ABET Course Syllabus

ENAE 432 Control of Aerospace Systems

Credits & Contact Hours: 3 credits (3 hours of lecture)

Course Status: Required

Schedule: Offered every Spring semester

Course Description: An introduction to the feedback control of dynamic systems. Laplace transforms and transfer function techniques; frequency response and Bode diagrams. Stability analysis via root locus and Nyquist techniques. Performance specifications in time and frequency domains, and design of compensation strategies to meet performance goals.

Pre-Requisites: ENAE283 and ENAE301

Co-Requisites: None

Textbooks: (1) N. Nise. Control systems engineering. Wiley, sixth edition, 2010 (recommended)

Other Required Material: Course lecture notes and handouts

Course Oversight: Dynamics and Control Committee

Syllabus Prepared By/Date: Dr. Robert Sanner in January, 2011

Course Objectives/Student Learning Outcomes:

1. Predict the response of a linear system to an arbitrary input
2. Understand the concept and significance of the modes of a system and their relation to the nature and duration of the transient response
3. Determine the shape of the Bode diagrams of a system from its transfer function, and conversely, be able to determine the transfer function from the Bode diagrams
4. Determine the stability and performance characteristics of a feedback system, and how these properties change as a function of the loop gain
5. Design a feedback control loop and compensator for a given dynamic system, so that the overall system meets specified transient and steady-state performance targets, as well as robust stability requirements
6. Confidently use Matlab to carry out the calculations required for 1)-5) above, and to assemble graphical documentation for these analyses
7. Understand in a broad sense the nature and goals of feedback control; its advantages and dangers; and its costs, both in dollars and in increased hardware/software complexity

Topics Covered:

1. Unit I: Linear System Response

   a. Introduction
   b. Laplace transforms and transfer functions (Chap 2)
   c. Transient and steady-state responses; stability (Chap 4)
   d. Second order transient responses (Chap 4)
   e. General transient responses: poles and zeros (Chap 4)
   f. Sinusoidal response (Chap 10)
   g. Bode and polar diagrams (Chap 10)
2. Unit II: Feedback Analysis and Synthesis
   a. Feedback systems: closed loop dynamics (Chap 5)
   b. Tracking performance; system type (Chap 7)
   c. Closed-loop stability via root locus analysis (Chap 8)
   d. Closed-loop stability via Nyquist analysis (Chap 10)
   e. Relative stability: phase and gain margins (Chap 10)
   f. Compensation design: P, P-D, P-I-D (Chap 9)
   g. Compensation design: lead and lag (Chap 9, 11)
   h. Model uncertainty and robustness

Relationship of Course Objectives to Program Outcomes
This course addresses program outcomes: 1, 3, 4, 5, 7, 8, 9, 14, 16