## EE379K/EE394V (16625/16810): Power Semiconductor Devices

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Teaching Assistant:	Mr. Junhong Tong, Email: jredtong@utexas.edu
Couse Time:	330pm to 5 pm TTH
<u>Classroom</u> :	ECJ 1.308
Professor Office Hours:	Professor Office Hour: T and TH 11-12, EER 7.878

# TA Office Hour: TBD

## **Course Objective:**

- 1) Understanding the material and current transport theory of semiconductor power devices
- 2) Detail analysis the operation of major power devices used in today's power electronics applications:
  - a. Two terminal devices: Schottky diode, PIN diode, JBS and MPS diodes
    - b. Three terminal devices: MOSFET, JFET, BJT, and IGBT.
- 3) Discuss the design and optimization of different type of power semiconductor devices,
- 4) Analysis switching transient of modern power semiconductor devices
- 5) Discuss the power loss and selection of devices for power conversion application
- 6) Learn how to use TCAD simulation tool to analyze power devices (for Graduate Students)

## Textbooks:

# Required: Baliga, B. Jayant. *Fundamentals of power semiconductor devices*. Springer Science & Business Media, 2010.

- Online Access of the Textbook: <u>https://catalog.lib.utexas.edu/record=b7092412</u>
- NOTE: It is expected that you read the textbook chapter ahead of our lecture. There are a lot of materials that we need to cover and not everything in the textbook will be covered in the lecture. So it is expected you read this as a pre-class assignment.

# Optional Textbook: Kimoto, Tsunenobu, and James A. Cooper. *Fundamentals of Silicon Carbide Technology: Growth, Characterization, Devices and Applications.* John Wiley & Sons, 2014.

### Prerequisite: EE339: Solid-State Electronic Devices or equivalent

Semiconductor materials; atomic orbitals to energy band structure of semiconductors; charge carrier transport, electron-hole generation and recombination; p-n junctions and Schottky barriers; bipolar and filed-effect transistors; MOS Field effect transistors;

For pre-requisite background see: B. G. Streetman and S. K. Banerjee "Solid State Electronic Devices", Pearson Prentice Hall, Sixth Edition

### **Course Topics:**

Please see the tentative course schedule below for details.

### Homework Policy:

Homework problems will be assigned to allow practicing your understanding of the concepts covered in the classroom. Students must work independently to solve the problems. All intermediate steps taken to get the solutions should be

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included. The homework number and the individual problem numbers must be clearly shown on the submitted answers to ensure proper credit. All homework assignments must be turned-in at the class on the due date to get credit.

# **Computer TCAD Simulation (Graduate Student Only):**

Modern power semiconductor devices design is a complex multi-objective optimization problem, involving current transport and electric field distribution in 2D or 3D. TCAD (Technology Computer Aided Design) is a frequently used approach to design power devices. In this lecture, a few TCAD simulation assignments will be made to enhance your understanding of power devices operation and their design for a given breakdown voltage and condition capability. You must independently conduct this simulation to obtain full credit. An additional TCAD TA is assigned to answer question and to assist in setting up the software. Access to a computer is needed. The simulation will be run in a remote computer managed by the college.

# **Computing Tools**

- TCAD Software:
  - Please follow the posted tutorial material to set up the TCAD software
- Canvas
  - This course will use UT's Canvas tool for online material distributions. Posted materials should only be used by registered students.

# **Grading Policy:**

- UG Student: Homework 30%, Project 35%, Final Exam 35%
- Graduate Students: Homework 25%, Project 25%, Final Test 25%, TCAD 25%

# **College of Engineering Drop/Add Policy:**

The Dean must approve adding or dropping courses after the fourth class day of the semester.

# **University Honor Code**

The core values of The University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the University is expected to uphold these values through integrity, honesty, fairness, and respect toward peers and community." http://www.utexas.edu/about/mission-and-values.

# **Religious Holidays**

By UT Austin policy, you must notify the instructor of any pending absence at least fourteen (14) days prior to the date of observance of a religious holy day, or on the first class day if the observance takes place during the first fourteen days of the semester. If you must miss class, lab section, exam, or assignment to observe a religious holiday, you will have an opportunity to complete the missed work within a reasonable amount of time after the absence.

# **Students with Disabilities**

UT provides upon request appropriate academic accommodations for qualified students with disabilities. Disabilities range from visual, hearing, and movement impairments to ADHD, psychological disorders (e.g. depression and bipolar disorder), and chronic health conditions (e.g. diabetes and cancer). These also include from temporary disabilities such as broken bones and recovery from surgery. For more information, contact Services for Students with Disabilities at (512) 471-6259 [voice], (866) 329-3986 [video phone], <u>ssd@uts.cc.utexas.edu</u>, or <u>http://ddce.utexas.edu/disability</u>.

# Mental Health Counseling

Counselors are available Monday-Friday 8am-5pm at the UTs Counseling and Mental Health Center (CMHC) on the 5th floor of the Student Services Building (SSB) in person and by phone (512-471-3515). The 24/7 UT Crisis Line is 512-471-2255.