SEMESTER S5

CONTROL SYSTEMS

Course Code	PCECT503	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-0-0-0	ESE Marks	60
Credits	3	Exam Hours	2Hr. 30 Min.
Prerequisites (if any)	GBMAT301 Mathematics for Electrical Science -3	Course Type	Theory

Course Objectives:

1. To study the elements of control system, modelling and perform stability analysis of systems.
2. To design control systems with compensating techniques.
3. To understand the state variable analysis method.

SYLLABUS

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Module No.	Syllabus Description	Contact Hours
1	**Introduction:** Basic Components of Control Systems, Open-Loop and Closed-Loop Control Systems with examples. **Mathematical modelling of control systems**: Electrical Systems and Mechanical translational systems. **Transfer Function:** Block diagram reduction techniques, Signal flow graph, Mason's gain formula.	8
2	**Time Domain Analysis of Control Systems:** Standard Test signals, Time response of first order systems (unit impulse, step and ramp inputs) and second order systems (step input only). Time response of undamped, under damped, critically damped second order system to unit step signal, Time domain specifications for a second order underdamped system, Steady state error and static error coefficients.	8
3	**Stability of linear control systems**: Concept of BIBO stability, absolute stability, Routh Hurwitz Criterion. **Root Locus Techniques**: Introduction, properties and its construction.	12

	Frequency domain analysis: Frequency domain specifications **Relative stability**: gain margin and phase margin. Stability analysis using Bode plot and Nyquist stability criterion. **P, PI & PID controllers**: Introduction. **Design of Compensators**: Need for compensators, lag and lead compensators using Bode plots(only design steps)	
4	**State Variable Analysis of Linear Systems:** State variables, state equations, state variable representation of electrical systems. Transfer function from State equation, Solutions of the state equations, state transition matrix, Controllability and observability - Kalman's Test.	**8**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination-2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Analyze the systems using transfer function approach	**K3**
CO2	Perform time domain analysis and steady state analysis of systems	**K2**
CO3	Determine the absolute stability and relative stability of a system using Routh Hurwitz Criterion and root locus	**K3**
CO4	Apply frequency domain techniques to assess the system stability and to design different compensation techniques	**K3**
CO5	Analyse system Controllability and Observability using state space representation	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Control Systems Engineering	I.J. Nagarath, M. Gopal	New Age International Publishers	7th Edition 2022
2	Automatic Control Systems	Benjamin C. Kuo, Farid Golnaraghi,	Wiley	10th Edition 2017
3	Modern Control Engineering	Katsuhiko Ogata	Pearson	Fifth Edition 2015

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Feedback and Control Systems	Joseph DiStefano, Allen R. Stubberud, and Ivan J. Williams	McGraw Hill	Third Edition 2013
2	Control systems	Ashok Kumar	Tata McGraw-Hill	Second Edition 2010
3	Control Systems: Principles and Design	M Gopal	McGraw Hill Education	Fourth Edition 2012
4	Nise's Control Systems Engineering	Norman S. Nise	Wiley India	8th Edition 2017

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://youtu.be/Cl23xQrvFhk?feature=shared https://youtu.be/fsxSst10_cE?feature=shared
2	https://youtu.be/cLyT6OWcmyU?feature=shared
3	https://youtu.be/CZL7_Z0i1KQ?feature=shared
4	https://youtu.be/CrXOMBlYFp0?feature=shared

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