

2/4 B.Tech. FOURTH SEMESTER

AE4T4

Kinematics of Machinery

Credits: 4

Lecture: 4 periods/week

Internal assessment: 30 marks

Tutorial: 1 periods/week

Semester end examination: 70 marks

Objectives:

1. To understand the concept of machines, mechanisms and related terminologies.
2. To calculate mobility (number of degrees-of-freedom). Enumeration of rigid links and types of joints within mechanisms.
3. To analyze a mechanism for displacement, velocity and acceleration at any point in a moving link which is prerequisite for dynamics of machines
4. To analyze Steering gear mechanisms and working of hooks joint, the theory of gears, gear trains and cams, To understand the working principles in Belt and chain drives

Learning outcomes:

At the end of course the students will be able to:

1. Build up critical thinking and problem solving capacity of various mechanical engineering problems related to kinematics of machines.
2. Asses various concepts of mechanisms like straight line motion mechanisms, Steering gear mechanisms and working principles of power elements (Gears, gear trains, Cams, Belt and Chain drives) and design related problems effectively.
3. Utilize analytical, mathematical and graphical aspects of kinematics of Machines for effective design.

Pre-Requisite subjects:

Engineering Graphics, Engineering Mechanics.

UNIT – I

INTRODUCTION: Elements or Links – Classification – Rigid Link, flexible and fluid link Types of kinematic pairs – constrained motion – completely, partially or successfully constrained and incompletely constrained, kutzbach Criteria, Grashoff's law.

MACHINES : Mechanism and machines – classification of machines – kinematic chain – inversion of mechanism – inversion of mechanism – inversions of quadric cycle, chain – single and double slider crank chains.

UNIT - II

STRAIGHT LINE MOTION MECHANISMS: Exact and approximate copiers and generated types –Peaucellier, Hart and Scott Russul – Grasshopper – Watt T. Chebicheff and Robert Mechanisms and Straight line motion, Pantograph.

UNIT – III

PLANE MOTION OF BODY: Instantaneous centre of rotation, centroids and axodes – relative motion between two bodies – Three centres in line theorem – Graphical determination of instantaneous centre, diagrams for simple mechanisms and determination of angular velocity of points and links

UNIT-IV

KINEMATICS: Velocity – Motion of link in machine – Determination of Velocity diagrams- Graphical method – Application of relative velocity method four bar chain. Analysis of slider crank chain for displacement, velocity diagram of slider given mechanism

ACCELERATION ANALYSIS: Acceleration, Four-Link Mechanism, Angular acceleration of Links, Acceleration of Intermediate and offset points, slider-Crank Mechanism, Coriolis component of acceleration.

UNIT-V

STEERING MECHANISMS: Conditions for correct steering – Davis Steering gear, Ackermans steering gear – velocity ratio, HOOKE'S JOINT: Single and double Hooke's joint – Universal coupling – application – problems.

UNIT-VI

CAMS: Definitions of cam and followers – their uses – Types of followers and cams – Terminology –Types of follower motion - Uniform velocity – Simple harmonic motion and uniform acceleration. Maximum velocity and maximum acceleration during outward and return strokes in the above 3 cases

UNIT-VII

GEARS: Introduction, Classification of gear terminology, Law of Gearing, Velocity of Sliding, Forms of Teeth, Cycloidal Profile Teeth, Involute Profile Teeth, Path of contact,

Arc of contact, Number of pairs of Teeth in contact, Interference in Involute Gears, Minimum number of Teeth to avoid interference, Undercutting

UNIT-VIII

GEAR TRAINS: Introduction, simple Gear Train, Compound Gear Train, Reverted Gear train, Planetary or Epicyclic Gear Train, Analysis of Epicyclic Gear Train, Torques in Epicyclic Trains. Tabular Method

Learning resources

Text books:

1. S.S.Rattan, "Theory of Machines", McGraw-Hill Professional Publishing, 1993
2. R.S. Khurmi & J.K Gupta, "Theory of Machines", Eurasia Publishing House, 2008
3. J.E. Shigley, "Mechanism and Machine Theory", McGraw-Hill, 1958

References:

1. C S Sharma & Kamlesh Purohit, "Theory of Mechanisms and Machines", Prentice Hall of India
2. Ghosh and Mallik, "Theory of Mechanisms and Machines", Affiliated East-West Press (P) Ltd., New Delhi Revised Second Edition (1988)