1. Course number and name
   EML 4316 Advanced 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
   Digital Control of Dynamic Systems, Franklin, G. F., Powell, J. D. and Workman, M. L., 1997
5. Specific course information
   a. *brief description of the content of the course (catalog description)*
      This course emphasizes design of advanced control systems (using time and frequency domains). Implementation of control systems using continuous (operational amplifier) or digital (microprocessor) techniques are addressed and practiced.
   b. *prerequisites or corequisites*
      Prerequisite: EML 4312
   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 Be able to state the basic reasons for using feedback control [1]
      2. Be able to describe the basic techniques for analog design and how they are used [1]
      3. Be able to describe at least 3 ways to discretize an analog controller [2]
      4. Be able to describe the frequency response of a digital system [3]
      5. Be able to use the discrete-time Nyquist criterion [3]
      6. Be able to write down the general form of a digital PID controller [3]
      7. Be able to describe both the z-Transform and state-space techniques for plant discretization [3]
      8. Be able to design in the digital domain controller using either root locus or frequency response design [3]
      9. Be able to formulate system identification as a least squares problem [4]
      10. Be able to state the meaning of the delta operator and describe the advantage of using the delta operator over the standard forward-shift operator in designing digital control systems [5]
      11. Present the results of a non-trivial successful control design which involves the use of MATLAB Simulink [7]
      12. Design and implement a controller using hardware [6]
      13. Design and evaluate the performance of a Kalman filter [7]

      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. To strengthen the students understanding of classical analog control concept and introduce advanced concepts in classical analog control, such as Nyquist plots [1, 3, 5, 10]

2. To introduce a variety of methods for implementing an analog controller on a digital processor [1, 3, 5, 10]
3. To show the extension of standard analog control concepts to digital control [1, 3, 5, 10]
4. To introduce basic concepts in system identification [1, 2, 10, 11]
5. To introduce the delta operator as a means of getting good digital control behavior in the presence of fast sampling and as a means of unifying analog and digital theories [1, 3, 11]
6. Conduct advanced control systems design projects in simulation and hardware implementation [1, 2, 3, 4, 5, 7, 9, 10]
7. To introduce the Kalman filter as a means of estimation of system states in the presence of limited and noisy measurements. (Time permitting.) [1, 5, 10]

Numbers refer to Departmental Student Outcomes, e.g. for course objective 1, [1, 3, 5, 10] refers to student outcomes 1, 3, 5, 10.

7. Brief list of topics to be covered
    - Review of standard analog control concepts, including Nyquist plots
    - Sensitivity functions
    - Delay systems
    - Sampled-data control systems
    - The z-transform
    - Controller digitization
    - Matrix theory
    - Plant discretization
    - The delta transform
    - Frequency response analysis for discrete-time systems
    - z-plane root locus
    - Frequency response design for discrete-time systems
    - Canonical forms for state space systems