

GUJARAT TECHNOLOGICAL UNIVERSITY

INSTRUMENTATION & CONTROL ENGINEERING (17)

Advance Control Theory

SUBJECT CODE: 2181705

B.E. 8th SEMESTER

Type of course: Core Engineering

Prerequisite: Basic of process control loop, Control systems design

Rationale: To meet the requirement of control speed and complexity, the complex system demands for modern control theories. In this subject, as the name suggest, the advance theory of control engineering and their possible applications are to be explored so that the modern control theory can be applied to improve the performance of the systems. This subject may be useful for those who aspire for the post graduation.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks						Total Marks
L	T	P		Theory Marks			Practical Marks			
			ESE (E)	PA(M)		ESE (V)		PA (I)		
PA	ALA	ESE		OEP						
4	0	2	6	70	20	10	20	10	20	150

Content:

S. N.	Content	Total Hrs	% Weight age
1	Discretization of continuous systems, sampling theorem, z transform, zero order hold, convert transfer function, continuous to discrete domain, mapping between s and z domain, stability criteria in z- domain. Effect of sample time on systems stability. Root locus for discrete time systems stability.	10	21
2	Converting of continuous time state space systems to discrete time state space, State space analysis and design of discrete time systems, stability in state space, design of state feedback controller, state observer design. Digital implementation of PID controller	10	21
3	Introduction to nonlinear systems. Types of common nonlinearities, Stability of nonlinear systems, describing functions analysis, limit cycles, phase plane analysis, phase trajectories.	10	21
4	Fuzzy logic applications in control systems, fuzzification and de-fuzzification, membership functions	08	16
5	Introduction to Multivariable Systems, interaction and decoupling, Relative Gain Array, stability of multivariable systems. Two degree of freedom controller design for SISO system in continuous and discrete domain.	10	21

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
7	14	14	14	21	-

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Discrete Time Control Systems *by* K. Ogata, PHI
2. Modern Control Engineering *by* K.Ogata, 2nd edition, PHI
3. Fuzzy Logic with engineering applications *by* Timothy Ross, Wiley, 2010
4. Digital Control & State variable methods *by* M. Gopal, Tata MC Graw Hill, 2003.
5. Digital Control Systems *by* Kuo, 2nd edition, Oxford
6. Process Systems Analysis and Control *by* Donald Coughanowr, MC Graw Hill, 2nd edition, 1995
7. Digital Control *by* R Kannan Moudgalya, Wiley India

Course Outcome:

After learning this course, the students should be able to:

- CO1. carry out modeling of discrete systems in state space
- CO2. evaluate programming strategies in the domain of control systems
- CO3. design modern control systems with computer simulation

List of Experiments:

(Following practicals are recommended but they are not limited for modifications and or alterations by the faculty member/s teaching the particular subject. The use of MATLAB or SCILAB or equivalent software is suggested.)

- 1 Modeling of continuous and discrete time system using Matlab/Scilab.
- 2 Discretize the continuous system in to z transform using Matlab/Scilab.
- 3 Analysis of effect of sampling time in z transform using Matlab/Scilab/simulink.
- 4 Root locus analysis of control system model in z-domain using Matlab/Scilab.
- 5 Time Response analysis of control system in continuous and discrete domain using Matlab/Scilab.
- 6 State space representation of continuous system in to discrete time using Matlab/Scilab.

- 7 Analyze the effect of sampling on discrete time state space using Matlab/Scilab.
- 8 Find stability of discrete time state space model using Eigen value analysis and plot its state response using Matlab/Scilab/simulink.
- 9 Design state feedback controller for the discrete time state space model using Matlab/Scilab.
- 10 Design state observer for the discrete time state space model using Matlab/Scilab.
- 11 Implement discrete PID controller for the discrete time state space model using Matlab/Scilab/simulink.
- 12 Analyze the effect of nonlinear element on sinusoidal input using Matlab/Scilab/simulink.

- 13 Obtain phase trajectory of any feedback control system using Matlab/Scilab/simulink.
- 14 Plot triangular, trapezoidal, Gaussian and bell membership fuzzy functions using Matlab/Scilab/simulink.
15. Obtain Relative Gain Array of multivariable system using Matlab/Scilab/simulink.
16. Analyze the effect of interacting and non-interacting multivariable systems using Matlab/Scilab/simulink.

Design based Problems (DP)/Open Ended Problem:

Design 2 DOF controller for the continuous system using Matlab/Scilab/simulink.

Design 2 DOF controller for the discrete system using Matlab/Scilab/simulink.

Major Equipment: Computers, Scilab/ MATLAB or equivalent software

List of Open Source Software/learning website:

<http://nptel.ac.in/video.php>

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.