

# ESE 231: SEMICONDUCTOR DEVICES

## Spring 2019

**Stony Brook University**  
**Department of Electrical and Computer Engineering**

### COURSE DESCRIPTION

The course covers physical principles of operation of semiconductor devices. Energy bands, transport properties and generation recombination phenomena in bulk semiconductors are covered first. Junctions between semiconductors and metal-semiconductor will then be studied. Equipped with an understanding of the character of physical phenomena in semiconductors, students learn the principles of operation p-n junction diodes, metal-semiconductor contacts, bipolar junction transistors, field effect transistors. This course will provide general background for subsequent courses in electronics.

**Prerequisites:** AMS 361 or MAT 303 and PHY 127/134 or 132/134 or 142

3 credits

<b>Instructor</b>	Ridha Kamoua, 237 Light Engineering ridha.kamoua@stonybrook.edu
<b>Office Hours</b>	M,W 12:00pm – 2:00pm
<b>Teaching Assistant</b>	Ruiyan Liu
<b>Class Time and location</b>	M, W 2:30pm – 3:50pm Frey Hall 201

### TEXTBOOK

*“An Introduction to Semiconductor Devices”* Donald Neamen, McGraw Hill, 2006, ISBN

9780072987560

### GRADING SYSTEM

Homework accounts for 10% of the final grade, a term paper for 10%, two exams for 25% each, and a final exam for 30%. **No Makeup Exams**

Homework	10%	Weekly, late homework submissions are not accepted.
Research paper	10%	
Exam 1	25%	March 6
Exam 2	25%	April 10
Final	30%	May 14, 5:30pm – 8:00pm

### Course Objectives:

- Apply standard device models to explain/calculate critical internal parameters and standard characteristics of the pn-junction diode.
- Apply standard device models to explain/calculate critical internal parameters and standard characteristics of the Bipolar Junction Transistor.
- Apply standard device models to explain/calculate critical internal parameters and standard characteristics of the Metal-Oxide-Semiconductor Field Effect Transistor

### Student Outcomes (SO):

Student Outcomes		% contribution
1.	an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.	70
2.	an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.	
3.	an ability to communicate effectively with a range of audiences.	10
4.	an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgements, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.	
5.	an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.	
6.	an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgement to draw conclusions.	
7.	an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.	20

## COURSE OUTLINE

1. ***Introductory Physical Concepts*** *Chapters 1, 2, 3*
  - Crystal Structure of Semiconductors
  - Energy Band Model
  - Fermi Energy Level
  - Semiconductor Doping
2. ***Carrier Transport and Excess Carriers in Semiconductors*** *Chapters 4,8*
  - Carrier Drift
  - Carrier Diffusion
  - Generation and Recombination
  - Continuity Equation
3. ***Junction Diodes*** *Chapters 5,9*
  - *p-n* Junction
  - Metal-Semiconductor Junction
  - I-V Characteristics
4. ***Bipolar Junction Transistors*** *Chapters 10*
  - Operating Principles
  - Minority Carrier Distribution
  - Ideal I-V Characteristics
  - Non-Ideal Effects
  - Small-Signal Models
5. ***MOS Transistors*** *Chapters 6,7*
  - Operation Principles
  - MOS Capacitor
  - Metal Oxide Field Effect Transistor (MOSFET)
    - a) Enhancement and Depletion MOSFETs
    - b) Current-Voltage Characteristics
  - MOSFET Fabrication

### **On-line Blackboard site:**

You can access Blackboard at: <http://blackboard.sunysb.edu>. Homework assignments, homework and exam solutions, and other pertinent information will be posted on the course's Blackboard site. You can access blackboard using your Net ID username and password. To look up or set your Net ID, you need to login to SOLAR. For help or more information see: <https://tlt.stonybrook.edu/support/Pages/support.aspx>  
For problems logging in, please contact [blackboard@stonybrook.edu](mailto:blackboard@stonybrook.edu) or (631) 632-2777.

***Americans with Disabilities Act:*** If you have a physical, psychological, medical or learning disability that may impact your course work, please contact Disability Support Services, located at ECC (Educational Communications Center) Building, Room 128 (631) 632-6748. They will determine with you what accommodations, if any, are necessary and appropriate. All information and documentation is confidential.

***Academic Integrity:*** Each student must pursue his or her academic goals honestly and be held personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty are required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology & Management, Nursing, Social Welfare, and Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more

comprehensive information on academic integrity, including categories of academic dishonesty, please refer to the academic judiciary website at: [http://www.stonybrook.edu/commcms/academic\\_integrity/index.html](http://www.stonybrook.edu/commcms/academic_integrity/index.html)

***Critical Incident Management:*** Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of University Community Standards any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures.

***Course Evaluation:*** Each semester Stony Brook University asks students to provide feedback on their courses and instructors through an online course evaluation system. The course evaluation results are used by the individual faculty, department chairs and deans to help the faculty enhance their teaching skills and are used as part of the personnel decision for faculty promotion and tenure. No individually identifiable data are ever reported back to the university or instructor. Students who have completed previous evaluations can view all faculty ratings at: <https://classie-evals.stonybrook.edu/>

***Academic Success and Tutoring Center (ASTC):*** The ASTC provides free academic support services for all undergraduate students, including one-on-one tutoring, small group tutoring, academic success coaching, and public speaking seminars. Learn more about these services and additional campus resources at [www.stonybrook.edu/tutoring](http://www.stonybrook.edu/tutoring).