INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad - 500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTION

Course Title	**MECHANICS OF SOLIDS**			
Course Code	**A30104**			
Course Structure	**Lectures**	**Tutorials**	**Practicals**	**Credits**
	4	-	-	4
Course Coordinator	Mrs. J. Swetha, Assistant Professor.			
Team of Instructors	USP Rao, Professor.			

I. COURSE OVERVIEW

Mechanics of Solids is the physical science that deals with the reaction of a body to movement and deformation due to mechanical, thermal, or other loads. The basis of virtually all mechanical design lies in how the material reacts to outside forces. Mechanics is the core of engineering analysis and is one of the oldest of the physical sciences. An in-depth understanding of material properties as well as how certain materials react to outside stimulus is paramount to an engineering education.

II. PREREQUISITE(S)

Level	Credits	Periods	Prerequisite
UG	4	6	Engineering Mechanics, Metallurgy and Material Science, Physics, Mathematics.

III. MARKS DISTRIBUTION

Sessional Marks	University End Exam Marks	Total Marks
There shall be 2 midterm examinations. Each midterm examination consists of subjective test. The subjective test is for 20 marks, with duration of 2 hours. Subjective test of each semester shall contain 5 one mark compulsory questions in part-A and part-B contains 5 questions, the student has to answer 3 questions, each carrying 5 marks. First midterm examination shall be conducted for the first two and half units of syllabus and second midterm examination shall be conducted for the remaining portion. Five marks are earmarked for assignments. There shall be two assignments in every theory course. Marks shall be awarded considering the average of two assignments in each course.	75	100

IV. EVALUATION SCHEME

S.No	Component	Duration	Marks
1	I Mid examination	90 minutes	20
2	I Assignment	--	05
3	II Mid examination	90 minutes	20
4	II Assignment	--	05
5	External examination	3 hours	75

V. COURSE OBJECTIVES

I. To understand the theory of elasticity including stress, strain / displacement and Hooke's law and strain energy relationships.
II. To understand the shear force and bending moment diagrams of symmetrical beams.
III. To determine bending and shear stresses developed in beams of various sections.**Understand** the advantages and limitations of various measuring instruments
IV. To understand various theories of failure, Mohr's circle of stresses, principle stresses and strains.
V. To determine stresses in a shaft under torsion and in thin cylindrical shells.

VI. COURSE OUTCOMES

After completing this course the student must demonstrate the knowledge and ability to:

1. Ability to apply the principles of elasticity, plasticity, stresses, strains and their relationships under various types of loads and to analyze the composite bars.
2. Able to draw shear force and bending moment diagrams for various loads.
3. To determine flexural and shear stresses developed in various sections of beams.
4. To find principle stresses and strains and to apply theories of failure in the design of various mechanical parts.
5. To determine stresses developed in a shaft and design of a shaft.

VII. HOW PROGRAM OUTCOMES ARE ASSESSED

Program outcomes		Level	Proficiency assessed by
PO1	Ability to apply acquired knowledge of science and engineering fundamentals in problem solving.	H	Assignments and Exams
PO2	Ability to undertake problem identification, formulation and providing optimum solution in software applications.	H	Assignments and Exams
PO3	Ability to utilize systems approach in designing and to evaluate operational performance of developed software.	S	Assignments and Exams
PO4	Graduates will demonstrate an ability to identify, formulate and solve complex information technology related problems.	N	--
PO5	Graduate will be capable to use modern tools and packages available for their professional arena.	H	Assignments and Exams
PO6	Understanding of the social, cultural responsibilities as a professional engineer in a global context.	N	--
PO7	Understanding the impact of environment on engineering designs based on the principles of inter-disciplinary domains for sustainable development.	N	--
PO8	Ability to understand the role of ethics in professional environment and implementing them.	N	--
PO9	Competency in software development to function as an individual and in a team of multidisciplinary groups.	N	--
PO10	Ability to have verbal and written communication skills to use effectively not	N	--

	only with engineers but also with community at large.		
PO11	Ought to have strong fundamentals in Information Technology and be able to have lifelong learning required for professional and individual developments.	N	--
PO12	Be able to design, implement and manage projects in Information Technology with optimum financial resources with, environmental awareness and safety aspects.	S	Assignments and Exams

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED

Program Specific Outcomes		Level	Proficiency Assessed by
PSO 1	**Professional Skills:** The ability to research, understand and analyze various measuring instruments for displacement, temperature, pressure, level, flow, acceleration, vibration, strain, humidity, force, torque and power and their appropriate application.	H	Lectures, Assignments
PSO 2	**Controlling practices:** The ability to apply standard practices and strategies in measurement controlling with servo mechanisms.	S	Projects
PSO 3	**Successful Career and Entrepreneurship:** The ability to employ modern measuring and controlling techniques in creating innovative career paths, to be an entrepreneur, and a zest for higher studies.	H	Guest Lectures

N - None **S - Supportive** **H – Highly Related**

IX. SYLLABUS

UNIT-I

Elasticity and plasticity – Types of stresses & strains–Hooke's law– stress – strain diagram for mild steel

– Working stress – Factor of safety – Lateral strain, Poisson's ratio & volumetric strain – Elastic moduli & the relationship between them – Bars of varying section – composite bars – Temperature stresses. Strain energy – Resilience – Gradual, sudden, impact and shock loadings.

UNIT-II

Definition of beam – Types of beams – Concept of shear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, u.d.l., uniformly varying loads and combination of these loads – Point of contra flexure – Relation between S.F., B.M and rate of loading at a section of a beam.

UNIT-III

Theory of simple bending – Assumptions – Derivation of bending equation: M/I = f/y = E/R Neutral axis

– Determination bending stresses – section modulus of rectangular and circular sections (Solid and Hollow), I, T, Angle and Channel sections – Design of simple beam sections.

Shear Stresses: Derivation of formula – Shear stress distribution across various beams sections like rectangular, circular, triangular, I, T angle sections.

UNIT-IV

Introduction – Stresses on an inclined section of a bar under axial loading – compound stresses – Normal and tangential stresses on an inclined plane for biaxial stresses – Two perpendicular normal stresses accompanied by a state of simple shear – Mohr's circle of stresses – Principal stresses and strains – Analytical and graphical solutions. Theories of Failure: Introduction – Various theories of failure - Maximum Principal Stress Theory, Maximum Principal Strain Theory, Strain Energy and Shear Strain Energy Theory (Von Mises Theory).

UNIT-V

Theory of pure torsion – Derivation of Torsion equations : $T/J = q/r = N\theta/L$ – Assumptions made in the theory of pure torsion – Torsional moment of resistance – Polar section modulus – Power transmitted by shafts – Combined bending and torsion and end thrust – Design of shafts according to theories of failure. Thin Cylinders: Thin seamless cylindrical shells – Derivation of formula for longitudinal and

circumferential stresses – hoop, longitudinal and Volumetric strains – changes in dia, and volume of thin cylinders– Thin spherical shells.

TEXT BOOKS:

T1. Strength of materials – R.S. Kurmi and Gupta, S Chand Publications
T2. Solid Mechanics, by Popov
T3. Strength of Materials – Ryder. G.H.; Macmillan Long Man Pub.
T4. Strength of Materials – W.A. Nash, TMH

REFERENCE BOOKS:

R1.Strength of Materials -By Jindal, Umesh Publications.

R2.Analysis of structures by Vazirani and Ratwani.

R3.Mechanics of Structures Vol –I by H.J.Shah and S.B.Junnarkar, Charotar Publishing House Pvt. Ltd.

R4. Strength of Materials by S. Ramamrutam, R. Narayan, Dhanpat Rai Publishing Company R5. Strength of Materials by R. K. Rajput, S Chand Publications.

X. COURSE PLAN:

The course plan is meant as a guideline. There may probably be changes.

Lecture No.	Course Learning Outcomes	Topics to be covered	Reference
1-2	**Explain** material properties	**UNIT-I** Elasticity and plasticity	T1, R4
3-4	**Explain** the stresses and strains	Types of stresses & strains–Hooke's law	T1, R4, R5
5-6	**Explain** stress-strain diagram	stress – strain diagram for mild steel – Working stress – Factor of safety	T1, R4
7-9	**Define** various parameters	Lateral strain, Poisson's ratio & volumetric strain	T1, R4
10-12	**Derive** elastic constants	Elastic moduli & the relationship between them	T1, R4
13-15	**Solve** for stresses and strains	Bars of varying section – composite bars – Temperature stresses.	T1, R4, R5
16-18	**Describe and Derive** strain energy for various loads.	Strain energy – Resilience – Gradual, sudden, impact and shock loadings.	T1, R4, R5
19-20	**Describe** shear force and bending moment.	**UNIT-II** **Shear Force and Bending Moment:** Definition of beam – Types of beams – Concept of shear force and bending moment	R4, R5
21-30	**Draw and analyze** shear force and bending moment diagrams.	S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, u.d.l., uniformly varying loads and combination of these loads	T1, R4, R5
31-32	**Identify** point of	Point of contra flexure – Relation	T1, R4

	contraflexure	between S.F., B.M and rate of loading at a section of a beam.	
33-34	**Derive** bending moment equation.	**UNIT-III** Theory of simple bending – Assumptions – Derivation of bending equation: M/I = f/y = E/R	T1, R4
35-36	**Determine** bending stresses	Neutral axis – Determination bending stresses	T1, R4
37-39	**Determine** section modulus of various sections.	Section modulus of rectangular and circular sections (Solid and Hollow), I, T, Angle and Channel sections	T1, R4, R5
40	**Design** various beam sections	Design of simple beam sections.	T1, R4
41-45	**Derive and Analyze** shear stress distribution	**Shear Stresses:** Derivation of formula – Shear stress distribution across various beams sections like rectangular, circular, triangular, I, T angle sections.	T1, R4, R5
46-47	**Discuss** stresses on inclined section.	**UNIT-IV** **Principal Stresses and Strains:** Introduction – Stresses on an inclined section of a bar under axial loading	T1, R4
48-50	**Solve** biaxial stresses on inclined section.	Compound stresses – Normal and tangential stresses on an inclined plane for biaxial stresses	T1, R4, R5
51-53	**Construct** Mohr's circle for principal stresses and strains.	Two perpendicular normal stresses accompanied by a state of simple shear Mohr's circle of stresses – Principal stresses and strains – Analytical and graphical solutions.	T1, R4, R5
54-58	**Analyze** various theories of failures	Theories of Failure: Introduction – Various theories of failure - Maximum Principal Stress Theory, Maximum Principal Strain Theory, Strain Energy and Shear Strain Energy Theory (Von Mises Theory).	T1, R4, R5
59-60	**Derive** an expression for torsion	**UNIT-V** **Torsion of Circular Shafts:** Theory of pure torsion – Derivation of Torsion equations : T/J = q/r = Nθ/L – Assumptions made in the theory of pure torsion	T1, R4
61-63	**Determine** torsional moment of resistance	Torsional moment of resistance – Polar section modulus	T1, R4
64-65	**Derive and Determine** power transmission and combined effects	Power transmitted by shafts – Combined bending and torsion and end thrust	T1, R4, R5
66-68	**Design** the shaft according theory of failure	Design of shafts according to theories of failure.	T1, R4, R5
69-70	**Derive** the formula for longitudinal and	Thin Cylinders: Thin seamless cylindrical shells – Derivation of	T1, R4, R5

	circumferential stresses of thin cylinders	formula for longitudinal and circumferential stresses	
71-73	**Determine** various strains for thin cylinders and spherical shells	Hoop, longitudinal and Volumetric strains – changes in dia, and volume of thin cylinders– Thin spherical shells.	T1, R4, R5

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

Course Objectives	Program Outcomes												Program Specific Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
I	H	H	S		H							H	S	H	H
II															
III	H	H	S	S				S	H				S	H	H
IV															
V	H	H	S		H									H	H

N = None **S = Supportive** **H = Highly related**

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

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	H	H	S	S	H									H	H
2															
3	H	H	S		H							H	S	H	H
4															
5	H	H	S		H								S	H	H

N = None **S = Supportive** **H = Highly related**

Prepared by:
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