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

5. *Specific course information*

   a. 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.

   b. prerequisites or co-requisites
   Grades of C- or better ENGR 305

   c. 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*
      Course addresses ABET Student Outcome(s): a, c, k.

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- 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^{st}-order filters. 2^{nd}-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.