Universidad Zaragoza

Academic Year/course: 2021/22

30011 - Mechanics

Syllabus Information

Academic Year: 2021/22
Subject: 30011 - Mecánica
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. 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.

The student, from these objectives, acquires training and competence to contribute to some extent to the achievement of the following targets of the Sustainable Development Goals 7 and 9, SDGs, of the 2030 Agenda (https://www.un.org/sustainabledevelopment/en/)

7. Affordable and Clean Energy

7.3 By 2030, double the global rate of improvement in energy efficiency

9. Industry, Innovation and Infrastructure

9.5 Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending

1.2. 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.

1.3. 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.

2. Learning goals

2.1. 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, make decisions, use initiative, be creative and make judgments about the results.
- Ability to communicate effectively about technical issues related to mechanical modeling in the 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

2.2. Learning goals

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

- 1. Distinguish absolute and relative motion
- 2. Define the kinematic model of a mechanical system
- 3. Identify the motion parameters of a mechanical system and its degrees of freedom.
- 4. Understand and apply the concept of rolling without slipping
- 5. Understand the contact forces between rigid bodies, driving forces; and draw clear and appropriate free-body diagrams.
- 6. Understand and apply the concepts of center of mass and inertia tensor of a rigid body
- 7. Apply the Newton-Euler?s equations of motion to mechanical systems and interpret the results.
- 8. Understand how a gyroscope works and its application.

2.3. 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 dynamic parameters to design a mechanical system; and, from a conceptual perspective , analyze, and understand how it moves, without developing its mathematical model.

3. Assessment (1st and 2nd call)

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

Continuous assessment (minimum grade per task: 3,5 out of 10)

Continuous assessment consists of the following three tasks:

- Attendance and completion of all the activities proposed in the practice sessions (laboratory, and 1/2 group problems), and tutored exercise:Weight 30%
- Exam 1: Learning outcomes assessment 1 to 4. Weight 35%
- Exam 2: Learning outcomes assessment 5 to 8. Weight 35%

The date and location will be announced in due time.

Final exam (minimum grade **per task: 3,5 out of 10**)

To be taken by students who have not opted for or passed the continuous assessment, or those that wish to improve the grade obtained in that assessment.

The final exam according to the official schedule dates and location consists of:

- 3D mechanical system problem. Weight 35%
- 2D mechanical system problem. Weight 35%
- Lab session multiple-choice questions. Weight 30%

4. Methodology, learning tasks, syllabus and resources

4.1. 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.

A central component of this course is the solution to problems and the practical experience with such solutions, *via* homework assignments. It is recommended that students try to solve all the problems before seeking the 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.

2 Homework assignments, students are encouraged to work regularly during the semester through a 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 have not the option of continuous assessment.

3. Practice sessions (lab and 1/2 group problems). 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 The autonomous study, the time spent studying and doing homework is the single most important factor in students learning the 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 thoughtful questions.

Further information regarding the course will be provided on the first day of class.

4.2. Learning tasks

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

Lectures

Forty-five hours 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~~ Practice sessions (Lab and 1/2 group problems)

- Lab sessions: 3 sessions, 3 h each. At the end of each lab session, students will solve some questions to gauge how much they have learned. Session 1 is devoted to the analysis of conceptual questions through a digital education tool. In sessions 2 and 3, 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 make decisions.
- 1/2 group sessions: 6 sessions, 1 h each. Students are expected to participate actively, to discuss information and concepts covered in lectures, and to reflex/analysis the problems to be solved.

Homework assignment

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.

4.3. Syllabus

The course will address the following topics:

- 1. Introduction.
- 2. Review of mathematical and geometry concepts.
- 3. Kinematics modeling of mechanical systems.
- 4. Kinematics of particles. Relative and absolute motion.
- 5. Kinematics of rigid bodies in 3D motion. Rolling without slipping.
- 6. Planar Kinematics of rigid bodies. Application to mechanisms.

- 7. Forces in Newtonian mechanics of rigid bodies.
- 8. Kinetics of particle
- 9. Body parameters: center of gravity and inertia tensor.
- 10. Newton-Euler?s laws of 3D motion: rigid body and multibody system.
- 11. Newton-Euler?s laws of 2D motion. Free body diagram.

4.4. 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.

4.5. Bibliography and recommended resources

Access to Bibliography:

http://biblos.unizar.es/br/br_citas.php?codigo=30011&year=2019