

GUJARAT TECHNOLOGICAL UNIVERSITY
MECHATRONICS
ADVANCE CONTROL SYSTEMS (Programme Elective – I)
SUBJECT CODE: 3714702
M.E. 1st SEMESTER

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 C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE(E)	PA (M)	PA (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

SR. NO.	CONTENT	TOTAL HRS	% WEIGHTAGE
1	INTRODUCTION: ADVANCE CONTROL SYSTEMS Requirements of Advance Control Systems, Various Advance Control Systems Techniques, Performance Measure for Control Systems, Time & Frequency Domain Design, Outline of various compensation techniques: Pahse-Lead, Phase-Lag, Phase-Lead-Lag, P/PI/PD/PID controllers.	6	15
2	NONLINEAR CONTROL SYSTEMS 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 control system, Lyapunov stability theorems, Lyapunov functions for nonlinear systems.	10	25
3	DIGITAL / DISCRETE TIME CONTROL SYSTEMS Introduction to discrete time systems, Analog and digital controllers, 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	25

4	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	25
5	INTELLIGENT CONTROL SYSTEMS Fuzzy control systems, Neural Network based control, Adaptive Control Systems, Model reference Adaptive Control, Reinforcement Learning Control, Embedded Control Systems	4	10

Reference Books:

1. M. Gopal, "Control Systems: Principles and Design" (4th Edition), TMH.
2. M. Gopal, "Digital control and state-variable methods" (4th Edition), TMH.
3. Norman Nise, "Control System Engineering", Wiley India Edition
4. D. White and D. Sofge, editors. Handbook of Intelligent Control: Neural, Fuzzy and Adaptive Approaches, Van Nostrand Reinhold, New York,

Course Outcome:

After learning the course the students will be able to:

1. Develop mathematical models for controlling system behaviour.
2. Control the systems with nonlinear behaviours.
3. Learn fundamentals and applications of Advance control theory for multidisciplinary engineering problems.
4. Learn fundamentals of intelligent/smart control systems used in automation.

List of Experiments:

1. Introduction to MATLAB & SIMULINK, and Control System Toolbox.
2. To study about Phase-Lead / 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 / OEP)

Major Equipment:

1. All these experimental study with Software Tool: MATLAB.
2. MATLAB contains Control Systems Toolbox, Digital Signal Processing Toolbox, Fuzzy Toolbox, and 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 soft wares are available free of cost for limited periods.