

EE 327 Theory and Design of IC Devices

Credits: 3

Categorization of credits: engineering topic

Instructors or course coordinator: Aaron Ohta

Textbook and Other Required Materials:

“Semiconductor Physics and Devices”, 4th Ed., by Donald Neaman

Reference Texts:

“Physics of Semiconductor Devices” (2nd Ed.) by S. M. Sze

“Semiconductor Device Fundamentals” by Robert F. Pierret

“Solid State Electronic Devices” (7th Ed) by Streetman and Banerjee

Designation: Elective (required for EP track students)

Catalog Description:

EE 327 Theory and Design of IC Devices (3) (3 Lec.) Band structure models and carrier transport physics review. Theory and design of semiconductor IC devices: Schottky diodes, bipolar devices (PN junction diodes, BJTs), FETs (MOSFETs, JFETs, and MESFETs). Pre: 324 and either MATH 243 or MATH 253A; or consent. DP

Pre-requisites: EE 324, MATH 243 (Calculus III) or MATH 253A (Accelerated Calculus III), and PHYS 274 (General Physics III); or consent.

Class/Lab Schedule: 3 lecture-hours per week. Exam review sessions as needed.

Topics Covered:

- Review: Band Structure, Carrier Statistics, Carrier Transport and Ambipolar Transport.
- Schottky Diodes
- PN Junction Diodes, including optoelectronics
- MOS Physics and MOSFETs
- CMOS, scaling issues
- Research-stage devices/technologies

Course Objectives and Relationship to Program Objectives:

The course objectives include providing the student with an understanding and command of integrated circuit device behavior, performance and design. The objective is also to enable the student to be able to understand and respond to new semiconductor devices emerging in support of integrated circuit design, semiconductor sensors and communications. The course is taught in a manner to enable device design capability development.

Course Outcomes and Their Relationship to Program Outcomes:

The following are the course outcomes and the subset of Program Outcomes (numbered 1-7 in square braces "[]") they address:

- The ability to apply device physics concepts to contemporary integrated circuit semiconductor devices. [1]
- Related fundamental physics concepts to device performance demonstrated by specific devices (e.g., 3D transistors). [1, 2, 3, 7]
- A device physics knowledge supportive of evolving IC and other semiconductor device applications. [1, 2, 7]
- The ability to synthesize device physics concepts and present them to their peers. [1, 3, 5, 7]

Contribution of Course to Meeting the Professional Component:

Engineering topics: 100%

Computer Usage:

Not required. However, mathematics software may be used by students to solve analytical problems. Other software may also be used for technical presentations.

Design Credits and Features: This course has 1.5 design credits incorporating device physics, transport, structures, performance and tradeoffs. Conceptual command of device physics is continually emphasized in support of enabling future device design and ability to move forward with field.

Person Preparing Syllabus and Date: J. Holm-Kennedy, Jan. 1, 2009. Modified by A. Ohta, Nov. 2014; A. Ohta, Jan. 14, 2021.