GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Machine Design

Subject Code : ME02078021

Subject Name : Fracture Mechanics

w. e. f. Academic Year:	2024-25
Semester:	2
Category of the Course:	PCC

Prerequisite:	Nil
Rationale:	This course acquire basic skills, to work professionally as an engineer and teach students how to analyze and predict the failure of materials and components. This knowledge is important for designing and maintaining structures that are subject to mechanical loading This means applying fracture mechanics theory and to calculate stress areas and the "energy release rate" around crack tips and crack growth due to fatigue.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT level
1	Students will be able to apply fracture mechanics theories to predict brittle fracture, identify and describe the basic fracture and fatigue mechanisms.	10
2	Students will be able to understand crack resistance and energy release rate for crack criticality.	20
3	Students will be able to identify the plane stress and plane strain conditions based on the shape and size of plastic zones.	30
4	Students will be able to identify the cause of failure in brittle and ductile materials based on fracture surface observations.	20
5	Students will be able to apply experimental techniques to determine the critical values of parameters at crack tip.	20

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

GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Machine Design

Subject Code : ME02078021

Subject Name : Fracture Mechanics

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Introduction to Fracture Mechanics:** Stress-Strain Curve, Elements of dislocation theory, Historical perspective, Stress Concentration effect of flaws, Fracture Mechanics approach to design, Effect of material properties on fracture, Cleavage, Brittle and Ductile fracture, ductile brittle transition, modes of fracture failure, Fatigue and stress corrosion cack growth, Damage tolerance.	06	14
2.	**Linear Elastic Fracture Mechanics:** An atomic view of fracture, Griffith Energy Balance, Energy release rate, instability and the R Curves, compliance, tearing modulus, Stress and Displacement field in isotropic elastic materials, Airy stress function, Westergard approach for different modes of fracture, Stress analysis of crack, Stress intensity factor (SIF), relation between K and global behaviour, Effect of finite size.	09	18
3.	**Elastic-Plastic Fracture Mechanics:** Crack tip deformation and plastic zone size, plane stress vs plane strain, effective crack length, Irwin plastic zone correction, Dugdale approach, effect of plate thickness. J Contour Integral: Relevance and scope, J as a path-independent line integral, J as a stress intensity parameter, Stress-Strain relations, J-Controlled fracture, Laboratory measurement of J, Crack Tip Opening Displacement (CTOD), Relationship between CTOD, K and G, Equivalence between CTOD and J, Determination CTOD from strip yield model, HRR Singularity	12	28
4.	**Fatigue Fracture:** Introduction to fatigue, factors affecting fatigue performance, fatigue loading, constant and variable amplitude loading, some characteristics of fatigue crack, Paris Law	08	18
5.	**Experimental and Finite Element Estimates of Fracture Mechanics:** Experimental determination of J-Integral, Critical Stress intensity factor and CTOD, Photo elasticity techniques, strain gage measurements, Fatigue crack initiation and propagation testing Preprocessing in Finite Element Method, Element selection and meshing of crack, Load application, constraints, preprocessing checks, processing the model, post processing	10	22
	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**
-	**20**	**30**	**20**	**20**	**10**

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. Anderson T.L., Fracture Mechanics Fundamentals and Applications, CRC Press, Second edition, 2005
2. Kumar Prashant, Elements of Fracture Mechanics, Tata McGraw Hill, India, Second edition, 2010
3. Hertzberg Richard W., Deformation and Fracture Mechanics of Engineering Materials, Wiley, Fifth Edition, 2012
4. Broek David, Elementary Engineering Fracture Mechanics, Kluwer Academic Publishers, Fourth revised reprint edition, 1999
5. Barsom John M. and Rolfe Stanley T., Fracture and Fatigue Control in Structures: Aplications of Fracture Mechanics, ASTM USA, Third Edition, 1999
6. Sanford R.J., Principles of Fracture Mechanics, Printice Hall USA, 2003

(b) Open-source software and website:

1. NPTEL Course

Suggested Course Practical List:

1. Experiments related to stress strain curve.
2. Experiments related to material properties.
3. Experiments related to topic no. 5 of syllabus.

List of Laboratory/Learning Resources Required:

* * * * * * *