30011 - Mechanics

Información del Plan Docente

Academic Year	2017/18
Faculty / School	110 - Escuela de Ingeniería y Arquitectura
Degree	436 - Bachelor's Degree in Industrial Engineering Technology
ECTS	6.0
Year	2
Semester	First semester
Subject Type	Compulsory
Module	---

1.General information

1.1.Introduction

Mechanics is a compulsory subject at the first semester of second course of the Bachelor's Degree in Industrial Engineering Technology. It builds upon the topics covered in Physics I, and expands them to mechanical systems. The goal is students acquire the necessary skills and are able to understand and develop the mathematical model of simulation of the motion of a mechanical system, machine o vehicle, and how it is applied to mechanisms.

1.2.Recommendations to take this course

The following courses are required: Physics I, Mathematics I / II, Technical drawing.

Students are expected to know: vector calculus, differential and integral calculus, basic knowledge of dynamics of a particle and a rigid body, and fundamentals of spatial representation of mechanical systems.

Students are encouraged to attend classes on a regular basis, participate actively on lectures and lab sessions, and work on homework assignments. Consistently attending each class will enable students gain gradually knowledge, tackle easily the periodic tasks, and have a positive influence on the grade received.

If students need academic support one-on-one tutoring is available for weekly appointments in office-hours.

1.3.Context and importance of this course in the degree

The course encourages student's creativity to model a mechanical system, and ability to analyze, develop and understand its mathematical model of motion simulation. This task is based on the technical and mathematical concepts acquired in the previous courses.

Students also get a basis to apply kinematic and kinetic principles within following technological courses.

30011 - Mechanics

1.4.Activities and key dates

Course schedule is posted on the degree website http://www.unizar.es/industriales.

At the beginning of the course students can find homework assignments, and office hours on http://moodle.unizar.es / .

2.Learning goals

2.1.Learning goals

Student, to successfully complete the course, will be able to demonstrate the next learning outcomes

- Distinguish absolute and relative motion
- Define the kinematic model of a mechanical system
- Identify the motion parameters of a mechanical systems and its degrees of freedom.
- Understand and apply the concept of rolling without slipping
- Understand the contact forces between rigid bodies, driving forces; and draw clear and appropiate free-body diagrams.
- Understand and apply the concepts of center of mass and inertia tensor of a rigid body
- Apply the Newton-Euler's equations of motion and interpret the results.
- Understand the static and dynamic balance of a rotor.
- Understand how a gyroscope works and its application.
- Apply the concepts of kinematics and kinetics to planar mechanisms

2.2.Importance of learning goals

Learning outcomes are fundamental because students know and apply the Newton- Euler's laws to the motion simulation of real mechanical systems, that is the key to design mechanisms, machines, robots, and vehicles, as well as to control their motion. Students are also able to critically establish the dynamics parameters to design a mechanical system; and, from a conceptual way, analyze, and understand how it moves, without developing its mathematical model.

3.Aims of the course and competences

3.1.Aims of the course

Subject matter and learning outcomes are focused on:

Students will master basic methodology to solution the motion of 2D and 3D rigid bodies, and a mechanical system consisting of a finite number of rigid bodies.

Students study the principles of kinematics and kinetics to formulate mathematical models, under simplified hypothesis, to understand the motion or its change.

Two-dimensional dynamic analysis applied to mechanisms is solved using graphic and mathematical methods, to have a conceptual knowledge of the real mechanic issue.

3.2.Competences

Student after module completion has the knowledge/ knows how to/is able to

30011 - Mechanics

Specific competence

- Students will demonstrate an understanding of Newtonian-Eulerian physics and basic equations underlying kinematics and kinetics of rigid bodies in 2D and 3D motion, and apply to mechanisms, machines and vehicles.

Generic competence

- Ability to solve a problem, take decisions, use initiative, be creative and make judgments about the results.
- Ability to communicate effectively technological issues related to mechanical modelling in Spanish language.
- ability to use the methods, skills and tools of Industrial Engineering for solving engineering tasks.
- Ability to learn progressively and develop own learning strategies

4.Assessment (1st and 2nd call)

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

Student should demonstrate that have achieved the learning outcomes through the next grading activities.

1. Lab sessions and homework assignments

Students that complete every homework assignment and every lab session, have the next assessment activities:

- Homework assignments; weigt 10%

- Test 1: lab sessions 1, 2 and 3. Learning outcomes assessments 1 to 4. Weight 15%

- Test 2: lab sessions 4, 5 and 6. Learning outcomes assessments 1 to 10. Weight 15%

Dates and location will be announced previously. Students need to hand in every homework and take both tests to have a grade in this part.

2. Final exam

There will be a comprehensive final exam at official schedule dates and location. It consists of:

- Kinematics exercise. Learning outcomes assessment 1 to 4 and the corresponding part of 10. Weight 35%

- Kinetics exercise. Learning outcomes assessment 5 to 9 and the corresponding part of 10. Weight 35%

- Lab session test. Learning outcomes assessment 1 to 10. Weight 30%

Lab session test only applies to students that do not attend the lab sessions and do not hand in homework assignments,

or want to improve test1+test2+homework assignment grade.

5.Methodology, learning tasks, syllabus and resources

5.1.Methodological overview

The learning process of this subject is based on:

1. Lectures , where instructor will explain the fundamentals of the subject and solve some problems applied to specific examples. These exercises can be found in the problem set provided at the beginning of the semester. Students are expected to participate actively, to discuss information and concepts covered n lectures, and to reflex/analysis the problems to be solved.

To promote students' work, previously to every lecture, readings and exercises to be solved will be posted on Moodle web page.

2. Homework assignments, students are encouraged to work regularly during the semester, through homework assignments based on the concepts of the lab sessions and lectures, to progress gradually on the comprehension of the matter.

Homework assignments are posted on Moodle web page and are due to the date posted in Moodle to be hand in at the beginning of a lab session where will be discussed to promote communication skills. Homework not turned in at that time is considered late, and students will miss the option of having a grade by homework assignments and tests 1 and 2.

A central component of this course, is the solution of problems, and practical experience with such solutions, via homework assignments. It is recommended that students attempt all problems before seeking assistance of any kind, and it is imperative that each student fully understand the solution to every homework problem. Copying the solutions of other students only ensure poor test performance.

Instructors can help and guide to solve the homework problems, but they shall no present complete solutions.

3. Lab sessions , biweekly along the semester. Students work together in groups, and are expected to participate actively. These activities will require practical demonstration and calculations, with the goal of reinforcing lecture material.

4. Private study, the time spent studying and doing homework is the single most important factor in students learning process. Working problems is the best way to learn the basic ideas in this course and to prepare for the exams.

5. Tutoring , about any subject matter. To have the maximum benefit students should come with clear, specific and reflexed questions.

30011 - Mechanics

5.2.Learning tasks

Students are expected to achieve the learning outcomes following the next activities...

Lectures

Three hours by week during the semester at official schedule, where fundamental concepts as well as problem resolution are included. Although it is not a mandatory activity, regular attendance is highly recommended.

Lab sessions

Along the semester there will be 6 sessions, 2.5 h each.

Graphical and analytical methods for the resolution of problems are used at sessions 1 to 3, and 5, so students have a wide perspective of the motion analysis of mechanical systems.

At sessions 4 and 6, activities will require practical demonstration and measurement as well as accompanying calculations to check theory.

Students should play the main role, guided by the instructor that will promote their participation and ability to take decisions.

Homework assignments

Students are expected to spend about 15 hours to solve the problems assigned for homework. They may ask the Instructor for help to solve the homework.

Private study

Outside class, students are expected to spend about 75 hours to study theory, solve problems, prepare lab sessions, and take exams.

Tutoring

Office hours will be posted on Moodle and degree webpage, to assist students with any question.

5.3.Syllabus

Lecture topics

30011 - Mechanics

1. Introduction (1h)

2. Review of mathematical and geometry concepts (3h)

3. Kinematics modelling of mechanical systems (3h)

4. Kinematics of particles. Relative and absolute motion. (3h)

5. Kinematics of rigid bodies in 3D motion. Rolling without slipping. (7h)

6. Planar Kinematics of rigid bodies. Application to mechanisms. (5h)

7. Forces in Newtonian mechanics of rigid bodies (6h)

8. Kinetics of particles (3h)

9. Body parameters: center of gravity and inertia tensor. (2h)

10. Newton-Euler's laws of 3D motion: rigid body and multibody systems (8h)

11. Newton-Euler's laws of 2D motion. Free body diagrams (5h)

Lab sessions

1. Review of mathematical and geometric concepts. Mechanical systems modellig.

2. Conceptual application of composed motion.

3. Kinematics of rolling without slipping.

4. Theoretical-experimental analysis of planar kinematics of mechanisms.

5. Conceptual application of center of mass and inertia tensor.

6. Experimental analysis of a gyroscope.

5.4.Course planning and calendar

30011 - Mechanics

Schedule of on-site activities and homework assignments

Lectures and lab sessions will be held according to the official schedule published before the course starts.

Dates to hand in homework assignments and take Tests 1 and 2 will be posted in advance in the Moodle page of the course.

5.5.Bibliography and recommended resources

BB. - Lladó París, Juan. Mecánica : Grado en Ingeniería de Tecnologías Industriales / Juan Lladó París, Beatriz Sánchez Tabuenca. Zaragoza : Copy Center, D.L. 2015

BB. - Agulló Batlle, Joaquim. Mecánica de la partícula y del sólido rígido / Joaquim Agulló Batlle ; versión en castellano de Ana Barjau Condomines . - 2ª ed. corr. y amp. Barcelona : OK Punt, D.L. 2000

C.B. - Teoría de máquinas. S. Cardona. Publicaciones d'Abast S.L.L. cpda-ETSEI Barcelona

C.B. - Vector Mechanics for Engineers: Dynamics by F.Beer, E.R.Johnston, P.Cornwell, 10th Edition, McGraw-Hill, 2012