INSTITUTO POLITÉCNICO DE BRAGANÇA

Course Unit	Applied Mechanics II			Field of study	Solid Mechanics and Structures		
Bachelor in	Mechanical Engineering			School	School of Technology and Management		
Academic Year	2022/2023	Year of study	2	Level	1-2	ECTS credits	6.0
Type	Semestral	Semester	1	Code	9123-759-2103-00-22		

Workload (hours)	162	Contact hours	T	-	TP	60	PL	-	TC	-	S	-	E	-	OT	-	O	-

T - Lectures; TP - Lectures and problem-solving; PL - Problem-solving, project or laboratory; TC - Fieldwork; S - Seminar; E - Placement; OT - Tutorial; O - Other

Name(s) of lecturer(s): Paulo Alexandre Gonçalves Piloto

Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:
1. Solve fundamental problems of particle kinematics, for rectilinear and curvilinear motion in different coordinate systems.
2. Solve fundamental problems of particle Kinetics, using Newton laws and draw the motion differential equation.
3. Solve kinetic problems for systems of particles, particularly variable systems (stationary and non-stationary).
4. Solve Kinetic problems for rigid bodies, understanding angular momentum, inertial matrix, principal inertia directions, studying body kinematics for plane and spatial motions.
5. Employ fundamental knowledge about energy methods and movement quantities.
6. Solve simple vibration prob. for mech. systems up to two degrees of freedom, with and without damping, in free and forced regime. Calculate natural frequencies. Characterized the resonance pheno.

Prerequisites

Before the course unit the learner is expected to be able to:
Understand differential, integral and matrix calculus. Understand Physics and Applied Mechanics I.

Course contents

1: Kinematics of particles (1 week). 2: Kinetics of particles (1, 5 week). 3: Kinetics of systems of particles (0, 5 week). 4: Kinetics of systems of particles – Energy methods (0, 5 week). 5: Kinematics of rigid bodies (2, 5 week). 6: Kinetics of rigid bodies (4, 5 week). 7: Kinetics of rigid bodies – Energy methods (0, 5 week). 8: Mechanical vibrations (2, 5 week). Review (1, 5 week).

Course contents (extended version)

1. Chapter 1: Kinematics of particles (1 week):
   - Rectilinear and curvilinear motion.
   - Position, velocity and acceleration definition and characterization.
   - Cartesian, curvilinear and polar coordinate systems.
2. Chapter 2: Kinetics of particles (1, 5 week):
   - Newton's second law.
   - Equation of motion.
   - Dynamic equilibrium. Linear and angular momentum of a particle.
   - Angular momentum conservation. Motion of a particle under central force.
3. Chapter 3: Kinetics of systems of particles (0, 5 week):
   - Newton equation of motion.
   - Quantity of movement and angular momentum.
   - Angular momentum in mass centre.
   - Principles of conservation of energy and conservation of angular momentum.
   - Kinetic and potential energy.
4. Chapter 4: Kinetics of systems of particles – Energy methods (0, 5 week):
   - Principle of Work and energy. Energy conservation.
   - Impulse and momenta quantities. Stationary and non-stationary systems.
5. Chapter 5: Kinematics of rigid bodies (2, 5 week):
   - Plane and three dimensional rigid body motion.
   - Rotation with respect to a fixed point and with respect to an axis.
   - General rotation and translation motion. Absolute and relative velocity / acceleration.
   - Instantaneous centre of rotation. Fixed and moving reference frames.
   - Rate of change of a vector with respect to a rotating frame.
6. Chapter 6: Kinetics of rigid bodies (4, 5 week):
   - Equation of motion in plane and in space. Angular momentum for a rigid body.
   - D' Alembert principle. Systems of rigid body.
7. Chapter 7: Kinetics of rigid bodies – Energy methods (0, 5 week):
   - Work and energy principles. Work of a generalized force.
   - Kinetic energy. Conservation of energy principle. Conservation of angular momentum.
8. Chapter 8: Mechanical vibrations (2, 5 week):
   - Vibration phenomenon. Damped and undamped vibrations.
   - Free and forced vibrations.
   - Differential equation for motion. Natural frequency. Resonance phenomenon.
9. Review (1, 5 week):
   - Classes for review.

Recommended reading

1. [1] - Beer P. Ferdinand, Johnston Jr. Russel, Cornwell; ''Mecânica Vetorial para Engenheiros - Dinâmica"; - 9 edição; McGraw Hill.
2. [2] - Piloto, P. A. G; "Applied Mechanics II", Diapositivos com apresentação do conteúdo programático (versão em inglês, "english version").
3. [3] - Meriam J. L. , Kraige L. G. ; "Engeneering Mechanics - Dynamics", John Wiley & Sons, Inc.
4. [4] - R. C. Hibbeler; "Mecânica: Dinâmica"; 8 ed. , LTC

Teaching and learning methods

Theoretical exposition of the fundamental concepts should be presented at classes, complemented with practical exercises. The remaining period should be used to solve the proposed problems. Out of classes, students are invited to solve problems and do specific work, using computational methods.

Assessment methods

1. Final season: (distributed assessment) - (Regular, Student Worker) (Final)
   - Final Written Exam - 70% (Final examination for 70 % final mark (exam duration 2. 5 h).)
   - Laboratory Work - 30% (Working project during classes for 30 % final mark.)
2. Appeal and special season: - (Regular, Student Worker) (Supplementary, Special)
   - Final Written Exam - 100% (Final examination for 100 % final mark (exam duration 2. 5 h))
3. Final season: - (Student Worker) (Final)
   - Final Written Exam - 100% (Students with labour status may choose final exame for 100 % final mark.)

Language of instruction

Portuguese, with additional English support for foreign students.

Electronic validation

Paulo Alexandre Gonçalves Piloto	Luís Manuel Ribeiro Mesquita	João da Rocha e Silva	Paulo Alexandre Vara Alves
28-09-2022	06-10-2022	07-10-2022	07-11-2022