FACULTY OF ENGINEERING & TECHNOLOGY

Effective from Academic Batch: 2022-23

Programme: **Bachelor of Technology (Electrical Engineering)**

Semester: **V**

Course Code: **202050501**

Course Title: **Control Systems**

Course Group: **Professional Core Course-IX**

Course Objectives: Automatic control of industrial processes is essential for increasing the output and in turn the profit of an industry. As a result, most of the companies are using automatic control of the machineries and processes. As an engineer, a student must know the basics of an automatic control system. This subject is intended to supplement the basic skill of an engineer. This course explores the fundamentals of systems and control. The course has two primary focuses: (1) Understanding and predicting system behavior, and (2) Design and analysis of closed loop control systems.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	0	2	4	50 / 18	50 / 17	25/9	25/9	150 / 53

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**Introduction To Control Systems:** Introduction, Open-Loop and Closed-Loop Control Systems, Transfer Functions of Linear Time Invariant (LTI) Systems, Block Diagram Algebra and Signal-Flow Graph Models.	08

Opp. Shastri Maidan, Beside BVM College, Vallabh Vidyanagar, Dist: Anand, Gujarat - 388120
(O): 02692-238001 | Email: adminoffice@cvmu.edu.in | www.cvmu.edu.in

2	**Time Response Analysis:** Standard Test Signals, Time Response of First and Second order Systems and their Design Specifications for Standard Test Inputs, Concept of Stability, The Routh-Hurwitz Stability Criterion, Root-Locus Technique and Construction of Root-Loci, The Relative Stability of Feedback Control Systems.	**12**
3	**Frequency-Response Analysis:** Relationship between Time and Frequency Responses, Definitions related to Frequency Response, Basics of Bode Plots & Construction of Bode Plots, Basics of Polar Plots & its Construction, Nyquist Theory & Nyquist Stability Criterion, Relative Stability using Nyquist Criterion.	**11**
4	**State Variable Models:** Concept of State and State Variables, State Space Model, The State Differential Equation, Conversion between State Space and Transfer Function Model, The State Transition Matrix, Concept of Controllability and Observability.	**07**
5	**Introduction to Controller/Compensator Design:** Approaches to System Design, Cascade Compensation Networks, Phase-Lead Design Phase-Lag Design and Phase Lead-Lag/Lag-Lead Design, Concept of Proportional, Integral and Derivative Controllers.	**04**

List of Practicals / Tutorials:

1	Introduction to Control Systems.
2	To Study and Obtain Transfer Function from given Electrical Networks.
3	To Study and Obtain Mathematical Model from given Mechanical Systems.
4	To Study and Obtain Transfer Function of Physical Systems.
5	To Study Block Diagram Algebra and Signal Flow Graph and to Obtain Transfer Function from given Block Diagrams and Signal Flow Graphs.
6	To Study and Simulate Time Response of Control Systems.
7	To Study and Obtain Pole-Zero Map of Control System.
8	To Study Root Locus Plot of a given Control System.
9	To Sketch Root Locus Plot for given Control Systems using Rules of Constructing Root Locus Plot.
10	To Sketch Bode Plots for given Control System.
11	To Sketch Bode Plots for given Control Systems using Rules of Constructing Bole Plots and using MATLAB.
12	To Sketch Nyquist Plots for given Control System.
13	To Sketch Nyquist Plots for given Control Systems using Rules of Constructing Nyquist Plots and using MATLAB.

Opp. Shastri Maidan, Beside BVM College, Vallabh Vidyanagar, Dist: Anand, Gujarat - 388120
(O): 02692-238001 | Email: adminoffice@cvmu.edu.in | www.cvmu.edu.in

14	To Obtain State-Space Model from given Transfer Function.
15	To Obtain Transfer Function from given State-Space System.
16	Introduction to Single Board Heater System (SBHS).
17	To Observe the System Response of First Order System using SBHS for Different Heater Inputs.
18	To Observe the System Response of First Order System using SBHS for Constant Heater Inputs with Disturbances.

Reference Books:

1	M. Gopal, "Control Systems: Principles and Design", McGraw Hill Education, 1997.
2	J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International, 2009
3	K. Ogata, "Modern Control Engineering", Prentice Hall, 1991.
4	B. C. Kuo, "Automatic Control System", Prentice Hall, 1995.
5	Norman S. Nise, "Control Systems Engineering", Wiley India Edition, 2019 edition

Supplementary learning Material:	
1	E-materials available at the website of NPTEL- http://nptel.ac.in/

Pedagogy:

- Direct classroom teaching
- Audio Visual presentations/demonstrations
- Assignments/Quiz
- Continuous assessment
- Interactive methods
- Seminar/Poster Presentation
- Industrial/ Field visits
- Course Projects

Internal Evaluation: The internal evaluation comprised of written exam (40% weightage) along with combination of various components such as Certification courses, Assignments, Mini Project, Simulation, Model making, Case study, Group activity, Seminar, Poster Presentation, Unit test, Quiz, Class Participation, Attendance, Achievements etc. where individual component weightage should not exceed 20%.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
30%	30%	20%	10%	10%	0%	

Opp. Shastri Maidan, Beside BVM College, Vallabh Vidyanagar, Dist: Anand, Gujarat - 388120
(O): 02692-238001 | Email: adminoffice@cvmu.edu.in | www.cvmu.edu.in

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.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Understand the Fundamental of Feedback Control System.	**20**
CO-2	Understand Time Response Specifications and Determine the (Absolute & Relative) Stability of a Closed-Loop Control System.	**20**
CO-3	Determine the Time and Frequency-Domain Responses of First and Second-Order Systems to Step and other Standard Inputs.	**30**
CO-4	Express and solve System Equations in State-Variable Form (State Variable Models).	**15**
CO-5	Design Controller as per given Specifications using Different Techniques.	**15**

Curriculum Revision:	
Version:	2.0
Drafted on (Month-Year):	June-2022
Last Reviewed on (Month-Year):	
Next Review on (Month-Year):	June-2025

Opp. Shastri Maidan, Beside BVM College, Vallabh Vidyanagar, Dist: Anand, Gujarat - 388120
(O): 02692-238001 | Email: adminoffice@cvmu.edu.in | www.cvmu.edu.in