



# INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal - 500 043, Hyderabad, Telangana

## COURSE CONTENT

AIRCRAFT STRUCTURES								
IV Semester: AE								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
AAED06	Core	L	T	P	C	CIA	SEE	Total
		3	0	-	3	40	60	100
<b>Contact Classes: 48</b>	<b>Tutorial Classes: Nil</b>	<b>Practical Classes: Nil</b>			<b>Total Classes: 48</b>			
<b>Prerequisite: Mechanics of Solids</b>								

### I. COURSE OVERVIEW:

This course is designed to study the behavior of aircraft structural elements subjected to inertial, aerodynamic, and maneuver loads. Thin-walled beams, thin plates analysis are being conducted by energy methods. Structural idealization and load analysis on wing, fuselage, and landing gears are integral part of this course. The ultimate goal is to design and development of the new generation aircraft components. This course is a prerequisite for Analysis of Aircraft structures and Finite Element Methods/Analysis.

### II. COURSE OBJECTIVES:

#### The students will try to learn:

- I. The application of mathematical principles to aircraft components to determine deflections and stresses under various loading conditions.
- II. The bending of thin-walled structures and the concept of structural idealization to transform complex structures to simple structures
- III. The concept of structural idealization and transformation of complex structures to simple structures.
- IV. The behavior of wing, fuselage and landing gears under various loading conditions.

### III. COURSE OUTCOMES:

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

- CO 1 Utilize the Impact Strength and Fatigue Strength concept for interpreting stresses due to axial, bending and torsional loads effect of inertia, Goodman and Soderberg relationship, and stresses due to combined loading, cumulative fatigue damage.
- CO 2 Choose Strain Energy and Columns concept for predicting the to axial, bending and Torsional loads, various end conditions, Euler's Column curve, Rankine's formula, and Column with initial curvature.
- CO 3 Inspect Bending of thin-walled beams for finding the Mechanical Behaviors.
- CO 4 Develop torsion and shear of thin plate for predicting the mechanical properties.
- CO 5 Illustrate the concepts General aspects of Shear stress distribution for interpreting end of a closed section beam, Thin-walled rectangular section beam subjected to torsion.
- CO 6 Make use of concept of Torsion of an arbitrary section beam, Distributed torque loading for determining the I-section beam subjected to torsion and Moment couple conditions.

### IV. COURSE CONTENT:

#### MODULE-I: INTRODUCTION TO AIRCRAFT STRUCTURAL COMPONENTS AND ENERGY METHODS (10)

Aircraft Structural components and loads, functions of structural components, airframe loads; Types of structural joints, type of loads on structural joints; Aircraft inertia loads; Symmetric manoeuvre loads, gust

loads. Monocoque and semi monocoque structures, stress in thinshells; Introductions to energy principles, castiglianos theorems, maxiwells reciprocal theorem, unit load method, Rayleigh Ritz method, total potential energy method, flexibility method.

#### **MODULE –II: THIN PLATE THEORY, STRUCTURAL INSTABILITY (10)**

Analysis of thin rectangular plates subject to bending, twisting, distributed transverse load, combined bending and in-plane loading: Thin plates having small initial curvature, energy methods of analysis. Buckling of thin plates:

Elastic, inelastic, experimental determination of critical load for a flat plate, local instability, instability of stiffened panels, failure stresses in plates and stiffened panels. Tension field beams- complete diagonal tension, incomplete diagonal tension, post buckling behavior.

#### **MODULE –III: BENDING, SHEAR AND TORSION OF THIN-WALLED BEAMS (09)**

Unsymmetrical bending: Resolution of bending moments, direct stress distribution, position of neutral axis; Deflections due to bending: Approximations for thin-walled sections, temperature effects; Shear loaded thin walled beams: General stress, strain and displacement relationships, direct stress and shear flow system, shear centre, twist and warping.

Torsion of beams of closed section: Displacements associated with Bredt-Batho shear flow; Torsion of open section beams; Warping of cross section, conditions for zero warping; Bending, shear, torsion of combined open and closed section beams.

#### **MODULE –IV: STRUCTURAL IDEALIZATION (10)**

Structural idealization: Principal assumptions, idealization of panel, effect on the analysis of thin-walled beams under bending, shear, torsion loading application to determining deflection of open and closed section beams. Fuselage frames - bending, shear and torsion

#### **MODULE –V: ANALYSIS OF FUSELAGE, WING AND LANDING GEAR (09)**

Wing spar and box beams, tapered wing spar, open and closed sections beams, beams having variable stringer areas; wings – three boom shell in bending, torsion and shear, tapered wings, deflections, cutouts in wings; Cutouts in fuselages; Fuselage frame and wing rib; principle of stiffener, web constructions. Landing gear and types; Analysis of landing gear

#### **V. TEXT BOOKS:**

1. T. H. G. Megson, “Aircraft Structures”, Butterworth-Heinemann Ltd, 5th Edition, 2012.
2. E. H. Bruhn, “Analysis and Design of Flight vehicles Structures”, Tri-state off set company, USA, 4<sup>th</sup> edition, 1965.

#### **VI. REFERENCE BOOKS:**

1. B. K. Donaldson, “Analysis of Aircraft Structures - An Introduction”, McGraw Hill, 3<sup>rd</sup> edition, 1993.
2. S. Timoshenko, “Strength of Materials”, Volumes I and II, Princeton D. Von Nostrand Co., Reprint, 1977.

#### **VII. ELECTRONICS RESOURCES:**

1. <https://as.wiley.com/WileyCDA/WileyTitle/productCd-1118806778.html>
2. <https://www.scribd.com/document/63588270/Aerospace-Propulsion-Systems>

#### **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