

GUJARAT TECHNOLOGICAL UNIVERSITY

MECHANICAL ENGINEERING (19)

THEORY OF MACHINES

SUBJECT CODE: 2151902

B.E. 5th SEMESTER

Type of course: Under Graduate

Prerequisite: None.

Rationale: Theory of Machines is a fundamental course for Mechanical engineers to understand the working principals of any machine. This course is essential to understand the motion, transmission of the motion and the forces responsible for the motion

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P		Theory Marks			Practical Marks			
			ESE (E)	PA (M)		PA (V)		PA (I)		
				PA	ALA	ESE	OEP			
3	0	2	5	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	Gyroscope: Principle of gyroscope, Definition of axes, active and reactive couples; Roll, Yaw and Pitch motions; Gyroscopic effect in a rotor, two wheelers, Four wheelers, ship and aeroplane.	10	20%
2	Friction Devices: Clutches, Brakes and Dynamometers Classification of clutches, torque transmission capacity, considerations for uniform wear and uniform pressure theory, single plate and multi-plate clutch, centrifugal clutch, Energy equation and thermal considerations. Classification of brakes, Braking effect, Analysis of Brakes: Block Brake, Band Brake, Band and Block Brake, Internal expansion shoe brake; Braking analysis of four wheelers. Classification of Dynamometers, Analysis of Dynamometers: Prony brake, Rope brake, Hydraulic, Belt Transmission, Epicyclic-Train and Bevis-Gibson torsion.	12	30%
3	Flywheels: Significance of flywheel, Turning moment and crank effort diagrams for reciprocating machines, coefficient of fluctuation of speed and energy, Limiting velocity of flywheel, Design of flywheels for engines and punching machines.	5	15%
4	Governors: Necessity of governor, Classification of Governors, Working principle of centrifugal governors, Concept of control force, Control force diagram, Stability of governor, Condition for stability, Concept of isochronism, Sensitivity of governor, Characteristics of governors, Hunting of governors.	**	5%

5	<p>Introduction to Dynamics: Newton's Laws of Motion, Applied and constraint forces, Free-body diagrams, conditions for equilibrium, Two and Three forces members, Four force members, Friction forces, Static force analysis with friction. Centroid and Centre of Mass, Mass Moments and products of inertia, Inertia forces and D'alembert's Principle. Planar rotation about fixed centre, Shaking forces and moments, Complex algebra approach, Equation of motion. Application of concepts to dynamic analysis of slider-crank mechanism and 4-bar mechanism.</p> <p>Spatial: Measuring mass moment of Inertia, Transformation of Inertia axes, Euler's equation of motion, Impulse and momentum, Angular impulse and momentum.</p>	15	30%
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**** Should be covered during practical session only.**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	15	15	10	10	10

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. S S Rattan 4/e, Theory of Machines, McGraw-Hill.
2. J.Uicker , Gordon R Penstock & J.E. Shigley, Theory of Machines and Mechanisms, Oxford.
3. A G Ambekar, Mechanism and Machine Theory, PHI.
4. R L Norton, Kinematics and Dynamics of Machinery, McGraw-Hill.
5. Kenneth J Waldron , Gary L Kinzel, Kinematics, Dynamics and Design of Machinery, Wiley.
6. Meriam, J L and Kraige, L G, Engineering Mechanics: Dynamics, Wiley.

Course Outcome:

After learning the course the students should be able to:

1. Analyse effect of gyroscopic couple on vehicles, ships and aeroplanes.
2. Design flywheels for IC engines and punching press.
3. Apply fundamentals of dynamics analysis to various mechanical systems.
4. Design and analyse clutches and brakes.
5. Perform power measurement using dynamometers.
6. Analyse governors.

List of Experiments:

1. Performance on gravity controlled governors.
2. Analysis of gyroscopic effect.
3. Performance on spring controlled governors.
4. Analysis of clutch.
5. Analysis of brakes.
6. Power measurement using dynamometers.
7. Dynamic force analysis of 4-bar mechanism and slider crank mechanism (Analytical Methods)
8. Design of Flywheel for IC engine and Punch press.

9. Measurement of mass moment of inertia.
10. Measurement of radius of gyration of various components.

Design based Problems (DP)/Open Ended Problem:

1. Carryout mechanism analysis using CAD tools.
2. Write program for analysis of mechanism.
3. Conceptualize a system to replace a clutch.
4. Perform analysis of braking system for various vehicles.

Major Equipment:

1. Governors.
2. Dynamometers.

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.