DELAWARE TECHNICAL COMMUNITY COLLEGE

Course Number and Title: ELC 266 Analog Circuits I

Campus Location:
Georgetown, Dover, Stanton

Effective Date:
2020-51

Prerequisite:
CEN 100, MAT 292 or concurrent, PHY 282 or concurrent

Co-Requisites:
none

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

Course Description:
This course covers the laws of the electric circuit, analysis of alternating current (AC) and direct current (DC) circuits, network equations, and network theorems.

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:
Digilent's Real Analog – Circuits I http://www.digilentinc.com/Classroom/RealAnalog/

Schedule Type:
Classroom Course

Disclaimer:
None

Core Course Performance Objectives (CCPOs):

1. Apply circuit analysis fundamentals. (CCC 1, 2, 5, 6; PGC 2, 4)
2. Use circuit analysis reduction methods. (CCC 1, 2, 5, 6; PGC 1, 2, 4)
3. Use nodal and mesh analysis methods. (CCC 1, 2, 5, 6; PGC 2, 4)
4. Apply system and network theorems to circuit analysis. (CCC 1, 2, 5, 6; PGC 2, 4)
5. Apply circuit analysis methods to circuits containing operational amplifiers. (CCC 1, 2, 5, 6; PGC 1, 2, 4)
6. Apply circuit analysis methods to circuits containing energy storage elements. (CCC 1, 2, 5, 6; PGC 1, 2, 4)
7. Apply circuit analysis methods to first order circuits. (CCC 1, 2, 5, 6; PGC 2, 4)
8. Apply circuit analysis methods to second order circuits. (CCC 1, 2, 5, 6; PGC 2, 4)
9. Explain the basic concepts of state variable models. (CCC 1, 2, 5, 6; PGC 1, 2, 4)
10. Analyze the steady state of dynamic systems subjected to sinusoidal forcing functions using circuit analysis methods. (CCC 1, 2, 5, 6; PGC 2, 4)
11. Examine the frequency response of circuits and filter. (CCC 1, 2, 5, 6; PGC 2, 4)
12. Analyze power transmission through sinusoidal or alternating current (AC) signals. (CCC 1, 2, 5, 6; PGC 2, 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. Apply circuit analysis fundamentals.
    1. Explain voltage and current in terms of electrical charge.
    2. Select prefixes and symbols to represent engineering notation.
    3. Identify the power absorbed or generated by a circuit element.
    4. Explain the function of independent and dependent voltage and current sources.
    5. Interpret the equations for dependent sources.
    6. Identify the resistance value and tolerance of resistors using the color code system.
    7. Use Ohm's law and power equations to perform voltage and current calculations.
2. Use circuit analysis reduction methods.

    1. Choose nodes and loops in an electrical circuit.
    2. Calculate voltages and currents of components in series, parallel, and series-parallel circuits using Kirchoff's laws.
    3. Calculate the equivalent resistance of series, parallel, and series-parallel combinations of resistors.
    4. Apply voltage and current divider equations to determine current and voltages in circuits.
    5. Analyze circuits containing non-ideal voltage and current sources.
    6. Produce complex and multiple source circuits using circuit analysis software simulation tools.
3. Use nodal and mesh analysis methods.
    1. Calculate the electrical characteristics of a circuit using nodal analysis.
    2. Calculate the electrical characteristics of a circuit using mesh analysis.
4. Apply system and network theorems to circuit analysis.
    1. Analyze electrical circuits using the principle of superposition.
    2. Create Thévenin and Norton equivalent circuits for circuits containing power sources and resistors.
    3. Relate Thévenin and Norton equivalent circuits to current-voltage characteristics of two-terminal networks.
    4. Calculate the load resistance to maximize power transfer from a circuit using the maximum power transfer theorem.
    5. Analyze non-series-parallel circuits using delta-wye conversion.
5. Apply circuit analysis methods to circuits containing operational amplifiers.
    1. Analyze operational amplifier circuits using modeling rules and characteristics of ideal operational amplifiers.
    2. Explain the role of negative feedback and the trade-off between circuit gain and dynamic range.
    3. Analyze inverting, non-inverting, voltage follower, summing, and difference operational amplifier circuits.
    4. Design inverting, non-inverting, voltage follower, summing, and difference operational amplifier circuits.
    5. Create circuit drawings using circuit analysis software simulation tools for inverting, non-inverting, voltage follower, summing, and difference operational amplifier circuits.
6. Apply circuit analysis methods to circuits containing energy storage elements.
    1. Explain the electrical properties of capacitors and inductors, including its voltage-current relationship and energy equation using differential and integral calculus.
    2. Analyze transient responses of resistor/capacitor (RC) and resistor/inductor (RL) circuits.
    3. Sketch voltage, current, and power waveforms as a function of time for circuits containing resistors, capacitors, and/or inductors.
    4. Interpret mathematical expressions for the mechanisms which capacitors and inductors store energy.
    5. Describe the response of capacitors and inductors to constant and instantaneous voltage changes.
    6. Calculate the equivalent capacitance of series and parallel combinations of capacitors.
    7. Calculate the equivalent inductance of series and parallel combinations of inductors.
    8. Design RC and RL circuits using circuit analysis software simulation tools.
7. Apply circuit analysis methods to first order circuits.
    1. Examine the relationships between a system's unforced response, zero-input response, natural response, and the homogeneous solution to the differential equation describing the system.
    2. Examine the relationships between a system's forced response, zero-state response, and the particular solution to the differential equation describing the system.
    3. Identify the time constant of a first order system from the differential equation describing the system.
    4. Interpret mathematical expressions for the natural and step responses of a first order system.
    5. Calculate the natural response of a first order system from the differential equation describing the system and the system's initial condition.
    6. Calculate the step response of a first order system from the differential equation governing the system and the amplitude of the input step function.
    7. Formulate differential equations governing RC and RL circuits.
    8. Calculate the time constant of RC and RL circuits from the given differential equation and the circuit itself.
    9. Compute the natural response of RC and RL circuits, given the governing differential equation and initial conditions.
    10. Solve the differential equation governing the step response of a first order electrical circuit.
    11. Calculate the steady-state response of a first order electrical circuit to a step input.
    12. Compute the step response of a first order electrical circuit from the governing differential equation, the initial conditions, and the final conditions.
8. Apply circuit analysis methods to second order circuits.
    1. Formulate differential equations governing second order parallel resistor/inductor/capacitor (RLC) circuits.
    2. Analyze the damping ratio and natural frequency from the coefficients of second order differential equation.
    3. Summarize the behavior of the complex exponentials in the system natural response for a damping ratio greater than one, less than one, and equal to one.
    4. Classify overdamped, underdamped, and critically damped systems according to their damping ratio.
    5. Use the coefficients of a second order system's governing equation to estimate the system's overshoot, rise time, and steady-state response.
9. Explain the basic concepts of state variable models.
    1. Formulate differential equations governing electrical circuits in state variable form.
    2. Create MATLAB functions to simulate the impulse and step response of an electrical circuit.
    3. Create MATLAB functions to plot the state trajectory of an electrical circuit.
10. Analyze the steady state of dynamic systems subjected to sinusoidal forcing functions using circuit analysis methods.
    1. Explain the relationship between the sinusoidal steady state system response and the forced response of a system.
    2. Explain the relationship between the input and output frequencies of a linear, time-invariant system having sinusoidal steady-state conditions.
    3. Examine the amplitude, frequency, radian, frequency, and phase of a sinusoidal signal.

    4. Analyze the mathematical function or signal output of an electrical circuit containing resistors, capacitors, and/or inductors using frequency domain analysis methods.
    5. Produce phasor diagrams of a circuit's input and output, and express the functions in phasor form.
    6. Calculate the impedance and admittance of resistors, capacitors, and inductors in series, parallel, and series-parallel combinations.
    7. Use Kirchoff's voltage and current laws and voltage and current divider formulas in phasor form to solve for currents and voltages in an AC circuit.
    8. Calculate the equivalent impedances of parallel and series impedance combinations.
    9. Employ circuit reduction techniques to frequency domain circuits.
    10. Analyze frequency domain circuits using nodal and mesh analysis.
    11. Analyze circuits containing multiple frequencies using superposition.
    12. Analyze frequency domain circuits using Thevenin's and Norton's theorems.
    13. Estimate the load impedance necessary to deliver maximum power to a load.
11. Examine the frequency response of circuits and filter.
    1. Use the frequency response of a system to determine the frequency domain response of a system to a given input.
    2. Interpret the mathematical expressions of the frequency spectrum of a time-domain signal.
    3. Create plots of a circuit's magnitude and phase spectrum.
    4. Evaluate a circuit's amplitude response at low and high frequencies against the expected physical behavior of the circuit.
    5. Generate a graph that represents a system's frequency domain response from provided signal spectra plots and plots of the system's frequency response.
    6. Evaluate low-pass and high-pass filters.
    7. Calculate a system's cutoff frequency.
    8. Calculate power, voltage, and current gains of a circuit in both ratio and decibel form.
    9. Create Bode plots using straight-line amplitude and phase approximations.
12. Analyze power transmission through sinusoidal or alternating current (AC) signals.
    1. Calculate the root mean square (RMS) value of a sinusoidal signal.
    2. Analyze and compare the differences between real, reactive, and apparent power in circuits containing resistive and reactive components.
    3. Illustrate power using the power triangle.
    4. Calculate power factor and power factor correction.

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.

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. Integrate modern tools of the engineering discipline into the field of study.
2. Apply mathematics, science, engineering, and technology theory to solve electrical and computer engineering and electronics engineering technology problems.
3. Conduct, analyze, and interpret experiments using analysis tools and troubleshooting methods.
4. Identify, analyze, and solve electrical and computer engineering and electronics engineering technology problems.
5. Explain the importance of engaging in self-directed continuing professional development.
6. Demonstrate basic management, organizational, and leadership skills that 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.