**Electronic Devices and Circuits – EENG385**

**Spring 2024**

**Dr. Chris Coulston, Teaching Professor, 303.273.3265, coulston@mines.edu**

**Office: 310E BB (Brown Hall)**

**Course Title: Electronic Devices and Circuits**

**Course Meeting:** Lecture MW F 11:00-11:50 241 Berthoud

Lab A R 8:00-10:50 304 Brown

Lab B R 11:00-2:50 304 Brown

Lab C R 3:00-5:50 304 Brown

**Course Description:** Semiconductor materials and characteristics, junction diode operation, bipolar junction transistors, field effect transistors, biasing techniques, amplifier and power supply design, laboratory study of semiconductor circuit characteristics.

**Prerequisite(s): EENG 307 – Introduction to Feedback Control of Dynamic Systems**

**Textbook(s):** **Microelectronics Circuit Analysis and Design: Neamen, Donald, 4th Edition.**

**Course Objectives:**

* Analyze and design a circuit containing one or more diodes.
* Analyze and design a circuit containing resistors and op amps.
* Perform a DC and AC analysis of a circuit containing BJT.
* Analyze and design a circuit containing one or more BJTs.
* Analyze and design a circuit containing a MOSFET.
* Derive the transfer function for a circuit.
* Use a Bode plot to predict circuit behavior.
* Produce a Bode plot for a circuit using test and measurement equipment in the laboratory.
* Assemble a circuit on a PCB using the equipment in the laboratory.
* Analyze and design a circuit consisting of several building blocks.

**Lab:** We will meet weekly in 304 Brown Hall. Labs are designed to take the entire week and be turned in during the following lab period. Late assignments are assessed a 50% late penalty. Your lowest lab grade will be dropped from your final grade.

**Homework:** Homework will be assigned through the term. Late assignments are assessed a 50% late penalty. Your lowest homework grade will be dropped from your final grade.

**Office Hours:** I like to have everyone from the same course in my office during office hours. If I am not working with your class, please interrupt me and let me know that you have a question from a different class. I will let the students present know that I need to attend to a question from another class and give them and give them 10 minutes to wrap-up their questions before I switch to yours. I will also be holding office hours on Zoom during which I will create breakout rooms for each course.

**Topics Covered:** This is an approximate timeline; changes may be made throughout the semester.

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| --- | --- | --- | --- | --- |
| Session | Date |  | Reading | Assignment |
| 1 | Jan 10 | Review: Ohms, Superposition, Thevenin | Supplemental |  |
|  | Jan 11 | No Lab :( |  |  |
| 2 | Jan 12 | Review: Capacitors, RC Circuits | Supplemental |  |
|  | Jan 15 (M) | Martin Luther King |  |  |
| 3 | Jan 17 | Review: Input, Output Impedance, 2-port networks | 9.1, 9.2 | HW 1 Due |
| Lab 1 | Jan 18 | CT: 555 Timer |  |  |
| 4 | Jan 19 | Op amps: Principle, Voltage Follower, Inverting, Non-Inverting | 9.3 |  |
| 5 | Jan 22 (M) | Opamps: Weighted Summer, Inverting/Non-Inverting, T-network | 9.4 |  |
| 6 | Jan 24 | Opamp: Schmitt Trigger Relaxation Oscillator, | 15.3, 9.5.3, 15.4 |  |
| Lab 2 | Jan 25 | CT: Schmitt Trigger Relaxation Oscillator |  | Lab 1 Due |
| 7 | Jan 26 | Opamp: Differential Amplifier, Inverting Integrator | 9.5.5 |  |
| 8 | Jan 29 (M) | Diode: Ideal Model, In Circuit Behavior with Resistors | 1.3 | HW 2 Due |
|  | Jan 31 | Career Fair | 2.4 |  |
| Lab 3 | Feb 1 | CT: Deboo Integrator |  | Lab 2 Due |
| 9 | Feb 2 | Diode: Circuits with Diodes and Resistors (Handout) | 1.2 |  |
| 10 | Feb 5 (M) | Diode: Circuits with Diodes and Capacitors (Handout) | 1.3.2,1.2.4 |  |
| 11 | Feb 7 | Diode: Constant Voltage Drop, Exponential model | 1.4 |  |
| Lab 4 | Feb 8 | CT: Pseudo Ramp | 2.1 (optional) | Lab 3 Due |
| 12 | Feb 9 | BJT: Cutoff, Active and Saturation |  | HW 3 Due |
|  | Feb 12 (M) | Exam Review |  |  |
|  | Feb 14 | Exam 1 | 5.1 |  |
| Lab 5 | Feb 15 | Full Bridge Rectifier |  | Lab 4 Due |
| 13 | Feb 16 | BJT: Circuit Analysis at DC with active and saturated | 5.2 |  |
|  | Feb 19 (M) | Presidents Day | Supplemental |  |
| 14 | Feb 21 | Lab 6 review | 5.3 |  |
| Lab 6 | Feb 22 | CT: Calibration |  | Lab 5 Due |
| 15 | Feb 23 | BJT: Circuit Analysis at DC with active and saturated | 5.4, 5.5, 5.6 |  |
| 16 | Feb 26 (M) | BJT: Current Source design and applications | 10.1, 10.2 | HW 4 Due |
| 17 | Feb 28 | BJT: Current Mirror design and applications | 10.1.4 |  |
| Lab 7 | Feb 29 | Audio: Power Supply |  | Lab 6 Due |
| 18 | March 1 | BJT: Differential Pair and active load | 11.1, 11.2 |  |
| 19 | March 4 (M) | BJT: Small Signal derive hybrid pi parameters | 6.9.2, 6.9.3 | HW 5 Due |
| 20 | March 6 | Lab 8 review and cross-over distortion | 8.5.2 |  |
| Lab 8 | March 7 | Audio: Amplifier Theory |  | Lab 7 Due |
| 21 | March 8 | BJT: Small Signal building AC models | 6.1 |  |
| 22 | March 11 (M) | BJT: Small Signal circuit analysis | 6.3 |  |
| 23 | March 13 | BJT: Small Signal Common Base, Emitter and Collector | 6.7 |  |
| ~~Lab 9~~ | March 14 | ~~Audio: Amplifier Measurements~~ SNOW DAY CLASS CANCLED |  | ~~Lab 8 Due~~ |
| 24 | March 15 | ~~BJT: Small Signal High gain~~ SNOW DAY CLASS CANCLED | 6.6 |  |
|  | March 18 (M) | Spring Break |  |  |
|  | March 25 (M) | Exam Review | Supplemental | HW 6 Due |
|  | March 27 | Exam 2 |  |  |
| Lab 9 | March 28 | Audio: Amplifier Measurements |  | Lab 8 Due |
| 25 | March 29 | Active Filters: Bode plot, dB and decades | 15.1 |  |
| 26 | April 1 (M) | Active Filters: 1st and 2nd order Filters, Calc. Transfer Functions | Supplemental |  |
| 27 | April 3 | Active Filters: Constellations, Magnitude, Low, Band, High pass | Supplemental |  |
| Lab 11 | April 4 | Frequency: Active Filter Design – 2 week lab |  | Lab 9 Due |
| 28 | April 5 | Active Filters: Bessel, Butterworth, Chebyshev | Supplemental |  |
| 29 | April 8 (M) | Active Filters: | Supplemental |  |
| 30 | April 10 | Active Filters: Constellation poles Low, Band and High pass | Chapter 14 |  |
|  | April 11 | Frequency: Active Filter Design – 2 week lab |  |  |
|  | April 12 | E-days |  |  |
| 31 | April 15 (M) | MOSFET: Introduction | 3.1 | HW 7 Due |
| 32 | April 17 | MOSFET: Circuit Analysis at DC | 3.2 |  |
| Lab 12 | April 18 | Frequency: Total Harmonic Distortion |  | Lab 11 Due |
| 33 | April 19 | MOSFET: Circuit Analysis at DC | 3.3 |  |
| 34 | April 22 (M) | MOSFET: Circuit Analysis at DC | 3.3 |  |
| 35 | April 24 | MOSFET: Digital Logic | 16.3 |  |
|  | April 25 |  |  | Lab 12 Due |
| 36 | April 26 | MOSFET: Digital Logic | 16.3 |  |
| 37 | April 29 (M) | MOSFET: Digital Logic | 16.4 |  |
|  | May 1 | Exam Review | Supplemental | HW 8 Due |
|  | May 6 | Final Exam at 10:15 am in 241 Berthoud |  |  |

**Computers:** We will be working with computers throughout this semester. Inevitably there will be problems that you will encounter. If a computer or its software are malfunctioning, then please report it. Please be professional with your interactions with the lab staff. The IT staff works hard to keep our problems to a minimum. Establishing a positive relationship with them will help expedite solutions to any problems we may have. If there are major problems with the system during critical times, I will have been made aware of them and will determine an appropriate course of action.

**Exams:**

* Exams will be scheduled during the class meeting time,
* Exams may be administrated online using Canvas, if so:
  + Some exam questions may require you to upload photos showing your work,
  + You may take the exam wherever you feel comfortable,
* The academic integrity guidelines apply while you are taking the exam.

**Makeup Exams:** Makeup exams can be arranged. Prior arrangements are appreciated but if some major emergency should arise and you cannot make it to an exam it is your responsibility to:

1. Contact me at my office phone (303.273.3265), or
2. Contact me by email (coulston@mines.edu).

Contact me as soon as you are able to return to campus. In general, I am pretty understanding about makeup exams – I do not want anyone hurt attempting to make it to campus as a result of foul weather. Please show me the same respect as you would like me to show you in complying with these guidelines.

**Grades:** The grade you earn in this class will based on the following distribution of points:

|  |  |
| --- | --- |
| Exam 1 | 15% |
| Exam 2 | 15% |
| Exam 3 | 20% |
| Labs | 25% |
| Homework | 25% |

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| --- | --- | --- |
| Grade | Upper | Lower |
| A | 100 | 93+ |
| A- | 93- | 90+ |
| B+ | 90- | 87+ |
| B | 87- | 83+ |
| B- | 83- | 80+ |
| C+ | 80- | 77+ |
| C | 77- | 73+ |
| C- | 73- | 70+ |
| D+ | 70- | 63+ |
| D | 67- | 63+ |
| D- | 63- | 60+ |
| F | 60- | 0.0 |

**Academic Integrity:** The Colorado School of Mines affirms the principle that all individuals associated with the Mines academic community have a responsibility for establishing, maintaining and fostering an understanding and appreciation for academic integrity. In broad terms, this implies protecting the environment of mutual trust within which scholarly exchange occurs, supporting the ability of the faculty to fairly and effectively evaluate every student’s academic achievements, and giving credence to the university’s educational mission, its scholarly objectives and the substance of the degrees it awards. The protection of academic integrity requires there to be clear and consistent standards, as well as confrontation and sanctions when individuals violate those standards. The Colorado School of Mines desires an environment free of any and all forms of academic misconduct and expects students to act with integrity at all times. Academic misconduct is the intentional act of fraud, in which an individual seeks to claim credit for the work and efforts of another without authorization, or uses unauthorized materials or fabricated information in any academic exercise. Student Academic Misconduct arises when a student violates the principle of academic integrity. Such behavior erodes mutual trust, distorts the fair evaluation of academic achievements, violates the ethical code of behavior upon which education and scholarship rest, and undermines the credibility of the university. Because of the serious institutional and individual ramifications, student misconduct arising from violations of academic integrity is not tolerated at Mines. If a student is found to have engaged in such misconduct sanctions such as change of a grade, loss of institutional privileges, or academic suspension or dismissal may be imposed. For this course, the following rules should be followed.

* Copying of solutions without understanding them is not allowed; if a student copies a solution and cannot explain it adequately this is considered academic dishonesty.
* During quizzes and exams, students must do 100 percent of the work on their own.
* The nominal penalty for academic dishonesty is an ’F’ in the course.

**Disability Support Statement:**

The Colorado School of Mines is committed to ensuring the full participation of all students in its programs, including students with disabilities. If you are registered with Disability Support Services (DSS) and I have received your letter of accommodations, please contact me at your earliest convenience so we can discuss your needs in this course. For questions or other inquiries regarding disabilities, I encourage you to visit disabilities.mines.edu for more information.

**Absenteeism (from Undergraduate Bulletin)**

Class attendance is required of all undergraduates unless the student has an official excused absence. Excused absences are granted for three general reasons:

1. Student is a varsity athlete and is representing the School in a varsity athletics activity.

2. Student is representing the School in an authorized activity related to a club or academic endeavor (academic competitions, student professional society conferences, club sport competition, program-sponsored competitions, etc.)

3. Student has a documented personal reason (illness, injury, jury duty, life-threatening illness or death in the immediate family, military service, etc.).

Students who miss academic work (including but not limited to exams, homework, and labs) for one of the reasons listed above may be issued an excused absence. If an excused absence is received, the student must be given the opportunity to make up the missed work in a reasonable period of time without penalty. While the student is not responsible for actually issuing the excused absence, the student is responsible for making sure documentation is submitted appropriately and for contacting his/her faculty member(s) to initiate arrangements for making up any missed work.