

Selected Topics in Control:

Focus on Controller Design using Classical and Modern Control Techniques

Total Credits: 3

Course Description:

This course will serve as the basic building block for advanced level Control System courses. The main focus of the course is to lay a strong foundation in time and frequency domain analysis. Controller design in Matlab/Simulink will be dealt in detail.

Course Contents

1. Review of mathematical modeling techniques, modeling of electrical systems, modeling of mechanical systems, Laplace transform, linearization of non-linear systems, pole/zero plots, signal flow graphs, Mason's Gain formula, time domain specifications for second order system, Steady State Error, Stability Analysis using Routh- Hurwitz.
2. Root locus analysis, Root Contours, Design aspects of the root-loci.
3. State Space design, Vector matrix representation of state equations, signal-flow-graph to state equations and vice-versa, State transition equations, Relationship between state equations and transfer functions, Similarity transformation, Controllability, Observability of control systems, State feedback control, pole placement design through state feedback.
4. Linear Quadratic Control (LQR) and LQG (Linear Quadratic Gaussian) Control.
5. Frequency response of closed loop systems, Resonant peak, resonant frequency and bandwidth of a control system, Bode plots, Phase-margin, Gain margin, Stability analysis with bode plots, effects of adding poles and zeros to forward path transfer function.
6. Nyquist plots, Nyquist stability criterion, Nyquist criterion for minimum phase transfer function, Relationship between root-loci and Nyquist plots.
7. Analysis and design using Nichols Charts.
8. Detailed design discussion of PI and lag controller.
9. Detailed design discussion of PD and lead controller.
10. Detailed design discussion of PID and lag-lead controller.
11. Concept of MIMO Systems. MIMO poles and zeros. SVD for MIMO System.
12. PID Controller for Multi Input Multi Output (MIMO) systems. Interaction analysis. Effect of decoupling.

Pre-requisites

1. Control system engineering.

Text Books

1. “Modern Control Engineering” by Ronald Burns.

Reference Books

1. “Automatic Control System”, by Benjamin C Kou, 9th Edition.
2. “Modern Control System”, by Richard C Dorf 12th Edition.