AE 3531 - Control System Analysis and Design

Hours: 3-0-3

Catalog Description: Control system performance analysis and specifications, classical methods of control system analysis and design, and introduction to modern control methods.

PREREQUISITS:
AE3530 System Dynamics and Vibrations

COURSE OBJECTIVE: Provide students with a foundational understanding of classical methods of feedback control system analysis and design and an introduction to modern control methods.

LEARNING OUTCOMES:
Students will gain a mastery level understanding of:

1. Analysis of Controlled Linear SISO Systems
2. Design of Controlled Linear SISO Systems

Students will gain exposure to:

3. Analysis of Controlled Linear MIMO Systems
4. Design of Controlled Linear MIMO Systems
5. Relevant Applications to Aerospace Systems

TOPICAL OUTLINE:

	Topic	*Hours*
I.	Introduction to Control Systems Examples of Control Systems Open-Loop versus Closed-Loop Control Feedback Block Diagrams and their Simplification Mason's Gain Formula Mathematical Modeling of Dynamical Systems Modeling in the State Space Transfer Functions and Impulse Response Functions	5
II.	Transient and Steady-State Response Analysis First- and Second-Order Systems Higher-Order Systems Transient Response Analysis Time Domain Performance Specifications Delay Time, Rise Time, Peak Time, Maximum Overshoot, and Settling Time Stability Analysis and Routh's Stability Criterion Proportional, Derivative, and Integral Control Actions Steady-State Error Analysis in Feedback Systems	6
III.	Root Locus Analysis Root Locus Plots General Rules for Constructing the Root Locus Positive feedback Systems Parameter Variation	5

IV.	Frequency-Response Analysis Bode Diagrams Nyquist Plots Stability and Relative Stability Analysis Systems with Transport Lags Gain and Phase Margins Closed-Loop Frequency Response Frequency Domain Performance Specifications Peak Resonance, Resonant Frequency, and Bandwidth	7
V.	Time and Frequency Domain Design of Control Systems PID Design Lead-Lag Compensation Sensitivity and Complimentary Sensitivity Transfer Functions Disturbance Rejection and Loop Shaping	6
VI.	Analysis and Control Design in the State Space Lyapunov Stability, Asymptotic Stability, Input-Output Stability State Transition Matrix Controllability and Observability The Lyapunov Equation Full-State Feedback Control Design and Pole Placement Optimal State Space Control System Design Linear Quadratic Regulator	9
VII.	Aerospace Applications Classical Control Theory Modern Control Theory	4
VIII.	Mid Term Exam and Quizzes	3
	Total	45