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**ECE 4040/6040 Section 001**  
**Semiconductor Devices**

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**Class Location/Time:** Riggs Hall 219 / Tuesdays and Thursdays 9:30AM-10:45AM Eastern

**Instructor:** Dr. Judson D. Ryckman **Email:** jryckma@clermson.edu **Office:** Riggs 207C  
**Office Hours:** By appointment

**Grader (if applicable):** Andrew Gunn  
**Email:** awgunn@g.clemson.edu **Office and Office Hours:** by appointment

### **Course Description**

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Consideration of the principles of operation, external characteristics, and applications of some of the more important semiconductor devices presently available. Preq: ECE 3200 with a C or better. Preq or concurrent enrollment: MATH 3110 or MATH 4340, each with a C or better

### **Course Objectives**

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At the completion of this course students will hold an in-depth knowledge and understanding of the physics of semiconductor materials and some of the more technologically important semiconductor devices. Students will further be able to analyze the basic properties of semiconductor materials and devices.

### **Required Materials**

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D. A. Neamen, Semiconductor Physics & Devices, 4th Edition (Required)  
R. F. Pierret, Advanced Semiconductor Fundamentals, 2nd Edition Prentice Hall, 2003. (Optional Reference material)

### **Course Format**

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As of August 19<sup>th</sup>, 2021 the course is planned to be delivered 100% in-person. No online component or zoom link is planned. Class will involve notetaking and instructor work on the whiteboard with limited powerpoint slides. For in-person absences see section below Contingency plan: During the semester it is possible we may temporarily move to an online modality (i.e. in the event of instructor illness).

**Students with disabilities needing accommodations should contact the Office of Student Accessibility Services in Suite 239, Academic Success Center building 864-656-6848, prior to contacting me during office hours.**

## Topical Outline

Week	Date	Text Coverage	Subject
Thu	19-Aug	Syllabus	Introduction, Crystal Structure
Tue	24-Aug	Chap. 1, pp. 1-21	Crystal Structure
Thu	26-Aug	Chap. 2, pp. 25-34	Quantum Mechanics, Wave Equation
Tue	31-Aug	Chap. 2, pp. 34-52	Applications of the Wave Equation
Thu	2-Sep	Chap. 3, pp. 58-82	Energy Bands, Conduction in Solids
Tue	7-Sep	Chap. 3, pp. 83-100	Statistical Thermodynamics
Thu	9-Sep	Chap. 4, pp. 106-131	Intrinsic and Extrinsic Semiconductors
Tue	14-Sep	Chap. 4, pp. 131-141	Dopant Statistics, Charge Neutrality
Thu	16-Sep	<b>EXAM #1</b>	<b>Chapters 1, 2, and 3</b>
Tue	21-Sep	Chap. 4, pp. 141-149	Position of the Fermi Energy Level
Thu	23-Sep	Chap. 5, pp. 156-172	Drift / Diffusion Model of Transport
Tue	28-Sep	Chap. 5, pp. 172-179	Diffusion, Graded Impurities
Thu	30-Sep	Chap. 6, pp. 192-201	G / R, Continuity Equations
Tue	5-Oct	Chap. 6, pp. 214-221	Continuity Equations, Quasi-Fermi E
Thu	7-Oct	Chap. 6, pp. 221-233	SHR Model, Lifetime, Surface States
Tue	12-Oct	----- NO CLASS ---- FALL BREAK: OCT 11 and 12 -----	
Thu	14-Oct	Chap. 7, pp. 241-250	pn Junction Electrostatics
Tue	19-Oct	<b>EXAM #2</b>	<b>Chapters 4, 5, and 6</b>
Thu	21-Oct	Chap. 7, pp. 251-269	Reverse Biased Junction
Tue	26-Oct	*Chap. 8, pp. 276-295	Forward Biased pn Junction
Thu	28-Oct	Chap. 8, pp. 276-295	Diode I-V Characteristics
Tue	2-Nov	Chap. 8, pp. 295-317	Selected Second Order Effects
Thu	4-Nov	Chap. 9, pp. 331-348	Schottky Barrier Diode
Tue	9-Nov	Chap. 9, pp. 349-354	Ohmic Contacts, Thermionic Emission
Thu	11-Nov	Chap. 12, pp. 491-509	Bipolar Junction Transistors
Tue	16-Nov	Chap. 12, pp. 509-521	Current Gain
Thu	18-Nov	<b>EXAM #3</b>	<b>Chapters 7, 8, and 9</b>
Tue	23-Nov	*Chap. 10, pp. 371-394	MOS Structure
Thu	25-Nov	----- NO CLASS ---- THANKSGIVING -----	
Tue	30-Nov	*Chap. 10, pp. 394-403	C-V Characteristics, MOSFETs
Thu	2-Dec	*Chap. 10, pp. 403-410	MOSFET Models & Parameters

\* Indicates supplemental notes from outside of text, to be provided

**Note:** Actual schedule may change, pending class progress.

## Grading

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Final grades will be determined by averaging the homework, projects, exams, and final exam based on the following scale:

Homework	20%	
3 Exams	60%	( 20% each )
Final Exam	20%	
Course Grade	100%	
Grading Scale (ECE 4040)*:	90 – 100	A
	80 - 89	B
	70 - 79	C
	60 - 69	D
	0 - 59	F
Grading Scale (ECE 6040)*:	90 – 100	A
	80 - 89	B
	70 - 79	C
	0 - 69	F

\*The instructor reserves the right to adjust the 4040 and/or 6040 grading scale depending on class performance.

## Additional Policies

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**Attendance:** Class roll may be called at the beginning of the semester until I know most of your names. You will obviously learn more if you attend class regularly; however, you are responsible for all of the material covered in class whether you attend or not. Class lectures will sometimes carefully follow the textbook, sometimes go beyond the textbook, and sometimes follow my own notes instead of the presentation in the textbook. Thus, attendance is crucial!

**Absences:** If you are unable to join an in-person lecture or examination due to an excused reason, such as quarantine, illness, etc., please use the notification of absence (NOA) system to log your situation: [noa.app.clemson.edu](http://noa.app.clemson.edu). For excused absences, I will at least seek to provide asynchronous materials in the form of lecture notes.

**Homework:** Homework Problems will be assigned periodically throughout the semester. These problems may include calculations, derivations, and extensions to the material covered in class. Some homework problems will come from the text, but some will come from me. Solutions to homework will be posted after the due date. It is expected that your homework will represent your own work, although working in groups is allowed and even encouraged. Homework is due at the beginning of class. Late homework will not be accepted!

**Exams:** There will be 3 regular exams and a final exam. Show all of your work in neat, organized detail. The correct answer without showing how you arrived at it, won't receive full credit. Each exam will contain one extra question for ECE-6040 students, which will tend to be more in depth.

**Exam Attendance:** If you cannot attend an exam, I should be notified ahead of time if possible, otherwise at least on the day of the exam. Except under unusual circumstances, no makeup will be given without appropriate notification. If a makeup is given, I will choose either a written or oral exam.

**Graduate Students:** Graduate students will be expected to pursue some topics in more depth. This may include material in the body of the text, appendices, other books, or handouts. Such topics will be the basis for more advanced homework/projects which will be assigned to ECE-6040 students in addition to the regular homework. Also, this material may be the basis for the extra exam questions.

**All policies enclosed within the ECE Common Course Syllabus, not noted herein also apply.**