2BM402: Control System Engineering **[4 0 2 4 1]**

Learning Outcomes:

The educational objectives of the course are to educate students to attain the following:

- To understand the basic concept of control system.
- Tounderstand system design and analysis criterion.
- The course contents will enable the students to study the application in Biomedical Engineering.
- The contents will allow the students to apply the knowledge of control system engineering in other application.

SYLLABUS

Unit No.	Topics	Lectures (Hours)
	Introduction to the basics and importance of this course.	
1	**INTRODUCTION CONTROL SYSTEMS:** History of automatic control,Types of control system: Manual and Automatic control system, Open loop and Close loop control systems, Linear and Nonlinear Control System, Time variant and Time invariant control system, Block diagram representation of control system, Examples of control systems.	3
2	**MATHEMATICAL MODELING AND TRANSFER FUNCTION:** Mathematical models of Mechanical and Electrical systems. Analogy system, Transfer functions of mechanical and Electrical systems. Block diagram of a closed loop systems, Block diagram reduction technique, Signal flow graphs technique: signal flow graph terms, properties, signal flow graph algebra, mason's gain formula.	8
3	**GENERAL FEEDBACK CHARACTERISTICS:** Importance of feedback in control system, Reduction of parameter variation and sensitivity, Effect of feedback on band width, Effect of feedback on system dynamics, Effect of feedback in presence of disturbances, Regenerative feedback and its use in control system, Advantages and Disadvantages of feedback.	4
4	**CONTROL SYSTEM COMPONENTS:** Elements of a control system, **Error detectors:** Potentiometers, Synchros. **Servo Amplifiers:** Amplidyne, Magnetic Amplifier.**Actuators:** DC and AC servo motors, Stepper Motors. **Feedback components:** DC and AC Tachogenerators, Optical incremental and absolute encoders, Control system Models of position and speed controls. Instrument servomechanism.	4
5	**TIME DOMAIN ANALYSIS:** Transient Response, standard test signals, Time response of first and second order system, Time response specifications, Transient response specifications of second order systems, Steady state response, Evaluation of steady state error and Error constants, Steady state error of second order system, Effect of control actions on transient response, Effect of Integral control on transient response, Effect of Zero on transient response.	8

6	**STABILITY ANALYSIS:** Characteristic equations of closed loop control systems and stability concept, Locus of complex conjugate roots, Poles and Zeros of transfer function. Routh and Hurwitz stability criterion, Relative stability	**4**
7	**ROOT LOCUS TECHNIQUES:** Basis of root locus, construction rules for sketching root locus.	**5**
8	**FREQUENCY DOMAIN ANALYSIS:** Frequency response of a control system, Frequency response of second order system, Performance specifications in frequency domain, Correlation between time response and frequency response, Normalized bandwidth, **Polar Plots**, **Bode diagrams:** concept of logarithmic plots, bode plots of standard terms, stability from bode plot, gain and phase margins.	**8**
9	**NYQUIST STABILITY CRITERION:** Principle of argument, Nyquist criterion, Nyquist contour modification for poles on jw axis, Relative stability from Nyquist criterion, Gain and Phase margins	**4**
10	**STATE VARIABLE ANALYSIS AND DESIGN:** Introduction, Concept of State, State Variables and State Model, State model of Linear Continuous-Time System, Diagonalization, Solution of state equations, Concept of Controllability and Observability.	**2**

Term Work and Practical shall be based on the above syllabus.

Text Books:

1. Control Systems Engineering by I.J.Nagrath and M.Gopal
2. Modern Control Engineering by K.Ogata.

Reference Books:

1. Control system Engineering by Prof. H.T. Kashipara
2. Elements of Control Systems by Sudhir Gupta
3. Automatic Control Systems by Benjamin C. Kuo and FaridGolnaraghi