Course Number and Title: ELC 126 Analog Electronics I

Campus Location:
Georgetown, Dover, Stanton

Effective Date:
2018-52

Prerequisite:
ELC 125, MAT 180 or concurrent, SSC 100 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 introduces analog electronics circuit analysis. Topics include semiconductor theory, filtered and unfiltered rectifiers, special purpose diodes, multipliers, limiters, clampers, bipolar junction transistors, and small-signal and large-signal amplifiers.

Required Text(s):
Obtain current textbook information by viewing the [campus bookstore - https://www.dtcc.edu/bookstores](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. Explain the fundamental atomic theory and construction of semiconductors. (CCC 1, 2, 5; PGC 1)
2. Identify diode schematic symbols, and describe their operating characteristics. (CCC 1, 2, 5; PGC 1)
3. Analyze unfiltered and filtered linear power supply circuits that use half-wave, full-wave, full-wave center-tapped, and bridge rectifier circuits. (CCC 2, 6; PGC 1, 2, 3, 4)
4. Assess voltage multipliers, limiters, clampers, and peak-to-peak detector circuits. (CCC 2, 6; PGC 1, 2, 3, 4)
5. Evaluate the characteristics and operating principles of special purpose diodes. (CCC 1, 2, 5, 6; PGC 1, 2, 3, 4)
6. Evaluate bipolar junction transistors and their operating characteristics by theoretical and practical means. (CCC 1, 2, 5, 6; PGC 1, 2, 3, 4)
7. Evaluate proper biasing methods for various transistor amplifier configurations that include: base, emitter, collector feedback, emitter feedback, and voltage divider bias techniques. (CCC 1, 2, 5, 6; PGC 1,2,3,4)
8. Design and construct small-signal amplifiers that include: common-emitter, common-collector, Darlington pair, differential, and common-base configurations. (CCC 1, 2, 5, 6; PGC 1, 2, 3, 4)
9. Analyze the design of large-signal and other amplifier configurations. (CCC 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. Explain the fundamental atomic theory and construction of semiconductors.
    1. Explain the differences among insulators, conductors, and semiconductors. Describe how current propagates through a semiconductor.
    2. Describe doping and the properties of n-type and p-type semiconductors.
    3. Describe barrier potential of p-type/n-type junctions and discuss its significance.
2. Identify diode schematic symbols, and describe their operating characteristics.
    1. Describe the electrical characteristics of a diode and the diode I-V curve.
    2. Describe the characteristics of a forward and reverse biased diode in terms of electrical approximations.
    3. Identify diode terminals on its schematic symbol and for various package styles.
    4. Interpret and use diode datasheets.

    5. Test a diode using a digital multimeter (DMM).
3. Analyze unfiltered and filtered linear power supply circuits that use half-wave, full-wave, full-wave center-tapped, and bridge rectifier circuits.
    1. Analyze and determine the expected peak input voltage to the rectifier from the transformer.
    2. Analyze and determine the expected output waveform and frequency from the rectifier without filtering.
    3. Identify the operating characteristics and behavior of unfiltered and filtered rectifier circuits and capacitor input filters.
    4. Calculate peak inverse voltage.
    5. Analyze, calculate, and determine expected direct current (DC) output, expected peak input voltage to the rectifier from a transformer or alternating current (AC) source, output waveform, DC and peak output voltages, and ripple voltage from a filtered rectifier circuits.
    6. Assemble and test rectifying circuits using acceptable industry practices.
4. Assess voltage multipliers, limiters, clampers, and peak-to-peak detector circuits.
    1. Analyze and determine the output voltage waveform for a biased and non-biased diode limiter circuit.
    2. Analyze and determine the output voltage waveform for a diode clamper circuit.
    3. Analyze and determine the output voltage waveforms for half-wave voltage doubler, full-wave voltage doubler, voltage tripler, and voltage quadrupler circuits.
    4. Assemble and test output waveforms using an oscilloscope of limiting and clamping circuits using acceptable industry standards and the tools and equipment required in your work environment.
    5. Generate an industry acceptable report using word processing, circuit design, and simulation software.
5. Evaluate the characteristics and operating principles of special purpose diodes.
    1. Identify a zener diode schematic symbol, define its function, and describe the zener diode operating characteristics.
    2. Calculate the expected output of a zener diode regulator, and determine the limits of zener operation for the given circuit elements.
    3. Solve for the maximum and minimum values of current required to maintain regulation for a given zener diode circuit.
    4. Predict the expected output waveform for a zener limiting circuit with an alternating current input source.
    5. Identify a varactor diode schematic symbol, define its function, and describe the varactor diode operating characteristics.
    6. Identify a light-emitting diode schematic symbol, define its function, and describe the light-emitting diode operating characteristics.
    7. Identify a photodiode schematic symbol, define its function, and describe the photodiode operating characteristics.
    8. Identify an opto-isolator and solar cell, define their function, and describe their operating characteristics.
    9. Interpret and use data sheets for the above listed special purpose diodes.
6. Evaluate bipolar junction transistors and their operating characteristics by theoretical and practical means.
    1. Describe the basic structure and operation of bipolar junction transistors.
    2. Identify the terminals on a bipolar junction transistor schematic symbol and for various packages.
    3. Interpret and use bipolar junction transistor datasheets.
    4. Identify the voltages and currents which flow in a bipolar junction transistor.
    5. Test a bipolar junction transistor using a digital multimeter (DMM).
    6. Define *DC beta* and *DC alpha*, and explain their significance.
    7. Sketch the DC load line for a bipolar junction transistor circuit.
    8. Define *saturation* and *cutoff*, and explain their significance.
    9. Describe how a bipolar junction transistor can be used as an amplifier or a switch.
7. Evaluate proper biasing methods for various transistor amplifier configurations that include: base, emitter, collector feedback, emitter feedback, and voltage divider bias techniques.
    1. Analyze biasing for each of the common configuration bipolar junction transistor circuits.
    2. Calculate and test the voltages and currents for each of the common configuration transistor circuits using acceptable industry standards and the tools and equipment required in your work environment.
8. Design and construct small-signal amplifiers that include: common-emitter, common-collector, Darlington pair, differential, and common-base configurations.
    1. Analyze the DC and AC operation for each of the small-signal amplifier configurations.
    2. Calculate the DC and AC input impedance and base-emitter resistance for each bias scheme.
    3. Sketch the AC and DC equivalent circuits for each bias scheme.
    4. Calculate the voltage gain for each bias scheme.
    5. Describe the function of a swamping resistor and how it affects the operation of an amplifier.
    6. Predict the input and output loading effects for each configuration.
    7. Construct, calculate, and test the voltages and currents for each of the small-signal amplifier configurations using accepted industry standards, tools, and equipment.
    8. Calculate and test the voltage gain of multi-stage amplifiers.
9. Analyze the design of large-signal and other amplifier configurations.
    1. Describe the difference between small-signal and large-signal operation.
    2. Analyze the operation of class A power amplifiers in terms of gain and efficiency.
    3. Analyze the operation of class B and class AB power amplifiers in terms of gain and efficiency.
    4. Analyze the operation of class C power amplifiers in terms of gain and efficiency.

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
3-4 Exams	50%
8-12 Laboratory Experiments	30%
Homework/Pop Quizzes	10%
Quizzes	10%
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.