THEORY AND DESIGN OF MACHINE ELEMENTS

ENME 307

Lecture : 3 **Year : III**
Tutorial : 1 **Part : I**
Practical : 1

Course Objectives:
The objective of this course is to provide students the concepts of kinematics of machine and machine elements, enabling them to analyze and solve problems related to motion. After the completion of the course the students will be able to design the machine elements.

1 Basic Concept of Mechanism (4 hours)

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

2 Cams (4 hours)

2.1 Classification of cams and followers
2.2 Terminology and definitions
2.3 Standard motions of follower
2.4 Cam profile synthesis for standard motions of follower

3 Gears (6 hours)

3.1 Classification of gears; Terminology and definitions
3.2 Gear tooth profiles; Meshing of gear teeth
3.3 Interference and undercutting
3.4 Contact ratio and center distance
3.5 Terminology and definitions of helical, bevel, and worm and worm gears
3.6 Kinematics of helical, bevel, and worm and worm gears

4 Gear Trains (5 hours)

4.1 Classification Classification of gear trains
4.2 Speed ratio of gear trains
4.3 Analysis of epicyclic gear trains: formula and tabular methods
4.4 Torques in epicyclic gear trains
4.5 All-wheel drive train

5 Fundamentals of Machine Design (6 hours)

5.1 Theories of failure for static loading
5.2 Stress concentration and notch sensitivity
5.3 Endurance limit and fatigue strength
5.4 Characterizing fluctuating stresses
5.5 Fatigue failure criteria for fluctuating stress
5.6 Design for fatigue under fluctuating stress

6 Shaft (7 hours)

6.1 Shaft materials
6.2 Shaft design for stress
6.3 Shaft design for variable load
6.4 Effect of stress concentration

7 Spur Gear (6 hours)

7.1 Gear materials
7.2 Beam strength of spur gear tooth
7.3 Dynamic load on gear
7.4 Wear strength
7.5 Design of a gear mesh

8 Belt (7 hours)

8.1 Belt drives
8.2 Belt materials
8.3 Design of flat belt and V-belt

Tutorial (15 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 reciprocating followers 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
3. Sample problems related to various gear terms, interference, contact ratio, and center distance for spur gear meshing
4. Sample problems related to speed ratio, number of teeth, and torque in epicyclic gear trains
5. Sample problems related to fatigue design for combined load
6. Sample problems related to shaft design for stresses resulting from axial, bending, and torsional loading
7. Sample problems related to the design of a gear mesh considering dynamic and wear loads
8. Sample problems related to the design of flat and V-belts

Practical **(15 hours)**

1. Design Project I: Introductory design project which may be the same for all students. It should be selected to combine the ideas of the design process with any analysis required, as well as the drawing process for communication of results. Students should be asked to outline and justify the logic behind the process of decision-making involved in the development of the design
2. Design Project II: More advanced machine design systems project requiring a team approach say four students per group. The work of the project must be planned by the students as a group, the work divided, and deadlines set for completion. Progress should be monitored and evaluated by the instructor at intervals to ensure success of the design effort. Again, detailed drawings are required and, if appropriate, oral presentations may be required for communication and justification of the project

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	4	4
3	6	8
4	5	7
5	6	8
6	7	9
7	6	9
8	7	9
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Uicker, J.J., Pennock, G.R., Shigley, J.E. (2023). Theory of machines and mechanisms (6th Edition). Cambridge University Press.
2. Ghosh, A., Mallik, A.K. (2020). Theory of mechanisms and machines (3rd Edition). East West Press Pvt. Ltd.
3. Wilson, C.E., Sadler, J.P. (2002). Kinematics and dynamics of machinery (3rd Edition). Pearson.
4. Budynas, R.G., Nisbett, J.K. (2024). Shigley's mechanical engineering design (11th Edition). McGraw Hill.
5. Sharma, C.S., Purohit, K. (2004). Design of machine elements (Latest Edition). Prentice-Hall of India Pvt. Ltd.
6. Mott, R.L. (2017). Machine elements in mechanical design. Pearson.