Course guide
230861 - SM - Stochastic Methods for Optimization and Simulation

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

Degree: MASTER'S DEGREE IN ENGINEERING PHYSICS (Syllabus 2018). (Optional subject).
ERASMUS MUNDUS MASTER'S DEGREE IN BIO & PHARMACEUTICAL MATERIALS SCIENCE (Syllabus 2021). (Optional subject).

Academic year: 2023  ECTS Credits: 4.0  Languages: English

LECTURER
Coordinating lecturer: Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/responsables-assignatura
Others: Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/professorat-assignat-idioma

PRIOR SKILLS
Calculus (differential and integral). Basic experience in numerical computer programming.

REQUIREMENTS
No requirements

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Basic:
CB7. Students should know how to apply the knowledge acquired and their problem-solving ability in new or little-known environments within broader (or multidisciplinary) contexts related to their area of study.
CB8. Students should be able to integrate knowledge and face the complexity of formulating judgments based on information that, being incomplete or limited, includes reflections on the social and ethical responsibilities linked to the application of their knowledge and judgment.

TEACHING METHODOLOGY
-Master classes
-Class exhibitions
-Team work
-Written work
-Problem resolution
-Practical exercises

Last modified: 14/12/2023
LEARNING OBJECTIVES OF THE SUBJECT

- Ability to generate random numbers according to simple probability distribution laws
- Ability to perform a multidimensional integral using the Monte Carlo method and correctly estimate its statistical variance
- Know the methods for reducing variance and their optimal choice according to the type of problem to be solved
- Know how to make a calculation program for the classical simulation of a multiparticulate system using the Metropolis method
- Ability to perform multidimensional optimization using stochastic techniques
- To know the main stochastic methods used in the study of quantum systems

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self study</td>
<td>64.0</td>
<td>64.00</td>
</tr>
<tr>
<td>Hours large group</td>
<td>36.0</td>
<td>36.00</td>
</tr>
</tbody>
</table>

Total learning time: 100 h
CONTENTS

Stochastic methods for optimization and simulation

Description:
1. Monte Carlo integration: distribution functions and their sampling, crude Monte Carlo, rejection, variance reduction techniques, multidimensional integration, Metropolis method.


5. Applications of Monte Carlo methods to quantum systems: wave functions for bosons and fermions, variational Monte Carlo, diffusive Monte Carlo, path integral Monte Carlo.

Specific objectives:
Knowledge of the techniques in optimal control theory and the ability to apply Monte Carlo methods to find the optimal solution.

Know how to make a classical simulation of a multiparticle system using the Metropolis method.

Understand the basic theory of quantum Monte Carlo, and to know how to build a Monte Carlo program for the calculation of its properties.

Related activities:
Lectures
Assisted practices
Development of Monte Carlo programs
Autonomous learning

Related competencies:
CB7. Students should know how to apply the knowledge acquired and their problem-solving ability in new or little-known environments within broader (or multidisciplinary) contexts related to their area of study.
CB8. Students should be able to integrate knowledge and face the complexity of formulating judgments based on information that, being incomplete or limited, includes reflections on the social and ethical responsibilities linked to the application of their knowledge and judgment.

Full-or-part-time: 100h
Theory classes: 24h
Practical classes: 10h
Guided activities: 10h
Self study: 56h

GRADING SYSTEM

Oral presentation 25%
Works carried out by the student 75%

No reassessments will be made.
EXAMINATION RULES.

Presentation of practical work in the classroom with computer equipment.

Evaluable written report.

BIBLIOGRAPHY

Basic:

RESOURCES

Computer material:
- Programació científica. Scientific programming languages and visualization tools