have typically used Bloom's taxonomy to inform or guide the development of assessments (tests and other evaluations of student learning), curriculum (units, lessons, projects, and other learning activities), and instructional methods such as questioning strategies.



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