VIBRATION AND STRUCTURAL DYNAMICS

PROFESSIONAL ELECTIVE – I

VI Semester

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
A5AE37	PCC	3	0	0	3	30	70	100

COURSE OBJECTIVES

The purpose of this subject is to provide the students with the theoretical background and engineering applications.

1. Identify the various elements of stiffened panels and types of mechanical load systems like transverse, longitudinal and torsional
2. Analyze one-degree-of-freedom system
3. Describe various terms like free vibrations, forced vibrations, damped vibrations and their engineering applications
4. To study the effect of time dependent forces on mechanical systems and to get the natural characteristics of system with more degree of freedom systems.
5. To study the aeroelastic effects of aircraft wing.

UNIT-I INTRODUCTION AND SINGLE DEGREE OF FREEDOM SYSTEMS

INTRODUCTION: Simple harmonic motion, terminology, Newton's Law, D'Alembert's Principle, Resonance, Introduction to mechanism of damping. Oscillations. Degrees of freedom.Various mechanisms of damping. Equivalent stiffness concept, vibration isolation

SINGLE DEGREE OF FREEDOM SYSTEMS: Free vibrations – damped vibrations– forced vibrations, with and without damping – Amplitude – Application - support excitation – transmissibility – vibration measuring instruments.

UNIT-II MULTI DEGREE OF FREEDOM SYSTEMS VIBRATION OF CONTINUOUS SYSTEMS

Two degrees of freedom systems - static and dynamic couplings - vibration absorber- Multi degree of freedom systems - principal co-ordinates - principal modes and orthogonal conditions – Eigen value problems - Hamilton's principle.

VIBRATION OF CONTINUOUS SYSTEMS

Longitudinal vibration, lateral vibration, torsional vibration of shafts, dynamical equations of equilibrium of elastic bodies.

UNIT-III DETERMINATION OF NATURAL FREQUENCIES AND MODE SHAPES AND ROTATING SHAFTS

Determining natural frequencies and mode shape. Natural Vibrations of solid continua. Determination of Eigen Values and Eigen modes – Matrix method. Kinematically consistent Load systems and determination of [K], [M], [C] and [I] matrices

ROTATING SHAFTS: Natural frequency of rotating shafts Whirling of shafts. Dynamic balancing of rotating shafts. Dynamic dampers.

UNIT-IV APPROXIMATE METHODS FOR FREQUENCY

Introduction to approximate methods for frequency analysis, Rayleigh Ritz method for vibration analysis. Diagonalization of stiffness, mass and damping matrices using orthogonality conditions.

UNIT-V INTRODUCTION TO THEORY OF AEROELASTIC STABILITY

Aeroelastic and inertial coupling- aeroelastic problems. Collar's triangle. Static and dynamic aeroelastic phenomena. Aeroelastic instabilities and their prevention. Wing divergence, control reversal and wing flutter– buffeting, flutter speed. Aeroelastic tailoring. Elements of servo elasticity

Text Books:

1.Mechanical Vibrations by V. Singh
2. Fug Y. C. (2008), An Introduction to Theory of Aeroelasticity, Dover Publications, US

Reference Books:

1. J. S. Rao, Gupta K. (2002), Theory and practice of Mechanical vibrations, Wiley Eastern Ltd, USA
2. Megson T. H. G (2012), Aircraft Structures for Engineering Students, 5th edition, Elsevier, New York

COURSE OUTCOMES:

At the end of the course the students are able to:

1. Analyze the problem and estimate the governing equation of motion
2. apply linear mathematical models of real-life engineering systems
3. Determine vibratory responses of single degree of freedom and multi-degree of freedom systems to the harmonic, periodic and non-periodic excitation
4. Develop the mathematical model of dynamic systems with a single degree of freedom,
5. Develop mathematical model of dynamic systems with multiple degrees of freedom