Reg. No. : [redacted]

J 3270

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2009.

Fourth Semester

(Regulation 2004)

Electrical and Electronics Engineering

IC 1251 — CONTROL SYSTEMS

(Common to Instrumentation and Control Engineering)

(Common to B.E. (Part-Time) Third Semester Electrical and Electronics Engineering Regulation 2005)

Time : Three hours Maximum : 100 marks

Ordinary graph and Semilog Sheets will be provided on demand.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. With necessary equations give the basic elements of a linear mechanical system.

2. Distinguish between the DC motor and a servo motor.

3. Write the equation in Laplace for an test signal analogous to a shock and a signal with linear variation of time.

4. What are the advantages of signal flow graphs with reference to the block diagram?

5. Define bandwidth.

6. Draw the polar plot for a Type 2 third order system.

7. Sketch the time response plot under (a) Roots lying on the imaginary axis (b) Roots lying in R.H.S. plane.

8. Define minimum phase and non minimum phase.

9. State Nyquist stability criterion.

10. What is the effect of a lag network?

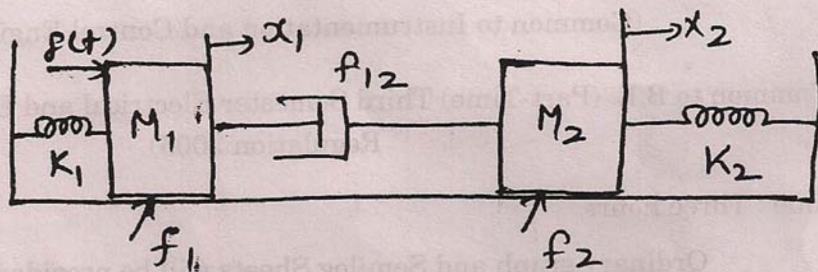
PART B — (5 × 16 = 80 marks)

11. (a) (i) Derive the transfer function of an armature controlled DC motor. (10)

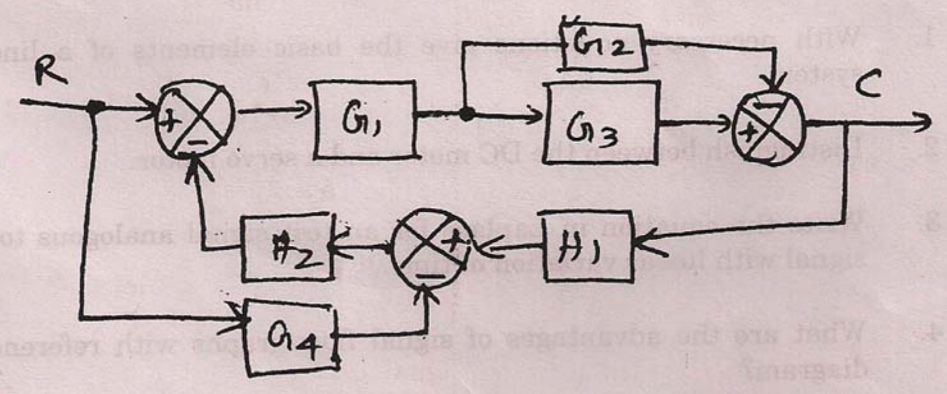
(ii) Discuss in detail the constructional details of a synchros. (6)

Or

(b) (i) Write the differential equations for the given mechanical system and draw an analogous electrical circuit based on force-voltage analogy. (8)



(ii) Draw a signal flow graph and evaluate the closed-loop transfer function of a system for the given block diagram. (8)



12. (a) (i) Derive an expression for the output response of a second order system. (8)

(ii) Derive an expression for peak time and rise time. (8)

Or

(b) A unity feedback system is characterized by the open-loop transfer function $G(S)=\frac{1}{s(1+0.5s)(1+0.2s)}$. Determine the steady state error for unit step, unit ramp and unit acceleration input. Also, determine the damping ratio and natural frequency of the dominant roots. (16)

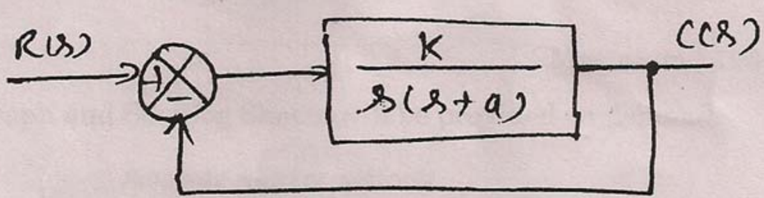
13. (a) Sketch the Bode plot (magnitude and phase angle plot) of the given transfer function. Also determine the gain cross-over frequency. (16)

$$G(s)=\frac{75(1+0.2s)}{s(s^2+16s+100)}.$$

Or

(b) (i) For the given system, determine the value of K and a to satisfy the following frequency domain specifications : $m_r=1.04$, $w_r=11.55$ rad/sec. (10)

(ii) For the values of K and a, calculate the settling time and bandwidth of the system. (6)



14. (a) The characteristic equation of a feedback control system is $s^4+3s^3+12s^2+(k-16)s+k=0$. Sketch the root locus plot for $0 \le K < \infty$ and show that the system is conditionally stable. Determine the range of gain for which the system is stable. (16)

Or

(b) The open loop transfer function of a unity feedback control system is given by

$$G(s)=\frac{K}{(s+2)(s+4)(s^2+6s+25)}$$

By applying the Routh criterion, discuss the stability of the closed-loop system as a function of K. Determine the values of K which will cause sustained oscillations in the closed loop system. What are corresponding oscillation frequencies? (16)

15. (a) Discuss in detail the design procedure for a lead compensator network. (16)

Or

(b) Design a lag compensator for a system with open loop transfer function of (16)

$$G_j(s) = \frac{K}{s(s+1)\ (s+4)}.$$

The system is to be compensated to meet the following specifications :

Damping ratio $\zeta = 0.4$ settling time t_s = 10 sec. Velocity error constant $K_v \geq 5$ sec^{-1}, $t_s = \frac{3}{\zeta w_n}$ for 5% tolerance band. The specification in frequency domain are : $\varphi_S = 43°$, w_b = 1.02 rad/sec; $K_V \geq$ 5 sec^{-1}.

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