

Department of Electrical and Computer Engineering
New Jersey Institute of Technology

ECE 374: Introduction to Semiconductor Devices (3 credits, 3 contact hours, required course)

Instructor: Leonid Tsybeskov; email: tsybesko@adm.njit.edu; Tel.: 973-596-6594

Text books Jaspit Singh, Semiconductor Devices, ISBN 0-471-36245-X (main text)
 S. O. Kasap, Principles of electronic materials and devices, ISBN 0-07-295791-3

Course Description:

This course addresses electronic devices on a fundamental level. Topics include semiconductor materials, p/n junctions, Schottky barriers, transistors (including bipolar junction transistors and metal-oxide-semiconductor field-effect transistors), light emitters, photodetectors and solar cells. It provides a broad background for advanced courses in electronics, photonics and integrated circuit design.

Prerequisite: ECE students - ECE 271, instructor permission **Corequisite:** none

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

1. understand major properties of semiconductor materials, 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 design of circuits based on specific semiconductor devices;
4. understand and outline major steps of semiconductor device fabrication and microelectronic industry trends.

Relevant student outcomes (ABET criterion 3):

- (a) an ability to apply knowledge of mathematics, science, and engineering (CLO 1, 2, 3)
- (b) an ability to design and conduct experiments, as well as to analyze and interpret data (CLO 1, 2, 3)
- (c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability (CLO 3, 4)
- (f) an understanding of professional and ethical responsibility (CLO 3, 4)
- (h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context (CLO 4)
- (i) a recognition of the need for, and an ability to engage in life-long learning (CLO 3, 4)
- (j) a knowledge of contemporary issues (CO 4)
- (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice (CLO 3, 4).

Computer assisted design and course specific software:

PSPICE, Multisim, Kaleidagraph

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 by individual instructors.

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	7-8
Bipolar Junction Transistors (BJT): basic principles and models of operation	9
Basic properties of metal-oxide-semiconductor (MOS) structures	10
Field-effect Transistors: MOS FETs and memory devices	11-12
Introduction to CMOS technology	13
Light emitting diodes and semiconductor lasers	14

Grading policy: weekly quizzes (-25% for missing or failed QZ, QZs can be retaken only once), four home projects (up to 50 points each), two midterm examination (100 points each), and final examination (100 points).

Homeworks and projects

PSpice/Multisim - based simulations of semiconductor devices; data processing requires Kaleidagraph software

Updates and Assignments to be distributed via e-mail

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.

Office: ECE Bldg., Room 207

Prepared by: L. Tsybeskov

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