

## MEPC3005 MECHANICAL VIBRATION (3-0-0)

### Course Objectives

The objectives of this course are to:

1. Introduce fundamental concepts of vibration and its significance in mechanical systems.
2. Enable the formulation of mathematical models for free, damped, and forced vibrations in single and multi-degree freedom systems.
3. Develop analytical skills to solve vibration problems using various methods like matrix iteration and classical techniques.
4. Explore the behavior of continuous systems subjected to different types of vibrations.
5. Introduce students to practical aspects of vibration control and measurement, including applications in mechanical design.

### Module - I: (05 Hours)

INTRODUCTION TO VIBRATION AND EQUATIONS OF MOTIONS: NATURAL FREQUENCY

Undamped Free Vibration: Systems with single degree of freedom, Equilibrium method, The energy method, Rayleigh's method, Stiffness of spring elements.

### Module - II: (07 Hours)

VISCOUSLY DAMPED FREE VIBRATION

Damped Free Vibrations: Viscous damping, laws of damping, logarithmic decrement.

### Module - III: (08 Hours)

FORCED HARMONIC VIBRATION

Forced Vibration with Harmonic Excitation: Steady state solution with viscous damping, Method of complex algebra, Reciprocating and rotating unbalance, Base excitation, Vibration isolation, Air springs, Energy dissipated by damping, Equivalent viscous damping, Structural damping, Sharpness of resonance, Vibration measuring instruments, Whirling of rotating shafts, Rigid shafts supported by flexible bearings.

### Module - IV: (08 Hours)

VIBRATION OF MULTI DEGREE FREEDOM SYSTEMS

Two degree of freedom system: Vibration of undamped two degree of freedom system, coordinate coupling, vibration absorber. Multi-degree freedom system: Influence coefficients, generalized co-ordinates, matrix method, matrix iteration method, Stodola Method, Holzer's Method, Dunkerley's method.

### Module - V: (08 Hours)

VIBRATION OF CONTINUOUS SYSTEMS

Vibration of Continuous systems, Vibration of String, Longitudinal Vibration of Rods, Torsional Vibration of Rods, Vibration of Beams.

### Course Outcomes

- CO1 Define and explain key concepts in vibration theory including natural frequency, damping, and vibration models for mechanical systems.
- CO2 Formulate and solve equations of motion for undamped and damped single-degree-of-freedom systems using energy methods and Rayleigh's method.

- CO3 Analyze forced vibration systems with harmonic excitation and evaluate the effects of damping, resonance, and vibration isolation systems.
- CO4 Model and determine the natural frequencies and mode shapes of multi-degree-of-freedom systems using matrix-based methods.
- CO5 Analyze the vibrational behavior of continuous systems such as strings, rods, and beams, and assess their dynamic response.

### **Essential Reading**

1. W.T. Thompson, Theory of Vibration with Application, Kindle Edition-2025, Pearson Education , 2025
2. Tony L. Schmitz (Author), K. Scott Smith (Author), Mechanical Vibrations: Modeling and Measurement, Kindle Edition 2025, Springer , 2025

### **Supplementary Reading**

1. Leonard Meirovitch, Elements of Vibration Analysis, MC GRAWHILL , 2019
2. Haym Benaroya (Author), Mark Nagurka (Author), Mechanical Vibration: Theory and Application, Kindle Edition: 2025, Rutgers University Press , 2025