

EE 426 Advanced Si IC and Solid State Devices

Credits: 3

Categorization of credits: engineering topic

Instructors or course coordinator: Victor Lubecke

Textbook and Other Required Materials:

Semiconductor Physics and Devices, D. Neaman, 4th ed., McGraw Hill

Reference Texts:

Physics of Semiconductor Devices 2nd Ed. by S. M. Sze

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

Class Handouts

Optoelectronics and Photonics, 2nd edition, S. O. Kasap

Device Electronics for Integrated Circuits 2nd Ed. by Muller and Kamins

Designation: Elective

Catalog Description: EE 426 Advanced Si IC and Solid State Devices (3) State of the art Si-based devices including advanced bipolar and MOS devices, heterojunction devices, new device trends. Topics from the most current literature included. Pre: 327 and either MATH 243 or MATH 253A, or consent. DP

Pre-requisites: EE 327 (Theory and Design of IC Devices) and MATH 243 (Calculus III) or MATH 253A (Accelerated Calculus III), or instructor consent.

Class/Lab Schedule: 3 lecture hours/week. 50 minute lectures. Depending on class size and time constraints, additional hours may be scheduled to incorporate student presentations. There is a minimum of 3 presentations for each student.

Topics Covered:

- Semiconductor Physics Review (3 hrs)
- Device Physics Review (detailed) (6 hours)
- Advance bipolar device phenomena (2 hrs)
- MOS and CMOS devices, latchup (4 hrs)
- Photodetectors (3 hrs)
- Heterojunction bipolar transistors (2 hrs)
- High Electron Mobility Transistors (2 hrs)
- LEDs and Junction Lasers (6 hrs)
- Advanced device structures - student presentations (variable hours)
- Novel device structures - student presentations (variable hours)
- Possible and expected future trends (2 hrs & student presentations)

Course Objectives and Relationship to Program Objectives:

The central objective of the course is to provide a broad exposure (and subsequent knowledge) of advanced semiconductor device structures and concepts in a manner which supports acquisition of device model command spanning the general field. Acquiring an understanding of the attendant relationship of advanced device physics to device performance is also intended. An awareness and foundation for lifelong learning is addressed through student independent device literature research, presentations, and technical writing. It is intended that students, upon finishing the course, will have acquired advanced device and related applied physics knowledge as well as quality oral technical communications skills. Students are expected to become familiar with using the current literature to support their technical presentations and self-learning. Peer and instructor presentation feedback is intended to provide speaker direction for improvement and support dialog skills acquisition. The objective of communications skills training in stages and teams is to support structured communications skills acquisition. An objective of student advanced presentations supported by the current literatures is to insure that the students acquire the information retrieval and assimilation skills needed to support life long learning. The inclusion of special and advanced subjects at the instructor's discretion is intended to create an expanded student device and applications knowledge base. Devices applied across disciplines support a cross disciplinary applications awareness.

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:

- Knowledge of the operating principles of advanced semiconductor devices [1, 7]
- Relationship of device performance to materials selection and device design [1, 7]
- Relationship of underlying fundamental physics and device performance [1, 7]
- Familiarity with and ability to use the device literature [1, 7]
- Technical communication skills [1, 3, 7]

Contribution of Course to Meeting the Professional Component.

Engineering topics: 100%

Computer Usage: The internet is used extensively in support of current literature search, student learning, presentation and writing preparation. Whenever possible, computer simulations (for example, study of the variations in band structure with alloying in compound semiconductors, etc) that are freely available on the internet are used to illustrate concepts.

Design Credits and Features: This course has 1 design credit.

Device performance needs are linked to the device structure, design, applied physics and materials selection (and at times fabrication processes). Student presentations are expected to incorporate design features and link the features to performance needs and limitations.

Person(s) Preparing Syllabus and Date: Dr. Holm-Kennedy, Feb. 26, 2003. Modified Nov. 2014. Modified by A. Ohta, Jan. 20, 2021.