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# Failure Analysis, Summer 2022 (Sabanci University)

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| **Instructor:** | Professor Dr. Ramazan Asmatulu |
| **Department / University:** | Mechanical Engineering / Wichita State Uni. |
| **Email:** | ramazan.asmatulu@wichita.edu  |
| **Classroom; Days/Time:** |  |
| **Teaching Assistant:**  |  |
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# Course Description

This course introduces the fundamental concepts of the failure analysis methods and tools of engineering components. Topics include analysis of broken components by macroscopic and microscopic observation, review of common experimental methods used in failure analysis, specific description of failure mechanisms of composite, metallic, ceramics, and polymeric materials. Throughout the classes, students are expected to gain an understanding of these subjects, and how they are applied in industrial applications.

# Measurable Student Learning Outcomes

Upon successful completion of this course, students will be able to demonstrate the understanding of the basic concepts and definitions, and to apply them to solve simple problems in Failure Analysis:

1. Recognize and use the terminology, symbols, and units specific to failure analysis, materials structures and properties
2. Define fundamentals of failure analysis
3. Identify the failure analysis principals in composites, metals and alloys, ceramics and polymers
4. Calculate the engineering problems regarding failure analysis
5. Understand the materials and properties under different environmental conditions
6. Evaluate different alternatives and select the best possible methods for the needs
7. Analyze all the given topics for better engineering applications
8. Learn basic manufacturing techniques for different types of materials in structural applications.

# Readings Textbook (Handouts Provided)

# Jose Luis Otegui, “Failure Analysis: Fundamentals and Applications in Mechanical Components,” Springer, New York, 2014.

# Other Readings

Hock-Chye Qua, Ching-Seong Tan, Kok-Cheong Wong, Jee-Hou Ho, Xin Wang, Eng-Hwa Yap, Jong-Boon Ooi, Yee-Shiuan Wong “Applied Engineering Failure Analysis: Theory and Practice,” CRC Press, New York, 2015.

# Class Protocol

You are strongly encouraged to take part in class discussion. Remember that there is no dumb question. This class will be livelier, and you will learn more if you participate in class discussion. Do not hesitate to see me in my office if you want to discuss privately any problem you might have. For most questions concerning HW problems, clarification of topics in book, handouts or those discussed in class, **e‑mail is the preferred mode of communication**. I will respond promptly to these queries. Cell phones must be turned in silent mode in the classroom.

# Grading Scale

The university uses a +/- grading scale for final grades and to calculate grade point averages. In this class, grades are assigned according to the following chart. (Note, other classes might assign grades differently: Be sure to understand the different grading scales in all of your classes.)

|  |  |  |  |
| --- | --- | --- | --- |
| **Percent** | **Letter grade** | **Grade Points** | **Interpretation** |
|  93-100 | A | 4.00 | *The A range denotes excellent performance.* |
|  90-93 | A- | 3.70 |  |
|  87-90 | B+ | 3.30 |  |
|  83-87 | B | 3.00 | *The B range denotes good performance.* |
|  80-83 | B- | 2.70 |  |
|  77-80 | C+ | 2.30 |  |
|  73-77 | C | 2.00 | *The C range denotes satisfactory performance.* |
|  70-73 | C- | 1.70 |  |
|  67-70 | D+ | 1.30 |  |
|  63-67 | D | 1.00 | *The D range denotes unsatisfactory performance.* |
|  60-63 | D- | 0.70 |  |
|  <60% | F | 0.00 | *F denotes failing performance.* |

## **Units of Assessment**

In this course, the 100-point scale is adopted for the final grading. The total points of a student will be from homework (and quiz if any), midterm exam, and the final exam. The contribution of each item is assigned in the following chart.

|  |  |
| --- | --- |
| **Item** | **Point (100 in total)** |
| Homework  | 20 |
| Term Project / Presentation | 20 |
| Exam I | 30 |
| Exam II | 30 |

# Homework Assignments

All homework will be done **independently**. No teamwork is allowed.

# Late Assignments

Homework will be accepted **up to 3 days late** but will receive a maximum grade of 50%. They will not be accepted after being 3 days late. Please remember that the exams will draw partially from the homework.

# Exams

All exams will be **closed book and notes**. The Exam I will be held during the class, and will last 1 hour and 15 minutes. The exam date will be announced both in class and on Blackboard. Note that the use of all other electronic devices, such as **mobile phone, laptop, and tablet**, is strictly prohibited.

# Missed Assignments and Exams

If you miss the mid-term exam without either a certified medical excuse or prior instructor approval, you may take a **makeup test** at a designated time near the end of the semester. Only one makeup exam will be given, which will be challenging. Exams missed with certified medical excuse or prior instructor approval will be dealt with individually. If you miss the Final Exam without a valid excuse, a zero will be averaged into your grade.

**Links**

<http://aldservice.com/Fracas/failure-analysis-methods-and-tools.html>

<http://www.journals.elsevier.com/engineering-failure-analysis>

<http://www.eag.com/mte/failure-analysis-tools-techniques.html>

<http://www.odonnellconsulting.com/what-we-do/failure-analysis/?gclid=CMvehrPJ280CFQwPaQod_rsMLQ>

# Tentative Schedule for Failure Analysis

|  |  |  |  |
| --- | --- | --- | --- |
| Week | Date Time | SectionsChapters | Topics |
| 1a |  | 1 | General Background |
| 1b |  | 2 | Introduction to Failure Analysis |
| 1c |  | 3 | Tools of Failure Analysis |
| 1d |  | 4 | Mechanical Aspects and Macroscopic Fracture-Surface Orientation I  |
| 2a |  | 5 | Mechanical Aspects and Macroscopic Fracture-Surface Orientation II |
| 2b |  | 6 | Fracture Mechanisms and Microfractographic Features I  |
| 2c |  | 7 | Fracture Mechanisms and Microfractographic Features II |
| 2d |  | 8 | Fracture Modes and Macrofractographic Features I |
| 3a |  | 9 | Fracture Modes and Macrofractographic Features II |
| 3b |  | 10 | Failure Analysis of Composites I |
| 3c |  | 11 | Failure Analysis of Composites II |
| 3d |  | - | Exam I |
| 4a |  | 12 | Failure Analysis of Polymers I |
| 4b |  | 13 | Failure Analysis of Polymers II |
| 4c |  | 14 | Failure Analysis of Ceramics I |
| 4d |  | 15 | Failure Analysis of Ceramics II |
| 5a |  | 16 | Failure Mechanisms of Ductile Materials |
| 5b |  | 17 | Failure Mechanisms of Brittle Materials |
| 5c |  | 18 | Effects of Corrosion on Failure Mechanisms |
| 5d |  | 19 | Effects of Stresses on Failure Mechanisms |
| 6a |  | 20 | Effects of Moisture on Failure Mechanisms |
| 6b |  | 21 | Effects of Nanosize grains on Failure Mechanisms |
| 6c |  | 22 | Computational Failure Analysis  |
| 6d |  | - | Exam II |