# INSTITUTE OF AERONAUTICAL ENGINEERING

**(Autonomous)**

Dundigal, Hyderabad -500 043

## CIVIL ENGINEERING

## COURSE DESCRIPTOR

| | | | | | |
|---|---|---|---|---|---|
| **Course Title** | **ENGINEERING MECHANICS** | | | | |
| **Course Code** | AME002 | | | | |
| **Programme** | B.Tech | | | | |
| **Semester** | II | AE\|ME\|CE | | | |
| **Course Type** | Core | | | | |
| **Regulation** | IARE - R16 | | | | |
| **Course Structure** | **Theory** | | | **Practical** | |
| | **Lectures** | **Tutorials** | **Credits** | **Laboratory** | **Credits** |
| | 3 | 1 | 4 | - | - |
| **Chief Coordinator** | Dr. D. Govardhan, Professor. | | | | |
| **Course Faculty** | MS. P Shruthilaya, Assistant Professor. | | | | |

## I. COURSE OVERVIEW:

The aim of Engineering Mechanics is to introduce students to the fundamental concepts and principles applied by engineers -whether civil, mechanical, aeronautical, etc. This course introduces the concepts of engineering based on forces in equilibrium. Topics include concentrated forces, distributed forces, forces due to friction, inertia, work –energy principle and vibrations as they apply to machines, structures, and systems. It is the branch of science for analyzing force systems that acts upon the bodies either at rest or in motion.

## II. COURSE PRE-REQUISITES:

| Level | Course Code | Semester | Prerequisites |
|---|---|---|---|
| - | - | - | Basic concepts of physics and mathematics |

## III. MARKS DISTRIBUTION:

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

## IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ✔ | Chalk & Talk | ✔ | Quiz | ✔ | Assignments | ✘ | MOOCs |
| ✔ | LCD / PPT | ✔ | Seminars | ✘ | Mini Project | ✔ | Videos |
| ✘ | Open Ended Experiments | | | | | | |

## 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 units and each unit 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 unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

| | |
|---|---|
| 50 % | To test the objectiveness of the concept. |
| 50 % | To test the analytical skill of the concept OR to test the application skill of the concept. |

**Continuous Internal Assessment (CIA):**
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

| **Component** | **Theory** | | **Total Marks** |
|---|---|---|---|
| **Type of Assessment** | CIE Exam | Quiz / AAT | |
| **CIA Marks** | 25 | 05 | 30 |

**Continuous Internal Examination (CIE):**
Two CIE exams shall be conducted at the end of the 8$^{th}$ and 16$^{th}$ week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five 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 / Alternative Assessment Tool (AAT):**
Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

## VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

| Program Outcomes (POs) | | 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. | 2 | Assignments |
| 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 | 2 | Term paper, Seminars |
| 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. | 2 | Assignments |

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

## VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

| Program Specific Outcomes (PSOs) | | Strength | Proficiency assessed by |
|---|---|---|---|
| PSO 1 | **Engineering knowledge:** Graduates shall demonstrate sound knowledge in analysis, design, laboratory investigations and construction aspects of civil engineering infrastructure, along with good foundation in mathematics, basic sciences and technical communication. | 2 | Lecture, Assignments. |
| PSO 2 | **Broadness and diversity:** Graduates will have a broad understanding of economical, environmental, societal, health and safety factors involved in infrastructural development, and shall demonstrate ability to function within multidisciplinary teams with competence in modern tool usage. | - | - |
| PSO 3 | **Self-Learning and service:** Graduates will be motivated for continuous self-learning in engineering practice and/ or pursue research in advanced areas of civil engineering in order to offer engineering services to the society, ethically and responsibly. | - | - |

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

## VIII. COURSE OBJECTIVES (COs):

| The course should enable the students to: | |
|---|---|
| I | Develop the ability to work comfortably with basic engineering mechanics concepts required for analyzing dynamic structures. |
| II | Identify an appropriate structural system to studying a given problem and isolate it from its environment, model the problem using good free-body diagrams and accurate equilibrium equations. |
| III | Identify and model various types of loading and support conditions that act on structural systems, apply pertinent mathematical, physical and engineering mechanical principles to the system to solve and analyze the problem. |
| IV | Understand the meaning of impulse and momentum, virtual work and solve the field problems. |
| V | Solve the problem of equilibrium by using the principle of work and energy and vibrations for preparing the students for higher level courses such as, Mechanics of Solids, Mechanics of Fluids etc. |

## IX. COURSE LEARNING OUTCOMES (CLOs):

| CLO Code | CLO's | At the end of the course, the student will have the ability to: | PO's Mapped | Strength of Mapping |
|---|---|---|---|---|
| AME002.01 | CLO 1 | Understand the concepts of kinematics of the particles and rectilinear motion. | PO1 | 3 |
| AME002.02 | CLO 2 | Demonstrate knowledge of ability to identify & apply fundamentals to solve problems like motion curves, rigid body motion and fixed axis rotation. | PO1 | 2 |
| AME002.03 | CLO 3 | Explore knowledge & ability to solve various particle motion problems. | PO2 | 2 |
| AME002.04 | CLO 4 | Derive the D' Alembert's principle and apply it to various field problems of kinetic motion. | PO2 | 1 |
| AME002.05 | CLO 5 | Discuss the nature of relation between force and mass under the influence of time. | PO4 | 2 |
| AME002.06 | CLO 6 | Develop the relations for motion of body in lift and on inclined plane. | PO2 | 2 |
| AME002.07 | CLO 7 | Determine the impact, impulse and impulsive forces occurring in the system. | PO1 | 3 |
| AME002.08 | CLO 8 | Understand the inter relationship between impulse-momentum and virtual work and an ability to use such relationships to solve practical problems. | PO1 | 2 |
| AME002.09 | CLO 9 | Knowledge of the lifting machines and simple framed structures equilibrium criteria, and the knowledge of the equilibrium condition systems. | PO2 | 2 |
| AME002.10 | CLO 10 | Determine the effect of law of conservation of energy and its consideration in field problems. | PO4 | 1 |
| AME002.11 | CLO 11 | Discuss the application of work energy method to particle motion. | PO1 | 2 |
| AME002.12 | CLO 12 | Develop the work energy relations and apply to connected systems. | PO2 | 2 |
| AME002.13 | CLO 13 | Understand the fixed axis rotation theory and solving the field problems by application of work energy method. | PO1 | 3 |
| AME002.14 | CLO 14 | Introduction to concepts of vibration and explain the relation between simple harmonic motion and the equilibrium systems. | PO4 | 3 |
| AME002.15 | CLO 15 | Derive the expressions for the concepts of simple, compound and torsional pendulums. | PO2 | 2 |
| AME002.16 | CLO 16 | Explore the use of modern engineering tools, software and equipment to prepare for competitive exams, higher studies etc. | PO4 | 1 |

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## X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

| Course Learning Outcomes (CLOs) | Program Outcomes (POs) | | | | | | | | | | | | Program Specific Outcomes (PSOs) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| CLO 1 | 3 | | | | | | | | | | | | | | | |
| CLO 2 | 2 | | | | | | | | | | | | 1 | | | |
| CLO 3 | | 2 | | | | | | | | | | | | | | |
| CLO 4 | | 1 | | | | | | | | | | | 2 | | | |
| CLO 5 | | | | 2 | | | | | | | | | | | | |
| CLO 6 | | 2 | | | | | | | | | | | | | | |
| CLO 7 | 3 | | | | | | | | | | | | | | | |
| CLO 8 | 2 | | | | | | | | | | | | | | | |
| CLO 9 | | 2 | | | | | | | | | | | 2 | | | |
| CLO 10 | | | | 1 | | | | | | | | | | | | |
| CLO 11 | 2 | | | | | | | | | | | | | | | |
| CLO 12 | | 2 | | | | | | | | | | | | | | |
| CLO 13 | 3 | | | | | | | | | | | | | | | |
| CLO 14 | | | | 3 | | | | | | | | | 1 | | | |
| CLO 15 | | 2 | | | | | | | | | | | | | | |
| CLO 16 | | | | 1 | | | | | | | | | | | | |

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## XI. ASSESSMENT METHODOLOGIES – DIRECT

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CIE Exams | PO1 PO2 PO4 | SEE Exams | PO1 PO2 PO4 | Assignments | PO1 PO4 | Seminars | PO2 |
| Laboratory Practices | - | Student Viva | - | Mini Project | - | Certification | - |
| Term Paper | PO2 | | | | | | |

## XII. ASSESSMENT METHODOLOGIES - INDIRECT

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

## XIII. SYLLABUS

| UNIT-I | KINEMATICS OF PARTICLES- RECTILINEAR MOTION |
|---|---|
| Motion of a particle – Rectilinear motion – motion curves – Rectangular components of curvilinear motion Kinematics of Rigid Body - Types of rigid body motion - Angular motion - Fixed Axis Rotation. | |
| **UNIT-II** | **KINETICS OF PARTICLE** |
| Introduction-Definitions of Matter, body, particle, mass, weight, inertia, momentum. Newton's law of motion. Relation Between force & mass. Motion of a particle in rectangular coordinates. D'Alembert's Principle.Motion of Lift. Motion of body on an inclined plane. Motion of connected Bodies. | |
| **UNIT-III** | **IMPULSE AND MOMENTUM, VIRTUAL WORK** |
| Impulse And Momentum: Introduction- Impact, Momentum, Impulse & Impulsive forces, Units. Law of conservation of Momentum, Newton's law of collision of elastic bodies- coefficient of Restitution. Recoil of Gun. Impulse Momentum Equation.<br>**VIRTUAL WORK:** Introduction – Principle of virtual work – Applications – Beams, Lifting machines, Simple framed structures. | |
| **UNIT-IV** | **WORK ENERGY METHOD** |
| Law of conservation of Energy, Application of Work Energy Method to particle motion and connected system- Work energy applied to Connected Systems - Work energy applied to Fixed Axis Rotation | |
| **UNIT-V** | **MECHANICAL VIBRATIONS** |
| Definitions and Concepts – Simple Harmonic Motion – Free vibrations, simple and Compound Pendulums – Torsion Pendulum – Free vibrations without damping: General cases. | |
| **Text Books:** | |
| 1. R.C. Hibbler, "Engineering Mechanics", Prentice Hall, 12th Edition, 2009.<br>2. Engineering Mechanics - Statics and Dynamics by Ferdinand.L. Singer / Harper International Edition.<br>3. Engineering Mechanics/ S. Timoshenko and D.H. Young, Mc Graw Hill Book Company. | |
| REFERENCES: | |
| 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 Publications, 8th Edition, 2013.<br>4. Engg. Mechanics / KL Kumar / Tata McGraw Hill.<br>5. Engg. Mechanics / S.S. Bhavikati & K.G. Rajasekharappa.<br>6. Basudeb Bhattacharya, "Engineering Mechanics", Oxford University Press, 2nd Edition, 2014.<br>7. K. Vijay Reddy, J. Suresh Kumar, "Singer's Engineering Mechanics, Statics and Dynamics", B S Publishers, 1st Edition, 2013. | |

## XIV. COURSE PLAN:

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

| Lecture No | Topics to be covered | Course Learning Outcomes (CLOs) | Reference |
|---|---|---|---|
| 1-2 | Motion of a particle – Rectilinear motion | CLO1 | T2:7.3 |
| 3-5 | motion curves – Rectangular components of curvilinear motion | CLO1 | T2:7.5,7.6<br>R1:2.9.2 |
| 6-8 | Kinematics of Rigid Body | CLO1 | T2:7.7<br>R1:2.10 |
| 9 | Types of rigid body motion - Angular motion | CLO2 | T2:7.7<br>R1:2.10 |
| 10 | Fixed Axis Rotation | CLO2 | T2:7.11<br>R1:2.10.2 |
| 11 | Introduction-Definitions of Matter, body, particle, mass, weight, inertia, momentum. | CLO3 | T2:7.11<br>R1:2.32 |

| Lecture No | Topics to be covered | Course Learning Outcomes (CLOs) | Reference |
|---|---|---|---|
| 12-13 | Newton's law of motion. Relation Between force & mass. | CLO3 | T2:15.2<br>R1:8.2 |
| 14-15 | Motion of a particle in rectangular coordinates. | CLO3 | T2:15.7<br>R1:8.3.3 |
| 16-17 | D'Alembert's Principle. | CLO4 | T2:15.13<br>R1:8.7.2 |
| 18-20 | Motion of Lift. Motion of body on an inclined plane. Motion of connected Bodies | CLO5 | T2:15.13<br>R1:8.7.2 |
| 21 | Introduction- Impact, Momentum, Impulse & Impulsive forces, Units. | CLO6 | T2:15.16<br>R1:8.7.3 |
| 22-24 | Law of conservation of Momentum | CLO6 | T1:11.9<br>R2:12.24 |
| 25-26 | Newton's law of collision of elastic bodies | CLO7 | T1:11.9<br>R3:12.25 |
| 27-28 | Coefficient of Restitution. Recoil of Gun. Impulse Momentum Equation. | CLO8 | T1:3.2<br>R3:3.2 |
| 29 | Introduction – Principle of virtual work – Applications. | CLO8 | T1:3.3.1<br>R3:3.2 |
| 30 | Beams, Lifting machines, Simple framed structures | CLO9 | T2:16.5<br>R1:8.10 |
| 31 | Law of conservation of Energy. | CLO10 | T2:16.9<br>R1:8.11.1 |
| 32-33 | Application of Work Energy Method to particle motion and connected system. | CLO11 | T2:16.9<br>R1:8.11.2 |
| 34-35 | Work energy applied to Connected Systems. | CLO12 | T2:16.8<br>R1:8.12.1 |
| 36-39 | Work energy applied to Fixed Axis Rotation. | CLO13 | T2:16.8<br>R1:8.12.2 |
| 40 | Definitions and Concepts**.** | CLO14 | T2:16.11<br>R1:8.14 |
| 41-42 | Simple Harmonic Motion – Free vibrations | CLO15 | T2:16.11<br>R1:8.20 |
| 43-44 | Simple and Compound Pendulums – Torsion Pendulum | CLO15 | T2:16.12<br>R1:8.19 |
| 45-48 | Free vibrations without damping: General cases. | CLO16 | T2:16.12<br>R1:8.77 |

## XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

| S NO | Description | Proposed actions | Relevance with POs | Relevance with PSOs |
|---|---|---|---|---|
| 1 | Banking angle theory for curvilinear motion | Guest lecturers/NPTEL | PO1 | PSO1 |
| 2 | Different types of loads on beams | Seminars | PO2 | PSO1 |
| 3 | Application of vibration theory to field problems | Guest lecturers/Seminars | PO4 | PSO1 |

**Prepared by:**

Ms. P Shruthilaya, Assistant Professor.

**HOD, CE**