Universitat Autònoma de Barcelona

2023/2024

Mathematical Tools

Code: 103302
ECTS Credits: 8

Degree	Type	Year	Semester
2501922 Nanoscience and Nanotechnology	FB	2	A

Contact

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Teaching groups languages

You can check it through this link. To consult the language you will need to enter the CODE of the subject.
Please note that this information is provisional until 30 November 2023.

Teachers

Josep Triginer Garcia

Prerequisites

There are none. The content and the methods introduced in this course presuppose knowledge of the first year M

courses:
Fonaments de Matemàtiques and
Càlcul.

Objectives and Contextualisation

The aim of the course is to enable the students to use some mathematical tools which are necessary for the study and modeling of nanosystems: analysis and resolution of ordinary and partial differential equations, and some basic tools of probability calculus and statistics.

Competences

- Apply the concepts, principles, theories and fundamental facts of nanoscience and nanotechnology to solve problems of a quantitative or qualitative nature in the field of nanoscience and nanotechnology.
- Communicate orally and in writing in one's own language.

- Demonstrate knowledge of the concepts, principles, theories and fundamental facts related with nanoscience and nanotechnology.
- Interpret the data obtained by means of experimental measures, including the use of computer tools, identify and understand their meanings in relation to appropriate chemical, physical or biological theories.
- Learn autonomously.
- Manage the organisation and planning of tasks.
- Obtain, manage, analyse, synthesise and present information, including the use of digital and computerised media.
- Reason in a critical manner
- Recognise and analyse physical, chemical and biological problems in the field of nanoscience and nanotechnology and propose answers or suitable studies for their resolution, including when necessary the use of bibliographic sources.
- Resolve problems and make decisions.

Learning Outcomes

1. Abstract the essential variables of the phenomena studied, relate them to each other and deduce properties.
2. Communicate orally and in writing in one's own language.
3. Correctly use specific computer programs and data processors to accurately determine magnitudes of measurement and estimate the associated uncertainty.
4. Identify the mathematical nature of certain physical and chemical phenomena.
5. Learn autonomously.
6. Manage the organisation and planning of tasks.
7. Mathematize certain physical, chemical or biological processes and use accurate mathematical tools to obtain conclusions and interpret the results.
8. Obtain, manage, analyse, synthesise and present information, including the use of digital and computerised media.
9. Reason in a critical manner
10. Recognise the real situations in which the most common probabilistic distributions appear in the field of nanoscience and nanotechnology.
11. Recognise the role of probability and statistics as basic tools of the scientific method.
12. Resolve problems and make decisions.
13. Show the necessary calculation skills to work correctly with formulas, chemical equations or physics models.
14. Use accurate mathematical tools to make a correct evaluation of experimental results, putting special emphasis on giving sense to the conclusions obtained.
15. Use calculation and simulation tools to substantiate explanatory hypotheses of experimental measures.
16. Use graphic and numeric methods to explore, summarise and describe data.
17. Use statistical programs and apply statistical data treatment methods to the interpretation of the results.

Content

I. ORDINARY DIFFERENTIAL EQUATIONS

1. General properties. First order Equations.
2. Second order linear Equations.
3. Systems of equations. Stability.

II. PARTIAL DIFFERENTIAL EQUATIONS

1. Fourier series and Fourier transforms.
2. Separation of variables.
3. Numeric solution schemes.

III. INTRODUCTION TO PROBABILITY AND STATISTICS

1. Basic concepts. Conditional probability and Bayes Theorem.
2. Random variables and Central Limit Theorem.
3. Estimators and sampling distributions.

Methodology

- Theory classes: The concepts and methods of the different subjects will be introduced, with a variety of examples.

- Problems classes: Teachers will solve selected exercises from a collection that will be available to the students beforehand.

- Practical classes: They will be held in a computer classroom. Activities will be proposed to be carried out by means of an adequate software. The results of this practical work must be presented within a given deadline.

- Autonomous work: It is imperative that students complement face-to-face activities with autonomous, individual or group work; to practice the resolution of problems is especially important.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Practical classes	6	0.24	6, 8, 9, 17, 14, 3, 15, 16
Problems classes	17	0.68	1, 2, 13, 11, 12, 14
Theory classes	49	1.96	1, 4, 7, 9, 11, 14
Type: Autonomous			
Personal study	40	1.6	
Preparation for the practical classes	9	0.36	
Problem solving	70	2.8	5

Assessment

Partial exams: Three partial tests will be carried out, with a weight in the final evaluation of 25% each. At the end of the course, a re-evaluation exam for this 75% will be held for students who need it.

Practical sessions and delivery of solved problmes: The remaining 25% will come from the evaluation of the delivered problems and from the results of the practical sessions in equal parts. The presentation of the results of the practical sessions will be mandatory.

Re-evaluation: Only students who have completed 2/3 of the assessment activities may opt for the re-evaluation; for example: the three term tests, or two term tests, the practical sessions and half of the problems delivered.

The student who carries out evaluation activities that involve less than 50% of the total evaluation will be considered "not assessable".

Single Assessment (UA):

Students following the single evaluation modality must take a final test similar to the pariial exams but comprising all the subject matter. This test will be carried out on the same day that the third partial exam and it will account for a 85% of the grade.

The results of the practical sessions is also mandatory, in the same dates as the other students, and will accounnt for the ramaining 15% of the grade.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Delivery of solved problems	12,5%	0	0	1, 5, 2, 13, 4, 7, 8, 9, 11, 10, 12, 14, 3, 16
Partial exams	75%	9	0.36	1, 2, 13, 4, 7, 8, 9, 11, 12
Results of the practical sessions	12,5%	0	0	1, 5, 6, 8, 9, 17, 12, 3, 15, 16

Bibliography

- W. E. Boyce, *Ecuaciones diferenciales y problemas con valores en la frontera*, Limusa, 2010.
- J. David Logan, *A First Course in Differential Equations,* Springer 2006
- J. David Logan, *Applied Partial Differential Equations*, Springer 2004
- R. Delgado de la Torre, *Probabilidad y estadística para ciencias e ingenierías*, Delta, 2008.
- S. M. Ross, *Introduction to Probability and Statistics for Engineers and Scientists*, 4th Ed. Acedemic Press 2009

Software

maxima: https://maxima.sourceforge.io/