COURSE CONTENT

VIBRATION AND AERONAUTICITY								
I Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
BAED04	**Elective**	3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Aircraft structures								

I. COURSE OVERVIEW:

Vibration and aeroelasticity overs the study of structural dynamics and the interaction between aerodynamic forces and structural vibrations in aerospace vehicles. 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 aeroelasticity. Each category of aeroelasticity will have specific importance and they shall take roots from one of the aforementioned three domains. Students shall go through the basics of aeroelasticity till dynamic phenomenon such as flutter

II. COURSE OBJECTIVES:

The students will try to learn:

I. The basic aspects of vibration theory e principles of dynamics and energy methods pertaining to structure.
II. The structural dynamic and steady and unsteady aerodynamics aspects of airframe and its components and their role in aeroelasticity.
III. The theoretical basis for the solution of static aeroelastic problems an estimate loads and other critical speeds.
IV. The 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 Solve the single degree of freedom system using energy method for damping the vibration generated.
CO 2 Make use of Hamilton's and Lagrange Principle for vibration analysis of multi degrees of freedom system
CO 3 Illustrate the S-N diagram for estimating the endurance limit (failure point) under mean and alternating stresses.
CO 4 Apply the fracture mechanics theories for materials (Ductile, Brittle) subjected to crack(s)for determining the conditions for failure.
CO 5 Illustrate the influence of material thickness, fracture toughness, and stress intensity factors for cracked bodies of various geometries for stress and strain patterns.
CO 6 Identify various types of composite materials used for constructing modern aircraft components and structures to reduce the weight.

IV. COURSE CONTENT:

MODULE-I: SINGLE DEGREE OF FREEDOM SYSTEMS (09)

Simple harmonic motion, definition of terminologies, Newton's Laws, D'Alembert's principle, Energy methods. Free and forced vibrations with and without damping, base excitation, and vibration measuring instruments.

MODULE-II: MULTI-DEGREES OF FREEDOM SYSTEMS (09)

Two degrees of freedom systems, Static and dynamic couplings, eigen values, eigen vectors and orthogonality conditions of eigen vectors, Vibration absorber, Principal coordinates, Principal modes. Hamilton's Principle, Lagrange's equation and its applications.

MODULE-III: AEROELASTIC PHENOMENA (10)
Stability versus response problems; The aeroelastic triangle of forces; Aero elasticity in Aircraft Design; Prevention of aero elastic instabilities. Influence and stiffness coefficients. Coupled oscillations.

MODULE-IV: 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-V: 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.

V. TEXT BOOKS:

1. Timoshenko, S. "Vibration Problems in Engineering", John Wiley & Sons, Inc., 2018
2. Y.C.Fung, "An Introduction to the Theory of Aero elasticity", John Wiley & Sons Inc., New York, 2008.
3. E.G. Broadbent, "Elementary Theory of Aeroelasticity", Bun Hill Publications Ltd, 1986.

VI. REFERENCE BOOKS:

1. Thomson W.T, Marie Dillon Dahleh, "Theory of Vibrations with Applications", Harlow, Essex Pearson 2014.
2. R.L. Bisplinghoff, H. Ashley, and R.L. Halfmann, "Aero elasticity", Edition Addison Wesley Publishing Co., Inc., 2nd Edition, 1996.
3. R. H. Scanlan and R. Rosenbaum, "Introduction to the study of Aircraft Vibration and Flutter", Macmillan Co., New York, 1981.

VII. ELECTRONICS RESOURCES:

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. MATERIALS ONLINE

1. Course template
2. Assignments
3. Tutorial question bank
4. Model question paper – I
5. Model question paper – II
6. Lecture notes
7. Power point presentations