EOPC2007 CONTROL SYSTEM (3-0-0)

Program Objectives: This course will enable students to:

1. To obtain mathematical models from the first principal equations of dynamical systems.
2. To carry out the performance assessment of a linear system using time-domain techniques.
3. To carry out stability analysis of a linear system using frequency-domain techniques.
4. To design compensators and controllers that meet design specifications for the transfer function-based model.
5. To obtain the state-space model of linear time-invariant systems.

Module I (8 Hours)

Introduction to Control System: Motivation, Open-loop versus Closed Loop Control System, Examples of Control System, Block Diagram of Control System, Principle of Feedback Control System.Mathematical Modelling and Representation of Systems: Mathematical Modelling of Electrical Systems (RLC Series and Parallel Circuits), Mechanical Systems (Mass-Spring-Damper System, Rotational Mechanical System). Analogous System: Force (Torque)-Voltage Analogy and Force (Torque)-Current Analogy.Introduction to Laplace Transformation and Important Formulas. Transfer Functions: Open-Loop and Closed-Loop Transfer Functions. Block Diagram Algebra: Block Diagram Reduction Techniques, Signal flow graph, Mason's gain formula.

Module II (6Hours)

Transient and Steady State Analysis of Linear Time-Invariant (LTI) Systems:Introduction to LTI systems, Standard Test Signals, Time Response of First Order System, Time Response of Second Order System, Time Response Specifications. Steady-State Error and Error Constants. Effect of Adding Zeroes to a System. Performance Indices: ISE, ITSE, IAE, ITAE Indices Comparison.

Module III (8Hours)

Frequency Domain Stability Analysis of LTI System: Routh Hurwitz Criteria, Stability Analysis using Root Locus, Stability Analysis using Bode Plot and Nyquist Criteria.

Module IV (4Hours)

Controller and Compensator Design: P, PI, and PID Controller Design, Lag, Lead and Lead-Lag Compensator Design.

Module V (4Hours)

Analysis of Control Systems in State Space: Introduction, State-Space Representations of Transfer-Function Systems, Solving the Time-Invariant State Space Model, Controllability and Observability.

Course Outcomes: On completion of this course, students are able to:

CO-1 Develop the mathematical model of the physical systems and simplify the complicated system.

CO-2 Employ time domain analysis to predict and diagnose transient performance parameters of the system for standard input functions.

CO-3 Formulate different types of analysis in the frequency domain to explain the nature of the stability of the system

CO-4 Identify the needs of different types of controllers and compensators to ascertain the required dynamic response from the system.

CO-5 Model and Analyse state space representation of LTI system to check the controllability and observability.

Text Book(s):

1. K. Ogata, Modern Control Engineering, 5th Edition,Prentice-Hall of India Pvt Ltd., New Delhi
2. I.J. Nagrath and M. Gopal, Control System Engineering, 7th Edition, New age international Publishers.

Reference Book(s):

1. R.C. Dorf and R.H.Bishop, Modern Control System, Pearson, 2017.
2. B.C. Kuo, Automatic Control System, Prentice Hall, Digitized Dec 5, 2007.
3. S. Hasan Saeed, Automatic Control Systems (with Matlab Programs), Katson Books.

The CO-PO (Course Outcome to Program Outcome) matrix maps the relationship between Course Outcomes (COs) and Program Outcomes (POs). Below is a sample matrix based on typical engineering POs.

Course Outcomes (COs)	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1 (Develop mathematical models and simplify complex systems.)	**3**	**2**	**-**	**-**	**2**
CO2 (Perform time-domain analysis for transient performance.)	**2**	**3**	**-**	**-**	**-**
CO3 (Conduct frequency-domain stability analysis.)	**-**	**-**	**3**	**2**	**-**
CO4 (Design controllers and compensators for dynamic response.)	**-**	**-**	**2**	**3**	**-**
CO5 (Model and analyse state-space representations for controllability and observability.)	**2**	**-**	**-**	**-**	**3**