Course Code	Course Title	L	T	P	C
BMEE330L	Control Systems	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To expose the students to classical methods of control engineering, physical system modeling and control.
2. To enable the students to design control system for various applications.
3. To enrich the ability of the students to analyse the performance of dynamic control systems.

Course Outcome

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

1. Apply the concepts of control systems and modelling techniques.
2. Develop various representations of system based on the first principles approach.
3. Infer the domain specifications from the time and frequency response.
4. Analyse the stability of closed-loop systems using different techniques.
5. Demonstrate the state-space representation and modern control theory.
6. Design appropriate control systems for different applications.

Module:1	**Introduction**	**4 hours**
Concept of control system, Classification of control systems - Open-loop and closed-loop control systems, Examples of control systems- Effects of feedback, Feedback Characteristics.		
Module:2	**Mathematical Modelling of Physical Systems**	**6 hours**
Transfer Functions of LTI Systems, Concepts of Poles and Zeros, Block diagram, Determining the Transfer function from Block Diagrams, Signal flow graphs – Reduction using Mason's gain formula.		
Module:3	**Control systems and Components**	**8 hours**
Components of control systems - Development of mathematical models: mechanical, electrical, electromechanical, Thermal, Hydraulic and Pneumatic systems.		
Module:4	**Time Response Analysis**	**6 hours**
Standard test signals, Time response of first order systems and second order systems, Transient response of second order systems – Time domain specifications, Steady state errors and error constants, General Controllers – P, PI, PD and PID controllers.		
Module:5	**Stability Analysis**	**6 hours**
The concept of stability – Routh-Hurwitz's stability criterion – qualitative stability and conditional stability – Root Locus Technique: Concept of root locus – Construction of root locus.		
Module:6	**Frequency Response Analysis**	**7 hours**
Frequency domain specifications, Bode plot, Phase margin and Gain margin, Polar plots, Nyquist Criteria.		
Module:7	**State Space Analysis**	**6 hours**
Concepts of state, state variables and state model, Modelling system in state space, Solving the time invariant state equations, State Transition Matrix, Concepts of Controllability and Observability.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Nagrath I.J, and Gopal M, Control Systems Engineering, 2017, 6th edition, New Age International Publishers.
2. Ogata K, Modern Control Engineering, 2015, 5th Edition, Prentice Hall of India Pvt. Ltd.

Reference Books			
1.	Norman S Nise, Control Systems Engineering, 2018, 7th edition, John Wiley and Sons, Inc.		
2.	Benjamin C. Ku, Farid Golnaraghi, Automatic Control Systems, 2017, 10th edition, McGraw-Hill Education.		
Mode of Evaluation: CAT / Written assignment / Quiz / FAT / Seminar / Case studies			
Recommended by Board of Studies	27-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022