EE2204PC: Control Systems

B.Tech. II Year II Sem.

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Prerequisite: Linear Algebra and Calculus, Ordinary Differential Equations and Multivariable Calculus Laplace Transforms, Numerical Methods and Complex variables

Course objectives:

- To understand the different ways of system representations such as Transfer function representation and state space representations and to assess the system dynamic response.
- To assess the system performance using time domain analysis and methods for improving it.
- To assess the system performance using frequency domain analysis and techniques for improving the performance.
- To design various controllers and compensators to improve system performance.

Course Outcomes:

- Model linear time-invariant systems using transfer functions and state-space representations for electrical, mechanical, and electromechanical systems.
- Analyze the time-domain response of control systems using standard test inputs and derive transient and steady-state performance measures.
- Evaluate system stability using Routh-Hurwitz criterion and root locus methods, and apply them to design basic feedback controllers.
- Interpret frequency-domain responses using Bode, Polar, and Nyquist plots, and analyze relative stability through gain and phase margins.
- Design and analyze state-space models, evaluate eigenvalues, and determine system properties such as controllability and observability.

UNIT – I

Introduction to Control Systems: Industrial Control examples, Open loop and closed loop control systems, classification of control systems, characteristics and effects of feedback, mathematical models differential equations, 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. Sensitivity of control system.

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. Introduction to PID Controller.

UNIT-III

Stability Analysis in Time Domain: Concept of stability, Routh-Hurwitz 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. Root-loci method of feedback controller design.

UNIT – IV

Frequency-Response Analysis: Relationship between time and frequency response, Polar plots, Bode plots. Nyquist stability criterion. Relative stability using Nyquist criterion – gain and phase margin. Closed-loop frequency response. Lead and Lag compensation in designs.

UNIT – V

State Variable Analysis and Concepts of State Variables: State space model. Diagonalization of State Matrix. Solution of state equations. Eigen values and Stability Analysis. Concept of controllability and observability.

TEXT BOOKS:

1. M. Gopal, “Control Systems: Principles and Design”, McGraw Hill Education, 1997.
2. B. C. Kuo, “Automatic Control System”, Prentice Hall, 1995.

REFERENCE BOOKS:

1. K. Ogata, “Modern Control Engineering”, Prentice Hall, 1991.
2. J. Nagrath and M. Gopal, “Control Systems Engineering”, New Age International, 2009.