KINEMATICS OF MECHANISMS

Course Code: 22ME1112

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

CO1: describe different mechanisms and their inversions

CO2: calculate velocity and acceleration of different points and links in a mechanism

CO3: explain the working of straight line motion mechanisms, steering gears and Hooke's joint

CO4: describe cam terminology and sketch cam profiles for given follower motions

CO5: differentiate gears, analyze gear performance and determine torque transmission in gear trains

UNIT- I **10 Lectures**

The World of Mechanisms: Introduction, analysis and synthesis, the science of mechanics, terminology, definitions and assumptions, planar, spherical, and spatial mechanisms, mobility, classification of mechanisms, Grashof's law.

Kinematic Inversion: Inversions of four bar chain, slider crank chain and double slider chain, mechanical advantage.

Learning Outcomes: At the end of this unit, the student will be able to

1. describe kinematic pairs, kinematic chains, analysis and synthesis (L2)
2. calculate degrees of freedom for different mechanisms (L3)
3. explain inversions of four bar, slider crank and double slider mechanisms and theirapplications (L2)

UNIT- II **10 Lectures**

Velocity Analysis: Absolute and relative motions, motion of a link, four-link mechanism, velocity images, angular velocity of links, velocity of rubbing, slider-crank mechanism, crank and slotted lever mechanism.

Instantaneous centre method, Kennedy's theorem; locating I-centres, angular velocity ratio theorem, centrode.

Acceleration Analysis: Acceleration, four-link mechanism, acceleration of intermediate and offset points, slider-crank mechanism, coriolis component, crank and slotted lever mechanism, analytical expression for displacement, velocity and acceleration of slider crank mechanism without offset.

Learning Outcomes: At the end of this unit, the student will be able to

1. analyze the given mechanism and determine the velocities and accelerations (L4)
2. determine instantaneous centers for a given mechanism (L3)
3. determine coriolis component for slider in slotted lever mechanism (L3)

UNIT- III **10 Lectures**

Lower Pairs: Pantograph, condition for exact straight line motion, Peaucellier, Hart and ScottRussell mechanisms. Approximate straight line mechanisms: Grasshopper, Watt, Tchebicheff and Robert mechanisms.

Steering gears and Hooke's joint: Condition for correct steering, Davis, Ackerman steering gears; velocity ratio, angular acceleration of driven shaft, double Hooke's joint.

Learning Outcomes: At the end of this unit, the student will be able to

1. describe applications of different mechanisms with lower pairs (L2)
2. differentiate Davis and Ackerman steering gear mechanisms (L2)
3. calculate torque transmitted by Hooke's joint and angular acceleration of driven shaft (L3)

UNIT- IV **10 Lectures**

Cams and Followers: Types of cams, types of followers, definitions, follower displacement program-SHM, constant acceleration, cycloidal motion. Derivatives of follower motion. Layout of cam profiles for reciprocating follower and oscillating follower. Analysis of cams with specified contours - circular arc cam operating a reciprocating flat faced follower.

Learning Outcomes: At the end of this unit, the student will be able to

1. describe cam terminology and sketch cam profile for different follower motions (L2)
2. calculate the maximum velocity and acceleration for different motions of follower (L3)
3. determine the acceleration of flat faced follower operated by a circular cam (L3)

UNIT- V **10 Lectures**

Gears: Classification of gears, gear terminology, law of gearing, velocity of sliding, cycloidal and involute tooth profile, interchangeable gears, non-standard gears, path of contact, arc of contact, number of pairs of teeth in contact, interference in involute gears, minimum number of teeth, interference between rack and pinion, undercutting. Introduction to helical, spiral, bevel gears.

Gear Trains: Simple gear train, compound gear train, reverted gear train. Planetary or epicyclic gear train - kinematic representation and analysis, torques.

Learning Outcomes: At the end of this unit, the student will be able to

1. explain the different gear profiles and parameters (L2)
2. describe interference and undercutting (L2)
3. calculate velocity ratio and torque transmission in gear trains (L3)

Text Books:

1. J. J. Uicker, G.R. Pennock and J. E. Shigley, *Theory of Machines and Mechanisms*, 4th Edition, International Version, Oxford University Press, New Delhi, 2011. (Unit-I)
2. S. S. Rattan, *Theory of Machines*, 4th Edition, Tata McGraw-Hill Education Pvt Ltd, New Delhi, 2014. (Units II-V)

Reference Books:

1. Thomas Bevan, *Theory of Machines*, 3rd Edition, Pearson Education, New Delhi, 2010.
2. R. C. Norton, *Kinematics and Dynamics of Machinery*, 3rd Edition in SI Units, Tata McGraw-Hill Education Pvt Ltd, 2011.