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

COURSE CONTENT

THEORY OF AEROELASTICITY								
VII Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AAED48	**Elective**	**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: Aerodynamics								

I. COURSE OVERVIEW:
The "Analysis of Aircraft Structures" course is designed to provide students with a comprehensive understanding of the principles, methods, and techniques used in analyzing and evaluating the structural integrity of aircraft components. This course covers both theoretical concepts and practical applications, aiming to equip students with the knowledge and skills necessary for the design, analysis, and optimization of aircraft structures. Topics include stress analysis, load distribution, material properties, fatigue, and fracture mechanics, with a focus on the unique challenges presented by aerospace engineering.

II. COURSES OBJECTIVES:
The students will try to learn

I. Understand the fundamental concepts of aero elasticity, including the coupling between aerodynamic loads and structural deformations.
II. Develop a strong foundation in structural dynamics to analyze and predict the behavior of flexible structures subjected to aerodynamic forces...
III. Gain knowledge of aerodynamic principles and their effects on the structural response of aerospace vehicles
IV. Learn about experimental techniques, especially wind tunnel testing, to validate aero elastic predictions and analyze the behavior of aerospace structures.
V. Study techniques for suppressing unwanted vibrations in aerospace structures, including passive and active control methods.

III. COURSE OUTCOMES:
At the end of the course students should be able to:

CO1 Identify the aero elastic phenomena flutter, divergence and aileron reversal arise and how they affect aircraft performance, collar triangle
CO2 Demonstrate a basic understanding of modern numerical methods and the state-of-the-art in structural dynamics and aero elasticity
CO3 Differentiate between static aero elasticity and dynamic aero elasticity
CO4 Develop equation of motion for linear motion and rotary motion
CO 5 Analyze the wing flutter, under the over damping and critical damping conditions
CO 6 Build confidence for self-learning needed for aircrafts, automobiles failures due to vibration effect

IV. COURSE CONTENT:

MODULE-I: INTRODUCTION (10)

Introduction to Aero elasticity COLLARS Triangle, Aerodynamics and interactions of Structural and Inertial forces Static and Dynamic Aero Elasticity Phenomena. Simple Two-dimensional idealization of flow, String Theory, Freehold Integral equations of Second Kind Exact Solutions for simple rectangular wings.

MODULE-II: ANLAYTICAL METHODS (9)

Formulations of Structural Dynamics Equation and Coupling effects for panels and plates, generalized coordinates, Lagrange 's Equations of motion Hamilton 's Principle Orthogonality conditions. Static Aero elastic Studies Divergences, control reversal, Aileron reversal speed, Aileron efficiency, lift distribution, Rigid and elastic wings.

MODULE-III: EXPERIMENTAL ANALYSIS & EQUATIONS OF AERO ELASTIC EXPERIMENTAL ANALYSIS (9)

Non-dimensional Parameters, stiffness criteria, dynamic mass balancing, model experiments and dimensional similarity, flutter analysis. EQUATIONS OF AERO ELASTIC: Formulation of Aero elastic Equations for a Typical Section, Quasi Steady Aerodynamic derivatives, modal equations Galerkins method of analysis.

MODULE-IV: FLUTTER (10)

Stability of motion of Continua Torsion flexure flutter, Solution of flutter determinant, method of determining the classical flutter speed, Flutter Prevention and control.

MODULE-V: AERO ELASTICITY APPLICATIONS (10)

Application of Aero Elasticity in Engineering Problems, galloping of transmission lines, flow induces vibrations of tall slender structures and suspension Budges.

V. TEXT BOOKS:

1. Dewey H. Hodges, G. Alvin Pierce, "Introduction to Structural Dynamics", 2nd Edition, Cambridge University Press, UK 2011.
2. Fung Y. C, "An Introduction to the Theory of Aero Elasticity", Dover Publications, USA 2008.
3. Jan R. Wright "Introduction to Aircraft Aero Elasticity and Loads", John Wiley, USA, 2008

VI. REFERENCE BOOKS:

1. Raymond L., Bisplinghoff and Holt Ashely, "Principles of Aeroelasticity", Drovers Publications, USA, 2010.
2. Adamu Yebi, "Vibration Analysis of Cracked Composite Aircraft Wing Modeled as Shell", VMD Verlag, New Delhi 2010.
3. E. H. Dwell, "A Modern Course in Aero Elasticity", Springer Publishers, Germany 2010.

VII. ELECTRONICS RESOURCES:

1. https://nptel.ac.in/courses/101104005
2. https://web.mit.edu/16.242
3. https://freevideolectures.com/course/3082/aero-elasticity

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