



# Si and Wide Band Gap Power Devices

## ECE 5244

**Credit Hours:**

3.00

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**Course Levels:**

Undergraduate (1000-5000 level)

Graduate (5000-8000 level)

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**Course Components:**

Lecture

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**Course Description:**

Basic design and operation of Si and Wide Band Gap (WBG: SiC, GaN and ultra wide band gap semiconductors) power devices and the applications of commercial devices in power electronics applications. Trade-offs between various devices. Static and dynamic operation. Comparison of Si and SiC devices and design differences.

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**Prerequisites and Co-requisites:**

Prereq: 3030, or Grad standing in Engr or Physics.

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**Course Goals / Objectives:**

- Provide an introduction to basic operation of Si and wide band gap power devices
  - Students master design principles of power devices
  - Students become competent with specifications of commercial power devices
  - Students are exposed to the processing details of power devices
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### **Course Topics:**

- Introduction to basic power devices, characteristics and applications
- Material Properties of Si and wide band gap semiconductors
- Design for Breakdown Voltage – various edge terminations
- Ideal Specific On-Resistance for Si and WBG device
- Schottky Diodes: Forward conduction and reverse blocking
- Design of Schottky Diodes
- Commercial specifications of Schottky Diodes
- PiN Diodes: Forward conduction and reverse blocking
- Design of PiN Diodes
- Commercial specifications of PiN Diodes
- Planar power MOSFETs: Forward conduction and forward blocking
- Channel mobility
- Design of Si and SiC planar power MOSFETs
- Dynamic operation
- Unclamped inductive switching and short circuit time
- Latch up and Safe Operating Area (SOA)
- Commercial specifications of Si and SiC planar power MOSFETs
- Reliability issues
- Trench MOSFETs
- Super Junction MOSFETs
- GaN and Ultra WBG Lateral Power HFETs
- Si and SiC IGBTs: Structure and Operation
- Symmetric and Asymmetric designs
- Forward conduction
- Forward blocking
- Dynamic operation and dependence on lifetime
- Latch up and Safe Operating Area (SOA)
- Design and processing of SiC power devices

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### **Designation:**

Elective