INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

AEROSPACE STRUCTURAL DYNAMICS								
VII Semester: AE								
Course Code	**Category**	**Hours /Week**			**Credits**	**MaximumMarks**		
AAED42	**Core**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	-	-	3	40	60	100
Contact Classes:48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes:48**		
Prerequisite: Engineering Mechanics, Mechanics of Solids								

I. COURSE OVERVIEW:

Mechanical vibration is an important consideration for the performance, functionality and integrity of many structures and machines. The objective of this course is to learn how to treat the vibration phenomena by transforming the physical model into a mathematical model and solve it by using the appropriate mathematical operations. Students will gain an understanding of the fundamental causes of various static and dynamic aeroelastic phenomena.

II.COURSE OBJECTIVES:

The students will try to learn:

I. Impart basic knowledge and importance on mechanical vibration in engineering fields.
II. Formulate mathematical models of problems in vibrations using Newton's second law and the principle of conservation of energy.
III. Impart the basic knowledge on aero elastic phenomena and its impact on aircraft design.

III.COURSE OUTCOMES:

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

CO1 Outline the fundamental concepts of mechanical vibrations and justify their application in a variety of engineering design contexts
CO2 Apply principles of mechanical vibrations such as Newton's second law, and the principle of conservation of energy to the mathematical models to obtain their governing equations of motion
CO3 Compute the natural frequency (or frequencies) of vibratory systems for determining the system's modal response.
CO4 Illustrate the various techniques of measurement and control of vibration and noise
CO5 Understand and identify the nature of the aeroelastic problems encountered inflight vehicles.
CO6 Make use of different tools to measure the vibrations on the aircraft structures with different frequencies.

IV. COURSE CONTENT:

MODULE - I: SINGLE-DEGREE-OF-FREEDOM SYSTEMS (11)

Introduction: Basic terminology in vibrations, methods of vibration analysis, types of vibrations, Fourier series, Harmonic motion and analysis, Numerical problems.

Free Vibration of undamped single-degree-of-freedom systems: Equation of motion using Newton s second law of motion for translational and torsional system, Rayleigh's Energy method. Equivalent stiffness of series and parallel springs

MODULE - II: DAMPED FREE VIBRATIONS (1DOF) (09)

Damped free vibrations (1DOF): Types of damping, damping elements, analysis with viscous and coloumb damping, derivations for over, critical and under damped systems, Logarithmic decrement and problems. Energy dissipated by viscous damping. Rotating imbalance, Whirling of shafts.

MODULE - III: SYSTEMS WITH TWO DEGREES OF FREEDOM (10)

Systems with two degrees of Freedom: Equations of motion for forced vibration, Free vibration analysis of an undamped system, torsional system.

Semidefinite systems, Co-ordinate coupling, Solutions using Laplace transform and frequency transfer functions

MODULE - IV: MULTI DEGREE FREEDOM SYSTEM AND NUMERICAL METHODS (09)

Multi degree freedom system: free vibration equation of motion. Stiffness influence coefficients, flexibility influence coefficient, inertia influence coefficient. Forced vibration of undamped systems using modal analysis

Numerical Methods: Dunkerley's Methods, Stodola method, Rayleigh 's Method, Holzer 's Method, Methods of matrix iterations, Jacobi's method.

MODULE - V: VIBRATION CONTROL AND ELEMENTS OF AEROELASTICITY (09)

Vibration Control: Transducers and vibration pickup, Vibrometer, accelerometer, velometer, frequency measuring instrument, FFT analyser, vibration exciters.

Elements of Aeroelasticity: Aeroelastic problems – Collar's triangle of forces, Static and dynam aeroelasticity– Torsional wing divergence, Aileron control reversal, Flutter, Aero elasticity.

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. Wright, J.R., and Cooper, J.E., Introduction to Aircraft Aeroelasticity and Loads, JohnWiley, (2008).

V. REFERENCE BOOKS:

1. R.L. Bisplinghoff, H.Ashley, and R.L. Halfmann, "Aeroelasticity", Addison Wesley Publishing Co., Inc., 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 International, Inc., 3rd Edition, 2001.

VI. ELECTRONICS RESOURCES:

1. https://archive.nptel.ac.in/courses/112/107/112107212/
2. https://archive.nptel.ac.in/courses/112/103/112103111/
3. https://ocw.mit.edu/courses/2-993j-introduction-to-numerical-analysis-for-engineering-13-002j-spring-2005/pages/lecture-notes/

VIII. MATERIALS ONLINE

1. Course template
2. Tutorial question bank
3. Tech-talk topics
4. Open-ended experiments
5. Definition and terminology
6. Assignments
7. Model question paper - 1
8. Model question paper - 2
9. Lecture notes
10. Power point presentations
11. E-learning readiness videos (ELRV)