



GOKARAJU RANGARAJU INSTITUTE OF ENGINEERING AND TECHNOLOGY

CONTROL SYSTEMS

Course Code: GR15A2042
II Year II Semester

L:3 T:1 P:0 C:4

Prerequisites: Knowledge of Laplace Transforms, Differential equations and Matrices.

Course Objectives

- Know differences between open and closed loop control systems and learn block diagram algebra.
- Learn time response analysis of second order systems.
- Know stability analysis, root locus technique.
- Know frequency analysis i.e., Bode plots and Nyquist plots.
- Know control ability and observe ability

Course Outcomes

- Ability to express the basic elements and structures of feedback control systems.
- Ability to apply Routh-Hurwitz criterion, RootLocus, Bode Plot and Nyquist Plot to determine the domain of stability of linear time-invariant systems.
- Ability to determine the steady-state response, errors of stable control systems and design compensators to achieve the desired performance.
- Ability to design lead, lag, lead-lag compensators.
- Ability to express control system models on state space models, to express state transition matrix and calculation of variables.

Unit-I

Concepts of Control Systems and Transfer Function Representation:

Concepts of Control Systems: Open loop and closed loop control systems, different examples of control systems, classification of control systems, characteristics and effects of feedback, mathematical models differential equations, impulse response and transfer functions, translational and rotational mechanical systems.

Transfer Function Representation: Transfer function of DC and AC Servomotor, Synchro transmitter and receiver, Block diagram representation of systems considering electrical systems as examples, Block diagram reduction techniques, signal flow graphs, reduction using Mason's gain formula.

Unit-II

Time Response Analysis: Standard test signals, time response of first order systems, characteristic equation of feedback control systems, transient response of second order systems-time domain specifications, steady state response-steady state errors and error constants, effects of proportional derivative, proportional integral systems.



Unit-III

Stability Analysis: Concept of stability, Routh stability criterion, qualitative and conditional stability. Root Locus Technique The root locus concept, construction of root loci, effects of adding poles and zeros to $G(s)H(s)$ on the root loci. **Frequency Response Analysis:** Frequency domain specifications, Bode diagrams, Determination of frequency domain specifications and transfer function from the Bode diagram-Phase and Gain margin, stability analysis from Bode plots.

Unit-IV

Stability analysis in frequency domain: Polar plots, Nyquist plots and applications of Nyquist criterion to find the stability, effects of adding poles and zeros to $G(s)H(s)$ on the shape of the Nyquist diagrams. Classical control design techniques- Compensation techniques Lag, Lead, Lead-Lag Controllers design in frequency domain, PID Controllers.

Unit-V

State Space Analysis of Continuous Systems: Concepts of state, state variables and state model, derivative of state models from block diagrams, diagonalization - solving the time invariant state equations, state transition matrix and its properties, Controllability and Observability.

Teaching Methodologies

1. CS ppts
2. Assignments uploaded in website
3. Software's: MATLAB.

Text Book

1. Modern Control Engineering by Katsuhiko Ogata Prentice Hall of India Pvt Ltd, 3rd edition, 1998.
2. Automatic Control Systems 8th edition by B. C. Kuo 2003 John Wiley and Son's.

Reference Books

1. Control Systems Engineering by I. J. Nagrath and M. Gopal, New Age International (P) Limited Publishers, 2nd edition.
2. Control Systems by N. K. Sinha, New Age International (P) Limited Publishers, 3rd edition, 1998.
3. Control Systems by S. Kesavan, Hitech Publications.
4. Control Systems Engineering by NISE 3rd Edition John Wiley.
5. "Modeling and Control of Dynamic Systems" by Narciso F. Macia George J. Thaler, Thomson Publishers.
6. Control Systems by A. Anand Kumar, 2nd edition, PHI Learning Private Limited.