GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering
Level: PG
Branch: Power Electronics
Course / Subject Code: ME01000271

Subject Name: Advanced Control System

w. e. f. Academic Year:	2024-25
Semester:	1st Semester
Category of the Course:	PEC

Prerequisite:	NA
Rationale:	The course is aimed to enhance the ability of student to analyze and control the multiple domain systems using advanced control techniques and tools related to control systems

Course Outcome:

After Completion of the Course, the student will able to:

No	Course Outcomes
01	Students will be able to develop mathematical models for controlling system behaviour
02	Students will be able to control the systems with nonlinear behaviors.
03	Students will learn fundamentals and applications of control theory for multi-disciplinary
04	Students will learn fundamentals of intelligent/smart control systems used in automation

Teaching and Examination Scheme:

Teaching Scheme in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightag
1.	**Design and Analysis of Compensation Techniques** • Performance specifications, design considerations in time and frequency domain, lead, lag and lead-lag compensation based on root locus and frequency response approaches, Effect of load disturbance upon control	7	15

2.	**State-Space Analysis of Control Systems** • Limitations of conventional control theory, state-variables and state Model, state Models for Linear Continuous-Time Systems, solution of homogeneous and non-homogeneous state equations in time-domain and frequency-domain, Controllability and Observability, state transition matrix, transfer matrix, Multivariable Systems, Solution of the Linear Time Invariant State Equations	10	30
3.	**Phase Plane and Lyapunov Stability Analysis:** • Phase plots: Concepts- Singular points – Classification of singular points, Definition of stability- asymptotic stability and instability. Construction of phase trajectories using the Isocline method for linear and nonlinear systems. Lyapunov stability analysis: Lyapunov function- Lyapunov methods to stability of nonlinear systems- Lyapunov methods	07	10
4.	**Digital Control Systems:** • Digital Systems, A/D Conversion and the z-Transform, Discrete time systems, stability analysis in Z-plane. Pulse Transfer, Functions of SISO Systems, Frequency Response of SISO Digital, Systems, Stability of SISO Digital Systems, Performance of SISO Digital, Systems, Closed-Loop Compensation Techniques for SISO Digital, Systems.	10	25
5.	**Modern Control concepts** • H_2, H∞ Robust control, Structured Singular Value Synthesis for Robust, Control, Time-Optimal Control with Pre-shaped Inputs, Output-Rate, Weighted Linear Optimal Control, Nonlinear Optimal Control.	07	10
6.	**Introduction to Adaptive Control System:** • Definition of adaptive control system, functions of adaptive, control, gain scheduling, model reference, series and parallel, schemes and their industrial applications.	04	10
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (%)					
R Level	U Level	A Level	N Level	E Level	C Level
40	20	20	20	0	0

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

Sr. No.	Title
1	Ashish Tiwari." Modern Control Design- with MATLAB and SIMULINK", John Wiley & Sons, Ltd., 2002
2	K. Ogata, "Modern Control Engineering", PHI, 2010.
3	B. C. Kuo, "Automatic Control System", Wiley, 2009.
4	L. J. Nagrath & M. Gopal , " Control Systems Engineering" , New Age International Publishers, 2009.
5	Control Systems Engineering ; By Norman S. Nise,

(b) Open source software and website:

1. https://nptel.ac.in/
2. www.scilab.org/

Suggested Course Practical List:

Sr. No.	
1	Phase-Lead Controller
2	Phase-Lag Controller
3	State Space Models and Analysis series/parrlel
4	Pulse Transfer Function
5	Digital Control of system
6	Phase Plane method
7	H∞ Control

In addition to above experiments, the other experiments can be added related to the syllabus. A small project work related to the subject should be assigned.

List of Laboratory/Learning Resources Required:

PC with internet facility and MATLAB/SCILAB software

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