# INSTITUTE OF AERONAUTICAL ENGINEERING

**(Autonomous)**

Dundigal, Hyderabad -500 043

## MECHANICAL ENGINEERING

## COURSE DESCRIPTOR

| | | | | | |
|---|---|---|---|---|---|
| **Course Title** | **ENGINEERING MECHANICS** | | | | |
| **Course Code** | AMEB03 | | | | |
| **Program** | B. Tech | | | | |
| **Semester** | THREE | | | | |
| **Course Type** | Foundation | | | | |
| **Regulation** | IARE - R18 | | | | |
| **Course Structure** | **Theory** | | | **Practical** | |
| | **Lectures** | **Tutorials** | **Credits** | **Laboratory** | **Credits** |
| | 3 | 1 | 4 | - | - |
| **Course Coordinator** | Dr. B D Y Sunil, Associate Professor | | | | |

## I. COURSE OVERVIEW:

Engineering mechanics is a branch of Physics which deals with the application of basic principles of mechanics to solve problems involving common engineering elements. The aim of Engineering Mechanics course is to expose students to problems in mechanics as applied to plausibly real-world scenarios. Problems of particular types are explored in detail in the hopes that students will gain an inductive understanding of the underlying principles at work; students should then be able to recognize problems of this sort in real-world situations and respond accordingly. The course includes forces, system of forces, equilibrium of forces, laws of friction, screw jack, analysis of pin jointed trusses, centroids and centre of gravity, particle dynamics and mechanical vibrations. The knowledge acquired through this course becomes the base for clear understanding of the advanced courses on analysis and design of structures.

## II. COURSE PRE-REQUISITES:

| Level | Course Code | Semester | Prerequisites |
|---|---|---|---|
| B.Tech | AHSB02 | 1 | Linear Algebra and Calculus |
| B.Tech | AHSB11 | II | Mathematical Transformation Techniques |

## III. MARKS DISTRIBUTION:

| Subject | SEE Examination | CIA Examination | Total Marks |
|---|---|---|---|
| Engineering Mechanics | 70 Marks | 30 Marks | 100 |

## IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ✔ | PPT | ✗ | Chalk & Talk | ✔ | Assignments | ✗ | MOOCs |
| ✔ | Open Ended Experiments | ✔ | Seminars | ✗ | Mini Project | ✔ | Videos |
| ✗ | Others | | | | | | |

## V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

**Semester End Examination (SEE):** The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either", "or" choice will be drawn from each module. Each question carries 14 marks. **There could be a maximum of two sub divisions in a question.**

The expected percentage of cognitive level of the questions is broadly based on the criteria given in Table: 1.

Table 1: The expected percentage of cognitive level of questions in SEE

| Percentage of Cognitive Level | Blooms Taxonomy Level |
|---|---|
| 10 % | Remember |
| 25 % | Understand |
| 50 % | Apply |
| 15 % | Analyze |
| 0 % | Evaluate |
| 0 % | Create |

**Continuous Internal Assessment (CIA):**

CIA is conducted for a total of 30 marks (Table 2), with 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (Table 3).

Table 2: Assessment pattern for CIA

| Component | Theory | | | Total Marks |
|---|---|---|---|---|
| Type of Assessment | CIE Exam | Quiz | AAT | |
| CIA Marks | 20 | 05 | 05 | 30 |

**Continuous Internal Examination (CIE):**

Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams

**Quiz – Online Examination:**

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Such a question paper shall be useful in testing of knowledge, skills, application, analysis, evaluation and understanding of the students. Marks shall be awarded considering the average of two quiz examinations for every course.

**Alternative Assessment Tool (AAT):**

This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table 3**.**

Table 3: Assessment pattern for AAT

| 5 Minutes Video | Assignment | Tech-talk | Seminar | Open Ended Experiment |
|---|---|---|---|---|
| 20% | 30% | 30% | 10% | 10% |

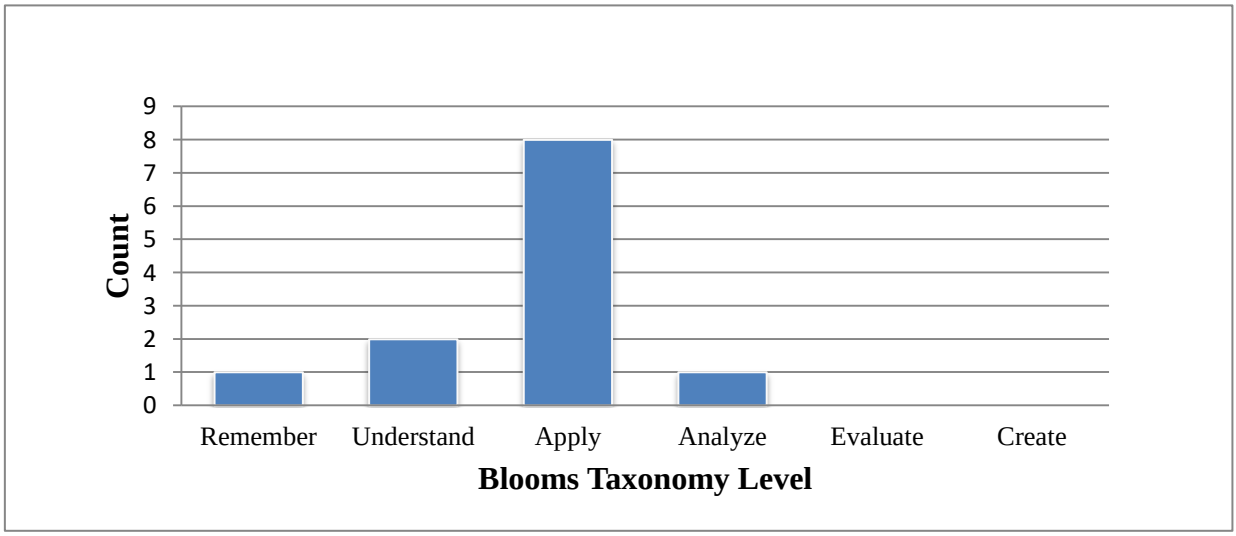
## VI. COURSE OBJECTIVES:

| The students will try to learn: | |
|---|---|
| I | The application of mechanics laws to static and dynamic equilibrium conditions in a body for solving the field problems. |
| II | The importance of free body diagram for a given system and put in the knowledge of mathematics and science into the vast area of rigid body mechanics. |
| III | The effects of force and motion while carrying out the innovative design functions of engineering. |

## VII. COURSE OUTCOMES:

| At the end of the course students are able to: | | |
|---|---|---|
| | **Course Outcomes** | **Knowledge Level (Bloom's Taxonomy)** |
| CO 1 | **Determine** the reactions and resultants for the system of forces in engineering applications with principles of mechanics. | Apply |
| CO 2 | **Analyze** the unknown forces with the help of free body diagrams to a given force system. | Analyze |
| CO 3 | **Identify** the equilibrium equations for a planar and spatial force systems from the rest or motion condition of the body. | Remember |
| CO 4 | **Apply** the static and dynamic friction laws for the equilibrium state of a wedge and ladder applications. | Apply |
| CO 5 | **Apply** the friction laws to a standard and differential screw jack for conditions of self-locking and overhauling. | Apply |
| CO 6 | **Demonstrate** the concepts of equilibrium for truss, beam, frames and machine applications. | Understand |
| CO 7 | **Identify** the centroid, centre of gravity and moment of inertia for the simple plane sections from the first principles. | Apply |
| CO 8 | **Explore** the theorems of moment and the mass moment of inertia of circular plate, cylinder, cone and sphere. | Apply |
| CO 9 | **Apply** the concepts of virtual work and work-energy method for single and connected configured systems. | Apply |
| CO 10 | **Determine** normal and tangential accelerations for a particle in rectilinear and curvilinear motion through kinematic equations. | Apply |
| CO 11 | **Derive** the dynamic equilibrium of a body in motion by introducing inertia force through D'Alembert's principle. | Apply |
| CO 12 | **Compute** the time period and frequencies of simple, compound and torsional pendulums using the basics of free and forced vibrations. | Understand |

## COURSE KNOWLEDGE COMPETENCY LEVELS



## VIII. HOW PROGRAM OUTCOMES ARE ASSESSED:

| Program Outcomes | | Strength | Proficiency Assessed by |
|---|---|---|---|
| PO 1 | **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. | 3 | CIE/Quiz/AAT |
| PO 2 | **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences | 1 | CIE/Quiz/AAT |
| PO 4 | **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions. | 1 | Seminar/ conferences / Research papers |

**3 = High; 2 = Medium; 1 = Low**

## IX. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

| Program Specific Outcomes | | Strength | Proficiency assessed by |
|---|---|---|---|
| PSO 1 | Formulate and evaluate engineering concepts of design, thermal and production to provide solutions for technology aspects in digital manufacturing. | 3 | Research papers / Group discussion / Short term courses |

**3 = High; 2 = Medium; 1 = Low**

## X. MAPPING OF EACH CO WITH PO(s), PSO(s):

| Course Outcomes | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| CO 1 | √ | √ | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CO 2 | - | √ | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CO 3 | - | √ | - | √ | - | - | - | - | - | - | - | - | - | - | - |
| CO 4 | √ | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CO 5 | √ | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CO 6 | - | √ | - | √ | - | - | - | - | - | - | - | - | √ | - | - |
| CO 7 | - | √ | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CO 8 | √ | √ | - | - | - | - | - | - | - | - | - | - | √ | - | - |
| CO 9 | √ | - | - | - | - | - | - | - | - | - | - | - | √ | - | - |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 10** | - | √ | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **CO 11** | √ | √ | - | - | - | - | - | - | - | - | - | - | √ | - | - |
| **CO 12** | √ | - | - | √ | - | - | - | - | - | - | - | - | √ | - | - |

## XI. JUSTIFICATIONS FOR CO – PO/PSO MAPPING – DIRECT

| Course Outcomes | POs / PSOs | Justification for mapping (Students will be able to) | No. of key competencies |
|---|---|---|---|
| **CO 1** | **PO 1** | **Apply** the knowledge and principals of mathematics to engineering problems for determining reactions and resultants of forces using the knowledge of **mathematics and science fundamentals** | **2** |
| | **PO 2** | **Analyze** and **formulate** the engineering problems to determine the reactions and resultants of given force systems. Analyze and **identify the problem statement**, **formulation and abstraction** for the **development of solution.** | **4** |
| **CO 2** | **PO 2** | **Collect the data** from complex engineering problems and **implement** them to draw the free body diagrams and **interpret the results**. | **3** |
| **CO 3** | **PO 2** | **Formulate** the spatial force system problem and **identify** the appropriate equilibrium equation and **develop the solution** from the **first principals of mathematics**. | **4** |
| | **PO 4** | **Understand** the principals of engineering and **apply** them to the spatial force systems by analyzing the condition of motion of rest of the body | **2** |
| **CO 4** | **PO 1** | **Apply the mathematical principles** and **engineering fundamentals** to get the solutions in the static and dynamic friction engineering problems. | **2** |
| **CO 5** | **PO 1** | Use the **fundamentals of engineering** and **science** in identifying the conditions of self-locking and over hauling in various screw jacks. | **2** |
| **CO 6** | **PO 2** | Formulate the **problem statement** and **model the system** for **getting the solution** for truss, beam, frame and machine applications. | **3** |
| | **PO 4** | **Understand** the technical concepts of truss, beam, frames and **interpret** the equilibrium conditions for various applications. | **2** |
| | **PSO 1** | **Formulate** and **evaluate** engineering concepts of design, thermal and production to provide solutions for technology aspects in digital manufacturing. | **2** |
| **CO 7** | **PO 2** | Identify the centroid, center of gravity and moment of inertia of various sections from the **first principals of mathematics** and **generate the solution.** | **2** |
| **CO 8** | **PO 1** | **Derive** the moment and mass moment of inertia for circular plate, cylinder, cone and sphere using the **engineering fundamentals.** | **2** |
| | **PO 2** | **Formulate** the theorems of moment and moment of inertia for **analyzing the given engineering problems** and **generate the solution.** | **3** |
| | **PSO 1** | **Formulate** and **evaluate** engineering concepts of design, thermal and production to provide solutions for technology aspects in digital manufacturing. | **2** |

| Course Outcomes | POs / PSOs | Justification for mapping (Students will be able to) | No. of key competencies |
|---|---|---|---|
| **CO 9** | **PO 1** | Apply the knowledge of **mathematics and science** to **determine the unknown variables** using virtual work and work energy methods | **2** |
| | **PSO 1** | **Formulate** and **evaluate** engineering concepts of design, thermal and production to provide solutions for technology aspects in digital manufacturing. | **2** |
| **CO 10** | **PO 2** | **Collect the data** by **identifying** the system of rectilinear and curvilinear motion and **generate the solution** for normal and tangential accelerations | **3** |
| **CO 11** | **PO 1** | Apply the D'Alembert's principle and use the **fundamentals of mathematics and science** to determine the dynamic equilibrium condition of a body. | **2** |
| | **PO 2** | Apply D'Alembert's principle to a body in motion and **model** the system to determine various accelerations from the **problem formulation** | **2** |
| | **PSO 1** | **Formulate** and **evaluate** engineering concepts of design, thermal and production to provide solutions for technology aspects in digital manufacturing. | **2** |
| **CO 12** | **PO 1** | Determine the time period and frequencies of simple, compound, torsional pendulums using the **mathematical and science principles**. | **2** |
| | **PO 4** | **Understand** the basics of free and forced vibrations and **apply the systems approach** to **identify** the time period and frequencies for various pendulums | **3** |
| | **PSO 1** | **Formulate** and **evaluate** engineering concepts of design, thermal and production to provide solutions for technology aspects in digital manufacturing. | **2** |

## XII. TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING

| Course Outcomes | Program Outcomes / No. of Key Competencies Matched | | | | | | | | | | | | PSOs/ No. of key competencies | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** |
| | **3** | **10** | **10** | **11** | **1** | **5** | **3** | **3** | **12** | **5** | **12** | **12** | **2** | **2** | **2** |
| **CO 1** | 2 | 4 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **CO 2** | - | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **CO 3** | - | 4 | - | 2 | - | - | - | - | - | - | - | - | - | - | - |
| **CO 4** | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **CO 5** | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **CO 6** | - | 3 | - | 2 | - | - | - | - | - | - | - | - | 2 | - | - |
| **CO 7** | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **CO 8** | 2 | 3 | - | - | - | - | - | - | - | - | - | - | 2 | - | - |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 9** | 2 | - | - | - | - | - | - | - | - | - | - | - | 2 | - | - |
| **CO 10** | - | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **CO 11** | 2 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - | - |
| **CO 12** | 2 | - | - | 3 | - | - | - | - | - | - | - | - | 2 | - | - |

## XIII. PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO/PSO):

| **Course Outcomes** | **Program Outcomes / No. of key competencies** | | | | | | | | | | | | **PSOs/ No. of key competencies** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** |
| | **3** | **10** | **10** | **11** | **1** | **5** | **3** | **3** | **12** | **5** | **12** | **12** | **2** | **1** | **2** |
| **CO 1** | 66.7 | 40.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **CO 2** | 0.00 | 30.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **CO 3** | 0.00 | 40.0 | 0.00 | 18.2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **CO 4** | 66.7 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **CO 5** | 66.7 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **CO 6** | 0.00 | 30.0 | 0.00 | 18.2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 100 | 0.00 | 0.00 |
| **CO 7** | 0.00 | 20.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **CO 8** | 66.7 | 30.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 100 | 0.00 | 0.00 |
| **CO 9** | 66.7 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 100 | 0.00 | 0.00 |
| **CO 10** | 0.00 | 30.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **CO 11** | 66.7 | 20.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 100 | 0.00 | 0.00 |
| **CO 12** | 66.7 | 0.00 | 0.00 | 27.3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 100 | 0.00 | 0.00 |

## XIV. COURSE ARTICULATION MATRIX (PO – PSO MAPPING)

COs and POs and COs and PSOs on the scale of 0 to 3, **0** being **no correlation**, **1** being the **Low correlation**, **2** being **medium correlation** and **3** being **high correlation**.

**0** – **0**≤ ***C***≤ 5%–No correlation
**1** – 5 <***C***≤ 40%– Low/ Slight
**2** − 40 % <***C***< 60% –Moderate
**3** – 60% ≤ ***C***< 100% – Substantial /High

| **Course Outcomes** | **Program Outcomes** | | | | | | | | | | | | **Program Specific Outcomes** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** |
| **CO 1** | 3 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 2** | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **CO 3** | - | 1 | - | 1 | - | - | - | - | - | - | - | - | - | - | - |
| **CO 4** | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **CO 5** | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **CO 6** | - | 1 | - | 1 | - | - | - | - | - | - | - | - | 3 | - | - |
| **CO 7** | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **CO 8** | 3 | 1 | - | - | - | - | - | - | - | - | - | - | 3 | - | - |
| **CO 9** | 3 | - | - | - | - | - | - | - | - | - | - | - | 3 | - | - |
| **CO 10** | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **CO 11** | 3 | 1 | - | - | - | - | - | - | - | - | - | - | 3 | - | - |
| **CO 12** | 3 | - | - | 1 | - | - | - | - | - | - | - | - | 3 | - | - |
| **TOTAL** | 21 | 8 | | 3 | | | | | | | | | 15 | | |
| **AVERAGE** | **3.0** | **1.0** | | **1.0** | | | | | | | | | **3.0** | | |

## XV. ASSESSMENT METHODOLOGY - DIRECT

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CIE Exams | PO 1,PO 2, PO 4,PSO 1 | SEE Exams | PO 1,PO 2, PO 4,PSO 1 | Assignments | PO 4 | Seminars | PO 4,PSO 1 |
| Laboratory Practices | - | Student Viva | - | Mini Project | - | Certification | - |
| Term Paper | - | 5 Minutes Video | PO 4 | Tech talk | PO 4 | Open Ended Experiments | PO 2,PO 4 |

## XVI. ASSESSMENT METHODOLOGY - INDIRECT

| | | | |
|---|---|---|---|
| ✔ | Early Semester Feedback | ✔ | End Semester OBE Feedback |
| ✗ | Assessment of Mini Projects by Experts | | |

## XVII. SYLLABUS

| **MODULE-I** | **INTRODUCTION TO ENGINEERING MECHANICS** |
|---|---|
| Force Systems Basic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminacy. | |
| **MODULE-II** | **FRICTION AND BASICS STRUCTURAL ANALYSIS** |
| Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack; Equilibrium in three dimensions; Method of Sections; Method of Joints; How to determine if a member is in tension or compression; Simple | |

| | |
|---|---|
| Trusses; Zero force members; Beams &types of beams; Frames &Machines. | |
| **MODULE-III** | **CENTROID AND CENTRE OF GRAVITY AND VIRTUAL WORK AND ENERGY METHOD** |
| Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia- Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere, Hook.<br><br>Virtual displacements, principle of virtual work for particle and ideal system of rigid bodies, degrees of freedom. Active force diagram, systems with friction, mechanical efficiency. Conservative forces and potential energy (elastic and gravitational), energy equation for equilibrium. Applications of energy method for equilibrium. Stability of equilibrium. | |
| **MODULE-IV** | **PARTICLE DYNAMICS AND INTRODUCTION TO KINETICS** |
| Particle dynamics- Rectilinear motion; Plane curvilinear motion (rectangular, path, and polar coordinates). 3-D curvilinear motion; Relative and constrained motion; Newton's 2nd law (rectangular, path, and polar coordinates). Work-kinetic energy, power, potential energy. Impulse-momentum (linear, angular); Impact (Direct and oblique). Introduction to Kinetics of Rigid Bodies covering, Basic terms, general principles in dynamics; Types of motion, Instantaneous centre of rotation in plane motion and simple problems. | |
| **MODULE-V** | **MECHANICAL VIBRATIONS** |
| Basic terminology, free and forced vibrations, resonance and its effects; Degree of freedom; Derivation for frequency and amplitude of free vibrations without damping and single degree of freedom system, simple problems, types of pendulum, use of simple, compound and torsion pendulums. | |
| **Textbooks:** | |
| 1. 1 Irving H. Shames (2006), "Engineering Mechanics", Prentice Hall, 4th Edition,2013<br>2. F. P. Beer and E. R. Johnston (2011), "Vector Mechanics for Engineers", Vol I - Statics, Vol II, – Dynamics, Tata McGraw Hill, 9th Edition,2013.<br>3. R. C. Hibbler (2006), "Engineering Mechanics: Principles of Statics and Dynamics", Pearson Press. | |
| **Reference Books:** | |
| 1. S. Bhavikatti, "A Text Book of Engineering Mechanics", New Age International,1st Edition, 2012<br>2. A.K.Tayal, "Engineering Mechanics", Uma Publications, 14th Edition, 2013.<br>3. R. K. Bansal "Engineering Mechanics", Laxmi Publication, 8th Edition, 2013.<br>4. Basudeb Bhattacharya, "Engineering Mechanics", Oxford University Press, 2nd Edition, 2014.<br>5. K.Vijay Reddy, J. Suresh Kumar, "Singer's Engineering Mechanics Statics and Dynamics", B S Publishers, 1st Edition, 2013. | |

## XVIII. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

| Lecture No | Topics to be covered | Course Outcomes | Text (T) book / Reference (R) book |
|---|---|---|---|
| 1 | Introduction to Engineering Mechanics, Basic Concepts- Force and types of forces, Laws of mechanics, Parallelogram laws of forces | CO 1 | T2:5.5<br>R1:1.12.1 |
| 2 | Composition and resolution of forces, Problems on composition and resolution | CO 1 | T2:5.6<br>R1:1.12.3 |

| Lecture No | Topics to be covered | Course Outcomes | Text (T) book / Reference (R) book |
|---|---|---|---|
| 3 | Problems on concurrent forces, Composition of non-concurrent forces, Problems on non-concurrent forces | CO 1 | T2:5.10 R1:1.15 |
| 4 | Moment concept, types of moments, Varignon's principle, Moment couple, characteristics of couple, | CO 1 | T2:5.15 R1:1.16 |
| 5 | Problems on moments, parallel like and unlike forces | CO 2 | T2:5.17 R1:1.13.1 |
| 6 | Problems on parallel like and unlike forces | CO 2 | T2:5.18 R1:1.13.2 |
| 7 | Equilibrium and principles of equilibrium, Free body diagram | CO 3 | T2:5.19 R1:1.13.3 |
| 8 | Lami's theorem, Problems on Lami's theorem. | CO 2 | T2:5.20 R1:1.7.1 |
| 9 | Problems on equilibrium by using equilibrium equations | CO 3 | T2:5.24 R1:1.17.3 |
| 10 | Problems on equilibrium by using equilibrium equations | CO 3 | T2:6.1 R1:2.3 |
| 11 | Composition of concurrent forces in space | CO 3 | T2:6.3 R1:2.6.1 |
| 12 | Problems on concurrent forces in space | CO 3 | T2:6.5 R1:2.6.2 |
| 13 | Introduction to friction, Laws of Friction, Angle of friction | CO 4 | T2:7.3 R1:2.8 |
| 14 | Static and Dynamic Friction, Equilibrium considering friction. | CO 4 | T2:7.5,7.6 R1:2.9.2 |
| 15 | Problems on max and min force required to overcome the friction force | CO 4 | T2:7.7 R1:2.10 |
| 16 | Problems on max and min force required to overcome the friction force | CO 4 | T2:7.7 R1:2.10 |
| 17 | Problems on max and min force required to overcome the friction force | CO 4 | T2:7.11 R1:2.10.2 |
| 18 | Problems on ladder | CO 4 | T2:7.11 |
| 19 | Problems on wedge | CO 5 | T2:15.2 R1:8.2 |
| 20 | Screw jack - Problems on screw jack, differential screw jack | CO 6 | T2:15.7 R1:8.3.3 |
| 21 | Introduction to centroids and Centre of gravity | CO 7 | T2:2.1 R1:7.9.2 |
| 22 | Problems on finding the centroid for simple figures | CO 7 | T2:2.2 R1:7.9.1 |
| 23 | Problems on centroids of Composite Figures | CO 7 | T2:2.4 R1:7.11 |
| 24 | Derivation for parallel axis theorem and perpendicular axis theorem | CO 8 | T2:16.8 R1:8.12.1 |
| 25 | Problems on parallel and perpendicular axis theorem | CO 8 | T2:16.8 R1:8.12.2 |
| 26 | Derive the equation for parallel and perpendicular axis theorems, finding surface areas and volumes of cone, sphere, etc | CO 8 | T2:5.17 R1:1.13.1 |

| Lecture No | Topics to be covered | Course Outcomes | Text (T) book / Reference (R) book |
|---|---|---|---|
| 27 | Moment of inertia, polar moment of inertia and radius of gyration | CO 8 | T2:5.18<br>R1:1.13.2 |
| 28 | Problems on moment of inertia | CO 8 | T2:5.19<br>R1:1.13.3 |
| 29-30 | Problems on polar moment of inertia and radius of gyration | CO 8 | T2:6.1<br>R1:2.3 |
| 31 | Introduction to concept of Virtual work. Principle of virtual work. | CO 9 | T2:1.2<br>R1:7.2 |
| 32-33 | Numerical Examples on virtual work. | CO 9 | T2:1.16<br>R1:7.7 |
| 34-35 | Introduction to dynamics types of motions, equations of motion for uniform velocity, uniform acceleration, and variable acceleration. | CO 10 | T2:6.3<br>R1:2.6.1 |
| 36-37 | Problems on rectilinear motion | CO 10 | T2:6.5<br>R1:2.6.2 |
| 38 | Problems on rectilinear motion under gravity | CO 10 | T2:5.24<br>R1:1.17.3 |
| 39 | Problems on rectilinear motion for variable acceleration | CO 11 | T2:6.1<br>R1:2.3 |
| 40 | Curvilinear motion,<br>1 horizontal projection<br>2 inclined projection on level ground<br>3 inclined projection on different levels of ground | CO 11 | T2:6.3<br>R1:2.6.1 |
| 41 | Problems on inclined projection | CO 11 | T2:15.13<br>R1:8.7.2 |
| 42 | Problems on inclined plane and point of projection and point of strike at different levels | CO 11 | T2:15.13<br>R1:8.7.2 |
| 43 | Kinematics of rigid bodies | CO 11 | T2:15.16<br>R1:8.7.3 |
| 44 | General plane motion concept ICR, problems on ICR | CO 11 | T1:11.9<br>R2:12.24 |
| 45-46 | Problems on rigid body plane motion | CO 11 | T1:11.9<br>R3:12.25 |
| 47 | Introduction to kinetics | CO 10 | T1:3.2<br>R3:3.2 |
| 48 | Problems on rectilinear kinetics | CO 10 | T1:3.3.1<br>R3:3.2 |
| 49-50 | Problems on kinetics of centroidal rotation | CO 10 | T2:16.9<br>R1:8.11.1 |
| 51 | Problems on general plane motion | CO 10 | T2:16.9<br>R1:8.11.2 |
| 52 | Concept of work energy method | CO 09 | T2:15.13<br>R1:8.7.2 |
| 53-54 | Problems on work energy method translation | CO 11 | T2:15.13<br>R1:8.7.2 |
| 55 | Problems on work energy method rotation | CO 11 | T2:15.16<br>R1:8.7.3 |
| 56 | Problems on work energy method plane motion | CO 11 | T1:11.9<br>R2:12.24 |

| Lecture No | Topics to be covered | Course Outcomes | Text (T) book / Reference (R) book |
|---|---|---|---|
| 57 | Introduction to vibration, simple harmonic motion | CO 12 | T1:11.9<br>R3:12.25 |
| 58 | Problems on vibrations | CO 12 | T1:3.2<br>R3:3.2 |
| 59 | Concept of simple pendulum, compound pendulum and torsional pendulum | CO 12 | T1:3.3.1<br>R3:3.2 |
| 60 | Problems on simple, compound and torsional pendulum | CO 12 | T2:16.5<br>R1:8.10 |

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