Curriculum Committee Approval: 02/17/2026

Lecture Contact Hours: 32-36; Outside-of-Class Hours: 64-72;
Laboratory Contact Hours: 48-54; Outside-of-Class Hours: 0;
Total Student Learning Hours: 144-162

CUYAMACA COLLEGE
COURSE OUTLINE OF RECORD

Engineering 230 – Basics of Mechatronics

2 hours lecture, 2 units
3 hours laboratory, 1 unit
Total units: 3

Catalog Description
Introductory mechatronics. Basic DC and AC circuits, breadboarding, capacitors, inductors, circuit components, integrated circuit amplifiers, filters, with applications to mechanical engineering. Ohm's Law. Laboratory topics include measurement techniques using function generator, multimeter, oscilloscope, and computer simulation using circuit analysis software.

Prerequisite
"C" grade or higher or "Pass" in MATH C2220 (formerly MATH 280) and PHYC 202, or equivalent

Entrance Skills
Without the following skills, competencies and/or knowledge, students entering this course will be highly unlikely to succeed:
1) Calculate electric and magnetic forces and fields.
2) Understand the basic concepts of voltage, current and power.
3) Understand the basic concepts of resistance, capacitance and inductance.
4) Solve for current, voltage, power and time constants in DC circuits consisting of resistors, capacitors, inductors and batteries.
5) Apply appropriate differentiation and integration techniques appropriate to analyzing responses of inductors and capacitors in electrical circuits.

Course Content
1) Fundamental concepts: current, voltage, power, dependent and independent sources, resistance
2) Simple circuits: Ohm's Law, Kirchoff's Law, circuit reduction, voltage and current dividers
3) Ideal and real operational amplifiers
4) Natural and step response of first and second order RLC circuits
5) Sinusoidal concepts: phasor concepts and complex algebra, complex impedance and admittance, phasor diagrams
6) Alternating current network analysis: nodal analysis, mesh analysis, source transformations
7) Energy and power: instantaneous and average power, root-mean-square and average voltage and current, complex power
8) Microcontroller (i.e., Arduino or Raspberry Pi) implementation to control circuits designed for mechanical engineering applications.
9) Labs for the course will cover, but are not limited to, the following concepts:
   a. Basic Electrical Measurements
   b. Analysis of DC Circuits
   c. AC circuits and Passive Filters
   d. Analysis of electronic circuits
      1. The Junction Diode and Bipolar Junction Transistor
      2. The Operational Amplifier
   e. Digital Input/Output handling

   f. DC Motor Control
   g. Analog Signal Measurement
10) Computer simulations (i.e. Tinkercad) to analyze circuits.

Course Objectives

Students will be able to:

1) Explain the voltage and current relationships for the following circuit elements: independent and dependent voltage and current sources, resistors, capacitors, inductors.
2) Analyze DC circuits using node-voltage and mesh-current methods.
3) Analyze simple circuits containing ideal and real operational amplifiers.
4) Analyze the natural and step responses of both RC and RL circuits.
5) Analyze the natural and step responses of both series and parallel RLC circuits.
6) Analyze circuits containing passive elements and powered by steady-state sinusoidal sources using node-voltage and mesh-current methods, source transformations, and superposition.
7) Explain and perform steady-state power calculations including instantaneous and average power.
8) Safely perform electrical measurements in a laboratory setting, using standard lab equipment such as oscilloscopes and signal generators.
9) Build circuits integrating microcontrollers to create useful solutions for the field of mechanical engineering.
10) Document results from electrical laboratory experiments and compare those results to theoretical predictions.

Method of Evaluation

A grading system will be established by the instructor and implemented uniformly. Grades will be based on demonstrated proficiency in the subject matter determined by multiple measurements for evaluation, one of which must be essay exams, skills demonstration or, where appropriate, the symbol system.

1) Classroom assessment tools, such as reading quizzes, concept quizzes, attention quizzes, muddiest point questions, and one-minute papers, that measure students' ability to apply concepts just discussed in class. An example would be a multiple-choice question answered using an audience response system in which students determine whether an RLC circuit is underdamped, overdamped, or critically damped.
2) Homework assignments that measure students' ability to interact with the course material outside the classroom and to extend the classroom and reading experience to novel situations. Questions are almost exclusively word problems. An example would be a problem in which students use the node-voltage method to determine the currents and voltages everywhere in a resistive circuit.
3) Periodic quizzes and exams that evaluate student learning and retention of the material on the time scale of weeks. Questions are mostly word problems, but with some short answer conceptual questions. An example would be a problem in which students determine the output voltage of an ideal operational amplifier circuit.
4) Final examination that evaluates students' ability to integrate the course material as a whole and to assess overall retention of the material. Questions are mostly word problems, but with some short answer conceptual questions. An example would be a problem in which students determine the steady-state AC voltages and currents everywhere in a linear circuit composed of resistors, inductors, and capacitors by determining the complex impedance of each component, then applying the node-voltage method.
5) Laboratory projects that document students' ability to apply theory from text and lecture to the testing of real working circuits. An example would be to perform a study of superposition, in which the behavior of a circuit with two voltage sources is predicted theoretically for each voltage source separately, then with both simultaneously, and then this prediction is tested both using circuit simulation software and with a real circuit.

Special Materials Required of Student
None

Minimum Instructional Facilities
1) Smart classroom with document camera
2) Electrical circuits laboratory with one lab station (oscilloscope, signal generator, power supply, microcontroller, etc.) for every student, or 2 students if equipment is limited.
3) Computers running circuit simulation software.
4) Microcontrollers for each student or pair of students

Method of Instruction
1) Lecture and discussion
2) Laboratory assignments
3) Homework
4) Group problem-solving

Out-of-Class Assignments
1) **Reading**: Lecture notes; assigned sections from the textbook; supplemental problem explanations; instructor-provided conceptual summaries and study guides. Students may also read articles or excerpts demonstrating real-world applications.
2) **Writing**: Problem sets requiring students to show reasoning using proper notation and explanation; error analysis and reflection on incorrect solutions; explanation of problem-solving strategies in multi-step applications; written solutions to group problem assignments; step-by-step documentation of computational methods used with technology.
3) **Other**: Laboratory projects that document students' ability to apply theory from text and lecture to the testing of real working circuits. An example would be to perform a study of superposition, in which the behavior of a circuit with two voltage sources is predicted theoretically for each voltage source separately, then with both simultaneously, and then this prediction is tested both using circuit simulation software and with a real circuit.

Texts and References
1) Required (representative example): Alexander, Charles and Matthew Sadiku. *Fundamentals of Electric Circuits*. 7th edition. McGraw-Hill, 2026.
2) Supplemental: Monk, Simon. *Programming Arduino: Getting Started with Sketches*, 3rd Edition. McGraw-Hill, 2023.

Student Learning Outcomes
Upon successful completion of this course, students will be able to:
1) Design circuitry to create solutions applicable to the field of mechanical engineering.
2) Demonstrate the ability to create functional circuits based on theoretical design.
3) Compare and contrast theory and laboratory results with the aid of computer simulations.