LOK JAGRUTI UNIVERSITY (LJU)

INSTITUTE OF ENGINEERING AND TECHNOLOGY

Department of Mechanical Engineering (710)

Bachelor of Engineering (B.E.) – Semester – III

Course Code:	**017103392**
Course Name:	**Kinematics of Machines**
Category of Course:	Professional Core Course (PCC)
Prerequisite Course:	Mathematics 1 (017101191), Engineering Graphics 1 (017102191), Engineering Mechanics (017102291), Strength of Material (017103391)

Teaching Scheme				
Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Credit**	**Total Hours**
4	**1**	**2**	**6**	**50**

Syllabus				
Unit No.	**Topic**	**Prerequisite Topic**	**Successive Topic**	**Teaching Hours**
01	**Introduction of Mechanisms and Machines**			**6 (12%)**
	1.1 Concepts of kinematics and dynamics, mechanisms and machines, Kinematic link and its types (Resistance, Flexible and Fluid link), Kinematic Joint and its types (Binary, ternary and Quaternary Joint)	Kinematics (017102291-Unit-10.1)	---	
	1.2 Kinematic Pair and its Classification (Higher and Lower Pair, Turning pair, Rolling pair, Sliding pair, Screw pair, Spherical pair, Open and closed pair), kinematic chains	---	---	
	1.3 Degrees of freedom for 2-D, mobility- Kutzbach and Grubler's criterion, Grashof's criterion	---	---	
02	**Inversion of Mechanisms**			**6 (12%)**
	2.1 Kinematic inversion, inversion of four bar chain(Double Crank Mechanism, Crank-Rocker Mechanism, Rocker-Rocker Mechanism)	---	---	
	2.2 Inversion of Single slider crank mechanisms (Reciprocating Engine, Rotary Engine, Whitworth QRRM, Oscillating Cylinder mechanism, Crank and Slotted bar Mechanism, Hand pump mechanism)	---	---	

	2.3 Inversion of double slider crank mechanisms (Elliptical Trammel mechanism, Scotch yoke mechanism, Oldham's Coupling)	---	---	
03	**Kinematics: Velocity Analysis**			**6 (12%)**
	3.1 Introduction, Space and Body Centrodes, Determine the Velocity of a Point on a link, Instantaneous centre of velocity, properties of Instantaneous centre, Number of Instantaneous centres in Mechanism,	Velocity (017102291-Unit-10.1)	---	
	3.2 Types of Instantaneous centres (Fixed, Permanent and Neither fixed nor permanent), Location of Instantaneous centres, Method of Locating Instantaneous centres in a Mechanism	---		
	3.3 Kennedy theorem, angular velocity ratio theorem	Instantaneous method (017103392-Unit-03)	---	
	3.4 Rubbing Velocity at a Pin joint, Relative velocity analysis	---		
04	**Kinematics: Acceleration Analysis**			**6 (12%)**
	4.1 Definition of acceleration, angular acceleration, a general case of acceleration, radial and transverse components of acceleration	Acceleration (017102291-Unit-10.1)	---	
	4.2 Examples of acceleration analysis, acceleration diagrams	Velocity diagram (017103392-Unit-03)	---	
	4.3 Klein's construction analysis, corioli's component of acceleration	Velocity diagram (017103392-Unit-03), Acceleration diagram (017103392-Unit-04)	---	
05	**Toothed Gears**			**6 (12%)**
	5.1 Introduction, classification of gears (spur gear, helical gear, double helical, bevel gear, metre gear, spiral gear, rack and pinion gear, worm and worm wheel gear, internal and external gear)	---	---	
	5.2 Gear terminology (Pitch, Pitch Point, Pitch circle, Pitch circle diameter, Pitch point, Pressure angle, Addendum, Dedendum, Addendum radius, Dedendum radius, Clearance circle, Circular pitch, Module, Diametral pitch, Gear ratio, Base circle, Backlash, Top and Bottom Land, Face, Flank, Path of contact, Arc of contact), law of gearing, velocity of sliding	Velocity (017102291-Unit-10.1)	Gears (017073301–Unit-10.3)	
	5.3 Forms of teeth, cycloidal profile teeth, involute profile teeth, comparison of cycloidal and involute tooth forms	Cycloidal and involute profile (017102291-Unit-6.1)	---	
	5.4 Path of contact, arc of contact, Contact ratio	---	---	

	5.5 Concept of interference in involute gears and its avoiding methods (modified tooth profile, modified in addendum and dedendum, Centre distance variation), minimum number of teeth on gear and pinion, undercutting	Path of contact (017103392-Unit-05)	---	
06	**Gear Trains**			**5 (10%)**
	6.1 Introduction of simple gear train, compound gear train, reverted gear train and epicyclic gear train (Derive Velocity ratio of each gear train)	Law of gearing (017103392-Unit-05)	---	
	6.2 Analysis of epicyclic gear trains, Numericals based on (simple gear train, compound gear train, reverted gear train and epicyclic gear train)	Law of gearing (017103392-Unit-05)	---	
07	**Flywheels- Turning Moment Diagram**			**2.5 (5%)**
	7.1 Introduction-significance of flywheel	Energy (017102291-Unit-10.2)	---	
	7.2 Turning moment and crank effort diagrams for reciprocating machines (single cylinder 4 stroke IC engine, multi cylinder engine)	Torque (017102291-Unit-3.1)	---	
	7.3 Coefficient of fluctuation of speed and energy, limiting velocity of flywheel, energy stored in flywheel	Energy and moment of inertia (017102291-Unit-10.2,9.1)	---	
08	**Flywheels**			**2.5 (5%)**
	8.1 Dimensions of flywheel rim (width and diameter of flywheel)	Stress and types of stress, Strain and types of strain (017103391-Unit-1.2)	---	
	8.2 Flywheel in punching press	Stress and types of stress, Strain and types of strain (017103391-Unit-1.2), Energy (017102291-Unit-10.2)	---	
09	**Cam**			**4 (8%)**
	9.1 Introduction of cam and followers and their uses.	---	---	
	9.2 Working and Types of Cam (Radial cam, Wedge Cam, Cylindrical Cam), Working and Types of Follower (knife edge, roller, flat face, mashroom, globoidal(convex-concave), spherical followers), Terminology (Base circle, trace point, prime circle, pitch point, Pressure angle, Pitch circle, angle of assent, angle of decent, Dwell)	---	---	
	9.3 Displacement diagrams of follower motion and its mathematical equations (Uniform Velocity, Uniform acceleration	Basic differentiation and integration (017101191-Unit-3.1)	---	

	and retardation, simple harmonic motion, cycloidal motion)			
10	**Cam Profile**			**6 (12%)**
	10.1 Determine of basic dimensions and Layout of cam profiles using graphical methods	Classification of cam and follower (017103392-Unit-07), Geometrical construction and scale (017102191- Unit-2.2)	---	

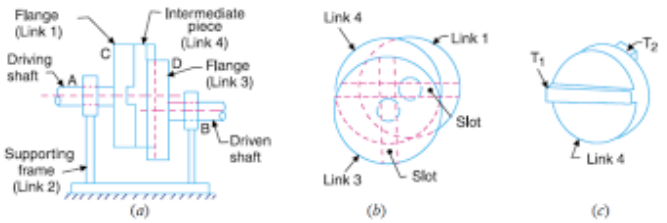
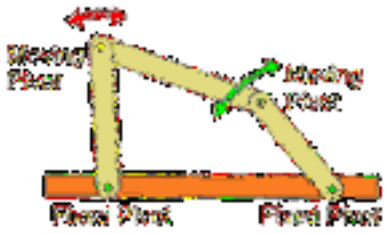
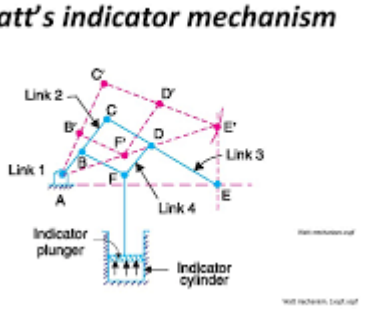
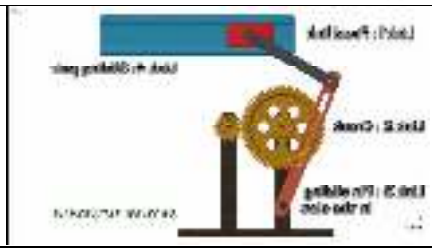
Sr No.	Practical Title	Link to Theory Syllabus
1	To demonstrate of Types of link pair and motion.	Unit-1
2	To illustrate and the detailed analysis of the four-bar chain mechanism.	Unit-2
3	To demonstrate and analysis of single slider chain mechanism.	Unit-2
4	To exhibit and detailing of double slider mechanism.	Unit-2
5	To understand the working of simple gear & gear train used in Mechanical components.	Unit-6
6	To determine the nature and relationship of the parts of compound gear train in working condition.	Unit-6
7	To understand epicyclic gear train working by examining.	Unit-6
8	To get explicit knowledge of flywheel and its design in engineering.	Unit-7
9	To demonstrate and comprehend every term and terminology of cam and follower.	Unit-9

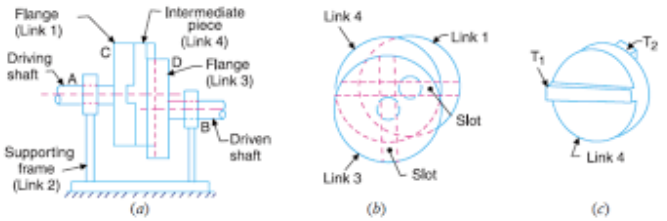
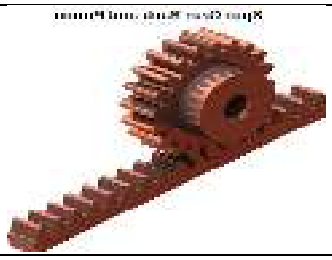
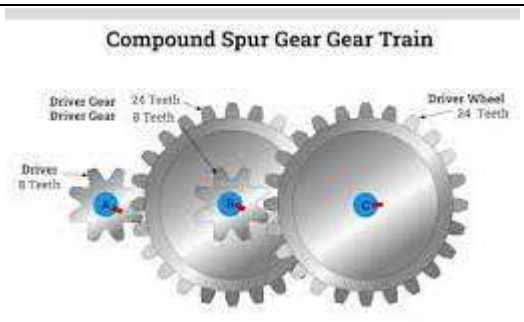
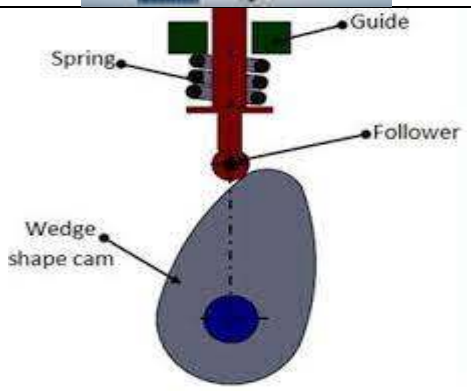
Proposed Theory + Practical Evaluation Scheme by Academicians (% Weightage Category Wise and it's Marks Distribution) (New version for KOM)					
L:	**4**	**T:**	**1**	**P:**	**2**
Note: In Theory Group, Total 4 Test (T1+T2+T3+T4) will be conducted for each subject. **Each Test will be of 25 Marks.** **Each Test Syllabus Weightage: Range should be 20% - 30%**					
Group (Theory or Practical)	**Group (Theory or Practical) Credit**	**Total Subject Credit**	**Category**	**% Weightage**	**Marks Weightage**
Theory	**5**	**6**	MCQ	38%	45
Theory			Theory Descriptive	3%	4
Theory			Formulas and Derivation	10%	12
Theory			Numerical	33%	39
Expected Theory %	**84%**		**Calculated Theory %**	**84%**	**100**
Practical	**1**		Individual Project	10%	60
Practical			Group Project	0%	0
Practical			Internal Practical Evaluation (IPE)	0%	0
Practical			Viva	6%	40
Practical			Seminar	0%	0
Expected Practical %	**16%**		**Calculated Practical %**	**16%**	**100**
Overall %	**100%**			**100%**	**200**

Course Outcome	
Upon completion of the course students will be able to	
1	demonstrate design thinking capability and identify functional characteristics of various machine elements. Also, the ability to analyze motion of mechanisms.
2	Determine position, velocity and acceleration of linkages in mechanism at any instant.
3	Understand basics of gear and importance of gear train and Ability to construct turning moment diagram and flywheel design.
4	Application of Fly-Wheel and analyze cam motion profiles and follower mechanism.
Suggested Reference Books	
1	Theory of Machines by S.S.Rattan, Tata McGraw-Hill Publishing Co. Ltd. New Delhi
2	Theory of Machines and Mechanisms by Shigley, J.E and Uicker, J.J, Oxford University Press
3	Mechanisms and Machine theory by Rao J.S. and Dukkipati R.V, Wiley Eastern Ltd.
4	Theory of Machines by Singh Sadhu, Pearson Education
5	Kinematics and Dynamics of Machinery by Wilson: 3rd Edition, Pearson Education
6	Mechanism and Machine Theory by A G Ambekar, PHI.
7	Kinematics, Dynamics and Design of Machinery by Kenneth J Waldron, Gary L Kinzel, Wiley
8	Kinematics and Dynamics of Machinery by R L Norton, McGraw-Hill

List of Open Source Software/Learning website	
1	http://nptel.ac.in

2	www.learnerstv.com
3	http://kmoddl.library.cornell.edu
4	https://www.coursera.org
5	https://www.edx.org
6	https://in.linkedin.com
7	https://www.skill-lync.com

	Practical Project/Hands on Project		
Sr. No.	**Project List**		**Linked with Unit**
1	Make a model based on application of fluid link in mechanism. (Example Hydraulic Crane).		Unit 01
2	Select any model based on 2D planner mechanism and calculate DOF using python program. (Example oldham's coupling).	 **Oldham's coupling.**	Unit 01
3	To prepare model for analysis of Grashof's law and also prepare python program for the same. (Four bar chain mechanism)		Unit 01
4	Make a project on any one application of four bar chain mechanism. (Example Watt's indicator Mechanism).		Unit 02
5	Demonstrate the application of Single Slider chain mechanism by using model. (Example Quick return motion mechanism).		Unit 02

6	Prepare a model and explain application of Double Slider chain mechanism. (Example Oldham's coupling).	 **Oldham's coupling.**	Unit 02
7	Make a project of Gear drive mechanism. Determine minimum number of teeth required to avoid interference on gear and pinion by using python.		Unit 05
8	Demonstrate on any one gear train application by using python. (Example Epicyclic gear train).		Unit 06
9	Analysis of velocity ratio of gear train using python and also give the demonstration by preparing a model of respective gear train.		Unit 06
10	Demonstrate any one application of flywheel with model. (Example sewing machine).		Unit 08
11	To prepare the model of any application of Cam and follower. Determine maximum and minimum velocity and acceleration during rise and return of follower using python program.		Unit 09