Reviewed by: P. Blake
Reviewed by: M. Mayfield
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Semester effective:

Engineering (ENGR) 2000 Circuit Analysis with Lab (4 Units) CSU: UC

Prerequisites: Successful completion of PHYS 2222 General Physics (Calculus) with a grade of 'C' or better.

Prerequisite knowledge/skills: Before entering the course the student should be able to:

1. apply the laws and principles of classical electricity and magnetism to the solution of problems of:
    a. forces between point charges; electric force fields and potential fields produced by individual point charges and sets of point charges and by uniformly charged surfaces and volumes having plane, spherical or cylindrical charge symmetry (Gauss' Law); potential difference calculations; and capacitance, capacitors, arrays of capacitors, and the effect of dielectrics on capacitors,
    b. current, resistance and electromotive force and direct current circuits and instruments,
    c. the magnetic field and the force it exerts on moving electric charges or currents, its production by moving electric charges or currents, induced electromotive force in conductors and electric circuits, and the magnetic properties of matter,
    d. mutual inductance and self inductance and, the basis of electrical machinery and the behavior of electric circuits involving resistance, inductance and capacitance in transient and alternating circuit) conditions
    e. electromagnetic waves
2. in all the subject areas of this course, be able to identify multiple applicable physical concepts and their use in an appropriate manner and sequence. Comprehend presentations in which calculus concepts are extended beyond those learned so far in the calculus course for specific physics needs, such as Gauss' Law, and be able to explain or reproduce the derivations and apply the results to problems,
3. perform assigned experiments in a reasonable manner, and to prepare adequate experimental reports presenting the numerical results and analyzing the sources and significance of errors, and
4. list and discuss objectives of any experiment, the type of measurements made, why they were made, and how they entered into the determination of the desired result.

Corequisites: MATH 2140 Ordinary Differential Equations

Corequisite knowledge/skill: throughout this course, the student should be able to:

1. Create and analyze mathematical models using ordinary differential equations;
2. Identify the type of a given differential equation and select and apply the appropriate analytical technique for finding the solution of first order and selected higher order ordinary differential equations;
3. Apply the existence and uniqueness theorems for ordinary differential equations;
4. Find power series solutions to ordinary differential equations;
5. Determine the Laplace Transform and inverse Laplace Transform of functions; and
6. Solve Linear Systems of ordinary differential equations

Advisory: Eligibility for English 1500 or 1501 strongly recommended

TAFTCOLLEGE

Hours and Units Calculations:
48 hours lecture. 96 Outside of class hours. 48 hours lab. (192 Total Student Learning Hours) 4 Units

Catalog Description: An introduction to the analysis, construction and measurement of electrical circuits. Use of analytical and laboratory techniques based on the application of circuit laws and network theorems including Ohm's and Kirkoff's laws and Thevenin's and Norton's theorems. Analysis of Direct Current (DC) and Alternating Circuit (AC) circuits containing resistors, capacitors, inductors, dependent sources, operational amplifiers and/or switches using nodal and mesh analysis Natural and forced responses of first and second order Resistance/Inductance/Capacitance (RLC) circuits, the use of phasors, AC power calculations, power transfer and energy concepts. Basic use of electrical test and measurement instruments including multimeters, oscilloscopes, power supplies, and function generators. Interpretation of measured and simulated data based on principles of circuit analysis. Practical considerations such as component value tolerance and non-ideal aspects of laboratory instruments. Construction and measurement of basic operational amplifier circuits. Use of circuit simulation software. C-ID: ENGR 260 & 260L

Type of Class/Course: Transfer Degree Credit

Text:

Alexander, Charles, and Mathew Sadiku. *Fundamentals of Electric Circuit.* 6th ed., McGraw, 2017.

Boylestad, Robert L. *Laboratory Manual for Introductory Circuit Analysis.* 13th ed., Pearson, 2015.

Course Objectives:

By the end of the course a successful student will be able to:

1. Analyze DC circuits to find current, voltage, resistance, power, and/or energy,
2. Draw and label circuit diagrams and show thorough mathematical solutions,
3. Apply different circuit analysis techniques and demonstrate a process for selecting an appropriate technique for a given problem,
4. Solve circuits containing two or more Operational Amplifiers (Op Amps),
5. Find the transient response and complete response for Resistance/Capacitance (RC), Resistance/Capacitance (RL), and RLC circuits involving DC sources,
6. Solve AC circuits by using Phasors,
7. Calculate average and complex power for AC circuits,
8. Introduction of 3-phase power concepts,
9. Access and use the most basic functions of electrical test and measurement equipment including oscilloscopes, multimeters, function generators and power supplies,
10. Read circuit schematics and construct linear circuits using resistors, capacitors, inductors, and/or op amps,
11. Measure resistance, DC and AC voltages, current, and power, and experimentally verify the results for a variety of electrical circuits,
12. Test circuits, analyze data and compare measured performance to theory and simulation,
13. Use a circuit simulation program and other computer applications to predict or describe circuit behavior, and
14. Troubleshoot and repair simple electric circuits.

Course Scope and Content (Lecture):

Unit I Basic Concepts

A. Voltage, Current, Power and Energy
B. Ohms Law
C. Circuit elements (R, L, C, ideal operational amplifiers, ideal transformer)
D. Independent and Dependent Sources
E. Kirchhoff's Laws
F. Series and Parallel Combinations of Elements
G. Voltage Division and Current Division

Unit II DC circuit analysis
A. Node Analysis
B. Mesh Analysis

Unit III Circuit Analysis and Theorems
A. Linearity
B. Superposition
C. Source Transformations
D. Thevenin's Theorem
E. Norton's Theorem

Unit IV Circuits Containing Operational Amplifiers
A. Ideal Op Amp model, with negative feedback condition
B. Inverting and Non-Inverting Configurations
C. Voltage Followers, Adders, Difference Amplifiers

Unit V First and Second-Order Circuits
A. Singularity Functions
B. RC and RL Source-Free Circuits
C. Constant and Non-Constant Forcing Functions
D. Initial and Final Values
E. Op-amp circuits for integration and differentiation
F. Measurement of signals in physical circuits
G. RLC circuits
H. Time-Domain Analysis

Unit VI Sinusoidal Steady-State (SSS) Analysis
A. Sinusoids
B. Complex Numbers
C. Complex Exponential Representations of Sinusoids (Phasors)
D. Impedance and Admittance
E. Superposition, Thevenin and Norton Theorems
F. Analysis and Network Theorems for SSS
G. Frequency response
H. Bode plots
I. Resonance
J. Measurement of frequency response of physical circuits

Unit VII Power Analysis
A. Instantaneous and Average Power
B. Power Factor and Power Factor correction
C. Complex Power
D. Maximum Power Transfer
E. 3 Phase Power – Introduction

Course Scope and Content (Lab):

Unit I Basic Concepts
- A. Safety
- B. Data Capture
- C. Notebooks

Unit II Equipment and Software
- A. Oscilloscopes
- B. Power Supplies
- C. Multi-meters
- D. Function Generators
- E. P-Spice

Unit III Circuit Construction Techniques
- A. Breadboarding
- B. Troubleshooting

Unit IV Component identification
- A. Labeling Standards
- B. Manufacturing Nomenclature
- C. Nominal and measured values
- D. Limitations on voltage, current, power dissipation

Unit V Circuit Concepts
- A. Kirchhoff's laws (KCL & KVL)
- B. Ohm's Law
- C. Voltage and Current Division

Unit VI Advanced Circuit Concepts
- A. Power dissipation;
- B. Series and Parallel Circuits
- C. Equivalent circuits
- D. Thevenin equivalent circuit
- E. Superposition

Unit VII Operational Amplifiers
- A. Practical Voltage
- B. Current Limits
- C. Circuit Design

Unit VIII Resistance/Inductance (RL), Resistance/Capacitance (RC), and Resistance/Inductance/Capacitance RLC circuits
- A. Step Response
- B. Frequency Response
- C. Resonance

Activities Required Outside of Class:

The students in this class will spend a minimum of 6 hours per week outside of the regular class time doing the following:

1. Studying assigned text, handout materials and class notes
2. Reviewing and preparing for quizzes, midterm and final exams
3. Completing individual and group homework assignments with clear calculations and engineering problem solving techniques.
4. Completing lab exercises, updating notebooks and writing lab reports showing clear calculations and engineering problem solving techniques.

Methods of Instruction:

1. Lecture, demonstrations and discussions
2. Individual homework assignments with emphasis on application of engineering problems solving methods.
3. Group projects with emphasis on design creativity, problem solving and teamwork
4. Guest Lecture(s)
5. Field Trip(s)
6. Completing lab exercises /practicals
7. Writing Lab reports

Methods of Evaluation:

1. Quizzes
2. Examinations
3. Participation
4. Individual assignments and group exercises
5. Case study analysis of design problem

Laboratory Category: Extensive Laboratory

Pre delivery criteria: All of the following criteria are met by this lab.
1. Curriculum development for each lab.
2. Published schedule of individual laboratory activities.
3. Published laboratory activity objectives.
4. Published methods of evaluation.
5. Supervision of equipment maintenance, laboratory setup, and acquisition of lab materials and supplies.

During laboratory activity of the laboratory: All of the following criteria are met by this lab.
1. Instructor is physically present in lab when students are performing lab activities.
2. Instructor is responsible for active facilitation of laboratory learning.
3. Instructor is responsible for active delivery of curriculum.
4. Instructor is required for safety and mentoring of lab activities.
5. Instructor is responsible for presentation of significant evaluation.

Post laboratory activity of the laboratory: All of the following criteria are met by this lab.
1. Instructor is responsible for personal evaluation of significant student outcomes (lab exercises, exams, practicals, notebooks, portfolios, etc.) that become a component of the student grade that cover the majority of lab exercises performed during the course.
2. Instructor is responsible for supervision of laboratory clean up of equipment and materials.

Supplemental Data:

TOP Code:	090100: Engineering, General (requires
SAM Priority Code:	E: Non-Occupational
Distance Education:	Not Applicable
Funding Agency:	Y: Not Applicable(funds not used)
Program Status:	1: Program Applicable
Noncredit Category:	Y: Not Applicable, Credit Course
Special Class Status:	N: Course is not a special class
Basic Skills Status:	N: Course is not a basic skills course
Prior to College Level:	Y: Not applicable
Cooperative Work Experience:	N: Is not part of a cooperative work experience education program
Eligible for Credit by Exam:	E: Credit By Exam
Eligible for Pass/No Pass:	NO
Taft College General Education:	NONE
Discipline	Engineering or Physycs/Astronomy