INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING
COURSE DESCRIPTOR

Course Title	**ENGINEERING MECHANICS**				
Course Code	AMEB03				
Program	B.Tech				
Semester	III	ME			
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 Mrs. V. Prasanna, 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 at 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 modules and each modules 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	Seminar
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	Term Paper

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills**: To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	2	Presentation on real-world problems
PSO 2	**Software Engineering Practices:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	-	-
PSO 3	**Successful Career and Entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become Technocrats.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES :

The course should enable the students to:	
I	Students should develop the 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	Understand the meaning of centre of gravity (mass)/centroid and moment of Inertia using integration methods and method of moments
IV	To solve the problem of equilibrium by using the principle of work and energy, impulse momentum and vibrations for preparing the students for higher level courses such as Mechanics of Solids, Mechanics of Fluids, Mechanical Design and Structural Analysis etc...

IX. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome

CO 1	Understand the concepts of laws of mechanics, force systems and friction forces.	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	Solve the problems of simple systems with the friction, calculate the linear moving bodies in general plane motion and applications of friction
CO 2	Analyze the spatial systems, forces in frames and the concepts of centroids and centre of gravity.	CLO 5	Analyze planer and spatial systems to determine the force in the members of truss and frames
		CLO 6	Solve the problems on different types of beams
		CLO 7	Obtain the centroid, center of gravity, first moment and second moment of area
CO 3	Understand the concepts of kinetics and kinematics to solve the problems related to motion of the body.	CLO 8	Understand the concept of virtual work and an ability to solve practical problems
		CLO 9	Understand the concepts of kinematics of the particles and rectilinear motion
		CLO 10	Explore knowledge & ability to solve various particle motion problems.
		CLO 11	Derive the D' Alembert's principle and apply it to various field problems of kinetic motion.
CO 4	Understand the concept of impulse forces, work energy relations for connected systems.	CLO 12	Determine the impact, impulse and impulsive forces occurring in the system and able to solve the problems
		CLO 13	Develop the work energy relations and apply to connected systems.
		CLO 14	Understand the fixed axis rotation theory and solving the field problems by application of work energy method.
CO 5	Explore the knowledge on vibrations and simple harmonic motion.	CLO 15	Introduction to concepts of vibration and explain the relation between simple harmonic motion and the equilibrium systems.
		CLO 16	Derive the expressions for the concepts of simple, compound and torsional pendulums.
		CLO 17	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
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	Solve the problems of simple systems with the friction, calculate the linear moving bodies in general plane motion and applications of friction	PO 1	3

AMEB03.05	CLO 5	Analyze planer and spatial systems to determine the force in the members of truss and frames	PO 2	3
AMEB03.06	CLO 6	Solve the problems on different types of beams	PO 2	2
AMEB03.07	CLO 7	Obtain the centroid, center of gravity, first moment and second moment of area	PO 2	3
AMEB03.08	CLO 8	Understand the concept of virtual work and an ability to solve practical problems	PO 2	2
AMEB03.09	CLO 9	Understand the concepts of kinematics of the particles and rectilinear motion	PO 3	1
AMEB03.10	CLO 10	Explore knowledge & ability to solve various particle motion problems.	PO 3	1
AMEB03. 11	CLO 11	Derive the D' Alembert's principle and apply it to various field problems of kinetic motion.	PO 2	2
AMEB03. 12	CLO 12	Determine the impact, impulse and impulsive forces occurring in the system and able to solve the problems	PO 2	2
AMEB03. 13	CLO 13	Develop the work energy relations and apply to connected systems.	PO 1	2
AMEB03. 14	CLO 14	Understand the fixed axis rotation theory and solving the field problems by application of work energy method.	PO 3	2
AMEB03. 15	CLO 15	Introduction to concepts of vibration and explain the relation between simple harmonic motion and the equilibrium systems.	PO 1	3
AMEB03. 16	CLO 16	Derive the expressions for the concepts of simple, compound and torsional pendulums.	PO 1, PO 2	3
AMEB03. 17	CLO 17	Explore the use of modern engineering tools, software and equipment to prepare for competitive exams, higher studies etc.	PO 1,PO 2	3

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		2		
CO 3		2	1	
CO 4	2	2	2	1
CO 5	3	2		1

3 = High; 2 = Medium; 1 = Low

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														
CLO 4	3												1		
CLO 5		3													
CLO 6		2													
CLO 7		3													
CLO 8		2													
CLO 9			1												
CLO 10			1												
CLO 11		2													
CLO 12		2											1		
CLO 13	2														
CLO 14			2												
CLO 15	3														
CLO 16	3	2											1		
CLO 17	3	2													

3 = High; 2 = Medium; 1 = Low

XIII. ASSESSMENT METHODOLOGIES – DIRECT

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

XIV. ASSESSMENT METHODOLOGIES - INDIRECT

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

XV. SYLLABUS

Module-I	**INTRODUCTION TO ENGINEERING MECHANICS**	**Classes: 10**
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**	**Classes: 09**
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**	**Classes: 10**
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**	**Classes: 08**
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**	**Classes: 08**
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.		

XVI. COURSE PLAN:

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

Lecture No	Topic/s 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, Varginons 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	Lamis theorem, Problems on Lamis theorem	CLO 4	T2:5.20 R1:1.17.1
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
11	Composition of concurrent forces in space	CLO 5	T2:6.3 R1:2.6.1
12	Problems on concurrent forces in space	CLO 5	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 friciton	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 5	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 6	T2:7.11 R1:2.10.2
18	Problems on ladder	CLO 6	T2:7.11 R1:2.32
19	Problems on wedge	CLO 6	T2:15.2 R1:8.2
20	Screw jack - Problems on screw jack, differential screw jack	CLO 6	T2:15.7 R1:8.3.3
21	Introduction to centroids and Centre of gravity	CLO 7	T2:2.1 R1:7.9.2
22	Problems on finding the centroid for simple figures	CLO 7	T2:2.2 R1:7.9.1
23	Problems on centroids of Composite Figures	CLO 7	T2:2.4 R1:7.11
24	Derivation for parallel axis theorem and perpendicular axis theorem	CLO 7	T2:16.8 R1:8.12.1
25	Problems on parallel and perpendicular axis theorem	CLO 7	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 8	T2:5.17 R1:1.13.1
27	Moment of inertia, polar moment of inertia and radius of gyration	CLO 8	T2:5.18 R1:1.13.2

28	Problems on moment of inertia	CLO 8	T2:5.19 R1:1.13.3
29-30	Problems on polar moment of inertia and radius of gyration	CLO 8	T2:6.1 R1:2.3
31	Introduction to concept of Virtual work. Principle of virtual work.	CLO 5	T2:1.2 R1:7.2
32-33	Numerical Examples on virtual work.	CLO 5	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 9	T2:6.3 R1:2.6.1
36-37	Problems on rectilinear motion	CLO 9	T2:6.5 R1:2.6.2
38	Problems on rectilinear motion under gravity	CLO 9	T2:5.24 R1:1.17.3
39	Problems on rectilinear motion for variable acceleration	CLO 9	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 9	T2:6.3 R1:2.6.1
41	Problems on inclined projection	CLO 9	T2:15.13 R1:8.7.2
42	Problems on inclined plane and point of projection and point of strike at different levels	CLO 8	T2:15.13 R1:8.7.2
43	Kinematics of rigid bodies	CLO 14	T2:15.16 R1:8.7.3
44	General plane motion concept ICR, problems on ICR	CLO 14	T1:11.9 R2:12.24
45-46	Problems on rigid body plane motion	CLO 10	T1:11.9 R3:12.25
47	Introduction to kinetics	CLO 10	T1:3.2 R3:3.2
48	Problems on rectilinear kinetics	CLO 11	T1:3.3.1 R3:3.2
49-50	Problems on kinetics of centroidal rotation	CLO 11	T2:16.9 R1:8.11.1
51	Problems on general plane motion	CLO 12	T2:16.9 R1:8.11.2
52	Concept of work energy method	CLO 13	T2:15.13 R1:8.7.2
53-54	Problems on work energy method translation	CLO 13	T2:15.13 R1:8.7.2
55	Problems on work energy method rotation	CLO 13	T2:15.16 R1:8.7.3
56	Problems on work energy method plane motion	CLO 15	T1:11.9 R2:12.24
57	Introduction to vibration, simple harmonic motion	CLO 15	T1:11.9 R3:12.25
58	Problems on vibrations	CLO 16	T1:3.2 R3:3.2
59	Concept of simple pendulum, compound pendulum and torsional pendulum	CLO 17	T1:3.3.1 R3:3.2
60	Problems on simple, compound and torsional pendulum	CLO 16	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	PSO 1
2	To improve the ability of understanding the concept of centroids and center of gravity with some complex Problems.	Seminars / MOOC	PO 3	PSO 1
3	Encourage students to solve real time applications and prepare towards competitive examinations.	NPTEL	PO 2	PSO 1

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