Course guide
240741 - 240741 - Mechanism and Machine Theory

Unit in charge: Barcelona School of Industrial Engineering
Teaching unit: 712 - EM - Department of Mechanical Engineering.

Degree: BACHELOR’S DEGREE IN INDUSTRIAL TECHNOLOGIES AND ECONOMIC ANALYSIS (Syllabus 2018).
(Compulsory subject).

Academic year: 2022  ECTS Credits: 6.0  Languages: English

LECTURER

Coordinating lecturer: Jordi Nebot, Lluisa
Others: Lores Garcia, Eduard
         Perez Gracia, Maria Alba
         Romanos Roca, David

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEGTI11. (ENG) Coneixements de teoria de màquines i mecanismes, sistemes de fabricalcòm càlcul, disseny i assaig de màquines, metrologia i control de qualitat.

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 60 students; the remaining credit is taught in lab classes in groups of around 20 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. Groups must be formed no later than the day of the third practice.
- 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.

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>Self study</td>
<td>90,0</td>
<td>60.00</td>
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<tr>
<td>Hours large group</td>
<td>50,0</td>
<td>33.33</td>
</tr>
<tr>
<td>Hours small group</td>
<td>10,0</td>
<td>6.67</td>
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</tbody>
</table>

Total learning time: 150 h

CONTENTS

1 MACHINE AND MECHANISM

Description:

Related activities:

Full-or-part-time: 10h 30m
Theory classes: 4h 30m
Self study : 6h

2 MOBILITY

Description:

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

Full-or-part-time: 13h 30m
Theory classes: 5h 30m
Laboratory classes: 2h
Self study : 6h
<table>
<thead>
<tr>
<th>3 KINEMATICS OF MECHANISMS</th>
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<tbody>
<tr>
<td><strong>Description:</strong> Kinematic study of mechanisms from geometric constraint equations. Redundancy and singular configurations. Kinematic study of mechanisms from kinematic constraint equations. Plane motion. Three centers theorem.</td>
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<tr>
<td><strong>Full-or-part-time:</strong> 29h</td>
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<td>Theory classes: 10h</td>
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<tr>
<td>Laboratory classes: 4h</td>
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<td>Self study : 15h</td>
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<tr>
<th>4 GEARS AND GEAR TRAINS</th>
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<tbody>
<tr>
<td><strong>Related activities:</strong> Practice 3: Gearbox and differential of a car.</td>
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<tr>
<td><strong>Full-or-part-time:</strong> 15h 30m</td>
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<tr>
<td>Theory classes: 4h 30m</td>
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<tr>
<td>Laboratory classes: 2h</td>
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<tr>
<td>Self study : 9h</td>
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<tr>
<th>5 DYNAMIC ANALYSIS</th>
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<tr>
<td><strong>Related activities:</strong> Practice 4: Simulation of mechanisms</td>
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<tr>
<td><strong>Full-or-part-time:</strong> 18h 30m</td>
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<tr>
<td>Theory classes: 4h 30m</td>
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<tr>
<td>Laboratory classes: 2h</td>
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<tr>
<td>Self study : 12h</td>
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<tr>
<th>6 CONTACT FORCE. CONSTRAINT FORCE. PASSIVE RESISTANCES</th>
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<tbody>
<tr>
<td><strong>Description:</strong> Constraint forces and passive resistances. Resistance to sliding, rolling and pivoting motions. Friction and rolling resistance models. Extreme conditions in the kinematic pairs. Wedging in guides and joints. Mechanisms based on friction.</td>
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<tr>
<td><strong>Full-or-part-time:</strong> 16h</td>
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<tr>
<td>Theory classes: 7h</td>
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<tr>
<td>Self study : 9h</td>
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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:
Practice 5: Simulation exercise

Full-or-part-time: 22h
Theory classes: 7h
Self study: 15h

8 WORK AND POWER IN MACHINES

Description:

Full-or-part-time: 25h
Theory classes: 7h
Self study: 18h

GRADING SYSTEM

The final mark, Nfinal, rounded to the decimal point, will be the following weighted average:

\[ N_{\text{final}} = \max(0,6 \times N_{\text{ef}} + 0,3 \times N_{\text{parcial}}, 0,9 \times N_{\text{ef}}) + 0,1 \times N_{\text{exer}}, \]

where:

Nfinal: final mark
Nef: 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.
Nparcial: 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.
Nexer: Mark of the mechanism simulation exercise.

Reevaluation
The reevaluation exam will be of a type test with theoretical and practical questions. The mark obtained -Nreaval- replaces Nparcial and Nef marks.
Point 3.1.3 of NAGARMA will be applied.

EXAMINATION RULES.

During the evaluations:
- Regarding to written material, students can only dispose of an A4 original manuscript, with the contents deemed necessary. This sheet can be done manually with a digital device, but it must be printed.
- Calculator and basic tools for writing are essential (pencil, rubber etc) 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:

RESOURCES

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