**20EE31O1 - LINEAR CONTROL SYSTEMS**

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| **Course Category:** | Open Elective | **Credits:** | 3 |
| **Course Type:** | Theory | **Lecture-Tutorial-Practical:** | 3-0-0 |
| **Pre-requisite:** | Basic knowledge of differentiation, integration and Laplace transform techniques. | **Sessional Evaluation:**  **External Exam Evaluation:**  **Total Marks:** | 40  60  100 |

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| **Course Objectives:** | To make the student learn about: | |
| 1. The various types of control systems and methods to obtain transfer  function.  2. The mathematical models of physical systems.  3. The time domain responses of first and second-order systems for  different input signals.  4. The stability of a control system using different techniques.  5. The frequency domain techniques to assess the system performance.  6. The different types of compensators for linear systems. | |
| **Course Outcomes:** | Upon successful completion of the course , the students will be able to: | |
| **CO1** | Understand the various types of control systems and methods to obtain transfer function. |
| **CO2** | Develop mathematical models of physical systems. |
| **CO3** | Determine the time domain responses of first and second-order systems for different input signals. |
| **CO4** | Evaluate the stability of a control system using different techniques. |
| **CO5** | Apply frequency domain techniques to assess the system performance. |
| **CO6** | Design the different types of compensators for linear systems. |
| **Course Content:** | **UNIT –I**  **Introduction to classical control systems:**Introduction, Classification of control systems, Difference between Open loop and Closed loop control systems, Feedback-Need of feedback -types of feedback and its effects, transfer functions, Block diagrams-Block diagram of a simple closed loop system-Block diagrams reduction, Signal flow graphs-Terminologies used in Signal Flow Graphs-Rules for Signal Flow Graphs-mason’s gain formula.  **UNIT-II**  **Mathematical modeling of physical systems:**Mechanical Translational System-Force Balance Equations of Idealized Elements,Mechanical Rotational System-Torque Balance Equations of Idealized Elements,Transfer Function of Armature Controlled DC Motor,Transfer Function of Field Controlled DC Motor,Analogous Systems- Electrical Analogous Of Mechanical Translational System ,Electrical Analogous of Mechanical Rotational Systems, DC Servo Motors,Two-Phase AC Servo Motors , Synchros.  **UNIT-III**  **Time domain analysis:** Introduction, Standard Test Signals,Order of a System,Characteristic Equation of a Transfer Function, Second Order System,Response of Second Order System for Unit Step Input, Time Response Specifications, Expressions for Time Domain Specifications, Type Number of Control Systems, Steady State Error, Static Error Constants, Steady State Error for Unit Step, Unit Ramp And Unit Parabolic Input Signals.  **UNIT-IV**  **Stability of control systems:**Absolutely Stable System,Unstable System , Critically Stable System,Relative Stability,Location of Poles on S-Plane for Stability, Necessary Conditions for Stability, Routh-Hurwitz Criterion- Root Locus- Rules For The Construction of Root Loci, Introduction to Proportional, Derivative and Integral Controllers.  **UNIT-V**  **Frequency domain Analysis:**Sinusoidal Transfer Function and Frequency Response,Frequency Domain Specifications,Frequency Domain Specifications of Second Order System , Bode Plots-Basic Factors of a Typical Transfer Function- Procedure for Magnitude Plot and Phase Plot of Bode Plot, Polar Plots-Typical Sketches of Polar Plot-Determination of Gain Margin and Phase Margin from Polar Plot, Nyquist Stability Criterion-Mathematical Preliminaries for Nyquist Stability Criterion-Arbitrary S-Plane Contours and their Corresponding F(S)-Plane Contours- Principle of Argument.  **UNIT-VI**  **Design of compensators:** Introduction to Design using Compensators, Lag Compensators- S-Plane Representation of Lag Compensator-Realization of Lag Compensator using Electrical Network- Frequency Response of Lag Compensator, Lead Compensators- S-Plane Representation of Lead Compensator-Realization of Lead Compensator using Electrical Network- Frequency Response of Lead Compensator. | |
| **Text books**  **&**  **Reference books:** | **Text books:**  1. “Control system engineering”, by I.J.Nagrath and M.Gopal, 6th Edition, New age International (P) Ltd.  2. “Control systems”, by A.Nagoorkani, 2nd Edition, RBA publishers.  3. “Control systems” by A.Anandkumar, 2nd Edition, PHI publishers.  **Reference books:**  1. “Automatic control systems”, by B.C.Kuo, 7thEdition, PHI publishers.  2. “Discrete time control systems”, by K.Ogata, PHI Publishers.  3. “Control systems engineering”, by Norman S Nise, Wiley, 2000. | |
| **e-Resources:** | <http://nptel.ac.in/courses>  <http://iete-elan.ac.in>  <http://freevideolectures.com/university/iitm> | |

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| **Contribution of Course Outcomes towards achievement of Program Outcomes** | | | | | | | | | | | | | | |
|  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | 2 | 3 | 3 |
| CO2 | 3 | 3 | 3 | 3 | 3 | - | - | 1 | - | - | - | 2 | 3 | 2 |
| CO3 | 3 | 3 | 3 | 1 | 1 | - | - | - | - | - | - | 2 | 2 | 3 |
| CO4 | 3 | 3 | 2 | 2 | 1 | 2 | 3 | - | - | - | - | 2 | 2 | 3 |
| CO5 | 3 | 3 | 2 | 2 | 1 | - | - | 1 | - | - | - | 2 | 3 | 2 |
| CO6 | 3 | 3 | 2 | 2 | 1 | - | - | 1 | - | - | - | 2 | 3 | 2 |