Course Code	Course Name	Credits
MTC402	**Kinematics of Machinery**	**04**

Prerequisite: FEC104 Engineering Mechanics

Objectives

1. To acquaint with basic concepts of kinematics and kinetics of machine elements
2. To understand analysis of mechanisms.
3. To understand synthesis of mechanisms.
4. To study functioning of motion and power transmission machine elements

Outcomes: Learner will be able to…

1. Identify various components of mechanisms
2. Conduct displacement, velocity and acceleration analysis of various mechanisms
3. Synthesize mechanisms to provide specific motion
4. Select appropriate power transmission mechanism.
5. Choose a cam profile for the specific follower motion

Module	Detailed Contents	Hrs.
01	**1.1 Kinetics of Rigid Bodies** Concept of mass moment of inertia and its application to standard objects. Kinetics of rigid bodies: Work and energy Kinetic energy in translating motion, Rotation about fixed axis and in general plane motion, Work energy principle and Conservation of energy **Basic Kinematics** Structure, Machine, Mechanism, Kinematic link & its types, Kinematic pairs, Types of constrained motions, Types of Kinematic pairs, Kinematic chains, Types of joints, Degree of freedom (mobility), Kutzbach mobility criterion, Grűbler's criterion & its limitations Four bar chain and its inversions, Grashoff's law, Slider crank chain and its inversions, Double slider crank chain and its inversions	7
02	**2.1 Displacement Analysis of Mechanisms** Forward and inverse kinematics of planer mechanisms (Closed and open chain). **2.2 Velocity Analysis of Mechanisms (mechanisms up to 6 links)** Velocity analysis by instantaneous centre of rotation method (Graphical approach), Velocity analysis by relative velocity method (Graphical approach) **2.3 Acceleration Analysis of Mechanisms (mechanisms up to 6 links)** Acceleration analysis by relative method including pairs involving Coriolis acceleration (Graphical approach)	10
03	**Synthesis of Mechanisms and linkages**: Classification of Synthesis Problem, precision points for function Generation, Graphical synthesis of four bar mechanism, Three position synthesis, Four point synthesis, coupler-curve synthesis, Graphical synthesis of slider crank mechanism, Synthesis of four bar mechanism for body guidance.	5
04	**Belts, Chains and Brakes:** **Belts**: Introduction, Types and all other fundamentals of belting, Dynamic analysis – belt tensions, condition of maximum power transmission	**4**

	Chains (No problems)**:** types of chains, chordal action, variation in velocity ratio, length of chain (No problems) **Brakes** (No problems)**:** Introduction, types and working principles, Introduction to braking of vehicles	
05	**Gears and Gear Trains:** **Gears**- Introduction, Types, Law of gearing, Forms of teeth, Details of gear terminology, Path of contact, Arc of contact, Contact ratio, Interference in involutes gears, Minimum number of teeth for interference free motion, Methods to control interference in involutes gears, **Gear Trains:** Kinematics and dynamic analysis of simple and compound gear trains, reverted gear trains, epi-cycle gear trains with spur or bevel gear combination	**7**
06	**6.1 Straight Line Generating Mechanisms** Exact–Peaucellier , Approximate– Watt, Grasshopper and Tchebicheff's. **6.2 Compliant mechanisms**, Flexure based straight line mechanism. **6.3 Cam and Follower Mechanism** Cam and its Classification based on shape, follower movement, and manner of constraint of follower; Followers and its Classification based on shape, movement, and location of line of movement; Cam and follower terminology; Motions of the follower: SHM, Constant acceleration and deceleration (parabolic), Constant velocity, Cycloidal; Layout of cam profiles.	**6**
Self-study Topic	Offset slider crank mechanisms, Pantograph, Steering Gear Mechanism- Ackerman, Davis steering gears Static force analysis in gears - spur, helical, bevel, worm & worm wheel	**--**

Term Work:

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per University pattern for practicals.
2. Graphical approach problems (minimum 10) from module 2, 3 and 6 should be solved under the guidance of instructor in a A3 size drawing book.
3. Software tools such as **MechAnalyzer® and MotionGenor any other similar software tool** should be used for demonstration and innovative exercises in addition to graphical approach problems.

The distribution of Term Work marks will be as follows
Attendance theory and tutorials 5 marks,
Graphical approach problems 15 marks,
Software exercises 5 marks.

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying20marks.
2. Total 04 questions need tobe solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub- questions of 2 to 5 marks will be asked.

4. Remaining questions will be mixed in nature.(e.g. Suppose Q.2 has part (a) from module3 then part (b) will be from any module other than module3)
5. In question paper weightage of each module will be proportional to number of respective lecture hrs as mentioned in the syllabus.

Text Books:

1. S.S. Ratan, “Theory of Machines”, Tata McGraw Hill
2. A. Ghosh and A.K. Mallik, “Theory of Mechanisms and Machines”, East-West Press

References:

1. J.J. Uicker, G.R. Pennock, and J.E. Shigley, “Theory of Machines and Mechanism”, Oxford Higher Education
2. P.L. Ballaney, “Theory of Machines”, Khanna Publishers
3. M.A. Mostafa, “Mechanics of Machinery”, CRC Press
4. R.L. Norton, “Kinematics and Dynamics of Machinery”, McGraw Hill
5. A.G. Erdman, G.N. Sander, and S. Kota, “Mechanism Design: Analysis and Synthesis Vol I”, Pearson
6. Kinematics of Machines by R T Hinckle (Prentice Hall Inc.)
7. Kinematics By V.M. Fairs (McGraw Hill)
8. Kinematics and Dynamics of Planer Mechanisms by Jeremy Hirsihham (McGraw Hill).