

## EE 220/220L: Circuits I

**CATALOG DATA:**

EE 220/220L – Circuits I: (3-1) 4 Credits. Prerequisites: MATH 125 completed with a minimum grade of C. Corequisite: MATH 321. This course is designed to provide the electrical engineering students with an understanding of the basic concepts of the profession. Topics covered include resistive circuits, transient circuits, and sinusoidal analysis. Students also investigate essential principles by conducting laboratory experiments related to the topics studied in the classroom. P-spice is used to analyze electrical circuits using personal computers.

**TEXTBOOK:**

*Fundamentals of Electric Circuits*, Sixth Edition, Charles K. Alexander and Matthew N.O. Sadiku, McGraw-Hill, 2017, ISBN 978-0-07-802822-9.

**COORDINATOR:**

Dr. Thomas P. Montoya, Associate Professor

**GOALS:**

The objective of this course is to provide students with the working knowledge of the fundamentals of electrical engineering. A particular emphasis is made on DC, transient, and AC steady-state circuit analysis.

**CLASS SCHEDULE:**

Lecture: 3 hours per week.

Laboratory: 2 hours every week (1 credit hour).

**Topics:**

- Chapter 1. Basic Concepts
  - a. Systems of units
  - b. Charge and current
  - c. Voltage.
  - d. Power and energy.
  - e. Circuit elements.
- Chapter 2. Basic Laws
  - a. Ohm's Law.
  - b. Nodes, branches, and loops.
  - c. Kirchoff's Laws.
  - d. Series resistors and voltage division.
  - e. Parallel resistors and current division.
  - f. Wye-Delta transformations.
- Chapter 3. Methods of Analysis
  - a. Nodal Analysis
  - b. Mesh Analysis
  - c. Circuit Analysis with PSpice
- Chapter 4. Circuit Theorems:
  - a. Linearity Property
  - b. Superposition
  - c. Source Transformation
  - d. Thevenin's Theorem

- e. Norton's Theorem
- f. Maximum Power Transfer
- Chapter 5. Operational Amplifiers
  - a. Operational Amplifiers (equivalent circuit model)
  - b. Ideal Operational Amplifiers
  - c. Inverting Amplifier
  - d. Noninverting Amplifier
  - e. Summing Amplifier
  - f. Difference Amplifier
  - g. Multiple Operational Amplifier Circuits
- Chapter 6. Capacitors and Inductors
  - a. Capacitors
  - b. Series and Parallel Capacitors
  - c. Inductors
  - d. Series and Parallel Inductors
- Chapter 7. First-Order Circuits
  - a. Source-Free RC and RL Circuits
  - b. Singularity Functions
  - c. Step Response of RC and RL Circuits
- Chapter 8. Second-order Circuits
  - a. Initial and Final (steady-state) Values
  - b. Source-Free Series and Parallel RLC Circuits
  - c. Step Response of Series and Parallel RLC Circuits
  - d. General Second-Order Circuits
- Chapter 9. Sinusoids and Phasors
  - a. Sinusoids
  - b. Effective or RMS Value
  - c. Phasors
  - d. Phasor Relationships for Circuit Elements
  - e. Impedance and Admittance
  - f. Kirchoff's Laws in the Frequency Domain
  - g. Impedance Combinations
- Chapter 10. Sinusoidal Steady-State Analysis
  - a. Nodal Analysis
  - b. Mesh Analysis
  - c. Superposition Theorem
  - d. Source Transformation
  - e. Thevenin and Norton Equivalent Circuits
- Chapter 11. AC Power Analysis
  - a. Instantaneous and Average Power
  - b. Maximum Average Power Transfer
  - c. Apparent Power and Power Factor
  - d. Complex Power
  - e. Conservation of AC Power
  - f. Power Factor Correction (time allowing)

**COMPUTER USAGE:**

Students use circuit simulation software (such as PSpice) to analyze simple circuits containing current & voltage sources, resistors, capacitors, inductors, operational amplifiers, and semiconductor devices such as BJTs. Also, students are encouraged to use computer programs for mathematics and graphing (e.g., Matlab, MS Excel, MathCad, ...).

**LABORATORY:**

A one credit hour laboratory EE 220L accompanies this course. The laboratory meets for two hours every week during the semester. Most laboratories will have pre- and post-laboratory work. A practical examination may be given near the end of the semester. In general, the laboratories will cover the following topics:

- 0 Overview & Introduction to use of logbooks; lab policies; lab safety; Professional and Ethical Responsibility
- 1 Introduction to Matlab
- 2/3 Using the Digital Multimeter and Ohm's Law; Voltage and Current Division
- 4 Nodal Analysis
- 5 Mesh Analysis
- 6 PSpice Demonstration and Use
- 7 Thevenin and Norton Equivalent Circuits
- 8 Use of Signal Generators and Oscilloscopes
- 9 Operational Amplifiers
- 10 RC/RL Circuits
- 11 PSpice Transient Analysis and Technical Report
- 12 Second-Order Circuits
- 13 AC Sinusoidal Circuits

The students use basic measurement equipment in the laboratories including power supplies, digital multimeters, function/signal generators and oscilloscopes. In the pre- and post-laboratory work, the students typically analyze circuits to familiarize themselves with the upcoming laboratory and sometimes asked to verify their solutions using PSpice.

**OUTCOMES:**

Upon completion of this course, students should demonstrate the ability to:

1. Understand, apply, and use the definitions of and the SI units for charge, current, voltage, energy, and power.
2. Apply Ohm's Law to calculate voltages, currents, and impedances/resistances for AC and DC circuits.
3. Understand and calculate equivalent capacitances, inductances, resistances, and impedances for series, parallel, Wye, and Delta connected resistors, capacitors, and inductors.
4. Understand and apply the voltage and current division rules to AC and DC circuits.
5. Understand and apply Kirchoff's Laws, including Nodal and Mesh analysis, to AC and DC circuits.
6. Understand and apply the principles of linearity and superposition to AC and DC circuits.
7. Understand and calculate the Thevenin and Norton equivalents for AC and DC circuits.
8. Analyze and design simple operational amplifier circuits.
9. Understand the properties of capacitors and inductors and apply the current-voltage relationships of capacitors and inductors.
10. Analyze natural and step response of first order circuits (series RC and RL).

11. Analyze natural and step response of second order circuits (series and parallel RLC).
12. Understand, apply, and use phasors for sinusoidal steady-state AC circuit analysis.
13. Understand and calculate apparent, complex, instantaneous, and average power, effective or RMS voltages and currents, power factor, and power factor correction for AC circuits.
14. Use PSpice to model/simulate simple DC, transient, and AC circuits.
15. Use Matlab to assist with problem solutions and preparing plots.
16. Use basic laboratory measurement equipment including the power supplies, digital multimeters, function generators, and oscilloscopes to conduct experiments.
17. Understand and use a laboratory notebook for documenting experiments and writing technical reports.

**RELATION OF COURSE TO PROGRAM OBJECTIVES:**

These course outcomes fulfill the following program objectives:

- (a) An ability to apply knowledge of mathematics, science, and engineering.
- (b) An ability to design and conduct experiments, as well as to analyze and interpret data.
- (c) An ability to design a system, component, or process to meet desired needs.
- (d) An ability to function on multi-disciplinary teams.
- (e) An ability to identify, formulate, and solve engineering problems.
- (f) An understanding of professional and ethical responsibility.
- (g) An ability to communicate effectively.
- (h) The broad education necessary to understand the impact of engineering solutions in a global and societal context.
- (i) A recognition of the need for, and an ability to engage in life-long learning.
- (j) A knowledge of contemporary issues.
- (k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

The following table indicates the relative strengths of each course outcome in addressing the program objectives listed above (on a scale of 1 to 4 where 4 indicates a strong emphasis).

Outcomes Objectives	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
(a)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	
(b)		2	2	2				2						4	4	4	4
(c)		1		2	2	2	2	3		2	2		2	3	1	3	
(d)																2	
(e)	1	2		2	2	2	4	2		2	2	2	2	3	3	3	
(f)																	3
(g)																	4
(h)																	
(i)																	
(j)																	
(k)	2	3	3	3	4	3	2	4	3	3	3	2	3	4	4	3	2

**PREPARED BY:**

- Thomas P. Montoya, Date: 1/8/2009
- Revised: Thomas P. Montoya, Date: 1/06/2015
- Revised: Thomas P. Montoya, Date: 1/08/2016
- Revised: Thomas P. Montoya, Date: 8/18/2016