

## 220037 - Learning From Mechanical Failure in Engineering

Coordinating unit:	205 - ESEIAAT - Terrassa School of Industrial, Aerospace and Audiovisual Engineering		
Teaching unit:	737 - RMEE - Department of Strength of Materials and Structural Engineering		
Academic year:	2019		
Degree:	BACHELOR'S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Teaching unit Optional) BACHELOR'S DEGREE IN AEROSPACE TECHNOLOGY ENGINEERING (Syllabus 2010). (Teaching unit Optional) BACHELOR'S DEGREE IN AEROSPACE VEHICLE ENGINEERING (Syllabus 2010). (Teaching unit Optional)		
ECTS credits:	3	Teaching languages:	English

### Teaching staff

Coordinator:	LLUIS GIL ESPERT
Others:	LLUIS GIL ESPERT

### Degree competences to which the subject contributes

#### Transversal:

3. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

### Teaching methodology

The course consists of 30 hours and over 45 hours of autonomous learning activities. In the classroom:

- Developing the theory of the subject and examples
- Practical activities related with the theory in class
- Oral presentations of Activity
- Final session of the Activity 2

The autonomous learning hours will be used for the preparation of activities 1 and 2. The teachers provide the curriculum and monitoring of activities (by ATENEA).

### Learning objectives of the subject

The object of engineering design is to anticipate failure and to design against it. This is achieved by understanding how much load an structure might carry without breaking. Nevertheless, engineers continuously develop new technological challenges and few of them sometimes drive to a tragic collapse. The objective of the subject is to introduce students to forensic engineering. The analysis of failures of engineering designs is an opportunity to learn practical concepts of mechanics. The investigation of failures requires the ability of crossing knowledge, searching information, choosing the relevant facts and fostering the critical point of view of engineering solutions. Moreover, failures covers a wide variety of crafts: aircrafts, spacecrafts, marine vessels, bridges, buildings and dams. Therefore it is interesting for aeronautic as well as mechanical engineers.

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

- To discuss professional ethics and the importance of errors in engineering
- Recognize the causes and technical problems associated with structural failures of a collection of historical disasters studied in class
- Have a practical training on how to deal with failures from the different involved agents.

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### Study load

Total learning time: 75h	Hours large group:	30h	40.00%
	Self study:	45h	60.00%

### Content

Module 1: Engineering disasters and failures	Learning time: 36h 30m Theory classes: 14h Self study : 22h 30m
<p>Description:</p> <ul style="list-style-type: none"> <li>- Introduction to the engineering practice and safety in engineering</li> <li>- Failures and defects in engineering</li> <li>- Theoretical Approach to the structural failure: elasticity, elastic instability, plasticity and fracture mechanics</li> <li>- Forensic Engineering and analysis of failures</li> <li>- Historical Engineering Failures</li> </ul> <p>Related activities:</p> <ul style="list-style-type: none"> <li>- Theoretical sessions by the teacher</li> <li>- Activities in class</li> <li>- Activity 1</li> </ul>	
Module 2: Practical engineering Failure	Learning time: 38h 30m Theory classes: 16h Self study : 22h 30m
<p>Description:</p> <ul style="list-style-type: none"> <li>- Microscopic and Macroscopic Methods to examine the fracture</li> <li>- Laboratory testing: chemical, mechanical and non-destructive tests</li> <li>- Investigation process in engineering failure</li> <li>- Write reports of engineering failures</li> </ul> <p>Related activities:</p> <ul style="list-style-type: none"> <li>- Theoretical sessions by the teacher</li> <li>- Activities in class</li> <li>- Activity 2</li> </ul>	

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### Planning of activities

<b>ACTIVITY 1: HISTORICAL ENGINEERING FAILURES</b>	Hours: 26h 30m Guided activities: 4h Self study: 22h 30m
<p><b>Description:</b>          Students, in groups, must search for information about historical engineering failures in the web or in the literature, synthesize the information and present it orally to their classmates. Students must propose an appropriate disaster to study or the teacher can propose a list of some historical engineering failures. The case proposed will be accepted by the teacher. The study should be approached from the technical point of view and the human considering: What failed / Why it failed / Possible corrective actions (How to make it not fail) / who was guilty at fault, and why</p> <p><b>Support materials:</b>          The teacher will have a list of Engineering failures</p> <p><b>Descriptions of the assignments due and their relation to the assessment:</b>          An oral presentation where the following generic competencies will be evaluated: autonomous learning, oral expression, working in group and English. All the students must evaluate the work and the skills of every group using an academic rubric.          The oral presentation should be about 20 minutes with 10 minutes extra to answer questions from the teacher and the other students. The students will use an academic rubric to evaluate the work presented (including English and oral skills).</p> <p>The mark of the activity is obtained from the following inputs:          PERCENT EVIDENCE EVALUATOR          40 % Information and activity of the wiki in MOODLE Teacher          40 % Oral presentation Students from the other groups          20 % Oral presentation Students from the own group</p> <p><b>Specific objectives:</b></p> <ul style="list-style-type: none"> <li>- Search and find autonomously information available online and/or in books about historical disasters</li> <li>- Know the technical and human aspects of the failure of several historical engineering failures</li> <li>- Synthesize the information found and do an oral presentation of the contents</li> <li>- Teamwork using wikis</li> </ul>	
<b>ACTIVITY 2: PRACTICAL ENGINEERING FAILURE</b>	Hours: 26h 30m Guided activities: 4h Self study: 22h 30m
<p><b>Description:</b>          Students must deal with a real failure situation. When a failure happens there are several agents involved. All of them play different roles according their personal interest. The students must assume the role of one of the agents and try to visualize the failure from their point of view. Students must defend his company in front of other agents. In this activity students must perform a kind-of trial around a claim.          Teachers play the role of judges of the court. The teacher will distribute some information to the groups in the beginning. Students must start to investigate about the failure and produce calculations, find information, create hypothesis, etc. in order to achieve his objective. Finally, all the groups must present their research in a kind of final judgment. Every agent must do an oral presentation about the failure and their position. There are two different claims. Every claim is covered by 4 agents (an agent is a group of 4/5 students): two parts, an independent expert and providers.</p>	

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### Support materials:

The teacher will have information (several reports) about the failure case.

### Descriptions of the assignments due and their relation to the assessment:

The day of the trial, each part will prepare an oral presentation of 15 minutes about the failure and their position. After all the presentations, the discussion starts where all the agents will try to convince the others.

All the students must evaluate the work and the skills of the groups of the other claim using an academic rubric ((including English and oral skills).

The mark of the activity is obtained from the following inputs:

#### PERCENT EVIDENCE EVALUATOR

75 % Oral presentation Students from the other groups

25 % Oral presentation Students from the own group

### Specific objectives:

- Formulate hypothesis about causes of disasters
- Defend their point of view and try to support it with scientific reasoning
- Know the technical and human aspects of the failure
- Synthesize the information found and do an oral presentation of the contents
- Teamwork

<b>ACTIVITIES IN CLASS</b>	Hours: 1h Theory classes: 1h
<p>Description: Activities related to the content of the theoretical session to do individually or in groups after some of the theoretical sessions</p> <p>Descriptions of the assignments due and their relation to the assessment: the resolution of the activity. The teacher will correct it</p>	

### Qualification system

The final grade depends on the following assessment criteria:

- Activity 1 (Historical Engineering Failures), weight: 30 %
- Activity 2 (Invited lectures), weight: 30 %
- Activity 3 (Cliams), weight: 40 %

### Regulations for carrying out activities

The two activities are mandatory to pass the subject.

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### Bibliography

#### Complementary:

- Petroski, Henry. To engineer is human: the role of failure in successful design. New York: Vintage Books, 1992. ISBN 0679734163.
- Gordon, J.E. Structures or why things don't fall down. 2nd ed. New York: Da Capo Press, 2003. ISBN 9780306812835.
- Godfrey, Edward. Engineering failures and their lessons. Charleston: Nabu, 2011. ISBN 9781178529791.
- Harland, Edward. Space systems failures: disasters and rescues of satellites, rockets and space probes. Berlin: Springer, 2005. ISBN 9780387215198.
- Reddy, A. Venugopal. Investigation of aeronautical and engineering component failures. Boca Raton: CRC Press, 2004. ISBN 0849323142.
- Campbell, Peter. Learning from construction failures: applied forensic engineering. Scotland: Whittles, 2001. ISBN 187032563X.
- Ross, Bob. Investigating mechanical failures: the metallurgist's approach. London: Chapman & Hall, 1995. ISBN 0412549204.
- Shepherd, R.; Frost, J. David. Failures in civil engineering: structural, foundation and geoenvironmental case studies. New York: American Society of Civil Engineers, 1995. ISBN 0784401225.