UAB
Universitat Autònoma de Barcelona

# Nanoscale Physics

2026/2027

Code: 106820
Credits: 6

| Degree programme | Type | Course |
|---|---|---|
| Nanoscience and Nanotechnology | OB | 3 |

## Contact lecturer

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## Teaching staff

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## Group languages

You can consult this information at the end of the document.

## Prerequisites

It is required to have successfully completed the Semiconductor Devices and Quantum Phenomena II subjects.

## Objectives

The objective of this subject is to provide the basis for the student to understand the variation of the physical properties (electronic, optical, thermal and transport) of materials on the nanometer scale.

## Learning outcomes

- CM18 (Solve problems resulting from the nanoscale by using calculation and simulation tools.) Solve problems resulting from the nanoscale by using calculation and simulation tools.
- CM19 (Work independently to solve problems and practical cases related to nanoscale phenomena.) Work independently to solve problems and practical cases related to nanoscale phenomena.
- CM21 (Acknowledge the contribution women have made to the study of nanoscale phenomena.) Acknowledge the contribution women have made to the study of nanoscale phenomena.
- KM32 (Describe the nanoscale effect on the electronic, thermal, optical, magnetic and transport properties of materials.) Describe the nanoscale effect on the electronic, thermal, optical, magnetic and transport properties of materials.
- KM36 (Recognise the physical principles underlying photonic and nanophotonic systems.) Recognise the physical principles underlying photonic and nanophotonic systems.
- SM30 (Predict the behaviour, properties and uses of nanomaterials and nano-systems as a consequence of low dimensionality.) Predict the behaviour, properties and uses of nanomaterials and nano-systems as a consequence of low dimensionality.

## Contents

Thermal transport: Kinetic Theory. Boltzmann's equation. Ballistic phononic transport.

4. Thermoelectric phenomena

Depending on the health situation, and the need to do non-face-to-face teaching, it can be adapted.

## Learning activities and methodology

| Title | Hours | ECTS | Learning outcomes |
|---|---|---|---|
| Lectures | 28 | 1.12 | |
| Practices | 6 | 0.24 | |
| Problems | 13 | 0.52 | |
| Study: exams, reports preparation, problem resolution | 60 | 2.4 | |

In this course, specific teaching is offered where there will be different formative activities that are described next. The work hours that are specified for each training activity correspond to an average student. Naturally, not all students need the same time to learn concepts and carry out certain activities, so the distribution of time should be understood as guidance. In this subject, we try to promote the active participation of the student as a relevant learning tool.

Direct training activities:

*Master classes sessions:* classes in which the theory teacher explains the most relevant concepts of each subject. Usually, they are blackboard classes, although in some cases classes are done with computer programs. Students have notes or copy of the transparencies in pdf format in advance uploaded in the virtual campus of the UAB.

*Problems sessions:* classes in which the problem teacher explains to the students how the standard problems of the subject are solved. The teacher will resolve in detail a list of selected problems and will propose to the students a list of problems that must be delivered as a mandatory task that will be part of the evaluation of the subject.

*Discussion classes:* discussion of selected readings (scientific articles) in direct relation to the topic of the subject will be evaluated with a presentation in class.

*Laboratory practices:* Students will perform laboratory practices as a learning tool.

Supervised training activities:

*Tutorials*: in the hours of attention to the students, the teachers will be available for the consultations of the students.

Autonomous training activities:

*Problem-solving and delivery of additional problems:* the student must solve the problems of the list given by the teachers. Some selected problems will be required to be delivered and will be evaluated by the professor.

Studyand preparation of exams: Personal work of the student to acquire the theoretical concepts of the subject

and the abilities for the resolution of problems.

Works: students will be asked to generate a small report, in certain thematics that complement the contents of the subject. The derived marks will be part of the evaluation.

If the health situation requires a reduced attendance:

-Master sessions will be uploaded in video format, and discussed online in tutorial sessions in the scheduled hours.
-On-site sessions will be used essentially to solve problems, and to the realization of specific tutorials on the theoretical material previously supplied.
-The assistance to laboratory practices will be addapted to follow health considerations.

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.

## Assessment

## Continuous assessment activities

| Title | Weight | Hours | ECTS | Learning outcomes |
|---|---|---|---|---|
| Continuous Assessment: Practices, problems, reports | 30% | 34 | 1.36 | CM18, CM19, CM21, KM32, KM36, SM30 |
| EXAMS | 70% | 9 | 0.36 | CM19, KM32, KM36, SM30 |

ASSESSMENT

The course will include different types of assessment activities.

Midterm Examinations

Several midterm examinations or synthesis tests (more than two) will be conducted, assessing the theoretical knowledge corresponding to each thematic block separately. These tests will be scheduled on the dates already allocated for midterm examinations throughout the semester. The combined weight of the midterm examinations will account for 70% of the final grade. If any midterm examination receives a mark below 4 out of 10, it must be retaken in the final resit assessment.

The relative weight of each midterm examination will be determined according to the academic year and the content covered, but in no case will any single midterm account for more than 50% of the final grade.

Continuous Assessment Activities and Laboratory Work

Throughout the course, students will complete various continuous assessment activities, which will account for 30% of the final grade. These activities may include laboratory sessions, laboratory reports, monographic assignments, presentations, and problem sets.

Recovery/Resit Examination

A final resit examination will be offered, allowing students to be reassessed on any thematic blocks they have failed.

To be eligible for the resit examination, students must have completed assessment activities representing at least two-thirds of the total assessment of the course. Continuous assessment activities are intended to evaluate students' ongoing engagement with the course and, therefore, like laboratory work, are not eligible for resit. Failure to attend the required resit examination will result in a grade of "Not Evaluable".

Should health-related circumstances require it, assessment activities will be adapted to a non-face-to-face format.

SINGLE ASSESSMENT

Theoretical Examination (70%)

Students who have opted for the single-assessment modality will be required to complete a final examination covering the content of the different thematic blocks developed throughout the course. This examination will account for 70% of the final grade (equivalent to the weight of the midterm examinations in the standard assessment pathway) and will be scheduled on the date of the second midterm examination, with an extended examination period. If the mark obtained in this examination is below 4 out of 10, the student must take a resit examination. Failure to attend the resit examination will result in a grade of Not Assessed.

Laboratory Work (15%) and Continuous Assessment Tasks (15%)

Students following the single-assessment pathway must complete the compulsory laboratory sessions, which account for 15% of the final grade. One or more laboratory groups composed exclusively of single-assessment students will be organized. These students must attend the laboratory sessions in person during either the first or the second scheduled session.

The reports for the two laboratory sessions must be submitted individually on the day of the examination (the date scheduled for the second midterm examination). On the same day, students must also submit individual assignments consisting of a selected problem set (5%) and a video-recorded individual presentation of a scientific article related to the course (10%).

The laboratory component and assignment submissions are not eligible for resit. Failure to attend the required resit examination will result in a grade of "Not Evaluable".

Use of AI

In this course, the use of Artificial Intelligence (AI) technologies is permitted exclusively for support tasks, such as literature and information searches, proofreading, and translations. Students must clearly identify any parts generated using these technologies, specify the tools employed, and include a critical reflection on how these tools influenced both the process and the final outcome of the activity. Failure to disclose the use of AI transparently in an assessed activity will be considered a breach of academic integrity and may result in a partial or total grade penalty, or more severe disciplinary sanctions in serious cases.

Any irregularity committed during an assessment activity (academic fraud, plagiarism, or improper use of AI, unless such use is expressly authorized in the course guide) that may lead to a significant alteration of the assessment outcome will result in a grade of 0 for that activity. If the course guide establishes a minimum grade requirement in that assessment activity as a compulsory condition for passing the course, or if multiple

irregularities occur within the same course, the final grade for the course will be 0. Furthermore, disciplinary proceedings may be initiated against any student involved in such misconduct.

## Bibliography

Books


- Chen, Gang. (2005). Nanoscale energy transport and conversion : a parallel treatment of Che

electrons, molecules, phonons, and photons. Oxford University Press

Disponible en paper a la biblioteca

- Datta, Supriyo. (1995). Electronic transport in mesoscopic systems.Cambridge Datt

University Press

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- Datta, Supriyo. (1995). Electronic transport in mesoscopic systems.Cambridge Datt

University Press

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- Davies, J. H. (1998). The physics of low-dimensional semiconductors : an introduction. Davi

Cambridge University Press

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Cambridge University Press

Disponible en paper a la biblioteca


## Software

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### Course groups and languages

The information provided is provisional until November 30. After this date, you will be able to consult the language of each group through this link. To access the information, you will need to enter the course CODE

| Type of teaching | Group | Language | Semester | Shift |
|---|---|---|---|---|
| (TE) Theory | 1 | Catalan/Spanish | second semester | afternoon |
| (PAUL) Classroom practices | 1 | Catalan/Spanish | second semester | afternoon |
| (PLAB) Practical laboratories | 1 | Catalan/Spanish | second semester | morning-mixed |

| | | | | |
|---|---|---|---|---|
| (PLAB) Practical laboratories | 2 | Catalan/Spanish | second semester | morning-mixed |
| (PLAB) Practical laboratories | 3 | Catalan/Spanish | second semester | morning-mixed |