Advanced kinematics and dynamics of machines

Academic Year: (2019 / 2020) **Review date: 30/09/2019 12:53:29**

Department assigned to the subject: Mechanical Engineering Department

Coordinating teacher: MENESES ALONSO, JESUS

Type: Compulsory ECTS Credits : 6.0

Year : 1 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Rigid body Mechanics, Machine Mechanics and Mechanisms Theory at a degree level.

OBJECTIVES

¿ Modelling of mechanical systems, machine or mechanism using different types of coordinates (Relative coordinates, reference point coordinates and natural coordinates).
¿ developing programs for solving kinematics and dynamics of mechanical systems, machine or mechanism.
¿ Applying the fundamentals of analytical mechanics to approach the equations of motion of mechanical systems, machine or mechanism.
¿ Applying numerical methods for solving the equations defining the mechanical behavior of mechanical systems, machine or mechanism.
¿ kinematic and dynamic modeling of articulated spatial mechanisms: serial and parallel robots
¿ Applying basic methods of synthesis of mechanisms
Presentation and defense of an original exercise carried out individually, consisting of a comprehensive project linked to the field of knowledge of machine engineering in which the competences acquired in the teaching are synthesized.
Ability for analysis and synthesis, organization and planning, abstraction and deduction.
Ability to propose original solutions to a machine or transport engineering problem
Ability to evaluate the operation and impact of a particular technology in the field of machine engineering

DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction to the Kinematics and Dynamics of Machines and Mechanisms. Mechanism degree of freedom. Type of Coordinates.
2. Advanced Kinematics of Mechanisms. Natural coordinates in 2D and 3D. Constraint equations.
3. Modelling of Mechanisms. Kinematics Modelling Using Natural Coordinates. Kinematics simulation. Overdetermined Mechanisms. Inverse kinematics.
4. Analytical Dynamics
5. Advanced Dynamics of Mechanisms. Inverse Vs. Forward Dynamics; Linked Vs. free set of coordinates. Newton-Euler equations. Lagrange equations for a set of dependent coordinates: Lagrange multipliers. Mass matrix. Vector of generalized forces. Numerical methods.
6. Modeling of State Space Systems and Computer resolution. Application to the detection and diagnosis of rotating machinery.
7. Articulated Mechanisms. Serial and Parallel Robots.
8. Design and Analysis of Clamping and Grip Mechanisms.
9. Synthesis of mechanisms.
10. Non-Conventional Mechanisms.

LEARNING ACTIVITIES AND METHODOLOGY

¿ Theoretical lectures and practical exercises led by the teacher. Students learn the theoretical content of the course and learn how to apply them by solving practical cases.
¿ Lessons in computer room. The student enhance their knowledge with the implementation of models

of mechanical systems, machines and mechanisms, software and the resolution of their kinematics and dynamics by means of numerical methods.
¿ Performing a work. The student demonstrates his ability to working in group, by applying the knowledge acquired to a real case. It consists in carrying out the design and / or optimization of a mechanical system using computer simulation, calculation or analysis tools, available to the University and / or the Department or, alternatively, in the development of an experimental work and characterization of a mechanical system, machine or mechanism. The work will be done under the direction and supervision of the teacher. Students must make a written report and a public presentation
¿ Participation in conferences, seminars or conferences related to the subject. By attending one or two lectures, students acquire a global knowledge about a topic related to the subject and its relation to other adjacent areas

ASSESSMENT SYSTEM

% end-of-term-examination/test:	50
% of continuous assessment (assigments, laboratory, practicals…):	50

A. Theoretical-practical exam on the theoretical and practical exercises of the course program.
B. Continuous assessment. It consists of:
B1. Practical exercises and computer modeling to be proposed by the teachers of the subject throughout the course.
B2. Work: written report and public presentation.
Ordinary examination: the final grade is composed into A: 50%, B1: 20%, B2: 30%. To pass, it is necessary to obtain in exam A a minimum of 3.5 points out of 10.
Extraordinary examination: the final grade will be the maximum between:
- With continuous assessment: A: 50% B: 50%
- Without continuous assessment: A 100%

BASIC BIBLIOGRAPHY

- Ahmed A. Shabana Dynamics of multibody systems, Wiley, 1989

- Ahmed A. Shabana Computational Dynamics, Wiley, 2009

- Javier García de Jalón, Eduardo Bayo Kinematic and Dynamic Simulation of Multibody Systems, Springer-Verlag, 1994