GUJARAT TECHNOLOGICAL UNIVERSITY

MECHATRONICS (47)

ADVANCE CONTROL SYSTEMS

SUBJECT CODE: 2714702

SEMESTER: I

Type of course: Engineering

Prerequisite: NA

Rationale: The course intends to provide foundations related to control engineering to graduate students. The course should enhance their ability to analyse and control multiple domain systems using techniques and tools related to control systems**.**

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks		Practical Marks				
				ESE (E)	PA (M)	PA (V)		PA (I)		
						ESE	OEP	PA	RP	
4	0	2	5	70	30	20	10	20	0	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
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	10	19
2	**DISCRETE TIME SYSTEMS** Introduction to discrete time systems, analog and digital controllers, the z-transform, basic definition of z-transform, derivation of z-transform of standard functions, difference equation and its solution by the z-transform method, initial and final value theorem, inverse z-transform using infinite series and partial fraction methods, pulse transfer function, pulse transfer function of closed-loop system using signal flow graph technique, stability analysis in z-plane	12	23
3	**STATE-SPACE ANALYSIS OF CONTROL SYSTEMS** Limitations of conventional control theory, state-variables and state vectors, state-space representation of higher order systems with forcing functions, solution of homogeneous and non-homogeneous state equations in time-domain and frequency-domain, matrix exponential, state-transition matrix, transfer matrix	10	19
4	**NONLINEAR SYSTEM ANALYSIS** Introduction to nonlinear systems, standard nonlinearities in control systems, Describing function analysis of nonlinear control systems, stability of sustained oscillations or limit cycle. Concepts of phase plane analysis, phase plane portraits, phase plane analysis of linear and nonlinear	12	23

	control system, Lyapunov stability theorems, Lyapunov functions for nonlinear systems		

Reference Books:

1. M. Gopal, "Control Systems: Principles and Design" (3rd Edition), TMH.
2. M. Gopal, "Digital control and state-variable methods" (3rd Edition), TMH.
3. B. C. Kuo, "Automatic control systems", PHI.
4. Norman Nise, "Control System Engineering", Wiley India Edition

Course Outcome:

After learning the course the students will be able to:

1. Students will be able to develop mathematical models for controlling system behaviour.
2. Students will be able to control the systems with nonlinear behavious.
3. Students will learn fundamentals and applications of control theory for multidisciplinary engineering problems.
4. Students will learn fundamentals of intelligent/smart control systems used in automation

List of Experiments:

1. To study about Phase-Lead Controller.
2. To study about Phase-Lag Controller.
3. To study about effect of Non-linearity in stable Control systems.
4. Phase-plane trajectory for Non-linear control systems.
5. To study about Z-Transform and its properties.
6. To study about stability analysis of Discrete-time Control Systems.
7. State-Space Analysis study with respect to Transfer function method for Stable Control Systems
8. To study about fuzzy control Systems.
9. To study about Neural Control Systems.
10. Practical Application Development (Mini project)

Open Ended Problems:

Students may carry out analysis of specific application based intelligent control system with its mathematical analysis and feedback control system. Control system analysis may be of a linear, nonlinear or discrete category and can be carried out using any simulation software

Major Equipments:

1. All these experimental study with Software Tool: MATLAB.
2. MATLAB contains Control Systems Toolbox, Digital Signal Processing Toolbox, Fuzzy Toolbox, Neural Toolbox.
3. Control Experiment Equipment: PID Control, Non-linear Control Systems, Discrete-time Control Systems

List of Open Source Software/learning website:

Demo versions of MATLAB and other control theory related softwares are available free of cost for limited periods