KINEMATICS OF MACHINERY

B.Tech. II Year II Semester

Course Code	Category	Hours/ Week			Credits	Maximum Marks		
		L	T	P		CIA	SEE	TOTAL
23ME402	Core	3	0	0	3	40	60	100
Contact Classes: 55	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 55		

Prerequisite: Engineering Mechanics

I. COURSE OVERVIEW:

Mechanical devices are designed to have mobility to perform certain functions. The theory behind the study of Kinematics of Machine emphasizes to design machines by understanding the relationship between the geometry and the motion of various parts of machine. This course will provide the knowledge on how to analyze the motions and design synthesis of mechanisms to give required mobility. This includes relative motion analysis and design of gears, gear trains, cams, linkages and steering mechanism by adopting both graphical and analytical approaches to estimate displacement, velocity and acceleration of links in a machine.

II. COURSE OBJECTIVES:

i. To study the classification, elements, and mobility of mechanisms, including kinematic pairs, constrained motion, and mechanical advantage in various linkages.

ii. To determine velocity and acceleration of machine components using graphical methods, relative velocity approaches, and instantaneous center techniques.

iii. To study different straight-line motion mechanisms, steering gears, and Hooke's joints, understanding their applications and working principles.

iv. To analyze various types of cams and followers, including their motion characteristics, velocity, and acceleration profiles, ensuring effective machine operation.

v. To understand the design and operation of gears, their profiles, interference phenomena, and different types of gear trains used in mechanical systems and automobiles.

III. COURSE OUTCOMES:

CO1: Classify different types of kinematic pairs and analyze their role in mechanisms.

CO2: Apply graphical and analytical methods to determine velocity and acceleration in mechanisms.

CO3: Examine various straight-line motion mechanisms, steering gears, and Hooke's joint applications.

CO4: Analyze cam and follower motions to determine velocity and acceleration characteristics.

CO5: Apply the law of gearing to design and evaluate gear trains and their motion transmission.

IV. COURSE SYLLABUS:

UNIT – I

Mechanisms: Elements or Links – Classification – Rigid Link, flexible and fluid link – Types of kinematics pairs – sliding, turning, rolling, screw and spherical pairs – lower and higher pairs –closed and open pairs – constrained motion – completely, partially or successfully and incompletely constrained.

Mechanism and Machines – Mobility of Mechanisms: Grubler's criterion, classification of machines – kinematics chain – inversions of mechanism – inversions of quadric cycle chain, single and double slider crank chains, Mechanical Advantage.

UNIT – II

Kinematics: Velocity and acceleration – Motion of link in machine – Determination of Velocity and acceleration – Graphical method – Application of relative velocity method.

Plane motion of body: Instantaneous center of rotation- centrodes and axodes – Three centers in line theorem – Graphical determination of instantaneous center, determination of angular velocity of points and links by instantaneous center method. Kliens construction - Coriolis acceleration - determination of Coriolis component of acceleration.

Analysis of Mechanisms: Analysis of slider crank chain for displacement- velocity and acceleration of slider – Acceleration diagram for a given mechanism.

UNIT – III

Straight-line motion mechanisms: Exact and approximate copied and generated types – Peaucellier - Hart - Scott Russel – Grasshopper – Watt -Tchebicheff's and Robert Mechanism - Pantographs

Steering gears: Conditions for correct steering – Davis Steering gear, Ackerman's steering gear.

Hooke's Joint: Single and double Hooke's joint –velocity ratio – application – problems.

UNIT – IV

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 and retardation. Maximum velocity and maximum acceleration during outward and return strokes in the above 3 cases.

Analysis of motion of followers: Tangent cam with Roller follower – circular arc cam with straight, concave and convex flanks.

UNIT – V

Higher pair: Friction wheels and toothed gears – types – law of gearing, condition for constant velocity ratio for transmission of motion – velocity of sliding.

Forms of teeth, cycloidal and involutes profiles – phenomena of interferences – Methods of interference. Condition for minimum number of teeth to avoid interference – expressions for arc of contact and path of contact of Pinion & Gear and Pinion & Rack Arrangements– Introduction to Helical – Bevel and worm gearing

Gear Trains: Introduction – Types – Simple – compound and reverted gear trains – Epicyclic gear train. Methods of finding train value or velocity ratio of Epicyclic gear trains. Selection of gear box - Differential gear for an automobile.

TEXT BOOKS:

1. Theory of Machines and Mechanisms/JOSEPH E. SHIGLEY/ Oxford
2. Theory of Machines / S. S. Rattan / Mc Graw Hill Publishers.

REFERENCE BOOKS:

1. Theory of Machines / Sadhu Singh / Pearson.
2. Theory of Machines / Thomas Bevan/CBS.