GANPAT UNIVERSITY

FACULTY OF ENGINEERING & TECHNOLOGY

Programme	Bachelor of Technology	Branch/Spec	Mechatronics Engineering
Semester	V	Version	2.0.0.0
Effective from Academic Year	2026-27	Effective for the batch Admitted in	July 2024
Subject code	2MC5110	Subject Name	CONTROL ENGINEERING

Teaching scheme						Examination scheme (Marks)			
(Per week)	Lecture(DT)		Practical(Lab.)		Total		CE	SEE	Total
	L	TU	P	TW					
Credit	3	0	1	0	4	Theory	40	60	100
Hours	3	0	2	0	5	Practical	30	20	50

Pre-requisites:

Students should have applied knowledge of following topics:

- Laplace transform, Linear algebra, Vector calculus
- Dynamics of machines

Objectives of Course:

1. Introduce the students for basics and operations various control systems concepts.
2. To make understand the students for time domain and frequency domain analysis.
3. To analyse and design various Root Locus, Bode plots, Polar plots and determine the
4. stability of the control systems.

Theory syllabus

Unit	Content	Hrs
1	**Introduction to Control System:** Introduction to control system, important definitions, Open loop and closed loop control systems, Concept of feedback & feed forward systems, Advantages and disadvantages of both types of system, Classification of control systems, Servomechanisms.	3
2	**Mathematical Modeling of Physical systems:** Definition of Transfer function, Impulse response and Transfer functions, Poles & Zeros of Transfer function, Mathematical modeling of physical systems-physical model and mathematical model - modeling of mechanical systems –Translation motion and Rotational motion-Analogous electrical systems, Force voltage analogy, Force current analogy, Advantages of analogous systems.	6
3	**Block Diagram and Signal flow graph:** Block diagram fundamentals, basic rules for block diagram reduction, Introduction to signal flow graph algebra, Node elimination in signal flow graph, Mason's Gain formula.	6
4	**Time Domain Analysis:** Time domain specifications, Standard test inputs, Time response of first and second order systems- Step, Ramp, Parabolic and Impulse response, Steady state errors & Error Coefficients.	7
5	**Stability Analysis of Control systems:** Characteristics equation of a control system, Location of roots of characteristics equation on s-plane and their effects on the response of the system, Routh-Hurwitz Stability Criterion, Special cases in RH Tabulation, Determination of the range of K for stable operation.	5
6	**Root Locus Plot:** Recalling vector algebra, Angle and Magnitude criterion for plotting root locus, General rules for plotting root locus, Prediction of system response from root locus plot, Effect of addition of pole or zero on root locus.	8
7	**Frequency Domain Analysis:** Sinusoidal response of liner control system, Magnitude and phase curve, Polar plot, Nyquist plot and stability criterion, Relative stability, margin and phase margin, Bode plots, determination of absolute and relative stability from Bode plot	8

8	**Case studies** Field and armature control DC motor, water level control system, 1DOF robotic arm, room temperature control system	2

Practical content	
The Practical/term work shall be based on the topics mentioned above and will be defended by the candidates.	
Text Books	
1	Nagrath and N. Gopal, “Control System Engineering”, New age international Ltd.
2	Katsuhiko Ogata, “Modern Control Engineering”, Prentice – Hall of India.
Reference Books	
1	M. Gopal, “Control Systems - Principles and Design”, Prentice Hall of India.
Related MOOC Links	
1	Control Engineering - https://nptel.ac.in/courses/108106098/
2	Automatic Control - https://nptel.ac.in/courses/112/107/112107240/
Course Outcomes:	
CO 1	To develop dynamics model and build block diagram for any engineering control systems.
CO 2	To analyze control system in time domain and frequency domain.
CO 3	To determine stability and performance parameters.
CO 4	To prepare and interpret Root Locus, Bode plots, Polar plots and Nyquist plots
CO 5	Design and develop different control systems for Mechatronics applications

Mapping of CO and PO:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	2	1	0	0	0	2	0	2	2
CO2	3	3	3	2	1	0	0	0	3	0	3	3
CO3	3	3	2	3	3	0	0	0	2	0	2	2
CO4	3	2	1	3	1	0	0	0	3	0	3	2
CO5	2	2	3	2	1	0	0	0	2	0	2	1