INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad - 500 043

AERONAUTICAL ENGINEERING

COURSE DESCRIPTION FORM

Course Title	**MECHANICS OF SOLIDS**			
Course Code	**R15 - A30104**			
Course Structure	**Lectures**	**Tutorials**	**Practicals**	**Credits**
	4	1	-	4
Course Coordinator	Mr G S D Madhav Assistant Professor			
Team of Instructors	Mr G S D Madhav Assistant Professor			

I. COURSE OVERVIEW

The objectives of this subject are to acquire fundamental understanding and behavior of structural components commonly used in engineering structures and machines. And develop skills to help them model and analyze the behavior of structural and machine components subjected to various loading and support conditions based on principles of equilibrium and material constitutional relationships.

II. PREREQUISITE(S)

Level	Credits	Periods	Prerequisite
UG	4	4	Basic concepts of Engineering mechanics, Some mathematical concepts

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. **Introduce** the various aspects of Mechanics of Materials as applied to engineering problems in a systematic manner stressing the fundamentals.

II. **Impart** the knowledge of fundamental concepts of stress, strain, Young's modulus, etc..

III. **Develop** understanding of compound bars, 2D systems and Mohr's circle.

IV. **Develop** competence and skill in solving problems related to Solid Mechanics

V. **Develop** an understanding of problems on thermal stresses, BM and SF diagrams, and deflection of beams and develop skill to solve them.

VI. **Develop** an understanding of the concepts of torsion of shafts for solving problems of practical interest.

VII. **Learn** the practical implications and applications of the Thin Cylinders

VI. COURSE OUTCOMES

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

1. **Understanding** the theory of elasticity including strain/displacement and Hooke's law relationships
2. **Determine** internal forces in prismatic member subjected to simple external loads.
3. **Understanding** of behavior of components when subjected to various type of loading.
4. **Determine** distribution of internal force across the cross section and deformation of prismatic member under simple loading
5. **Apply** knowledge for analyzing given simple engineering problems.
6. **Calculate** the stresses induced in thin cylinders and obtain safe dimensions.
7. **Participate** and succeed in competitive examinations like GATE, CEED, PSUs, etc.

VII. HOW PROGRAM OUTCOMES ARE ASSESSED

Program outcomes		Level	Proficiency assessed by
PO1	**Engineering knowledge** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	H	Assignments
PO2	**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.	H	Exercise
PO3	**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	H	Assignments, Discussion

PO4	**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.	H	Exercise
PO5	**Modern tool usage** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	H	------
PO6	**The engineer and society** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	N	Exercise
PO7	**Environment and sustainability** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	N	Discussion, Seminars
PO8	**Ethics** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	N	Discussion, Seminars
PO9	**Individual and team work** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	S	Discussions
PO10	**Communication** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	S	Discussion, Seminars
PO11	**Project management and finance** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	N	-----
PO12	**Life-long learning** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	H	Prototype, Discussions

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED

Program Specific Outcomes		Level	Proficiency Assessed by
PSO 1	**Professional skills:** Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamic and challenging environment for design and development of new products	H	Lectures and Assignments
PSO 2	**Problem solving skills:** imparted through simulation language skills and general purpose CAE packages to solve practical, design and analysis problems of components to complete the challenge of airworthiness for flight vehicles	H	Discussions
PSO 3	**Practical implementation and testing skills:** Providing different types of in house and training and industry practice to fabricate and test and develop the products with more innovative technologies	H	projects
PSO 4	**Successful career and entrepreneurship:** To prepare the students with broad aerospace knowledge to design and develop systems and subsystems of aerospace and allied systems and become technocrats	S	Seminars and Projects

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

IX. SYLLABUS

UNIT – I

SIMPLE STRESSES AND STRAINS:
Elasticity and Plasticity-Types of stresses & strains-Hook's law-Stress-strain diagram for mild steel-Working stress-factor of safety-Lateral strain, poisson's ration & 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

SHEAR FORCE AND BENDING MOMENT
Definition of beam-Types of beams-Concept of shear force and bending moment-S.F and B.M diagrams for cantilever, simply supported and over hanging 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 beam.

UNIT– III

FLEXURAL STRESSES: 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, Tangle sections.

UNIT– IV

PRINCIPAL SRRESSES AND STRAINS: 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-Principle stresses and strains-Analytical and graphical solutions.
THEORIES OF FAILURES: Introduction-Various theories of failures-Maximum principal stress theory, Maximum principal strain Theory, Strain energy and shear strain energy theory (Von Misses stresses)

UNIT– V

TORSION OF CIRCULAR SHAFTS: Theory of Pure torsion-Derivation of torsion equation: T/J=q/r=Nθ/L-Assumptions made in the theory of pure torsion –Torsional moments of resistance-Polar section modulus-Power transmitted by shafts-Combined bending and torsion and end thrust-Design of shafts according to theories of failures.
THIN CYLINDERS: Thin seamless cylindrical shells-Derivation of formula for longitudinal and circumferential stresses-hoop, longitududinal and volumetric strains-changes in dia and volume of thin cylinders-Thin spherical shells**.**

Text books:

1. Strength of materials-R.S.Kurmi and Gupta.
2. Solid Mechanics by Popov.
3. Strength of materials-R K BANSAL
4. Strength of materials-W.A.Nash,TMH

References

1. Strength of materials-By Jindal,Umesh Publications
2. Analysis of structures by Vazirani and Ratwani
3. Mechanics of structures Vol-1 by H.J Shah and S.B.Junnarkar, CharotarPublishing House Pvt

4. Strength of materials-D.S.Prakash Rao, Universities Press Pvt.Ltd..
5. Strength of materials-S.S.Ratan,Tata McGrawHill Education Pvt.Ltd.
6. Strength of materials-R.K.Rajput,S.Chand&company Ltd

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	**Define** stress and strain. Equations associated with them	**UNIT 1** **SIMPLE STRESSES AND STRAINS:** Elasticity and Plasticity-Types of stresses & strains-Hook's law	T3
3-4	**Explain** design aspects of structure	Stress-strain diagram for mild steel-Working stress-factor of safety	T3
5-7	**Define** characteristics of material	Lateral strain, poisson's ration & volumetric strain	T3
8-9	**Derive** relation between different characteristics	Elastic moduli &the relationship between them	T3
10-11	**Analyze** the structure	Bars of varying section-composite bars	T3
12-13	**Describe** different kind of stress	Temperature stresses.	T3
14-17	**Discuss** types of energy	Strain energy-Resilience-Gradual sudden, impact and shock loadings.	T3
18-19	**Explain** different types of beams	**UNIT 2** **SHEAR FORCE AND BENDING MOMENT** Definition of beam-Types of beams	T3
20-22	**Discuss** the concept of SFD & BMD	Concept of shear force and bending moment	T3
23-30	**Solve** different types of beams	S.F and B.M diagrams for cantilever, simply supported and over hanging beams subjected to point loads, u.d.l, uniformly varying loads and combination of these loads.	T3
31-32	**Evaluate** relation between force and moment diagrams	Point of contra flexure-Relation between S.F, B.M and rate of loading at a section of beam.	T3
33-34	**Demonstrate** simple bending theory	**UNIT 3** **FLEXURAL STRESSES:** Theory of simple bending- Assumptions	T3
35-36	**Evaluate** bending equation	Derivation of bending equation: M/I=f/y=E/R Neutral axis.	T3
37-40	**Analyze** different sections	Determination bending stresses-section modulus of rectangular and circular sections (Solid and hollow), I, T, angle and Channel sections).	T3
41-42	**Design** different section of beams	Design of simple beam sections.	T3
42-43	**Explain** stress distribution on different section	**SHEAR STRESSES**: Derivation of formula-Shear stress distribution across various beams sections like rectangular section	T3
44-45	**Solve** different sections for stress distribution	Derivation of formula-Shear stress distribution across various beams sections like circular section.	T3

46-47	**Solve** different sections for stress distribution	Derivation of formula-Shear stress distribution across various beams sections like triangular section	T3
48-50	**Solve** different sections for stress distribution	Derivation of formula-Shear stress distribution across various beams sections like I,T Angle sections	T3
51-52	Explain stresses on inclined planes.	**PRINCIPAL SRRESSES AND STRAINS:** Introduction-Stresses on an inclined section of a bar under axial loading	T3
53-54	Describe stresses at various angles	Compound stresses-Normal and tangential stresses on an inclined plane for biaxial stresses.	T3
55-57		Two perpendicular normal stresses accompanied by a state of simple shear-	T3
58-60	**Demonstrate** graphical method to analyze stresses	Mohr's circle of stresses-Principle stresses and strains-Analytical and graphical solutions.	T3
61--62	Discuss various failure theories	**THEORIES OF FAILURES:** Introduction-Various theories of failures-	T3
63-64	**Explain** stress theory	Maximum principal stress theory	T3
65-66	**Explain** strain theory	Maximum principal strain Theory	T3
67-68	**Describe** theory of energies	Strain energy and shear strain energy theory (Von Misses stresses)	T3
69-70	**Derive** torsion equation	**TORSION OF CIRCULAR SHAFTS:** Theory of Pure torsion-Derivation of torsion equation: $T/J=q/r=N\theta/L$	T3
70-71	**Understand** concept of torsion	Assumptions made in the theory of pure torsion	T3
71-72	**Analyze** shafts under different boundary conditions	Torsional moments of resistance-Polar section modulus-Power transmitted by shafts	T3
73-74	**Solve** different shafts with combined effects	Combined bending and torsion and end thrust-Design of shafts according to theories of failures.	T3
75-76	**Explain** different types of stresses on cylinders	Seamless cylindrical shells-Derivation of formula for longitudinal and circumferential stresses	T3
77-77	**Evaluate** effect of stresses on cylinders	hoop, longitudinal and volumetric strains-changes in dia and volume of thin cylinders	T3
78-79	**Discuss** behavior of spherical shells	Thin spherical shells	T3

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

Course Objectives	Program Outcomes												Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
I	H	H	H	H	H	S	S	S	S	S	N	H	H	H	H	S
II	H	H	H	H	H	S	S	S	S	S	N	H	H	H	H	S
III	H	H	H	H	H	S	S	S	S	S	N	H	H	H	H	S
IV	H	H	H	H	H	S	S	S	S	S	N	H	H	H	H	S
V	H	H	H	H	H	S	S	S	S	S	N	H	H	H	H	S

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

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

Course Objectives	Program Outcomes												Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	H	H	H	H	H	H	S	S	S	S	N	S	H	H	H	S
2	H	H	H	H	H	H	S	S	S	S	N	S	H	H	H	S
3	H	H	H	H	H	H	S	S	S	S	N	S	H	H	H	S
4	H	H	H	H	H	H	S	S	S	S	N	S	H	H	H	S
5	H	H	H	H	H	H	S	S	S	S	N	S	H	H	H	S
6	H	H	H	H	H	H	S	S	S	S	N	S	H	H	H	S
7	S	S	S	S	S	N	N	N	N	N	N	S	H	H	H	S

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

Prepared by: Mr G S D Madhav, Assistant Professor

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