INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

CIVIL ENGINEERING

COURSE DESCRIPTOR

Course Title	**ENGINEERING MECHANICS**				
Course Code	AMEB03				
Programme	B.Tech				
Semester	III	CE			
Course Type	Foundation				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Dr. Ch. Sandeep, Associate Professor				
Course Faculty	Dr. Ch. Sandeep, Associate Professor Dr. U Vamsi Mohan, 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	Credits
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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 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 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 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (AAT).

Table 1: 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 centre. 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

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.	3	Presentation on real-world problems
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	Assignment
PO 3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	1	Seminar

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	Seminar
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 :

The course should enable the students to:	
I	Ability to work comfortably with basic engineering mechanics concepts required for analyzing static 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 center of gravity (mass)/centroid and moment of Inertia using integration methods and method of moments

IX. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Develop the ability to work comfortably with basic engineering mechanics concepts required for analysing rigid bodies and structures. Identify an appropriate structural system for studying a given problem and isolate it from its environment, model the problem using free body diagrams and accurate equilibrium equations.	CLO 1	A basic understanding of the laws and principle of mechanics.
		CLO 2	The ability to solve simple force system problems in mechanics.
		CLO 3	Determine the resultant and apply conditions of static equilibrium to a plane force system
		CLO 4	Can be able to apply the knowledge of forces and force systems in the analysis of more complex problems.

COs	Course Outcome	CLOs	Course Learning Outcome
CO 2	Understand laws of friction and advantages of friction. Can be able to use this knowledge for various engineering applications. Can be able to analyse simple pin-jointed frames under different load conditions	CLO5	Understands the concepts of static and dynamic friction, advantages and disadvantages of friction.
		CLO6	Solve the problems of simple systems with friction effect. Calculate the linear moving bodies in general plane motion and applications of friction.
		CLO7	Analyze planar and spatial systems to determine the force in the members of truss and frames.
		CLO8	Solve the problems on different types of beams.
CO 3	Can be able to locate the centroids and calculate the moments of inertia for various simple cross-sections such as I section , T-scetion, Channel section etc., and composite sections. Mass moments of inertia can also be determined. Can apply the , principle of virtual work for the analysis of structures.	CLO9	Obtain the centroid, center of gravity and centre of mass for simple and composite objects.
		CLO10	Understand the concept of moment of inertia and can calculate second moment of area for simple and composite sections..
		CLO11	Can apply the knowledge of first and second moments of area in the analysis and design of complex structures.
		CLO12	Understand the concept of virtual work and an ability to solve practical problems using the principle of virtual work.
CO 4	Understand the principles (Laws of rigid body motion, Work-energy principle and Impulse-momentum principle etc.,), for analysing the problems related to the motion of rigid bodies with and without considering the forces which causes motion.	CLO13	Understand the concepts of kinematics of the particles and rectilinear motion.
		CLO14	Explore knowledge & ability to solve various particle motion problems.
		CLO15	Derive the D' Alembert's principle and apply it to various field problems of kinetic motion.
		CLO16	Determine the impact, impulse and impulsive forces occurring in the system and able to solve the problems.
CO 5	Understands the concepts related to the free and forced vibrations and can be able to apply the same to real world problems. Also understands the simple harmonic motion of simple pendulum.	CLO17	Understands the concepts of vibration and explain the relation between simple harmonic motion and the equilibrium systems.
		CLO18	Derive the expressions for the concepts of simple, compound and torsional pendulums.
		CLO19	Applies the knowledge of vibrations in the analysis and design of various machine foundations.
		CLO20	Explore the use of modern engineering tools, software and equipment to prepare for competitive exams, higher studies etc

X. 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
AMEB03.01	CLO 1	A basic understanding of the laws and principle of mechanics.	PO 1	3
AMEB03.02	CLO 2	The ability to solve simple force system problems in mechanics.	PO 2	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AMEB03.03	CLO 3	Determine the resultant and apply conditions of static equilibrium to a plane force system	PO 1	3
AMEB03.04	CLO 4	Can be able to apply the knowledge of forces and force systems in the analysis of more complex problems.	PO 2	2
AMEB03.05	CLO 5	Understands the concepts of static and dynamic friction, advantages and disadvantages of friction.	PO 1	3
AMEB03.06	CLO 6	Solve the problems of simple systems with friction effect. Calculate the linear moving bodies in general plane motion and applications of friction.	PO 2	2
AMEB03.07	CLO 7	Analyze planar and spatial systems to determine the force in the members of truss and frames.	PO 2	2
AMEB03.08	CLO 8	Solve the problems on different types of beams.	PO2	2
AMEB03.09	CLO 9	Obtain the centroid, center of gravity and centre of mass for simple and composite objects.	PO 1	2
AMEB03.10	CLO 10	Understand the concept of moment of inertia and can calculate second moment of area for simple and composite sections..	PO 2	2
AMEB03.11	CLO 11	Can apply the knowledge of first and second moments of area in the analysis and design of complex structures.	PO 3	2
AMEB03.12	CLO 12	Understand the concept of virtual work and an ability to solve practical problems using the principle of virtual work.	PO 2	2
AMEB03.13	CLO 13	Understand the concepts of kinematics of the particles and rectilinear motion.	PO 1	3
AMEB03.14	CLO 14	Explore knowledge & ability to solve various particle motion problems.	PO 3	1
AMEB03.15	CLO 15	Derive the D' Alembert's principle and apply it to various field problems of kinetic motion.	PO 2	2
AMEB03.16	CLO 16	Determine the impact, impulse and impulsive forces occurring in the system and able to solve the problems.	PO 2	2
AMEB03.17	CLO 17	Understands the concepts of vibration and explain the relation between simple harmonic motion and the equilibrium systems.	PO1	2
AMEB03.18	CLO 18	Derive the expressions for the concepts of simple, compound and torsional pendulums.	PO2	2
AMEB03.19	CLO 19	Applies the knowledge of vibrations in the analysis and design of various machine foundations.	PO3	2
AMEB03.20	CLO 20	Explore the use of modern engineering tools, software and equipment to prepare for competitive exams, higher studies etc	PO3	2

3= High; 2 = Medium; 1 = Low

XI. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Outcomes (COs)	Program Outcomes (POs)			
	PO 1	PO 2	PO 3	PSO1
CO 1	3	2		1
CO 2	3	2		1
CO 3	2	2	2	1
CO 4	3	2	1	1
CO 5	2	2	2	1

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XII. 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
CLO 1	3												1		
CLO 2		2													
CLO 3	3												1		
CLO 4		2											1		
CLO 5	3														
CLO 6		2													
CLO 7		2													
CLO 8		2													
CLO 9	2														
CLO 10		2													
CLO 11			2										1		
CLO 12		2											1		
CLO 13	3														
CLO 14			1												
CLO 15		2													
CLO 16		2											1		

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
CLO 17	2												1		
CLO 18		2											1		
CLO 19			2										1		
CLO 20			2										1		

3 = High; 2 = Medium; 1 = Low

XIII. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1, PO2, PO3,PSO1	SEE Exams	PO1, PO2, PO3,PSO1	Assignments	PO 3	Seminars	PO3, PSO1
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-						

XIV. ASSESSMENT METHODOLOGIES - INDIRECT

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

XV. 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. 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;	
Text Books:	
1. Irving H. Shames (2006), "Engineering Mechanics", Prentice Hall, 4th Edition,2013 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. 3. R. C. Hibbler (2006), "Engineering Mechanics: Principles of Statics and Dynamics", Pearson Press.	
Reference Books:	
1. S.Bhavikatti,"ATextBookofEngineeringMechanics",NewAgeInternational,1st Edition,2012 2. A.K.Tayal, "Engineering Mechanics", Uma Publications, 14th Edition, 2013. 3. R. K. Bansal "Engineering Mechanics", Laxmi Publication, 8thEdition, 2013. 4. Basudeb Bhattacharya, "Engineering Mechanics", Oxford University Press, 2nd Edition, 2014. 5. K.Vijay Reddy, J. Suresh Kumar, "Singer's Engineering Mechanics Statics and Dynamics", B S Publishers, 1st Edition, 2013.	

XVI. 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	Introduction to Engineering Mechanics, Basic Concepts- Force and types of forces, Laws of mechanics, Parallelogram laws of forces	CLO 1	T2:5.5 R1:1.12.1
2	Composition and resolution of forces, Problems on composition and resolution	CLO 2	T2:5.6 R1:1.12.3
3	Problems on concurrent forces, Composition of non-concurrent forces, Problems on non-concurrent forces	CLO 2	T2:5.10 R1:1.15
4	Moment concept, types of moments, Varginon's principle, Moment couple, characteristics of couple,	CLO 3	T2:5.15 R1:1.16
5	Problems on moments, parallel like and unlike forces	CLO 3	T2:5.17 R1:1.13.1
6	Problems on parallel like and unlike forces	CLO 3	T2:5.18 R1:1.13.2
7	Equilibrium and principles of equilibrium, Free body diagram	CLO 4	T2:5.19 R1:1.13.3
8	Lami's theorem, Problems on Lami's theorem.	CLO 4	T2:5.20 R1:1.7.1
9	Problems on equilibrium by using equilibrium equations	CLO 4	T2:5.24 R1:1.17.3
10	Problems on equilibrium by using equilibrium equations	CLO 4	T2:6.1 R1:2.3

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
11	Composition of concurrent forces in space	CLO 4	T2:6.3 R1:2.6.1
12	Problems on concurrent forces in space	CLO 4	T2:6.5 R1:2.6.2
13	Introduction to friction, Laws of Friction, Angle of friction	CLO 5	T2:7.3 R1:2.8
14	Static and Dynamic Friction, Equilibrium considering friction.	CLO 5	T2:7.5,7.6 R1:2.9.2
15	Problems on max and min force required to overcome the friction force	CLO 6	T2:7.7 R1:2.10
16	Problems on max and min force required to overcome the friction force	CLO 6	T2:7.7 R1:2.10
17	Problems on max and min force required to overcome the friction force	CLO 7	T2:7.11 R1:2.10.2
18	Problems on ladder	CLO 7	T2:7.11
19	Problems on wedge	CLO 8	T2:15.2 R1:8.2
20	Screw jack - Problems on screw jack, differential screw jack	CLO 8	T2:15.7 R1:8.3.3
21	Introduction to centroids and Centre of gravity	CLO 9	T2:2.1 R1:7.9.2
22	Problems on finding the centroid for simple figures	CLO 9	T2:2.2 R1:7.9.1
23	Problems on centroids of Composite Figures	CLO 9	T2:2.4 R1:7.11
24	Derivation for parallel axis theorem and perpendicular axis theorem	CLO 9	T2:16.8 R1:8.12.1
25	Problems on parallel and perpendicular axis theorem	CLO 10	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	CLO 10	T2:5.17 R1:1.13.1
27	Moment of inertia, polar moment of inertia and radius of gyration	CLO 10	T2:5.18 R1:1.13.2
28	Problems on moment of inertia	CLO 10	T2:5.19 R1:1.13.3
29-30	Problems on polar moment of inertia and radius of gyration	CLO 11	T2:6.1 R1:2.3
31	Introduction to concept of Virtual work. Principle of virtual work.	CLO 12	T2:1.2 R1:7.2
32-33	Numerical Examples on virtual work.	CLO 12	T2:1.16 R1:7.7
34-35	Introduction to dynamics types of motions, equations of motion for uniform velocity, uniform acceleration, and variable acceleration.	CLO 13	T2:6.3 R1:2.6.1
36-37	Problems on rectilinear motion	CLO 13	T2:6.5 R1:2.6.2
38	Problems on rectilinear motion under gravity	CLO 13	T2:5.24 R1:1.17.3

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
39	Problems on rectilinear motion for variable acceleration	CLO 14	T2:6.1 R1:2.3
40	Curvilinear motion, 1 horizontal projection 2 inclined projection on level ground 3 inclined projection on different levels of ground	CLO 14	T2:6.3 R1:2.6.1
41	Problems on inclined projection	CLO 15	T2:15.13 R1:8.7.2
42	Problems on inclined plane and point of projection and point of strike at different levels	CLO 15	T2:15.13 R1:8.7.2
43	Kinematics of rigid bodies	CLO 16	T2:15.16 R1:8.7.3
44	General plane motion concept ICR, problems on ICR	CLO 16	T1:11.9 R2:12.24
45-46	Problems on rigid body plane motion	CLO 16	T1:11.9 R3:12.25
47	Introduction to kinetics	CLO 17	T1:3.2 R3:3.2
48	Problems on rectilinear kinetics	CLO 17	T1:3.3.1 R3:3.2
49-50	Problems on kinetics of centroidal rotation	CLO 17	T2:16.9 R1:8.11.1
51	Problems on general plane motion	CLO 18	T2:16.9 R1:8.11.2
52	Concept of work energy method	CLO 18	T2:15.13 R1:8.7.2
53-54	Problems on work energy method translation	CLO 18	T2:15.13 R1:8.7.2
55	Problems on work energy method rotation	CLO 18	T2:15.16 R1:8.7.3
56	Problems on work energy method plane motion	CLO 18	T1:11.9 R2:12.24
57	Introduction to vibration, simple harmonic motion	CLO 19	T1:11.9 R3:12.25
58	Problems on vibrations	CLO 19	T1:3.2 R3:3.2
59	Concept of simple pendulum, compound pendulum and torsional pendulum	CLO 20	T1:3.3.1 R3:3.2
60	Problems on simple, compound and torsional pendulum	CLO 20	T2:16.5 R1:8.10

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

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	To improve standards and analyze the concepts of Engineering mechanics.	Seminars	PO 1	PSO1

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
2	To improve the ability of understanding the concept of centroids and center of gravity with some complex problems	Seminars	PO 3	PSO1
3	Encourage students to solve real time applications and prepare towards competitive examinations.	NPTEL	PO 2	PSO1

Prepared by:

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