ECE3040 **Microelectronic Circuits** **Summer 2026**

M 12:30-1:45 PM, **Clough UG Learning Commons** **Section A, QUP**
TR 12:30 – 2:40 **Rm. 423**

Instructor: Dr. Douglas Yoder
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Office Hours:

To be announced. Please feel free to consult with me during office hours on issues that are academic, professional or otherwise.

Textbooks:

1. Jaeger & Blalock, *Microelectronic Circuit Design* (5th edition), McGraw Hill, 2015, ISBN 9780073529608.
2. Pierret, *Semiconductor Device Fundamentals*, Addison Wesley, 1996. ISBN 0201543931

Website: **canvas.gatech.edu**

Prerequisites:

ECE 3043 and ECE 2031/20X2 and (ECE 2035 or ECE 2036) and ECE 2040 and CHEM 1310/1211K/12X1 and MATH 2401/2411/24X1 and MATH 2403/2413/24X3

Course Content:

Students are responsible for all material presented in lectures, relevant chapters in the official textbooks, and homework assignments. The textbook and the lectures are designed to complement each other, and neither one alone is a substitute for the other. Class attendance is an important part of the educational experience.

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Course Objectives:

1. understand the physical, electrical and optical properties of semiconductor materials and their use in microelectronic circuits
2. relate the atomic and physical properties of semiconductor materials to device and circuit performance issues
3. develop an understanding of the connection between device-level and circuit-level performance of microelectronic systems

Course Outcomes:

1. compute carrier concentrations for semiconductor materials under a variety of conditions
2. compute conductivity and resistivity of semiconductor materials under a variety of conditions
3. compute terminal voltage and current characteristics for pn junction diodes under a variety of conditions.
4. compute terminal voltage and current characteristics for bipolar transistors under a variety of conditions.
5. compute terminal voltage and current characteristics for MOS transistors under a variety of conditions.
6. compute terminal voltage and current characteristics for ideal operational amplifiers under a variety of conditions.
7. analyze the DC performance of single-stage analog amplifiers containing these circuit elements.
8. analyze the AC performance of single-stage analog amplifiers containing these circuit elements.
9. analyze the DC performance of simple digital circuits (e.g., inverters and logic gates) containing these circuit elements.

Grading Policy:

Evaluations:		**Final Grades:**	
Homework:	20%	>90%	A
Midterm 1	25%	80-90%	B
Midterm 2	25%	70-80%	C
Final Examination	30%	60-70%	D
		<60%	F

Although there is no “curve” for this course in the traditional sense, there will be bonus points on the final exam from which you can receive an “earned curve”. If you do not learn the material, you cannot benefit from the curve.

Homework Policy:

Problem sets will typically be assigned on or before Wednesday of each week, and will be due by the beginning of class on Wednesday of the following week. ***On each problem set, you receive full credit if you make good progress on every problem. If one or more problems do not reflect good progress, you will receive a 0 for that week's homework assignment.*** Only those homework assignments submitted on time will be graded. Solutions to all assigned problems will be made available following the return of graded homework submissions. A homework assignment may be due during the final two instructional days of the semester.

Exam Policy:

There will be two in-class midterm exams, as indicated above. The final exam will be given at the scheduled time during exam week. The tentatively scheduled time is **not yet determined by the Registrar's Office.** Cell phones and pagers must be turned off during lectures, quizzes, and exams.

Office of Disability Statement:

Georgia Tech is committed to a climate of mutual respect and full participation. Our goal is to create learning environments that are usable, equitable, inclusive and welcoming. If there are aspects of this course that result in barriers to your learning or accurate assessment thereof, please notify me as soon as possible. Students with disabilities should contact the Office of Disability Services to discuss options for all relevant accommodations. ODS can be reached at 404 894 2563, dsinfo@gatech.edu, or disabilityservices.gatech.edu .

Academic Honor Code:

Students are expected to act according to the highest ethical standards. Academic misconduct is any act which does or could improperly distort student grades or other student academic records. Such acts include but are not limited to the following

- Unauthorized Access: Possessing, using, or exchanging improperly acquired written, verbal or digital information in the preparation of a problem set, laboratory report, essay, examination, or other academic assignment.
- Unauthorized Collaboration: Unauthorized interaction with another Student or Students in the fulfillment of academic requirements.
- Plagiarism: Submission of material that is wholly or substantially identical to that created or published by another person or persons, without adequate credit notations indicating the authorship.
- False Claims of Performance: False claims for work that has been submitted by a Student.
- Deliberate Falsification: Deliberate falsification of a written or verbal statement of fact to a Faculty member and/or Institute Official, so as to obtain unearned academic credit.

Academic Honor Code (continued):

- Forgery: Forgery, alteration, or misuse of any Institute document relating to the academic status of the Student.
- Distortion: Any act that distorts or could distort grades or other academic records.

Institute Absence Policy:

All students are expected to attend announced quizzes, laboratory periods, and final examinations. Although it is recognized that occasionally it may be necessary for students to be absent from scheduled classes or laboratories for personal reasons, students are responsible for all material covered in their absences, and they are responsible for the academic consequences of their absences. Students should discuss planned absences with me as soon as possible after the beginning of an academic term. When prior notice of absence is given, or in cases of sickness-related absence, late work will be accepted for full credit if submitted within a reasonable time frame.

Communications:

Verbal notices may be given in class. It is your responsibility to obtain this information in class. If you are not present, you must get this information from other students. Notices and other communications may also be delivered via email or Canvas; read your email and check Canvas regularly. To reach the instructor via email, send messages directly to doug.yoder@gatech.edu rather than through Canvas.

Tips for Homeworks and Exams:

- Homework assignments are not intended to be mechanical busywork, and are not even intended to be a primary mechanism for learning. *The purpose of assignments is to provide students with immediate feedback about their level of understanding, **after learning has already taken place**. If you find you are not able to solve an assigned homework problem without referring back to the textbook, then you will likely have the same problem on exams*. What should you do? Read and review the weekly material in the textbook and your lecture notes again *in their entirety* (i.e. not in a patchwork fashion) before attempting any more homework problems. Do not be satisfied by letting things you read to be left ununderstood.
- Always read the textbook and review lecture notes before attempting to solve homework problems. Re-read as necessary for **a clear understanding**. Clarify any outstanding questions you have with me, the teaching assistant, or your fellow classmates.
- Past experience shows that two additional keys to earning an "A" in this class are regular class attendance and working through all the homework problems. If you choose to "cheat" by letting others do the homework for you, you are only hurting yourself.

Tips for Homeworks and Exams (continued):

- In order **to receive full credit**, you must
  - **Show all work.** It is important that you demonstrate to the grader that you understand the process of how to solve each problem. Especially on exams, the exact numerical answer is less important: if you do not know how to think about formulating a problem correctly, you cannot receive any credit for your solution.
  - **Label answers** with proper units, e.g. Volts, kg/m^3, etc. If your answer is a vector, the vector direction must be clearly indicated, e.g. $\vec{a}_x$, $\vec{a}_y$, $\vec{a}_z$, etc.
  - **Box your final answers.** This eliminates any ambiguity concerning what constitutes your final answer.

What is Expected of Students:

- Students are expected to adhere to the academic Honor Codes established by Georgia Tech.
- Students are expected to be respectful towards each other.
- Students are responsible for material covered or assigned during lectures, regardless of attendance.

Why ECE 3040 is Important for Students:

- This course introduces students to a diverse set of fundamental concepts in solid state physics, electron devices, and elementary circuits, which lay the foundation for many junior- and senior-level courses in the ECE curriculum.
- Success in ECE 3040 is strongly correlated to success in future courses, including but not limited to ECE 3450.

How to Succeed in ECE 3040:

- Approach learning the material with commitment and determination, starting Day 1. Sometimes learning will come easily, and sometimes not. This is normal. Seek help from your instructor or teaching assistant for all issues that you have trouble resolving on your own. We are always happy to help!
- Stay synchronized with the class: read ahead the night before a lecture, attend all lectures and stay current with reading assignments. Your understanding of past and current material is the best predictor of how well you will understand future material, and how quickly you can learn it.
- Recognize that study time does not equate to learning. Learning happens during quality study time, when you are 100% focused and free from all distractions.
- Read the relevant book chapter(s) and review lecture notes before working on homework assignments. Before working on homework assignments, write down 5-10 questions that you have about what you have just read. If you can't think of any questions to ask, this is a red flag, and you need to go back and review your lecture notes and the book chapter(s) to improve your level of understanding. Resolve any questions you *do* have before starting work on your homework assignment.

How to Succeed in ECE 3040 (continued):

- Start each homework assignment well in advance of the due date: you will find that your quality of learning will improve the more time you have to think through each question (and make connections with the concepts you have learned through your readings).
- Read and review relevant book chapter(s) and lecture notes in advance of exams for mastery of the material. (Twice through is not uncommon.)

Evaluations and End-Of-Chapter Problems:

- Evaluations are designed to reflect your level of understanding of the topics covered, on a scale from 0 to 100 Strive therefore to achieve a clear understanding of the concepts involved, rather than a "mechanical memorization" of solution techniques for previously-worked problems (as a technician would). If you are able to pose questions to yourself about the material you have studied, but are unable to answer them, this is one of the warning signs of gaps in understanding.
- On exams and homework assignments, be prepared to demonstrate your understanding of the concepts presented in the course through the solution of <u>new problems</u> (as an engineer does). Mere memorization will not be sufficient to earn a passing grade.
- **The purpose of end-of-chapter problems in the text is to provide students with instant feedback on their level of understanding**
    - if after reading the problem statement and a couple minutes of thought it is still not clear how to go about solving the problem, this is a red flag telling you to go back and re-read the **entire** chapter before attempting to solve any more end-of-chapter problems.
    - If after studying for an exam, you pick an unassigned end-of-chapter problem at random and do not have a clear idea of how to solve the problem, you will probably experience the same situation on the exam unless you go back and re-read the **entire** book chapter for a deeper understanding. This is another example of a "red flag", helping you to self-assess your level of understanding.
    - If you cheat yourself and only read that portion of the book chapter relevant to a specific problem, there **will** be gaps in your understanding which will **likely** be exposed on exams.

Instructor Commitment to the Student:

Although the laws of statistics suggest that some students will perform poorly in this class, no student will perform poorly due to lack of access to the instructor. To this end, I will make every reasonable effort possible to ensure your success in this class. Students are strongly encouraged to seek help from this instructor with any problems they may have, academic, personal or otherwise. Students are also strongly encouraged to provide the instructor with feedback regarding all aspects of this course. Constructive criticism, especially that which might be considered "negative", is particularly welcome.

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Tentative Syllabus

Normal Semester Week	Topics	Reading Material
1	Semiconductor materials, crystal structure Quantization, band model, bond model Carrier properties State and carrier distributions	Pierret 1.1, 1.2, 1.4 2.1, 2.2 2.3 2.4
2	Equilibrium carrier concentrations Drift and Diffusion Generation/Recombination, equations of state	Pierret 2.5, 2.6 3.1, 3.2 3.3, 3.4
3	**Institute Holiday:** **Memorial Day (no instruction)**	
3	Qualitative p-n junction electrostatics Quantitative p-n junction electrostatics	Pierret 5.1-5.3 6.1.1-6.1.4
4	**Midterm 1**	
4	Load lines, iterative solutions, simplified models Multiple-diode circuits: voltage regulation, half- and full-wave rectification	Jaeger 3.10 Jaeger 3.11-3.14
5	Introduction to bipolar junction transistors: qualitative theory, biasing modes, circuit configurations BJT Physics: quantitative theory, deviations from ideal.	Pierret 10 Pierret 11.1-11.2
6	The MOS Capacitor	Pierret 16.1-16.4
6	**Institute Holiday:** **Juneteenth (no instruction)**	
7	MOSFET basics MOSFET device physics	Pierret 17.1 17.2
8	**Midterm 2**	
8	Small-signal modeling Common Emitter and Common Source Amplifiers	Jaeger 13.1-13.5, 13.8 Jaeger 13.6, 13.10
8	**Institute Holiday:** **Student Recess (no instruction)**	
9	Single-transistor amplifiers Differential Amplifiers: simple and 2-stage	Jaeger 14.1-14.7 Jaeger 15.1-15.2
10	Differential Amplifiers: output stages Logic Gates: qualitative and quantitative operation, voltage transfer characteristic, switching	Jaeger 15.3 notes notes
11	Bonus material, e.g. introduction to QM or Optoelectronics	notes

Final Exam Date: Not Yet Determined by Registrar's Office

Please note that the syllabus is subject to change. The best indicator of what will be covered in a given class is what is covered in the class previous. Attend lectures!