THEORY OF MACHINES AND MECHANISMS

ENME 303

Lecture : 3 **Year : III**
Tutorial : 2 **Part : I**
Practical : 0

Course Objectives:
The objective of this course is to provide students with a comprehensive understanding of the basic concepts of kinematics and dynamics of machine, enabling them to analyze and solve problems related to motion and forces within mechanisms.

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1 Basic Concept of Mechanism (4 hours)

1.1 Kinematic links, kinematic pairs, and kinematic chains
1.2 Mechanism
1.3 Classification of mechanisms
1.4 Inversions of mechanism
1.5 Mobility
1.6 Grübler criterion
1.7 Grashof's law

2 Velocity and Acceleration in Mechanisms (6 hours)

2.1 Graphical methods
2.2 Velocity analysis of planar linkages using velocity polygons
2.3 Instantaneous centers of velocity
2.4 Kennedy theorem of three centers
2.5 Velocity analysis of planar linkages using instantaneous centers
2.6 Coriolis acceleration
2.7 Acceleration analysis of planar linkages using acceleration polygons
2.8 Rubbing velocity

3 Kinematic Synthesis of Mechanisms (6 hours)

3.1 Function, path, and motion generation
3.2 Freudenstein's equation
3.3 Chebyshev spacing of precision points
3.4 Limit position, dead center position, and transmission angle
3.5 Dimensional synthesis of planar mechanisms

4 Cams (4 hours)

4.1 Classification of cams and followers
4.2 Terminology and definitions

4.3 Standard motions of follower
4.4 Cam profile synthesis for standard motions of follower

5 Spur Gears (5 hours)

5.1 Classification of gears
5.2 Terminology and definitions
5.3 Gear tooth profiles
5.4 Meshing of gear teeth
5.5 Interference and undercutting
5.6 Contact ratio
5.7 Center distance

6 Helical Gears, Bevel Gears, and Worm and Worm Gears (5 hours)

6.1 Terminology and definitions of helical gear
6.2 Velocity ratio and center distance of helical gears
6.3 Helical gear forces and efficiency
6.4 Terminology and definitions of bevel gears
6.5 Velocity ratio and pitch cones of bevel gears
6.6 Terminology and definitions of worm and worm gear
6.7 Velocity ratio and center distance of worm and worm gear
6.8 Efficiency of worm gears

7 Gear Trains (5 hours)

7.1 Classification of gear trains
7.2 Speed ratio of gear trains
7.3 Analysis of epicyclic gear trains: Formula and tabular methods
7.4 Torques in epicyclic gear trains
7.5 All-wheel drive train

8 Dynamic Force Analysis (5 hours)

8.1 Inertia force and inertia couple
8.2 Line of action of inertia force in a link
8.3 Force analysis of a four-bar mechanism: Graphical method
8.4 Force analysis of slider-crank mechanism: Graphical or analytical method

9 Balancing (5 hours)

9.1 Static and dynamic balancing
9.2 Balancing of several masses revolving in the same plane
9.3 Balancing of several masses revolving in different planes
9.4 Balancing of reciprocating mass

Tutorial **(30 hours)**

1. Sample problems related to mobility of kinematic chain/mechanisms, Grashof's law, determining all inversions of kinematic chain/mechanisms
2. Sample problems related to velocity and acceleration of linkages in planar mechanisms; four-bar mechanisms, slider-crank mechanisms, and combination of four-bar and slider-crank mechanisms
3. Sample problems related to dimensional synthesis of planar mechanisms; four-bar mechanisms and slider-crank mechanisms
4. Sample problems related to reciprocating follower with simple harmonic motion, uniform velocity, uniform acceleration and retardation, and cycloidal motion. Drawing of cam profiles for standard motions of radial/offset followers with knife-edge/roller/flat contact points
5. Sample problems related to various gear terms, interference, contact ratio, and center distance for spur gear meshing
6. Sample problems related to helical gears, bevel gears, and worm and worm gears
7. Sample problems related to speed ratio, number of teeth, and torque in epicyclic gear trains
8. Sample problems related to inertia force and torque in four-bar linkages and reciprocating engine parts
9. Sample problems related to balancing multiple masses rotating in the same or different planes, as well as balancing reciprocating masses

Assignments

1. Tutorial submission
2. A case study of real-world applications
3. Presentation and demonstration

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks distribution*
1	4	6
2	6	9
3	6	9
4	4	4
5	5	7
6	5	6
7	5	7
8	5	6
9	5	6
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Uicker, J. J., Pennock, G. R., Shigley, J. E. (2003). Theory of machines and mechanisms. Oxford University Press.
2. Ghosh, A., Mallik, A. K. (2008). Theory of mechanisms and machines. East-West Press.
3. Bevan, T. (2009). Theory of machines. Pearson.
4. Wilson, C. E., adler, J. P. (2003). Kinematics and dynamics of machinery. Pearson.
5. Norton, R. L. (2003). Design of machinery. McGraw-Hill.