GUJARAT TECHNOLOGICAL UNIVERSITY

AERONAUTICAL ENGINEERING
BASIC CONTROL THEORY
SUBJECT CODE: 2160104
B.E. 6th SEMESTER

Type of course: Engineering Science

Prerequisite: Basics of Maths

Rationale: In aircraft it is necessary to control three different types of axis i.e. yaw, pitch and roll. So in order to control such axis it is necessary to understand the basic concepts of control and its detailed theory.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	Unit 1:Introduction Concept, Natural & Man made control systems, Open Loop & Closed Loop systems	2	10
2	Unit 2: Mathematical models of systems Modeling of mechanical systems, Modeling of electrical systems, Examples.	2	10
3	Unit 3: Block Diagrams & Signal Flow Properties of block diagrams, Block diagram reductions, Construction of SFG, Mason's Gain Formula	4	10
4	Unit 4: Time Domain Performance Analysis Excitation functions, First Order, Second Order and Higher Order Systems, Transient response, Steady State Error, Error constants, s- plane root location and transient response, Time response of second order system	6	20
5	Unit 5: Stability Analysis of Control Systems Introduction, Bode's Plot, Polar plots, Hurwits Criterion, Routh-Hurtwitz criterion, Nyquist Plot, Nyquist Stability Criterion, Stability analysis, Relative Stability, Closed Loop Frequency response of Unity feed Back System.	6	10
6	Unit 6: Root Locus Method Introduction, Root Locus plots, Rules for construction of root loci, Feedback systems, Stability Conditions	4	10

7	Unit 7: State Space Analysis Introduction, Comparison between modern control theory and conventional control theory, concepts of State, State Variables and State models, State Space Equations, Linear time-Invariant systems, State model for single input single output linear system, State space representation	7	10
8	Unit 8: Composite Controllers Introduction, Proportional – Integral (PI) control, Proportional – Derivative (PD) control, Proportional – Integral – Derivative (PID) control, Special terminology, (proportional band, repeats per minute, rate gain, direct action, reverse, action), desired features of a feedback control algorithms, Proportional mode, integral mode, derivative mode.	5	20

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
35%	**25%**	**20%**	**15**	**5**	**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. Control Systems By A. Anand Kumar
2. Control Theory By U. A. Bakshi & V. U. Bakshi
3. Process Control: Principles and Applications by Surekha Bhanot, Pub: Oxford University Press
4. Control Systems By Rao V Dukkipati.
5. Automatic Control Systems By Prof B. S. Manke
6. Process Control: Designing Processes and Control for Dynamic Performance by Thomas E. Marlin; Pub: McGraw – Hill, International Edition

Course Outcome:

After learning the course the students should be able to:

1. Understand the basic concepts of control systems.
2. Know the procedure about how to analyze the problem.
3. Design the mathematical model of the system.
4. Design the composite types of controllers for any closed loop system.

List of Experiments:

Sr. No.	Name of Practical	Objective
1.	To study about MATLAB software and its application for Control System Analysis.	Introduce MATLAB software for Control System.
2.	To study about various MATLAB commands for Control System.	Introduce various MATLAB commands for Control System application.
3.	To study about building and analyzing multi block models.	Introduce multi block models in MATLAB.
4.	To study about system time response to Unit Step, Unit Impulse, Unit Ramp, Unit Parabolic input signal.	Show the system behavior by using standard test input signals.
5.	To study the steady state error of type-zero, type-one and type-two control systems on standard test input signals.	Show the behavior of type 0, type 1 and type 2 system by using standard test input signals and understand which type of system is best.
6.	To study about Bode plot and Nyquist plot for stability analysis using MATLAB.	To learn various commands for stability analysis used in Control System.
7.	To study about root locus for stability analysis using MATLAB.	To learn various commands for root locus techniques used in control system MATLAB.
8.	To study about Bode's Plot for Frequency Response Analysis.	To understand about bode plot circuit kit for stability analysis used in Control System.
9.	To study about Liquid Level Controller using Magnetic Float Type Liquid Level Sensor.	Introduce the water level controller for real application.
10.	To study Simulation and Design using MATLAB.	To introduce Simulink in MATLAB based application.
11.	To prepare P, I, D algorithm on MATLAB Simulink and visualize their response to the Step Signal.	Implement P, I, D algorithm on MATLAB Simulink.

Design based Problems (DP)/Open Ended Problem:

Designing of PID, PD and PI controllers and understand the behavior of the system with different input signals.

Major Equipment: Matlab

List of Open Source Software/learning website: http://nptel.ac.in/

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.