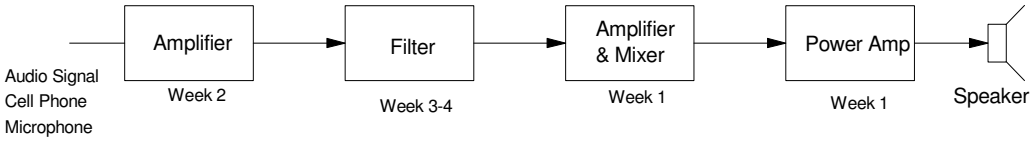
ECE 321 Electronics II: Analog Electronics (week 11-16)

Spring 2024: www.BisonAcademy.com

In ECE 320, we covered digital electronics. With digital electronics, the outputs should be binary: either 5V (true) or 0V (false). This allows us to build logic gates (NAND, NOR), turn on and off motors with a transistor switch, or change direction with an H-bridge.

In ECE 321, we cover analog electronics. The types of circuits we cover are:

- Amplifiers: Take a small analog signal and amplify it so you can hear it.
- Power Amplifiers: Take a circuit with limited power capability and amplify the power to drive a motor or a speaker.
- Sensors: Convert something you want to measure (such as temperature) to something you can measure (such as a voltage), and
- Filters: Pass some frequencies and reject others, such as a crossover for a sub-woofer.



Two types of circuits will be used in this class

- Op-Amp circuits: Using a high-gain differential amplifier to implement these circuits
- Transistor Circuits: Designing amplifiers at the transistor level

Typically, you'll use op-amps when building amplifiers: they're easy to use, accurate, reliable, and cheap. Sometimes, such as in Communications Circuits, you'll design an amplifier at the transistor level. The latter is included for completeness.

Overall, this is a fun course: by the end you should be able to build:

- A subwoofer: Take an audio signal from your cell phone, amplify it, filter it to pass frequencies below 250Hz, and then drive an 8-Ohm speaker
- An Octolively: When you wave your hand over a light sensor, an LED bounces up and down in response to the shadow,
- An 8-Key Piano: Using a PIC processor (or the like), generate 8 notes. Amplify, and filter this signal to produce a sine wave rather than a square wave, then drive a speaker with that sine wave.
- A temperature-controlled fan: Control the speed of a fan based upon temperature

Each week we cover part of these designs:

- Week 1: Op-Amp Amplifiers. Amplify the magnitude of a signal or amplify the power to drive an 8-Ohm speaker, a 50W LED, or drive a motor (or fan).
- Week 2: Sensors and Instrumentation. How to measure temperature, light, sound, and strain. Determining calibration functions to relate the resulting voltage to the original parameter (temperature, light, sound, strain).
- Week 3 & 4: Filters: Determining how the transfer function of a filter affects its frequency response. Designing high-pass, low-pass, and band pass filters.
- Week 5&6: Transistor Amplifiers. Biasing a transistor in the active region and then amplifying small audio signals

ECE 321: Electronics II

Analog Electronics

Course Information:

Instructor:	Ivan Lima
Class Times	Tu/Th 9:30am, Stevens 231
	Fr 3:00pm, AGHill 228
Labs:	Part of homework sets
	Lab kits are provided for each student
Office Hours:	t.b.d.
Text:	Microelectronic Circuit Design by Richard Jaeger ($7 used from Amazon)
On-Line Reference:	www.BisonAcademy.com
	www.electronics-tutorials.ws/index.html

Bulletin Description:

ECE 321: Characterization, modeling, and analysis of analog circuits using diodes, BJTs, FETs, and Op Amps. 4 one-hour lecture, 1 two-hour laboratory each week for 6 weeks. Prereq: EE 206. F, S

- ECE 320 is required for all electrical and computer engineers. Everyone should sign up for ECE 320.
- ECE 321 is required for all electrical engineers and is optional for computer engineers. It counts as a 2cr technical elective for computer engineers.
- If you took ECE 321 previously as a 5 credit course and want to replace your old grade, you need to take both ECE 320 and ECE 321. Your old grade will be replaced by the grade you get in ECE 321 - and you will lose 3 credits (5cr becomes 2cr). BUT, you also gain these 3 credits back in ECE 320. Yes, it's strange, but it kind of works.

Course Objectives:

By the end of the semester, students should:

- Explain how to put a transistor into the active region
- Design and analyze transistor circuits with analog inputs and outputs,
- Design and analyze filters to meet design requirements, and
- Design an analyze op-amp circuits with analog inputs and outputs

Required Student Resources:

- Calculator capable of complex numbers
  HP35S recommended ($57 from Amazon)
  Most ECE students use TI84 Plus ($100 from Amazon)
- Ability to make videos and preferably post them on YouTube.

Evaluation Procedures and Grading Criteria

Grades will be the average of the following:

	Weekly Quizzes	Homework	Final Exam
ECE 321	33%	33%	33%

Grades are rounded to the nearest 1%, with your final grade being

F	D	C	B	A
59% or less	60% - 69%	70% - 79%	80% - 89%	90% or more

Weekly Quizzes: Most weeks, there will be a quiz covering the previous week's homework.

Homework & Labs: Each week, there will also be homework assignments coupled with lab exercises. Typically, the homework will consist of a few problems everyone does (such as design a circuit to push 20mA through an LED) as well as a problem you devise on your own to demonstrate your knowledge of that week's material. These latter problems should have the following sections:

- Requirements: What your circuit does. Inputs / Outputs / and how they relate
- Analysis: Math behind your design. Design a circuit to meet your requirements.
- Test: Check that your analysis was correct. Usually simulation results to verify currents, voltages, etc
- Validation: Simulate your circuit in CircuitLab (or similar), collect data, and verify that you did or did not meet your requirements.

Note that lab reports are a part of the homework assignments: this is the actual data you collect to check your design. Separate lab reports are not required. Only one homework set per group is requierd.

Final Exam: The final exam covers material from the previous quizzes

- The final exam for ECE 321 is Tuesday, May 9th

Lab Time and Lab Access: Labs will be done in simulation using CircuitLab (or similar) software.

Legal Stuff:

Special Needs - Any students with disabilities or other special needs, who need special accommodations in this course, are invited to share these concerns or requests with the instructor and contact the Disability Services Office (www.ndsu.edu/disabilityservices) as soon as possible.

Academic Honesty - The academic community is operated on the basis of honesty, integrity, and fair play. NDSU Policy 335: Code of Academic Responsibility and Conduct applies to cases in which cheating, plagiarism, or other academic misconduct have occurred in an instructional context. Students found guilty of academic misconduct are subject to penalties, up to and possibly including suspension and/or expulsion. Student academic misconduct records are maintained by the Office of Registration and Records. Informational resources about academic honesty for students and instructional staff members can be found at www.ndsu.edu/academichonesty.

Academic Honesty Defined: All written and oral presentations must “respect the intellectual rights of others. Statements lifted verbatim from publications must be cited as quotations. Ideas, summaries or paraphrased material, and other information taken from the literature must be properly referenced” (Guidelines for the Presentation of Disquisitions, NDSU Graduate School).

ECE Honor Code: On my honor I will not give nor receive unauthorized assistance in completing assignments and work submitted for review or assessment. Furthermore, I understand the requirements in the College of Engineering Honor System and accept the responsibility I have to complete all my work with complete integrity.

Veterans and Student Soldiers: Veterans and student soldiers with special circumstances or who are activated are encouraged to notify the instructor in advance.

Attendance: According to NDSU Policy 333 (www.ndsu.edu/fileadmin/policy/333.pdf), attendance in classes is expected. Students are responsible for the material covered in class and in assignments regardless of their attendance.