CONTROL SYSTEMS

OBJECTIVES

1.To provide sound knowledge in the basic concepts of linear control theory and design of control system.
2.To understand the methods of representation of systems and getting their transfer function models.
3.To provide adequate knowledge in the time response of systems and steady state error analysis.
4.To give basic knowledge is obtaining the open loop and closed–loop frequency responses of systems.
5.To understand the concept of stability of control system and methods of stability analysis.
6.To study the various ways of designing compensation for a control system.

Course Contents

Introduction to Control system

Terminology and classification of control system, examples of control system, Laplace Transform and its application, mathematical modeling of mechanical and electrical systems, differential equations, transfer function, block diagram representation and reduction, signal flow graph techniques.

Feedback characteristics of control systems

Open loop and closed loop systems, effect of feedback on control system and on external disturbances, linearization effect of feedback, regenerative feedback.

Time response analysis

Standard test signals, time response of 1^{st} order system, time response of 2^{nd} order system, steady-state errors and error constants, effects of additions of poles and zeros to open loop and closed loop system.

Time domain stability analysis

Concept of stability of linear systems, effects of location of poles on stability, necessary conditions for stability, Routh-Hurwitz stability criteria, relative stability analysis, Root Locus concept, guidelines for sketching Root-Locus.

Frequency response analysis

Correlation between time and frequency response, Polar plots, Bode Plots, all-pass and minimum-phase systems, log-magnitude versus Phase-Plots, closed-loop frequency response.

Frequency domain stability analysis

Nyquist stability criterion, assessment of relative stability using Nyquist plot and Bode plot (phase margin, gain margin and stability).

Approaches to system design

Design problem, types of compensation techniques, design of phase-lag, phase lead and phase lead-lag compensators in time and frequency domain, proportional, derivative, integral and PID compensation.

State space analysis

State space representation of systems, block diagram for state equation, transfer function decomposition, solution of state equation, transfer matrix, relationship between state equation and transfer function, controllability and observability.

Course Outcomes:

Students who are successful in this class will demonstrate at least the abilities to:

1.Demonstrate an understanding of the fundamentals of (feedback) control systems.
2.Determine and use models of physical systems in forms suitable for use in the analysis and design of control systems.
3.Express and solve system equations in state-variable form (state variable models).
4.Determine the time and frequency-domain responses of first and second-order systems to step and sinusoidal (and to some extent, ramp) inputs.
5.Determine the (absolute) stability of a closed-loop control system
6.Apply root-locus technique to analyze and design control system.

Text books –

1. I.J. Nagrath and M. Gopal, 'Control Systems Engineering', New Age International Publishers, 2003.
2. Benjamin C. Kuo, Automatic Control systems, Wiley India Pvt. Ltd, 9^{th} edition.
3. http://www.nptelvideos.in/2012/11/control-engineering.html

REFERENCES

1.A. Anand Kumar, " Control Systems" PHI, New Delhi, 2007

2.Norman S. Nise, Control System Engineering, Wiley India Pvt. Ltd.

3.R. Anandnatarajan, P. Ramesh Babu, "Control System Engineering" Scitech Publication (India) Pvt. Ltd. 2014

4.Distefano (schaum series) Control Systems TMH

5.M. Gopal, 'Control Systems, Principles and Design', Tata McGraw Hill, New Delhi, 2002.

6.Manik, Control System, Cengage Learnings.

7.Stefani shahian- Design of feedback control system oxford university press.

8.Salivahanan Control Systems engg. Pearson Education, New Delhi

9.K. Ogata, 'Modern Control Engineering', Pearson Education, New Delhi

10.B.S. Manke linear control system, khanna publishers.