

SEPTEMBER 1981

CONTROL SYSTEMS N611

(One 3-hour paper)

A. General theory of control systems

1. Block diagram algebra : Definition of the transfer function and various ratios including error, primary feedback and control ratios of closed-loop control systems. Series and parallel block systems. Single and multiple inputs.
2. Transient response : Transient response of a system as determined by Laplace transform methods. Definitions of step, ramp and sine functions. Initial and final value theorems. Rise and delay time and time constant of a system. Damping ratio and natural frequency of second-order systems. Under, over and critical damping. Transfer function of lag and lead compensators, amplifiers, gear trains, servomotors potentiometers, synchro-pairs and rate generators.
3. Bode diagrams : Sketching of magnitude and phase diagrams. Gain and phase margins. Series lag and lead compensation with aid of templates. Gain compensation.
4. Nichols diagrams : Gain and phase margin, resonant peak and frequency. Closed loop frequency response for unity feedback system.
5. Root-locus diagrams : Construction of root-locus diagrams. Stability determination. Gain margin. Damping ratio.

B. Practical control systems

1. Transducers : Potentiometers, synchros, linear variable differential transformers, ac and dc tachogenerators, capacitive and electro-optical transducers, as applied to error detection.
2. Electronic systems : Phase-sensitive rectifiers. Emitter coupled and operational amplifiers. A.C. amplifiers. Thyristor and triac control.
3. Electrical machines and systems : Direct and a.c. servo motors. Ward-Leonard speed control. Solid state speed control. Matching of motors and gearing with load. Rotary and magnetic amplifiers.

4. Hydraulic systems : Basic hydraulic systems. Gear, vane and piston pumps. Piston, flapper and nozzle, and jet-pipe valves. Hydraulic activators. Simple linear servosystems using mechanical and electronic feedback.
5. Pneumatic systems : On-off control. Proportional control. Integral control. Proportional plus integral control. Derivative control. Air-operated control systems.
6. Tests and testing equipment : Signal generation. Recording and display. The matching of test equipment. Determining the frequency response of a system.