

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC409	CONTROL SYSTEMS	3-0-0-3	2016

Prerequisite: EC202 Signals & Systems

Course objectives:

- To introduce the elements of control system and its modelling
- To introduce methods for analyzing the time response, the frequency response and the stability of systems.
- To design control systems with compensating techniques.
- To introduce the state variable analysis method.
- To introduce basic concepts of digital control systems.

Syllabus:

Control system, types and application, feedback system, mathematically modelling of control systems, block diagram representation, signal flow graph, Mason's formula, test signals, time response analysis, frequency analysis, stability concepts and analysis, state variable analysis, Observability and controllability, digital control systems, state space analysis, Jury's test

Expected outcome:

The Students will be able to

- i. Represent mathematically a systems and deriving their transfer function model.
- ii. Analyse the time response and frequency response of the systems for any input
- iii. Find the stability of system
- iv. Design a control system with suitable compensation techniques
- v. Analyse a digital control system.

Text Books

1. Farid Golnaraghi, Benjamin C. Kuo, Automatic Control Systems, 9/e, Wiley India.
2. Gopal, Control Systems, 4/e, McGraw Hill Education India Education, 2012.
3. Ogata K., Discrete-time Control Systems, 2/e, Pearson Education.

References

1. Gopal, Digital Control and State Variable Method, 4/e, McGraw Hill Education India 2012.
2. Norman S. Nise, Control System Engineering, 5/e, Wiley India
3. Ogata K., Modern Control Engineering, Prentice Hall of India, 4/e, Pearson Education, 2002.
4. Richard C Dorf and Robert H. Bishop, Modern Control Systems, 9/e, Pearson Education, 2001.

Course Plan

Module	Course contents	Hours	End Sem Exam Marks
I	Basic Components of a Control System, Applications, Open-Loop Control Systems and Closed-Loop Control Systems, Examples of control system	1	15%
	Effects of Feedback on Overall Gain, Stability, External, disturbance or Noise	1	

	Types of Feedback Control Systems, Linear versus Nonlinear Control Systems, Time-Invariant versus Time-Varying Systems.	1	
	Overview of solving differential equations using Laplace transforms	1	
	Mathematical modelling of control systems - Electrical Systems and Mechanical systems.	2	
	Block diagram representation and reduction methods	2	
	Signal flow graph and Mason's rule formula.	2	
II	Standard test signals. Time response specifications.	1	15%
	Time response of first and second order systems to unit step input, ramp inputs, time domain specifications	2	
	Steady state error and static error coefficients.	1	
	Dynamic error coefficient.	1	
FIRST INTERNAL EXAM			
III	Stability of linear control systems: methods of determining stability, Routh's Hurwitz Criterion.	2	15%
	Root Locus Technique: Introduction, properties and its construction.	2	
	Frequency domain analysis: Frequency domain specifications, correlation between time and frequency responses.	1	
IV	Nyquist stability criterion: fundamentals and analysis	2	15%
	Relative stability: gain margin and phase margin. Stability analysis with Bode plot.	2	
	Design of Control Systems: PI, PD and PID controllers	2	
	Design with phase-lead and phase-lag controllers (frequency domain approach), Lag-lead	2	
SECOND INTERNAL EXAM			
V	State variable analysis: state equation, state space representation of Continuous Time systems	2	20%
	Transfer function from State Variable Representation, Solutions of the state equations, state transition matrix	2	
	Concepts of Controllability and Observability, Kalman's Test, Gilbert's test	2	
VI	Discrete Control systems fundamentals: Overview of Z transforms. State space representation for Discrete time systems.	2	20%
	Sampled Data control systems, Sampling Theorem, Sample & Hold, Open loop & Closed loop sampled data systems.	2	
	State space analysis : Solving discrete time state space equations, pulse transfer function, Discretization of continuous time state space equations	3	
	Stability analysis of discrete time systems Jury's test	1	
END SEMESTER EXAM			

Question Paper Pattern

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 30% for theory and 70% for logical/numerical problems, derivation and proof.

