I YEAR M. TECH (MACHINE DESIGN) FIRST SEMESTER

17MEMD1T3 MECHANICAL VIBRATIONS Credits 4

Lecture: 4 periods/week **Internal assessment: 40 marks**

Tutorial: - - **Semester end examination: 60 marks**

COURSE OBJECTIVES:

- Derive the equation of motion of a single-degree-of-freedom system and solve for their free vibration response depending upon the type of damping.
- Find the responses of Undamped and viscously damped single-degree-of-freedom systems subjected to different types of harmonic force, including base excitation and rotating unbalance.
- Formulate the equations of motion of two-degree-of-freedom systems and Identify the mass, damping, and stiffness matrices from the equations of motion to compute the natural frequencies of vibration and the modal vectors.
- Formulate the equations of motion of multi degree-of-freedom systems using Newton's second law, influence coefficients, or Lagrange's equations to find the natural frequencies of vibration and the modal vectors by solving the Eigen value problem.

COURSE OUTCOMES:

After completed course, the students are expected to be able to:

1. Apply the knowledge of Mathematics and science to solve the free vibration problems of Single-Degree-of-Freedom Systems.
2. Identify various types of forced vibration problems and develop the mathematical models, analyze, solve to find the response of Single-Degree-of-Freedom Systems subjected to a harmonic excitation.
3. Identify and develop the mathematical models, analyze, solve to find the free/ forced vibration response of Two-Degrees-of-Freedom Systems.
4. Develop the mathematical models, analyze, solve to find the free vibration response of Multi-Degrees-of-Freedom Systems.

UNIT-I

FREE VIBRATION OF SINGLE-DEGREE-OF-FREEDOM SYSTEMS:

Importance of the Study of Vibration, Elementary Parts of Vibrating Systems, Number of Degrees of Freedom, Discrete and Continuous Systems, Classification of Vibration, Vibration Analysis Procedure, Harmonic Motion, Harmonic Analysis, Free Vibration of an Undamped Translational and Torsional Systems, Rayleigh's Energy Method, Free Vibration with Viscous Damping and Coulomb Damping**.**

UNIT-II

HARMONICALLY EXCITED VIBRATION:

Equation of Motion, an Undamped System Under Harmonic Force, Damped System Under Harmonic Force, Damped System Under the Harmonic Motion of the Base, Damped System

Under Rotating Unbalance, Transfer-Function Approach, Solutions using Laplace Transform, Frequency Transfer Functions, Representation of Frequency-Response Characteristics

UNIT-III

VIBRATION UNDER GENERAL FORCING CONDITIONS:

Response to impulse excitation, Step Input, Ramp Input, Rectangular Pulse

Two-Degree-of-Freedom Systems: Free Vibration Analysis of an Undamped System, Coordinate Coupling and Principal Coordinates, Forced-Vibration Analysis, Semidefinite Systems, dynamic vibration absorber.

UNIT- IV

MULTIDEGREE-OF-FREEDOM SYSTEMS: Influence Coefficients, Potential and Kinetic Energy Expressions, Generalized Coordinates and Generalized Forces, Using Lagrange's Equations to Derive Equations of Motion, free vibration of Multidegree-of-Freedom Systems.

Continuous Systems: Transverse Vibration of a String or Cable, Longitudinal Vibration of a Bar or Rod, Torsional Vibration of a Shaft or Rod, Lateral Vibration of Beams.

Learning Resources

Text book:

1. Mechanical Vibrations (5^{th} edition) by Singiresu S. Rao, Pearson Education

References:

1. Elements of Vibration Analysis (2^{nd} edition) by Leonard Meirovitch, McGraw-Hill
2. Mechanical Vibrations : theory and applications by (1^{st} edition) S Graham Kelly, Cengage Learning
3. Vibrations (2^{nd} edition) by Balakumar Balachandran and Edward B. Magrab, Cengage Learning