

# **THEORY OF MECHANISM AND MACHINE II**

**Mechanical IV/I**

# Course Objective

- To provide basic concept for the dynamics response analysis of common machines and machine components.
- To model a given system for a vibratory response.
- To develop computer simulation and program for the dynamic response

## Course Outline

- 1. Engine Force Analysis (2 hours)**
  - Analytical Method for Velocity and Acceleration of the Piston and the Connecting Rod
  - Equivalent Dynamical System
  - Analytical Method for Inertia Torque
  - Graphical Method for Velocity and Acceleration of the Piston and the Connecting Rod

## **2. Turning Moment Diagram and Flywheel (2 hours)**

- Turning Moment Diagram
- Fluctuation of Energy and Coefficient of Fluctuation of Energy
- Flywheel
- Coefficient of Fluctuation of Speed
- Energy Stored in a Flywheel and Flywheel Sizing

## **3. Gyroscopic Couple (3 hours)**

- Precessional Angular Motion
- Gyroscopic Couple
- Effect of Gyroscopic Couple on Aeroplane
- Stability of a Four Wheel and Two Wheel Vehicles
- Effect of Gyroscopic Couple on a Disc Fixed Rigidly at a Certain Angle to a Rotating Shaft

## **4. Governors**

**(4 hours)**

- Function of a Governor
- Terms Used in Governor
- Types of Governors
- Sensitiveness and Stability of Governors

## **5. Balance of Machinery**

**(6 hours)**

- Balancing of a Single Rotating Mass by a Single Mass Rotating in the Same Plane
- Balancing of a Single Rotating Mass by Two Masses Rotating in Different Planes
- Balancing of Several Masses Rotating in the Same Plane
- Balancing of Several Masses Rotating in the Different Planes
- Types of Balancing Machines
- Balancing of Reciprocating Masses
- Balancing of Multicylinder Engines, In-line, V-type, Opposed and Radial Configurations
- Balance of Four Bar Linkages



## **6. Vibration of Single Degree of Freedom Systems (10 hours)**

- Definition and Effects of Vibration, Terms Used in Vibration
- Elements of a Vibrating System
- Undamped Vibration of Single Degree of Freedom System
- Damped Vibration of Single Degree of Freedom System
- Forced Harmonic Response of Single Degree of Freedom System with Viscous Damping
- Systems with Coulomb Damping
- Rotating Unbalance
- Whirling of Rotor-Shaft Systems
- Vibration Isolation and Force Transmissibility
- Response of Harmonic Excitation of Support
- Vibration Measuring Instruments
- Energy Dissipated by Damping
- Convolution Integral and General Force Excitation

## **7. Vibration of Two Degree of Freedom Systems (4 hours)**

- Undamped Vibration of Two Degrees of Freedom System, Natural Frequencies and Mode Shapes
- Damped Vibration of Two Degrees of Freedom System
- Forced Harmonic Vibration of Two Degrees of Freedom System
- Vibration Absorber

## **8. Vibration of Multi Degree of Freedom Systems (6 hours)**

- Equations of Motion in Matrix Form
- Flexibility and Stiffness Matrices, Reciprocity Theorem
- Eigenvalues and Eigenvectors, Orthogonal Properties of Eigenvectors
- Modal Analysis
- General Forced Response

## **9. Vibration of Multi Degree of Freedom Systems**

**(4 hours)**

- Rayleigh Method
- Rayleigh-Ritz Method
- Dunkerley Method
- Matrix Iteration Methods
- Finite Difference Method

## **10. Vibration of Continuous Systems**

**(4 hours)**

- Lateral Vibration of a String
- Longitudinal Vibration in Rods
- Torsional Oscillation in Circular Shafts
- Lateral Vibration in Beams

# References

## Mechanism Part

- Theory of Machine: R.S. Khurmi and J.K. Gupta
- Mechanism and Machine Theory: J. S. Rao, R. V. Duggipati
- Dynamics of Machines: Dr. Sadhu Singh
- Theory of Machine: S.S. Rattan

## Vibration Part

- Theory of Vibrations with Applications: W. T. Thomson
- Mechanical Vibrations: S. S. Rao
- Mechanical Vibrations: Tse, Morse, Hinkle
- An Introduction to Mechanical Vibrations: R. F. Steidel
- Introductory Course on Theory and Practice of Mechanical Vibrations: J. S. Rao, K. Gupta
- Mechanical Vibrations: V. P. Singh
- Mechanical Vibrations: G. K. Grover



# Revision

## Second order linear differential equation

- Particular and complementary solution
- Initial value problem

## Second order partial differential equation

## Matrix

- Matrix multiplication, Inverse
- Eigenvalues and Eigenvectors

## Strength of Materials

- End conditions for beams
- Beam deflection