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| **ECx515** | **Control Systems** | **L-T-P: 3-0-0; Total 42 Lectures** |

**Pre-requisite**: Laplace Transforms, Complex Analysis, Differential Equation, Matrix

**Objectives:** To understand the methods of representation of systems and to desire their transfer function models. To provide adequate knowledge in the time response of systems and steady state error analysis. Mathematical modelling of different Physical systems, To understand the concept of stability of control system and stability analysis of Linear System using Time domain and Frequency domain techniques. To develop base for linear system design using Time domain and Frequency domain techniques

***Topics Covered :***

Unit 1. **Introduction:** Linear, nonlinear, time varying and linear time invariant system, servomechanism, historical development of automatic control and introduction to digital computer control, mathematical models of physical systems, differential equations of physical systems, transfer functions, block diagram algebra and signal flow graphs. [**10** Lecture]

Unit 2. **Feed Back Characteristics of Control Systems:** Feedback and non‐feedback systems, advantages and disadvantages of negative feedback, regenerative feedback. Control Systems and Components: DC and AC servomotors, synchros, tacho generator and stepper motors, ADC and DAC. [**6** Lecture]

Unit 3.**Time Response Analysis, Design Specifications and Performance Indices:** Standard test signals, time response of first‐order systems, time response of second‐order systems, steady‐state error and error constants, effect of adding a zero to a system, P, PI and PID control actions and their effect, design specifications of second‐order systems and performance indices. [**8** Lecture]

Unit 4 .**Concepts of Stability and Algebraic Criteria:** The concept of stability, necessary and sufficient conditions for stability, Routh’s stability criterion and relative stability analysis. Root locus technique: root locus concept, construction of root loci, root contours, systems with transportation lag, sensitivity of the roots of the characteristic equation, analysis and design of control systems with MATLAB. [**8** Lecture]

Unit 5. **Frequency Response Analysis:** Correlation between time and frequency response, polar plots, Bode plots, and all pass and minimum‐phase systems. Stability in frequency domain: mathematical preliminaries, Nyquist stability criterion, definition of gain margin and phase margin, assessment of relative stability using Nyquist and Bode Plots, closed‐loop frequency response. [**10** Lecture]

***Suggested Readings:***

1. Kuo, B. C, Automatic Control Systems. Prentice Hall of India.
2. Ogata. K, Modern Control Engineering, Prentice Hall of India
3. Nagrath I. J. and Gopal M, Control Systems Engineering, New Age International. Publishers
4. James Melsa, Donald Schultz, Linear Control Systems, Mcgraw-Hill, 1992.
5. Norman S. Nise, Control Systems Engineering, John Wiley and Sons, 2011.
6. B. S. Manke, Control system Engineering, Khanna Publication

**Course Outcome:** By the end of the course, students should be able to do the following:

1. Mathematical modelling of different Physical systems
2. Draw the pole-zero diagram and the root loci, which are the change in location of the poles as parameters are of a system are varied.
3. Analyze stability of Linear system.
4. Understand the meaning of proportional control, integral control, and derivative control, lag compensation, and lead compensation, and how to use them to achieve desired stability, steady-state error, and frequency response.
5. Designing linear system using different techniques