EE 327 Theory and Design of IC Devices

**Designation:** Required of EP Track Majors

**Catalog Description:** Band structure models and carrier transport physics review. Theory and design of semiconductor IC devices: Schottky diodes, bipolar devices (PN junction diodes, BJT), FETs (MOSFETs, JFETs, and MESFETs).

**Credits:** 3

**Pre--requisites:** MATH 243 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 (time assigned approximate):**
- EE 324 Review: Band Structure, Carrier Statistics, Majority Carrier Transport and Ambipolar Transport. (2 weeks)
- Introduction to Schottky Diodes (1 week)
- Introduction to PN Junction Diodes including Photodetectors and Photovoltaics (2 weeks)
- Bipolar Junction Devices (2 weeks)
- Regenerative Feedback and Thyristors including latchup (1 week)
- Advanced Bipolar Junction Devices, Heterojunction BJT (graded bandgap and high injection efficiency devices) (2 weeks)
- Introduction to FETs -- JFET, MESFET and MOSFET (2 weeks)
- Introduction to Heterojunction Optical Devices (time permitting)
- Additional Special Semiconductor Topics (time permitting)

**Textbook and Other Required Materials:**
“Semiconductor Physics and Devices”, 3rd Ed., by Donald Neaman
Reference Texts:
“Physics of Semiconductor Devices” (2nd Ed.) by S. M. Sze
“Semiconductor Device Fundaments” by Robert F. Pierret
“Physics of Semiconductor Devices” by Michael Shur

**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 optical communications. The course is taught in a manner to enable device design capability development. [Program Objectives: this course addresses: Undergraduate Program Objectives Addressed: 1, 2, 3 and 4.

**Course Outcomes and Their Relationship to Program Outcomes:** The student shall acquire
• 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., high gain heterojunction BJTs). [1, 2, 3, 9]
• A device physics knowledge infrastructure supportive of evolving IC and other semiconductor device applications. [1, 2, 3, 9]

**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.

**Design Credits and Features:** This course has 1 1/2 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.

**Instructor(s):** Dr. James Holm-Kennedy, Dr. Vinod Malhotra, Dr. Victor Lubecke, Dr. Olga Boric-Lubecke, Dr. Aaron Ohta, Dr. David Garmire

**Person(s) Preparing Syllabus and Date:** Dr. James Holm-Kennedy, 1/9/2009