

**FR. Conceicao Rodrigues College Of Engineering**  
 Father Agnel Ashram, Bandstand, Bandra-west, Mumbai-50  
**Department of Mechanical Engineering**

**S.E. (Mechanical) (semester IV) (2020-2021)**

**Lecture Plan**

**Subject: Kinematics of Machinery (MEC403)**

**Credits-03**

**Subject: Kinematics of Machinery Lab (MEL402)**

**Credits-01**

**1. Syllabus.**

Module	Details	Hours
1	Introduction to Production Processes and Metal Casting 1.1. Classification of Production Processes and applications areas 1.2. Pattern making materials, Types of pattern and allowances. 1.3. Sand moulding and Machine moulding 1.4. Gating system :Types of riser, types of gates, solidification 1.5.Special casting processes : CO2 and shell moulding, Investment casting, Die casting, Vacuum casting, Inspection & casting defects and remedies	8
2	Joining Processes 2.1.Classification of various joining processes; Applicability, advantages and limitations of Adhesive bonding, Mechanical Fastening; Welding and allied processes, Hybrid joining processes. 2.2.Classification and Working of various welding methods: Gas, Arc, Chemical, Radiant, Solid State etc. 2.3.Welding Joints, Welding Positions, Welding defects and their remedies.	8
3	3.1. Forming processes • Introduction and classification of metalworking processes, hot and cold working processes • Introduction, classification and analysis of forging and rolling operations, Defects in rolled and forged components, • Extrusion process, Classification and analysis of wire and tube drawing processes. 3.2. Sheet metal working processes • Classification of Sheet metal operations, types of Presses used in sheet metal operations, types of dies.	8
4	4.1. Machine Tools, Machining Processes. • Machine Tools and Machining Processes: Lathe Machines, Milling Machines, Drilling Machines, and Grinding Machines and selection of grinding wheel	12

	(Dressing and Truing), Broaching machines, Lapping/Honing machines (Super Finishing Operations) and shaping/slotting/planning Machines. • Gear Manufacturing Gear milling, standard cutters and limitations, Gear Hobbing, Gear Shaping, Gear Shaving and Gear Grinding processes 4.2. Tool Engineering • Geometry and nomenclature of single point cutting tool, Speed, feed, depth of cut, Taylor's tool life equation, Concept of chip formation and types of chips. Introduction to Jigs and Fixtures and types.	
5	5.1 Non Traditional Machining Processes: • Electro-chemical machining (ECM) • Electric-discharge machining (EDM) • Ultrasonic machining (USM) • Laser Beam Machining (LBM)	4
6	6.1 Polymer Processing: • Polymer Molding Techniques for thermoplastic and thermosetting plastics. Applications of Plastics in engineering field. 6.2 Powder Metallurgy: • Introduction to PM, Powder making processes, Steps in PM. Compaction and Sintering processes. Secondary and finishing operations in PM. 6.3 Intelligent manufacturing in the context of Industry 4.0, • Cyber-physical systems (CPS) • Internet of Things (IoT) enabled manufacturing • Cloud Manufacturing	8

## 2. CO Statements.

Learner will be able to

1. Identify various components of mechanisms
2. Develop mechanisms to provide specific motion
3. Draw velocity and acceleration diagrams of various mechanisms
4. Choose a cam profile for the specific follower motion
5. Predict condition for maximum power transmission in the case of a belt drive
6. Illustrate requirements for an interference-free gear pair

## 3. CO-PO-PO Mapping.

CO# / PO#	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	3	-	-	-	-	-	-	-	-	-	-
2	3	3	-	-	-	-	-	-	-	-	-	-
3	3	3	-	-	-	-	-	-	-	-	-	-
4	3	3	2	-	-	-	-	-	-	-	-	-

5	3	3	-	-	-	-	-	-	-	-	-	-
6	3	3	-	-	-	-	-	-	-	-	-	-

**4. CO Assessment tools with target.**

	Target for Assessment Tools		
	Unit Test	End Semester Exam	Course Exit Survey
1	50%	50%	60%
2	50%	50%	60%
3	-	50%	60%
4	50%	50%	60%
5	50%	50%	60%
6	-	50%	60%

**5. Curriculum Gap/Content beyond syllabus (if any).**

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**6. Lecture/Lab/Mini Project/Assignment Plan.**

**(Due to Online Teaching-Learning in current pandemic situation, Laboratory work is covered during Lectures and 4 lectures per week are conducted (instead of 3 as defined in the curriculum) following the timetable prepared for the current semester**

**\*Contents in Brown indicate Lab Work completed during Lectures)**

Week	Duration (Hrs.)	Topic	Module
<b>Week 1</b> (25/01/21 – 31-01-21)	3	1.2 Basic Kinematics Structure, Machine, Mechanism, Kinematic link & its types, Kinematic pairs, Types of constrained motions, Types of Kinematic pairs, Kinematic chains, Types of joints,	1
<b>Week 2</b> (1/02/21 – 7/02/21)	4	Degree of freedom (mobility), Kutzbach mobility criterion, Grübler's criterion & its limitations Numericals Car Differential (beyond syllabus)	1

<p><b>Week 3</b> (8/02/21 – 14/02/21)</p>	<p>4</p>	<p>Four bar chain and its inversions, Grashoff's law, Slider crank chain and its inversions, Double slider crank chain and its inversions 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</p>	<p>1</p>
<p><b>Week 4</b> (15/02/21 – 21/02/21)</p>	<p>4</p>	<p>Numericals on Kinetics of Rigid Bodies  Special Mechanisms (No problems on this module) 2.1 Straight line generating mechanisms: Introduction to Exact straight line generating mechanisms - Peaucillier's and Hart's Mechanisms, Introduction to Approximate Straight line generating mechanisms- Watt's, Grasshopper mechanism, Tchebicheff's mechanisms</p>	<p>1 &amp; 2</p>
<p><b>Week 5</b> (22/02/21 – 28/02/21)</p>	<p>4</p>	<p>2.2 Offset slider crank mechanisms - Pantograph, Hook-joint (single and double). 2.3 Steering Gear Mechanism - Ackerman, Davis steering gears  Cam and Follower Mechanism 4.1 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; 4.2 Motions of the follower: SHM, Constant acceleration and deceleration (parabolic), Constant velocity, Cycloidal;</p>	<p>2 and 3</p>
<p><b>Week 6</b> (1/03/21 – 7/03/21)</p>	<p>4</p>	<p><b>Motion analysis and plotting of displacement–time, velocity-time and acceleration-time, jerk-time, and 2 to 3 problems (Lab Work)</b> Introduction to cam profiles (No problems on this point) <b>layout of cam profiles - 2 to 3 problems (Lab Work)</b></p>	<p>3</p>
<p>(8/03/21 – 14/03/21)</p>	<p><b>Unit Test 1</b></p>		
<p><b>Week 7</b> (15/03/21 – 21/03/21)</p>	<p>4</p>	<p>3.1 Velocity Analysis of Mechanisms (mechanisms up to 6 links) Velocity analysis by instantaneous centre of rotation method (Graphical approach)  <b>Analysis of velocity of mechanisms by Instantaneous Centre of Rotation method – 3 to 5 problems (Lab</b></p>	<p>3</p>

		Work)	
<b>Week 8</b> (22/03/21 – 28/03/21)	4	Velocity analysis by relative velocity method (Graphical approach) <b>Analysis of velocity of mechanisms by Relative Velocity method – 3 to 5 problems (Lab Work)</b>  3.2 Acceleration Analysis of Mechanisms (mechanisms up to 6 links) Acceleration analysis by relative method including pairs involving Coriolis acceleration (Graphical approach)	4
<b>Week 9</b> (29/03/21 – 4/04/21)	4	<b>Analysis of acceleration of mechanism by Relative method including pairs involving Coriolis acceleration – 3 to 5 problems (Lab Work)</b>	4
<b>Week 10</b> (5/04/21 – 11/04/21)	4	Gears and Gear Trains: 6.1 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, Static force analysis in gears - spur, helical, bevel, worm & worm wheel (No problems on this point)	4
<b>Week 11</b> (12/04/21 – 18/04/21)	4	6.2 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  <b>Assignment on Gears and Gear Trains (Lab Work)</b>	5
<b>Week 12</b> (19/04/21 – 25/04/21)	4	Belts, Chains and Brakes: 5.1 Belts: Introduction, Types and all other fundamentals of belting, Dynamic analysis –belt tensions, condition of maximum power transmission 5.2 Chains (No problems): types of chains, chordal action, variation in velocity ratio, length of chain (No problems) 5.3 Brakes (No problems): Introduction, types and working principles, Introduction to braking of vehicles	5
(26/04/21 – 2/05/21)	4	Unit Test 2	6
<b>Week 14</b> (3/05/21 – 9/05/21)	4	<b>Assignment on Belts and Chains (Lab Work)</b> <b>Assignment on Brakes (Lab Work)</b>	6

## **MEL402 Kinematics of Machinery Lab**

### Course Outcomes:

1. Draw velocity diagram using Instantaneous Centre method
2. Find velocity and acceleration of a point on a four-bar mechanism by using Relative method.
3. Analyze velocity and acceleration of a specific link of a slider crank mechanism using graphical approach by Relative method.
4. Plot displacement-time, velocity-time, and acceleration-time diagrams of follower motion.
5. Draw cam profile for the specific follower motion.
6. Develop and build mechanisms to provide specific motion.

### Syllabus

#### **Laboratory Work:**

1. Analysis of velocity of mechanisms by Instantaneous Centre of Rotation method – 3 to 5 problems
2. Analysis of velocity of mechanisms by Relative Velocity method – 3 to 5 problems
3. Analysis of acceleration of mechanism by Relative method including pairs involving Coriolis acceleration – 3 to 5 problems
4. Motion analysis and plotting of displacement–time, velocity-time and acceleration-time, jerk-time, and layout of cam profiles - 2 to 3 problems
5. Mini project on design and fabrication of any one mechanism for a group of maximum 4 students

#### **Assignments:**

Minimum two problems on each of the following topics

1. Belts and Chains
2. Brakes
3. Gears and Gear trains

## CO-PO Mapping

CO# / PO#	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	3	-	-	-	-	-	-	-	-	-	-
2	3	3	-	-	-	-	-	-	-	-	-	-
3	3	3	-	-	-	-	-	-	-	-	-	-
4	3	3	-	-	-	-	-	-	-	-	-	-
5	3	3	2	-	-	-	-	-	-	-	-	-
6	3	3	2	-	-	-	-	-	-	-	-	-

## CO Assessment tools with target.

CO#	Laboratory Work	Course Exit Survey
	1	60%
2	60%	60%
3	60%	60%
4	60%	60%
5	60%	60%
6	60%	60%