GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Machine Design

Course / Subject Code : ME01078011

Course / Subject Name : Advanced machine Design

w. e. f. Academic Year:	2024-25
Semester:	1st Semester
Category of the Course:	PEC

Prerequisite:	Nil
Rationale:	The course is intended to strengthen fundamentals of applied mechanics of solids and build understanding of design and analysis of machine components under dynamic loading. The course introduces design and analysis of machine components at elevated temperature. The course also includes fundamentals and application of fracture mechanics and surface failures in machine component design.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT level
1	Students will be able to design mechanical components subjected to static loading.	N
2	Students will be able to design and analyse mechanical components subjected to dynamic loading.	N
3	For the design and analysis of components students will be able to incorporate effect of crack and creep.	A
4	Students will be able to analyse components subjected to fatigue loading	A

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 / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Review of Stresses, Strains and Theories of Failures:** Introduction, Plane Stress, Rotation of Coordinate Axes, Generalized Plane Stress, Principal Stresses and Maximum Shear Stress, 3D state	10	21

	of stress, Stresses on Octahedral plane, Plane strain, Strain gage rosettes. Introduction to basic Constitutive Relations and Rheological Models: Elastic (Generalized Hooke's Law), Plastic (Rigid-Perfectly Plastic, Elastic-Perfectly, Elastic-Linear Hardening), Creep (Steady state and Relaxation, Transient), Anisotropic and Orthotropic Hooke's Law, Theories of Failures: Distortion Energy, Maximum-Shear Stress, Maximum Normal Stress, Modified Coulomb-Mohr Theory, Comparison of theories of failures.		
2.	**Fracture Mechanics:** Introduction, Rise in stresses due to crack, Crack tip opening displacement, LEFM: Effect of crack on strength of ductile and brittle material, Crack opening modes and Griffith theory, Concept of *SIF* and *K* Crack Tip Plasticity, Use of *K* in design and analysis, Determination of plastic zone, size and shape, Limitations of LEFM.	09	21
3.	**Fatigue:** Introduction, factors affecting fatigue behaviour, Theoretical stress concentration factor and notch sensitivity factor, Fatigue under complex stresses, cumulative fatigue design, Linear damage (Miner's Rule), Manson's method, Fatigue crack propagation and life estimation for constant and variable amplitude stress. Strain Based Approach to Fatigue: Strain Vs Life Curve, Mean stress effect, Strain-Life Equation, Life estimate for structural components.	10	24
4.	**Surface Failures:** Friction: Rolling, Effect of roughness, velocity and lubrication on friction, Wear: Adhesive, Abrasive and Corrosive, Lubrication: Hydrodynamic, hydrostatic and elsatorydrodynamic lubrication, Surface Fatigue, Contact Stresses: Spherical, Cylindrical, General and Dynamic, Surface Fatigue Strength, design to avoid surface fatigue.	08	17
5.	**Creep and Damping:** True stress and true strain, Creep phenomenon, Creep Curve, Creep parameters, time-temperature parameters and life estimate: Sherby-Dorn and Larson-Miller, Stress relaxation. Stress-Strain-Time relation, Creep deformation under varying stress, Component stress-strain analysis, Energy dissipation in materials.	08	17
	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**
10	**20**	**20**	**30**	**20**	**-**

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. Mechanical Behaviour of Materials: Engineering Methods for Deformation Fracture an Fatigue 4\e N E Dowling Pearson.
2. Machine Design: An Integrated Approach 3\e R L Norton Pearson Education.
3. Fundamentals of Machine Design 5\e R C Juvinall & K M Marshek Wiley India.
4. Mechanical Design of Machine Elements and Machines: A failure prevention perspective J A Collins, H Busby and G Stabb Wiley India.
5. Dislocations and Mechanical Behaviour of Materials M. N. Shetty PHI.
6. Mechanical Behaviour of Materials, 2\e T H Courney McGraw-Hill / Overseas Press India.
7. Metal Fatigue in Engineering R I Stephens, A Fatemi, R R Stephens and H O Fuchs. John-Wiley.
8. Elements of Fracture Mechanics Prashant Kumar McGraw-Hill. 9. Engineering Design Dieter, G McGraw-Hill

(b) Open-source software and website:

1. https://nptel.ac.in/

Suggested Course Practical List:

1. To understand various factors to be considered affecting design process and understand material selection procedure through case studies.
2. Problems related to calculation of stresses and strain along with transformations of basis and Theories of Failures.
3. Study various materials depicting different constitutive relations and understand behaviour of anisotropic and orthotropic materials of composites.
4. Case studies (thin/thick plates and pressure vessels) related to estimation of SIF and its use in design.
5. Case Studies related to plastic zone and validation of LEFM.
6. Case studies of Mechanical Components subjected to fluctuating load.
7. Case studies related to complex loading, cumulative damage and strain life approach.
8. Case studies of surface failures in Bearings, Cams and Gears.
9. Study effects of various types of wear mechanisms and effectiveness and suitability of lubrication methods.
10. Study creep mechanism and related parameters

List of Laboratory/Learning Resources Required: --

Suggested Project List:

1. Detail and assembly design of mechanical components

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