GUJARAT TECHNOLOGICAL UNIVERSITY
MECHATRONICS ENGINEERING (20)

SUBJECT NAME: MODERN CONTROL SYSTEMS
SUBJECT CODE: 2172007
B.E. 7th SEMESTER

Type of course: Engineering Science (Departmental Elective - II)

Prerequisite: Knowledge of linear control systems and linear algebra

Rationale: This subject is useful to understand the aspects of Design, Analysis of Modern control system with the state space tool. Concept of stability can be obtained for the single input, single output with the help of state space analysis. Concept of compensator/controller will help student to implement in real control system.

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)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment; OEP-Open Ended problem; AL-Active learning;

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Basic Principles of Feedback Control:** Introduction to Block diagram of on-off control, proportional control, integral control, derivative control, PI, PD control, PID control, Feedback Control Systems characteristics, Proportional Mode of Feedback, integral Mode of Feedback Control, Derivative Mode of Feedback Control.	05	10%
2	**Compensator Design Using Root-Locus Plots:** Design of root locus, Selective illustration of root locus, Reshaping the root locus, Cascade Lead Compensation, Cascade Lag Compensation, Cascade Lag Lead Compensation.	09	20%
3	**Compensator Design Using Bode Plots** : Design of bode plot, Selective illustration of bode plot, Reshaping the Bode Plot,	08	20%

	Cascade Lead Compensation, Cascade lag compensator, Cascade Lag-Lead Compensation, Cascade PID compensation		
4	**State Space Analysis of Continuous – time Control Systems:** Introduction to State space, State variable representation including Electrical, Mechanical, Electro-mechanical system, Conversion of state variable Models to Transfer function via direct, cascade, parallel decomposition, solution of state equation, State Transmission Matrix, Concepts of Controllability and observability.	**10**	**25%**
5	**Design of State Feedback Controller:** Introduction, state Variable Feedback structure, Pole placement Design using State Feedback controller. State feedback with integral control.	**05**	**15%**
6	**Discrete Time System:** sampler, sampling process, Laplace transform of sampled function, z transform, z transform of some useful function, stability analysis of Sampled data control system	**05**	**10%**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks				
Remembrance **R Level**	**Understanding** **U Level**	**Application** **A Level**	**Analyze** **N Level**	**Evaluate** **E Level**
30	**30**	**10**	**20**	**10**

Legends: R : Remembrance ; U = Understanding; A = Application 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. Control Systems : Principal and Design, M. Gopal , Third Edition , Mc Graw Hill Education
2. Control system Engineering, Norman Nise, Third Edition, Willey Publication
3. Modern Control Engineering, Katsuhiko Ogata, 4th Edition,Prentice Hall of India
4. Automatic control Systems, B.C.Kuo, Farid Golnaraghi, Ninth Edition , John Wiley & sons, INC
5. Dorf, R.C., and R.H. Bishop; Modern control system, 10th Edition, Pearsons Education.
6. Friedland, B., Control system Design: An Introduction to state space Method, New York, MCGraw-Hill,2008

7. Digital Control and State Variable Methods, M. Gopal, Tata Mc Graw Hill-2008

Course Outcome:

After learning the course the students should be able to:

1. Design and Analyze control system using Lead, Lag, and Lag-Lead compensator with the help of the root locus and bode plot techniques for multidisciplinary applications of engineering.
2. Design of single input single output system, Multi Input Multi output system via modern control tool like state space analysis.
3. Stability analysis of State space system using state feedback control techniques.
4. Mathematical modeling, Analysis and stability of control system using discrete time analysis.

List of Experiments:

1. Lead Compensator Design of Root Locus.
2. Lag Compensator Design of Root Locus.
3. Lead-Lag Compensator Design of Root Locus.
4. Lead, Lag, Lag-Lead Compensator Design of Root Locus by SISO Tool Design.
5. Lead Compensator Design of Bode plot.
6. Lag Compensator Design of Bode plot.
7. Lag-Lead Compensator Design of Bode plot.
8. Lead, Lag, Lag-lead Compensator Design of Bode plot by SISO Tool Design.
9. Design of state-space analysis.
10. Design of controllability and Observability.
11. Design of feedback control by Pole Placement technique.

Design based Problems (DP)/Open Ended Problem:

Student may be given a task to exhibit their knowledge of the course studied during the academic year.

Major Equipment / Software:

Matlab/Scilab

SISO Tool Box

List of Open Source Software/learning website:

The website of NPTL may be utilized for additional learning.

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.