# EECS 598 Section 001, Fall 2016
# Power Semiconductor Devices

**Instructor:** Prof. Becky Peterson, 2302 EECS, 734-615-3105, blpeters@umich.edu

**Lecture:** Lec. 001 Monday & Wednesday 1:30-3:00pm, 3433 EECS

**Office Hours:** Tuesdays 2:30-3:30pm and Fridays 1:30-2:30pm in EECS 2302. (No office hours will be held on F 9/16) Alternate times are available if you have a conflict. Please contact Prof. Peterson to arrange.

**Email/Chat:** Please post questions about assignments to Canvas-Discussion, so all can see and respond. For other questions, please send email to Prof. Peterson with "EECS 598" in the subject line (for brief questions), or visit office hours (for extended discussion).

**Prerequisites:** This course assumes a working knowledge of introductory semiconductor physics and devices. The pre-requisite is EECS 320 (Introduction to Semiconductor Devices) or equivalent, graduate standing, or permission of the instructor.

**Class Website:** Canvas site "EECS 598 001 F16". Pdfs of lecture notes, homework assignments, announcements and grades, and other materials will be posted.

**Main Textbook:** B. J. Baliga, *Fundamentals of Power Semiconductor Devices*, Springer, 2008, ISBN: 9780387473147. Available for download or you can purchase *MyCopy Softcover Edition* (printed version) for $24.99 from Springer. Go here and click on "Available Online": http://mirlyn.lib.umich.edu/Record/006834933

**Supplemental Textbooks** (Chapter 7 only) B. El-Kareh and L. N. Hutter, *Silicon Analog Components*, Springer Publishing, 2015, DOI 10.1007/978-1-4939-2751-7. Available for download or you can purchase *MyCopy Softcover Edition* (printed version) for $24.99 from Springer. Go here and click on "Available Online":
http://mirlyn.lib.umich.edu/Record/013731328

(Chapter 1 only) Farid Medjdoub and Krzysztof Iniewski, Eds., *Gallium nitride (GaN) physics, devices and technology*, CRC Press, 2015, ISBN 9781482220032. Available for download. Go here and click on "Available Online": http://mirlyn.lib.umich.edu/Record/014178466

Note: you must be on campus (or use VPN or proxy) to download the books.

**Computer-based Resources:** We will use CAEN-based device simulation softwares Silvaco and Sentaurus. Detailed tutorials will be provided.

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| **Grading:** | Grades for this course will be posted in Canvas, and will be based on: |

- Homeworks (five, each 7%) 35%
- Homework closed-book mini-quizzes (each 1%) 5%
- Synopsys Simulation Project 20%
- Silvaco Simulation Project 20%
- Group Presentation 20%

Letter grades are assigned based on final course numerical grades.

> 90.0% will always be some sort of A (A-, A, or A+)
> 80.0% will always be some sort of B (B-, B, or B+) or better
> 70.0% will always be some sort of C (C-, C, or C+) or better

All students are graded on the same scale and the course is not curved: if everyone gets above a 90%, everyone gets an A-/A/A+. I may lower the % breakpoint for the entire class (i.e. 87% might be the A/B breakpoint in one semester), i.e. grades can only go "up" from what is listed above.

Graded work will be returned in class or may be picked up during office hours. If you have questions about grading, please contact me within two weeks of return.

**Homework:** The purpose of homework is to learn. I strongly encourage you to discuss homework and work alongside other students. I will provide spreadsheets to streamline analytical calculations so that problems can focus on device analysis and design. Homework is turned in and graded individually.

To encourage you to engage fully with the homework, on each homework due date there will be an in-class *closed-book mini-quiz of < 5 min which is designed to confirm your basic understanding of the assignment (no studying is expected)*. Each mini-quiz counts for 1% of your total grade. If you must miss class, please let me know in advance so we can arrange an alternate time for the mini-quiz.

**Simulation Projects**: There will be two individual projects on power device simulation using two commercial platforms: Silvaco Atlas and Synopsys Sentaurus. In each of the projects, you will begin with a vendor-provided device example and then explore and explain its operation by modifying the simulation. Each student will write a project report. Detailed tutorials will be given on the software packages; no prior knowledge is assumed.

**Group presentations:** Group presentations will be done in teams of 2-3 people. Each group will select a current research area, a characterization technique, or a new commercial class of devices that is related to the course and write a two-page abstract, which I will use to approve the topic and give feedback. A few weeks later, each group will give a 30-minute presentation in lecture. Each person must speak during the presentation. Presentations will occur toward the end of the semester.

**Exams:** There are no exams. There is no final exam.

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| **Late Policy:** | In fairness to all students, late work is not normally accepted. If there is an extenuating circumstance please contact me before the due date. |
| **Honor Code Statement:** | All work in this class shall be in accordance with the College of Engineering's Honor Code (http://honorcode.engin.umich.edu/) |
| **Electronics Policy:** | Electronics can be used in class, as long as they are not a distraction to me or others. |
| **Accommodations for Students with Disabilities:** | If you need an accommodation, please let me know as early as possible in the semester. If you already have a Verified Individualized Services and Accommodations (VISA) form, please provide a signed copy. If you do not have a VISA form, please work with the Services for Students with Disabilities (SSD, 734-763-3000; http://ssd.umich.edu) office. Any information you provide to me and to SSD will be treated as private and confidential. |

## EECS 598 Section 001, Fall 2016

| Date | | | Lecture Topic / Event | Readings | Tentative Deadlines (Canvas is official) |
|---|---|---|---|---|---|
| Sept | 7 | W | Introduction | Baliga Ch. 1 | |
| | 12 | M | Transport & Recombination Physics | Baliga Ch. 2 | |
| | 14 | W | Breakdown Voltage I | Baliga Ch. 3 | |
| | 19 | M | Breakdown Voltage II | | |
| | 21 | W | PIN Rectifiers I | Baliga Ch. 5 | |
| | 26 | M | PIN Rectifiers II | | HW 1 (physics) due |
| | 28 | W | (tbd) | | |
| Oct | 3 | M | Schottky Rectifiers I | Baliga Ch. 4 | |
| | 5 | W | Schottky Rectifiers II | | |
| | 10 | M | Power Device Technology | Lecture Notes | |
| | 12 | W | Thermal Effects and Packaging | | HW 2 (diodes) due |
| | 17 | M | NO CLASS – Fall Study Break | | |
| | 19 | W | Power Silicon FET (LDMOS) | El-Kareh and Hunter, Ch. 7 | |
| | 24 | M | GaN Power Devices (HEMTs) | Medjdoub and Iniewski, Ch. 1 | Simulation Project #1 (Diode) Due |
| | 26 | W | Vertical Power MOSFET – I | Baliga, Ch. 6 | |
| | 31 | M | Vertical Power MOSFET – II | | |
| Nov | 2 | W | Power BJT – I | Baliga Ch. 7 | |
| | 7 | M | Power BJT – II | | HW 3 (FETs) due |
| | 9 | W | Power BJT – III | | |
| | 14 | M | Thyristor – I | Baliga Ch. 8 | |
| | 16 | W | Thyristor – II | | Simulation Project #2 (Transistor) Due |
| | 21 | M | IGBT – I | Baliga Ch. 9 | Presentation abstract |
| | 23 | W | IGBT – II | | |
| | 28 | M | (tbd) | | HW 4 (BJT/thyristor) due |
| | 30 | W | IGBT – III | | |
| Dec | 5 | M | Group Presentations | | Presentations |
| | 7 | W | Group Presentations | | |
| | 12 | M | Conclusion | | HW 5 (IGBT) due |