

# Course-Plan

School	: School of Engineering
Department	: Mechanical Engineering Dept.
Course Code	: ME 504
Course Name	: Failure Analysis of Materials

*Instructor: Dr. Sanjib Banerjee*

## 1. Abstract:

- The course offers the basics and advances of Failure Analysis. The general topics like causes and principles of failures are covered. The various aspects of failure mechanisms and different modes of failures like creep, fatigue and fracture are discussed.
- The significance of the course lies on the in-depth knowledge in principles and modes of failure in various materials, which have major applications in mechanical design.

## 2. Objectives:

- To give detailed knowledge in causes and principles of fracture and failure.
- To generate ideas on different modes of failure.
- To increase interest in application of knowledge in failure within the field of mechanical design.

## 3. Prerequisites of the course:

Basic knowledge on Material Science, Strength of Materials, and Mechanical Design and is preferable.

## 4. Course outline:

- Introduction, common causes of failure, failure investigation, principles of failure analysis;
- Fracture mechanics: energy approach and stress intensity factor approach to linear elastic fracture mechanics, concept of crack tip opening displacement and J-integral fracture criteria, mechanisms of fracture, evaluation of fracture toughness, fracture in composite materials, computational fracture mechanics analysis, fracture mechanics in nano materials and structures;
- Creep - stress-time-temperature relations, creep curve;
- Fatigue - stresses in cyclic loading, fatigue testing, S-N curves and endurance limit, mechanisms of fatigue crack initiation and propagation, influence of stress concentration on fatigue strength, notch sensitivity, factors influencing fatigue behaviour, prevention of fatigue failure.

**5. (a) Time-Plan:**

Topic	Content	Contact Hours	
		L	T
	<ul style="list-style-type: none"> <li>• Introduction, common causes of failure, failure investigation, principles of failure analysis;</li> </ul>	10	
	<ul style="list-style-type: none"> <li>• Fracture mechanics: energy approach and stress intensity factor approach to linear elastic fracture mechanics, concept of crack tip opening displacement and J-integral fracture criteria, mechanisms of fracture, evaluation of fracture toughness, fracture in composite materials, computational fracture mechanics analysis, fracture mechanics in nano materials and structures;</li> </ul>	15	
	<ul style="list-style-type: none"> <li>• Creep - stress-time-temperature relations, creep curve;</li> </ul>	5	
	<ul style="list-style-type: none"> <li>• Fatigue - stresses in cyclic loading, fatigue testing, S-N curves and endurance limit, mechanisms of fatigue crack initiation and propagation, influence of stress concentration on fatigue strength, notch sensitivity, factors influencing fatigue behavior, prevention of fatigue failure;</li> </ul>	10	
<b>Total contact hours</b>		40	

**Text Books:**

- a. Dieter, G. Mechanical Metallurgy (McGraw-Hill, 1986)
- b. W. D. Callister, Material Science and Engineering - An Introduction, Wiley, 2002.

**Reference Books:**

- a. Kumar, P. Elements of Fracture Mechanics (McGraw-Hill, 2009)
- b. Anderson, T.L. Fracture Mechanics: Fundamentals and Applications (CRC Press, 2004)
- c. Bruck, D. Elementary Engineering Fracture Mechanics (Springer, 1986)
- d. Barson, J.M. and Rolfe, S.T. Fracture and Fatigue Control in Structures (Butterworth-Heinemann, 1999)
- e. Gdoutos, E.E. Fracture of Nano and Engineering Materials and Structures (Springer, 2006)

**5. (b) Evaluation Plan:**

Test No.	Marks	Duration (minutes)
Test I	20	-
Test II	20	-
Test III	20	-
Test IV (End Term)	40	120
Total Marks	100	

*All the tests will be held as per the schedule notified by the Controller of Examinations, Tezpur University*

## **6. Pedagogy:**

Students should visualize the different causes, principles and modes of failure, and expertise in applications of the knowledge in mechanical design, considering the concerned material strength.

## **7. Expected outcome:**

Towards the end of the course the student would be able to:

- Identify the different causes, principles and modes of fracture and failure.
- Apply knowledge of fracture and failure in the field of mechanical design.
- Present the outcome carried out in the form of group projects on advanced design of mechanical / structural components considering the in-depth knowledge of material strength and failure.
- Correlate design considerations with material strength and fracture properties.