204188 Control Systems

Teaching Scheme:

Lectures: 3 Hrs/ Week

Tutorial : 1 Hr/Week

Examination Scheme:

Theory Online : 50 Marks

Theory Paper : 50 Marks

Term work: 25 Marks

Course Objectives and Outcomes:

The concept and theory of control systems are needed in almost all electronics and telecommunication engineering fields and in many other engineering and scientific disciplines as well. The main objective of this course is to introduce and give an exposure to the students the fundamentals of control systems, various components in the control system, time domain, frequency domain analysis and also the system stability analysis. This course would also provide the basis for control system analysis using state space analysis and finally the digital control systems and their applications.

Having successfully completed this course, the student will be able to:

1. Model a physical system and express its internal dynamics and input-output relationships by means of block diagrams, mathematical model and transfer functions.
2. Understand and explain the relationships between the parameters of a control system and its stability, accuracy, transient behavior.
3. Identify the parameters that the system is sensitive to. Determine the stability of a system and parameter ranges for a desired degree of stability.
4. Plot the Bode, Nyquist, Root Locus diagrams for a given control system and identify the parameters and carry out the stability analysis.
5. Determine the frequency response of a control system and use it to evaluate or adjust the relative stability,
6. Design a P, PD, PI, or PID controller based on the transient and steady state response criteria.
7. Model and analyze the control systems using state space analysis.

Unit I : Basics of Control Systems **6L**

Introduction , Types of Control Systems : Open loop & Closed loop , Feed back Control System, Effect of Feed Back , Modeling of Simple Electrical & Mechanical Systems Using Differential Equations, Concept of Transfer Function , Characteristics Equation, Poles and Zeros , Block Diagram Algebra ,Control system Components : A.C. & D.C. Servomotors , Stepper Motor

Unit II : Time Domain Analysis **6L**

Type and Order of the Control Systems , Types of Standard Inputs , Response of First Order System to Step, Ramp and Parabolic Inputs , Response of Second Order System to Step Input ,

Time Domain Specifications of Second Order Systems, Steady State Error and Error Coefficients, Effects of addition of Poles and Zeros

Unit III : Stability **6L**

Concept of Stability , Absolute ,Relative , Marginal and Unstable Stability analysis in S Plane , Dominant Poles and Zeros , Routh-Hurwitz Criterion , Concept of Root Locus

Unit IV : Frequency Domain Analysis **6L**

Need of Frequency Domain Analysis , Correlation between Time & Frequency Domain , Frequency Domain Specifications , Bandwidth , Bode Plot , Construction of Bode Plot , Gain and Phase Margin , Determination of Relative Stability , Nyquist Stability Criterion, Relative Stability Using Nyquist Criterion

Unit V : State Space Analysis **6L**

Advantages of State Space Analysis over Classical Control , Concept of State , State Variables and State Model , State Space Representation using State Model, State Transition Matrix and its properties, Solution of State Equations for LTI System , Concept of Controllability and Observability

Unit VI : Digital Control Systems **6L**

Introduction, Advantages over analog control system, Sampled Data Control System, Transfer Function of Digital Control System, Step Response (First & Second Order Systems only), Introduction to Digital PID Controller, Introduction to PLC: Block schematic, PLC addressing, any one application of PLC using Ladder diagram. Concept of Offset ,P, PI , PD and PID Characteristics

Text Books :

1. Katsuhiko Ogata, Modern Control Engineering, Fifth Edition, PHI Learning Private Limited, New Delhi, 2010
2. I.J. Nagrath , M.Gopal, Control Systems Engineering, Fifth Edition, New Age International Publishers, New Delhi, 2007

Reference Books :

1. Curtis D Johnson, Process Control Instrumentation Technology, Eighth Edition, PHI Private Limited, New Delhi, 2011
2. Richard C. Drof , Robert N. Bishop, Modern Control Systems, Addison Wesley Publishing Company, 2001
3. B.C.Kuo, Digital Control Systems, Second Edition, Oxford University Press, New York, 1992

Control Systems

(Tutorial Assignments)

Tutorials must be conducted batch wise. Batch size should not be more than 20 students.

The main objective of this tutorial is to focus on the outcomes defined in the theory syllabus by solving the following assignment based on paper work. Paper work is compulsory for all assignments; however it is desirable, few assignments may also be implemented using appropriate software.

Assignment to be given on the following topics.

1. Find overall transfer function of the system using block diagram algebra.
2. Find determine the stability of a system using Routh Hurwitz Criterion, marginal value of K and frequency of sustained oscillations.
3. Construct the root locus and comment on the stability.
4. Find the time domain specifications of the given system.
5. Find the steady state error and error coefficients of the type 0, 1 and 2 systems for step, ramp and parabolic inputs.
6. Find frequency domain specifications of the system.
7. Draw Bode Plot, find PM and GM and Comment on the stability. Also, find transfer function of the system from given Bode plot.
8. Find stability of the system using Nyquist Criteria.
9. Write State space model of the system and solution.
10. Find State Transition Matrix for given system and verify the properties of the same.
11. Find the Transfer Function of a Digital System.
12. Find the response of first and second order Digital Systems for Step Input.
13. Study the Digital PID Controller with reference to response time, steady state error and offset.