Course Type	Course Code	Name of Course	L	T	P	Credit
DC	NMEC521	Control System	3	1	0	4

Course Objective

- The course is intended to provide knowledge of any industrial operations involving control of position, velocity, temperature, pressure etc.
- It is desirable that most engineers and scientists are familiar with theory and practice of automatic control.

Learning Outcomes

Upon successful completion of this course, students will:

- Have a broad understanding of open-loop and closed-loop control system used in practice.
- Be able to design different control systems by using the time response, frequency response and state feedback method.

Unit No.	Topics	Lecture Hours (L+T)	Learning Outcome
1	Introduction: Review of Laplace Transform, Closed-loop control versus open-loop control, Linear Time Invariant (LTI) systems.	2+1	Understanding basics of close-loop and open-loop control systems
2	Representation of physical system: Transfer function and impulse response function, modelling in state space, phase portraits, system modes and decompositions, discrete-time systems	5+1	To enable students to model dynamic systems and analyze dynamic characteristics
3	Time response analysis: Transient and steady-state response analyses, 1^{st} order, 2^{nd} order and higher-order systems, effects of integral and derivative control actions on system performance, PID controllers, Ziegler–Nichols rules for gain tuning of PID controllers	6+2	The students will learn basics of controller and also tuning gain values of PID controllers.
4	Control Systems Analysis and Design by the Root-Locus Method: Plotting Root Loci with MATLAB, Root-locus plots of positive feedback systems, lag, lead and lag– lead compensation	6+3	Understanding the movement of the closed-loop poles in the s-plane and modification of the dynamics to satisfy the given specifications.
5	Frequency-Response Method: Bode diagrams, Polar plots, Nyquist stability criterion.	5+1	The students will be able to use the data obtained from measurements on the physical system for system identification and control.
6	System stability: Lyapunov stability, equilibrium points for linear and nonlinear systems, Lyapunov function for nonlinear and LTI systems, stability test for a parameterized system, discrete time LTI Lyapunov equation.	7+2	The students will learn the stability analysis of linear as well as nonlinear systems.
7	Controllability and observability: Controllability tests for LTI systems, modal controllability and observability, Kalman decomposition	7+2	The students will learn how to investigate these properties as it marks the first step of designing a controller and observer.
8	State feedback and observers: Pole placement,	4+2	The students will understand the

	continuous time and discrete time observers.		design of state-feedback controllers for SISO and MIMO systems.
Total		42+14	

Text book:

1. Modern Control Engineering by K.Ogata, 5th edition, Prentice Hall, 2010.
2. Automatic Control Engineering by F.H.Raven, 5th ed., McGraw Hill International, 1994.

Reference books:

1. Fundamentals of Linear State Space Systems by John S. Bay, McGraw Hill, international edition, 1999.