ANALYSIS OF AIRCRAFT STRUCTURES

V Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB14	Core	2	1	-	3	30	70	100
Contact Classes: 30	Tutorial Classes: 15	Practical Classes: Nil				Total Classes: 45		

I. COURSE OVERVIEW:

This course deals with the fundamental theories of solid mechanics for analyzing the aircraft structures and their limitations to estimate the component life. Composites materials, their importance over metals/alloys, their applications, and their mechanical behavior under loading conditions are discussed in this course. The concepts of open and closed section beams subjected to various loading conditions like torsion and bending which are useful in the design of aircraft sub-structures like wings, fuselages, landing gears, etc are also discussed.

II. OBJECTIVES:

The course should enable the students to:

I. The concepts of estimation of the endurance and failure mechanism of aircraft structural components for safe design.

II. The properties and analysis of composite structures for replacement of aluminium structures with composites for high strength to weight ratio.

III. The mechanism involved in thin walled closed and rectangular section beam subjected to torsion and Shear loads for design of modern aircrafts.

IV. The concepts of Stresses and deflections of various open and closed section aircraft beam structures.

III. COURSE OUTCOMES:

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

CO 1	**Illustrate** the S-N diagram for estimating the endurance limit (failure point) under mean and alternating stresses.	Understand
CO 2	**Analyze** the stresses developed in components like notches, shafts, and methods to reduce stress concentrations for better resistance against failure.	Apply
CO 3	**Apply** the fracture mechanics theories for materials (Ductile, Brittle) subjected to crack(s) for determining the conditions for failure.	Apply
CO 4	**Illustrate** the influence of material thickness, fracture toughness, and stress intensity factors for cracked bodies of various geometries for stress and strain patterns.	Apply
CO 5	**Demonstrate** the crack growth mechanisms for estimating the life of the structural components.	Understand
CO 6	**Summarize** various types of composite materials for deducing the governing constitutive relations for various types of loads and deflections.	Understand
CO 7	**Identify** various types of composite materials used for constructing modern aircraft components and structures to reduce the weight..	Understand
CO 8	**Make use of** the various composite fabrication methods for deflection, shear, and bending and torsion analysis of composite structures.	Understand
CO 9	**Construct** the shear stress distribution in closed section beams subjected to torsion for minimizing stress intensity.	Understand
CO 10	**Analyze** the stresses developed in thin-walled rectangular cross-section beams under torsion load and shear lag analysis to optimize the structure for better load carrying capacities.	Understand
CO 11	**Analyze** the thin walled I- cross sectional Structural member subjected to torsion loads for modern aircraft structural members for better resistance to deflections.	Apply

CO 12	**Extend** the theory of Moment Couple and for better load resistance in aircraft applications.	Apply

IV. SYLLABUS:

MODULE -I	**FATIGUE OF AIRCRAFT STRUCTURE**	**Classes: 08**
S.N. curves - Endurance limits - Effect of mean stress, Goodman, Gerber and Soderberg relations and diagrams - Notches and stress concentrations - Neuber's stress concentration factors - Plastic stress concentration factors - Notched S.N. curves.		
MODULE -II	**FRACTURE MECHANICS OF AIRCRAFT STRUCTURE**	**Classes: 10**
Strength of cracked bodies - Potential energy and surface energy - Griffith's theory - Irwin - Orwin extension of Griffith's theory to ductile materials - stress analysis of cracked bodies - Effect of thickness on fracture toughness - stress intensity factors for typical geometries. Crack growth mechanisms.		
MODULE -III	**LAMINATED AIRCRAFT COMPOSITE STRUCTURES**	**Classes: 09**
Classification and characteristics of composite materials - Fibrous, Laminated Particulate, Combinations of composite materials, Mechanical Behavior. Basic terminology-laminae, laminates, Manufacture – Initial form of constituent Materials, Layup, Curing, Strength and stiffness Advantages, Cost Advantages, and Weight Advantages. Applications- Military, Civil Aircraft, Space and Automotive. Elastic constants of a simple lamina, Stress–strain relationships for an orthotropic ply(macro- approach), Thin-walled composite beams.		
MODULE -IV	**STRUCTURAL AND LOADING DISCONTINUITIES - CLOSED SECTION BEAMS**	**Classes: 09**
General aspects, Shear stress distribution at a built-in end of a closed section beam, Thin-walled rectangular section beam subjected to torsion, Shear lag.		
MODULE-V	**STRUCTURAL AND LOADING DISCONTINUITIES - OPEN SECTION BEAMS**	**Classes: 09**
I-section beam subjected to torsion, Torsion of an arbitrary section beam, Distributed torque loading, Extension of the theory to allow for general systems of loading, Moment couple (bimoment).		

V. Text Books:

1. Prasanth Kumar, "Elements of fracture mechanics", Wheeter Publication, 1999.
2. Jones, R.M, "Mechanics of Composite Materials", Taylor & Francis, 2nd Edition, 2010.
3. T. H. G. Megson, "Aircraft Structures for Engineering Students",Butterworth-Heinemann Ltd, 5th Edition, 2012.

VI. Reference Books:

1. Barrois W, Ripely, E.L., "Fatigue of Aircraft Structure", Pe/gamon press. Oxford, 1983.
2. B. K. Donaldson, "Analysis of Aircraft Structures" - An Introduction", McGraw Hill, 3rd Edition, 1993.
3. E. H. Bruhn, "Analysis and Design of Flight Vehicles Structures", Tri-state off set company, USA, 4th Edition, 1965.
4. S. Timoshenko, "Strength of Materials, Vols I and II", Princeton D. Von Nostrand Co., Reprint, 1977.
5. J E shigley, C R Mischke, R G Budynas, K J Nisbett, "Mechanical Engineering Design" The McGraw Hill, 8th Edition, 2010.

VII. Web References:

1. https://nptel.ac.in/courses/112101095/
2. https://www.scribd.com/doc/244154727/theory-of-structures-timoshenko-pdf

VIII. E-Text Books:
1. https://www.freeengineeringbooks.com/AeroSpace/Aircraft-Structures-Books.php 2. https://docs.google.com/file/d/0Bw8MfqmgWLS4RlNqaE1oUzdOajQ/view?pref=2&pli=1