1. Course number and name
   EML 4312 Design and Analysis of Control Systems
2. Credits and contact hours
   3 cr, 2.5 contact hours (2 hrs. 30 min. lecture)
3. Instructor's or course coordinator's name
   Instructor: Dr. Camilo Ordonez, Coordinator: Dr. Jonathan Clark
4. Text book, title, author, and year
   Control Systems Engineering, Nise, N. S., 2010
   a. *References, Additional Resources*
      - Modern Control Engineering, Ogata, K., 2010
5. Specific course information
   a. *brief description of the content of the course (catalog description)*
      This course focuses on mathematical modeling of continuous physical systems. Frequency and time domain analysis and design of control systems. State variable representations of physical systems.
   b. *prerequisites or corequisites*
      Prerequisite: EML 3014C
   c. *indicate whether a required, elective, or selected elective course in the program*
      Selected Technical Elective course
6. Specific goals for the course
   a. *Course Outcomes*
      1. Be able to represent dynamic systems in either standard ordinary differential equation form, transfer function form, or state-variable form and convert from one form to another [1]
      2. Be able to linearize a nonlinear system in state-variable form about a selected operating point [1]
      3. Be able to state and illustrate the two primary reasons that feedback control is used [2]
      4. Be able to determine the stability of a linear system of arbitrary order [3]
      5. Given a step response of a system, be able to determine the rise time, overshoot, settling time, and steady-state error of the system [3]
      6. Be able to discuss and illustrate the qualitative relationship between system poles and zeros and the system time-domain response [3]
      7. Be able to use the Ziegler-Nichols tuning criteria for PID controllers [4]
      8. Be able to discuss and illustrate the qualitative effect of the proportional, integral and derivative gains of a PID controller on a feedback system [4]
      9. Be able to sketch a root locus plot of an arbitrary linear system [5]
      10. Be able to use the root locus plot to investigate the influence of an arbitrary system parameter on the system behavior [5]
      11. Be able to sketch the Bode plot of an arbitrary linear system [6]
      12. Given a Bode plot, be able to sketch the corresponding Nyquist plot [6]
      13. Be able to use a Bode plot to qualitatively predict the speed of response [6]
      14. Be able to determine the stability of a system from either a Bode plot (when applicable) or a Nyquist plot [6]
      15. Be able to design lead and lag controllers using a Bode plot

Numbers refer to Course Objectives below, e.g. for course outcome 1, [1] refers to course objective 1.

b. Course Objectives and Relation to Student Outcomes

1. Be able to represent a variety of dynamic open-loop and closed-loop systems in a variety of forms [1, 4, 9, 11]
2. To introduce the principle of feedback for controlling a variety of dynamic systems, including the primary reasons that feedback is used [3, 9, 10]
3. To introduce standard time-domain criteria for analyzing the stability and performance of a feedback system [1, 2, 5]
4. To introduce the PID controller as a standard feedback control scheme [2, 3, 7]
5. To introduce the root locus method as a tool for feedback control design [1, 3, 5, 7, 10]
6. To be able to use frequency response plots as a means for designing feedback control laws [1, 2, 3, 5, 7, 10]

Numbers refer to Departmental Student Outcomes, e.g. for course objective 1, [1, 4, 9, 11] refers to student outcomes 1, 4, 9, 11.

7. Brief list of topics to be covered
    - Review of modeling of mechanical, electrical, and electromechanical systems
    - Review of Laplace transforms and block diagrams
    - System response and time domain specifications
    - Basic properties of feedback
    - The PID controller
    - Steady-state tracking and system type
    - Stability and Routh’s criterion
    - Root locus design
    - Bode plots
    - The Nyquist stability criterion
    - Stability margins
    - Lead and lag compensation