

**Catalogue Description:**

This course starts with a general approach for failure analysis describing the failure analysis tools, mechanical, macro/micro-fractographic aspects of fractures. The lectures also focus on the failure analysis of metals, ceramics, polymers, composites, manufacturing aspects of casting, welding, corrosion, and heat treatment failures. Finally, some of the real-world case studies are considered to emphasize the practical significance and experiences of failure analysis investigation.

**Credits:** 3.0 Credit Hours (Lectures)

**Designation:** Technical Elective/Graduate course (Metallurgical & Materials Engineering, General/Mechanical Engineering)

**Prerequisites:** EMAT 251/EGEN 213 *or* consent of the instructor.

**Lab:** There is no lab allotted to this course.

**Textbook:**

- *Required:* Neville W Sachs, *Practical Plant Failure Analysis, A Guide to Understanding Machinery Deterioration and Improving Equipment Reliability*, 2<sup>nd</sup> ed., ISBN 978-1-03-217685-7, CRC Press, 2021.

**Additional References:**

- Charles R. Brooks, Ashok Choudhury, *Failure Analysis of Engineering Materials*, ISBN 0-07-135758-0, McGraw-Hill, 2002.
- ASM Handbook Volume 11: *Failure Analysis and Prevention*, ASM Publications, 2002.
- Arthur J. McEvily, Jirapong Kasivitanunay, *Metal Failures: Mechanisms, Analysis, Prevention*, 2<sup>nd</sup> ed., ISBN: 978-1-118-16396-2, John Wiley & Sons, Inc., 2013.
- ASM Handbook Volume 12: *Fractography*, ASM Publications, 2002.

**Relationship of Course to Metallurgical and Materials Engineering Program Outcomes:**

This course provides an opportunity for the students to recognize and investigate failure of a material/component in an organized manner, combining basic knowledge of metallurgy/materials engineering with professional judgment to redesign parts, devices, or procedures to eliminate/minimize failures.

**Objectives:** The objective of this course is to:

- Understand general failure analysis procedures.
- Learn fundamental sources of failures.
- Suggest appropriate remedial measures for engineering material/component failures.

**Outcomes:** Graduates of this course will be able to:

- Develop an understanding of the relationships between the mechanical properties of materials, their microstructure and their processing history.
- Characterize the major modes of failure using a variety of microscopy and analytical techniques.
- Examine and determine the root cause of a component/material failure.
- Strengthen their ability to take appropriate corrective actions to prevent repeat failures.
- Plan and undertake an individual project.
- Fulfill **ABET outcomes** 1 and 7 (consult the Course Catalog and Department Guidelines)

<u>Tentative Course Plan</u>	<u>Forecast lectures</u>	
1	Significance and General approach of failure analysis	3
2	Failure analysis tools	3
3	Mechanical aspects – Stresses and Strains of fracture	3
4	Fracture mechanisms/Failure modes in Engineering Materials	3
5	Overload, Fatigue, Creep/Stress Rupture Failures... <i>Test 1</i>	3
6	Corrosion Failures in Engineering Materials	3
7	Fracture of Polymers and Ceramics	3
8	Manufacturing aspects: Casting failures	3
9	Manufacturing aspects: Welding failures... <i>Test 2</i>	3
10	Manufacturing aspects: Heat treatment failures	3
11	Failure analysis of Composites	3
12	Case Studies ( <i>Real World Component Failures</i> )... <i>Finals</i>	6
	<b>Seminars</b>	<b>3</b>
	<u>Exams</u>	<u>3</u>
	<b>Total</b>	<b>45</b>

**Assessment:**

Test 1 & Test 2: (25% each)	50%
Term paper (PP Presentation (10%) + Written Report (10%):	20%
<u>Finals:</u>	<u>30%</u>
<b>Total</b>	<b>100%</b>

A = (92-100), A- = (90-91.9), B+ = (88-89.9), B = (82-87.9), B- = (80-81.9), C+ = (78-79.9), C = (72-77.9), C- = (70-71.9), D+ = (68-69.9), D = (62-67.9), D- = (60-61.9), F = (0-59.9)

***Excessive absence will result in lowering of the final grade.***

**Academic Integrity:**

Academic dishonesty/cheating will not be tolerated. Acts of academic dishonesty include (but are not limited to):

- Plagiarism
- Copying from another student’s paper while taking a quiz or examination
- Using unlawful aids (books, notes, cell phones or other electronic devices, etc.) to pass an examination (unless the instructor has clearly stated that it is an open notes or open book exam)
- Assisting another student in an act of academic dishonesty

**Requirements:**

1. Attend all exams/term paper seminars
2. **Talking with other students during lecturing in class is prohibited and is considered disruptive behavior**

**Contribution to Professional Component:**

- Engineering Topics - 100%
- Engineering Design - Yes (*Introductory*)
- Computer Usage - Limited usage
- Ethics – No, Statistics – No, Safety - No

**ABET outcomes covered: 1 & 7**

- (1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
- (7) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies