

UNIVERSITA' DEGLI STUDI MEDITERRANEA DI REGGIO CALABRIA

Subject Code 16498
Subject Name Semiconductor Physics
Professor Giacomo Messina

Department: DIIES
Degree course: Information Engineering
Class: L-8
Type of educational activity:
Disciplinary Area:
Scientific-Disciplinary Sector: FIS/01

Compulsory preliminary exams: General Physics
Course Year: III
Semester: II

ECTS: 6
Hours: 48

Synthetic description:

The purpose of the course is to provide the basis for understanding the characteristics, operation and limitations of present day semiconductor devices. The course is intended for students of the third year; the prerequisites for understanding the subjects are the courses of Mathematical Analysis and Physics of the first year. An introductory course of Electronics is helpful, but not essential.

The first part of the course presents an introduction to the crystal structure of solids, in particular silicon, germanium and gallium arsenide, and to the basic principles of Quantum Mechanics that are vital to the understanding of the energy bands in solids.

The second part of the course deals with the transport phenomena of the charge carriers in a semiconductor, under the influence of an external electric field or a concentration gradient. The study of the behaviour of excess carriers is vital to understand the operation of semiconductor electronic devices.

The third part deals with the physics of the basic semiconductor devices and the electrostatics of the p-n junction. Metal-semiconductor junctions, both rectifying and nonrectifying, are considered. The physics of the metal-oxide-semiconductor field-effect transistor (MOSFET) is studied.

Acquisition of knowledge on:

Basic crystal structures. Principles of Modern Physics. Energy bands in semiconductors. Mechanisms of charge transport in semiconductor materials. Electrostatics of the p-n junction. Metal-semiconductor junctions. Fundamentals of MOSFET.

Evaluation method:

Written test and interview

Student's independent work

Individual study of the subjects. Solution of exercises and problems to test the understanding of the subjects covered.

Detailed course program

Crystal Structure of solids – Crystal lattices – Primitive and unit cell – Basic crystalline structures: sc, fcc, bcc. Crystalline planes and Miller indices – Diamond and zincblende structure – Imperfections and impurities in solids.

Introduction to Quantum Mechanics - Infinite potential well - Energy bands - . Semiconductors in equilibrium – Charge carriers in semiconductors – Intrinsic Concentration – Extrinsic semiconductors – Donors and acceptors – Fermi level

Transport phenomena in a semiconductor – Drift velocity - Mobility – Carrier diffusion - Diffusion and drift current – Excess carriers – Carrier injection – Generation and recombination processes

Metal-semiconductor junction – p-n junction – Step junction – Built-in potential barrier- The p-n junction diode - I-V characteristics – Heterojunctions – Metal-oxide-semiconductor field-effect transistor (MOSFET) – n-channel and p-channel MOSFET - The basic MOSFET operation - The CMOS technology -

Resources and main references

Neamen D.A., Semiconductor Physics and Devices. Basic Principles, Mc Graw-Hill
S.M. Sze, Physics of Semiconductor Devices, Wiley-Interscience