Bachelor in Physics
(Academic Year 2022-23)

Electronic Physics		Code	800527	Year	4th	Sem.	1st
Module	Applied Physics	Topic	Obligatory of Applied Physics	Character	Optional		

	Total	Theory	Exercises/Lab
ECTS Credits	6	4.2	1.8
Semester hours	45	31	14

Learning Objectives (according to the Degree's Verification Document)

- To understand the meaning of the band structure of a semiconductor.
- To understand the meaning of the effective mass and mobility of a semiconductor and in general all concepts related to carrier transport.
- To know how to calculate carrier concentrations in both equilibrium and non-equilibrium situations.
- To understand the continuity and current equations as basic for the operation of electronic devices.
- To understand the phenomenon of carrier injection and the Shockley theory of the P-N junction.
- To understand basically the physics of electronic devices.

Brief description of contents

Electronics (semiconductors: electronic states and band structures; carrier statistics, recombination; carrier transport, Hall effect, ambipolar transport; p-n junction).

Prerequisites

Solid State Physics

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Theory/Exercises – Schedule and Teaching Staff

Group	Lecture Room	Day	Time	Professor	Period/ Dates	Hours	T/E	Dept.
B	5	Tu,Th	15:30-17:00	David Pastor Pastor	Whole semester	45	T/E	EMFTEL

Office hours

Group	Professor	Schedule	E-mail	Location
B	David Pastor Pastor	Sem. 1st: Mo: 12:00-13:00 We: 10:00-11:00 Sem. 2nd Th: 10:00-13:00	dpastor@fis.ucm.es	207.A 3rd Floor Central Module

Syllabus

1. Basic concepts of the band structure in solids

1. E-k diagrams.
2. Electrons and holes in semiconductors. Effective mass.
3. Real semiconductor band diagrams.

2. Equilibrium carrier statistics

1. Occupation of states in bands: density function of states; Fermi-Dirac and Maxwell-Boltzmann statistics.
2. Intrinsic semiconductors.
3. Doping of semiconductors. Extrinsic semiconductors.

3. Out-of-equilibrium carrier statistics

1. Generation and Recombination processes.
2. Pseudo Fermi levels.
3. Recombination mechanisms. Demarcation levels.
4. Calculation of lifetimes by modeling.

4. Kinetic theory of carrier transport

1. Kinetic model of semiconductor transport. Mobility.
2. Drag currents. Conductivity in the presence of magnetic field. Hall effect.
3. Diffusion currents. Continuity equation.
4. Ambipolar transport. Haynes-Shockley experiment.

5. Ideal PN junction

1. Equilibrium bonding Abrupt bonding approach.
2. Polarization bonding. Transition capacity.
3. Shockley's model of the junction. Currents.
4. Diffusion capacity.
5. Equivalent circuit of the PN junction.
6. Introduction to electronic devices.

Bibliography

1.-Bhattacharya P., "Semiconductor Optoelectronic Devices", Prentice Hall, 1998
2.- Bube R.H., "Electronic Properties of Crystalline Solids. An Introduction to Fundamentals", Academic Press, 1992
3.- Hess, K. "Advanced theory of semiconductor devices". IEEE Press, 2000.
4.- Neamen, D. A. "Semiconductor physics and devices. Basic principles". Irwin, 1992.
5.- Pierret, R. F. "Advanced semiconductor fundamentals". Modular Series on Solid State Devices, Volumen VI. Addison-Wesley, 1989
6.- Sapoval, B. y Hermann, C. "Physics of semiconductors". Springer-Verlag, 1995
7.- Shalímova, K. V. "Física de los semiconductores". Mir, 1975
8.- Tyagi, M. S. " Introduction to semiconductor materials and devices". John Wiley and ons, 1991.
9.- Wang, S. " Fundamentals of semiconductor theory and device physics". Prentice Hall, 1989

Online Resources
UCM Campus Virtual: https://www.ucm.es/campusvirtual/CVUCM/index1.php

Methodology

The following training activities will be developed:

- Theory lessons where the main concepts of the subject will be explained, including examples and applications (3 hours per week).
- Practical classes of problems and directed activities depending on the volume of enrollment.

In the theory lessons the blackboard and projections with computer and transparencies will be used.

Occasionally, these lessons will be complemented with computer simulations and virtual practices, which will be projected in the classroom.

Students will be provided with a series of problem sets prior to solving them in class, which will be available on the virtual campus.

As part of the continuous evaluation, students will have to hand in exercises such as solved problems exercises such as solved problems and specific works.

Evaluation Criteria

Exams	Weight:	70%

This evaluation block will consist only of a final exam.

The exam will have a part of theoretical-practical questions and another part of problems (of a similar level to those solved in class).

A form will be provided through the space that the course has in the virtual campus to take the part of the exam corresponding to problems.

Other Activities	Weight:	30%

The following continuous evaluation activities, among others, will be carried out:

- Problems and exercises delivered throughout the course individually or in groups.

Final Mark

The final grade will be the best of the options:

CFinal=0.7NExam+0.3NOtherActiv . CFinal=NExam .

where NOtherActiv is the grade corresponding to other activities and NExamen is the grade obtained from the exam.

The grade for the extraordinary exam in July will be obtained following exactly the same evaluation procedure.