THEORY OF MACHINE

ENME 257

Lecture : 3 **Year : II**
Tutorial : 1 **Part : II**
Practical : 0

Course Objectives:
The objective of this course is to provide knowledge on various mechanisms used in machines and devices and to conduct comprehensive analyses of machines and mechanisms, including linkages, gears, gear trains, cams, and followers.

1 Introduction (6 hours)

1.1 Basic definitions and descriptions
1.2 Kinematic links, kinematic pairs and kinematic chain
1.3 Mobility/degree of freedom: Grubler and Kutzbach criterion
1.4 Mechanism types and inversions
1.5 Position analysis of the four-bar mechanism: Grashoff's law and loop closure equations
1.6 Synthesis concepts

2 Kinematic Analysis of Mechanisms (8 hours)

2.1 Absolute and relative motion velocity analysis: Velocity polygons, graphical or vector algebra solutions
2.2 Instantaneous centers of velocity and Aronhold-Kennedy theorem
2.3 Velocities by instantaneous centers
2.4 Relative motion acceleration analysis; Acceleration polygons; Graphical or vector algebra solutions; Coriolis acceleration applications
2.5 Kinematic analysis by complex number method

3 Kinetic Analysis of Mechanisms (8 hours)

3.1 Introduction to methods of force analysis of mechanisms
3.2 Superposition force analysis methods of mechanisms: Graphical or analytical
3.3 Linkage force analysis by alternative methods
  3.3.1 Matrix methods
  3.3.2 Virtual work method
  3.3.3 Complex number method
3.4 Analytical and graphical method for velocity and acceleration of four-bar and slider-crank mechanisms

4 Cams and Followers (7 hours)

4.1 Classification of cams and nomenclature and graphical cam layout
4.2 Disc cam with knife edge, roller and flat-faced follower
4.3 Disc cam with radial or offset follower
4.4 Disc cam with oscillating roller follower
4.5 Standardized follower displacement, velocity and acceleration diagram for
  4.5.1 Uniform motion
  4.5.2 Uniform accelerated and retarded motion
  4.5.3 Simple harmonic motion
  4.5.4 Cycloidal motion
4.6 Force analysis on cams and followers

5 Toothed Gear (5 hours)

5.1 Introduction to spur gear, types of gears and law of gearing
5.2 Geometry and characteristics of gear tooth: Involute and cycloidal tooth
5.3 Interference and undercutting of involute gear: Numbers of teeth to avoid interference
5.4 Determining backlash in involute gears
5.5 Forces on spur gear teeth

6 Bevel, Helical and Worm Gears (5 hours)

6.1 Terminology and definitions of bevel gears
6.2 Velocity ratio and pitch cones of bevel gears
6.3 Terminology and definitions of helical gear
6.4 Velocity ratio and center distance of helical gears
6.5 Terminology and definitions of worm and worm gear
6.6 Velocity ratio and center distance of worm and worm gear
6.7 Theory of spiral and hypoid gears

7 Simple and Planetary Gear Trains (6 hours)

7.1 Theory on gear train and speed ratio
7.2 Simple, compound and reverted gear train
7.3 Theory of planetary gear trains and internal gear system
7.4 Applications by formula and tabular methods for velocity and torque
7.5 Assembly of planetary gear trains

Tutorial (15 hours)

1. Mobility of kinematic chain/mechanisms, Grashoff's law
2. Velocity and acceleration of linkages in planar mechanisms
3. Inertia force and torque in in planar mechanisms
4. Displacement diagram and cam profile generation
5. Interference, contact ratio, and center distance for spur gear Flow measurement and flow through orifices and notches and weirs
6. Nomenclature and profiling of helical gears, bevel gears and worm gears
7. Speed ratio, number of teeth, and torque in epicyclic gear trains

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	6	8
2	8	12
3	8	12
4	7	8
5	5	8
6	5	4
7	6	8
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Shigley, J. E., Uicker, J. J., Jr. (2023). Theory of machines and mechanisms. McGraw Hill.
2. Rao, J.S., Dukkipati, R.V. (2007). Mechanisms and machine theory. John Wiley & Sons.
3. Mabie, H. H., Reinholtz, C. F. (1987). Mechanism and dynamics of machinery. Wiley.
4. Khurmi, R. S. (2005). Theory of machines. S. Chand & Co. Ltd.
5. Singh, V. P. (2017). Theory of machines. Dhanpat Rai & Co. (P) Ltd
6. Paul, B. (1979). Kinematics and dynamics of planar machinery. Prentice Hall.
7. Wilson, C. E., Sadler, J. P., Michels, W. J. (1960). Kinematics and dynamics of machinery. Harper Row.