820429 - CDIM - Kinematics and Dynamics of Machines

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)
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ECTS credits: 6  Teaching languages: Catalan, Spanish

Teaching staff
Coordinator: Petreñas Ranedo, Jesus Maria
Others: Jesús Mª Petreñas Ranedo

Prior skills
The student should be able to perform the calculation:
1. Scalar product: For calculations of strength, power and labor force and moments about an axis.
2. Vector Product: For calculations of moments (first) of force about a point.
3. Application of moments (first) about a point.
4. Calculation of equivalent (resulting forces and moments).
5. Balance in the plane (support reactions).
6. Center of gravity.
7. Calculation time (seconds) of inertia.

Requirements
DINÀMICA - Prerequisite

Degree competences to which the subject contributes

Specific:
1. Understand the theoretical principles of machines and mechanisms.

CEMEC-20. Calculate the characteristics of, design and test machines.

Transversal:
2. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 2. Using strategies for preparing and giving oral presentations. Writing texts and documents whose content is coherent, well structured and free of spelling and grammatical errors.
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Teaching methodology

The classroom teacher explains the methodology used and how the evaluation is done. Stresses that the student has a more active role and that the evaluation is performed continuously and guidelines, arguing the benefits this has on learning and developing interpersonal skills.

Characteristics of the methodology used:
1. Scheme of classes: Classes of Theory and Problems consist of a descriptive part of the teacher and another in which the student involved. There will be activities in the classroom so that students actively participate by answering questions or solving exercises.
2. Resources to use during the course: In class the teacher uses multimedia and real machines to the best explanation of the content. The student will have a teaching material in both paper and CD ROM, available in print shops and in the virtual space ATENEA, respectively.
3. are scheduled to perform activities outside the classroom: The student solves the periods indicated, prepares and submits the report of individual.

Activities in class:

Exposure using Powerpoint presentation:
Describe the subject comprehensively and involvement in the rest of the course.
· Explain the general concepts, terminology and language used.
· To pause after the explanation.
· Give students participate in to comment or ask.

Exposure using the board:
· Put examples that apply the concepts.
· Summary of points of interest and raise the focus of the next class.

Learning objectives of the subject

1. Knowing the language and terminology for the kinematic and dynamic study of the mechanisms.
2. Interpret relationships between geometry, the movement of parts and the forces that generate it.
3. Know the operation and design parameters of the mechanisms of bars, levers, gears, pulleys and belts.
4. Apply analytical and graphical methods for the study of kinematic and dynamic behavior of the links on the machines.
5. Identify and assess the results of the position, velocity and acceleration of machine elements using kinematic analysis.
6. Identify and assess the results of the forces and torques acting through the static and dynamic analysis.
7. Using the simulation tools necessary to evaluate behavior in the cycle.
8. Evaluate the results and draw conclusions about the behavior of the mechanism.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group:</th>
<th>45h</th>
<th>30.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours medium group:</td>
<td>0h</td>
<td></td>
<td>0.00%</td>
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<tr>
<td>Hours small group:</td>
<td>15h</td>
<td></td>
<td>10.00%</td>
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<tr>
<td>Guided activities:</td>
<td>0h</td>
<td></td>
<td>0.00%</td>
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<tr>
<td>Self study:</td>
<td>90h</td>
<td></td>
<td>60.00%</td>
</tr>
</tbody>
</table>
### Content

<table>
<thead>
<tr>
<th>Topic 1: Geometry of the movement in the mechanisms</th>
<th>Learning time: 15h 40m</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 5h</td>
</tr>
<tr>
<td>General Definitions. Nomenclature and Symbols.</td>
<td>Laboratory classes: 0h</td>
</tr>
<tr>
<td>Kinematic scheme. Classification of the bars.</td>
<td>Self study: 10h 40m</td>
</tr>
<tr>
<td>Classification of kinematic pairs. Degrees of</td>
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<tr>
<td>freedom of kinematic pairs. Kinematic Chain.</td>
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<tr>
<td>Degrees of freedom of the mechanism and</td>
<td></td>
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<tr>
<td>kinematic chain mobility. Equation of mobility</td>
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<tr>
<td>and the degree of freedom. Criteria for</td>
<td></td>
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<tr>
<td>determining the degrees of freedom.</td>
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<tr>
<td><strong>Specific objectives:</strong></td>
<td></td>
</tr>
<tr>
<td>1.-To know the nomenclature and the simbologia</td>
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<tr>
<td>for the representation of the mechanisms,</td>
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<tr>
<td>2.-To interpret the cinematic scheme of the</td>
<td></td>
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<tr>
<td>machine or mechanism.</td>
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<tr>
<td>3.-Identificar the bars and the cinematic</td>
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<tr>
<td>couples of the mechanismos</td>
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<tr>
<td>4.-To calculate the degrees of freedom by</td>
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<td>means of Glubler's method, the method of</td>
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<td>restriction and the method of elimination of</td>
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<tr>
<td>the groups of ASSUR.</td>
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<tr>
<td>5.-Interprets the movilidad of the elements of</td>
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<tr>
<td>the mechanism from the movement of entry.</td>
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| Topic 2: Composition of movement in the         | Learning time: 19h 20m |
| mechanisms                                       | Theory classes: 6h     |
| **Description:**                                | Laboratory classes: 2h |
| Plans mechanisms of Bars. Machine with          | Self study: 11h 20m    |
| parallel planes mechanisms. Grashof Act.       |                          |
| Considerations. Consequences. Obtaining        |                          |
| mechanisms for kinematic investments.          |                          |
| Mechanisms plans of Cams, Gears, pulleys and    |                          |
| belts.                                          |                          |
| **Specific objectives:**                        |                          |
| 1.-To interpret the movement with regard to     |                          |
| fixed and mobile reference                     |                          |
| 2.-To know the different mechanisms of          |                          |
| transmission of movements                      |                          |
| 3.-To identify the different mechanisms of      |                          |
| bars, used in diverse applications             |                          |
| 4.-To know the parameters of functioning and    |                          |
| of design of the mechanisms of cam, of gears    |                          |
| and of pulleys and straps.                      |                          |
### Topic 3: Speeds

**Learning time:** 20h 20m  
Theory classes: 7h  
Laboratory classes: 2h  
Self study: 11h 20m

**Description:**  

**Specific objectives:**  
1. Plantear the equation of speed distribution for the mechanisms with movement in the plane  
2. Conocer the graphical and analytical methods of speed determination  
3. Aplicar the theorem of three centers or of Kennedy  
4. Interpretar the theorem of the relation of angular speeds and of the mechanical advantage.  
5. Comprobar and to interpret the results obtained between the graphical and analytical methods

### Topic 4: Accelerations

**Learning time:** 19h 20m  
Theory classes: 6h  
Laboratory classes: 2h  
Self study: 11h 20m

**Description:**  

**Specific objectives:**  
1. To raise the distribution equation of acceleraciones for the mechanisms with movement in the plane  
2. To know the graphical and analytical methods of determination of accelerations  
3. To verify and to interpret the results obtained between the graphical and analytical methods
## Topic 5: Relative Movement

**Description:**
Speeds and Acceleration equation in relative motion. Coriolis acceleration. Application of analytical and graphical methods.

**Specific objectives:**
1. -Identificar the mechanisms with mobile references.
2. -Plantear the equation of speed distribution and aceleraciones in mechanisms with relative movement.
3. -Aplicar the graphical and analytical methods to calculate the speeds and the accelerations of the points of the mechanism with relative movement.
4. -Interpretar the results of speeds and accelerations
5. -To verify and to interpret the results obtained between the graphical and analytical methods.

**Learning time:** 19h 20m
- Theory classes: 6h
- Laboratory classes: 2h
- Self study : 11h 20m

## Topic 6: Static Analysis of the solid one in flat movement

**Description:**

**Specific objectives:**
1. -To know the graphical and analytical methods of determination of the force or couple equilibrante.
2. -To interpret the transmission of the efforts.
3. -To apply the método of Newtonian calculation.
4. -To know and to apply the method of energy: Beginning of the virtual powers.

**Learning time:** 17h 20m
- Theory classes: 4h
- Laboratory classes: 2h
- Self study : 11h 20m
**Topic 7: Dynamic Analysis of the solid one in flat movement**

**Learning time:** 19h 20m
- Theory classes: 6h
- Laboratory classes: 2h
- Self study: 11h 20m

**Description:**
Force and Moment of inertia of the mechanism. Determination of Force and Torque Balancing taking into account the inertia of the mechanism according to the Principle of Virtual Powers. Dynamically equivalent systems. Substitution point masses. Center of percussion.

**Specific objectives:**
1. To know the behavior of the force and the couple of incercia of the mechanism.
2. To calculate the force or the couple equilibrante for the method of virtual powers.
3. To know the determining ones of the dynamically equivalent systems.
4. To apply the method of substitution for punctual masses.
5. To know the behavior of the percussion center of an element of mechanism.
6. To interpret the results of the force or the couple equilibrante.

**Topic 8: Dynamic analysis: kinetic energy method of a mechanism**

**Learning time:** 19h 20m
- Theory classes: 5h
- Practical classes: 3h
- Self study: 11h 20m

**Description:**
Principle of Reduction. Moment of inertia reduced to a main axis. Torque reduced to one axis. Mass reduced to one point. Dynamics of systems with a degree of freedom. Cyclic variation of kinetic energy in machines. Application of the reduction method for the calculation of the own frequencies of vibration.

**Specific objectives:**
1. To know the behavior of the kinetic energy of a mechanism.
2. To know the beginning of reduction.
3. To know and to apply the method of energy: Moment of inertia reduced.
4. To calculate the moment of inertia reduced and the couple diminished to a principal axis.
5. To know the dynamic behavior of the systems with a degree of freedom.
6. To identify the machines with cyclical variation of the kinetic energy.
7. To interpret the results of the moment of inertia reduced.
Qualification system

No Examination Re - evaluation

The student will make the activities:
Review Part 1 (items 1,2,3) = 15%
Review Part 2 (up to item 4) = 25%
Final Exam (full agenda) = 40%
Laboratory Practice = 20%
Generic Competition

Competition Second Level - Effective Communication: Oral and Written.
Average between the 1st and 2nd Partial Test (considering the oral discussion in the review of one tests)

Regulations for carrying out activities

Form not supported

Bibliography

Basic:

Others resources:
The student will have a teaching material, both in paper and on CDROM, available in copy and in virtual space of ATENEA

Computer material

Programas de simulación por ordenador de mecanismos