Course guide
340661 - EFFI - Forensic Engineering and Industrial Reliability

Last modified: 17/05/2023

Unit in charge: Vilanova i la Geltrú School of Engineering
Teaching unit: 702 - CEM - Department of Materials Science and Engineering.

Degree: BACHELOR'S DEGREE IN INDUSTRIAL DESIGN AND PRODUCT DEVELOPMENT ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Optional subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish, English

LECTURER

Coordinating lecturer: ENRIQUE MARTIN FUENTES

Others: ENRIC MARTIN - TEO MUNIATEGUI - SANTI MESTRES

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. CE25. Knowledge and ability to apply material engineering.
2. CE14. Knowledge and application of basics of material resistance.
3. CE23. Knowledge and ability to calculate and design structures and industrial constructions.

Transversal:
5. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.
6. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 3. Communicating clearly and efficiently in oral and written presentations. Adapting to audiences and communication aims by using suitable strategies and means.
7. EFFECTIVE USE OF INFORMATI0N RESOURCES - Level 3. Planning and using the information necessary for an academic assignment (a final thesis, for example) based on a critical appraisal of the information resources used.

TEACHING METHODOLOGY

Attending sessions of exposition of contents.
- Attending sessions of practical work (resolution of exercises).
- Attending sessions of practical work in working groups (practices of laboratory).
In the content presentation sessions, the teacher will introduce the theoretical bases of the subject.
In the real case analysis and presentation sessions, students will present real cases of accidents about the different causes that can cause them. The teacher will guide the student in the understanding of the theoretical concepts; also, the oral communication will be worked through the presentation and public discussion of the proposed works.
In the laboratory sessions the competence of teamwork will be developed.
In the out-class activities, the professor supervises the student’s work by means of the analysis of their evolution through the evaluation acts and the guided activities.

The professor will introduce the theoretic bases of the matter of the manufacturing processes in the sessions of exposition of contents.
The professor will guide the student in the understanding of the theoretic concepts in the sessions of resolution of exercises, likewise, the oral communication by means of the presentation will be worked up and resolution in public of the proposed problems.
The ability of work in team will develop in the sessions of laboratory.

In the out-class activities the professor supervises the student's work by means of the analysis of his evolution through the evaluation activity and the guided activities.

LEARNING OBJECTIVES OF THE SUBJECT

1. Ensure better and more responsible engineering
2. Applying design criteria in order to ensure the mechanical reliability of products and systems.
3. Identifying the possible causes of failures of a component, in terms of the in service environment.
4. Offering solutions to avoid the failure of components.
5. Analyzing and applying the methodology of application of nondestructive testing

STUDY LOAD

Type	Hours	Percentage
Hours small group	15,0	10.00
Hours large group	45,0	30.00
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

1. Fundamentals of forensic engineering

Description:
Legal Systems. Fundamentals of forensic practices. Products liability. Accidents analysis techniques. Documentation.

Full-or-part-time: 3h
Theory classes: 2h
Guided activities: 1h

(ENG) 2. Mechanical failures

Description:
(ENG) Mechanical Failures: prevention and/or analysis?. Failure modes: ductile fracture and brittle fracture

Full-or-part-time: 4h
Theory classes: 2h
Guided activities: 2h

(ENG) 3. Fracture mechanics

Description:
(ENG) Fracture mechanics: Fracture toughness. Metallurgical variables

Full-or-part-time: 6h
Theory classes: 2h
Guided activities: 4h

(ENG) 4. Fatigue design

Description:
(ENG) Fatigue design: cyclic loadings. Crack initiation and growth. Total-life approaches and damage-tolerant approaches.

Full-or-part-time: 6h
Theory classes: 2h
Guided activities: 4h

(ENG) 5. Design for high temperature

Description:
(ENG) . Creep: Alloys for high temperatures. Thermal shock.

Full-or-part-time: 4h
Theory classes: 2h
Guided activities: 2h

6. Analysis and Interpretation of Fire Scene Evidence

Description:
Fire Dynamics. Fire Scene Investigation. Approach to Fire Debris Analysis.

Full-or-part-time: 4h 30m
Theory classes: 2h
Guided activities: 2h 30m

(ENG) 7. Wear

Description:
(ENG) 12.1 Wear: wear mechanisms. 12.2 Effects of lubrication and metallurgical variables.

Full-or-part-time: 2h
Theory classes: 1h
Guided activities: 1h

(ENG) 8. Materials degradation

Description:
(ENG) 13.1 Materials degradation: Electrochemical basis of corrosion. 13.2 Corrosion modes. Corrosion control. 13.3 Photochemical degradation

Full-or-part-time: 6h 30m
Theory classes: 2h
Laboratory classes: 2h
Guided activities: 2h 30m

(ENG) 9. Nondestructive testing and industrial reliability

Description:
(ENG) Nondestructive Testing: Applicability. Reliability. Qualification and Certification

Full-or-part-time: 1h 30m
Theory classes: 1h
Guided activities: 0h 30m

(ENG) 10. Penetrant testing

Description:
(ENG) 2.1 Penetrant Testing: Theory and principles. 2.2 Penetrant procedures. 2.3 Techniques and variables. 2.4 Advantages and limitations.

Full-or-part-time: 0h 30m
Theory classes: 0h 30m

(ENG) 11. Magnetic particles testing

Description:
(ENG) 3.1 Magnetic particle testing: Theory and principles. 3.2 Equipment and techniques. 3.3 Variables. 3.4 Advantages and limitations.

Full-or-part-time: 2h
Theory classes: 1h
Laboratory classes: 1h

(ENG) 12. Ultrasonic testing

Description:
(ENG) Theory and principles: sound waves. Ultrasonic Wave Propagation: Transmission and damping. Equipment and techniques. Variables. Advantages and limitations.

Full-or-part-time: 4h
Theory classes: 2h
Laboratory classes: 2h

(ENG) 13. Eddy currents testing

Description:
(ENG) Eddy currents testing: Theory and principles (electromagnetic induction). Impedance of samples. Metallurgical variables. Inspection techniques. Advantages and limitations.

Full-or-part-time: 5h
Theory classes: 2h
Laboratory classes: 3h

(ENG) 14. Radiographic Testing

Description:
(ENG) Electromagnetic spectrum. Sources of emissions. Damping of radiations. Radiographic equipment and procedures. Radiographic evaluation. Biological Effects: safety considerations and health hazard

Full-or-part-time: 3h
Theory classes: 2h
Guided activities: 1h

(ENG) 14.Other Nondestructive testing techniques

Description:
(ENG) Thermal infrared testing. Visual inspection

Full-or-part-time: 1h
Theory classes: 1h

GRADING SYSTEM

The evaluation of the course will become according to the following indicators:

T, Theory: weighted average of questionnaires, PT1 (30%), and practical work (presentations) on a real case, PT2 (70%).
The evaluation of the presentations will be done with 40% by the teacher and 60% by the rest of the students. It is compulsory to evaluate at least 75% of the presentations, and to intervene with questions in at least 40% of the students' presentations,
L, Laboratory Practice: Weighted average of the different programmed practices.

Final grade = 0,75T+ 0,25L

Given the evaluation character of the subject, laboratory practices, tests carried out via Digital Campus or activities carried out in the classroom in the ordinary period of classes (problems and / or presentations of works) are not considered re-evaluable. Only the part of (PT1) is considered re-evaluable.

The completion and presentation of the corresponding reports of at least 75% of the laboratory practices will be a necessary condition for the approval of the subject. It will also be a necessary condition to have participated in, at least, 75% of the presentations made in the classroom and to have made the evaluations of them.

BIBLIOGRAPHY

Basic:
- Noon, Randal K. Scientific method: application in failure investigation and forensic science [on line]. Boca Ratón: CRC Press, Taylor & Francis Group, 2009 [Consultation: 20/02/2024]. Available on: https://www-taylorfrancis-com.recursos.biblioteca.upc.edu/books/edit/10.4324/9780367802929/scientific-method-randall-noon. ISBN 9781420092806.
- Ensayos no destructivos [Recurs electrònic]. Madrid: AENOR, 2010. ISBN 9788481437126.
- Hellier, Charles J. Handbook of nondestructive evaluation. 3rd ed. New York: McGraw-Hill Education, 2020. ISBN 9781260441437.
- Hertzberg, Richard W. Deformation and fracture mechanics of engineering materials [on line]. 5th ed. New York [etc.]: John Wiley & Sons, 2013 [Consultation: 14/12/2022]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=2064702. ISBN 9780470527801.
- Rösler, Joachim; Harders, H.; Bäker, M. Mechanical behaviour of engineering materials [on line]. Berlin ; New York: Springer, 2007 [Consultation: 06/04/2022]. Available on: https://link.springer.com/book/10.1007/978-3-540-73448-2. ISBN 9783540734468.
- Mix, Paul E. Introduction to nondestructive testing : a training guide [on line]. 2nd ed. Hoboken: John Wiley & Sons, 2005 [Consultation: 15/02/2024]. Available on: https://onlinelibrary-wiley-com.recursos.biblioteca.upc.edu/doi/book/10.1002/0471719145. ISBN 9780471420293.
- Kardon, Joshua B. Guidelines for forensic engineering practice [on line]. 2nd ed. Reston, Virginia: American Society of Civil Engineers, 2012 [Consultation: 23/03/2022]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=3115626. ISBN 9780784476963.

Complementary:
- ASM handbook. Vol. 11, Failure analysis and prevention. Materials Park, Ohio: ASM International, 2002. ISBN 9780871707048.
- Ashby, M. F.; Shercliff, Hugh; Cebon, David. Materials : engineering, science, processing and design. 3rd ed. Oxford : Butterworth-Heinemann ; Amsterdam [etc.]: Elsevier, 2014. ISBN 9780080977737.
- ASM handbook. Vol. 17, Nondestructive evaluation and quality control. Materials Park, Ohio: ASM International, 2005. ISBN 0871700239.
- Kienzler, Reinhold; Herrmann, George. Mechanics in material space : with applications to defect and fracture mechanics. Berlin: Springer, 2000. ISBN 3540669655.

RESOURCES

Hyperlink:
- National Academy of Forensic Engineers (NAFE). https://www.nafe.org/- AEND, Asociación Española de Ensayos No Destructivos . https://www.aend.org/- Forensic Engineering. https://www.asce.org/forensic-engineering/forensic-engineering/- Journal of Nondestructive Testing (Ofereix articles en línia). http://www.ndt.net/v03n12.htm- ASNT (American Society for Nondestructive Testing). http://www.asnt.org/- Engineering Failure Analysis. http://www.sciencedirect.com/science/journal/13506307