
Prepared by the Department of Engineering Sciences & Applied Technology

Date of Departmental Approval: January 11, 2017

Date Approved by Curriculum and Programs: February 15, 2017

Effective: Fall 2017

1. **Course Number:** ENR105 / ENR105L

Course Title: Circuit Theory and Analysis / Circuit Theory and Analysis Laboratory

2. **Description:** This course begins a student's preparation for a career in electronics, renewable energy, and related fields; it is also well structured for those interested in just expanding their background into the world of electronics. The course focus is on electrical circuit theory as well as an introduction to analog and digital signal processing. Laboratory experiments are used to reinforce basic concepts and develop laboratory skills, as well as to provide system-level understanding. This course does not require any prior engineering background.

3. **Student Learning Outcomes** (instructional objectives, intellectual skills):

Upon successful completion of this course, students are able to do the following.

- Explain and demonstrate and analyze current, voltage, resistance, and power in ac and dc circuits.
- Discuss and calculate energy, power, voltage, current, resistance, and cost of energy in ac and dc circuits.
- Explain and construct electric circuits which fulfill the specifications given in a schematic diagram.
- Apply, categorize, and justify the key steps in troubleshooting ac and dc circuits to locate shorts, opens, and overloads; recognize solutions to resolve issues.
- Explain, measure, and analyze inductance, capacitance, impedance, and phase shift.
- Design, build, and analyze ac circuits to determine current, voltage, reactance, impedance, phase angle, and power.
- Differentiate between and appropriately choose components used in ac and dc circuits as to type, rating, and applications.
- Connect and change configurations of three phase ac transformers and circuits.
- Analyze complex circuits by reducing them to equivalent circuits.
- Discuss the importance of Thevenin's and Norton's theorems.
- Demonstrate the use of data sheets, catalogs, substitution guides, and other reference materials to properly choose replacement parts.
- Demonstrate and practice laboratory etiquette and the safe operation of basic tools, test equipment, and circuitry.
- Synthesize electric circuits which fulfill the specifications given in a schematic diagram.
- Describe and use a multimeter, as a tool in solving a wide variety of electrical problems.
- Use and evaluate the credibility of measurements from a variety of laboratory devices and instruments.
- Explain, demonstrate and analyze the basic concepts and components of digital electrical circuits, analog/digital conversion, basic digital logic gates and combinatorial circuits.
- Work as part of a team, design an electrical circuit, write a design report, and present the design.
- Compare and contrast the roles and responsibilities of the most common electronic disciplines.
- Exhibit an understanding of professional ethics and the application to real-life situations involving the use of electrical and electronics technology.
- Formulate an experiment that highlights the importance of using electrical components to control mechanical behavior and be able to measure, graph, analyze, and interpret sensor data.
- Use word processing, graphics, and spreadsheet software to prepare and present designs and laboratory reports.
- Interpret and use basic math skills and concepts, such as proportions and ratios, graphing data, and computation.
- Assess the impact that electrical/electronic technologies are having on current sustainability and environmental issues.
- Argue why the electrical technician or engineer is a team worker who needs strong skills in problem solving and communication.
- Be able to debate the impact electrical engineering and electronics deployment has had on the modern world. Emphasis on today's manufacturing, service, and medical industries.

4. **Credits:** 4 credits (3 class hours / 2 laboratory hours)

5. **Satisfies General Education Requirement:** No

Prerequisite(s): MAT035 (Algebra for Non-STEM) or MAT041 (Elementary Algebra for STEM), ENL108 (Critical Reading & Thinking) or satisfactory basic skills assessment scores

6. Semester(s) Offered: Varies

7. Suggested General Guidelines for Evaluation: The course grade will be based on homework assignments; class work and participation; one-hour exam(s); laboratory work and reports; and a final examination. Specific course grading procedures and make-up policies are detailed in a student handout.

8. General Topical Outline (Optional):

1. INTRODUCTION

- Identify some major events in the history of electronics.
- Classify circuit operation as digital or analog.
- Name major analog circuit functions.
- Begin developing a system viewpoint for troubleshooting.
- Analyze circuits with both dc and ac sources.
- List the current trends in electronics.

2. CIRCUIT COMPONENTS; MULTIPLE-LOAD CIRCUITS

- Specify component values for simple circuits.
- Determine resistance values by using the standard color code.
- Interpret switch symbols and specifications.
- Interpret fuse and circuit-breaker specifications.
- Measure wire sizes.
- Explain and measure voltage in series circuits.
- Explain and measure current in parallel circuits.
- Simplify and solve problems involving complicated series-parallel circuits.
- Determine maximum power transfer.
- Explain the relationship between power transfer and efficiency.

3. COMPLEX-CIRCUIT ANALYSIS

- Identify complex circuits.
- Select appropriate techniques for analyzing a given complex circuit.
- Explain how a current source differs from a voltage source.
- Reduce a complex circuit to a simple equivalent circuit.
- Convert from a voltage source to a current source and vice versa.
- Use simultaneous-equations techniques to solve sets of loop equations.

4. ALTERNATING CURRENT AND VOLTAGE; POWER IN AC CIRCUITS

- Graphically illustrate a sine wave, a square wave, and a sawtooth wave.
- List and explain three ways of specifying the amount of alternating current.
- List the advantages of alternating current over direct current.
- Explain the relationship between period, frequency, and cycle.
- List the advantages of three-phase alternating current over single-phase alternating current.
- Use phasors to show phase relationships.
- Calculate ac power in resistive circuits.
- Calculate power in out-of-phase circuits.
- Use the properties of a right triangle to determine the power factor of a circuit.
- Explain the difference between apparent power and true power.
- Explain the importance of power factor.

5. CAPACITANCE; INDUCTANCE

- Determine the reactance of a capacitor at any specified frequency.
- Describe the behavior of a capacitor in ac and dc circuits.
- Write specifications for ordering capacitors from electrical supply distributors.
- List several types of capacitors and describe their major uses.
- Calculate current and voltage distributions in capacitive circuits.
- Explain phase shift in a capacitor.
- Determine when a capacitor is open or shorted.
- Calculate RC time constants.
- Identify various types of inductors.
- Write complete specifications for inductors.
- List uses of inductors.
- Determine reactance of inductors at various frequencies.
- Calculate total inductance for series and parallel combinations of inductances.

6. R, C, AND L CIRCUITS

- Determine resonant frequency.
 - Calculate impedance for a variety of combinations of R, C, and L circuits.
 - Graphically and mathematically add phasors representing electrical quantities.
 - Determine phase angles for circuits containing different combinations of R, C, and L.
 - List and explain the characteristics of four basic types of filters.
7. SEMICONDUCTORS
- Identify some common electronic materials as conductors or semiconductors.
 - Predict the effect of temperature on conductors.
 - Predict the effect of temperature on semiconductors.
 - Show the directions of electron and hole currents in semiconductors.
 - Identify the majority and minority carriers in N-type semiconductors.
 - Identify the majority and minority carriers in P-type semiconductors.
 - Explain the term band gap.
8. DIODES
- Predict the conductivity of diodes under the conditions of forward and reverse bias.
 - Interpret volt-ampere characteristic curves for diodes.
 - Identify the cathode and anode leads of some diodes by visual inspection.
 - Identify the cathode and anode leads of diodes by ohmmeter testing.
 - Identify diode schematic symbols.
 - List several diode types and applications.
 - Describe the structure and characteristics of photovoltaic devices.
9. POWER SUPPLIES
- View power supplies as systems.
 - Identify and explain common rectifier circuits.
 - Predict and measure dc output voltage for unfiltered and filtered power supplies.
 - Explain how voltage multipliers work.
 - Measure and calculate ripple and voltage regulation.
 - Explain and make basic calculations for zener voltage regulators.
 - Troubleshoot power supplies.
 - Select replacement parts.
10. TRANSISTORS
- Define amplification and power gain.
 - Identify transistor schematic symbols and leads.
 - Calculate current gain.
 - Identify power-supply polarity and current flow for NPN and PNP transistors.
 - Interpret characteristic curves and determine current gain and power dissipation.
 - Discuss package styles and data sheets.
 - Test bipolar junction transistors using an ohmmeter.
 - Explain junction field-effect transistors and metal oxide semiconductor field-effect transistors and identify their schematic symbols.
 - Compare the types of transistors.
 - Explain transistor switching and hard saturation.
 - Explain analog switching.
11. INTRODUCTION TO SIGNAL AMPLIFIERS
- Calculate decibel gain and loss.
 - Draw a load line for a basic common-emitter amplifier.
 - Define clipping in a linear amplifier.
 - Find the operating point for a basic common-emitter amplifier.
 - Determine common-emitter amplifier voltage gain.
 - Identify common-base and common-collector amplifiers.
 - Explain the importance of impedance matching.
 - Discuss SPICE and explain the importance of models.
 - Identify the standard methods of signal coupling and list their characteristics.
 - Calculate the input impedance of common-emitter amplifiers.
 - Find voltage gain in cascade amplifiers.
 - Draw a signal load line for a common-emitter amplifier.
 - Solve FET amplifier circuits.
 - Identify negative feedback and list its effects.
 - Determine the frequency response of a common-emitter amplifier.

- Identify positive feedback and list its effects.
- Define hysteresis.
- Calculate amplifier efficiency.
- Identify the class of amplifier operation.
- Recognize crossover distortion in push-pull amplifiers.
- Explain the operation of complementary symmetry amplifiers.
- Describe tank circuit action in class C amplifiers.
- Explain how class D amplifiers work.

12. OPERATIONAL AMPLIFIERS

- Predict the phase relationships in differential amplifiers.
- Determine the CMRR for differential amplifiers.
- Calculate the power bandwidth for operational amplifiers.
- Find voltage gain for operational amplifiers.
- Determine the small-signal bandwidth for operational amplifiers.
- Identify various applications for operational amplifiers.
- Discuss the operation and application of comparators.