GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3141907
Semester – IV
FUNDAMENTAL OF MACHINE DESIGN

Type of course: Professional Core

Prerequisite: None**.**

Rationale: The course aims to impart basic skills of force and stress analysis for design of machine elements.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	**Basics of stress and strain**: 3 -D state of stress (Concept only) Normal/axial stresses: Tensile & compressive Stresses: Shear and complementary shear Strains: Linear, shear, lateral, thermal and volumetric. Hooke's law, Elastic Constants: Modulus of elasticity, Poisson's ratio, Modulus of rigidity and bulk modulus and relations between them with derivation.	**07**
2	**Moment of inertia of planar cross -sections:** Derivation of equation of moment of inertia of standard lamina using first principle, Parallel & perpendicular axes theorems, polar moment of inertia,	**04**
3	**Flexural stresses** – Theory of simple bending, Assumptions, derivation of equation of bending, neutral axis, determination of bending stresses, section modulus of rectangular & circular (solid & hollow), I,T, Angle, channel sections	**04**
4	**Torsion:** Derivation of equation of torsion, Assumptions, application of theory of torsion equation to solid & hollow circular shaft, torsional rigidity	**03**
5	**Introduction to Machine Design**: Design procedure, Selection of preferred sizes, Aesthetic and Ergonomic considerations in Design, Manufacturing considerations in Design, Mechanical Properties of Materials, Effect of Alloying elements and heat treatment on properties of steels, Materials Selection in Machine Design, Standardization	**06**
6	**Design Against Static Load**: Concepts of stresses and Strain, Combinations of Axial, Shear, Torsional and Bending loads; Theories of Failures: Distortion energy (von Mises), Maximum-Shear stress, Maximum Principal stress, Selection and Use of theories of failures; Factor of safety, Contact stresses, Crushing and Bearing stress. Application Problems: Eccentric Loading; Cotter and Knuckle Joints; Design and analysis of levers: Cranked, Bell crank, Foot, Rocker arm.	**10**
7	**Beams and Columns:** Different types of supports / end conditions, Revision of Stresses in beams: Effect of Section, Orientation, and type of loading; Deflection of beams for different loading conditions. Compressive axial loading of columns and struts, Slenderness	**06**

	ratio, Compressive stress and Buckling of members, Effect of end conditions; Euler's Formula, Applications, validity and limitations; Rankine's Formula, stresses in curved beam	
8	**Shafts and Keys:** Design of solid and hollow circular shaft subjected to torque and combined loading for rigidity and stiffness; Design of Keys and splines.	**05**
9	**Power Screws and Threaded Joints:** Forms of thread, Single and Multiple threaded screw, Terminology of power screw, Torque requirement of lifting/lowering, Self-locking, Efficiency of threads, coefficient of friction, design of screw and nut. Basic types of screw fastening, Cap and Set screw, Bolt of Uniform strength, locking devices, Terminology of Screw thread, Bolted Joint: Simple and Eccentric loading, Torque requirement for bolt tightening.	**09**
10	**Design Against Fluctuating Loads:** Stress Concentration, Endurance limit and Fatigue failure, Factors affecting endurance limit, S-N Diagram, Design for reversed stresses and cumulative damage, Fluctuating stresses: Soderberg, Gerber, Goodman and Modified Goodman criteria, Combined stresses	**06**

Reference Books:

1. Design of Machine Elements, V B Bhandari, 3/e, McGraw Hill.
2. A Textbook of Machine Design, P C Sharma and D K Aggarwal,S K Kataria & sons.
3. Shigley's Mechanical Engineering Design, R G Budnyas, J K Nisbett, McGraw Hill.
4. Fundamentals of Machine Component Design, R C Juvinall, 4/e, Wiley.
5. Machine Design: An Integrated Approach, R L Norton, Pearson
6. Strength of Materials, Part I & II, S Timoshenko, CBS publishers and distributers Pvt. Ltd.
7. Strength of Materials, Bansal R K, Laxmi publication.
8. Strength of Materials, Patnaik S, Hopkins D, Elsevier.
9. Engineering Mechanics, Bansal R K, Laxmi Publication.

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	15	10	40	15	-

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

Course Outcome:

After learning the course the students will be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	understand fundamentals of material selection, strength of materials and loading patterns of machine elements.	20
CO-2	distinguish basic failure modes of machine elements.	15
CO-3	analyse beams and columns for stresses and deflection.	10

CO-4	design and analyse machine components under static loading.	40
CO-5	design and analyze machine components under variable loading.	15

List of Experiments:

Practical should be designed to include followings:

1. Detail and assembly of mechanism/machine.
2. Problems related to fundamentals of design (chapter no. 1 to 4)
3. Design and drawing of Joints and levers.
4. Design and drawing of screw jacks (Bottle neck and Toggle).
5. Design of machine components under fluctuates loading.
6. Case study for design of mechanical components.
7. 2D drawing of machine components using computer software.

Major Equipment:

1. Computational facility.
2. CAD Software like Fusion 360

List of Open Source Software/learning website:

1. http://nptel.ac.in
2. http://help.autodesk.com/view/fusion360/ENU/