403145: Control Systems – II

Teaching Scheme

Lectures: 4 Hrs./Week
Practical: 2 Hrs./Week

Examination Scheme

Theory: 100 Marks
Oral: 50 Marks
Term Work: 50 Marks

Unit I (7)

Compensation Technique: Approaches and preliminary consideration. Design of Linear Control System, Common compensating networks, Transfer function of Lag, Lead and Simple lag-lead network. Design using Bode diagram. Physical realization of compensators using active and passive elements.

Unit II (8)

State Space Analysis: Review of state space analysis, Concept of diagonalization, eigen values, eigenvectors, diagonalization of system matrices with distinct and repeated eigen values, Vander Monde matrix.

Solution of homogeneous and non-homogeneous state equation, state transition matrix, its properties, various methods to determine e^{At} Laplace inverse transform, Caley-Hamilton technique, Infinite power series method, Taylor's series expansion technique.

Unit III (9)

Design of Control System Using State Space Technique: Definition of controllability & observability, controllability & observability matrices, condition for controllability & observability from the system matrices in canonical form, Jordan canonical form, effect of pole zero cancellation on the controllability & observability of the system, duality property. Pole placement design by state feedback. State observer, design of full order observer.

Unit IV (7)

PID Controllers: Design specifications in time domain and frequency domain. Time design of P, PI and PID control. Frequency domain design of P, PI and PID control. Tunning of PID controller. Ziegler-Nichol method.

Unit V

(8)

Non linear System Analysis: Introduction, qualitative analysis of nonlinearities in real life, classification, common type of non-linearities, peculiar behavior of nonlinear system- response, jump resonance, limit cycle: stable and unstable, amplitude as function of frequency oscillation, non linear spring mass system, sub harmonic oscillation, asynchronous quenching, frequency entrainment etc.

Introduction to describing function, describing function of ideal relay, relay with dead zone and saturation nonlinearities, Stability analysis with describing function, Limitations.

Unit VI

(9)

Stability of Nonlinear System: Introduction to phase plane method, singular point, construction of phase plane trajectory of a second order system using delta method and phase portrait, calculation of time from phase plane trajectory, phase portrait, stability analysis from phase plane.

Lyapunov's Stability analysis- Lyapunov's Stability, asymptotic stability, instability, positive definiteness, negative definiteness, positive semi definiteness, negative semi definiteness, indefiniteness. Methods of constructing Lyapunov's function for nonlinear systems, *Linearization of nonlinear state equations and local stability*, use of Lyapunov's theory for control system design.

List of Experiments:

Minimum 8 experiments from the following list.

1. Linear analysis of DC position control system using simulink.
2. Phase plane analysis of nonlinear system using simulink.
3. Software programming for determination of STM.
4. Software programming for determination of controllability and observability of state model of a given system.
5. Software programming for determination eigen values & eigen vector of system metrics.
6. Software programming for determination of state space representation for given transfer function.
7. Assignment problem to draw phase plane trajectory.
8. Assignment problem to decide stability, amplitude & frequency of limit cycle using describing function method.
9. Software programming to design system by pole placement through state feedback.
10. Software programming to obtain transfer function from state model.
11. **Assignment problems optimal control theory**
12. Observer design using MATLAB.
13. To design Lead and Lag compensator and to obtain the characteristic by simulation using Software.

4. **Text Book:**

I. J. Nagrath, M. Gopal "Control System Engineering", 5th Edition. New Age International Publishers

Reference Books:

1. Benjamin C. Kuo, "Automatic Control Engineering", Prentice Hall of India Pvt. Ltd.
2. K. Ogata, "Modern Control Engineering", Prentice Hall of India Pvt. Ltd.
3. M. Gopal, "Digital Control Engineering", Wiley Eastern, 1988
4. M. N. Bandyopadhyan, "Control Engineering – Theory and Practice", Prentice Hall of India Ltd. Delhi
5. Applied Non linear Control , Jean-Jacques E. Slotine, Weiping Li, Prentice Hall

Changes to be incorporated in the syllabus:

1. The topic "*Linearization of nonlinear state equations and local stability*" in unit VI to be added.
2. The experiment number 11 - **Assignment problems optimal control theory- is to be removed**
3. The reference book-Applied Non linear Control , Jean-Jacques E. Slotine, Weiping Li, Prentice Hall- is to be added