The object of engineering design is to anticipate failure and to design against it. This is achieved by understanding how much load a 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 cover a wide variety of crafts: aircrafts, spacecrafts, marine vessels, bridges, buildings and dams. Therefore it is interesting for aeronautical 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.
# 220037 - Learning From Mechanical Failure in Engineering

## Study load

<table>
<thead>
<tr>
<th>Total learning time: 75h</th>
<th>Hours large group: 30h</th>
<th>40.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Self study: 45h</td>
<td>60.00%</td>
</tr>
</tbody>
</table>

## Content

### Module 1: Engineering disasters and failures

**Learning time:** 36h 30m  
- Theory classes: 14h  
- Self study: 22h 30m

**Description:**
- Introduction to the engineering practice and safety in engineering  
- Failures and defects in engineering  
- Theoretical Approach to the structural failure: elasticity, elastic instability, plasticity and fracture mechanics  
- Forensic Engineering and analysis of failures  
- Historical Engineering Failures

**Related activities:**
- Theoretical sessions by the teacher  
- Activities in class  
- Activity 1

### Module 2: Practical engineering Failure

**Learning time:** 38h 30m  
- Theory classes: 16h  
- Self study: 22h 30m

**Description:**
- Microscopic and Macroscopic Methods to examine the fracture  
- Laboratory testing: chemical, mechanical and non-destructive tests  
- Investigation process in engineering failure  
- Write reports of engineering failures

**Related activities:**
- Theoretical sessions by the teacher  
- Activities in class  
- Activity 2
Planning of activities

**ACTIVITY 1: HISTORICAL ENGINEERING FAILURES**

<table>
<thead>
<tr>
<th>Description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>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</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Support materials:</th>
</tr>
</thead>
<tbody>
<tr>
<td>The teacher will have a list of Engineering failures</td>
</tr>
</tbody>
</table>

**Descriptions of the assignments due and their relation to the assessment:**
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).

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

**Specific objectives:**
- Search and find autonomously information available online and/or in books about historical disasters
- Know the technical and human aspects of the failure of several historical engineering failures
- Synthesize the information found and do an oral presentation of the contents
- Teamwork using wikis

**ACTIVITY 2: PRACTICAL ENGINEERING FAILURE**

<table>
<thead>
<tr>
<th>Description:</th>
</tr>
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<tbody>
<tr>
<td>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.</td>
</tr>
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</table>

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**Descriptions of the assignments due and their relation to the assessment:**
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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).

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
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

ACTIVITIES IN CLASS

<table>
<thead>
<tr>
<th>Description:</th>
<th>Hours: 1h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 1h</td>
<td></td>
</tr>
</tbody>
</table>

| Descriptions of the assignments due and their relation to the assessment: | |
| the resolution of the activity. |
| The teacher will correct it |

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 (Claims), weight: 40 %

Regulations for carrying out activities

The two activities are mandatory to pass the subject.
Bibliography

Complementary:


