



SARVAJANIK UNIVERSITY
Sarvajanik College of Engineering and Technology
Bachelor of Technology



B.Tech. Semester VI ELECTRICAL ENGINEERING

Subject Name: Advanced Control System

Subject Code: BTEL14612

Type of course:	Professional Elective Course (Electrical Engineering)								
Prerequisite:	A basic knowledge in Linear Algebra and Classical Control Systems								
Course Objectives:	<ul style="list-style-type: none"> • The aim of this course is to provide a theoretical understanding of advanced linear control systems and strategies, including the principles of digital control. • The course introduces students to modern and advanced control techniques for solving complex control problems. 								
Teaching and Examination Scheme:									
TEACHING SCHEME				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	100
3	0	0	3	60	25	15	0	0	

CA1: Continuous Assessment (assignments/projects/open book tests/closed book tests) **CA2:** Sincerity in attending classes/class tests/ timely submissions of assignments/self-learning attitude/solving advanced problems **TEE:** Term End Examination **TEP:** Term End Practical Exam (Performance and viva on practical skills learned in course) **CA3:** Regular submission of Lab work/Quality of work submitted/Active participation in lab sessions/viva on practical skills learned in course

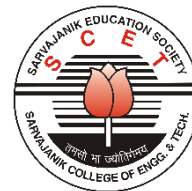
Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage %
1.	Feedback Control and design in State Space: Introduction to state space, solution of state space equations. Controller Design by State Feedback, Necessary and Sufficient Condition for Arbitrary Pole Placement-State Regulator Problem and State Regulator Design, Evaluation of State Feedback Gain Matrix K, Selection of Location of Desired Closed Loop Poles, State Observer Design, Full Order/Reduced Order Observer Design, Observer Based State Feedback Control	12	28
2.	Nonlinear Control System: Introduction, Common Types of Nonlinearities, phase plane analysis, equilibrium points, Describing Function Analysis, Stability and Limit Cycles Lyapunov's Stability Analysis, Method of Construction of Lyapunov Functions for Nonlinear Systems (Variable gradient and Kravoskii method)	12	28
3.	Introduction to Optimal Control, Parameter Optimization: Introduction, Optimal Control versus Conventional Control, Types of Optimal Control Problem, Basic Concepts of Calculus of Variation, Finding Minima of function, Linear Quadratic Regulator (LQR) Problem, Calculus of variations, Pontryagin's optimum policy, Bang-Bang Control, Hamilton-Jacobi Principle.	12	20

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4.	Discrete Time Systems:Introduction, Spectrum Analysis of Sampling Process, Signal Reconstruction, Difference Equations, Z transforms, and the Inverse Z transform, Pulse Transfer Function, Time Response of Sampled Data Systems.	4	12
5.	Introduction to other fields of Control SystemTheory: Robust control, Adaptivecontrol, Predictive control, Fuzzy control, Neural network control.	5	12

Suggested Specification table with Marks (Theory/Practical):

% Distribution of Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	20	25	25	15	-

Legends: R: Remembrance, **U:** Understanding; **A:** Application, **N:** Analyze, **E:** Evaluate **C:** Create and above Levels (**Revised Bloom’s Taxonomy**)

Note: This specification table shall be treated as a general guideline for students andteachers. The actual distribution of marks in the question paper may vary slightly from above table.

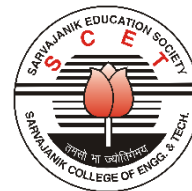
Reference Text Books:

Sr. No.	Title of book /article	Author(s)	Publisher and details like ISBN	Year of publication	Publication Edition
1	Modern Control Engineering	Katsuhiko Ogata	Pearson Education International,	2009	Fifth edition
2	Nise’s Control Systems Engineering	Norman S Nise	John Wiley & Sons, Inc	2018	Sixthedition
3	Automatic Control Systems	Benjamin C Kuo	Prentice Hall India Learning Private Limited	1995	Ninth edition
4	Control System Engineering	J.Nagrath and M.Gopal	New Age International Publishers	2007	Fifth Edition
5	Digital Control Systems	Benjamin C. Kuo	Oxford University Press	1992	
6	Discrete-time Control Systems	Katsuhiko Ogata	Prentice Hall	1995	
7	Non-linear systems,	Hasan K. Khalil,	Prentice-Hall of India,	2002.	Third Edition

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8	Optimal Control Theory: An Introduction	Donald E. Kirk	Dover Publications Inc.	2004	
9	Fuzzy Logic with Engineering Applications	Timothy J Ross.	John Wiley & Sons, Ltd	2010	Third Edition
10	Neural Networks - A Comprehensive Foundation	Simon S. Haykin	Pearson Education (US)	1997	
11	Linear Systems: Optimal and Robust Control	AlokSinha	CRC Press	2007	

Course Outcome:

Sr. No.	CO Statement After learning this subject, students will be able to	Marks % weightage
CO-1	Provide a theoretical understanding of advanced linear control systems and strategies, including the principles of digital control.	20%
CO-2	Concept of nonlinearities, their types, modelling and stability analysis using Method of Lyapunov. Design Lyapunov energy functions for nonlinear systems for stability analysis	20%
CO-3	Concept of optimal control and develop design skills in optimal control problems.	20%
CO-4	Derive discrete-time mathematical models in both time domain (difference equations, state equations) and z-domain (transfer function using z-transform) Predict and analyze transient and steady-state responses and stability and sensitivity of both open-loop and closed-loop linear, time-invariant, discrete-time control systems	15%
CO-5	Conceptual knowledge of various domains in control engineering	15%



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Mapping with POs Mapping with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO-1	3	3	2	3	3				2	2	3	1	3	3	
CO-2	3	3	2	3	3				2	2	3	1	3	3	
CO-3	3	3	2	3	3	1	3	1	2	2	3	1	3	3	
CO-4	3	3	2	3	3				2	2	3	1	3	3	
CO-5	3	3	2	3	3	2	2	2	3	3	3	2	3	3	
Rationale *															

Rationale*: Explaining why it is matching this particular program outcome

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.

List of Open Source/learning website:

- https://en.wikipedia.org/wiki/Control_engineering
- <https://ledin.com/control-systems-basics/>
- <https://ocw.mit.edu/courses/mechanical-engineering/2-04a-systems-and-controls-spring-2013/>
- <https://umdearborn.edu/cecs/graduate-programs/certificates/control-systems>
- <https://nptel.ac.in/courses/108/106/108106098/> (video course)
- <https://nptel.ac.in/courses/112/104/112104158/>

List of Open Source Software:

- <https://www.scilab.org>
- www.simscale.com