Name of Institute: **Indus Institute of Technology & Engineering**
Name of Faculty: **Mr. Piyushkumar Surani**

Course Code: **ME0313**
Course Name: **Kinematics of Machines (PCC)**
Pre-requisites: Technical Drawing, Engineering Graphics
Credit points: 03
Offered Semester: 3rd Semester

Subject: Kinematics of Machines (PCC)								
Program: B. Tech. (Mechanical)				**Subject Code: ME0313**			**Semester: III**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Exam**	**University Practical Exam**	**Continuous Internal Evaluation (CIE) Theory**	**Continuous Internal Evaluation (CIE) Practical**	**Total Marks**
2	1	0	3	16/40	***	24/60	***	100

Course Coordinator (weeks 16 – 02 lecture per week)

Full Name: Piyushkumar Surani
Department with seating location: Mechanical Workshop
Email: piyushsurani.me@indusuni.ac.in
Consultation times: Every Saturday, 9:00 a.m. to 5:00 p.m.

Students will be contacted throughout the Session via mail with important information relating to this Course.

Course Objectives

This course enables the students to:

1) To understand the basic components and layout of linkages in the assembly of a system/machine
2) To understand the principles in analyzing the assembly with respect to the displacement, velocity, and acceleration at any point in a link of a mechanism
3) Selection of power transmission devices like belt drive, rope drive, gears, gear trains and its applications
4) To facilitate students to understand the types of cam and follower, motion and profile drawing of cam
5) To synthesis mechanism to perform certain prescribed task/motion

Course Outcomes (CO)

After completing this course, Students can

1. Understand the principles of kinematic pairs, chains and their classification, DOF, inversions, equivalent chains and planar mechanisms.
2. Analyze the planar mechanisms for position, velocity and acceleration.
3. Synthesize planar four bar and slider crank mechanisms for specified kinematic conditions.
4. Evaluate gear tooth geometry and select appropriate gears for the required applications.
5. Analyze cams and followers for specified motion profiles.
6. Assess various concepts of mechanisms like straight line motion mechanisms, steering gear mechanisms and working principles of power elements (Gears, gear trains, Cams, Belt and Chain drives) and design related problems effectively.

Course Outline

Sr. No.	Unit No	Chapter Title	Hours
1	1	Mechanisms & Machines	06
2	2	Velocity and Acceleration Diagrams of Mechanisms	08
3	3	Belt Rope and Chain	04
4	3	Gears & Gear Trains	06
5	4	Cam and Followers	05
6	4	Kinematic Synthesis of Mechanisms	03

Method of delivery

Lecture through presentation, black board and videos, demonstration

Study time

3 Hours/week

CO-PO Mapping (PO: Program Outcomes)

Program Outcomes (PO's)

Engineering Graduates will be able to:

PO1 Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that

meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8 Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

P012 Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs) of Department

At the end of the program, the student:

PSO1. Should be able to clearly understand the concepts and applications in the field of design of mechanical systems, thermal engineering and production technology and also possess the skills to communicate effectively as well as demonstrating the practice of professional ethics and the concerns for societal and environmental wellbeing.

PSO2. Should be able to associate the learning from the courses related to Thermodynamics, Fluid Science, Mechanical system design, Machining and Manufacturing processes, Production Technology and Automation of systems, to arrive at solutions to real world problems.

PSO3. Should have the capability to comprehend the technological advancements in the usage of modern design tools to analyze and design subsystems/processes for a variety of applications.

Mapping CO's with PO's

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C0 1	3	1	1	-	1	-	-	-	-	-	-	1
C0 2	2	3	2	-	-	-	-	-	-	1	-	1
C0 3	2	1	3	3	2	-	-	-	-	1	-	2
C0 4	2	2	1	3	1	-	-	-	-	-	-	2
C0 5	1	2	1	3	2	-	-	-	-	-	-	1
C0 6	1	2	1	-	-	-	-	-	-	-	-	-
ME0313	1.83	1.83	1.5	3	1.5	-	-	-	-	1	-	1.4

Mapping of CO's with PSO's

CO	PSO1	PSO2	PSO3
CO 1	2	-	-
CO2	2	-	-
CO 3	1	-	-
CO 4	1	1	-
CO 5	2	2	-
CO 6	1	1	-
ME0313	1.5	1.33	-

Blooms Taxonomy and Knowledge retention

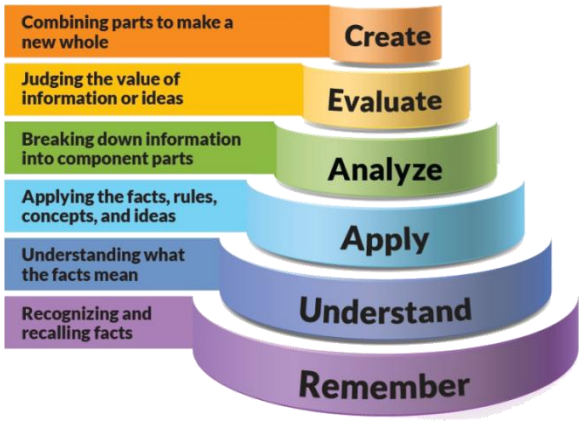

Figure 1: Blooms Taxonomy

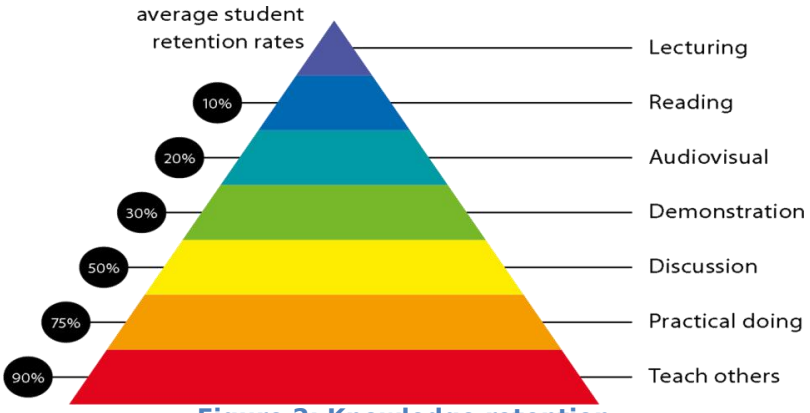

Figure 2: Knowledge retention

Graduate Qualities and Capabilities covered

General Graduate Qualities	Specific Department of Mechanical Graduate Capabilities
Informed Have a sound knowledge of energy management, need to study or profession and understand its current issues, locally and internationally. Understand how to apply this knowledge to ground level. Understand how an energy management has developed and how it relates to other areas.	**1 Professional knowledge, grounding & awareness**
Independent learners By case study on energy management lead to develop ideas and ways of thinking and critically analyze issues. By providing expert lecture references help in to get extend subject knowledge. Find and evaluate information, using a variety of sources and technologies. Acknowledge the work and ideas of others.	**2 Information literacy, gathering & processing**
Problem solvers Take on challenges and opportunities in industries and organization related to Energy issues by case study. By Demonstration of energy losses help in to understand problem faces in industries and try to give solution to resolve problems. Apply creative and logical to respond effectively. Make and implement decisions.	**3 Problem solving skills**
Effective communicators Report or Assignment writing help in improve written communication.	**4 Written communication** **5 Oral communication** **6 Teamwork**

Presentation need to give based on case study or research paper related to course. Work collaboratively and engage with people for innovative ideas of energy saving and presentation. Recognize how culture can shape communication.	
Responsible Understand and Implements of Energy management techniques lead to sustainability of nation and world. Help in fulfill energy requirement of the nation and world without harmful environment impact.	**7 Sustainability, societal & environmental impact**

Lecture times:

As per Time Table

Attendance Requirements

The University norms states that it is the responsibility of students to attend all lectures, tutorials, seminars and practical work as stipulated in the Course outline. Minimum attendance requirement as per university norms is compulsory for being eligible for mid and end semester examinations.

Details of referencing system to be used in written work

Text book, Reference book, online sources like NPTEL lectures

Text books and Reference Books

Text Books

1) Theory of Machines and Mechanisms, Shigley, J.E and Uicker, J.J , Oxford University Press , 5 th Edition, 2016.

2) 2. Theory of Machines, Rattan S.S, Tata McGraw-Hill Publishing Co. Ltd, New Delhi, 4 th Edition, 2014.Reference Books

Additional Materials

Reference Books

1) Theory of Machines, Thomas Bevan, CBS Publishers and Distributors, New Delhi, 3 rd Edition, 1984.

2) Mechanisms and Machine Theory, Rao.J.S. and Dukkipati.R.V, Wiley-Eastern Ltd, New Delhi, 2 nd Edition, 1992.

3) Theory of Mechanisms and Machines, C.S. Sharma and Kamlesh Purohit, PHI Learning Pvt. Limited, New Delhi, 6 th Edition, 2006

4) Mechanics of Machines, Cleghorn. W. L, Oxford University Press, 2nd Edition, 2014

5) Kinematics and Dynamics of Machinery, Robert L. Norton, Tata McGraw-Hill, New Delhi, 2 nd Edition, 2009.

6) Kinematics and Linkage Design, Allen S. Hall Jr, Prentice Hall, US, 1st Edition, 1961.

7) Theory of Mechanisms and Machines, Ghosh. A and Mallick, A.K., Affiliated East-West Pvt. Ltd, New Delhi, 3 rd Edition, 2015.

8) Theory of Machines, Sadhu Sigh, Pearson Education, New Delhi, 3rd Edition, 2012

Web links:

1) https://nptel.ac.in/courses/112104121
2) http://kmoddl.library.cornell.edu/
3) https://www.journals.elsevier.com/mechanism-and-machine-theory
4) Mech analyzer software for mechanism, http://www.roboanalyzer.com/mechanalyzer.html

ASSESSMENT GUIDELINES

	Name of the Component	Total marks	CO mapped
Component-1	Mid Semester Exam	40	CO1,CO2, CO3,CO4,CO6
Component-2	Presentation	05	CO2,CO4,CO5,CO6
Component-3	Assignment	10	CO1,CO2, CO3,CO4,CO5
Component-4	Test	05	CO1,CO2,CO3,CO4,CO5,CO6

Your final course mark will be calculated from the following:

SUPPLEMENTARY ASSESSMENT

Students who receive an overall mark less than 40% in Continues Internal Evaluation (CIE) and end semester will be considered for supplementary assessment in the respective components (i.e CIE or end semester) of semester concerned. Students must make themselves available during the supplementary examination period to take up the respective components (CIE or end semester) and need to obtain the required minimum 40% marks to clear the concerned components.

Late Work

Late assignments will not be accepted without supporting documentation. Late submission of the reports will result in a deduction of - % of the maximum mark per calendar day

Format

All assignments must be presented in a neat, legible format with all information sources correctly referenced. **Assignment material handed in throughout**

the session that is not neat and legible will not be marked and will be returned to the student.

Retention of Written Work

Written assessment work will be retained by the Course coordinator/lecturer for two weeks after marking to be collected by the students.

University and Faculty Policies

Students should make themselves aware of the University and/or Faculty Policies regarding plagiarism, special consideration, supplementary examinations and other educational issues and student matters.

Plagiarism - Plagiarism is not acceptable and may result in the imposition of severe penalties. Plagiarism is the use of another person's work, or idea, as if it is his or her own - if you have any doubts at all on what constitutes plagiarism, please consult your Course coordinator or lecturer. Plagiarism will be penalized severely.

Do not copy the work of other students.
Do not share your work with other students (except where required for a group activity or assessment)

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Course Plan schedule

	Week #	Topic & contents	CO Addressed	Teaching Learning Activity (TLA)
	Weeks 1	*Terminology and Definitions, Mechanism & Machines, Rigid and resistance body, link, Kinematic pair, classification of Kinematic pairs, Kinematic Chain*	CO 1	PPT, Animation, Tutorial
	Weeks 2	*Linkage, Mechanics, degrees of freedom, Mobility – Kutzbach criterion, Gruebler's criterion, Grashof's Law, Kinematic Inversion of four bar chain*	CO 1	PPT, Animation, Tutorial
	Week 3	*Kinematic Inversion of four bar chain, Single and Double slider crank Chain, Four bar chain mechanism with lower pairs, Steering gear mechanisms such as Davis and Ackermann Steering gear.*	CO 1	PPT, Animation, Tutorial
	Assignment/Tutorial - 1			
	Week 4	*Velocity and acceleration analysis in simple mechanisms, Graphical Method -velocity and acceleration polygons*	CO 2	PPT, Animation, Tutorial
	Week 5	*Graphical Method-velocity and acceleration polygons, Instantaneous Centre of Velocity*	CO 2	PPT, Animation, Tutorial
	Week 6	*Instantaneous Centre of Velocity, Kennedy Theorem*	CO 2	PPT, Animation, Tutorial
	Week 7	Angular velocity ratio theorem, Coriolis, acceleration componen	CO 2	PPT, Animation, Tutorial
	Assignment/Tutorial - 2			
	Week 8	Introduction, belt and ropes drives, selection of belt drive, types of belt drives, Materials used for belt and rope drives, law of belting, velocity ratio, tension ratio	CO 6	PPT, Animation, Tutorial

	Week 9	Length of belt, V-belts, Wire rope, Slip and Creep of belt drive, tensions for flat belt drive, Angle of contact, centrifugal tension, Maximum power transmitted by belt, chain drive & its classification.	CO 6	PPT, Animation, Tutorial
	Week 10	Introduction, Classification of Gears, Gear Terminology, Law of Gearing, Velocity of Sliding, Forms of teeth, Involutes and cycloidal tooth profiles, Arc of the contact, Numbers of pairs of teeth in contact, Interference in involute Gears	CO 4	PPT, Animation, Tutorial
	Week 11	Minimum Number of teeth, Under cutting, Comparison of Cyclonical and involutes tooth forms, Spur, Helical, Spiral, Worm, Worm Gear and Bevel Gears (Basics only)	CO 4	PPT, Animation, Tutorial
	Week 12	Simple, Compound, Reverted & Epicyclic gear trains, Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains.	CO 4	PPT, Animation, Tutorial
	Assignment/Tutorial - 3			
	Week 13	Introduction, Definitions of cam and followers, applications, Types of Cams, Types of Followers, Cam Terminology	CO 5	PPT, Animation, Tutorial
	Week 14	displacement, velocity and acceleration curves for uniform velocity, Simple Harmonic Motion, displacement, velocity and acceleration curves for Uniform Acceleration Retardation, Cycloidal motion	CO 5	PPT, Animation, Tutorial

	Week 15	Cam profiles: cam with reciprocating/oscillating follower having knife-edge, Cam profiles: cam with roller and flat-face follower inline and offset. Tangent circular arc and eccentric cam.	CO 5	PPT, Animation, Tutorial
	Week 16	Types of synthesis, Function generation, Path generation, Motion generation, Graphical synthesis, Chebyshev's spacing for accuracy points, Freudenstein's equation	CO 3	PPT, Animation, Tutorial
Assignment/Tutorial - 4 End of Semester				