AERO ELASTICITY

I Semester: AE								
Course Code	**Category**	**Hours /Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
BAEC04	**Elective**	3	-	-	3	30	70	100
Contact Classes:45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes:45**		

I. COURSE OVERVIEW:

Aeroelasticity is a study of behavior of aircraft structural components while submerged in a fluid. In simpler terms, it deals with the comprehension of elastic, aerodynamic and inertial forces on a body due to fluid flow around it. It is a combination of three distinct fields of aeronautical engineering *i.e.* aerodynamics, stability and control, and solid mechanics. This course, deals with static aeroelasticity as well as dynamic aero elasticity. Each category of aero elasticity will have specific importance and they shall take roots from one of the aforementioned three domains. Students shall go through the basics of aero elasticity till dynamic phenomenon such as flutter.

II. COURSE OBJECTIVES:

The students will try to learn:

I. Outline importance of aero elasticity in flight vehicle design and classify static and dynamic aeroelastic problems.
II. The structural dynamic and steady and unsteady aerodynamics aspects of airframe and its components and their role in aero elasticity.
III. To construct theoretical basis for the solution of static aeroelastic problems an estimate loads and other critical speeds.
IV. To construct theoretical basis for the solution of flutter problems and estimate of flutter speeds.

III. COURSE OUTCOMES:

After successful completion of the course, students will 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	**Apply** the fracture mechanics theories for materials (Ductile, Brittle) subjected to crack(s) for determining the conditions for failure.	**Apply**
CO 3	**Illustrate** the influence of material thickness, fracture toughness, and stress intensity factors for cracked bodies of various geometries for stress and strain patterns.	**Understand**
CO 4	**Identify** various types of composite materials used for constructing modern aircraft components and structures to reduce the weight.	**Apply**
CO 5	**Construct** the shear stress distribution in closed section beams subjected to torsion for minimizing stress intensity.	**Apply**
CO 6	**Apply** the theory of Moment Couple for better load resistance in aircraft applications.	**Apply**

IV. COURSE SYLLABUS:

MODULE-I: AEROELASTIC PHENOMENA (08)

Stability versus response problems; The aeroelastic triangle of forces; Aero elasticity in Aircraft Design; Prevention of aeroelastic in stabilities. Influence and stiffness coefficients. Coupled oscillations.

MODULE-II: DIVERGENCE OF A LIFTING SURFACE (10)

Simple two-dimensional idealizations; Strip theory, Integral equation of the second kind Exact solutions for

simple rectangular wings, Semirigid "assumption and approximate solutions; Generalized coordinates, successive approximations, numerical approximations using matrix equations.

MODULE-III: STEADY STATE AEROLASTIC PROBLEMS (08)
Loss and reversal failer on control, critical ailer on reversal speed, ailer on efficiency, semi rigid theory and successive approximations, lift distribution, rigid and elastic wings.

Tail efficiency, effect of elastic deformation on static longitudinal stability.

MODULE-IV: FLUTTER PHENOMENON (10)
Non-dimensional parameters, stiffness criteria, dynamic mass balancing, dimensional similarity; Flutter analysis, two dimensional thin airfoils in steady incompressible flow, quasi steady aerodynamic derivatives; Galerkin method for critical flutter speed, stability of disturbed motion, solution of the flutter determinant, methods of determining the critical flutter speeds, flutter prevention and control.

MODULE-V: EXAMPLES OF AERO ELASTIC PROBLEMS (09)
Gall oping of transmission lines and Flow induced vibrations of transmission lines, tall slender structures and suspension bridges.

V. TEXT BOOKS:

1. Y.C.Fung, "An Introduction to the Theory of Aero elasticity", John Wiley & Sons Inc., New York, 2008.
2. E.G. Broadbent, "Elementary Theory of Aeroelasticity", Bun Hill Publications Ltd, 1986.

VI. REFERENCE BOOKS:

1. R.L. Bisplinghoff, H.Ashley, and R.L. Halfmann, "Aero elasticity", Edition Addison Wesley Publishing Co., Inc., 2nd Edition, 1996.
2. R.H.Scanlan and R. Rosenbaum, "Introduction to the study of Aircraft Vibration and Flutter", Macmillan Co., New York, 1981.
3. R.D.Blevins, "Flow Induced Vibrations", Krieger PubCo, 2001.

VII. WEB REFERENCES:

1. http://www.efunda.com/math/math_home/math.cfm
2. http://ocw.mit.edu/resources/#Mathematics
3. http://www.sosmath.com/
4. http://mathworld.wolfram.com/

VIII. E-TEXT BOOKS:

1. http://www.e-booksdirectory.com/details.php?ebook=10166
2. http://www.e-booksdirectory.com/details.php?ebook=7400re