Spring 2024

ECE 375-004: Introduction to Semiconductor

Leonid Tsybeskov

Hellen and John C. Hartmann Department of Electrical and Computer Engineering

New Jersey Institute of Technology

ECE 375. Introduction to Semiconductor Devices. 4 credits, 5 contact hours (3;2;0).

Instructor: Leonid Tsybeskov; email: tsybesko@adm.njit.edu; Tel.: 973-596-6594
Textbooks: Leonid Tsybeskov, Introduction to Semiconductor Devices for Undergraduate Engineering Students.

Course Description: This course addresses electronic devices on a fundamental level. Topics include semiconductor properties, P-N junction, Schottky barrier, BJT, MOSFET, and optoelectronic devices. The integrated laboratory involves measurements and simulations of semiconductor devices.
Prerequisite: Prerequisites: ECE 271, ECE 291.
Corequisite: none

Specific course learning outcomes (CLO): The student will be able to

1. Understand the major properties of semiconductor materials, and explain energy band diagrams and connections with the device structures and properties.
2. Understand and utilize the basic governing equations to analyze semiconductor devices; design semiconductor devices and calculate device characteristics.
3. Quantitatively evaluate limitations in the design of circuits based on specific semiconductor devices.
4. Understand and outline major steps of semiconductor device fabrication and microelectronic industry trends.
5. Perform measurements and extract major characteristics of semiconductor devices.

Relevant student outcomes (ABET criterion 3):

(1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics (CLO 1, 2, 3, 4);
(2) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors (CLO 3, 4, 5);
(4) an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts (CLO 3, 4)
(6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions (CLO 1, 2, 3, 5);
(7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies (CLO 3, 4, 5).

Computer-assisted design and course-specific software: Multisim, Kaleidagraph

Tentative Course Schedule	Weeks
Semiconductor microelectronics and the latest industrial revolution	1
Introduction to energy-band diagrams, density-of-states and semiconductor statistics	2-3
Semiconductors in equilibrium, charge carriers and doping	4
Carrier transport and excess carriers, drift and diffusion, carrier recombination	5
Structure and properties of the Schottky barrier	6
Structure and properties of the p/n junction, photodetectors and solar cells, lab 1-3	7-8
Bipolar Junction Transistors (BJT): basic principles and models of operation, lab 4	9
Basic properties of metal-oxide-semiconductor (MOS) structures	10
Field-effect Transistors: MOS FETs and memory devices, lab 5	11-12
Introduction to CMOS technology	13
Light emitting diodes and semiconductor lasers, lab 6	14

Grading policy:
Quizzes, midterm examination(s) and final examination – 55 %
Homeworks, simulation assignments, and labs – 45 %

Updates and Assignments: to be distributed via Canvas

Office hours, recitations, and group studies: By appointment

Honor Code: The NJIT Honor Code will be upheld; any violations will be brought to the immediate attention of the Dean of Students.

Instructor: Leonid Tsybeskov, Tel.: 973-596-6594, leonid.tsybeskov@njit.edu

Office: ECE Bldg., Room 207

Prepared by: L. Tsybeskov

This course outline serves to provide a big picture of the course. Instructional materials such as textbooks, individual topics, and grading policy are subject to revision and changes.