

ECE 3040 - Microelectronic Circuits (4-0-4) COURSE SCHEDULE AND OUTLINE (Spring 2009)

Section **C**, Time: **12:05 PM – 1:25 PM** Location: **VL C341**

Instructor: **S.-C. Shen, Assistant Professor , School of ECE**

Course Website: <http://users.ece.gatech.edu/~shensc/teaching/ECE3040/>

Week	Date	Topic	Assigned Study
1	1/5,1/7,1/9	Introduction	Read Information Packet
		Material classification, Crystalline planes, Miller index, Bonding model, Energy band diagram	Pierret 1.1 - 2.1
2	1/12,1/14, 1/16	Density of states, Fermi energy, Extrinsic and intrinsic Semiconductors, Carrier properties, Drift, Mobility, Resistivity,	Pierret, 2.2 – 2.5, 3.1
3	(1/19 holiday) 1/21,1/23	Diffusion, and Einstein relationship, Recombination and generation, Direct and indirect semiconductors	Pierret 3.2, 3.3
4	1/26,1/28, 1/30	Hall effect, Equation of states, Steady-state carrier injection, Quasi Fermi-level and diffusion length	Pierret 3.4-3.6, class slides
5	2/2,2/4, 2/6	Ideal PN junction: Contact potential, Equilibrium condition, and Depletion region approximation, Minority carrier transport phenomenon, Current-voltage characteristics, Bias modes	Pierret 5.1 - 6.1
6	2/9,2/11,2/13	Exam #1 (2/9 Monday) [Topics covered between wk1 ~ wk5]	
		(2/11: Tentatively scheduled for undergraduate advising) Practical PN junction: Breakdown mechanisms,	Pierret 6.2, 6.3.1, 7.2.1, 7.2.2, 7.3.1, 8.1.2
7	2/16,2/18, 2/20	Optoelectronic applications: Photodiode, Solar cells, LEDs	Pierret 9.1-9.4
		Diode-based circuits analysis	Jaeger 3.10-3.17
8	2/23,2/25, 2/27	Ideal Bipolar Junction Transistors: Operation principles -- qualitative description, Biasing modes	Pierret 10.1, 10.4, 10.5
9	3/2,3/4, 3/6	BJT: Performance parameters, Ideal BJT analysis, Minority carrier transport mechanisms, Ebers-Moll model, and Practical BJT: current-voltage characteristics, Early effect, Breakdown mechanisms,	Pierret 11.1 – 11.3, lecture notes
10	3/9,3/11, 3/13	Ideal MOS capacitor: Qualitative description, Quantitative analysis, and Charge-voltage relationship	Pierret 16.1-16.3
11	3/16 - 3/20	<i>Spring Break</i>	
12	3/23,3/25, 3/27	Exam #2 (3/25, Wednesday) [Covering wk6 ~ wk10]	
		Ideal MOSFET: The makings of the MOSFET – qualitative description, Biasing modes, First-order quantitative analysis, Performance parameters	Pierret 17.1, 17.2, 18.1
13	3/30,4/1,4/3	MOSFET: Short channel effect; BJT and MOSFET small signal models	Pierret 12.1, 17.3.1,19.1
		Biasing circuits and amplifier configurations for BJT and MOSFET	Jaeger 1.5, 13.4,13.5, 13.8, 13.9, 4.8,4.9,5.11
14	4/6,4/8,4/10	Single transistor amplifiers: Small signal analysis & full-circuit analysis examples	Jaeger 13,14
15	4/13,4/15, 4/17	Multi-transistor amplifier analysis and basic OpAmp analysis	Jaeger 11.1-11.3
16	4/20,4/22, 4/24	Digital circuit analysis: CMOS inverter, NOR, NAND, and complex gates	Jaeger 6.1-6.4, 7.1-7.6
		Final review	
17	4/30	FINAL EXAM (8:00 AM – 10:50 AM, 4/30, Thursday)	

1. **Textbooks:**
 - a) *Semiconductor Device Fundamentals*, Robert Pierret, ISBN 0-201-54393-1
 - b) *Microelectronic Circuit Design – 3rd edition*, Richard Jaeger and Travis Blalock, ISBN 0-07-319163-9
2. **Prerequisite:** ECE 2030, ECE 2040, Math 2403, Chem 1211
3. *The online lecture slides are password protected.*
4. **Homework Policies**
 - a) Homework will be assigned on weekly basis. The deadlines can be found on the class website.
 - b) Homework must be turned in by the end of the class on the due date.
 - c) Homework formats and guidelines
 - i - Be **neat, easily readable, and stapled**. All work leading to answers must be shown.
 - ii - Show your name, GTID, and homework assignment number on the first page.
 - d) Although students are encouraged to form small study group to discuss on class materials, homework should be done through individual effort (see Section 4.e.ii).
 - e) Each homework credit will be graded based on a binary system:
 - i - **One credit** will be earned with sufficient effort putting toward the completion of each assigned problem. Sometimes the TA may use different score systems. One credit will be given for those homework scores greater than 50% of the full scale.
 - ii - **Zero credit** will be given if the homework 1) is deemed a **late submission** by the instructor, 2) is submitted **by emails**, 3) is **copied from solution manuals**, or 4) is **copied from other's work**. All identical homework submissions will receive zero credit regardless of which one is the original work.
5. **Exams**
 - a) **There are two hour exams (80 min. each)**, along with dates and materials to be covered, are specified in the syllabus. They will take place at the same time and in the same classroom of regular class meetings.
 - b) Final exam will be a **comprehensive examination** that will cover all materials discussed.
 - c) All the exams are **close-book**. You may prepare a one-page equation sheet for hour exams. You are allowed to bring up to 3 pages of equation sheets for the final exam.
 - d) **“Equation Sheet” policy:** You may prepare **ONE** page of letter-sized equation sheet for all exams. Double-sided is acceptable but not 2 pages of single-sided papers.
 - e) Calculator will be allowed in exams. However, to make this equitable, the use of programmable or alphanumeric calculators will be limited to mathematical functions only –use of pre-programmed equations in tests is strictly prohibited and is considered as a violation of student's honor codes.
 - f) **Sample exam problems** are available on the class website. The style of the actual exams however may change slightly without prior notice. For example, multiple-choice problems may be offered in some of the exams, which may not be seen in the practice exams.
 - g) Exam design approaches:
 - i - Exam problems will cover the topics discussed in the class, whether they are in the posted class lecture slides or not.
 - ii - The exams will emphasize the understanding of primary semiconductor device concepts and the “Critical thinking” processes. There will be 10 ~20 bonus points in each exam.
 - iii - All exams will be graded by the instructor and final letter grades will be given based upon a curve.
 - iv - **Students who miss exams without prior approval will NOT be allowed to take a “make-up” exam** except for unexpected medical reasons or family emergencies.
 - v - Conflict of exam schedule due to planned personal vacation or family events will **NOT** be valid reasons for a make-up exam.
 - vi - **No time extension for those who are tardy** in exams.
6. **Academic dishonesty** will be punished to the full extent of The Institute's rules as described in the applicable GaTech General Catalog.
7. **Grading Criteria:** Homework: 5 %; Exam 1: 30%, Exam 2: 30%, Final Exam: 35%

$$\text{Final Score} = \text{curved} \left(\frac{(\# \text{ Homework submitted} + \# \text{ Pop Quizzes attended})}{(\# \text{ HW assignment} + \# \text{ Pop Quizzes})} * 5 + \frac{\text{HE1} + \text{HE2}}{100} * 60 + \frac{\text{Final Exam}}{200} * 35 \right)$$
8. **What are expected of students**
 - a) All students are required to follow **the academic honor codes** established by Georgia Tech
 - b) **Keep your cell phones and/or PDA turned off and not visible** in the classroom
 - c) Be courteous and respect others in the class
 - d) All students are responsible for any materials discussed in the classroom whether they attended class or not.

9. Tips for ECE3040 study

- a) Class lectures will combine PowerPoint presentation slides, overhead transparency projector, board writing, or whichever ways that suit best for the classroom discussion. It is beneficial to **take class notes** even though the PowerPoint presentation slides will be posted on the class website.
- b) Although it is not required to remember equations in this class, some basic physical laws that are associated with simple equations, for examples, Gauss's law, mass-action law, etc., may be worthy of memorization.
- c) Ask questions in class whenever you feel you are lost
- d) If you have problems and I can be of assistance for your study, you can visit me during the office hour. For efficient communication, please write down a list of specific questions before you come. You may also send me an email with your questions. I will post the answers in the Q&A session of the class website to help your study.

10. Reference Books

- a) Author: Ben G. Streetman and Sanjay Banerjee
Title: Solid State Electronic Devices, 5th or 6th edition
- b) Authors: Neamen, Donald A.
Title: Semiconductor Physics and Devices