Course Name: Control System II

Course Code : EE603

Course Credit: 3

Contact Hour: 2L-1T

Prerequisite: Engineering Mathematics, Control System I

Course Objective

The course objectives are:

1. To provide with basic knowledge of state space representation of control systems, non linear system analysis, associated terminologies.
2. Analysis, design & implementation of SISO & MIMO systems using state space approach.
3. To make students familiar with digital control system and its analysis.
4. To provide basic idea of real time non linear systems, their analysis method.

Course Outcome

After successful completion of the course students:

1. Can analyze MIMO systems using State variable approach.
2. Can understand and demonstrate discrete, digital, non linear control systems.
3. Can explain sampling, quantization, encoding and their mathematical modeling. Thus understand signal conversion techniques.
4. Can explain effects of common non linearities introduced in a system.
5. Can understand Z transform, pulse transfer function and able to apply that concept for digital system analysis.
6. Able to analyze digital system and non linear system stability using different analysis tools.

CO Mapping with departmental POs

H: High, M: Medium, L: Low

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	H	H	H	H	H							
CO 2	H	M		M	M							
CO 3	H	L	L	H	M							
CO 4	M	M	L	M	M							
CO 5	H	H	H	H	H							
CO 6	H	M	M	H	M							

Course Content:

Module 1: State variable analysis **14L**

Concept of state, state variable, state model. State variable formulation of control system, diagonalization, Obtaining SV model from Transfer Function. Obtaining characteristic equation and transfer functions from SV model. Time response of state model of linear time-invariant system (solution of state equation and STM). Alternative representations in state space (cascade form, parallel form, controllable canonical form, observable canonical form). Elementary concept of controllability & observability

Module 2: Digital Control Systems **10L**

Unit – 1: Introduction: Basic Elements of discrete data control systems, advantages of discrete data control systems, examples. **1L**

Unit – 2: Signal conversion & processing: Digital signals & coding, data conversion & quantization, sample and hold devices, Mathematical modeling of the sampling process; Data reconstruction, aliasing and filtering of sampled signals: Zero order hold. **2L**

Unit – 3: Z-Transforms & its applications: Z-Transforms, ROC, Applications of z-Transforms to Difference equations and ladder Network problem. **4L**

Unit – 4: Introduction to Pulse Transfer function and z-Transfer function, Closed loop systems, characteristic equation in discrete domain. Stability test of discrete data systems: Jury's Stability Test. **3L**

Module 3: Non Linear Control **18L**

Unit – 1: Introduction: Introduction to nonlinear systems, Common nonlinearities: saturation, dead-zone, nonlinear friction, on-off controller, backlash, Phenomena of nonlinear system: frequency amplitude dependency, jump resonance, sub-harmonic oscillation, limit cycle, multiple equilibrium states, multiple modes of behaviour. **3L**

Unit – 2: Approaches to analysis and design of nonlinear control systems:

Describing function method: Harmonic linearization, Determination of describing function of common nonlinearities, Limit cycles in nonlinear systems: Prediction of limit cycles using describing function technique. **5L**

Phase plane method: Phase trajectory, phase-plane, phase-plane portraits, singular points, Phase plane analysis of linear and nonlinear second order systems, Methods of obtaining phase plane trajectories by graphical method, isoclines method, Qualitative analysis of simple control systems by phase plane methods. **5L**

Lyapunov stability analysis: Equilibrium state, local & global stability, stability in the sense of Lyapunov: Asymptotic stability, Global asymptotic stability, Definiteness of scalar function, Sylvester's criterion, Second method of Lyapunov, Definitions of Lyapunov functions, Basic properties of Lyapunov function, Lyapunov's main stability theorem, Geometric interpretation of Lyapunov function, Lyapunov stability analysis of LTI systems, Krasovskii's method. **5L**

Text Book:

1. Digital control systems (Second Edition) by Kuo, Oxford University Press
2. Control system Engineering, I.J. Nagrath & M. Gopal, New Age International.
3. Discrete Time control systems – by Ogatta, 2nd ed. (PHI)

Reference:

1. Control System Design, Goodwin, Pearson Education.
2. Digital Control Engineering – by M. Gopal, (New Age Publ.)
3. Nonlinear Control system, J.E. Gibson, Mc Graw Hill Book Co.
4. Control System Engineering – by Nagrath & Gopal (Wiley Eastern)
5. Modern Control system, R.C. Dorf & R.H. Bishop, Pearson Education
6. Continuous & Discrete Control Systems – by John Dorsey (MGH)