

COURSE TITLE : CONTROL SYSTEMS
COURSE CODE : 5043
COURSE CATEGORY : E
PERIODS/WEEK : 4
PERIODS/SEMESTER : 52/5
CREDITS : 4

TIME SCHEDULE

MODULE	TOPICS	PERIODS
1	Introduction To Control System.	13
2	Systems and Transfer Functions.	13
3	Time Response Analysis.	13
4	Stability Analysis.	13
TOTAL		52

Course General Outcome:

Module	GO	On completion of the study of this course the students will be able:
1	1	To understand the basics of control system.
	2	To understand Laplace and inverse Laplace transform.
2	3	To know systems and transfer function.
	4	To understand methods of obtaining transfer function
3	5	To understand time response analysis.
	6	To understand stability of a system and Routh stability criterion.
4	7	To understand bode plot and root locus techniques for stability analysis.

GO - General Outcome

On the completion of the study the student will be able:

MODULE I INTRODUCTION TO CONTROL SYSTEM

1.1.0 To understand the basics of control system.

- 1.1.1 To understand physical model of control system.
- 1.2.1 To analyze mathematical model of control system.
- 1.1.2 To explain linear time invariant and linear time variant system.
- 1.1.3 To know open loop and closed loop control systems.

1.2.0 To understand Laplace and inverse Laplace transforms.

- 1.2.1 To discuss Laplace transforms.
- 1.2.2 To find the Laplace transform of e^{at} , e^{-at} , t , $\sin at$ and $\cos at$.
- 1.2.2 To find the Laplace transform of test inputs such as step, ramp, parabolic, impuls inputs.
- 1.2.3 To state Laplace transform theorems - differentiation theorem and integration theorem.
- 1.2.4 To find Inverse Laplace transforms using partial fraction method to solve simple problems.

MODULE II SYSTEMS AND TRANSFER FUNCTIONS

2.1.0 To know systems and transfer function.

- 2.1.1 To define transfer function.
- 2.1.2 To find the order of transfer function.
- 2.1.3 To write transfer function of linear system.
- 2.1.4 To derive of general transfer function of Mechanical Translational system and rotational system.
- 2.1.5 To derive the transfer function of Electrical circuits – R, L and C (series & parallel).
- 2.1.6 To describe force/torque - voltage and force/torque - current analogy.

2.2.0 To understand methods of obtaining transfer function.

- 2.2.1 To explain Block diagram reduction rules.
- 2.2.2 To find the overall transfer function of control systems by block diagram.
- 2.2.3 Reduction rules (single input- single reduced output systems).
- 2.2.4 To define the parameters of signal flow graph.
- 2.2.5 To write Mason's gain formula.
- 2.2.6 To draw SFG from block diagram.
- 2.2.7 To obtain overall transmittance of control system by signal flow graph.

MODULE III TIME RESPONSE ANALYSIS

3.1.0 To understand time response analysis.

- 3.1.1 To explain the time response of first order system.
- 3.1.2 To find the response of first order systems such as step, ramp, and impulse inputs.
- 3.1.3 To define the type of a system.
- 3.1.4 To define static error coefficients such as static position, velocity & acceleration error coefficient.
- 3.1.5 To derive steady state error in terms of K_p , K_v & K_a for Type 0, Type 1, Type 2 Systems.

3.2.0 To understand Routh Hurwitz criterion.

- 3.2.1 To state absolute stability, relative stability and marginal stability.
- 3.2.2 To explain Routh hurwitz criterion.
- 3.2.3 To solve simple problems using Routh Hurwitz criterion.

MODULE IV STABILITY ANALYSIS

4.1.0 To understand bode plot and root locus techniques of stability analysis.

- 4.1.1 To draw Bode plot for simple transfer functions. K, Ks, K/s, 1+Ts, Ts, 1/1+Ts, 1/1Ts.
- 4.1.2 To explain gain cross over frequency, phase cross over frequency, gain margin and phase margin.
- 4.1.3 To describe the Procedure to construct Root locus.
- 4.1.4 To construct Root Locus for transfer functions (Single poles only).

CONTENT

MODULE I Introduction to control system

Basics of control system - physical model - mathematical model of control system - linear time invariant and linear time variant system - open loop and closed loop control systems - Laplace transforms - Laplace transform of e^{at} , e^{-at} , t, sin at and cos at - Laplace transform of step, ramp, parabolic, impulse inputs - Laplace transform theorems - differentiation theorem and integration theorem - Inverse Laplace transforms - partial fraction method to solve simple problems.

MODULE II Systems and Transfer Functions

Transfer function - definition and order - transfer function of linear system - general transfer function of Mechanical Translational system and rotational system - transfer function of Electrical circuits – R, L and C (series & parallel) - force/torque - voltage and force/torque - current analogy - block diagram reduction – rules - overall transfer function of control systems using block diagram reduction rules - signal flow graph - parameters - Mason's gain formula - procedure to draw SFG from block diagram - overall transmittance of control system by signal flow graph.

MODULE III Time Response analysis

Time response analysis - time response of first order system - response of first order system for step, ramp, and impulse inputs - type of a system - static error coefficients - static position, velocity & acceleration error coefficient - steady state error in terms of K_p , K_v & K_a for Type 0, Type 1, Type 2

Systems - Routh Hurwitz criterion - absolute stability, relative stability and marginal stability – simple problems using Routh hurwitz criterion

MODULE IV Stability analysis

Bode plot – stability analysis of simple transfer functions. K , K_s , $K/s, 1+Ts, 1-Ts, 1/1+Ts, 1/1-Ts$ - gain cross over frequency, phase cross over frequency, gain margin, phase margin - Root locus - Procedure to construct - Root Locus for single pole transfer functions.

TEXT BOOK

1. Control systems Engg -I.J.Nagarath, N. Gopal (New Age International Publisher).
2. Control Systems- R.S. Manke (Khanna Publisher).

REFERENCE

1. Modern Control Engineering - Katsuhiko Ogata – PHI.
2. Control Systems Engineering - R.Anandanatarajan.P.Ramesh Babu (Scitech Publisher).