Universidad Zaragoza

Year : 2018/19

30011 - Mechanics

Syllabus Information

Academic Year:	2018/19
Subject:	30011 - Mechanics
Faculty / School:	110 -
Degree:	436 - Bachelor's Degree in Industrial Engineering Technology
ECTS:	6.0
Year:	2
Semester:	First semester
Subject Type:	Compulsory
Module:	---

General information

Aims of the course

Subject matter and learning outcomes are focused on:

- To teach students, using vector and matrix methods, the basic principles of the dynamics of rigid bodies in planar and 3D motion, and to show them how these laws of mechanics can be used to describe and predict the motion or its change.
- To educate students to identify, formulate and solve engineering problems in rigid body dynamics.

Context and importance of this course in the degree

The course encourages students' creativity to model a mechanical system, and their 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 acquire an ability that provides them with a basis to apply kinematic and kinetic principles within following technological courses.

Recommendations to take this course

The following courses are required before taking this subject: Physics I, Mathematics I / II, Technical drawing.

Students are expected to know something about: 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 in the lectures and lab sessions, and work on their homework assignments. Consistent attendance to the lectures will enable students **to gain gradually knowledge, tackle easily** the periodic tasks, as well as this will have a positive influence on the grade they may obtain.

If students need academic support one-to-one tutoring is available for weekly appointments during the teacher's office hours.

Learning goals

Competences

Students after module completion will have the knowledge/ know how to/be able to

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 about 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 their own learning strategies

Learning goals

In order to pass this subject, at the end of the course students should be able to...

- Distinguish absolute and relative motion
- Define the kinematic model of a mechanical system
- Identify the motion parameters of a mechanical system 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

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 perspective , analyze, and understand how it moves, without developing its mathematical model.

Assessment (1st and 2nd call)

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

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

There will be homework assignments and two tests given during the semester, plus a final exam.

1. Lab sessions and homework assignments

Students that complete **every** homework assignment and lab session can take two tests during the semester. In order to assess these activities:

- Homework assignments: Weight 10%
- Test 1: lab sessions 1, 2 and 3. Learning outcomes assessments 1 to 4. Weight 10%
- Test 2: lab sessions 4, 5 and 6. Learning outcomes assessments 1 to 10. Weight 10%

Date and location will be announced in due time.

2. Final exam

There will be a comprehensive final exam according to the 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 those students that have not attended the lab sessions and do not hand over homework assignments, or those that want to improve homework assignments+test1+test2 grade.

Methodology, learning tasks, syllabus and resources

Methodological overview

The learning process of this subject is based on:

1. Lectures, where the 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 in lectures, and to reflex/analysis the problems to be solved.

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 in order to progress gradually in the comprehension of the matter.

Homework assignments and their corresponding due dates will be posted on the Moodle web page. The homework that is not presented in the deadline established will be considered late, and the student will receive no grade and not take the tests 1 and 2.

A central component of this course is the solution of problems and the practical experience with such solutions, *via* homework assignments. It is recommended that students try to solve all the problems before seeking assistance of any kind, and it is imperative that each student fully understands the solution to every homework problem. Copying the solutions of other students will 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 in the sessions. These activities will require practical demonstration and calculations, with the goal of reinforcing the lecture material.

4 Autonomous study, the time spent studying and doing homework is the single most important factor in students learning process. Working with 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.

Learning tasks

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

Lectures

Three hours every week during the semester according to the 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.

In 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.

Autonomous 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.

Syllabus

Lecture topics

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.

Course planning and calendar

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 on the degree or university websites http://www.unizar.es/industriales/ and https://eina.unizar.es/.

During the course, the homework assignments will be posted on http://moodle2.unizar.es/; and collected on the due date.

Bibliography and recommended resources