Universidad Zaragoza

Year : 2019/20

30112 - Mechanics

Syllabus Information

Academic Year: 2019/20
Subject: 30112 - Mechanics
Faculty / School: 175 - Escuela Universitaria Politécnica de La Almunia
179 - Centro Universitario de la Defensa - Zaragoza
Degree: 457 - Bachelor's Degree in Industrial Organisational Engineering
563 - Bachelor's Degree in Industrial Organisational Engineering
425 - Bachelor's Degree in Industrial Organisational Engineering
ECTS: 6.0
Year: 2
Semester: First semester
Subject Type: Compulsory
Module: ---

1.General information

1.1.Aims of the course

The main goal of the subject is to build graduate engineers with the particular ability to carry out the analysis of machines, mechanisms and mechanical systems. Accordingly, learners will be able to understand a wide range of physical phenomena, develop creative abilities for technological design and analytical procedures for problems resolution, with the aim of application of the acquired knowledge.

The combination of the competences achieved leads the graduated engineers on Industrial Organisational Engineering to obtain a versatile education, being able to access a wide field of professional positions.

The main goal of the subject guarantee graduate engineers to acquire competences that will be included in the following sections.

1.2.Context and importance of this course in the degree

This subject belongs to the common training module to face, in addition to the generic competences of the Industrial Organization Engineer, knowledge about the principles of machine theory and mechanisms.

Brief presentation of the subject

Mechanical engineering is a huge part field of engineering that involves the use of the principles of physics for the analysis, design and manufacture of mechanical systems. Traditionally, it has been the branch of engineering that using the application of physical principles has allowed the creation of useful devices, such as tools and machines.

Mechanical Engineering is the branch of the machines, equipment and facilities always keeping in mind ecological and economic aspects for the benefit of society. To fulfill its task, mechanical engineering analyzes the needs, develops and solves technical problems through interdisciplinary work, and supported on scientific developments, transforming them into elements, machines, equipments and facilities that provide an suitable service, through rational and efficient use of the available resources.

1.3.Recommendations to take this course

Students enrolled in this subject are recommended to have pursued the subject Fisica I, where the fundamental concepts required and employed in the present subject are explained.

2.Learning goals

2.1.Competences

After passing the subject, the learner will be competent to:

C04 - Ability to solve problems and take decisions with initiative, creativity and critical reasoning.

C06 - Ability to communicate knowledge and skills in Spanish.

C07 - Ability to use techniques, skills and tools necessary to practise engineering.

C11 - Ability to continue learning and develop self-learning strategies.

C21 - Knowledge of the principles of the theory of machines and mechanisms.

2.2.Learning goals

The student, to overcome this subject, must demonstrate the following results:

To obtain knowledge from the combination of movements. Inertial and non-inertial reference systems.

To define and identify the parameters involved in the movement of a mechanical system as well as its degrees of freedom.

To know the application of forces that emerge in the interaction between solids in mechanical systems.

To know the application to mechanical systems of the concepts of mass center and inertia tensor.

To know the application of theorems of vector calculus to mechanical systems and interpret the results obtained. Newton's laws and conservation principles.

To obtain knowledge and employ software of modelling of mechanical systems.

2.3.Importance of learning goals

This subject has a strong engineer character supporting the learning with content of immediate applicability in the present professional market. The learner will acquire through the learning goals the ability required to understand the operation of machines and mechanisms, which will be essential to design and setup any mechanical application within the field of Industrial Organisation Engineering.

3.Assessment (1st and 2nd call)

3.1.Assessment tasks (description of tasks, marking system and assessment criteria)

The student must demonstrate that he / she has attained the expected learning outcomes through the following assessment activities.

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Assessment methodology

The evaluation methodology is based on written examinations and on practical sessions of simulation of mechanical systems:

- **Written examinations**. Exams are comprised by exercises and questions. A mid-semester exam on the Statics and Kinematics blocks (Part1) will be carried out. If a student obtains a minimum mark of 4.0 in this examination he/she can choose not to re-take this Part1 on the final examination of the 1st assessment period (February) and complete only Part2 (Geometry of mass, Dynamics and Machines Theory). This possiblity is only available for the 1st assessment period (February) where the exam consists on two parts (Part1 and Part2). In the 2nd assessment period (August), the final examination consist of a unique Part, comprising contents corresponding to all the subject. The mark corresponding to any of the Part1 or Part2 is not saved for the 2nd assesment period: the student will have to pursue the exam corresponding to the complete subject.

- **Practical sessions**. Three computer lab sessions about simulation of mechanical systems are scheduled. In the course of the practical sessions the students will complete a written questionnaire which, along with the simulation files, will be used for evaluating this block. In case that the student does not pass the evaluation, he/she will have the possibility of an exam within the final exam at the assesment periods (February, August) that will comprise the full content corresponding to the three practical sessions. In case that the student does not pass the exam of the 1st evaluation period, he/she will have the possibility of an exam at the 2nd assessment period (August) that will comprise the full content corresponding to the three practical sessions.

Assessment criteria

In order to compute the final mark and evaluate if the student has passed the subject the following criteria have been established:

- The minimum marks to be obtained in the practical session's assessment (PM) and in the final examinations assessment (EM) are 5.0.

- Moreover, on the 1st assesment period evaluation, it is needed to obtain a minimum mark of 4.0 in each of the two blocks in which the subject is divided for examinations (Statics and Kinematics for the first part and Geometry of mass, Dynamics and Machines Theory for the second part). This means that both the mark of the first part (EM1) and of the second part (EM2) must be greater or equal to 4.0. This will only be required for the first assessment period (February).

- The overall mark of the examinations on the 1st assesment period evaluation will be worked out as follows:

$$EM = 0.5*EM1 + 0.5*EM2$$

if EM1 and EM2 are both greater or equal to 4.0.

For the 2nd assesment period evaluation (August) EM equals the mark of the unique exam.

- The final mark (FM) of the subject will obtained by means of a weighed average as follows:

$$FM = 0.8*EM + 0.2*PM$$

4.Methodology, learning tasks, syllabus and resources

4.1.Methodological overview

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Strong interaction between the teacher/student. This interaction is brought into being through a division of work and responsibilities between the students and the teacher. Nevertheless, it must be taken into account that, to a certain degree, students can set their learning pace based on their own needs and availability, following the guidelines set by the teacher.

The current subject (Mechanical Engineering) is conceived as a stand-alone combination of contents, yet organized into three fundamental and complementary forms, which are: the theoretical concepts of each teaching unit, the solving of problems or the resolution of questions and laboratory work, at the same time supported by other activities.

The organization of teaching will be carried out using the following steps:

- **Lectures**: Theoretical activities carried out mainly through exposition by the teacher, where the theoretical supports of the subject are displayed, highlighting the fundamental, structuring them into topics and or sections, interrelating them.
- **Practice Sessions**: The teacher resolves practical problems or cases for demonstrative purposes. This type of teaching complements the theory shown in the lectures with practical aspects.
- **Laboratory Workshop**: Practical activities will be conducted in the computer room 1.1 software simulation mechanisms (GIM16.0) with the presence and teacher mentoring.
- **Individual Tutorials**: Those carried out giving individual, personalized attention with a teacher from the department. Said tutorials may be in person or online

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The teaching will be structured as follows:

- A) There will be in-class (54 hours) and non-in-class (90 hours) activities.
- B) In addition, there will be 6 hours for assessment activities (two hours of the mid-semester examination and four hours for the final examination).
- C) The in-class activities can be:
  - Masterclasses: Theoretical and exercises sessions (48 hours).
  - Practical sessions (6 hours).
- D) The non-in-class activities will consist basically in autonomous work of the student (90 hours).

4.2.Learning tasks

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The program offered to the student to help them achieve their target results is made up of the following activities...

Involves the active participation of the student, in a way that the results achieved in the learning process are developed, no away from those already set out, the activities are the following:

- **Face-to-face generic activities**:

Theory Classes: The theoretical concepts of the subject are explained and illustrative examples are developed as a suppo theory when necessary.

Practical Classes: Problems and practical cases are carried out, complementary to the theoretical concepts studied.

Laboratory Workshop: This work is tutored by a teacher, in groups of no more than 20 students.

- **Generic non-class activities**:

Study and understanding of the theory taught in the lectures.

Understanding and assimilation of the problems and practical cases solved in the practical classes.

Preparation of seminars, solutions to proposed problems, etc.

Preparation of laboratory workshops, preparation of summaries and reports.

Preparation of the written tests for continuous assessment and final exams.

The subject has 6 ECTS credits, which represents 150 hours of student work in the subject during the trimester, in other wo hours per week for 15 weeks of class.

A summary of a weekly timetable guide can be seen in the following table. These figures are obtained from the subject file Accreditation Report of the degree, taking into account the level of experimentation considered for the said subject is mode

Activity	Weekly school hours
Lectures	3

Laboratory Workshop	1
Other Activities	6

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1. Theoretical and exercises master sessions. In these sessions, the teacher will detail the theoretical basis of the subject. Moreover, these will be complemented with exercises sessions in which the teacher will highlight the applications of the basic concepts and will provide the students with general guidelines for solving exercises. These which will be extracted from the collections proposed for each block.

2. Practice sessions. These are compulsory in-class activities which the student has to complete to pass the subject. The practical sessions will consist of simulation of mechanical systems. Groups for performing the computer lab sessions will be made up of two (exceptionally of three) students. Before beginning the sessions the students will be provided with guidelines where the theoretical principles and the motivation of the practical can be consulted. In addition, each group will complete during the session a written questioner which will be handed in at the end of the class.

3. Tutorials. These will be used for orienting and guiding the learning process of the students adequately.

4.3.Syllabus

The course will address the following topics:

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- **Chapter 1: Structural Analysis of Mechanisms Plans**
- **Introduction: Historical development of the theory of mechanisms and machines**
    - Terminology mechanisms
    - Classifications of elements and kinematic pairs of a mechanism
    - Mobility and Degrees of Freedom: Criteria Grübler
    - Act Grashoff Theorem and Graphical Analysis
    - Obtaining a mechanism kinematic scheme
- **Chapter 2: Kinematic Analysis of Mechanisms Plans**
    - Statement of the problem Kinematic
    - Relative Movement Plano
    - Relative Instant Center
    - Determination of the instantaneous centers mechanism
    - Theorem Aronhold -Kennedy
    - Calculation of speed of a mechanism analytically
    - Calculation of speed of a mechanism graphically
- **Chapter 3: Dynamic Analysis of Mechanisms Plans**
    - Dynamic Approach problem
    - Calculation of acceleration of a mechanism analytically
    - Calculation of acceleration of a mechanism graphically
    - Forces of inertia mechanisms
    - Balance mechanisms
- **Chapter 4: Kinematic Analysis of Gear and Gear Trains**
    - Gears: Gear Fundamental Law
    - Classification of Gears
    - Gear Trains
    - Classification Gear Trains
    - Applications: Differential of a vehicle
- **Chapter 5: Theory of Mechanical Vibrations**
    - Fundamental concepts in vibration
    - Systems degree of freedom
    - Free Vibrations in systems of one degree of freedom
    - Vibrations systems forced a degree of freedom
    - Resonance Phenomenon

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- **0. INTRODUCTION (2 hours)**
    - 0.1. Presentation. Review of vector calculus.
    - 0.3. Equivalent force-momentum systems.
- **1. STATICS (12 hours)**

- 1.1. Equilibrium conditions. Free body diagram. Reaction forces.
- 1.2. Distributed forces. Centre of gravity.
- 1.3. Static friction. Case studies: overturns, friction bands and wedges.
- 1.4. Practical session of simulation: Dimension of a clutch.

- **2. KINEMATICS (13 hours)**
  - 2.1. Types of motion. Motion around a fixed axis.
  - 2.2. General plain motion. Instant Rotation Centre. Degrees of freedom.
  - 2.3. Relative motion. Absolute and relative velocity. Absolute, relative and Coriolis acceleration.
  - 2.4. Tri-dimensional motion: about a fixed point and general case.
  - 2.5. Motion on Earth's surface.
  - 2.6. Practical session of simulation: Kinematic study of a crank-rod-piston mechanism.
- **MID-TERM EXAMINATION (2 hours)**
- **3. GEOMETRY OF MASS (7 hours)**
  - 3.1. Moments of inertia and products of inertia. Inertia tensor.
  - 3.2. A theorem of Steiner. Composed bodies.
- **4. DYNAMICS (17 hours)**
  - 4.1. Dynamic variables. Linear momentum. Angular momentum. Kinetic energy.
  - 4.2. Fundamental equations. D'Alembert principle and inertia forces. Theorems of linear and angular momentums.
  - 4.3. Theorem of energy and work.
  - 4.4. Tri-dimensional motion. Balancing of rotors.
  - 4.5. Practical session of simulation: Dimension of the traction system of a spy robot.
- **5. MACHINES THEORY (3 hours)**
  - 5.1. Design of mechanical mechanisms.
  - 5.2. Transmission of motion.
  - 5.3. Degrees of freedom. The Grübler criterion.
- **FINAL EXAMINATION (4 hours)**

4.4.Course planning and calendar

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weeks	WEEKLY PLANNING SEMESTER	
1ª		Exercise No. 1 Continuous Assessment
2ª	Topic 1	
3ª		Exercise No. 2 Continuous Assessment
4ª		
5ª	Topic 2	1st Practice with software GIM (Topic 1 and 2)
6ª		1st Written Test (Topic 1 and 2)
		Exercise No. 3 Continuous Assessment
7ª		
8ª	Topic 3	2nd Practice with software GIM (Topic 3)
9ª		2nd Written Test (Topic 3)
		Exercise No. 4 Continuous Assessment
10ª		

11ª	Topic 4	
12ª		3rd Written Test (Topic 4)
13ª		Exercise No. 5 Continuous Assessment
14ª	Topic 5	
15ª		4th Written Test (Topic 5)

The weekly schedule of the subject will be published at http://www.eupla.unizar.es/asuntos-academicos/calendario-y-horarios

The dates of the global evaluation test (official calls) will be published at http://www.eupla.unizar.es/asuntos-academicos/examenes

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Check section 4.3 in order to obtain a detailed schedule, which specifies the number of hours dedicated to each of the topics in which the subject is divided.

The subject consists of 6 ECTS credits, which represent 150 hours of student work in the subject during the semester.

40% of this work (60 h.) will be done in the classroom, and the rest will be autonomous. The teaching team will inform in advance of the dates in which activities to be evaluated will be carried out.

For information about:

- Academic calendar (school term, holiday dates, exam period).
- Schedules and classrooms.
- Dates in which the exams of the official calls will take place.

Consult the following websites: http://cud.unizar.es

- Moodle webpage of the subject

4.5.Bibliography and recommended resources

Bibliography available on http://biblos.unizar.es/br/br_citas.php?codigo=30112&year=2019