EE 324 Physical Electronics

Credits: 3

Categorization of credits: engineering topic

Instructors or course coordinator: Vinod Malhotra

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 Fundaments" by Robert F.Pierret
>   "Solid State Electronic Devices" (7th Ed) by Streetman and Banerjee

Designation: Required.

Catalog Description: <u>EE 324 Physical Electronics (3) (3 Lec)</u> Review of quantum mechanics fundamentals, H-atom, and chemical bonding. Introduction to band structure models and materials. Semiconductor doping, charge carrier statistics and charge transport, including ambipolar transport. Metal-semiconductor and PN junctions. Pre: MATH 243 or MATH 253A, and PHYS 274; or consent. DP

Pre--requisites: 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:

- Introduction to Materials. Insulators, semiconductors, conductors. (2 hrs)
- Review of Quantum Mechanics Fundamentals & K-P Model. (6 hrs)
- The Semiconductor Band Model -- key properties and features (6 hrs)
- Carrier Statistics (2 hrs)
- Charge Transport in Semiconductors. (5 hrs)
- Ambipolar Transport in Semiconductors (5 hrs)
- Semiconductor Junctions -- Metal-semiconductor junctions (2 hrs)
- PN junctions & Design (6 hrs)
- BJTs, FETs – Introductory overview & design features (2 hrs)
- Course Summary (integrating all course components) (2 hrs)

Course Objectives and Relationship to Program Objectives: The course objectives are directed to building an understanding of the semiconductor device materials and charge transport models supportive of understanding and designing current and emerging semiconductor IC devices. The introduction to semiconductor devices is provided in a format to support related subsequent design and analysis. Model command is a central objective in support of future design. [Program Objectives this course addresses: 1, 2, and 4.]

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 student shall acquire

- The ability to apply electron and hole carrier statistics to semiconductor devices. [1]
- A knowledge of the underlying quantum mechanics, statistical mechanics and charge transport physics models governing semiconductor materials and devices. [1, 2, 7]
- An understanding of the basic principles of semiconductor devices [1, 3, 9, 11]

Contribution of Course to Meeting the Professional Component: Engineering topics: 100%

Computer Usage: Mathematics software may be used to solve assigned problems.

Design Credits and Features: This course has no design credit, although approximately 5% of the homework and exam problems incorporate some design feature or issue. Design issues are pertinent to the second half of the course.

Person Preparing Syllabus and Date: D. Garmire, Nov. 2014. Modified by A. Ohta, Jan. 14, 2021.