GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3161707
CONTROL SYSTEM DESIGN
6th SEMESTER

Type of course: Professional Elective Course

Prerequisite: Knowledge of engineering mathematics, basics of control theory, simulation know-howon Matlab/ Scilab or other equivalent software

Rationale: The course is useful for the students to get idea of ideal practices in the field of control systemsdesign. This makes students capable for further studies and/ or conducting research work in the field. Students get in touch with recent trends in the field of modern control engineering. Importance of designing the control systems is emphasized.

Teaching and Examination Scheme:

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

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Design of Feedback Control Systems :** Introduction; Approaches to System Design; Cascade Compensation Networks; Phase-Lead Design Using the Bode Diagram; Phase-Lead Design Using the Root Locus; Phase-Lag Design Using the Root Locus; Phase-Lag Design Using the Bode Diagram; lead-lag Design using root locus and bode diagram Design Examples.	**12**	33
2	**Design of State Variable Feedback Systems** Introduction, State space representation of physical systems, State space models of some common systems like R-L-C networks, DC motor, inverted pendulum etc., Controllable Canonical Form, Observable Canonical Form, Diagonal Canonical Form, State transition matrix, Solution of state equations, Controllability and Observability, Full-State Feedback Control Design; Observer Design; Integrated Full-State Feedback and Observer.	**12**	33
3	**Introduction to Optimal Control** introduction to optimal control, Riccatti Equation, Linear Quadratic Regulator, Design Examples.	**6**	16

4	**Introduction to Robust Control** Robust control system and system sensitivities to parameter perturbations, analysis of robustness, systems with uncertain parameters, considerations in design of robust PID controller.	**6**	18

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
14	**14**	**14**	**14**	**14**	**0**

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. Modern Control Engineering by K. Ogata, PHI.
2. Discrete Time Control Systems by K. Ogata, PHI.
3. Automatic Control Systems by B C Kuo, PHI.
4. Control Systems, Principles and Design by M. Gopal, MC Graw Hill, 2012.
5. Modern control systems / Richard C. **Dorf**, Robert H. **Bishop, Pearson.**

Course Outcome:

After learning the course the students should be able to:

CO1 Apply time domain techniques to analyses and design closed-loop control system.
CO2 Apply frequency domain techniques to analyses and design closed-loop control system.
CO3 Apply state variable approach to design control systems
CO4 Understand optimal control and design closed loop optimal control system
CO5 Understand robustness of control system and design robust controller for a system with parameter uncertainties

List of Experiments:

*(Followingpracticals 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 Analysis of root locus using MATLAB.
2 Design lead compensator using time response analysis using MATLAB and design lead network.
3 Design lag compensator using time response analysis using Matlab and design lag network.

4 Find stability of any state space model using eigen value analysis and plot it state response.
5 Check controllability and observability of the given state space models.
6 Design state feedback controller using pole placement method based on MATLAB.
7 Analysis of bode plot using MATLAB.
8 Analysis and design of frequency response of lead compensating network.
9 Analysis and design frequency response of lag compensating network.
10 Design optimal controller using Riccatti equation
11 Design robust PID control system and check its response using Matlab.
12 Studying any prototype closed loop system.

All practical can be designed in MATLAB or SCILAB ,/Proteus /Keil.

Major Equipment:

Educational prototype models, Computers, simulation software, microcontrollers etc.

List of Open Source Software/learning website:

http://nptel.ac.in/courses/108103007/16

https://en.wikipedia.org/wiki/State-space_representation

http://ctms.engin.umich.edu/CTMS/index.php?example=Introduction&section=ControlStateSpace