Universidad Zaragoza

Year : 2020/21

29811 - Mechanics

Syllabus Information

Academic Year: 2020/21
Subject: 29811 - Mechanics
Faculty / School: 110 - Escuela de Ingeniería y Arquitectura
326 - Escuela Universitaria Politécnica de Teruel
Degree: 440 - Bachelor's Degree in Electronic and Automatic Engineering
444 - Bachelor's Degree in Electronic and Automatic Engineering
ECTS: 6.0
Year: 2
Semester: First semester
Subject Type: Compulsory
Module: ---

1.General information

1.1.Aims of the course

1.2.Context and importance of this course in the degree

1.3.Recommendations to take this course

2.Learning goals

2.1.Competences

2.2.Learning goals

2.3.Importance of learning goals

3.Assessment (1st and 2nd call)

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

4.Methodology, learning tasks, syllabus and resources

4.1.Methodological overview

This course is concerned about the relationship between the forces acting on a mechanical system (vehicles or robots in 3D, planar mechanisms in 2D) and the motion which is produced by these actions, that is to say, a course of Newtonian Dynamics.

This course is divided in two consecutive and interconnected parts: kinematics (motion description without being concerned about causes) and kinetics (causes analysis and modelling and resolution of dynamic problem).

Kinematics will be extended to 3D systems as it was explained before (Eulerian angles for example), and kinetics 3D models using Newtonian laws will be solved. Energy principles will be only applied to 2D systems with one DOF for clarity.

The student will attend theory sessions where the main course contents are presented and discussed, problem-solving sessions where practical applications of the theoretical concepts are developed and solved, and lab sessions where the theoretical contents are applied.

At the same time, the student will solve some programmed exercises in small groups, promoting collaborative learning, following the basic topics from movement description to dynamical analysis.

4.2.Learning tasks

The course includes the following learning tasks:

ON-SITE WORK: 2.4 ECTS (60 hours)

1) Lectures (T1 type) (30 hours face to face)

During these sessions, theoretical and practical concepts are shown. These concepts consist of the mechanical systems explained by means of real examples. Student participation will be encouraged through questions and brief discussions. Basic documentation of the course will be available through the ADD.

2) Practice session (T2 type) (15 hours face to face)

Problems and real cases will be developed with the participation of students. Problem-solving will always be coordinated in time with the theoretical contents.

Students will be encouraged to previous work on the problems.

3) Laboratory sessions (T3 type) (15 hours face to face)

In these sessions, the student will follow a practical script which the student must prepare in advance in order to complete the concepts explained during lectures and problem sessions. During lab sessions, the student will work in movement calculation and geometrical resolutions. The set of lab sessions will be assessed together with other exercises as indicated above.

Laboratory sessions programmed by EINA (6 sessions; 2.5 hours per session)

- Position and orientation: importance in robotics
- Mechanism I: generalities, types, and applications
- Mechanism II: generalities, types, and applications
- Mass geometry: calculation and applications
- Case Study: approach and solving a dynamic problem

Laboratory sessions programmed by Escuela Universitaria Politécnica de Teruel (EUPT):

- Position and orientation problem: importance in robotics
- SolidWorks introduction
- Movement analysis I
- Movement analysis II
- Dynamics

AUTONOMOUS WORK: 3.6 ECTS (90 hours)

1) Assignments (T6 type) (30 personal hours)

The professor will suggest during the course, a set of activities which the students must solve to be assessed. Each student must present an individual academic dossier. Each student will dispose of two tutorial hours to guide this work.

2) Autonomous study (T7 type) (55 personal hours)

Autonomous study of the theoretical part and realization of problems. The autonomous work of the student will be encouraged by the homogeneous distribution during the term of a set of learning activities. Uniform distribution over time is suggested because of the structure of the course in which every concept is linked with the following. Short questionnaries after recommended readings will be made by students using ADD, before theoretical classes. Tutorial sessions are included in autonomous work and study to guide the student in the identification of learning problems, orientation in the course, attention to exercises and other assignments.

3) Assessments (T8 type) (5 hours face to face).

Evaluation tests are tools to assess the student and they are useful in order for the student to check the knowledge and understanding level of the course. A first test has been included during the term to reach this objective.

4.3.Syllabus

The course will address the following topics:

Lecture topics

1. Particle kinematics
   - Kinematic work frames: relative and absolute motion
   - Kinematic vectors: position, velocity, acceleration
2. Bases and orientation
   - Vectorial bases and orientation. Eulerian angles and mechanical systems rotations.
   - The derivative of an arbitrary vector
3. Relative motion
   - Velocity and acceleration using a moving reference frame
   - Motion from a moving reference system: case studies
4. Kinematics of rigid bodies
   - General equations
   - Rolling without slipping
5. Mechanical systems kinematics
   - Generalized coordinates and degrees of freedom

- Constrains. Holonomic and non-holonomic systems.

6. 2D kinematics of rigid bodies.
   - Planar kinetics. Mechanisms.
   - Instant centre of rotation.
7. Forces in Newtonian mechanics
   - Force and moment. Torsor of forces.
   - Active and passive forces.
   - Basic models for mechanical elements: springs, dumpers, engines, friction...
8. Body parameters.
   - Centre of inertia. Examples.
   - Inertia tensor. Moments and products of inertia. Steiner's theorem.
   - Moment of inertia tensor.
9. Newtonian kinetics of rigid body systems
   - Equations of motion: Newton-Euler laws
   - Case studies in 3D motion
10. Work-energy principles
    - Work and energy. Kinetic and potential energy.
    - Work and energy principle application to planar systems. Case studies.

4.4.Course planning and calendar

Schedule sessions and assignments deadlines

The course calendar is defined by the University of Zaragoza. Further information concerning the timetable, classroom, office hours, assessment dates and other details regarding this course will be provided on the first day of class or please refer to the EINA website (http://eina.unizar.es) and EUPT website (https://eupt.unizar.es/).

Each teacher will inform about his office hours.

The other activities will be planned depending on the number of students and will be announced long in advance.

References and course material

1. Slides and notes of the course (Available in ADD)
2. Suggested problems and scripts of practice sessions (Available in ADD)
3. Reference book:
   - J. Lladó, B. Sánchez, ?Mecánica? Copy Center Digital, 2013
4. Complementary books: consult references and bibliography

4.5.Bibliography and recommended resources