# ENGR A285: ENGINEERING CIRCUITS

| Item | Value |
|---|---|
| Curriculum Committee Approval Date | 10/30/2024 |
| Top Code | 090100 - Engineering, General (requires Calculus) (Transfer) |
| Units | 4 Total Units |
| Hours | 108 Total Hours (Lecture Hours 54; Lab Hours 54) |
| Total Outside of Class Hours | 0 |
| Course Credit Status | Credit: Degree Applicable (D) |
| Material Fee | No |
| Basic Skills | Not Basic Skills (N) |
| Repeatable | No |
| Open Entry/Open Exit | No |
| Grading Policy | Standard Letter (S) |

## Course Description

Analysis of electric circuits, including DC circuits, network theorems, energy sources, transient analysis, sinusoidal analysis, phasors, AC power, and frequency response of circuits. Lab will include connection of circuits and observation of circuit behavior using electronic instrumentation. PREREQUISITE: MATH A285 or MATH A285H, or concurrent enrollment; and PHYS A280. Transfer Credit: CSU; UC.

## Course Level Student Learning Outcome(s)

1. Mathematically analyze the electrical behavior of DC, AC, and switching transients circuits.
2. Utilize a computer circuit analysis and simulation program to analyze DC and AC circuits.
3. Work with electronic test equipment to build and analyze circuits. This will include voltmeters, ammeters, DC power supplies, function generators, and oscilloscopes.

## Course Objectives

- 1. Identify basic circuit components on a schematic drawing.
- 2. Analyze electric circuits for voltage, current, power and energy values.
- 3. Use techniques of mesh and nodal analysis.
- 4. Apply Thevenin?s and Norton?s theorems to analysis of circuits.
- 5. Solve first and second order transient problems.
- 6. Find the transient response and complete response for RC, RL, and RLC circuits involving DC sources.
- 7. Use phasors and complex algebra in AC analysis problems.
- 8. Connect electric circuits in the lab.
- 9. Measure resistance, current, AC and DC voltage and power values. Experimentally verify these values for a variety of electrical circuits.
- 10. Test circuits, analyze data and compare measured performance to theory and simulation.
- 11. Use oscilloscopes and amplifiers.
- 12. Use diodes in combination with other electric components.
- 13. Implement rectifiers and power supplies.
- 14. Use a circuit simulation program (e.g. PSpice, Multisim, etc.) and other computer applications (e.g. MATLAB, MS Excel, etc.) to predict or describe circuit behavior.
- 15. Troubleshoot and repair simple electric circuits.
- 16. Record and document results of lab work using text and graphs.
- 17. Work effectively in groups by sharing responsibilities and collaborating on findings.

## Lecture Content

DEFINITIONS AND BASIC CONCEPTS Systems of Units Definition of Charge, Current, Voltage, and Power Definition of a Circuit Circuit Elements: Energy Sources and Resistors FUNDAMENTAL LAWS Ohm's Law Kirchoff's Laws Series and Parallel Circuits SIMPLE CIRCUIT ANALYSIS Voltage and Current Division Combining Resistors and Energy Sources Ideal Operational amplifiers Practical Limitations of Operational Amplifiers DC ANALYSIS TECHNIQUES Nodal and Mesh Analysis Superposition Source transformations Introduction to DC analysis with SPICE circuit analysis computer program DC CIRCUIT ANALYSIS AND OPERATIONAL AMPLIFIERS Thevenin's and Norton's Theorems Nodal Analysis of Operational Amplifiers INDUCTORS AND CAPACITORS Defining Calculus Equations for an Inductor Defining Calculus Equations for a Capacitor Inductance and Capacitance Combinations Duality NATURAL REPONSE OF RL AND RC CIRCUITS Properties of Exponential Waveforms Transient RL Circuit Analysis Transient RC Circuit Analysis FORCED REPONSE OF RL AND RC CIRCUITS Unit-Step Forcing Function Combined Natural and Forced Responses Other Transient Analysis of RL and RC Circuits TRANSIENT BEHAVIOR OF RCL CIRCUITS Types of Natural Responses Overdamped Circuits Underdamped Circuits Critically Damped Circuits Combined Natural and Forced Responses CHARACTERISTICS OF SINUSOIDAL WAVEFORMS Amplitude, Frequency, and Phase Shift Circuit Response to Sinusoidal Wa veforms PHASORS The Complex Forcing Function Representing Sinusoids with Phasors Phasor Relationships of RLC Components CIRCUIT RESPONSE TO SINUSOIDS Impedance and Admittance Nodal and Mesh analysis Superposition and Thevenin's Theorem Phasor Diagrams FREQUENCY RESPONSE Frequency Response Circuit Responses as Frequency Varies Bode Plots AC POWER Instantaneous and Average AC Power Effective (RMS) Values of Voltage and Current Apparent Power and Power Factor

## Lab Content

OHM'S LAW AND KIRCHOFF'S LAWS SERIES AND PARALLEL CIRCUITS SUPERPOSITION THEVIER EQUIVALENT CIRCUITS BASIC INSTRUMENTATION (RESISTORS, CAPACITORS, INDUCTORS) COMPONENT IDENTIFICATION AND LABELING; NOMINAL AND MEASURED VALUES; LIMITATIONS ON VOLTAGE, CURRENT, POWER DISSIPATION CIRCUIT CONSTRUCTION TECHNIQUES FOR LABORATORY USE (BREADBOARDING) OSCILLOSCOPES, MULTIMETERS, FUNCTION GENERATORS, POWER SUPPLIES IDEAL VERSUS NON-IDEAL OPERATIONAL AMPLIFIERS STEP AND FREQUENCY RESPONSE OF RL, RC, RLC CIRCUITS SERIES AND PARALLEL RESONANCE DIODES RECTIFIER CIRCUITS LABORATORY SAFETY

## Method(s) of Instruction

- Lecture (02)
- DE Live Online Lecture (02S)
- DE Online Lecture (02X)
- Lab (04)

- DE Live Online Lab (04S)
- DE Online Lab (04X)

## Instructional Techniques
Lectures using overhead projector and/or dry erase board Discussion of homework assignments Instructions for laboratory exercises Use of scientific calculators to demonstrate problem solutions

## Reading Assignments
0.75 hrs./week of textbook reading.

## Writing Assignments
2 hrs./week of lab report writing.

## Out-of-class Assignments
4 hrs./week of practice problems.

## Demonstration of Critical Thinking
Written Examinations: Written exams will be used to evaluate the student's mastery of lecture and lab material. Practical Examinations: Students will build, test and troubleshoot basic electric circuits. They will complete lab assignments that demonstrate these abilities.

## Required Writing, Problem Solving, Skills Demonstration
Written Examinations: Written exams will be used to evaluate the student's mastery of lecture and lab material. Practical Examinations: Students will build, test and troubleshoot basic electric circuits. They will complete lab assignments that demonstrate these abilities.

## Eligible Disciplines
Engineering: Master’s degree in any field of engineering OR bachelor’s degree in any of the above AND master’s degree in mathematics, physics, computer science, chemistry, or geology OR the equivalent. (NOTE: A bachelor's degree in any field of engineering with a professional engineer's license is an alternative qualification for this discipline.) Master's degree required. Title 5, section 53410.1

## Textbooks Resources
1. Required Hayt, W.H., Kemmerly, J.E., Phillips, J., Durbin, S.M.. Engineering Circuit Analysis, 9th ed. McGraw Hill, 2019 Rationale: rationale 2. Required Alexander, C.K., Sadiku, M.N.O.. Fundamentals of Electric Circuits, 6th ed. McGraw Hill, 2017 3. Required Nilsson, J.W., Riedel, S.. Electric Circuits, 11th ed. Pearson, 2019

## Manuals Resources
1. Boylestad, R.L., Kousourou, G.. Laboratory Manual for Introductory Circuit Analysis, Pearson , 07-19-2015

## Other Resources
1. Spice Circuit analysis program (student version)