NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	B.Tech. Electronics & Communication Engineering
Course Code:	3EC801ME24
Course Title:	Control Theory
Course Type:	Departmental Elective
Year of Introduction:	2024-25

L	T	Practical component				C
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Course Learning Outcomes (CLOs):

At the end of the course, students will be able to

1. apply the basic concept of mathematical modeling for the control system. BL-3
2. analyse time response and frequency responses of control system. BL-4
3. analyse the stability of linear control system. BL-4
4. model a control system with state space modelling. BL-3

Unit No.	Contents	Teaching hours (Total 45)
I	**Mathematical Modeling of Dynamic Systems:** Introduction, classification of control systems, open loop and closed loop control systems, examples of control systems, closed loop control versus open-loop control, modeling of mechanical, electrical and electromechanical systems, differential equations of physical systems, Laplace transform of signals, properties of Laplace transform, determination of transfer function, systems, analogy, block diagrams and signal flow graphs	10
II	**Feedback Characteristics of Control System:** Introduction, types of feedback, Feedback and non-feedback systems, feedback control system characteristics, proportional mode of feedback control, reduction of parameter, variation by use of feedback, steady state accuracy, shaping the dynamic response, disturbance reduction using feedback control, proportional and derivative controller, proportional and integral controller, proportional integral and derivative controller	10
III	**Transient Response Analysis:** Introduction, first order systems, second order systems, steady state error for unity feedback system, type of system & error constant, transient response analysis, R-H criterion	05
IV	**Root Locus Analysis:** Introduction, root locus plots, summary of general rules for constructing root loci, root locus analysis of control systems, root loci for systems with transportation lag, root contour plots, stability analysis	05
V	**Frequency Response Analysis:** Introduction, advantages of frequency response analysis, frequency response of closed loop systems, correlation between time and frequency response, bode diagrams, polar plots, nyquist plots, nyquist stability criterion, stability analysis, stability margin, stability margins on the bode plot bounded input bounded output stability, zero input stability, relative stability, closed loop frequency response of a unity feedback control system, experimental determination of transfer functions	10
VI	**State Space:** Concept of state variable and state model, state model of electrical systems, state model of mechanical systems, conversion of state model into transfer function, solution of time invariant state equation	05

Self-Study:
The self-study contents will be declared at the commencement of the semester. Around 10% of the questions will be asked from self-study content.

Suggest List of Tutorials (not restricted to the following):
(Only for information)

Sr. No.	Title of the tutorial	Hours
1.	Mathematical modelling of control systems	01
2.	Transfer functions	01
3.	Block diagram reduction method	01
4.	Feedback characteristics of control systems	01
5.	Time domain response of first order system	01
6.	Time domain response of second order system	01
7.	Steady state errors and error constants	01
8.	Proportional plus integral integral (PI) controller.	01
9.	Proportional plus integral plus derivative integral (PID) controller.	01
10.	Routh Hurwitz criterion	01
11.	Root locus technique	01
12.	Frequency response analysis	01
13.	Stability analysis	01
14.	State space analysis	01
15.	Solution of time invariant state equation.	01

Suggested Readings:

1. Katsuhiko Ogata, Modern Control Engineering, PHI Publication
2. Nagrath & Gopal, Control System Engineering, New Age International Publication
3. M.Gopal, Modern Control System Theory, New Age International Publication
4. Norman S. Nise, Control System Engineering, Wiley publication