GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Mechatronics / Robotics and Automation
Subject Code: BE05000341
Subject Name: Design of Mechanisms

w.e.f.Academic Year:	2024-25
Semester:	5
Category of the Course:	Professional Core Course

Prerequisite:	Nil
Rationale:	Design of Mechanisms is intended to develop the knowledge and skills required for the analysis, design, selection, and dynamic evaluation of mechanical systems and machine components used in modern engineering applications. The course emphasizes the design of clutches, brakes, bearings, hoisting mechanisms, gears, and engine components along with dynamic analysis of mechanisms for reliable, safe, and efficient operation. The subject enables students to understand the relationship between motion, force transmission, stress distribution, vibration behavior, material selection, and component life in engineering systems. The knowledge gained through this course helps students design sustainable, energy-efficient, and durable mechanical systems for industrial automation, transportation, manufacturing, robotics, and heavy engineering applications.

Course Objectives: To identify the required parameters of the various mechanisms and analyze the mechanisms based on stress and deformation**.**

Course Outcomes:

Sr.No.	CO statement	Marks% weightage
CO-1	Identify basic failure modes of machine elements.	20
CO-2	Design and dissect mechanisms for strength and improve their life.	20
CO-3	Design the mechanisms for desire motion.	20
CO-4	Analyze mechanism for its dynamic characteristics.	20
CO-5	Selection of standard Mechanical components for the mechanisms	20

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL	Total no of hours per semester		ESE (E)	PA / CA (M)	PA/CA (I)	PBL (I)	ESE (V)	
45	0	30	45	120	4	70	30	20	30	50	200

**** Problem-Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.***

Content:

Sr.No.	Content	Total Hrs
1	**Design of Clutch and Brakes** Torque Transmitting Capacity of clutch, Multi-disk Clutches , Friction Materials, ConeClutches , Centrifugal Clutches, EnergyEquation, Thermal Considerations in Clutches, Types of Brakes, EnergyEquations , Block Brake with Short Shoe, Block Brake with Long Shoe, Pivoted Block Brake with Long Shoe, Internal Expanding Brake, Band Brakes, Disk Brakes, Thermal Considerations.	6
2	**Bearing Selection for Mechanisms** Types of Bearings, Types of rolling-contact bearings, Selection of bearing type, Static load carrying capacity of bearing, Dynamic load carrying capacity of bearing, Equivalent bearing load, Load-life relationship, Selection of bearing from manufacturer's catalogue, Bearing with probability of survival other than 90 percent, Design for cyclic load , Function of Lubricants, Hydrostatic and Hydrodynamic Bearings, Performance Parameters of Hydrodynamic Bearings and Analysis.	10
3	**Design of hoisting mechanism:** Design of crane hook, wire rope and sheaves, Design of tackle and pins.	7
4	**Design of Spur gear** Classification of gears, Selection of type of gears, Standard system of gear tooth, Force analysis, Gear tooth failures, selection of material, Beam strength of gear tooth, Wear strength of gear tooth	6
5	**Design of IC Engine Components:** Analysis and Design of Cylinder, Analysis and Design of Piston, Analysis and Design of Crankshaft, Valve-Gear Mechanism.	8
6	**Dynamic Analysis of Mechanisms:** Equations of Motions for Single Degree of Freedom System, Equations of Motions of Two Degree of Freedom Systems, Two Rotor Systems, Three Rotor Systems, Critical Speed of Shaft, Multi Degree of Freedom Systems, Use of Lagrange's Equation to Derive Equations of Motion , Eigen Value Problems	8
	TOTAL	45

SuggestedSpecificationtablewithMarks(Theory):(ForB.E.only)

Distribution ofTheory Marks					
RLevel	ULevel	ALevel	NLevel	ELevel	CLevel
10%	**25%**	**25%**	**25%**	**10%**	**5%**

R:Remembrance;U:Understanding;A:Application,N:AnalyzeandE:EvaluateC:Create and above Levels (Revised Bloom's Taxonomy)

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

The syllabus of Design of Mechanisms directly contributes to

SDG 4	Providing industry-oriented design knowledge, analytical skills, and practical exposure in machine design and dynamic analysis.
SDG 8	Through development of competencies required in machine design, manufacturing industries, automotive systems, maintenance engineering, and industrial automation sectors.
SDG 9	By promoting innovative mechanism design, efficient power transmission systems, and reliable industrial machinery.
SDG 11	Sustainable cities Through safe lifting systems, transportation mechanisms, vibration reduction, and reliable infrastructure equipment design.
SDG 12	Responsible consumption by emphasizing optimized material usage, efficient lubrication systems, wear reduction, maintenance planning, and enhancement of machine life.
SDG 13	Climate action through the design of energy-efficient mechanical systems, reduction of frictional losses, and sustainable engineering practices.

Reference Books:

1. Design of Machine Elements by V B Bhandari, McGraw Hill.
2. Mechanical Vibrations by S S Rao, Prentice Hall
3. Design of Machine Elements by M F Spott, Person
4. Machine Design: An Integrated Approach by R L Norton, Prentice Hall
5. Shigley's Mechanical Engineering Design, R G Budnyas, J K Nisbett, McGraw Hill.
6. Design Data, Faculty of Mechanical Engineering, PSG College of Engineering, Coimbatore.

List of Experiments:

1	Design and Analysis of clutches and brakes.
2	Design and drawing of hoisting mechanism.
3	Design of power transmission mechanism for a machine.
4	Analysis, design and drawing of IC Engine components. (4 hrs.)
5	Experimental dynamic analysis of two DOF freedom system.
6	Dynamic analysis of multi DOF freedom system using computer program.
7	Estimation of natural frequency of mechanism using computer program. (4 hrs.)
8	Case Study / Minor Project

Major Equipment:

Nil

List of Open Source Software

Nil

List of learning website:

Supplementary learning Material:	
1	NPTEL Resources

Pedagogy:

- Direct classroom teaching
- Audio Visual presentations/demonstrations
- Assignments/Quiz
- Continuous assessment
- Interactive methods
- Seminar/Poster Presentation
- Industrial/ Field visits
- Course Projects

Listofsuggested activities for Problem-based Learning (PBL):

Sr. No.	PBL category	Name of the activity	No. of hours	Evaluation Criteria
1.	Complex Problem-Solving targeting relevant SDGs / Mini Project	Mini Project	15h (need to be changed as per total PBL hours)	Based on the novelty of project, technical understanding, report quality and presentation
2.	Case Study Analysis / Seminar	Seminar	15h (need to be changed as per total PBL hours)	Based on the quality of report and presentation, technical understanding
3.	Micro project	Micro project	8h (need to be changed as per total PBL hours)	Based on the novelty of project, technical understanding, quality of report and demonstration
4.	Industry/Research laboratory visit	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
5.	Video Based Learning	Technical video-based learning related to the subject	Duration of video =5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
6.	Assignment /	Assignment writing.	5 assignments of 4 h	Based on the correctness

	Technical Writing / Research Writing	Numerical based assignment is preferable.	each Total = 20h	of submitted assignment
7.	Group Discussion / Quiz / Simulation	Problem solving/Coding using C, C++,MATLAB, Python, SCILAB,modeling and Analysis software or any other software	5 small coding-based assignment of 2h each Total = 10h	Based on the coding solution submitted.
8.	Video Based Learning	Self-learning online course	Minimum duration of the course should be 10h	Examination based assessment at the end of course. Based on the certificate produced.
9.	Complex Problem-Solving targeting relevant SDGs / Mini Project	Identification and solution of Complex problem	Maximum 2 problems. Study of the problem and solution finding, Total =10h	Based on the depth of the solution submitted.
10.	Video Based Learning	Videos on Industrial safety/Disaster Management aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
11.	Research Paper Review / Analysis	Technical paper reading and summarization of research papers based on relevant subject	5 research papers = 20h	Summarize research paper and evaluation critical parameters
12.	Poster/Chart/Power Point presentation	Poster/chart/power point preparation on technical topics	Duration = 6h	Based on poster/chart preparation and presentation skills
13.	Industry/Research laboratory visit	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/ sustainability/any other issue	Duration = 15h for industrial exposure Problem identification and tentative solution = 10h Total = 20h	Based on evaluation of critical problems and solutions
14.	Group Discussion / Quiz / Simulation	Group Discussion on emerging/trending technical topics based on subject	Duration = 1h – 3hper topic	Based on performance in group discussion, technical depth, knowledge etc.
15.	Case Study Analysis / Seminar	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.

16.	Group Discussion / Quiz / Simulation	Application/Software development	Duration = 10h	Depending on the complexity of the Application/Software
17.	Assignment / Technical Writing / Research Writing	Research paper publication	Duration = 10h	Based on submission of proof of publication
18.	Micro project	Upgradation/Reverse engineering studies of existing equipment of the laboratory	Duration 10h	Based on the performance of the equipment
19.	Industry/Research laboratory visit	Expert lecture/session	Duration 3h For attending the lecture/session– 2h and for report writing 1h	Based on the proof of attendance and report submitted
20.	Video Based Learning	Annotated Video Explanation of Concept/Problem	10h (Preparation + Recording + Submission)	Based on accuracy of explanation, clarity, and presentation style.
21.	Assignment / Technical Writing / Research Writing	Patent Search and Innovation Gap Identification	10h (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.
22.	Assignment / Technical Writing / Research Writing	Preparation of a report on Indian Standard(s)	10h (study of Indian Standard(s) + report	Based on report quality and understanding of the relevant Indian Standard(s).

Note:

1. In alignment with Outcome-Based Education (OBE) and NBA accreditation requirements, the subject **Micro Project and 5 marks as PBL activities for PEC and Seminar and Mini Project for PCC.**
   These activities are incorporated as integral Project-Based Learning (PBL) components. These activities are designed to foster experiential learning, encourage innovation, and strengthen problem-solving skills by engaging students in practical applications of power converter design, simulation, and analysis. The inclusion of PBL ensures that learners develop higher-order cognitive abilities mapped to Bloom's taxonomy, while simultaneously enhancing teamwork, communication, and research competencies essential for professional engineering practice.
2. The hours allocated to specific activities should be proportionate to the total no. of PBL hours and marks.
3. All the suggested activity should be related to the subject.
4. The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
5. Rubrics for the evaluation can be prepared by the faculty.
6. Subject teacher can add the relevant activities other than those listed above, with the consent of head of the department and DQAC.

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