CONTROL SYSTEMS
BEG 320 EL

Year: III      Semester: I

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* Continuous
**Duration: 3 hrs

Course Objectives: To provide knowledge on feedback control principles and to apply these concepts to control processes.

1. System Modeling 7
   1.1 Differential equation and transfer function
   1.2 State-space formulation of differential equations, matrix notation
   1.3 Mechanical components and Electrical components: mass, spring, damper, Inductance, capacitance, resistance, sources, motors, technometers, transducers, operational amplifier circuits.
   1.4 Fluid and fluidic components, Thermal system components
   1.5 Mixed systems
   1.6 Linearized approximations

2. Transfer Functions and Responses 8
   2.1 Components to physical systems
   2.2 Block diagram and system reduction
   2.3 Mason's loop rules
   2.4 Laplace transforms analysis of systems with standard input functions-steps, ramps, impulses, sinusoids
   2.5 System state: initial and final steady-state
   2.6 Effects of feedback on steady-state gain, bandwidth, error magnitude, dynamic responses

3. Stability 4
   3.1 Heuristic interpretation for stability of a feedback system
   3.2 Characteristic equation, complex plane interpretation of stability, root locations and stability
   3.3 Routh-Hurwitz criterion, eigenvalue criterion
   3.4 Setting loop gain using the R-H criterion
   3.5 Relative stability from complex plane axis shifting

4. Root locus method 6
   4.1 Relationship between root locus and time responses of systems
   4.2 Rules for construction of root locus diagram
   4.3 Computer programs for root locus plotting, polynomial root finding
   4.4 Derivative feedback compensation design with root locus
   4.5 Setting controller parameters using root locus, parameter change sensitivity analysis by root locus
5. Frequency Response Methods
   5.1 Frequency domain characterization of systems
   5.2 Bode amplitude and phase plots, Effects of bain time constants on Bode diagrams, Stability from the Bode diagram
   5.3 Nyquist plots, Correlation between Nyquist diagrams and real time response of systems: stability, relative stability, gain and phase margin, damping ratio

6. Computer Simulation of Control System
   6.1 Role of simulation studies
   6.2 Linear and non-linear simulations

7. Performance Specifications for Control Systems
   7.1 Time domain specifications: steady-state errors, response rates, error criteria, hard and soft limits on responses, damping ratio, log decrement.
   7.2 Frequency domain specifications: bandwidth, response amplitude ratio.

8. Compensation and Design
   8.1 Root locus, frequency response and simulation in design
   8.2 Feed back compensation
   8.3 Lead, lag, and lead-lag compensation, PID controllers

9. Digital Control System
   9.1 Introduction of Digital Control System
   9.2 Components of Digital Control System
   9.3 Designing criteria of Digital Control System

Laboratory

1. Identification of Control System Components
2. Open and Closed Loop Performance of Servo Position Control System
3. Simulation Study of Feedback System Using TUTSIM or MALTAB
4. Design of a PID Controller
5. Non-Electrical Control System

Reference Book