EECE2412— FUNDAMENTALS OF ELECTRONICS— Fall 2024

Syllabus

INSTRUCTOR:	Charles A. DiMarzio, Associate Professor Electrical and Computer Engineering Lab: 334 Egan Mail: 409 Dana Office: 302 Stearns Northeastern University Boston, Massachusetts 02115 Phone: 617–373–2034 Electronic Mail: dimarzio@ece.neu.edu Course Website: http://www.ece.neu.edu/courses/eece2412/dimarzio/ Faculty Website: http://www.ece.neu.edu/faculty/dimarzio/ Research Lab Website: http://www.ece.neu.edu/groups/osl

OFFICE HOURS:	M 1:00-2:00, Th 12:00-1:00, (302 ST or Zoom)or By Appointment Feel free to email questions as well.

TEXT:	Hambley, Allan R. *Electronics*, Second Edition, Prentice–Hall.

OTHER RESOURCES:	For PSPICE, you can download a student version from http://www.electronics-lab.com/downloads/schematic/013/ There will be some use of Matlab or other software for calculations. I recommend Matlab, but I don't insist on it. I will put pointers to other resources on the class website.

LOCATION:	228RI

TIME:	Mon, Wed, Thu, 4:35 — 5:40 PM

LAB:	As scheduled, in 9HA EECE2413, Electronics Lab. This lab must be taken simultaneously since the material in the lab supplements the lecture. Note that students from the two lectures sections are intermixed in the labs. The schedule is posted on the course website.

READING:	Reading is to be done before the start of the week. When I lecture, I will assume that you have read the related material.

COURSE DESCRIPTION:	In this course you will learn about four types of electronic devices: op–amps, diodes, bipolar junction transistors (BJTs), and metal-oxide-semiconductor field effect transistors (MOSFETs). You will learn how to design and analyze useful electronic circuits (such as amplifiers and logic circuits) using these components.

GRADING:	20 % on homework (Equal weight on best $n-1$ of n assignments where $n \approx 10$) 50 % on 2 mid–term exams 30 % on final exam. Please discuss questions regarding homework grading first with the TA and then with the instructor. Discuss questions regarding exam grading with the instructor.

HOMEWORK:	Homework is typically given on Wednesday and due at the beginning of class the following Wednesday. Late homework is reduced by 10% per day until the solutions are posted (usually about 3 days), after which it is recorded as a zero. Be sure to show all steps. Simply writing the answer is not acceptable. Keep a photo of your homework for your own use while grading is being done. Working together is acceptable, and even encouraged, on homework, BUT the work that you submit must be your own (no copies of the group's solution!) If you are working with a group, make certain you understand every part of your solution. If you work in a group, indicate the names of members of the group (on each problem if applicable). Late homework will incur a penalty of 10 points out of 100 until solutions are posted. After that, late homework will not be graded and will be scored as a zero in the gradebook.

ETHICAL BEHAVIOR:	The following paragraph is specifically modified to allow for collaboration on homework. No collaboration, except as specifically authorized, is allowed under penalty of failure. Plagiarism and cheating will not be tolerated; they will be dealt in accordance with University policies described in the Student Handbook. All engineering majors should be familiar with the Honor Code of our College of Engineering that is included in the freshman course material, and with professional engineering codes of ethics. Although students are encouraged to collaborate on homework assignments to develop a deeper understanding of the topics presented in this course, each student is expected to prepare and submit his/her own narrative reports, drawings, and other materials. If two students' work is suspiciously similar, a penalty may be assessed to both students. If a situation arises in which you are uncertain if cooperation with another student would constitute cheating or some other violation of the honor code, please ask the instructor for guidance and clarification of these rules. Violators will be referred to the Student Court for review, where penalties may include but are not restricted to: zero credit on the work, student placed on probation, submission of information on judgment in the students' permanent record.

SPECIAL NEEDS:	The University will make reasonable accommodations for persons with documented disabilities. Students should notify the Disability Resource Center located in 20 Dodge Hall and their instructors of any special needs. Instructors should be notified the first day of classes.

Tentative Schedule

1	4,5,9 Sep	Administrivia. Schedule. Expectations. Syllabus. Introduction. Course overview. Review of Circuits Properties and uses of controlled sources. Amplifier models. **Reading:** Sections 1.4 to 1.8.
2	9,11,12 Sep	Op–Amps: Basic Applications. **Reading:** Sections 1.9 to 1.11, 2.1 to 2.5. **Homework:** 1 Due Wednesday.
3	15,16,19 Sep	Amplifier Circuits: Applications. Deviations from Ideal in Op–Amps. **Reading:** Sections 2.6 to 2.11. **Homework:** 2 Due Wednesday. **Lab:** 1 (Op Amps) Parts 1-2: 18 or 21 Sep.
4	23,25,26 Sep	Diodes: Characteristics, modeling, and applications. **Reading:** Sections 3.1 to 3.6 and 3.12. **Homework:** 3 Due Wednesday. **Lab:** 1 (Op. Amps) Part 3: 25 or 28 Sep.
5	30 Sep, 2,3 Oct	Diode Circuits. Physical operation of the junction diode. **Reading:** Sections 3.7 to 3.11. **Homework:** 4 Due Wednesday. **Lab:** 2 Part 1 (Diode Circuits): 2 or 5 Oct.
6	7 Oct	Review Day **Lab:** 2 Part 2 (Diode Circuits): 9 or 12 Oct.

	9 Oct	Exam 1. Two sheets of notes, both sides.

Monday 14 Oct — Indigenous Peoples' Day Holiday: No class

7	Thu 10, Wed 16, Thu 17 Oct	Introduction to the biopolar junction transistor (BJT): Physics of operation and circuit models **Reading:** Sections 4.1 through 4.4. **Homework:** 5 Due Wednesday. **Lab:** 3 Part 1 (BJT): 16 or 19 Oct.

8	21,23,24 Oct	BJT Circuit Analysis: Large signal and small signal analysis of BJT circuits. **Reading:** Sections 4.5 to 4.7. **Homework:** 7 Due Wednesday. **Lab:** 3 Part 2 (BJT): 23 or 26 Oct.

9	28,30,31 Oct	BJT Applications: Amplifiers and Logic circuits. **Reading:** Sections 4.8 and 4.9. **Homework:** 9 Due Wednesday. **Lab:** 4 Part 1 (BJT Amplifier): 30 Oct or 2 Nov.

10	4,6,7 Nov	Introduction to the field–effect transistor (FET): Physical operation, large–signal analysis. **Reading:** Sections 5.1 to 5.3. **Homework:** 9 Due Wednesday. **Lab:** 4 Part 2 (BJT Amplifier): 6 or 9 Nov.

Mon 11 Nov — Veterans' Day: No class

11	13 Nov	Review Day

	14 Nov	Exam 2. Two sheets of notes, both sides. **Lab:** 5 Part 1 (MOS): 13 or 16 Nov.

12	18 Nov	FET Small Signal Analysis. **Reading:** Sections 5.4 to 5.6.

	20,22 Nov	FET Circuits: Digital Logic **Reading:** Section 6.1–6.5. **Homework:** 10 Due Wednesday.

Wed,Thu 27,29 Nov — Thanksgiving Break: No class

13	2 Dec	Digital Logic: Basic logic circuits in MOS and CMOS. **Reading:** Sections 6.6 to 6.9. **Homework:** 12 Due Wednesday. **Lab:** 5 Part 2 (MOS): 27 or 30 Nov.

	4 Dec	Review Day

Reading Day: No Class, 5 Dec

	TBD	Final Exam (2 hours). Closed–book with three sheets of notes (both sides) allowed.

Notation

This is the notation used by the text to represent voltages and currents. While I like the choice, I've found it adds some extra confusion for the student. This table may help.

Quantity	V or I	Subscript	Voltage Example
Total Instantaneous Signal	lower case	CAPITAL	v_A
DC Signal	CAPITAL	CAPITAL	V_A
AC Signal	lower case	lower case	v_a
Phasor of AC	CAPITAL	lower case	V_a

Thus, any signal is represented by

$$v_A = V_A + v_a \qquad \text{Text}$$

and a sinusoidal signal is represented by

$$v_A = V_A + V_a \sin(\omega t + \phi) \qquad \text{Text}$$

Remember that the RMS of an AC signal is $V_a/\sqrt{2}$.

Decibels

Decibels are a convenient concept to describe gains and losses in electronic systems. The gain of an amplifier is described in terms of the power ratio of output to input, and is expressed in dB. (note lower–case "d," meaning "deci–," and capital "B" for "Bel.") as

$$g = 10 \log (p_{OUT}/p_{IN}).$$

If the output and input impedances are the same, then the power gain is the square of the voltage (or current) gain, and

$$g = 10 \log \left(\frac{v_{OUT}}{v_{IN}} \right)^2] = 20 \log (v_{OUT}/v_{IN}).$$

Although it is not needed for this course, signals are often expressed in dBm. This is not a measure of gain, but of signal level. It is the ratio of the power to one milliwatt.

$$y = 10 \log (p/10^{-3}\text{W}).$$

Typically, this concept is used with 50–Ohm impedances common in RF work, and

$$y = 10 \log (v^2/10^{-3}\text{W}/50\text{Ohms}).$$