



# GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering (Part Time)

Subject Code: 2971904

Advanced Machine Design

B.E. 7<sup>th</sup> SEMESTER

Type of course: Departmental elective

Prerequisite: None

**Rationale:** The course aims to impart basic knowledge of fracture mechanics, surface failure and failure of machine elements under creep, fatigue and multiaxial stresses.

## Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE(E)	PA (M)	PA (V)	PA (I)	
3	0	2	4	70	30	30	20	150

## Content:

Sr. No.	Topics	Teaching Hrs.
1	<b>Fracture Mechanics:</b> 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
2	<b>Surface Failures:</b> Friction: Rolling, Effect of roughness, velocity and lubrication on friction, Wear: Adhesive, Abrasive and Corrosive, Lubrication: Hydrodynamic, hydrostatic and elasto hydrodynamic lubrication, Surface Fatigue, Contact Stresses: Spherical, Cylindrical, General and Dynamic, Surface Fatigue Strength, design to avoid surface fatigue.	07
3	<b>Creep and Damping:</b> 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.	07
4	<b>Fatigue Failure:</b> Fatigue test and stress life (S-N) approach, Factor Influences on S-N Behavior, Life Estimating using S-N curve, Fatigue from Variable Amplitude Loading, Spectrum Load and Cumulative Damage, Cumulative Damage Theories, Cycle Counting Methods, Life estimation using Stress Life Approach, Life Estimation using Strain Life Approach, Crack Growth and Life Estimation Model,	08
5	<b>Multiaxial stresses :</b> States of Stress and Strain and Proportional versus Non proportional Loading, Yielding and Plasticity in Multiaxial Fatigue, Stress-Based Criteria, Equivalent Stress Approaches, Sines Method, Examples Using the Stress-Life Approach, Strain-Based, Energy-Based, and Critical Plane Approaches, Strain-Based and Energy-Based Approaches, Critical Plane Approaches and the Fatemi-Socie Model, Example of Non proportional Loading, Fracture Mechanics Models for	08



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	Fatigue Crack Growth, Notch Effects and Variable Amplitude Loading.	
6	<b>Housings :</b> The Function of Housings, Materials for Housings, Design of Housings , Housings Split through the Axes of Shafts, Design of Mounting Feet, Design of Lifting Elements, Housings Split at Right Angle to the Axes of the Shafts, Non-split Housings, Deformations and Stiffness Problems, Housing Seals, Sealing of Rigid Connections (Static Seals, Sealing Movable Joints ,Noncontact Seals, Contact Seals, Combined Seals.	06

### Reference Books:

1. Mechanical Behaviour of Materials: Engineering Methods for Deformation Fracture and 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. Metal Fatigue in Engineering R I Stephens, A Fatemi, R R Stephens and H O Fuchs, John-Wiley.
6. Elements of Fracture Mechanics, Prashant Kumar McGraw-Hill.
7. Engineering Design Dieter, McGraw-Hill
8. Machine Elements Life and Design, B M Klebanov, D M Barlam, F E Nystrom, CRC Press

### Distribution of marks weightage for cognitive level

Bloom's Taxonomy for Cognitive Domain	Marks % weightage
Recall	10
Comprehension	10
Application	30
Analysis	40
Evaluate	10
Create	-

### Course Outcome:

After learning the course the students will be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Make use of fracture mechanics, surface failure and creep in design of machine components.	35
CO-2	Demonstrate time dependent failure of machine components.	10
CO-3	Examine life of machine components based on fatigue failure.	30
CO-4	Construct the housing for gearboxes.	10
CO-5	Determine multiaxial stresses in machine components.	15

### List of Experiments:

Students should be assigned work to design machine components/mechanisms and case studies which covers all topics mentioned in content. Examples:



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1. Design of machine components subjected to fatigue loading, creep.
2. Design of mechanical components subjected to multiaxial stresses.
3. Failure analysis based on fracture mechanics.
4. Case study based on surface failure considerations, contact stresses for mating surfaces.

## **Major Equipment:**

1. Computational facility and drawing hall facility.