COURSE OUTLINE

1. GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MINERAL RESOURCES ENGINEERING		
LEVEL OF STUDIES	*Undergraduate*		
COURSE CODE	MRE893	**SEMESTER**	8th
COURSE TITLE	Failure Analysis / Forensic Engineering		

INDEPENDENT TEACHING ACTIVITIES	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures	2	5
Laboratory or Tutorials	2	
Overall	4	

COURSE TYPE	Special background -Scientific Area
PREREQUISITE COURSES:	Mechanics - Structures (MRE204) Mechanics - Strength of Materials (MRE302) Steel Structures Design (MRE502) Geotechnical and Soil Mechanics (MRE401) Retaining and Support of Surface & Underground Excavations (MRE811)
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE WEBSITE (URL)	

2. LEARNING OUTCOMES

Learning outcomes

The course deals with the failures of structural elements and structures in minerals resources engineering projects. The most common failure mechanisms are analyzed and the main causes of failures are examined. The methodologies used for failure analysis are also presented. It is supported by a weekly laboratory exercise where the student comes in contact with real case studies of failures from the Greek Mining Industry as well as the international literature. It is also called upon to carry out a specific failure study individually. The case studies come from the studies that have been carried out by the Mining Industry in recent years.

The learning outcomes of the course that students will gain after the successful completion of the course are: Understanding of basic concepts for the meaning and implications of risk, Learning, practicing and using quantitative methods to identify, evaluate and manage failures, hazards and risks in projects, processes, products, services, etc., Understanding the theory of expectation, Understanding the concept of crisis, Crisis management methods, Practical training of students in failures and risk management in multiple fields, as well as in crisis management issues.

Upon successful completion of the course students will have the ability to:

- Recognize the limits of performance and failure.
- Understand basic failure mechanisms.
- Recognize key features of failures.
- Recognize and classify the probability of failure.
- Synthesize & evaluate findings within a project failure investigative process.
- Prepare documented failure investigation reports.
- Describe the main causes of hazards, risks and failures.
- Use basic laboratory methods for characterizing materials.
- Design measures (design / production) to avoid failures.

General Competences

Decision-making. Researching, Analyzing & Synthesizing Data & Information using necessary technologies. Application of optimization methods and technologies. Selection and evaluation of business operations management tools. Promoting free, creative and inductive thinking. Working independently, Working in groups (Teamworking).

3. SYLLABUS

Theory: Introduction. Definition of performance and failure. Cause-effect analysis. Failure investigation process: collection-synthesis, analysis and evaluation of findings. Failure case study. Legislation-writing up of a technical expertise report.

Tutorial exercises: Through a case study, all stages of the process and investigation of a failed project are examined.

More details:
The mechanisms, causes and analysis of failures.

- ✓ Introduction
- ✓ Failure mechanisms
- ✓ The main causes of failure
- ✓ The methodology of failure analysis

Corrosion Failures

- ✓ Uniform corrosion
- ✓ Schismatic corrosion
- ✓ Selective corrosion
- ✓ Cavitation
- ✓ Mechanical corrosion
- ✓ Erosion
- ✓ Hydrogen vaporization

Failures at high temperatures

- ✓ Oxidation
- ✓ Carbonation
- ✓ Metal powdering
- ✓ Corrosion from combustion products
- ✓ Sulfidation
- ✓ Thermal shock

Mechanical failures

- ✓ Failure of Slopes and Underground Openings
- ✓ Failure of supports and retaining wall systems
- ✓ Fatigue of steel elements
- ✓ Damage to steel elements and infrastructure
- ✓ Creep of structural supporting elements
- ✓ Fragile fracture and Plastic deformation of support-supporting structural elements
- ✓ Impacts on the mechanical design of the mines
- ✓ Design for optimization of resistance to: fatigue, creep, corrosion, disintegration, weathering, erosion.

4. TEACHING and LEARNING METHODS - EVALUATION

DELIVERY	In the classroom and in the laboratory (Face-to-face). Webinars. Tutorials. Laboratory demonstrations. Possibility of distance lectures if required via Zoom Cloud Meeting.
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY	Presentation of lectures using PC (presentations, experimental videos, etc.). Support of learning process through the electronic platform eLearning and electronic communication with students (Online announcements and comments, forum, email etc.). Self-assessment questionnaires in the eLearning environment of the course and asynchronous training platform - eclass. Assistance in completing assignments through result files for each individual student.
TEACHING METHODS	

Activity	***Semester Workload***
Lectures	60
Tutorial - exercise solutions integrated in lectures	20

	Individual assignments on laboratory exercises & theory (Coursework) and application exercises	20
	Independent Home Study	
	Overall Course Set (20 hours of workload per credit unit)	***100***

STUDENT PERFORMANCE EVALUATION	• Written final exam: Theory 50% -Exercises 50%, • Laboratory: Individual work 100%.

5. SUGGESTED BIBLIOGRAPHY

- Carper LK Forensic Engineering. 2nd ed. CRC Press, 2001. Noon LR Forensic Engineering Investigation. CRC Press.2001.
- Franck H., Franck D. Forensic Engineering Fundamentals. CRC Press 2013.
- Shuirman G., Slosson J. Forensic Engineering: Environmental Case histories for civil engineers and geologists. Elsevier, 1992.
- Project Risk Management Manual, K. Kiryttopoulos, Ed. Key number
- Risk Analysis: A Quantitative Guide, David Vose, 2000, John Wiley.
- Risk Management, C. Chapman, S. Ward, published by Epikentro.
- G.N. Haidemenopoulos, AD Zervaki, Material Failures: Case studies from the Greek Industry, Materials Laboratory Notes, Univ. Thessaly.
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- 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.
- Journal of Failure analysis and prevention, Editor: McIntyre R. Louthan Jr., ASM, ISSN 1547-7029
- Engineering Failure analysis, Elsevier, Editor DRH Jones, ISSN 1350-6307.