GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Diploma

Branch: Mechanical Engineering / Mechanical Engineering (CAD/CAM) / Mechatronics Engineering

Course / Subject Code: DI03000141

Course / Subject Name: Theory of Machines and Mechanisms

w. e. f. Academic Year:	2024-25
Semester:	3rd
Category of the Course:	PCC

Prerequisite:	Engineering Mechanics, Strength of Materials, Basic Physics
Rationale:	Theory of Machines and Mechanisms equips diploma engineering students with essential knowledge of mechanical motion and force transmission. It builds foundational skills for analyzing and designing machine elements like gears, cams, and linkages, enabling students to work effectively in maintenance, manufacturing, and mechanical design roles across various industries.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes
01	Understand Kinematics and Dynamics of different machines and mechanisms.
02	Understand different types of Cams and their motions along with the drawing ability of Cam profiles.
03	Justify the role of Flywheel, Governor, Brakes, Bearings and Clutches along with selection of suitable drives in Mechanical applications.
04	Appreciate concept of balancing and vibrations.

Teaching and Examination Scheme:

Teaching scheme (in Hours)			Total Credits L+T+(PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial/Practical		
L	T	PR	C	ESE (E)	PA (M)	PA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

*Legends: **L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **PR** - Practical; **C** – Credit, **PA** - Progressive Assessment; **ESE** - End Semester Examination.*

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1	**Motions & Mechanisms** 1.1 Theory of machines: Introduction, need, scope and importance in design and analysis, basic terminology that has already been studied in Engineering Mechanics. 1.2 Kinematics of Machines: Definition of Kinematics, Dynamics, Statics, Kinetics, Kinematic link, Kinematic pair, and its types, degree of freedom, constrained motion and its types, Kinematic chain and its types, Mechanism, inversion, machine, and structure. 1.3 Inversions of four-bar chain, Single Slider Crank chain and Double Slider Crank Chain. 1.4 Concept of velocity and acceleration of a point on link by relative velocity method in four-bar chain and single slider crank mechanism **(without numerical).**	8	18
2.	**Cams and Followers** 2.1 Concept, definition and application of Cams and Followers. 2.2 Classification of Cams and Followers. 2.3 Different follower motions and their displacement diagrams like Uniform velocity, Simple harmonic motion (SHM), Uniform acceleration and retardation. 2.4 Drawing of a profile of radial cam with a knife-edge, roller & flat-faced follower with and without offset with reciprocating motion (Graphical method).	8	18
3.	**Bearings, Clutches, Brake & Dynamometer** 3.1 Concept, definition, basic terminology of friction, types and application of friction, simple numerical based on friction. 3.2 Uniform pressure and Uniform wear theories. 3.3 Types of thrust bearing, Torque and Power lost in Flat pivot, conical pivot, single collar, multi-collar bearing and it's numerical. 3.4 Function of Clutch and its application, Construction and working of Single plate clutch, multi-plate clutch, Centrifugal Clutch, Cone clutch, Diaphragm clutch. (Simple numerical on single and multi-plate clutch) 3.5 Function of brake and its application, Construction and working of i) block brake ii) band brake iii) Band & block brake iv) internal expanding shoe brake v) disc brake **(without numerical)**. 3.6 Dynamometer- Function, Construction and working of i) Rope	10	22

	Brake, ii) Hydraulic iii) Eddy current.		
4.	**Power transmission** 4.1 Concept, need, and types of power transmission. 4.2 Types of Drives-Belt, Chain, Rope, Gear and their comparison with applications, advantages & limitations. 4.3 Flat belt, V-belt & its applications, material, angle of lap, belt length. Slip and Creep. Determination of velocity ratio, the ratio of tight side and slack side tension, centrifugal tension and initial tension, condition for maximum power transmission (Numerical on belt drives) 4.4 Rope Drives- types; application; Advantages & limitations of steel ropes 4.5 Chain Drives- Advantages & disadvantages; Selection of chain & sprocket wheels 4.6 Gear Drives- Classification of Gears - Nomenclature of a gear - explanation and applications of spur, helical and bevel gears, worm and worm wheel, rack and pinion; types of gear trains; their selection for different applications. 4.7 Train value & Speed ratio for Simple, Compound, and Riveted gear trains using spur gears (Numerical of gear drive for finding Speed ratio or Train ratio excluding epicyclic gear train).	8	16
5.	**Flywheel and Governors** 5.1 Flywheel- Concept, function and application of flywheel with the help of turning moment diagram for Single cylinder double acting steam engine, Single cylinder 4 -Stroke I.C. Engine, Co-efficient of fluctuation of energy, Co-efficient of fluctuation of speed, Energy stored in a Flywheel and its significance. Simple numerical. 5.2 Governor- Concept, function and application & terminology of Governors. Types, Explanation of Watt, Porter, Proell. 5.3 Comparison between Flywheel and Governor.	6	14
6	**Balancing and Vibrations** 6.1 Concepts and types of balancing. 6.2 Effects of unbalanced masses. 6.3 Balancing of single rotating mass. Analytical and graphical method for balancing of several masses revolving in the same plane. 6.4 Concept, types and terminology used in vibration, causes of vibrations in machines, their harmful effects and remedies.	5	12
	TOTAL	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
16	23	31	0	0	0

Where R: Remember; U: Understanding; A: Application, N: Analyze, and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Theory of Machines – Jagdish Lal, published by Metropolitan Book, New Delhi.
2. Theory of Machines – R. S. Khurmi & J. K. Gupta, published by S. Chand, New Delhi.
3. Theory of Machines – Abdulla Shariff, published by Dhanpat Rai & Sons, New Delhi.
4. Theory of Machines – A. Ghosh & A. K. Malik, published by East-West Press (Pvt) Ltd., New Delhi.
5. Theory of Machines – P. L. Bellaney, published by Khanna Publications, New Delhi.
6. Theory of Machines – Sadhu Singh, published by Pearson Education, India.
7. Theory of Machine and Mechanisms – Gordon R. Pennock, Joseph E. Shigley, and John J. Uicker, published by Oxford University Press.
8. Theory of Machines – Dr. V. P. Singh, published by Dhanpat Rai Publishing Co. Pvt. Ltd.

(b) Open source software and website:

Sr.	Topic	Link
1	Cam profile, displacement diagram	https://youtu.be/lcjxBqIgwGw?si=96q0Y_HEUZHfhWqi
2	Steps to draw cam profile	https://youtu.be/q2JJqWw2OlE?si=wE3qrwQ8Ntavr8i1
3	Offset cam profile	https://youtu.be/qN7Q6PIe0VQ?si=Y3UAJwD6w-2ez6uh
4	What is friction? It's importance.	https://youtu.be/qkf27nGneRg?si=eikHKCwk7K6Veydq
5	Bearings and clutches	https://youtu.be/15RFGRkC0hQ?si=UQ797HWDjPUnu8oU
6	Flat belt drive	https://youtu.be/wYpGtUS1TnQ?si=lVNgd8cKG8ufnPmw
7	Static and dynamic balancing	https://youtu.be/OYlOAghXNHc?si=uwM05ZroKtK5L1i8
8	Flywheel	https://youtu.be/79SY5UkOQcI?si=Ux8jUg_N0dilFPMo
9	Theory of Mechanisms-NPTEL	https://nptel.ac.in/courses/112106270
10	Kinematics of Machines-NPTEL	https://nptel.ac.in/courses/112104121
11	Fundamentals of Mechanism	https://youtu.be/lgk41I9g7pk
12	Fundamentals of Engg. Mechanics	https://youtu.be/6nguX-cEsvw
13	How Centrifugal Governors Work	https://youtu.be/ASIl3HWTT4U
14	How Disc Brakes Work	https://youtu.be/MAuVDB-G-HQ
15	How Drum Brakes Work in Cars	https://youtu.be/ApuBEn2zct8
16	Clutch - How Does It Work?	https://youtu.be/devo3kdSPQY
17	Clutch Animation	https://youtu.be/HY_PjmHRxuE

18	Clutch working (3D Animation)	https://youtu.be/6DL0j0eKD8Y
19	Clutch Working Principle	https://youtu.be/lqo0_StXf4M
20	Clutch and Flywheel	https://youtu.be/m4UmBbS7mfI
21	Prony Brake Dynamometer	https://youtu.be/uwZGtFRtGoU
22	Eddy Current Dynamometer	https://youtu.be/zDRc01bD6a8
23	Dynamometer	https://youtu.be/uW1CvgfJuEg
24	Basics of Gears	https://youtu.be/ZhDO16FDmxA
25	Cam and Follower Mechanism	https://youtu.be/YbjmphKVVpA
26	Types of Belt Drives	https://youtu.be/j6woGQdUPFs
27	Cams and Followers	https://youtu.be/u5nwkm5IbqY
28	Gear Train and its Types	https://youtu.be/LmYhzHnMH9o
29	Theory of Machines and Mechanisms	
https://youtube.com/playlist?list=PL5Rqb_WO7qVwHtqAaYzZGQr9QTxOLnd5l&si=b9zfjIlqQ0awzBy7		

Suggested Course Practical List:

Sr.	Unit	**Practical Exercises** (Outcomes' in psychomotor domain)	Hrs
1	All	**Preparatory Activity:** a. Interpret and write course related quantities, SI units and their conversions. b. Recall and write scalar and vector quantities. c. Demonstrate various mechanisms.	
2	II	**Cam Profile:** a. Demonstrate working of any type of cam and followers. b. Prepare one sheet on construction of cam profile for given data (without offset). This should include knife-edge follower and roller follower. c. Prepare one sheet on the construction of cam profile for given data (with offset). This should include knife-edge and flat face follower.	04
3	III	**Demonstration of Clutches:** To demonstrate the working of plate/cone/centrifugal /diaphragm clutch.	02
4	III	**Demonstration of Brakes:** To demonstrate the working block/band/block & band/ Disc	02
5	III	**Study of Dynamometers:** To demonstrate the working of Rope Brake/Hydraulic/Eddy current dynamometer.	02
6	IV	**Demonstration of Power Transmission Systems:** a. Identify various power transmission systems by observing different machines and equipment used in the Mechanical engineering laboratory/workshop. Examples- IC Engine test rigs, Compressors, Machine tools, Elevators, etc. Sketch at least four mechanisms with labeling on each. b. Demonstrate the working of each.	04

7	V	**Demonstration of Governors:** To demonstrate the working Watt/Porter/Proell governor.	02
8	VI	**Balancing:** Prepare one sheet on balancing using graphical and analytical methods for a given data. This should include a minimum of two problems.	04
9	III IV V	**Tutorials:** a. Calculate at least one problem of power loss due to friction in bearings and clutches from given problems/experimental data. b. Solve at least two problems of power transmission systems by a belt drive and gear drive from given problems/ experimental data. c. Calculate and prepare at least one turning moment diagram from given problems/experimental data. d. Calculate the mass of the flywheel from given problems/ experimental data.	
		Note: Teachers will provide the data for tutorial problems well in advance to the students. (Within two weeks of the commencement of the semester) So that the students can complete the numerical problems timely and submit the solutions simultaneously.	
TOTAL			**28**

List of Laboratory/Learning Resources Required:

- Cam Analysis Apparatus.
- Journal Bearing Apparatus.
- Setups to show different modes of transmissions
- Universal Governor apparatus
- Rope Brake and Dynamometer.
- Epicyclic Gear Train Apparatus.
- Working / Wooden / Thermocol Models & Mechanisms of:
    1. Kinematic links and pairs.
    2. Single slider-crank.
    3. Four bar chain.
    4. Types of cams, followers, and cam/follower arrangements.
    5. Friction bearing- all types.
    6. Dynamometers - all types.
    7. Friction clutches - all types.
    8. Friction brakes - all types.
    9. Rope/belt – All types of flat and V- belts.
    10. Gear trains - all types. (Simple, compound, reverted, epicyclical).
    11. Balancing machines -Revolving masses.
    12. Steam engine, Internal combustion engine.

Suggested Project List:

1. Compile information from the internet related to various mechanisms/elements like piston, crank, connecting rod, cam, clutch, brake, flywheel, governor, animation of mechanism, etc. along with functions of each.
2. Select any one mechanism (preferably that which is NOT part of the syllabus) from mechanical laboratory/workshop/real life. Sketch the same. Take a photograph of the same. Also, record the movie of its working.
3. Prepare any simple model of a subject-related mechanism. This has to be proposed by the student/sand has to be approved by the teacher.
4. Present the detail of selected simple model in above point C with a PowerPoint presentation. This has to include:
    i. Compile and synchronize the information.
    ii. Explain the mechanism selected at b above. Use photographs and movie recordings.
    iii. Explain the working of the model prepared at c above.
    iv. Photographs/movies of students working on a project.

Suggested Activities for Students:

1. Select any machine tool's mechanism available in the institute's workshop and perform the following activity:
    a. Measuring dimensions of different links of a given shaper machine/any machine
    b. Sketching
    c. Labelling the sketch
2. List the mechanisms which you are using in your day-to-day life. Sketch any three from these and explain in brief.
3. Identify the type of clutches used in different automobiles and explain how it works.
4. Identify the type of brakes used in different automobiles and bicycles. Explain how it works.
5. Write the names of the five mechanical power transmissions you have seen in your daily life.
6. Choose any vehicle and tell what kind of brakes it has and give a brief description of how it works.
7. Make a note 'Is there "friction" in your routine?' and justify your viewpoint.

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