Course guide
270151 - FOMAR - Physics of Realistic Modelling and Animation

Last modified: 30/01/2024

Unit in charge: Barcelona School of Informatics
Teaching unit: 748 - FIS - Department of Physics.

Degree: BACHELOR'S DEGREE IN INFORMATICS ENGINEERING (Syllabus 2010). (Optional subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** English

LECTURER

Coordinating lecturer: JOAQUIN CASULLERAS AMBROS

Others: Segon quadrimestre:
JOAQUIN CASULLERAS AMBROS - 10

PRIOR SKILLS

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DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CCO2.2. Capacity to acquire, obtain, formalize and represent human knowledge in a computable way to solve problems through a computer system in any applicable field, in particular in the fields related to computation, perception and operation in intelligent environments.
CT1.2A. To interpret, select and value concepts, theories, uses and technological developments related to computer science and its application derived from the needed fundamentals of mathematics, statistics and physics. Capacity to solve the mathematical problems presented in engineering. Talent to apply the knowledge about: algebra, differential and integral calculus and numeric methods; statistics and optimization.
CT1.2B. To interpret, select and value concepts, theories, uses and technological developments related to computer science and its application derived from the needed fundamentals of mathematics, statistics and physics. Capacity to understand and dominate the physical and technological fundamentals of computer science: electromagnetism, waves, circuit theory, electronics and photonics and its application to solve engineering problems.
CT5.1. To choose, combine and exploit different programming paradigms, at the moment of building software, taking into account criteria like ease of development, efficiency, portability and maintainability.
CT5.2. To know, design and use efficiently the most adequate data types and data structures to solve a problem.
CT5.5. To use the tools of a software development environment to create and develop applications.

Generical:
G9. PROPER THINKING HABITS: capacity of critical, logical and mathematical reasoning. Capacity to solve problems in her study area. Abstraction capacity: capacity to create and use models that reflect real situations. Capacity to design and perform simple experiments and analyse and interpret its results. Analysis, synthesis and evaluation capacity.

TEACHING METHODOLOGY

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LEARNING OBJECTIVES OF THE SUBJECT

1.To know, understand and use correctly the relationships between reference frame transformations.
2.To be able to develop mathematical models of articulated rigid bodies systems.
3.Mastering the Denavit-Hartenberg formalism.
4.To be able to identify the appropriate set of variables for the physical system studied. To be able to determine the joint variable values in order to achieve a given configuration in static conditions.
5.To build a mathematical model of the physical properties of large bodies (a rock, a rigid element of arbitrary shape), articulated rigid systems (robots, industrial manipulators). To understand the concept of inertia tensor to describe the mass distribution of an object.
6.To understand and to be able to use the laws of kinematics and dynamics in systems of many particles.
7.Understand and properly use conservations theorems for some quantities of motion.
8.to know how to describe and determine the effects of various forces: gravity, aerodynamic drag, elastic forces.
9.To use the Lagrangian formalism in order to determine statics and dynamics equations.
10.To identify the relevant variables in systems acting under restricted dynamic conditions.
11.To be able to incorporate the effects of constraint conditions on the dynamic equations.
12.To know and be able to use computer mathematical methods for the integration of dynamic equations.
13.Being able to build an animation on the basis of the computer numerical solution of the dynamic equations of the system.

STUDY LOAD

Type	Hours	Percentage
Hours large group	30,0	20.00
Hours small group	15,0	10.00
Guided activities	6,0	4.00
Hours medium group	15,0	10.00
Self study	84,0	56.00

Total learning time: 150 h

CONTENTS

Geometric transformations in space. Denavit-Hartenberg formalism.

Description:
Transformation relationships between reference systems. Denavit-Hartenberg formalism. Mathematical modelling of rigid, articulated systems.

Rigid body physics.

Description:
Mathematical modelling of the physical properties of large bodies (a rock, a rigid element), articulated rigid systems (robots, industrial handling devices). Mass distribution, inertia tensor.

Interacting N-body systems.

Description:
Kinematics and dynamics in many particles systems. Conservation theorems. Types of relevant forces: gravity, aerodynamic drag, elastic forces. Collisions.

Dynamics of N degrees of freedom systems. Dynamics in restricted conditions.

Description:
Identification of relevant generalized variables. Systems under constrained dynamic conditions. Restricted dynamic equations.

Physically realistic animations.

Description:
integration of dynamic equations. Trajectory. Visualization of objects and systems in motion subject to kinematic constraints.

ACTIVITIES

partial exam

Description:
written examination.

Specific objectives:
1, 2, 3, 4, 5

Related competencies :
G9. PROPER THINKING HABITS: capacity of critical, logical and mathematical reasoning. Capacity to solve problems in her study area. Abstraction capacity: capacity to create and use models that reflect real situations. Capacity to design and perform simple experiments and analyse and interpret its results. Analysis, synthesis and evaluation capacity.

Full-or-part-time: 9h 30m
Guided activities: 1h 30m
Self study: 8h

Final exam

Description:
Course final exam.

Specific objectives:
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11

Related competencies :
G9. PROPER THINKING HABITS: capacity of critical, logical and mathematical reasoning. Capacity to solve problems in her study area. Abstraction capacity: capacity to create and use models that reflect real situations. Capacity to design and perform simple experiments and analyse and interpret its results. Analysis, synthesis and evaluation capacity.

Full-or-part-time: 14h 30m
Guided activities: 2h 30m
Self study: 12h

Execution and delivery of the final practice

Description:
Preparation of the final practice with its report.

Specific objectives:
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13

Related competencies :
G9. PROPER THINKING HABITS: capacity of critical, logical and mathematical reasoning. Capacity to solve problems in her study area. Abstraction capacity: capacity to create and use models that reflect real situations. Capacity to design and perform simple experiments and analyse and interpret its results. Analysis, synthesis and evaluation capacity.

Full-or-part-time: 12h
Self study: 12h

Development of Theory classes

Description:
Combining blackboard expositions and projection of multimedia content.

Specific objectives:
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13

Related competencies :
G9. PROPER THINKING HABITS: capacity of critical, logical and mathematical reasoning. Capacity to solve problems in her study area. Abstraction capacity: capacity to create and use models that reflect real situations. Capacity to design and perform simple experiments and analyse and interpret its results. Analysis, synthesis and evaluation capacity.

Full-or-part-time: 26h
Theory classes: 26h

problems classes

Description:
Discussing and solving problems.

Specific objectives:
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11

Related competencies :
G9. PROPER THINKING HABITS: capacity of critical, logical and mathematical reasoning. Capacity to solve problems in her study area. Abstraction capacity: capacity to create and use models that reflect real situations. Capacity to design and perform simple experiments and analyse and interpret its results. Analysis, synthesis and evaluation capacity.

Full-or-part-time: 15h
Practical classes: 15h

Lab work

Description:
Develop the scheduled laboratory work.

Specific objectives:
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13

Related competencies :
G9. PROPER THINKING HABITS: capacity of critical, logical and mathematical reasoning. Capacity to solve problems in her study area. Abstraction capacity: capacity to create and use models that reflect real situations. Capacity to design and perform simple experiments and analyse and interpret its results. Analysis, synthesis and evaluation capacity.

Full-or-part-time: 15h
Laboratory classes: 15h

Study and preparatory work for lab sessions.

Description:
Students will study the material provided, and on the basis of the theoretical tools explained in class, prepare work to be held in the laboratory.

Specific objectives:
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13

Related competencies :
G9. PROPER THINKING HABITS: capacity of critical, logical and mathematical reasoning. Capacity to solve problems in her study area. Abstraction capacity: capacity to create and use models that reflect real situations. Capacity to design and perform simple experiments and analyse and interpret its results. Analysis, synthesis and evaluation capacity.

Full-or-part-time: 36h
Self study: 36h

Solving problems and exercises

Description:
Personal work, solving problems and exercises

Specific objectives:
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11

Related competencies :
G9. PROPER THINKING HABITS: capacity of critical, logical and mathematical reasoning. Capacity to solve problems in her study area. Abstraction capacity: capacity to create and use models that reflect real situations. Capacity to design and perform simple experiments and analyse and interpret its results. Analysis, synthesis and evaluation capacity.

Full-or-part-time: 22h
Self study: 22h

GRADING SYSTEM

The evaluation will be done by means of two exams (partial and final), which will provide an exam mark (Ex_grade), together with the realization of a series of computation lab practices and assignments which will provide the laboratory grade (Lab_grade).
The relative weights of the partial and final exam will be 25% and 75% respectively (0% and 100% in case the final exam grade is higher than the partial ones). The degree of achievement of the objectives set in the different phases will be taken into account in the assessment of the computation lab practices (Lab_grade)..

The course grade will be calculated based on the average of the two grades:

Course_grade = (Ex_grade + Lab_grade) / 2

The assessment of the transversal competence G9.1 will be done by means of the weighted average of the marks assigned to this competence in the partial and final exams, with the same weights of 25% and 75% respectively, (0% and 100% in case that of the end it is a note superior to the partial one).

The assessment of transversal competence G9.1 will be made through a weighted average of the grades assigned to this competence in the partial and final exams, with the same weights of 25% and 75% respectively (0% and 100% should the final exam result be better than the partial one).

BIBLIOGRAPHY

Basic:
- Garcia, D.; Guardia, E. Elements de mecànica aplicada a la robòtica. Edicions UPC, 1996. ISBN 8483011670.
- Riley, W.F.; Sturges, L.D. Ingeniería mecánica: vol. 2: dinámica. Reverté, 1996. ISBN 8429142568 (V.2).