240141 - Machine and Mechanism Theory

Coordinating unit: 240 - ETSEIB - Barcelona School of Industrial Engineering
Teaching unit: 712 - EM - Department of Mechanical Engineering
Academic year: 2019
Degree: BACHELOR'S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN ENGINEERING PHYSICS (Syllabus 2011). (Teaching unit Optional)
ECTS credits: 6
Teaching languages: Catalan, Spanish

Teaching staff
Coordinator: Jordi Nebot, Lluisa
Others: Cabré Gimeno, Marc
Guzman Pérez, Ismael
Lores García, Eduard
Morera Roca, Roger
Puig Ortiz, Joan
Romanos Roca, David
Sararols Figueras, Miquel
Zayas Figueras, Enrique Ernesto

Degree competences to which the subject contributes
Specific:
1. Knowledge on machines and mechanisms theory principles.
2. Knowledge and capacities to calculate, design and test machines.
240141 - Machine and Mechanism Theory

**Teaching methodology**

The teaching load of the course is 6 ECTS; 5 of which are taught in slate lectures, theory and problems, in nominally groups of around 75 students; the remaining credit is taught in lab classes in groups of around 25 students.

In slate lectures, twice a week in 1h.40min, the basic theory concepts are exposed with the support of teaching material and a good number of examples. Exercises are presented, analysed and solved often inspired in real situations and are proposed to be done as personal work.

In lab classes, five during the semester and each two hours long, practices are carried out with material available in the Machines Lab, the program of analysis of machinery is introduced which is used in an exercise of simulation of mechanism.

The additional personal dedication to the slate and lab lectures is expected of 90 hours uniformly divided throughout the course but with slightly more emphasis on the last issues.

**Simulation exercise**

Is an exercise based in the cinematic and dynamic analysis of a mechanism of a mechanical system which is provided by the professors and it is developed during the course. To perform it some concepts must be taken into account:

- Must be performed in groups of 3 students
- The report must have a maximum length of 4 pages with a format that conforms the guidelines which can be found on the subject’s website.

**Practices**

- P1 Mechanism of a sewing machine. Schematization
- P2 Machinery elements. Analysis of various mechanisms.
- P3 Gear box and differential in an automobile
- P4 Simulation by computer of mechanisms. Mechanism analysis.
- P5 Simulation exercise

Practices are carried out in the Machinery Lab (Laboratori de Màquines). G Pavilion Floor -1.

**Learning objectives of the subject**

**General objectives**

- To integrate the Theory of Machines and Mechanisms in Engineering studies using prior knowledge taught in previous subjects, working the capabilities of engineering and making it attractive and useful for students, willing or not to opt for a mechanical profile.
- To sensitize the students about the relationship between technology and society by analyzing the role of machines in this binomial and the sustainability of the current model of human activity.

**Specific objectives**

- Doing the kinematic, static and dynamic analysis of the mechanisms and machines, from the concepts of rigid body mechanics and using the basic and operational tools.
- Using computer applications for the calculation and the simulation of mechanisms.
- Recognizing the mechanical components and basic mechanical groups of the machines and mechanisms from examples taken of real situations.
- Doing the energy balances and calculations of performance applied to the machines.
# 240141 - Machine and Mechanism Theory

## Study load

<table>
<thead>
<tr>
<th>Study load</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total learning time:</strong> 150h</td>
<td>50h</td>
<td>33.33%</td>
</tr>
<tr>
<td>Hours large group:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td>Hours medium group:</td>
<td>10h</td>
<td>6.67%</td>
</tr>
<tr>
<td>Hours small group:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td>Guided activities:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td>Self study:</td>
<td>90h</td>
<td>60.00%</td>
</tr>
</tbody>
</table>
## Content

<table>
<thead>
<tr>
<th>Machine and Mechanism Theory</th>
<th>Learning time: 10h 30m</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1 MACHINE AND MECHANISM</strong></td>
<td>Theory classes: 4h 30m</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 0h</td>
</tr>
<tr>
<td></td>
<td>Self study: 6h</td>
</tr>
</tbody>
</table>

**Description:**

**Related activities:**

<table>
<thead>
<tr>
<th>Mobility</th>
<th>Learning time: 13h 30m</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2 MOBILITY</strong></td>
<td>Theory classes: 5h 30m</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Self study: 6h</td>
</tr>
</tbody>
</table>

**Description:**

**Related activities:**
Practice 2: Elements of machines. Analysis of various mechanisms.

<table>
<thead>
<tr>
<th>Kinematics of Mechanisms</th>
<th>Learning time: 29h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3 KINEMATICS OF MECHANISMS</strong></td>
<td>Theory classes: 10h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 4h</td>
</tr>
<tr>
<td></td>
<td>Self study: 15h</td>
</tr>
</tbody>
</table>

**Description:**

**Related activities:**
Practice 3: Simulation of mechanism by computer. Analysis of a mechanism.
Tutoring session 1: Explanation of course project.
4 GEARS AND GEAR TRAINS

**Description:**

**Related activities:**
Practice 4: Gearbox and differential of a car.

<table>
<thead>
<tr>
<th>Learning time: 15h 30m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 4h 30m</td>
</tr>
<tr>
<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td>Self study : 9h</td>
</tr>
</tbody>
</table>

5 DYNAMIC ANALYSIS

**Description:**

**Related activities:**
Tutoring session 2: Analysis of the normalized representation of the chosen mechanism.

<table>
<thead>
<tr>
<th>Learning time: 18h 30m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 4h 30m</td>
</tr>
<tr>
<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td>Self study : 12h</td>
</tr>
</tbody>
</table>

6 CONTACT FORCE. CONSTRAINT FORCE. PASSIVE RESISTANCES

**Description:**

<table>
<thead>
<tr>
<th>Learning time: 16h</th>
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<tbody>
<tr>
<td>Theory classes: 7h</td>
</tr>
<tr>
<td>Self study : 9h</td>
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</tbody>
</table>
### 7 VIRTUAL POWER METHOD

**Description:**
Virtual power associated to a system of forces. Virtual Motions. Obtaining motion equations and constraint forces. Generalized forces.

**Related activities:**
Tutoring session 3: Presentation of results of the simulation of the studied mechanism.

**Learning time:** 22h
- Theory classes: 7h
- Laboratory classes: 0h
- Self study: 15h

### 8 WORK AND POWER IN MACHINES

**Description:**

**Learning time:** 25h
- Theory classes: 7h
- Self study: 18h
### Planning of activities

<table>
<thead>
<tr>
<th>SIMULATION EXERCISE</th>
<th>Hours: 5h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td></td>
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<tr>
<td>It is an exercise based on kinematic and dynamic analysis of a mechanism of a mechanical system that, in principle, will facilitate the teaching staff. For its realization it is necessary to keep in mind that:</td>
<td></td>
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</tbody>
</table>
| · It must be done in groups of 3 students.  
  · The report must have an extension of 3 pages in a format that conforms to the guidelines that can be found on the web page of the subject. |

<table>
<thead>
<tr>
<th>PARTIAL EXAM</th>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Assessment of knowledge.</td>
</tr>
<tr>
<td><strong>Descriptions of the assignments due and their relation to the assessment:</strong></td>
<td>Solved exam.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FINAL EXAM</th>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Assessment of knowledge.</td>
</tr>
<tr>
<td><strong>Descriptions of the assignments due and their relation to the assessment:</strong></td>
<td>Solved exam.</td>
</tr>
</tbody>
</table>

### Qualification system

The final mark, \( N_{final} \), rounded to the decimal point, will be the following weighted average:

\[
N_{final} = \max(0.6 \times N_{ef} + 0.3 \times N_{parcial}, 0.9 \times N_{ef}) + 0.1 \times N_{exer},
\]

where:
- \( N_{final} \): final mark
- \( N_{ef} \): mark of the final exam. The final exam will consist on a set of exercises of similar valuation. For its performance, three hours will be given.
- \( N_{parcial} \): Mark of the partial exam. The partial exam will consist on a set of exercises of similar valuation. For its performance an hour and a quarter will be given.
- \( N_{exer} \): Mark of the mechanism simulation exercise.

Reevaluation

The reevaluation exam will be of a type test with theoretical and practical questions. The mark obtained -\( N_{reaval} \)- replaces \( N_{parcial} \) and \( N_{ef} \) marks.

Paragraph 3.1.3 of NAGARMA will be applied.
240141 - Machine and Mechanism Theory

Regulations for carrying out activities

During the evaluations:
- Regarding to written material, students can only dispose of an A4 original manuscript, with the contents deemed necessary.
- Calculator and basic tools for writing are essential (pencil, rubber ...) so as to help neatness in presentation.
- It is forbidden to use any storage device or information transmission, mobile phone or other.
- Questions to professors may refer only to the comprehension of the statement.

Neatness, conciseness and accuracy while doing the exercises is valued.
To obtain the highest mark possible in an exercise, the numeric values must be found and indicate their units.

Bibliography

Basic:

Complementary:

Others resources:
Collection of problems and solved examples and other material:
http://www.em.upc.edu/docencia/estudis_grau/etseib/teoria_maquines