# MECHANICAL VIBRATIONS

I Semester

**Course Code: 19ME2103**

| L | P | C |
|---|---|---|
| 3 | 0 | 3 |

Course Outcomes: At the end of the course, the student will be able to

CO1: Determine the natural frequency of transverse vibrations of the shaft and torsional vibrations of rotor systems.

CO2: Analyze the mathematical modeling of the two degrees of freedom systems and explain about the working principle of vibration absorber.

CO3: Calculate the natural frequencies and mode shapes of a multi degree of freedom system and explain the modal analysis of a vibrating system.

CO4: Apply the numerical methods to determine natural frequencies of the beam and rotor systems.

CO5: Compute the natural frequencies and mode shapes of continuous systems and calculate the critical speed of the shaft.

**UNIT-I** **(10-Lectures)**

Basics of vibrations-Free and forced vibrations, vibration isolation; Transverse vibrations-single concentrated load, uniformly distributed load, several loads, Dunkerley's method.

Torsional vibrations – single rotor, two-rotor, three-rotor systems, torsionally equivalent shaft, geared system.

Learning outcomes:

1. Determine the natural frequencies of transverse vibrations of the shaft. (L3)
2. Determine the torsional natural frequencies of single rotor, two-rotor, three-rotor systems. (L3)
3. Explain geared system. (L2)

**UNIT-II** **(10-Lectures)**

Two degree of freedom systems – Principal modes of vibration – two masses fixed on tightly stretched string – double pendulum – torsional system with damping – forced vibration with harmonic excitation – undamped dynamic vibration absorber – untuned viscous damper.

Learning outcomes:

1. Analyze the mathematical modeling of the two degrees of freedom systems. (L4)
2. Determine the natural frequencies of tightly stretched string. (L3)
3. Explain the working principle of vibration absorbers. (L2)

**UNIT-III** **(10-Lectures)**

Multi degree of freedom systems – exact analysis - free vibrations – equations of motion – influence coefficients - generalized co-ordinates –Co-ordinate coupling – natural frequencies and mode shapes – eigenvalues and eigenvectors - orthogonal properties of normal modes – modal analysis.

Learning outcomes:

1. Compute the natural frequencies and mode shapes of a multi degree of freedom system. (L3)
2. Explain the influence coefficients and generalized co-ordinates. (L3)
3. Determine eigenvalues and eigenvectors of three degrees of freedom systems. (L3)

**UNIT-IV** **(10-Lectures)**

Multi degree of freedom systems – numerical methods – Rayleigh`s method – Dunkerley`s method – Stodola's method – Rayleigh Ritz method – method of matrix iteration – Holzer's method for natural frequencies of multi rotor systems.

Learning outcomes:

1. Calculate the natural frequencies and mode shapes of a multi degree of freedom system using Rayleigh`s method. (L3)
2. Determine the natural frequencies and mode shapes of a multi degree of freedom system using Dunkerley`s method. (L3)
3. Evaluate the natural frequencies and mode shapes of a multi degree of freedom system using Holzer's method. (L5)

**UNIT-V** **(10-Lectures)**

Continuous systems – vibration of strings – longitudinal vibrations of bars – torsional vibrations of circular shafts - lateral vibration of beams critical speeds of shafts – critical speed of a light shaft having a single disc – without damping and with damping. critical speed of a shaft having multiple discs – secondary critical speed.

Learning outcomes:

1. Analyze the mathematical modeling of continuous systems. (L4)
2. Determine natural frequencies and mode shapes of bars and strings. (L3)
3. Calculate the critical speed of shaft. (L3)

**TEXT BOOK:**

1. Rao S.S., *Mechanical Vibrations*, 5th Edition, Pearson, 2018.

**REFERENCE BOOKS:**

1. G.K. Grover, *Mechanical Vibrations*, Nemchand & Bros, Roorkee, 8th Edition, 2009.
2. V.P.Singh, *Mechanical vibrations*, 3rd Edition, Dhanpat Rai & Co., 2006.