# KINEMATICS OF MACHINES

**IV Semester: ME**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| AMEB10 | Core | 3 | 1 | - | 4 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: 15 | Practical Classes: Nil | | | | Total Classes: 60 | | |

## COURSE OBJECTIVES:

**The course should enable the students to:**

I. To understand the mechanisms of various machines in order to find the velocity and accelerations for ideation of product development
II. Understand the basic principles of kinematics and the related terminology of machines..
III. Discriminate mobility; enumerate links and joints in the mechanisms.
IV. Formulate the concept of analysis of different mechanisms.
V. Understand the working of various straight line mechanisms, gears, gear trains, steering gear mechanisms, cams and a Hooke"s joint.
VI. Analyze a mechanism for displacement, velocity and acceleration of links in a machine.

## COURSE OUTCOMES (COs):

1. Understand designing a suitable mechanism depending on application
2. Understand displacement diagrams and cam profile diagram for followers executing different types of motions and various configurations of followers
3. Visualize drawing velocity and acceleration diagrams for different mechanisms.
4. Select gear and gear train depending on application.
5. Explore the knowledge on differential gear design.

## COURSE LEARNING OUTCOMES (CLOs):

1. Classifications of the kinematic links, kinematic pairs and formation of the kinematic chain.
2. Distinguish between mechanism and machine.
3. Design and develop inversions of quadric cycle chain.
4. Design and develop inversions of slider crank mechanism.
5. Construct Graphical methods of velocity and acceleration polygons for a given configuration diagram.
6. Understand other methods of acceleration determination diagrams like Klien's construction.
7. Develop acceleration component of Corioli's acceleration involving quick return mechanisms
8. Alternative approach for determining velocity by using Instantaneous centers and relative velocity methods.
9. Significance of exact and approximate straight line mechanisms.
10. Application of straight line mechanism in engine indicators
11. Applications of Ackerman's and Davis steering mechanisms in automobiles.
12. Develop the condition for exact steering.
13. Develop the polar velocity diagram for a single Hook joint and develop condition for unity for higher and lower speeds.
14. Study different displacement diagrams applicable in cams.
15. Plot the displacement, velocity and acceleration diagrams with respect to time.
16. Understand the geometry of gears and deduce the expression for arc of contact.
17. Derive the expression for minimum number of teeth to avoid interference in case of pinion and gear.

| MODULE I | MECHANISMS | Classes: 09 |
|---|---|---|

Mechanisms: Elements or links, classification, rigid link, flexible and fluid link, types of kinematic pairs types of constrained motion, kinematic chain, mechanism, machine, structure, inversion of mechanism, inversions of quadric cycle chain, single and double slider crank chains, mechanical advantage, Grubler's Criterion.

| MODULE II | KINEMATICS, PLANE MOTION OF BODY, ANALYSIS OF MECHANISMS | Classes: 09 |
|---|---|---|
| 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, centroids and axodes, three centers in line theorem, graphical determination of instantaneous center, determination of angular velocity of points and links by instantaneous center method. Kleins 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. | | |
| MODULE III | STRAIGHT LINE MOTION MECHANISMS, STEERING GEARS, HOOKE'S JOINT | Classes: 09 |
| **Straight-line motion Mechanisms:** Exact and approximate copied and generated types, Peaucellier, Hart and Scott Russell, Grasshopper, Watt Tchebicheff and Robert mechanisms, pantograph.<br>**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. | | |
| MODULE IV | CAMS, ANALYSIS OF MOTION OF FOLLOWERS | Classes: 09 |
| **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 three cases; **Analysis of motion of followers**: Tangent cam with roller follower, circular arc cam with straight, concave and convex flanks. | | |
| MODULE V | HIGHER PAIRS, GEAR TRAINS | Classes: 09 |
| Higher Pairs: friction wheels and toothed gears, types, law of gearing, condition for constant velocity ratio for transmission of motion, velocity of sliding, form of teeth, cycloidal and involute 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 and gear pinion and rack arrangements; Introduction to helical, bevel and worm gearing; Gear trains: Introduction, types, simple 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 automobiles. | | |

**Text Books:**


1. Joseph E. Shigley, "Theory of Machines and Mechanisms", Oxford University Press, 4th Edition, 2010.
2. Thomas Bevan, "Theory of Machines", Pearson, 3rd Edition,2009..


**Reference Books:**


1. JagadishLal, "Theory of Mechanisms and Machines", Metropolitan Book Company, 1st Edition, 1978.
2. S.S. Rattan, "Theory of Machines", Tata McGraw-Hill Education, 1st Edition, 2009.
3. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw-Hill, 3rd Edition, 2008.
4. Sadhu Singh, "Theory of Machines", Pearson, 2nd Edition, 2006.
5. J. S Rao, R. V Duggipati, "Mechanisms and Machine Theory", New Age Publishers, 2nd Edition, 2008.
6. R. K. Bansal, "Theory of Machines", Lakshmi Publications, 1 Edition, 2013.