820430 - DIMA - Machine Design

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering
Teaching unit: 712 - EM - Department of Mechanical Engineering
Academic year: 2019
Degree: BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
ECTS credits: 6
Teaching languages: Catalan, Spanish

Teaching staff
Coordinator: PEDRO ORTIZ MORÓN
Others: Pedro Ortiz, Javier Alonso, Rubén Arroyo, Eduard Calduch, Arnau Velasco

Opening hours
Timetable: Personal attention to students will be made by agreeing appointment with the teacher by mail.

Requirements
CINEMÀTICA I DINÀMICA DE MÀQUINES - Prerequisite
RESISTÈNCIA DE MATERIALS - Prerequisite

Degree competences to which the subject contributes
Specific:
CEMEC-20. Calculate the characteristics of, design and test machines.

Transversal:
04 COE N3. 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.

Teaching methodology
The subject uses the expository methodology and study by case, with a presentation of each theoretical topic accompanied by comments that encourage adequate and comprehensive understanding of the concepts. On the other hand, problems representative of the contents in the classroom will be solved and students will be made available the problems, solved problems and diverse material for autonomous study.

Learning objectives of the subject
1. Learn the basics of machine design. 2. To enable the student to develop design algorithms that allow the calculation and design of machine components. 3. Develop skills in experimental techniques and results analysis. 4. Develop an awareness of design safety and the importance of the use of standards and codes. 5. Familiarity with the use of advanced computational techniques in solving computational problems of mechanical elements. 6. Develop modeling capabilities. 7. Promote independent learning through observation by the student of mechanical systems that surround it, and his mental abstraction useful models for the mechanical calculation. 8. Promote critical thinking and intuitive interpretation of the results obtained through calculations. 9. Purchase orders of magnitude of common physical properties.
## Study load

<table>
<thead>
<tr>
<th></th>
<th>Hours large group:</th>
<th>Hours medium group:</th>
<th>Hours small group:</th>
<th>Guided activities:</th>
<th>Self study:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total learning time:</strong></td>
<td>150h</td>
<td>45h</td>
<td>0h</td>
<td>15h</td>
<td>90h</td>
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<td>30.00%</td>
<td>0.00%</td>
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</tbody>
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**Study load:**

- **Total learning time:** 150h
- **Hours large group:** 45h (30.00%)
- **Hours medium group:** 0h (0.00%)
- **Hours small group:** 15h (10.00%)
- **Guided activities:** 0h (0.00%)
- **Self study:** 90h (60.00%)
## 1. Introduction to the design of machines

**Description:**
1.1 Design in mechanical engineering.
1.2 Relation of the subjects of the degree in relation to Machine Design.
1.3 Design considerations.
1.4 Materials in the mechanical design.

**Learning time:** 6h
- Theory classes: 3h
- Self study: 3h

## 2. Constant load. Static

**Description:**
2.1 Analysis of solicitations. Free solid diagram. Reactions
2.2 Simple efforts in machine elements: cutting, traction / compression, bending, torsion.
2.3 Resistant design. Static safety factor.
2.4 Main tensions. Circle of Mohr.
2.5 Static fault theories. Equivalent voltage of Von Mises - Hencky.

**Learning time:** 15h
- Theory classes: 6h
- Laboratory classes: 3h
- Self study: 6h

## 3. Brittle / Ductile

**Description:**
3.1 Brittle material - ductile material.
3.2 Brittle fracture - ductile fracture.

**Learning time:** 2h
- Theory classes: 1h
- Self study: 1h
## 4 - STRESS CONCENTRATION

**Learning time:** 2h  
Theory classes: 1h  
Self study: 1h

**Description:**  
4.1 Description of the stress concentration phenomenon.  
4.2 Tables of stress concentration factors.  
4.3 Effect on resistant elements depending on the static or variable character of the load and the brittle / ductile behaviour of the material.

## 5 - VARIABLE LOADS. FATIGUE

**Learning time:** 24h  
Theory classes: 7h  
Laboratory classes: 3h  
Self study: 14h

**Description:**  
5.1 Fatigue of the materials. Introduction to the phenomenon and mechanism of fatigue failure.  
5.2 Recent accidents caused by fatigue.  
5.3 Expression of a variable load cycle in medium component and amplitude component.  
5.4 Rotating bending test. Wöhler diagram for the specimen.  
5.5 Materials with endurance limit and materials with fatigue strength.  
5.6 Correction of the Wöhler diagram: endurance limit modifying factors.  
5.7 Influence of the mean stresses in uniaxial fatigue.  
5.8 Söderberg diagram. Description, equations and use in the resolution of cases of uniaxial fatigue with medium tensions.  
5.9 Security factor to infinite life. Safety factor to life N cycles.

## 6 - DESIGN OF ELEMENTS OF MACHINES SUBMITTED TO VARIABLE LOADS

**Learning time:** 29h  
Theory classes: 6h  
Self study: 23h

**Description:**  
Application of the tools exposed in the previous topics in different cases of resistant elements submitted to variable loads.  
These cases have been selected seeking to show different typologies, both in the type of machine element solved, and in the variability of the loads applied.
# 7 - MECHANICAL TRANSMISSIONS

**Description:**
- 7.1 Definition.
- 7.2 Principles of operation.
- 7.3 Comparative characteristics according to the operating principle.
- 7.4 Functions of mechanical transmissions.
- 7.5 Some useful classifications in transmissions.
- 7.6 Descriptive exposition of mechanical transmission elements.
- 7.7 Transmission ratio.

**Learning time:** 11h
- Theory classes: 3h
- Laboratory classes: 3h
- Self study: 5h

# 8 - FORCES IN MECHANICAL TRANSMISSIONS THROUGH GEARS

**Description:**
- 8.1 Spur Gears.
  - 8.1.1 General.
  - 8.1.2 Geometric parameters in spur gears.
  - 8.1.3 Forces in transmissions with spur gears.
- 8.2 Helical gears.
  - 8.2.1 General.
  - 8.2.2 Geometrical parameters in helical gear.
  - 8.2.3 Forces in transmissions with helical gears.
  - 8.2.4 Compensation of the axial component.
  - 8.2.5 Effect of the axial component on the diagram of bending moments.

**Learning time:** 16h
- Theory classes: 5h
- Laboratory classes: 3h
- Self study: 8h

# 9 - FORCES IN MECHANICAL TRANSMISSIONS THROUGH BELTS AND CHAINS

**Description:**
- 9.1 Flat and trapezoidal belts.
- 9.2 General.
- 9.3 Geometric parameters in belt and chain transmissions.
- 9.4 Forces in transmissions with flat and trapezoidal belts.
- 9.4 Expression of Eytelwein, stress ratio, pretension.
- 9.5 Forces in transmissions with toothed belts and chains.

**Learning time:** 11h
- Theory classes: 3h
- Laboratory classes: 3h
- Self study: 5h
The qualification consists of the marks obtained in three evaluation acts: partial exam (EP), practice test (PR) and final exam (EF), with an initial weighting of 45%, 10% and 45% respectively.

In application of the concept of continuous evaluation, and taking into account the fact that the concepts demanded in the partial exam continue to be asked in the final exam, a second weighting is proposed that favors the students who have obtained a worse result in the first test, being this second weighting 25%, 10% and 65% respectively.

Thus the final grade of the subject is determined by the expression:

\[
DIMA\ NF = \text{MAX} \ [(0.45NEP + 0.10NPR + 0.45NEF); (0.25NEP + 0.10NPR + 0.65NEF)]
\]

This subject does not have the re-evaluation test planned.

To perform the tests, teachers will be given instructions in each case of what the material can be used and the rules for conducting them.
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Bibliography

Basic:


Complementary:


Others resources: