

## EL- 602: Control Systems

Core Paper  
Total Periods: 48

### UNIT1

Introduction of open loop and closed loop control systems, mathematical modeling of physical systems (Electrical, Mechanical and Thermal), derivation of transfer function, Armature controlled and field controlled DC servomotors, AC servomotors, block diagram representation & signal flow graph, Reduction Technique, Mason's Gain Formula. Effect of feedback on control systems, Basic Control Actions: Proportional, integral and Derivative controls

12 Periods

### UNIT 2

**Time – Domain Analysis:** Time domain performance criteria, transient response of first, second & higher order systems, steady state errors and static error constants, performance indices, response with P, PI and PID Controllers. **Concept of Stability:** Asymptotic stability and conditional stability, Routh – Hurwitz criterion, relative stability analysis, Root Locus plots and their applications.

12 Periods

### UNIT3

**Frequency Domain Analysis:** Correlation between time and frequency response, Polar and inverse polar plots, frequency domain specifications, Logarithmic plots (Bode Plots), gain and phase margins, Nyquist stability criterion, relative stability using nyquist criterion, constant M & N circles.

14 Periods

### UNIT4

**Compensation Techniques:** Concept of compensation, Lag, Lead and Lag-Lead networks **State Space Analysis:** Definitions of state, state variables, state space, representation of systems, Solution of time invariant, homogeneous state equation, state transition matrix and its properties

Essential Books:

#### UNIT 1

Chapter 1,2,3,4- I. J. Nagrath & M. Gopal, Control System Engineering, New Age International, 2000

Chapter 1,3- K. Ogata, Modern Control Engineering, PHI 2002

Chapter 1,3,4- B. C. Kuo , “Automatic control system”, Prentice Hall of India, 2000

#### UNIT 2

Chapter 5,6,7 - I. J. Nagrath& M. Gopal, Control System Engineering, New Age International, 2000

Chapter 5,6,7 - K. Ogata, Modern Control Engineering, PHI 2002

Chapter 6,7,8,10 - B. C. Kuo , “Automatic control system”, Prentice Hall of India, 2000

### UNIT 3

Chapter 8,9 - I. J. Nagrath & M. Gopal, Control System Engineering, New Age International, 2000

Chapter 8 - K. Ogata, Modern Control Engineering, PHI 2002

Chapter 9 - B. C. Kuo, "Automatic control system", Prentice Hall of India, 2000

### UNIT 4

Chapter 10,12 - I. J. Nagrath & M. Gopal, Control System Engineering, New Age International, 2000

Chapter 9,11 - K. Ogata, Modern Control Engineering, PHI 2002 2

Chapter 5,10 - B. C. Kuo, "Automatic control system", Prentice Hall of India, 2000

### **Suggested Books:**

1. Dr. N.K Jain, Automatic Control System Engineering, Dhanpat Rai Publication, 2005
2. B. S. Manke, Linear Control Systems, Khanna Publishers, Delhi

### **Control Systems (Practical based on Paper No 11)**

(Any eight)

1. To study characteristics of :
  - a. Synchro transmitter receiver
  - b. Synchro as an error detector
2. To study position control of DC motor
3. To study speed control of DC motor
4. To find characteristics of AC servo motor
5. To study time response of type 0,1 and 2 systems
6. To study frequency response of first and second order systems
7. To study time response characteristics of a second order system.
8. To study effect of damping factor on performance of second order system
9. To study frequency response of Lead and Lag networks.
10. Study of P, PI and PID controller.

Some of the experiments mentioned above can be simulated on software (Matlab, MathCAD, LabVIEW)