ECE4435 Course Syllabus

ECE4435

Operational Amplifier Design (2-0-3-3)

CMPE Degree
This course is Elective for the CMPE degree.

EE Degree
This course is Elective for the EE degree.

Lab Hours
3 supervised lab hours and 0 unsupervised lab hours

Course Coordinator
Wang,Hua

Prerequisites
ECE 3041 [min C] or ECE 3043 [min C]

Corequisites
None

Catalog Description
Analysis and design techniques for the utilization of integrated circuit operational amplifiers for applications in electronic systems.

Textbook(s)
Franco, *Design with Operational Amplifiers and Analog Integrated Circuits* (4th edition), McGraw Hill, 2014. ISBN 9780078028168 (required)

Course Outcomes
Upon successful completion of this course, students should be able to:

1. Describe operational amplifiers (op-amps) fundamentals and their applications.
2. Analyze and design of op-amp based feedback circuits with various inverting and non-inverting configurations.
3. Design linear op-amp circuits, including amplifiers, I-V/V-I converters, instrumentation amplifiers, integrators, differentiators.
4. Describe the static and dynamic limitations of practical op amps, their causes, and their impacts on application circuits based on op-amps.
5. Demonstrate basic filter theory, filter responses, and filter synthesis techniques.
6. Analyze and design of various continuous-time active filter designs based on op amps.
7. Analyze and design of discrete-time circuits (switched capacitor circuits) based on op amps.
8. Analyze and design of nonlinear circuits (e.g., comparators, Schmitt triggers, rectifiers, and peak detectors) based on op amps.

Student Outcomes
In the parentheses for each Student Outcome:
"P" for primary indicates the outcome is a major focus of the entire course.

"M" for moderate indicates the outcome is the focus of at least one component of the course, but not majority of course material.
"LN" for "little to none" indicates that the course does not contribute significantly to this outcome.

1. (P) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. (P) An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. (M) An ability to communicate effectively with a range of audiences
4. (LN) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. (LN) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. (LN) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. (LN) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Topical Outline

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Properties of Op-Amps
  The ideal op-amp.  Open-loop gain, input resistance, and output
  resistance.

Ideal Op-Amp Circuits
  Inverting and non-inverting amplifiers.  Differential input and o
  amplifiers.  Integrators and differentiators.  Single-pole low-pa
  high-pass amplifiers.  The op-amp as a comparator.

Op-Amp Active Filters
  Filter transfer functions.  Butterworth, Chebyshev, Thompson, and
  elliptic approximations.  Sallen-Key, infinite-gain-multi-feedbac
  variable, generalized impedance converter, and switched capacitor
  topologies.

Nonlinear Applications
  Precision rectifier, peak detector, wave-shaping, and log-convert
  circuits.

Characteristics of Non-Ideal Op-Amps
  Open-loop transfer function, bandwidth, gian-bandwith product, sl
  power bandwidth, clipping, rise time, offset voltages and current
  stability, frequency compensation, noise.

Op-Amp Signal Generator Circuits
  Sine-wave oscillators, triangle-wave generators, square-wave gene
  and pulse generators.

Other Applications of op-Amps
  Applications to digital-to-analog and analog-to-digital converter
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electronic switching circuits, voltage-to-current converters, and voltage-to-frequency and frequency-to-voltage converters.