GENERAL

SCHOOL	Engineering		
ACADEMIC UNIT	Mechanical Engineering		
LEVEL OF STUDIES	*Undergraduate*		
COURSE CODE	MY3210	**SEMESTER**	7th
COURSE TITLE	Failure Analysis		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures	5	6
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialized general knowledge, skills development*	Special background
PREREQUISITE COURSES:	
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	No
COURSE WEBSITE (URL)	https://mie.uth.gr/?page_id=18404&lang=en

Learning outcomes

One of the main objective of the course is to familiarize the students with the fundamental concepts of failure analysis procedure and to provide an insight view on how the materials behave in real industrial conditions. Thus, this course provides a description on the most expected material failures (Corrosion, High temperature, Mechanical failures) supported by real examples - case studies from industry- that are presented and analyzed both theoretically and in the laboratory.

At the end of the course the student should be able to:

- Classify the main failure mechanisms.
- Identify engineering problems
- Understand and describe the mechanisms beyond the macroscopic failure
- Suggest testing methodologies to analyze and understand the root cause of a specific failure.
- Determine the root cause(s) and recommend corrective actions.

General Competences

- Working independently.
- Decision making
- Team work
- Search analysis and synthesis of collected data and information

SYLLABUS

The course is focused on the failure analysis of mechanical engineering components and structures. Main failure mechanisms are reviewed and analyzed. The course is based on two pillars: Lectures and laboratory classes on a weekly basis.

1. Mechanisms, causes and analysis of failures.
   - Introduction
   - Overview of failure mechanisms
   - Causes of failures
   - Methodology of failure analysis
2. Corrosion failures:
   - Uniform corrosion,
   - Galvanic corrosion,
   - Pitting, crevice,
   - Selective corrosion
   - Stress corrosion cracking
   - Hydrogen embrittlement
3. High Temperature Failures:
   - Oxidation
   - Carburization
   - Metal dusting
   - Thermal Shock
   - Sulfidation
   - Fuel Ash corrosion
4. Mechanical Failures:
   - Creep
   - Fatigue
   - Wear
   - Plastic deformation
   - Brittle fracture
   - Corrosion Fatigue
5. Effects on engineering design.
   - Design to optimize resistance to: fatigue, creep, corrosion

Laboratories:

1. Example of failure due to Galvanic Corrosion.
2. Example of failure due to Pitting Corrosion.
3. Example of failure due to Crevice Corrosion.
4. Example of failure due to Stress Corrosion Cracking.
5. Example of failure due to Hydrogen Embrittlement.
6. Example of failure due to Hot Corrosion.
7. Example of failure due to Thermal Shock.
8. Example of failure due to Sulphidation.
9. Example of fatigue failure. Laboratory analysis.
10. Example of failure due to brittle fracture.
11. Example of Creep Failure. Basic Creep Calculations.

TEACHING and LEARNING METHODS - EVALUATION

DELIVERY ***Face-to-face, Distance learning, etc.***	Face-to face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY	Parts of the course material are presented using ICT Course support material is provided through the UTH e-Class online platform, Search for case studies online

Use of ICT in teaching, laboratory education, communication with students	
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non- directed study according to the principles of the ECTS*	<table><tr><th>*Activity*</th><th>*Semester workload*</th></tr><tr><td>Lectures</td><td>70h</td></tr><tr><td>Laboratory Exercises</td><td>35h</td></tr><tr><td>Exercises</td><td>45h</td></tr><tr><td>***Total***</td><td>***150h***</td></tr></table>
STUDENT PERFORMANCE EVALUATION ***Description of the evaluation procedure*** *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open- ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	Language of evaluation: Greek Methods of evaluation: Student assessment is based on a set of written individual assignments (30%), a set of laboratory individual assignments (20%) and a written final exam (50%).

ATTACHED BIBLIOGRAPHY

-Suggested bibliography:

- *G .N. Haidemenopoulos, A. D. Zervaki, Failures Of Mechanical Components and Construction, Tziolas, 2024. (in Greek)*
- *D.R.H. Jones, Engineering Materials 3 - Failure analysis, Pergamon Press, 1993.*
- *D. Wulpi, Understanding How Components Fail, ASM, 1999.*
- *A. K. Das, Metallurgy of failure analysis, Mc Graw-Hill,1996.*
- *D. Broek, The practical Use of Fracture Mechanics, Kluwer Academic Press, 1988.*
- *J. Knott, P. Whithey, Fracture Mechanics. Worked Examples, IOM, 1979.*
- *A. Shukla, Practical Fracture Mechanics in Design, Second Edition, Taylor and Francis,2004.*
- *J. A. Collins, Failure of Materials in Mechanical Design: Analysis, Prediction, Prevention, Wiley-Interscience, 2007.*
- *V. J. Colangelo and F. A. Heiser, Analysis of Metallurgical Failures, John Wiley & Sons, 1987.*
- *A. J. McEvily, Metal Failures: Mechanisms, Analysis, Prevention, Wiley-Interscience, 2001.*

Handbooks

- *ASM Handbook, 9th edition, Vol.11 Failure Analysis and Prevention, ASM, 2002 International,*

Materials Park, OH, USA, 1986.

- *Handbook of Case Histories in Failure Analysis, Vol.1 and 2, ASM, 1992*

CD-ROMs

- *Failure Analysis Library, ASM International, 2000*

Internet Site

- *ASM Failure Analysis Center Online, www.asminternational.org/materialsinfo*

-Suggested bibliography:

- *Journal of Failure analysis and prevention, Editor: McIntyre R. Louthan Jr., ASM, ISSN 1547-7029*
- *Engineering Failure analysis, Elsevier, Editor D.R.H. Jones, ISSN 1350-6307*
- *Case Studies in Engineering Failure Analysis, ISSN2213-2902*