Course Code	Course Title	ECTS Credits
PHYS-305	Semiconductor Physics and Technology	6
Department	**Semester**	**Prerequisites**
Engineering	Fall or Spring	PHYS-160, MATH-191
Type of Course	**Field**	**Language of Instruction**
Elective	Science	English
Level of Course	**Year of Study**	**Lecturer(s)**
1st Cycle	3rd	Dr Marios Nestoros
Mode of Delivery	**Work Placement**	**Co-requisites**
Face-to-face	N/A	None

Objectives of the Course:

The main objectives of the course are to:

- Present the technology behind semiconductor fabrication.
- Introduce students to the basic concepts of quantum mechanics and present its implications in the solid state.
- Develop an understanding of the processes taking place in a p-n junction.
- Develop an understanding of the p-n junction as power source and detector.

Learning Outcomes:

After completion of the course students are expected to:

- Describe in brief the technology of growth of semiconductor materials as well as the processes of doping and annealing.
- Solve Schrödinger's equation for square potential barriers, calculate the tunneling probability and explain qualitatively the Kronig-Penney Model and its implications (band gap).
- Calculate carrier concentration and Fermi level position in semiconductors
- Explain the effects of temperature, impurities and defects on carrier transport parameters.
- Explain the generation and recombination processes in semiconductors, develop and solve the carrier transport equation in simple cases
- Describe the basic steps/technology of fabrication of a p-n junction
- Explain and deduce: the depletion region, the build in voltage under zero, positive and negative bias and the ideal I-V characteristic of a p-n junction
- Calculate the free carrier generation rate under optical excitation, and explain the function of solar cells and photo-detectors.

Course Contents:

1. Atoms Molecules and Solids: types of bonds, basic crystallography, types of defects, crystal growth, doping, annealing.

2. Wave-particle duality: Heisenberg's Principle, Schrödinger's equation in one dimension, potential barriers and tunneling.
3. The Kronig Penney Model: forbidden and allowed energy bands, extension in three dimensions.
4. Equilibrium carrier statistics: electrons, holes, effective mass, energy gap, density of states, Fermi energy, intrinsic carrier concentration, statistics of donors and acceptors.
5. Carrier Transport: diffusion, mobility effects, conductivity, drift currents, total current density, Einstein relation
6. Non equilibrium Excess Carriers in Semiconductors: carrier generation and recombination statistics, continuity equation, ambipolar transport.
7. The p-n junction: basic fabrication processes, depletion region and build in potential barrier, charge flow under forward and reverse polarization, ideal p-n junction current, the tunnel diode.
8. Optical Properties and Devices: radiative transitions, optical absorption coefficient, solar cells, photodiodes.

Teaching Methods:

Lectures (2 hours/week), Tutorial and Simulations (1 hour/week)

Assessment Methods:

Midterm Test, Homework, Final Examination

Required Textbooks:

Authors	Title	Publisher	Year	ISBN
D. A. Neamen	Semiconductor Physics and Devices	Mc Graw Hill	2003	0-07-232107-5

Recommended Textbooks/Reading:

Authors	Title	Publisher	Year	ISBN
S.M.Sze	Semiconductor Devices	Wiley	2002	0-471-33372-7
R.F. Pierret	Semiconductor Fundamentals	Addison Wesley	1988	0-201-12295-2
J. R. Hook, H. E. Hall	Solid State Physics, 2nd Edition	Wiley	1991	978-0-471-92805-8

Other sources: An online "book" with simulations about solar cells and semiconductors at http://www.udel.edu/igert/pvcdrom/index.html