GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRICAL ENGINEERING (07)

MODERN CONTROL SYSTEMS
SUBJECT CODE: 2720714
SEMESTER: II

Type of course: Master of Engineering

Prerequisite: Basic concepts, principles and techniques of linear control systems

Rationale: This course provides detailed concepts of feedback control design, state-space approach, non-linear system analysis and overview of optimal control.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks		Practical Marks				
				ESE (E)	PA (M)	ESE (V)		PA (I)		
						ESE	OEP	PA	RP	
3	2#	0	4	70	30	30	0	10	10	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	State Variable Analysis Introduction, Concepts of State, State Variable and State Model, Various State Models for Linear-Continuous Time systems, State Variables and Discrete-Time Systems, Eigen values and eigen vectors, Diagonalization, Solution of State Equation, State transition matrix, Controllability, Observability, Principle of Duality.	12	25
2	State Variable Design Introduction, Pole-Placement, Design of Servo Systems, State Observers, Design of Regulator System with Observers, Design of Control System with Observers.	05	15
3	Non-Linear Systems Introduction, Common Physical Nonlinearities, The Phase Plane Method, Singular Points, Stability Of Nonlinear System, Construction of Phase Trajectories, Linearization, Describing Function Method, Derivation of Describing Function, Stability Analysis by Describing Function.	09	20
4	Lyapunov's Stability Analysis Introduction, Lyapunov's Stability Criteria, The direct method of Lyapunov, Methods of constructing Lyapunov Function for Non-linear Systems.	08	20
5	Optimal Control 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.	08	20

Reference Books:

1. Control System Engineering (Fifth Edition) by I. J. Nagrath and M. Gopal, New Age International Publishers
2. Modern Control Engineering (Fifth Edition) by K. Ogata, EEE, PHI
3. Automatic Control Systems, High Education Press, 2003- B. C. Kuo

Course Outcome:

Upon the successful completion of this course, students should be able to:

1. Understand how the state space system representation provides an internal description of the system including possible internal oscillations or instabilities.
2. Design state observers.
3. Place closed loop poles at desirable locations.
4. Derive the describing function for different types of non-linearities and then do the stability analysis.
5. Understand how the system design minimizes or maximizes the selected performance index

List of Tutorials:

1. Introduction to MATLAB for various matrix operations.
2. Simulink for various state space models.
3. MATLAB problem for pole-placement design.
4. MATLAB program for controllability and observability.
5. MATLAB program for observer design.
6. MATLAB program for Lyapunov methods.
7. MATLAB for Phase-plane trajectories.
8. MATLAB for LQR problem.

Major Equipment: Computers.

List of Open Source Software/learning website:

MATLAB Software.

CONTROL SYSTEM TUTORIALS by University of Michigan

Review Presentation (RP): The concerned faculty member shall provide the list of peer reviewed Journals and Tier-I and Tier-II Conferences relating to the subject (or relating to the area of thesis for seminar) to the students in the beginning of the semester. The same list will be uploaded on GTU website during the first two weeks of the start of the semester. Every student or a group of students shall critically study 2 papers, integrate the details and make presentation in the last two weeks of the semester. The GTU marks entry portal will allow entry of marks only after uploading of the best 3 presentations. A unique id number will be generated only after uploading the presentations. Thereafter the entry of marks will be allowed. The best 3 presentations of each college will be uploaded on GTU website.