Department of Electrical and Computer Engineering
ECE 371: Electronic Circuits Design

ECE 371 - Electronic Circuits Design 4 credits 5 contact hours (3;2;0)

Instructor: M. Feknous; email: feknous@njit.edu; Tel: 609-533-5818
Textbook: R. C. Jaeger – T. N. Blalock, Microelectronic Circuit Design, ISBN 978-0-07-338045-2 or latest edition (main text)
Reference Book: Sergio Franco, Design with Operational Amplifiers and Analog Integrated Circuits, ISBN 0-07-232084-2

Course Description:
Principles of FET and BJT small signal amplifiers: Q point design, input and output impedance, gain, and signal range limitations for the six different single stage configurations. Design of analog integrated circuits including current sources, differential amplifiers, noise sources, active loads, and CMOS circuits. Transistor high frequency models, Miller effect, and frequency response of multistage amplifiers. Feedback with multistage amplifiers and two-port network theory.

Prerequisites: ECE 232, ECE 271, and ECE 294
Corequisite: none

Computer Usage in course:
Multisim, Excel, Matlab

Educational objectives for the course:
This course emphasizes the design skills involved in dealing with mostly analog circuits and applications. In addition, the course is associated with laboratory experiments that will allow the students to practice and experiment with designs taught in the lecture portion of the course. A portion of the experiments will enhance the ability to analyze relevant circuits and extract information that will enhance their capability to select circuits that will satisfy required specifications. Another part of the experiments will rely on the competence of the students to offer circuits that will satisfy specifications chosen by the instructor. The design skills will culminate in a class project with the topic chosen by the students, in which they need to demonstrate the mastering of the system, through a power point presentation, a report, and a realization to confirm the validity of their design and offer some practical application to show the usefulness of such product in serving the needs of the human race.

Course Learning Outcomes (CLO): The student will be able to

1. analyze and obtain relevant characteristics of the most popular single stage configurations involving BJTs and MOSFETs
2. learn to design these single stage amplifiers, select the appropriate configuration that would fit the specifications of a more complex circuit

3. evaluate the effect that capacitors (coupling and bypass capacitors at low frequencies, and internal capacitances affecting the response at high frequencies) have on the frequency responses of these amplifiers
4. analyze and design differential pairs, and understand the importance of this configuration not only in the case of simple amplifiers but also as a basic block in the design of operational amplifiers
5. determine the characteristics of multistage amplifiers, current sources, active loads, and the blocks that form the backbone of an operational amplifier
6. understand and evaluate the effect of feedback on the characteristics of amplifiers
7. investigate and design operational-amplifier and comparator-based circuits including Schmitt triggers, sine wave generators, and timers
8. reverse engineer a design, reconfigure it based on different specifications, and present it in front of peers.
9. utilize the knowledge acquired in lectures to analyze, design, and realize relevant circuits.
10. realize the steps involved in design from a concept to a working product through calculations, simulation, and the need for debugging a practical circuit that does not always conform to a conceived model.
11. analyze basic OPAMP- based circuits, lowpass, highpass, bandpass active filters, design and realize a 6^{th}-order lowpass Sallen-Key filter.
12. analyze basic comparator-based circuits, comparator-based Schmitt triggers, and design a 4-level bargraph display.
13. analyze and design 555-based multivibrators, and a Wien-bridge sinusoidal oscillator.
14. analyze, design and realize common-emitter, common-source, emitter follower, source follower amplifiers, and a 1000-gain multistage amplifier.
15. suggest a class project, realize the product, and present it to their peers as an audience.

Relevant ABET 1-7 Student Outcomes(SOs):

SO1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

SO1.1. an ability to identify and formulate complex engineering problems by applying principles of engineering, science, and mathematics (CLOs 1-15).

SO1.2. an ability to solve complex engineering problems by applying principles of engineering, science, and mathematics (CLOs 1-15).

SO2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors (CLOs 10-15).

SO5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

SO5.1. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment (CLOs 10-15).

SO5.2. an ability to establish goals, plan tasks, and meet objectives (CLOs 10-15).

SO6. an ability to develop and conduct appropriate experimentation, analyze, interpret data, and use engineering judgment to draw conclusions.

SO6.1. an ability to develop and conduct appropriate experimentation (CLOs 10-15).

SO6.2. an ability to analyze and interpret data (CLOs 10-15).

SO6.3. an ability to use engineering judgment to draw conclusions (CLOs 2, 4, 5, 7, 8, 10-15)

SO7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies. (CLOs 10-15).

Topics:

Topic	Week
Analog systems • Two-port networks • Ideal operational amplifiers • Operational amplifier-based circuits • Active filters	1-2
Nonlinear Circuits • Comparators • Applications: ON-OFF Control, Window Detectors, Schmitt Triggers	3-4
Signal Generators • Oscillators • multivibrators	5-6
Midterm exam #1 10/9 or latest 10/16	6
Small-signal modeling • BJT amplifiers • MOSFET amplifiers	7
Single and multistage amplifiers • Common emitter, common source • Common collector, common drain • Coupling and bypass capacitor design • Multistage AC-coupled amplifiers	8-9
Differential amplifier • DC and AC analyses • Differential-mode gain, common-mode gain, common-mode rejection ratio • Input and output resistances • Transition to operational amplifiers • Output stages	10-11
Current Sources and Feedback	11

• MOSFET Current Sources • BJT Current Sources • Buffered Current Sources • Widlar Current Sources	
Midterm exam #2 11/20	12
Amplifier frequency response • Estimation of ω_L using the short-circuit-time-constant method • Transistor models at high frequencies • Estimation of ω_H using the Open-circuit-time-constant method	12-13
Group project presentation, review presentations between 4/21 and 5/1	13-14
Final exam	15

Grading:

Class participation, Homework, quizzes	10%
Lab Experiments and Class Project (project is 20% of lab grade)	25%
Midterm examinations	2 x 20%
Final examination	25%

Honor Students will be required to provide additional services to be determined in class.

Homework Problems:

Chapter	**Problems**
10	14, 17, 54, 66,
13	11, 21, 31, 59, 62, 63
14	22, 30, 76, 95, 119
15	TBA
17	TBA

These numbers are associated with the 5th edition of the text.
Date of submission will be announced in class. The topics of the class project will be selected by groups of students and approved by the instructor no later than 4 weeks after the beginning of the semester. The project topic should be about mastering an existing mostly analog electronics design, then manipulating the design to fit the specifications related to another application that the group will select. Each group should elect a project manager to interact with the instructor and manage the project.

Honor Code:

"Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at: http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf.

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. ***Any student found in violation of***

the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. *If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu"*

Office hours:

M	11:30 AM – 11:59 AM
T	10:00 PM – 10:50 PM
W	11:00 AM – 11:45 AM
R	10:00 PM – 10:50 PM

Other times can be arranged through appointments; All appointments in the office should be preceded by an email at least 15 min before the appointment, and noting **the day and time** you want to meet. Any time, other than the office hour times, will be conducted through Zoom with a day and time suitable for both parties. Times can be extended to beyond 10 PM on a few days of the week, if need be.

Set up an appointment for any office hour (regular or extraordinary) meeting through email stating the suitable meeting day and time.

For extraordinary times, try to avoid Tuesdays to Fridays (you can use weekends if an emergency arises)

Office: ECEC 311

Prepared by: M. Feknous