Course guides
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: 2021  ECTS Credits: 4.0  Languages: English

LECTURER

Coordinating lecturer: Joaquim Casulleras
Others: Gregory Astrakharchik

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Basic:
CB7. (ENG) Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio.
CB8. (ENG) Que los estudiantes sean capaces de integrar conocimientos y enfrentarse a la complejidad de formular juicios a partir de una información que, siendo incompleta o limitada, incluya reflexiones sobre las responsabilidades sociales y éticas vinculadas a la aplicación de sus conocimientos y juicio.

TEACHING METHODOLOGY

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

LEARNING OBJECTIVES OF THE SUBJECT

- Ability to generate random numbers according to simple laws of probability distribution
- Ability to perform a multidimensional integral through the Monte Carlo method and correctly estimate its statistical variance
- Know how to perform a calculation program for the classical simulation of a system multiparticular using the Metropolis method
- Know the methods of variance reduction and their optimal choice according to the type of problem to solve
- Ability to perform multidimensional optimization using techniques stochastic
- 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>Hours large group</td>
<td>36.0</td>
<td>36.00</td>
</tr>
<tr>
<td>Self study</td>
<td>64.0</td>
<td>64.00</td>
</tr>
</tbody>
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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.

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

**GRADING SYSTEM**

Oral tests 20% - 30%
Works carried out by the student 70% - 80%

**BIBLIOGRAPHY**

Basic:
- Duchi, John C. Introductory lectures on stochastic optimization [on line]. [Stanford]: Park City Mathematics Institute, Graduate Summer School Lectures [, 2016Available on: https://stanford.edu/~jduchi/PCMIConvex/.