INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

MECHANICS OF SOLIDS								
III Semester: AE								
Course Code	**Category**	**Hours /Week**			**Credits**	**Maximum Marks**		
AAED01	**Core**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	0	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Engineering Mechanics								

I. COURSE OVERVIEW:

Mechanics of solids focuses on analyzing stresses and deflection in deformable solids and structural components subjected to different types of forces and thermal loadings. It allows for the safe design of structures that are capable of supporting their intended loads. and also decide either it is suitable for a particular application by satisfying the safety and serviceability conditions. This course introduces the concepts of simple stresses, strains, and principal stresses and focuses on the analysis of members subjected to axial, shear, bending, and torsional loads. In a nutshell, the course aims at developing the skill to solve engineering problems on strength of materials. It acts as a pre-requisite to the advanced courses on Aircraft structures and Analysis of aircraft structures.

II. COURSES OBJECTIVES:

The students will try to learn:

I. The concepts of mechanics of deformable solids and their constitutive relations (including stress – strain relations), principal stresses and strains, and resilience produced under various loading conditions used in predicting the strength of aircraft structures.
II. The procedure of estimating shear force - bending moment, twisting moment, flexural Stresses, shear stresses in beams subjected to various loadings, for designing the shape, size and material of aircraft components.
III. The methods for determining the slope and deflection of beams and critical load on columns subjected to various loading conditions for determining the stiffness and strength of aircraft structures.
IV. The methods of failures and distribution of stresses in cylinders due to internal pressure.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1 Demonstrate the concepts of stress-strain, material constitutional relationship and strain energy induced in isotropic materials under different loadings.
CO 2 Make use of the concepts of shear force and bending moment in beams, and power transmission in shafts for analyzing the strength under different loadings.
CO 3 Apply theory of distribution of bending stresses and shearing stress across the beams for the safe design of aircraft components subjected different loadings.
CO 4 Utilize Maxwell's reciprocal theorem and double integration for determining the slope and deflections in beams under different types of loadings.
CO 5 Utilize Euler's formula for determining the buckling load in columns under different end conditions.

CO 6 Apply the concepts of longitudinal and circumferential stresses induced in cylinders for the safe design under inside and outside pressure.

IV. COURSE CONTENT:

MODULE – I: STRESSES AND STRAINS (09)
Elasticity and plasticity – Types of stresses and strains–Hooke's law– stress – strain diagram for mild steel – Working stress – Factor of safety – Lateral strain, Poisson's ratio, volumetric strain – Elastic module and the relationship between them – Bars of varying section – composite bars – Temperature stresses. Strain energy – Resilience – Gradual, sudden, impact and shock loadings.

MODULE – II: SHEAR FORCE AND BENDING MOMENT (09)
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.

TORSION OF CIRCULAR SHAFTS: Theory of pure torsion – Derivation of Torsion equations: $T/J = q/r = C\theta/L$ – Assumptions made in the theory of pure torsion – Torsional moment of resistance –Polar section modulus – Power transmitted by shafts;

MODULE – III: FLEXURAL STRESSES AND SHEAR STRESSES (09)
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.

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

MODULE –IV: DEFLECTION OF BEAMS AND COLUMNS (09)
Deflection in simply supported beams and cantilever beams with concentrated loads, uniformly distributed loads and their combination using Double integration method and Macaulay 's method,

Columns and Struts: Introduction; Failure of a column; Euler's column theory; assumptions in the Euler's column theory; Sign conventions; types of end conditions of the columns; columns with both ends hinged; column one end fixed and other end free; columns with both ends fixed; columns with one end fixed and other end hinged; Euler's formula and equivalent length of a column; slenderness ratio; limitations of Eluer's formula, Empirical formulae for columns; Rankine's formulae; Johnson's formula for columns; Indian Standard code for columns

MODULE –V: PRINCIPAL STRESSES, STRAINS AND CYLINDERS (09)
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. Thin Cylinders: Thin seamless cylindrical shells – Derivation of formula for longitudinal and circumferential stresses – hoop, longitudinal and volumetric strains – changes in diameter, and volume of thin cylinders due to internal pressure; Thick Cylinders: Lame's equation- cylinders subjected to inside and outside pressures

V. TEXT BOOKS:

1. R. K Bansal, “Strength of Materials”, Laxmi publications, 6th edition, 2018.
2. T. H. G. Megson, “Aircraft Structures for Engineering Students”, Butterworth-Heinemann Ltd, 6th edition, 2015.
3. Gere, Timoshenko, “Mechanics of Materials”, McGraw Hill, Reprint 2020.

VI. REFERENCE BOOKS:

1. B. C. Punmia, Ashok K Jain and Arun K Jain, “Mechanics of Materials”, Laxmi Publications Pvt. Ltd., New Delhi, 12th edition, 2007.

VII. ELECTRONICS RESOURCES:

1. http://www.efunda.com/sm home/sm.cfm
2. https://nptel.ac.in/courses/112105171/1

VIII. MATERIALS ONLINE:

1. Course template
2. Tutorial question bank
3. Tech talk topics
4. Open end experiments
5. Definitions and terminology
6. Assignments
7. Model question paper - I
8. Model question paper - II
9. Lecture notes
10. E-learning readiness videos (ELRV)
11. Power point presentation