

1. *Course number and name*

**ENGR 442: Operational Amplifier Network Design**

2. *Credits and contact hours*

3 credit hours

3. *Instructor's or course coordinator's name*

Instructor: Hao Jiang,

Course coordinator: Hao Jiang, Associate Prof. in EE

4. *Text book, title, author, and year*

1. Sergio Franco, *Design with Operational Amplifiers and Analog ICs*, 3rd ed. McGraw-Hill, 2002.

5. *Specific course information*

*brief description of the content of the course (catalog description)*

Design of op-amp based amplifiers, signal converters, conditioners, filters. Negative feedback, practical op-amp limitations. Voltage comparators; Schmitt triggers; nonlinear signal processing. Sinewave oscillators; multivibrators; timers.

*prerequisites or co-requisites*

Grades of C- or better ENGR 305

*indicate whether a required, elective, or selected elective course in the program*

Required for Electrical Engineering and Elective for Computer Engineering

6. *Specific goals for the course*

a. *Specific outcomes of instruction, ex. The student will be able to explain the significance of current research about a particular topic.*

- To investigate a variety of resistive op–amp circuits with emphasis on feedback principles.
- To analyze and design active filters
- To investigate the effect of op–amp non-idealities upon the DC as well as the AC and transient responses of popular op–amp circuits
- To study the design of popular op–amp and comparator applications in test, control, and instrumentation
- To perform SPICE simulation of common analog circuits.

b. *Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.*

- Students will demonstrate the ability to analyze and design a variety of popular op- amp circuits, including signal converters and instrumentation blocks.
- Students will demonstrate an understanding of the curative properties of negative feedback.
- Students will demonstrate an ability to identify negative-feedback topologies and estimate the loop gain of a circuit.
- Students will become conversant with systems poles, zeros, and Bode Plots as applied to op–amp circuits.
- Students will demonstrate an ability to analyze and design first-order op–amp filters.
- Students will demonstrate an ability to analyze and design second-order active filters and compare different topologies.
- Students will become conversant with the internal structure of a practical op–amp and the origins of its nonidealities.
- Students will demonstrate a skill in using data sheets to assess the limitations of practical analog ICs.
- Students will demonstrate an ability to predict the effect of static op–amp limitations upon DC circuit performance.
- Students will demonstrate an ability to predict the effect of dynamic op–amp limitations upon circuit performance in both the frequency and time domains.
- Students will become conversant with a variety of popular test, control, and instrumentation blocks (comparators, Schmitt triggers, precision rectifiers, SHAs, timers, function generators, VCOs, and  $V-F$  and  $F-V$  converters).
- Students will be capable to assess the impact of component nonidealities upon circuit performance.
- Students will demonstrate a skill in the PSpice simulation of the circuits investigated in the course.

7. *Brief list of topics to be covered*

- Review; basic closed-loop configurations; negative feedback; op-amp powering and saturation.
- $I$ - $V$ ,  $V$ - $I$ , and  $I$ - $I$  converters; difference and instrumentation amplifiers.
- 1<sup>st</sup>-order filters. 2<sup>nd</sup>-order active filters:  $KRC$ , multiple feedback, state-variable and biquads.
- Input-referred DC errors; drift; CMRR and PSRR; operating limits.
- Frequency response; input and output impedances; small-signal and large-signal transient response.
- Voltage comparators and Schmitt triggers; precision rectifiers; peak detectors and sample-and-hold amplifiers.
- Sinusoidal oscillators; multivibrators; IC timers; waveform generators; VCOs.