Course Number and Title: ELC 226 Analog Electronics II

Campus Location:
Georgetown, Dover, Stanton

Effective Date:
2019-51

Prerequisite:
ELC 126, MAT 190 or concurrent, ELC 225 or concurrent

Co-Requisites:
none

Course Credits and Hours:
3.00 credits
2.00 lecture hours/week
2.00 lab hours/week

Course Description:
This course covers the fundamentals of analog electronic circuits with emphasis toward application, circuit/component recognition, expected input and output signals, and measurement criteria. Topics include field effect transistors (FETs), frequency response of amplifiers, operational amplifiers, and industrial circuits including unijunction transistors (UJTs), silicon controlled rectifiers (SCRs), photoelectronics, sensors, and transducers.

Required Text(s):
Obtain current textbook information by viewing the campus bookstore - https://www.dtcc.edu/bookstores online or visit a campus bookstore. Check your course schedule for the course number and section.

Additional Materials:
Electronics Parts Kit, Digital Multimeter, TI-84+ or TI-89 Calculator.

Schedule Type:
Classroom Course

Disclaimer:
None

Core Course Performance Objectives (CCPOs):

1. Identify and discuss FETs and their operating characteristics. (CCC 1, 2, 5; PGC 1)
2. Identify and evaluate FET small-signal amplifier configurations, including common-source, common-drain, and common-gate techniques. (CCC 2, 6; PGC 1, 2, 3, 4)
3. Analyze the frequency response of amplifier circuits. (CCC 2, 6; PGC 1, 2, 3, 4)
4. Explain the theoretical and practical aspects of industrial sensors and thyristor circuits. (CCC 1, 2, 6; PGC 1, 2, 3, 4)
5. Explain the theoretical and practical aspects of operational amplifiers. (CCC 2, 6; PGC 1, 2, 3, 4)
6. Evaluate the electrical concepts and equations needed for designing and constructing active filter circuits. (CCC 2, 6; PGC 1, 2, 3, 4)
7. Analyze oscillator and phase-locked loop circuits. (CCC 1, 2, 6; PGC 1, 2, 3, 4)
8. Compare and contrast regulated and switching power supply designs. (CCC 1, 2, 6; PGC 1, 2, 3, 4)

See Core Curriculum Competencies and Program Graduate Competencies at the end of the syllabus. CCPOs are linked to every competency they develop.

Measurable Performance Objectives (MPOs):
Upon completion of this course, the student will:

1. Identify and discuss FETs and their operating characteristics.
    1. Describe the basic structure and operation of a junction field-effect transistor (JFET) and how it differs from a bipolar junction transistor.
    2. Identify the terminals on P and N channel JFET schematic symbols and for various packages.
    3. Interpret JFET characteristic curves.
    4. Interpret and use JFET transistor datasheets.
    5. Identify the voltages and currents which flow in a p and n channel JFET.
    6. Define *pinch-off voltage* and *cutoff voltage,* and explain their differences.
    7. Discuss the meaning and limitations for commonly encountered JFET parameters.
    8. Analyze JFETs in a self-bias configuration.
    9. Analyze JFETs in a midpoint bias configuration.
    10. Analyze JFETs in a voltage-divider bias configuration.
    11. Describe the difference in characteristics between a D-Type metal oxide semiconductor field-effect transistor (MOSFET) and an E-Type MOSFET (both p- and n-channel) and how they differ from a JFET.
    12. Identify the terminals on a D-MOSFET and an E-MOSFET.
    13. Analyze MOSFETs using zero bias, drain-feedback, and voltage divider bias schemes.
2. Identify and evaluate FET small-signal amplifier configurations, including common-source, common-drain, and common-gate techniques.
    1. Analyze the operation for each of the JFET amplifier configurations.
    2. Solve for gate-to-source voltage and drain current for each configuration, and plot the direct current (DC) load line.
    3. Develop the alternating current (AC) and DC equivalent circuits for each configuration.
    4. Calculate the voltage gain for each configuration.
    5. Recognize the input and output loading effects for each configuration.
3. Analyze the frequency response of amplifier circuits.
    1. Calculate upper and lower critical frequencies and voltage and power gain by use of decibels.
    2. Analyze and determine amplifier frequency response using Miller's theorem.
    3. Calculate and construct a Bode plot of total frequency response of the common emitter amplifier.
    4. Demonstrate the relationship of rise time to bandwidth.
4. Explain the theoretical and practical aspects of industrial sensors and thyristor circuits.
    1. Describe the characteristics and applications for the UJT, DIAC, SCR, and TRIAC solid-state devices.
    2. Analyze and measure an industrial circuit using TRIAC, UJT and SCR solid-state devices using acceptable industry standards and the tools and equipment required in the work environment.
    3. Describe the characteristics and applications for optical encoders, photo cells, proximity sensors, strain gauges, level sensors, pressure sensors, and temperature sensors.
5. Explain the theoretical and practical aspects of operational amplifiers.
    1. Describe the characteristics of an ideal operational amplifier.
    2. Describe, analyze, test, and explain the significance of an operational amplifier's common-mode rejection ratio, slew rate, and voltage gain.
    3. Describe, analyze, and test the output signals for inverting and non-inverting linear operational amplifiers and window operational amplifier comparators.
    4. Describe, analyze, and test the output signals for summing, differential, integrating, and differentiating linear operational amplifiers.
    5. Analyze and explain the operation of special purpose operational amplifier circuits, including instrumentation, isolation, and Schmitt trigger configurations.
6. Evaluate the electrical concepts and equations needed for designing and constructing active filter circuits.
    1. Analyze the basic filter response characteristics of active, low-pass, high-pass, band-pass, and notch filters.
    2. Calculate critical frequencies, bandwidth, quality factors, and damping factors of various filter configurations.
    3. Describe Butterworth, Bessel, and Chebyshev response characteristics.
    4. Predict the gain versus frequency response, and construct a Bode plot of the frequency and phase response for the filters.
7. Analyze oscillator and phase-locked loop circuits.
    1. Describe the basic operating principles of an oscillator.
    2. Describe and analyze the basic operations of various resistor-capacitor (RC) and resistor-inductor (RL) feedback oscillators.
    3. Describe and analyze the basic operation of various relaxation oscillators.
    4. Describe and analyze the basic operation of a phase locked loop circuit (PLL).
8. Compare and contrast regulated and switching power supply designs.
    1. Describe and analyze the basic operations of various series and shunt voltage regulators.
    2. Explain and calculate line and load regulation.
    3. Describe and analyze the operation of linear series regulators.
    4. Describe and analyze the operation of linear shunt regulators.
    5. Examine the design of switching regulators circuits.
    6. Diagram basic regulated and switching power supplies.
    7. Compare various power supply architectures, including wall adapters, charging circuits, and switching power supplies.

Evaluation Criteria/Policies:
Students must demonstrate proficiency on all CCPOs at a minimal 75 percent level to successfully complete the course. The grade will be determined using the Delaware Tech grading system:

92	–	100	=	A
83	–	91	=	B
75	–	82	=	C
0	–	74	=	F

Students should refer to the [Student Handbook - https://www.dtcc.edu/handbook](https://www.dtcc.edu/handbook) for information on the Academic Standing Policy, the Academic Integrity Policy, Student Rights and Responsibilities, and other policies relevant to their academic progress.

Final Course Grade:
Calculated using the following weighted average

Evaluation Measure	Percentage of final grade
Summative: 3-4 Exams (equally weighted)	50%
Summative: 10-15 Laboratory Experiments (equally weighted)	40%
Formative: Homework/Pop Quizzes (equally weighted)	5%
Formative: Quizzes (equally weighted)	5%
TOTAL	100%

Core Curriculum Competencies (CCCs are the competencies every graduate will develop):

1. Apply clear and effective communication skills.
2. Use critical thinking to solve problems.
3. Collaborate to achieve a common goal.
4. Demonstrate professional and ethical conduct.
5. Use information literacy for effective vocational and/or academic research.
6. Apply quantitative reasoning and/or scientific inquiry to solve practical problems.

Program Graduate Competencies (PGCs are the competencies every graduate will develop specific to his or her major):

1. Perform the duties of an entry-level technician using the skills, modern tools, theory, and techniques of the electronics engineering technology.
2. Apply a knowledge of mathematics, science, engineering, and technology to electronics engineering technology problems that require limited application of principles but extensive practical knowledge.
3. Conduct, analyze, and interpret experiments using analysis tools and troubleshooting methods.
4. Identify, analyze and solve narrowly defined electronics engineering technology problems.
5. Explain the importance of engaging in self-directed continuing professional development.
6. Demonstrate basic management, organizational, and leadership skills which commit to quality, timeliness and continuous improvement.

Disabilities Support Statement:
The College is committed to providing reasonable accommodations for students with disabilities. Students are encouraged to schedule an appointment with the campus Disabilities Support Counselor to request an accommodation needed due to a disability. A listing of campus Disabilities Support Counselors and contact information can be found at the [disabilities services - https://www.dtcc.edu/disabilitysupport](https://www.dtcc.edu/disabilitysupport) web page or visit the campus Advising Center.