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

COURSE CONTENT

AEROSPACE STRUCTURAL DYNAMICS

VII SEMESTER: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEC35	Core	3	1	-	4	30	70	100
Contact Classes: 45	Tutorial Classes: 15	Practical Classes: Nil				Total Classes: 60		

Prerequisite: Aircraft Structures

I. COURSE OVERVIEW:

Aerospace Structural Dynamics subject focuses on the vibration analysis of different structural components. It provides the students with basic knowledge of mechanical vibrations of single and multiple degrees of freedom systems. These concepts are then extended to vibrations of continuum elastic bodies. Moreover, this course will also provide the required knowledge on aeroelasticity, which is one of the emerging fields of research in aerospace / aeronautical engineering. The theoretical knowledge gained through this course serves as a complement for the aerospace structural dynamics laboratory. Altogether, will be a good addition to the student's curriculum.

II. COURSE OBJECTIVES:

The student will try to learn:

I. The knowledge of mathematics, science, and engineering by developing the equations of motion for vibratory systems and solving for the free and forced response.
II. The identification, formulation and solve engineering problems. This will be accomplished by having students model, analyze and modify a vibratory structure order to achieve specified requirements.
III. The structural vibrations which may affect safety and reliability of engineering systems.
IV. The structural dynamic and steady and unsteady aerodynamics aspects of airframe and its components of space structures.

III. COURSE OBJECTIVES:

MODULE-I: SINGLE-DEGREE-OF-FREEDOM LINEAR SYSTEMS (10)

Introduction to theory of vibration, equation of motion, free vibration, response to harmonic excitation, response to an impulsive excitation, response to a step excitation, response to periodic excitation (Fourier series), response to a periodic excitation (Fourier transform), Laplace transform (Transfer Function).

MODULE-II: TWO-DEGREE-OF-FREEDOM SYSTEMS (10)

Introduction, Equations of Motion for Forced Vibration, Free Vibration Analysis of an Undamped System, Torsional System, Coordinate Coupling and Principal Coordinates, Forced-Vibration Analysis, Semi definite Systems, Self-Excitation and Stability Analysis, Transfer- Function Approach, Solutions Using Laplace Transform, Solutions Using Frequency Transfer Functions.

MODULE-III: MULTI-DEGREE-OF-FREEDOM LINEAR SYSTEMS (08)

Matrix formulation, stiffness and flexibility influence coefficients; Eigen value problem; normal modes and their properties; Free and forced vibration by Modal analysis;

Method of matrix inversion; Torsional vibrations of multi- rotor systems and geared systems; Discrete- Time systems.

MODULE-IV: DYNAMICS OF CONTINUOUS ELASTIC BODIES (09)

Introduction, transverse vibration of a string or cable, longitudinal vibration of a bar or rod, torsional vibration of shaft or rod, lateral vibration of beams, the Rayleigh-Ritz method.

MODULE-V: INTRODUCTION TO AEROELASTICITY (08)

Static Aeroelasticity; Typical Section Model of an Airfoil: Typical Section Model with Control Surface, Typical Section Model—Nonlinear Effects. One Dimensional Aeroelastic Model of Airfoils: Beam-Rod Representation of Large Aspect Ratio Wing, Eigen value and Eigen function Approach, Galerkin's Method.

Dynamic Aeroelasticity; Hamilton's Principle: Single Particle, Many Particles, Continuous Body, Potential Energy, Non potential Forces, Lagrange's Equations.

IV. TEXT BOOKS:

1. Bismarck-Nasr, M.N., "Structural Dynamics in Aeronautical Engineering", AIAA Education Series, 2nd Edition, 1999.
2. Rao, S.S., "Mechanical Vibrations", Prentice-Hall, 5th Edition, 2011.
3. Earl H. Dowell, "A Modern Course in Aeroelasticity" Volume 217, Duke University, Durham, NC, USA.

V. REFERENCE BOOKS:

1. R.L. Bisplinghoff, H. Ashley, and R.L. Halfmann, "Aeroelasticity", Addison Wesley Publishing Co, 2nd Edition, 1996.
2. Leissa, A.W., "Vibration of continuous system", The McGraw-Hill Company, 2nd Edition, 2011.
3. Inman, D.J, "Vibration Engineering", Prentice Hall Int., Inc., 3rd Edition, 2001.

VI. WEB REFERENCES:

1. http://ase.sbu.ac.ir/FA/Staff/abbasrahi/Lists/Dars/Attachments/11/Vibrations%20of%20Continuous%20Systems.pdf
2. http://arc-test.aiaa.org/doi/book/10.2514/4.862458
3. http://arc-test.aiaa.org/doi/abs/10.2514/5.9781600862373.0719.0728

VII. E-TEXT BOOKS:

1. http://www.gregorypaulblog.com/structural-dynamics-in-aeronautical-engineering-aiaa-education-series.pdf
   https://aerocastle.files.wordpress.com/2012/10/mechanical_vibrations_5th-edition_s-s-rao.pdf