EE 303: CONTROL SYSTEMS (3-0-2: 4)

Basic Concepts

Basic definition, basic elements of control system, open loop control system, closed loop control system, control system terminology, manually controlled closed loop systems, automatic controlled closed loop systems, basic elements of a servo mechanism, electrical analogue of multidisciplinary systems, Notion of Feedback

Modeling and Representations of Control Systems

Ordinary Differential Equations, derivation of transfer functions of physical systems, block diagram representation of physical systems, signal flow graphs, conversion of block diagram to signal flow graph, block diagram reduction technique, signal flow graph Manipulation using Mason's gain formula. State-Space Representation of physical systems.

Linear System Performance in Time and Frequency Domain

Standard test signals, significance of system impulse response, Transient step response analysis of zero, first and second order systems and determination of different time domain performance specification, steady state error analysis for Type-0, Type-1 and Type-2 systems, static and dynamic errors coefficients, and errors criteria, significance of system sinusoidal response, Frequency response analysis of first and second order system, link between time and frequency domain response, Effect of addition of poles and zeros on system time response.

Stability of LTI Systems

Fundamental concepts of LTI system stability, Definitions of stability: BIBO stability, Absolute stability, relative stability, limited stability, asymptotic stability etc., Determination of closed loop control system stability from characteristic equation: Routh stability criterion, Hurwitz stability criterion.

Graphical Techniques for Measurement of System Relative Stability

The Root-Locus concepts, Contruction of Root Loci, Root contour, Frequency domain techniques: Bode-plot, Polar-plot, Nyquist plot, Nyquist Stability Criteron for open loop stable and unstable systems, concept of Gain Margin, Phase Margin, Closed loop frequency response.

Compensator Design

Introduction, different types of compensators, design of lag, lead,lag-lead compensators using root locus and Bode diagrams, design of P, PI, PD and PID controllers by analytical method, frequency response method and root locus technique.

Suggested list of Experiments:

1. Familiarization with MATLAB control system toolbox, MATLAB-SIMULINK toolbox
2. Simulation of Step response & Impulse response for Type-0, Type-1 & Type-2 system with unity feedback using MATLAB
3. Study of time response for first and second order systems with unity feedback and calculation of control system specifications by using CRO

4. Study of Synchro devices
5. Study of Magnetic Levitation System
6. Determination of root-locus, Bode plot, Nyquist plot using MATLAB toolbox for a given system transfer function and listing of the specifications.
7. Determination of the effect of P, PI, PD, PID Controller action on different hardware simulated process.
8. Determination of approximate transfer functions experimentally from Bode plot.
9. Design and test cascade compensator
10. Identification of a DC servomotor transfer function
11. Identification of a AC servomotor transfer function

Text Books

1. Ogata K, “Mordern Control Engineering”; PHI.
2. Nagrath I.J, Gopal M, “Control System Engineering”, New Age International.

References

1. Nise N.S, “Control System Engineering”, Wiley India.
2. Dorf R.C, Bishop R. H, “Mordern Control Systems”, Pearson.
3. Kuo B.C, “Automatic Control Systems”, Wiley India.