FACULTY OF ENGINEERING & TECHNOLOGY

Effective from Academic Batch: 2022-23

Programme: **BACHELOR OF TECHNOLOGY (Electronics and Communication)**

Semester: **IV**

Course Code: **202060402**

Course Title: **Control System Engineering**

Course Group: Professional Core Course

Course Objectives: To provide a basic understanding of the concepts and techniques involved in designing control schemes for dynamic systems, including determining stability, transient performance, and steady-state error. Study the relationship between closed loop poles and system performance. Control System design using time and frequency domain techniques. Controller design for proportional, derivative, and integral control.

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 and Overview of Control Systems:** Basic blocks of Control Systems; Understanding the terms reference input, control input, disturbance input and controlled output; Tracking and the disturbance rejection problems; History of Control Systems, Manual vs. automatic control; Feedback and feed forward control, Analysis and Design Objectives.	4
2	**System Modelling**: LTI systems, Review of Laplace Transform Review. *Modelling in Frequency Domain*: Transfer function, Electrical Network Transfer Functions, Transfer Functions of Mechanical Translational System, Rotational System, and Electromechanical System, Case Study. *Modelling in Time Domain*: Concept of states; State-space modelling of general systems; Operating points and linearization about the same; State-space to transfer function transformation and the reverse (i.e., realization) problem for LTI systems; Block-diagram (and Signal-flow-graph) representation of systems and their reduction to get Transfer Function; Mason's Gain Formula; Case Studies.	6

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3	**Feedback Control System Characteristics and Performance**: Test Input Signals, pole-zero and order of control system, Significance of poles and eigenvalues, Transient and steady-state response, Cost of feedback, Performance of various test signals on first and second order Systems, Effects of a Pole and a Zero on the System Response, The Steady-State Error of Feedback Control Systems, Performance Indices, Case Studies.	**6**
4	**Stability of Linear Feedback Systems**: The Concept of Stability, Asymptotic and BIBO stability, Absolute and relative stability, Routh-Hurwitz criteria, Stability in State Space, Case Studies.	**5**
5	**Stability in the Time Domain:** Concept of Root Locus, Root Locus Design Techniques, Parameter Design by the Root Locus Method, Sensitivity, and the Root Locus, Case Studies.	**8**
6	**Stability in the Frequency Domain:** Frequency Response Plots, Performance Specifications in the Frequency Domain, Magnitude and Phase Diagrams (Bode Plots), Design via Bode plots, Nyquist Criterion, Relative Stability via Bode plots and Nyquist Criterion, Nichol's chart, Systems with Transportation Delay, Case Studies.	**8**
7	**Compensation Design Techniques:** Performance goals - Steady state, transient and robustness specifications; Phase-lag, Phase-lead, Phase Lag-lead, and PID Compensators, Time domain vs. Frequency-domain design approaches; Example Study.	**8**
		45

List of Practicals / Tutorials:

1	(a) To Study the potentiometer characteristics. (b) To study the potentiometer as an error detector.
2	(a) To Study the Synchro characteristics. (b) To study the Synchro as an error detector.
3	To Study the torque-speed characteristics of D.C Motor and determine its transfer function.
4	To study the performance characteristics of a DC Motor speed control system.
5	To study the performance characteristics of a DC Motor angular position control system.
6	To study the characteristics of a small AC servomotor and determine its transfer function.
7	To study the responses of Type – 0, Type – 1 and Type – 2 systems.
8	Introduction to MATLAB/SCILAB/Python: MATLAB: Control System Toolbox and Simulink, Basics of Control Systems Commands, Poles, Zeros, Type and Order of Control Systems.
9	MATLAB/SCILAB/Python simulation experiments – Time Response Analysis, Bode Plot, Root Locus, Nyquist Plot, State-Space Analysis.
10	To study Phase-lead and Phase-lag network using discrete components.
11	MATLAB/SCILAB/Python simulation experiments – Phase-lead and Phase-lag network
12	Open Ended Design Problem based on real-time applications.

Reference Books:

1	M. Gopal, **Control Systems: Principles and Design**, 4th Edition, TMH Publication.
2	Norman Nise, **Control Systems Engineering**, 7th Edition, Wiley.
3	Katsuhiko Ogata, **Modern Control Engineering**, 4th Edition, Prentice Hall of India.

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4	I. J. Nagrath and M. Gopal, **Control systems Engineering**, 5th Edition, New Age International Publisher.
5	Benjamin C. Kuo and Farid Golnaraghi, **Automatic Control Systems**, 8th Edition, John Wiley & Sons.

Supplementary learning Material:	
1	NPTEL and Coursera Video Lecture
2	www.vlab.co.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**	
10	25	10	25	15	15	

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	Linear Time Invariant System Modeling Using Differential Equations, Transfer Function Realizations and State-Space Equations.	**15**
CO-2	Design and evaluate LTI system behavior in time and frequency domains based on the mathematical model of the system.	**25**
CO-3	Using Time and Frequency Domain techniques Design analysis and performance evaluation for stability of closed loop LTI system.	**25**
CO-4	Compensator Designing for Dynamic Systems.	**25**
CO-5	Devise a safe and effective method of investigating a system identification problem in the lab.	**10**

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

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