CONTROL SYSTEMS(EC503PC)
COURSE PLANNER
(NPTEL LINK:https://swayam.gov.in/nd1_noc20_ee62/preview)

I. COURSE OVERVIEW:

In this course it is aimed to introduce to the students the principles and applications of control systems in everyday life. The basic concept of block diagram reduction, time domain analysis solutions to time invariant systems ad also deals with the different aspects of stability analysis of systems in time domain and frequency domain.

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

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

IV. COURSE OUTCOMES: At the end of this course, students will demonstrate
1. Understand the modeling of linear-time-invariant systems using transfer function and statespace representations.
2. Understand the concept of stability and its assessment for linear-time invariant systems
3. Design simple feedback controllers.

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V. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		**Level**	**Proficiency assessed by**
PO1	An ability to apply knowledge of mathematics, science and engineering Fundamentals to the conceptualization of engineering modeling. (Fundamentals of digital communication Skills)	3	Lectures
PO2	An ability to design and conduct experiments, as well as analyze and interpret the data (Information retrieval skills)	2	Lectures, Assignments, Exams

PO3	An ability to design, implement and evaluate an electronics & communication engineering based system that meets desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability . (Creative Skills)	3	Problem Solving Seminars, Exercises
PO4	An ability to identify, formulate and apply appropriate techniques, resources to solve complex electronics & communication engineering problems (Engineering problem solving skills)	3	Lectures, Assignments, Exams
PO5	An ability to use current techniques, skills and modern engineering tools necessary to analyze electronics & communication engineering practice in digital	3	Lectures, Assignments, Workshops
PO6	An ability to apply knowledge of contemporary issues like health, Safety and legal which influences engineering design (Engineering impact assessment	3	Lectures, Assignments, Workshops
PO7	Knowledge of contemporary issues like increased use of portable devices viz., mobile devices, comm. towers etc. which influence engineering design (Social awareness	3	Lectures, Assignments, Workshops
PO8	An ability to demonstrate understanding of professional and ethical responsibilities (Professional	-	--------
PO9	An ability to function effectively as an individual and as a member or a leaders in multidisciplinary teams (Team skills)	2	Assessments Discussions
PO10	An ability to communicate effectively and efficiently both in verbal and written form (Communication	3	Lectures, Assignments,
PO11	An ability to engage in life-long learning and an understanding of the need to keep current of the developments in the specific field of practice (Continuing education awareness & Research aptitude)	3	Lectures, Assignments, Workshops
PO12	An ability to recognize the importance of professional developments by post graduate studies or facing competitive examinations that offer challenging and rewarding careers in designing. (Successful Career and Immediate Employment).	3	Problem solving, Mini project, technical seminars

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) - : None

VI. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

	PROGRAM SPECIFIC OUTCOMES	**LEVEL**	**PROFICIENCY ASSESSED BY**
PSO 1	Professional Skills: An ability to understand the basic concepts in Electronics & Communication Engineering and to apply		Lectures and

	Electronics, Communications, Signalprocessing, VLSI, Embedded systems etc., in the design and implementation of complex systems.	1	Assignments
PSO 2	Problem-solving skills: An ability to solve complex Electronics and communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.		Tutorials
PSO 3	Successful career and Entrepreneurship: An understanding of social awareness & environmental-wisdom along withethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.	3	Seminars and Projects

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

VII. SYLLABUS:

UNT - I

Introduction to Control Problem: Industrial Control examples. Mathematical models of physical systems. Control hardware and their models. Transfer function models of linear time-invariant systems. Feedback Control: Open-Loop and Closed-loop systems. Benefits of Feedback. Block diagram algebra.

UNT - II

Time Response Analysis of Standard Test Signals: Time response of first and second order systems for standard test inputs. Application of initial and final value theorem. Design specifications for secondorder systems based on the time-response. Concept of Stability. Routh-Hurwitz Criteria. Relative Stability analysis. Root-Locus technique. Construction of Root-loci.

UNT - III

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.

UNT - IV

Introduction to Controller Design: Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness of control systems. Root-loci method of feedback controller design. Design specifications in frequency-domain. Frequency-domain methods of design. Application of Proportional, Integral and Derivative Controllers, Lead and Lag compensation in designs. Analog and Digital implementation of controllers.

UNT - 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. Pole-placement by state feedback. Discrete-time systems. Difference Equations. State-space models of linear discrete-time systems. Stability of linear discrete-time systems.

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.
1. I. J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International, 2009.

NPTEL Web Course: Control System Engineering

NPTEL Video Course: Control System Engineering

Relevant Syllabus for GATE:

Control Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative (PID) control. State variable representation and solution of state equation of LTI control systems.

Relevant Syllabus for IES:

Transient and steady state response of control systems; Effect of feedback on stability and sensitivity; Root locus techniques; Frequency response analysis. Concepts of gain and phase margins: Constant-M and Constant-N Nichol's Chart; Approximation of transient response from Constant-N Nichol's Chart; Approximation of transient response from closed loop frequency response; Design of Control Systems, Compensators; Industrial controllers.

VIII Lesson Plan

Lecture No.	Unit No.	Topics to be covered	Link for PDF	Link for Small Projects/ Numericals(if any)	Course learning outcomes	Teaching Methodology	Reference
1		Introduction to Control System	https://drive.google.com/file/d/1HdfOWR3GxHA-gcG8tJVh8EyHgXKApEez/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/ PPT	
2	I	Introduction to Control System	https://drive.google.com/file/d/1HdfOWR3GxHA-gcG8tJVh8EyHgXKApEez/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**	Understanding the subject to appreciate it for engineering application	Board, Chalk/ PPT	M. Gopal, “Control Systems: Principles and Design”, McGraw Hill Education, 1997.
3		Industrial Control examples.	https://drive.google.com/file/d/1HdfOWR3GxHA-gcG8tJVh8EyHgXKApEez/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/ PPT	

4		Industrial Control examples.	https://drive.google.com/file/d/1HdfOWR3GxHA-gcG8tJVh8EyHgXKApEez/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/ PPT	
5		Mathematical models of physical systems	https://drive.google.com/file/d/1HdfOWR3GxHA-gcG8tJVh8EyHgXKApEez/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/ PPT	
6		Mathematical models of physical systems	https://drive.google.com/file/d/1Ae8XBM_R_kLCqXmM2g8gJEMd4-gw9gtt/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/ PPT	
7		Control hardware and their models	https://drive.google.com/file/d/1Ae8XBM_R_kLCqXmM2g8gJEMd4-gw9gtt/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**	To state and solve an engineering Problem	Board, Chalk/ PPT	
8		Control hardware and their models	https://drive.google.com/file/d/1Ae8XBM_R_kLC	**https://projectabstracts.com/matlab-projects-**		Board, Chalk/ PPT	

			qXmM2g8gJEMd4-gw9gtt/view?usp=sharing	**on-control-system**			
9		Transfer function models of linear time-invariant systems	https://drive.google.com/file/d/1oNa44f-10xTrtet1h9n3Ac2kzy9Hnhy-/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/ PPT	
10		Transfer function models of linear time-invariant systems	https://drive.google.com/file/d/1oNa44f-10xTrtet1h9n3Ac2kzy9Hnhy-/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**	Perform open loop and Closed loop System	Board, Chalk/ PPT	
11		Feedback Control: Open-Loop system	https://drive.google.com/file/d/1oNa44f-10xTrtet1h9n3Ac2kzy9Hnhy-/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/ PPT	
12		Feedback Control: Open-Loop system	https://drive.google.com/file/d/1oNa44f-10xTrtet1h9n3Ac2kzy9Hnhy-/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/ PPT	
13		Feedback Control: Closed-loop systems.	https://drive.google.com/file/d/1oNa44f-	**https://projectabstracts.com/matlab-**		Board, Chalk/ PPT	

			10xTrtet1h9n3Ac2kzy9Hnhy-/view?usp=sharing	projects-on-control-system			
14		Feedback Control: Closed-loop systems.	https://drive.google.com/file/d/1oNa44f-10xTrtet1h9n3Ac2kzy9Hnhy-/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/PPT	
15		Benefits of Feedback,Block diagram algebra.	https://drive.google.com/file/d/1oNa44f-10xTrtet1h9n3Ac2kzy9Hnhy-/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/PPT	
16	**II**	Introduction Time Response Analysis	https://drive.google.com/file/d/1tPodSF19vH5rbp7PBOdr8WNdbWupEoBW/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**	Understand the Time response of Control system	Board, Chalk/PPT	M. Gopal, "Control Systems: Principles and Design", McGraw Hill Education, 1997.
17		Time response of first order systems for standard test inputs.	https://drive.google.com/file/d/1tPodSF19vH5rbp7PBOdr8WNdbWupEoBW/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/PPT	
18		Time response of first order systems	https://drive.google.	**https://projectabstrac**		Board, Chalk/	

		for standard test inputs.	com/file/d/1tPodSF19vH5rbp7PBOdr8WNdbWupEoBW/view?usp=sharing	**ts.com/matlab-projects-on-control-system**		PPT	
19		Application of initial and final value theorem.	https://drive.google.com/file/d/1tPodSF19vH5rbp7PBOdr8WNdbWupEoBW/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/ PPT	
20		Application of initial and final value theorem.	https://drive.google.com/file/d/1tPodSF19vH5rbp7PBOdr8WNdbWupEoBW/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/ PPT	
21		Design specifications for second-order systems based on the time-response.	https://drive.google.com/file/d/1tPodSF19vH5rbp7PBOdr8WNdbWupEoBW/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**	Understand the various method to check the stability of control system.	Board, Chalk/ PPT	
22		Design specifications for second-order systems based on the time-response.	https://drive.google.com/file/d/1tPodSF19vH5rbp7PBOdr8WNdbWupE	**https://projectabstracts.com/matlab-projects-on-control-**		Board, Chalk/ PPT	

			oBW/view?usp=sharing	system			
23		Design specifications for second-order systems based on the time-response.	https://drive.google.com/file/d/1tPodSF19vH5rbp7PBOdr8WNdbWupEoBW/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/ PPT	
24		Concept of Stability. Routh-Hurwitz Criteria. Relative Stability analysis.	https://drive.google.com/file/d/1tPodSF19vH5rbp7PBOdr8WNdbWupEoBW/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/ PPT	
25		Concept of Stability. Routh-Hurwitz Criteria. Relative Stability analysis.	https://drive.google.com/file/d/1tPodSF19vH5rbp7PBOdr8WNdbWupEoBW/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/ PPT	
26		Root-Locus technique. Construction of Root-loci.	https://drive.google.com/file/d/1tPodSF19vH5rbp7PBOdr8WNdbWupEoBW/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/ PPT	
27		Root-Locus technique.	https://drive.google.	**https://projectabstrac**		Board, Chalk/	

		Construction of Root-loci.	com/file/d/1tPodSF19vH5rbp7PBOdr8WNdbWupEoBW/view?usp=sharing	**ts.com/matlab-projects-on-control-system**		PPT	
26		Introduction of Frequency-Response Analysis	https://drive.google.com/file/d/1tPodSF19vH5rbp7PBOdr8WNdbWupEoBW/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/ PPT	
27	**III**	Relationship between time and frequency response	https://drive.google.com/file/d/1tPodSF19vH5rbp7PBOdr8WNdbWupEoBW/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**	Understand the various method to check the stability of control system.	Board, Chalk/ PPT	I. J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International, 2009.
28		Polar plots	https://drive.google.com/file/d/1xt-z9vpw3c7c4bHR8uJGlp8jNRkpGBpp/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/ PPT	
29		Polar plots	https://drive.google.com/file/d/1xt-z9vpw3c7c4bHR8uJGlp8jNRk	**https://projectabstracts.com/matlab-projects-on-control-**		Board, Chalk/ PPT	

			pGBpp/view?usp=sharing	system			
30		Bode plots	https://drive.google.com/file/d/114MMLNVJbIWYEUrEYQ4lT8_bb3rNWaFC/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/PPT	
31		Bode plots	https://drive.google.com/file/d/114MMLNVJbIWYEUrEYQ4lT8_bb3rNWaFC/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**	Understand the various method to check the stability of control system.	Board, Chalk/PPT	I. J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International, 2009.
32		Nyquist stability criterion	https://drive.google.com/file/d/1oY4DGTi5KfM4wuDQ_ivhheCuZBFf8QII/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/PPT	
33	**III**	Nyquist stability criterion	https://drive.google.com/file/d/1oY4DGTi5KfM4wuDQ_ivhheCuZBFf8QII/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/PPT	
34		Relative stability using Nyquist	https://drive.google.	**https://projectabstrac**		Board, Chalk/	

		criterion – gain and phase margin.	com/file/d/1oY4DGTi5KfM4wuDQ_ivhheCuZBFf8QII/view?usp=sharing	**ts.com/matlab-projects-on-control-system**		PPT	
35		Closed-loop frequency response	https://drive.google.com/file/d/1oY4DGTi5KfM4wuDQ_ivhheCuZBFf8QII/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/ PPT	
35	**IV**	**Introduction to Controller Design**:	https://drive.google.com/file/d/12R5aI69UgP-XuIJaNgULdfyB8WqJX6oK/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**	Designing concept of Controllers	Board, Chalk/ PPT	I. J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International, 2009.
36		Stability, steady-state accuracy	https://drive.google.com/file/d/12R5aI69UgP-XuIJaNgULdfyB8WqJX6oK/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/ PPT	
37		Transient accuracy, disturbance rejection	https://drive.google.com/file/d/12R5aI69UgP-XuIJaNgULdfyB8W	**https://projectabstracts.com/matlab-projects-on-control-**		Board, Chalk/ PPT	

			qJX6oK/view?usp=sharing	**system**			
38		Insensitivity and robustness of control systems.	https://drive.google.com/file/d/12R5aI69UgP-XuIJaNgULdfyB8WqJX6oK/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/ PPT	
39		Root-loci method of feedback controller design.	https://drive.google.com/file/d/12R5aI69UgP-XuIJaNgULdfyB8WqJX6oK/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/ PPT	
		Root-loci method of feedback controller design.	https://drive.google.com/file/d/12R5aI69UgP-XuIJaNgULdfyB8WqJX6oK/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/ PPT	
40	**IV**	Design specifications in frequency-domain.	https://drive.google.com/file/d/12R5aI69UgP-XuIJaNgULdfyB8WqJX6oK/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**	Various compensati on Techniques	Board, Chalk/ PPT	I. J. Nagrath and M. Gopal, “Control Systems Engineering” , New Age International, 2009.

41		Frequency-domain methods of design.	https://drive.google.com/file/d/12R5aI69UgP-XuIJaNgULdfyB8WqJX6oK/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/ PPT	
42		Application of Proportional, Integral and Derivative Controllers	https://drive.google.com/file/d/12R5aI69UgP-XuIJaNgULdfyB8WqJX6oK/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/ PPT	
43		Lead and Lag compensation in designs.	https://drive.google.com/file/d/12R5aI69UgP-XuIJaNgULdfyB8WqJX6oK/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/ PPT	
45		Analog and Digital implementation of controllers.	https://drive.google.com/file/d/12R5aI69UgP-XuIJaNgULdfyB8WqJX6oK/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/ PPT	
46	**V**	Introduction: State Variable Analysis and Concepts of State Variables	https://drive.google.com/file/d/12R5aI69UgP-	**https://projectabstracts.com/matlab-projects-**	Understand and Solution of state Variable	Board, Chalk/ PPT	I. J. Nagrath and M. Gopal, “Control Systems

			XuIJaNgULdfyB8WqJX6oK/view?usp=sharing	**on-control-system**	Analysis of Control System		Engineering", New Age International, 2009.
47		State space model.	https://drive.google.com/file/d/12R5aI69UgP-XuIJaNgULdfyB8WqJX6oK/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/PPT	
48		Diagonalization of State Matrix.	https://drive.google.com/file/d/12R5aI69UgP-XuIJaNgULdfyB8WqJX6oK/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/PPT	
49		Solution of state equations.	https://drive.google.com/file/d/12R5aI69UgP-XuIJaNgULdfyB8WqJX6oK/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/PPT	
50		Solution of state equations.	https://drive.google.com/file/d/12R5aI69UgP-XuIJaNgULdfyB8WqJX6oK/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/PPT	

51		Eigen values and Stability Analysis.	https://drive.google.com/file/d/12R5aI69UgP-XuIJaNgULdfyB8WqJX6oK/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/ PPT	
52		Concept of controllability and observability.	https://drive.google.com/file/d/12R5aI69UgP-XuIJaNgULdfyB8WqJX6oK/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/ PPT	
53		Pole-placement by state feedback. Discrete-time systems.	https://drive.google.com/file/d/12R5aI69UgP-XuIJaNgULdfyB8WqJX6oK/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/ PPT	
54		Difference Equations.	https://drive.google.com/file/d/12R5aI69UgP-XuIJaNgULdfyB8WqJX6oK/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/ PPT	
55		Difference Equations.	https://drive.google.com/file/d/12R5aI69UgP-	**https://projectabstracts.com/matlab-projects-**		Board, Chalk/ PPT	

			XuIJaNgU LdfyB8W qJX6oK/v iew?usp=s haring	**on- control- system**			
56		State-space models of linear discrete-time systems.	https://drive.google.com/file/d/12R5aI69UgP-XuIJaNgULdfyB8WqJX6oK/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/ PPT	
57		State-space models of linear discrete-time systems.	https://drive.google.com/file/d/12R5aI69UgP-XuIJaNgULdfyB8WqJX6oK/view?usp=sharing	**https://projectabstracts.com/matlab-projects-on-control-system**		Board, Chalk/ PPT	

IX. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Objectives	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10		PO12	PSO1	PSO2	PSO3
I	1	2	1	1	2	1	1	-	2	1	1	1	1	2	1
II	2	1	1	1	1	2	1	-	1	1	2	1	1	1	2
III	1	2	2	2	2	1	2	-	2	2	1	2	2	1	2

IV	1	2	1	1	2	1	1	-	1	1	1	2	1	2	2
V	2	1	2	2	1	2	2	-	1	2	2	1	2	2	1
VI	1	1	2	2	1	2	2	-	1	2	2	2	2	1	1

X Question Bank:

Descriptive

UNIT – I

Short Answer Questions:

S. No	Question	Blooms taxonomy level	Course Outcomes
1	Define about open loop and closed loop control systems	Understand	1
2	What are advantages of closed loop control system compared to open loop system.	Remember	1
3	Discuss the effect of feedback on overall gain.	Remember	1
4	Why negative feedback is preferred in control systems.	Remember	1
5	Define transfer function and what are its limitations	Understand	1
6	Give the Mason's gain formula.	Understand	1

Long Answer Questions:

S. No	Question	Blooms taxonomy level	Course Outcomes
1	Discuss the characteristics of feedback in closed loop control systems.	Understand	1
2	Define the impulse response of the system. Find the impulse response of the system with open loop transfer function $G(s) = 10/(s+3)$.	Remember	1
3	Illustrate atleast two examples of feedback control systems	Understand	1
4	Give the f-v analogy of mechanical translational system and	Remember	1

	electrical system.		
5	Give the f-i of analogy mechanical rotational system and electrical system.	Understand	1
6	Derive the transfer function of the mechanical system.	Understand	1
7	Derivethedifferentialequationrelatingthepositiony(t)andthefo rcef(t)asshown infigure. Determine thetransfer function Y(s)/F(s).	Understand	1
8	Using Mason,s gain formula reduce the signal flow graph and find out transfer function of the system.	Apply	1

UNIT – II

Short Answer Questions:

S. No	Question	Blooms taxonomy level	Cour se Outc omes
1	Define Peak time, settling time, Peak overshoot.	Understand	2
2	Discuss the relation between generalized and static error coefficients	Remember	2
3	Find the type and order of the system G(S)=40/S(s+4)(s+5)(s+2)	Remember	2
4	Discuss PI, PD, and PID controller?	Remember	2
5	Define Damping ratio. How the system is classified depending on the value of damping?	Understand	2
6	What is the time response of the first order system?	Understand	2

Long Answer Questions:

S. No	Question	Blooms taxonomy level	Course Outco mes
1	a)How steady state error of a control system is determined? How it can be reduced? b) Derive the static error constants and list the disadvantages?	Understand	2
2	For a system $G(s)\,H(s) = K/\,S^2(S+2)\,(S+3)$ Find the value of K to limit steady state error to 10 when input to system is $1 + 10t + 40/2t^2$	Remember	2

3	(a)Explain error constants Kp, Kv and Ka for type I system. (b) Explain error constants Kp, Kv and Ka for type II system	Understand	2
4	(a)Explain about various test signals used in control systems? (b)Define time constant and explain its importance?	Remember	2
6	A unity feedback system is characterized by an open loop transfer function $G(s) = K/(S+10)$ Determine gain 'K' so that system will have a damping ratio of 0.5. For this value of 'K' determine settling time, peak overshoot and time to peak overshoot for a unit step input. Also obtain closed loop response in time domain	Understand	2

UNIT – III

Short Answer Questions:

S. No	Question	Blooms taxonomy level	Course Outcomes
1	Explain the method of Least Mean Squares Filtering (Wiener) for image restoration	Understand	4
2	Explain model of image degradation/restoration process with a block diagram	Apply	4
3	Explain the method of Constrained Least Squares Filtering for image restoration	Understand	4
4	Explain three principle ways to estimate the degradation function for use in image restoration	Understand	4
5	Discuss the process of image restoration by direct inverse filtering?	Understand	4
6	Write about Noise Probability Density Functions for all noise models	Understand	4

Long Answer Questions:

S. No	Question	Blooms taxonomy level	Course Outcomes
1	Define the terms (i) Absolute stability (ii) marginal stability (iii) conditional stability (iv) stable system (v) Critically	Understand	1
2	State Routh's stability criterion. State their advantages What are the limitations of Routh Hurwitz criteria?	Remember	1
3	what are the necessary conditions to have all the roots of characteristics equation in the left half of s-plane?	Understand	1
4	With the help of Routh Hurwitz criterion comments upon the stability of the system having the following characteristic equation S 6 +s5 -2s4 -3s3 -7s2 -4s-4=0	Remember	1
5	Check the stability of the given characteristic equation using Routh's method S 6 + 2S 5 + 8S 4 +12S 3 +20S 2 + 16S + 16 = 0	Understand	1
8	. (a)Explain the steps for the construction of root locus? (b)From the given root locus plot, how can you determine the gain margin and phase margin for the specified gain value 'k	Apply	1

UNIT – IV

Short Answer Questions:

S. No	Question	Blooms taxonomy level	Course Outcomes
1	Define gain margin	Understand	1
2	Define corner frequency.	Remember	1
3	What is lead compensator?	Understand	1
4	What is lag compensator??	Remember	1
5	What is lead lag controller techniques	Understand	1
6	Explain Gain cross-over frequency and phase cross-over frequency?	Apply	1

Long Answer Questions:

S. No	Question	Blooms taxonomy level	Course Outcomes

1	(a)write short notes on various frequency domain specifications (b) Derive expression for resonant peak and resonant frequency and hence establish correlation between time and frequency response	Understand	1
2	Explain the steps for the construction of Bode plot? What are the advantages of Bode Plot?	Remember	1
3	Explain with the examples (i) minimum phase function (ii) non-minimum phase function (iii) all pass function	Understand	1
4	Sketch the Bode plot for the open loop transfer function $Gs = 10(S + 3)/ S(S + 2) (S^2 + 4S + 100)$	Understand	1
5	Sketch the bode plot for a system with unity feedback having the transfer function, and assess its closed-loop stability. $Gs = 75/ S(s^2 + 16s +100)$	Understand	1
6	The open loop transfer function of a system is $G(s) = K /S (1 + S) (1 + 0.1S)$ Determine the value of K such that (i) Gain Margin = 10dB and (ii) Phase Margin = 50 degree	Remember	1
7	Given the open loop transfer function $20 /s (1+3s) (1+4S)$ Draw the Bode plot and hence the phase and gain margins	Understand	1
8	Draw the polar plot for open loop transfer function for unity feedback system	Remember	1
9	Sketch bode phase angle plot of a system $G(s)= 1 (1+s)(1+2s)$	Understand	1
10	Sketch polar plot for $G(S) = 1 /S^2 (1+s)(1+2s)$ with unity feedback system. Determine gain margin and phase margin.	Understand	1

UNIT – V

Short Answer Questions:

S. No	Question	Blooms taxonomy level	Course Outcomes
1	.What are Eigen values?	Understand	1
2	What are draw backs of transfer function model analysis	Remember	1
3	What is state, state variable and state vector?	Understand	1
4	Write properties of state transition matrix?	Remember	1

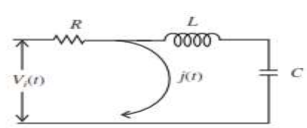
5	What are the advantages of state space analysis?	Understand	1
6	What is i/p and o/p space?	Apply	1

Long Answer Questions:

S. No	Question	Blooms taxonomy level	Course Outcomes
1	Explain the state variable and state transition matrix?	Understand	1
2	consider the differential equation system given by y +3y + 2Y = 0, y(0)=0.1,y(0)=0.05.	Remember	1
3	Write short notes on canonical form of representation .list its advantages and disadvantages?	Understand	1
4	Write properties of state transition matrix?	Understand	1
5	for the state equation x =Ax Where A= 0 1 0 3 0 2 −12 −7 −6 .	Understand	1
6	find the intial condition vector x(0) which will excite only the mode corresponding to eigen value with the most negative real part.	Remember	1

IES

1. For the network shown in figure P2.43, V_i (t) is the input and i(t) is the output. Transfer function V_i (t)/i(t) is given by



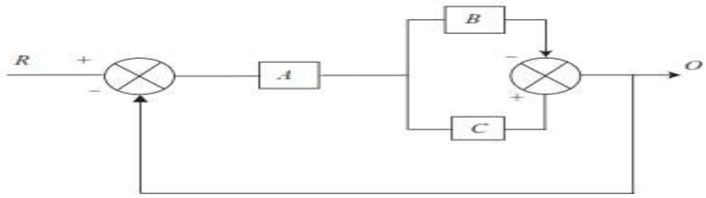
(a) $\frac{Cs}{LCs^2 + RCs + 1}$ (b) $\frac{C}{LCs^2 + RCs + 1}$

(c) $\frac{Cs}{RCs^2 + LCs + 1}$ (d) $\frac{C}{RCs^2 + LCs + 1}$

2. The transfer function of the system is given by

(a) $\frac{O}{R} = \frac{ABC}{1 + ABC}$ (b) $\frac{O}{R} = \frac{A + B + C}{1 + AB + AC}$

(c) $\frac{O}{R} = \frac{AB + AC}{ABC}$ (d) $\frac{O}{R} = \frac{AB + AC}{1 + AB + AC}$



3. In regeneration feedback the transfer function is given by

(a) $\frac{G(s)}{R(s)} = \frac{G(s)}{1 + G(s)H(s)}$ (b) $\frac{G(s)}{R(s)} = \frac{G(s)H(s)}{1 - G(s)H(s)}$

(c) $\frac{G(s)}{R(s)} = \frac{G(s)H(s)}{1 + G(s)H(s)}$ (d) $\frac{G(s)}{R(s)} = \frac{G(s)}{1 - G(s)H(s)}$

4. Type of the system depends on the

(a) No. of its poles (b) Difference between the no. of poles and zeros
(c) No. of its real poles (d) No. of poles it has at the origin

5. A system has the following transfer function

$$G(s) = \frac{100(s + 5)(s + 50)}{s^4(s + 10)(s^2 + 3s + 10)}$$

The type and order of the system are respectively

(a) 4 and 9 (b) 4 and 7
(c) 5 and 7 (d) 7 and 5

6. The step response of the system is $c(t) = 1 - 5e^{-t} + 10e^{-2t} - 6e^{-3t}$. Then the impulse response is

(a) $5e^{-t} - 20e^{-2t} + 18e^{-3t}$ (b) $5e^{t} - 20e^{2t} + 18e^{-3t}$
(c) $5e^{-t} + 20e^{-2t} + 18e^{-3t}$ (d) $5e^{-t} + 20e^{-2t} - 18e^{-3t}$

7. Given a unity feedback with $G(s) = \frac{K}{s(s + 4)}$
The value of K for the damping ratio of 0.5 is
(a) 1 (b) 16 (c) 4 (d) 2

8. A unity feedback control system has forward path transfer function G(s) is given by $G(s) = \frac{10(1 + s)}{s^2(s + 1)(s + 5)}$. The steady state error due to unit parabolic input $r(t) = \frac{t^2}{2}U(t)$ is
(a) 0 (b) 0.5 (c) 1 (d) Infinite

9. If the time response of a system is given by the following expression

$$y(t) = 5 + 3\sin(\omega t + \delta_1) + e^{-3t}\sin(\omega t + \delta_2) + e^{-5t}$$

Then the steady state part of the above response is given by

(a) $5 + 3\sin(\omega t + s_1)$ (b) $5 + 3\sin(\omega t + \delta_1) + e^{-3t}\sin(\omega t + \delta_2)$

(c) $5 + e^{5t}$ (d) 5

10. The impulse response of a system is $5e^{-10t}$, its step response is equal to

(a) $0.5e^{-10t}$ (b) $5(1 - e^{-10t})$

(c) $0.5(1 - e^{-10t})$ (d) $10(1 - e^{-10t})$

11. The transfer function of a system is 10/((1+s) when operated as unity feedback system, the steady state error to unit step input is

(a) 0 (b)1/11 (c) 10 (d) Infinity

12. Which of the following gives the steady state error for a unity feedback system excited by

$u_s(t) + tu_s(t) + t^2\frac{u_s}{2}$

(a) $\frac{1}{2+K_p} + \frac{1}{K_v} + \frac{1}{K_a}$ (b) $\frac{1}{1+K_p} + \frac{1}{K_v} + \frac{2}{K_a}$

(c) $\frac{1}{K_p} + \frac{1}{K_v} + \frac{1}{K_a}$ (d) $\frac{1}{1+K_p} + \frac{1}{K_v} + \frac{1}{K_a}$

13. The steady state error due to a ramp input for a type-2 system, is equal to

(a) Zero (b) Infinite

(c) Non-zero number (d) Constant

14. The steady state error due to a ramp input for a type-1 system, is equal to

(a) $2\xi\omega_n$ (b) $2\xi/\omega_n$

(c) $4\xi/\omega_n$ (d) None of these

15. Which of the following is the steady-state error of a control system with step-error, ramp-error and parabolic-error constants K_p, K_v, K_a , respectively for the input $(1 - t^2)3\mu(t)$

(a) $\frac{3}{1+K_p} - \frac{3}{2K_a}$ (b) $\frac{3}{1+K_p} + \frac{6}{K_a}$

(c) $\frac{3}{1+K_p} - \frac{3}{K_a}$ (d) $\frac{3}{1+K_p} - \frac{6}{K_a}$

16. A control system, having a unit damping factor, will give

(a) A critically damped response (b) An oscillatory response

(c) An undamped response (d) No response

17. Principles of homogeneity and superposition are applied to

(a) Linear time-variant systems (b) Nonlinear time-variant systems

(c) Linear time-invariant system (d) Nonlinear time-invariant systems

18. The transfer system of a control system is given as

$$T(s) = \frac{K}{x^2 + 4s + K}$$

where K is the gain of the system in radians/amp. For this system to be critically damped,

the value of K should be

(a) 1 (b) 2 (c) 3 (d) 4

19. The response c(t) to a system is described by the differential equation

$$\frac{d^2c(t)}{dt^2} + 4\frac{dc(t)}{dt} + 5c(t) = 0$$

The system response is:
(a) Undamped (b) Underdamped
(c) Critically damped (d) Oscillatory

20. The open-loop transfer function of a unity-feedback control system is given by

$$G(s) = \frac{K}{s(s+1)}$$

If the gain K is increased to infinity, then the damping ratio will tend to become

(a) Zero (b) 0.707 (c) Unity (d) Infinity

21. A second-order system exhibits 100% overshoot. Its damping coefficient is:

(a) Equal to 0 (b) Equal to 1 (c) Less than 1 (d) Greater than 1

22. In the type-1 system, the velocity error is:

(a) Inversely proportional to the bandwidth of the system

(b) Directly proportional to gain constant

(c) Inversely proportional to gain constant

(d) Independent of gain constant

23. A second-order system has the damping ratio ξ and undamped natural frequency of oscillation ω_n. The settling time at 2% tolerance band of the system is

(a) $\frac{2}{\xi\omega_n}$ (b) $\frac{3}{\xi\omega_n}$

(c) $\frac{4}{\xi\omega_n}$ (c) $\xi\omega_n$

24. When the time period of an observation is large, the type of error is:

(a) Transient error (b) Steady-state error

(c) Half-power error (d) Position-error constant

25. An underdamped second-order system with negative damping will have the two roots:

(a) On the negative real axis as real roots

(b) On the left-hand side of the complex plane as complex roots

(c) On the right-hand side of the complex plane as complex conjugates

(d) On the positive real axis as real roots

26. Which of the following expresses the time at which second peak in step response occurs for a second-order system?

(a) $\frac{\pi}{\omega_n\sqrt{1-\xi^2}}$ (b) $\frac{2\pi}{\omega_n\sqrt{1-\xi^2}}$

(c) $\frac{3\pi}{\omega_n\sqrt{1-\xi^2}}$ (d) $\frac{\pi}{\sqrt{1-\xi^2}}$

27. If the characteristic equation of a closed-loop system is $s^2 + 2s + 2 = 0$, then the system is

(a) Overdamped (b) Critically damped (c) Underdamped (d) Undamped

28. For making an unstable system stable:

(a) Gain of the system should be increased.

(b) Gain of the system should be decreased.

(c) The number of zeros to the loop transfer function should be increased.

(d) The number of poles to the loop-transfer function should be increased.

29. While forming a Routh's array, the situation of a row zeros indicates that the system:

(a) Has symmetrically located roots

(b) Is not sensitive to variations in gain

(c) Is stable (d) Is Unstable

30. When all the roots of the characteristic equation are found in the left of an s-plane, the response due to the initial condition will:

(a) Increase to infinity as time approaches infinity

(b) Decrease to zero as time approaches infinity

(c) Remain constant for all time

(d) Be oscillating

31. The Routh–Hurwitz criterion cannot be applied when the characteristic equation of the system contains any coefficients which are:

(a) Negative real and exponential functions of s

(b) Negative real, both exponential and sinusoidal functions of s

(c) Both exponential and sinusoidal functions of s

(d) Complex, both exponential and sinusoidal functions of s

32. Consider the following statements: Routh–Hurwitz criterion gives

1. Absolute stability

2. The number of roots lying on the right half of the s-plane.

3. The gain margin and phase margin

Which of the statements are correct?

(a) 1, 2 and 3 (b) 1 and 2

(c) 2 and 3 (d) 1 and 3

33. A system has a single pole at the origin. Its impulse response will be:

(a) Constant (b) Ramp (c)Decaying exponential (d) Oscillatory

34. The open-loop transfer function of a unity-feedback control system is

$$G(s) = \frac{K(s+10)(s+20)}{s^2(s+2)}$$

The closed-loop system will be stable, if the value of K is:

(a) 2 (b) 3 (c) 4 (d) 5

35. Which one of the following application software is used to obtain an accurate root locus plot?

(a) LISP (b) MATLAB (c) dBASE (d) Oracle

36. The intersection of root locus branches with the imaginary axis can be determined by use of:

(a) Nyquist criterion (b) Routh's criterion
(c) Polar plot (d) None of above

36. Which of the following is not necessarily valid for root-locus pattern?

(a) The n finite zeros and m poles are plotted on the s-plane. Then (m – n) indicates the number of non-finite zeros.

(b) The number of poles gives the number of loci.

(c) A value of s on the real axis is a point on the root locus, if the total number of poles and zeros on the real axis to the right of the point is even.

(d) There are as many asymptotes as non-finite zeros.

37. An open-loop transfer function of a feedback system has m poles and n zeros (m > n). Consider the following statements:

1. The number of separate root loci is m.

2. The number of separate root loci is n.

3. The number of root loci approaching infinity is (m _ n).

4. The number of root loci approaching infinity is (m þ n).

Which of the statements given above are correct?

(a) 1 and 4 (b) 1 and 3

(c) 2 and 3 (d) 2 and 4

38. Which of the following effects are correct in respect of addition of a pole to the system loop transfer function?

1. The root locus is pulled to the right.

2. The system response becomes slower.

3. The steady state error increases.

Of these statements:

(a) 1 and 2 are correct. (b) 1, 2 and 3 are correct.

(c) 2 and 3 are correct. (d) 1 and 3 are correct.

39. The instrument used for plotting the root locus is called:

(a) Slide rule (b) Spirule (c) Synchro (d) Selsyn

40. Consider the following statements: In root-locus plot, the breakaway points:

1. Need not always be on the real axis alone

2. Must lie on the root loci

3. Must lie between 0 and_1

Which of these statements are correct?

(a) 1, 2 and 3 (b) 1 and 2 (c) 1 and 3 (d) 2 and 3

41. Which of the following is not the property of root loci?

(a) The root locus is symmetrical about jω axis.

(b) They start from the open-loop poles and terminate at the open-loop zeros.

(c) The breakaway points are determined from dK/ds =0.

(d) Segments of the real axis are part of the root locus, if and only if the total number of real poles and zeros to their right is odd.

42. The characteristic equation of a feedback control system is given by

$$s^3 + 5s^2 + (K+6)s + K = 0$$

In a root-loci diagram, the asymptotes of the root loci for large K meet at a point in the s-plane, whose coordinates are:

(a) (2, 0) (b) (1, 0) (c) (-2, 0) (d) (-3, 0)

43. Which of the following are the characteristics of the root locus of

$$G(s)\,H(s) = \frac{K(s+5)}{(s+1)(s+3)}$$

1. It has one asymptote. 2. It has intersection with jv-axis.

3. It has two real axis intersections. 4. It has two zeros at infinity.

Select the correct answer using the codes given below:

(a) 1 and 2 (b) 2 and 3 (c) 3 and 4 (d) 1 and 3

44. Given a system represented by equation

$$\mathbf{X} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u, \quad \mathbf{Y} = [1 \quad 0]\, x$$

The equivalent transfer function representation G(s) of the system is:

(a) $G(s) = \dfrac{1}{s^2 + 5s + 2}$ (b) $G(s) = \dfrac{1}{s^2 + 3s + 2}$

(c) $G(s) = \dfrac{3}{s^2 + 3s + 2}$ (d) $G(s) = \dfrac{2}{s^2 + 2s + 2}$

45. A system is described by state equation

$$\begin{bmatrix} X_1 \\ X_2 \end{bmatrix} = \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u$$

The state transition matrix of the system is:

(a) $\begin{bmatrix} e^{2t} & 1 \\ 0 & e^{2t} \end{bmatrix}$ (b) $\begin{bmatrix} e^{-2t} & 0 \\ 0 & e^{-t} \end{bmatrix}$

(c) $\begin{bmatrix} e^{2t} & 1 \\ 0 & e^{2t} \end{bmatrix}$ (d) $\begin{bmatrix} e^{-2t} & 1 \\ 0 & e^{-2t} \end{bmatrix}$

46. The state equation of a system is $\mathbf{x} = \begin{bmatrix} 0 & 1 \\ -20 & -9 \end{bmatrix} \mathbf{x} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$

The poles of this system are located at:

(a) -1,-9 (b) -1, -20 (c) -4, -5 (d) -9, -20

47. The state space representation of a system is given by:

$$\mathbf{X} = \begin{bmatrix} -1 & 0 \\ 0 & -2 \end{bmatrix} X + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u \quad \text{and} \quad \mathbf{Y} = \begin{bmatrix} 1 \\ 1 \end{bmatrix} X$$

Then the transfer function of the system is:

(a) $\frac{1}{s^2 + 3s + 2}$ (b) $\frac{1}{s + 2}$

(c) $\frac{s}{s^2 + 3s + 2}$ (d) $\frac{1}{s + 1}$

48. For the minimum phase system to be stable:

(a) Phase margin should be negative and gain margin should be positive.

(b) Phase margin should be positive and gain margin should be negative.

(c)Both phase margin and gain margin should be positive.

(d) Both phase margin and gain margin should be negative.

49. With negative feedback in a closed-loop control system, the system sensitivity to parameter

variations:

(a) Increases (b) Decreases (c) Becomes zero (d) Becomes infinite

50. Consider the following statements with regard to the bandwidth of a closed-loop system:

1. In a system, where the low-frequency magnitude is 0 dB on the Bode diagram, the bandwidth is measured at the -3-dB frequency.

2. The bandwidth of the closed-loop control system is a measurement of the range of fidelity of response of the systems.

3. The speed of response to a step input is proportional to the bandwidth.

4. The system with the larger bandwidth provides a slower step response and lower fidelity ramp response.

Which of the statements give above are correct?

(a) 1, 2 and 3 (b) 1, 2 and 4 (c) 1, 3 and 4 (d) 2, 3 and 4

GATE

1. A state variable system $\mathbf{X}(t) = \begin{bmatrix} 0 & 1 \\ 0 & -3 \end{bmatrix} X(t) + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u(t)$ with the initial condition $\mathbf{X}(0) = [-1 \quad 3]^{T}$ and the unit step input u(t) has the state transition equation

(a) $\begin{bmatrix} 1 & \frac{1}{3}(1 - e^{-3t}) \\ 0 & e^{-3t} \end{bmatrix}$ (b) $\begin{bmatrix} 1 & \frac{1}{3}(e^{-t} - e^{-3t}) \\ 0 & e^{-t} \end{bmatrix}$

(c) $\begin{bmatrix} 1 & \frac{1}{3}(e^{-t} - e^{-3t}) \\ 0 & e^{-3t} \end{bmatrix}$ (d) $\begin{bmatrix} 1 & (1 - e^{-t}) \\ 0 & e^{-t} \end{bmatrix}$

2. Given the homogenous state space equation $X = \begin{bmatrix} -3 & 1 \\ 0 & -2 \end{bmatrix}$ the steady state value of $X_{ss} = \lim_{t \to \infty} x(t)$ given the initial value of $X(0) = [10, -10]^{T}$ is

(a) $X_{ss} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$ (b) $X_{ss} = \begin{bmatrix} -3 \\ -2 \end{bmatrix}$

(c) $X_{ss} = \begin{bmatrix} -10 \\ 10 \end{bmatrix}$ (d) $X_{ss} = \begin{bmatrix} \infty \\ \infty \end{bmatrix}$

3. The state variable equations of a system are: 1. $x_1 = -3_{x1-x2} + 2$ 2. $x_2 = 2_{x1}$ The system is

(a) Controllable but not observable (b) Observable but not controllable

(c) Neither controllable nor observable (d) Controllable and observable

4. The transfer function, $Y(s)/U(s)$, of a system described by the state equations $x(t) = -2x(t) + 2u(t)$

and $y(t) = 0.5x(t)$ is

(a) $0.5/(s-2)$ (b) $1/(s-2)$
(c) $0.5/(s+2)$ (d) $1/(s+2)$

5. If the compensated system shown in Figure P7.50 has a phase margin of 60 at the crossover frequency of 1 rad/sec, then the value of the gain K is:

(a) 0.366 (b) 0.732(c)1.366 (d) 2.738

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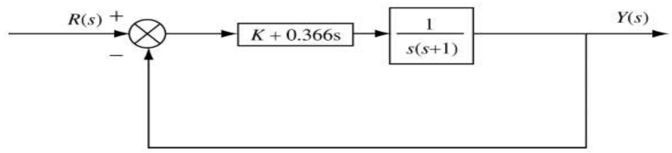


Figure P7.50 Figure for Objective Question 175.

6. In the GH (s) plane, the Nyquist plot of the loop-transfer function $G(s)H(s) = \frac{\pi e^{-0.25}}{s}$ passes through the negative real axis at the point:

(a) $(-0.25, j0)$ (b) $(-0.5, j0)$
(c) $(-1, j0)$ (d) $(-2, j0)$

7. The gain margin of a unity-feedback control system with the open-loop transfer function $G(s) = \frac{s+1}{s^2}$ is:

(a) 0 (b) 1/√2 (c)√2 (d) α

8. The open-loop transfer function of a unity feedback control system is given as

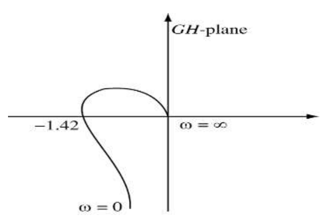
$G(s) = \frac{as+1}{s^2}$ The value of a to give a phase margin of 45 is equal to:

(a) 0.141 (b) 0.441 (c) 0.841 (d) 1.141

9. The Nyquist plot of a loop transfer function G(s)H(s) of a closed-loop control system passes through the point (-1, j0) in the G(s)H(s) plane. The phase margin of the system is:

(a) 0 (b) 45 (c) 90 (d) 180

10. The polar plot of a type -1, 3 pole, open-loop system is shown in Figure P7.49. The closed-loop system is:



(a) Always stable (b) Marginally stable
(c) Unstable with one pole on the right half s-plane
(d) Unstable with two poles on the right half s-plane

11. The Nyquist plot of G(jω)H(jω) for a closed control system passes through the (-1, j0) point in the GH-plane. The gain margin of the system in dB is equal to:

(a) Infinite (b) Greater than zero (c) Less than zero (d) Zero

12. A unity-feedback system has the open-loop transfer function $G(s) = \frac{1}{(s+2)(s-1)(s+3)}$

The Nyquist plot of G encircles the origin:

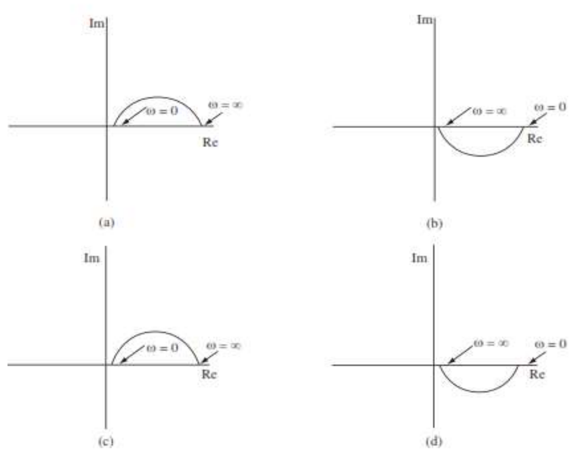
(a) Never (b) Once (c) Twice (d) Thrice

13. The gain and phase crossover frequencies in rad/sec are respectively:

(a) 0.632 and 1.26 (b) 0.632 and 0.485

(c) 0.485 and 0.632 (d) 1.26 mA and 0.632 V

14. Which of the following polar diagrams corresponds to a lag network?



15. The system with the open-loop transfer function $G(s)H(s) = \frac{1}{s(s^2+s+1)}$ has a gain margin of:

(a) -6dB (b)0dB (c) 3.5 dB (d) 6 dB

16. The gain margin and the phase margin of a feedback system with $G(s)H(s) = \frac{s}{(s+100)^3}$ are:

(a) 0 dB, 08 (b) α, α (c) α; 0 (d) 88:5dB; α

17. Non-minimum phase-transfer function is defined as the transfer function, which has:

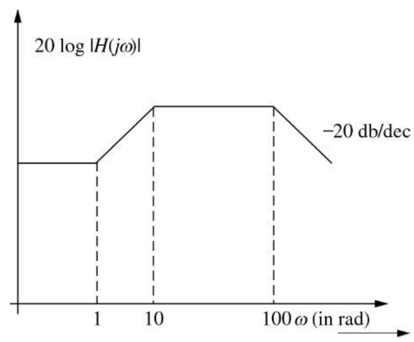
(a) Zeros in the right-hand s-plane (b) Zeros only in the right-half s-plane

(c) Poles in the right-half s-plane (d) Poles in the left-half s-plane

18. In the Bode plot of a unity-feedback control system, the value of phase of G(jω) at the gain crossover frequency is -125, the phase margin of the system is:

(a) -125 (b) -55 (c) 55 (d) 125

19. Consider the Bode-magnitude plot shown in Figure P7.21.



The transfer function $H(s)$ is:

(a) $\frac{s+10}{(s+1)(s+100)}$ (b) $\frac{10(s+1)}{(s+1)(s+100)}$

(c) $\frac{10^2(s+1)}{(s+10)(s+100)}$ (d) $\frac{10^3(s+100)}{(s+1)(s+10)}$

20. For a system with the transfer function $H(s) = \frac{3(s-2)}{4s^2-2s+1}$ the matrix A in the state-space form X = AX + Bu is equal to:

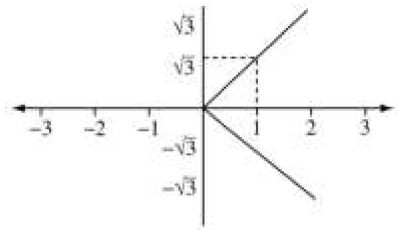
(a) $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ -1 & 2 & -4 \end{bmatrix}$ (b) $\begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & 2 & -4 \end{bmatrix}$

(c) $\begin{bmatrix} 0 & 1 & 0 \\ 3 & -2 & 1 \\ 1 & -2 & 4 \end{bmatrix}$ (d) $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \\ -1 & 2 & -4 \end{bmatrix}$

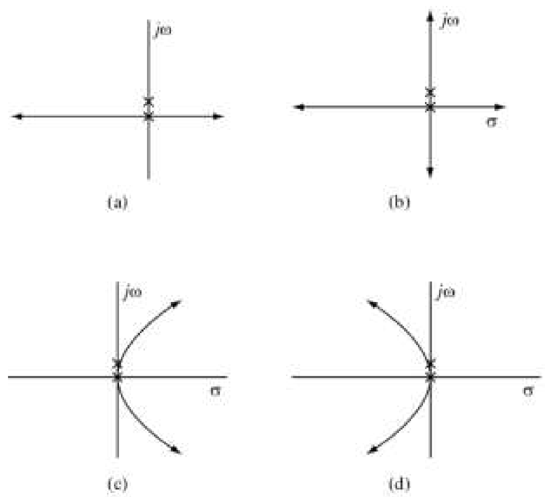
21.Figure P6.32 shows the root-locus plot (location of poles not given) of a third-order system whose open-loop transfer function is:

(a) $\frac{K}{s^3}$ (b) $\frac{K}{s^2(s+1)}$

(c) $\frac{K}{s(s^2+1)}$ (d) $\frac{K}{s(s^2-1)}$



22. A unity-feedback system has an open-loop transfer function, $G(s)=K/s^2$: The root loci plot is:



Websites

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- www.wikipedia.com
- www.wikibooks.org
- www.google.com

Expert Details

- Prof. M. Gopal, Department of Electrical Engineering, IIT Delhi
- Prof. S.D. Agashe, Department of Electrical Engineering, IIT Bombay

- Prof. S. Majhi, Department of Electrical Engineering, IIT Guwahati
- Dr. IndraniKar, Department of Electrical Engineering, IIT Guwahati

Journals

- *IEEE Control Systems Magazine*
- International Journal of Systems, Control and Communications
- The International Journal of INTELLIGENT CONTROL AND SYSTEMS
- ICGST International Journal on Automatic Control and System Engineering
- Journal of Control Engineering and Technology

Student Seminar Topics

1. Cocept of CorolSstems
2. Mathematical Modelling of Cotrol Systems
3. Block Diagram reduction Techniques
4 Sigal flow Graph.
5. Time Respose Analysis
6. Time Domain Specifications
7. FrequecyRespose Analysis
8. State Space Analsis
9. Root Locus Techniqes
10. Nquist Plots
11. Bode Plots
12. Cocept of stability

Case Studies:

1. Study of Stability Analysis in Time Domain.
2. Study of Stability Analysis in Frequency Domain.
3. Study of State Space Analysis.
4. Study of Advanced Control Systems.