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Question Paper Code : 21503

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2015.

Fourth Semester

Electrical and Electronics Engineering

EE 2253/EE 44/EE 1253 A/080280033/10133 IC 401 — CONTROL SYSTEMS

(Common to Instrumentation and Control Engineering and Electronics and Instrumentation Engineering)

(Regulations 2008/2010)

(Also common to PTEE 2253 – Control Systems for B.E. (Part-Time) Third Semester – Electronics and Instrumentation Engineering – Regulations 2009 and 10133 IC 401 – Control System for B.E. (Part-Time) Third Semester – EEE – Regulations 2010)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define transfer function.
2. Compare open loop and closed loop control systems.
3. Classify the system based on damping.
4. Write the relation between static error coefficients and generalized error coefficients.
5. Why is frequency response analysis important in control applications?
6. List out the techniques used for determining closed loop response from open loop response.
7. State Routh's Hurwitz criterion.
8. What is the effect of pole on the system response?
9. Write the need for compensation.
10. Draw the circuit of lag-lead compensator.

PART B — (5 × 16 = 80 marks)

11. (a) Obtain the closed loop transfer function C(s)/R(s) for the system shown in Fig. 11 (a) using block diagram reduction technique. Also verify it using Mason's gain formula. (8+8)

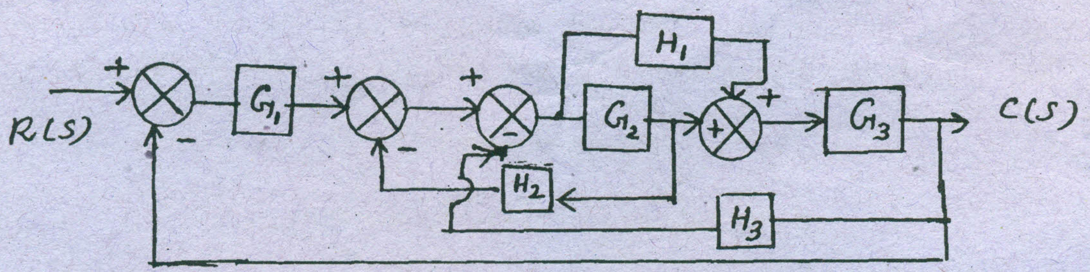

Fig. 11 (a)

Or

(b) (i) Draw the force voltage analogy and force current analogy for the mechanical System shown in Fig. 11 (b). (8)

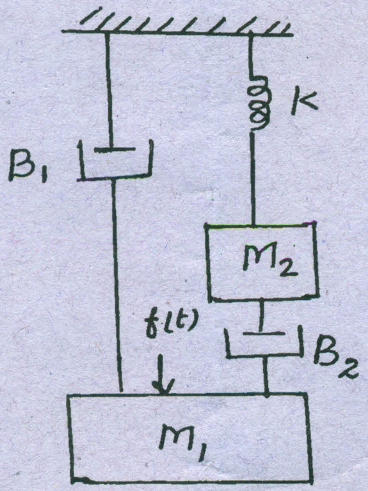

Fig. 11 (b)

(ii) Explain armature controlled DC servo motor with relevant block diagram. (8)

12. (a) (i) A unity feedback control system has the open loop transfer function $G(s) = \frac{K}{(s+A)(s+2)}$. Find the values of K and A, so that the damping ratio is 0.707 and the peak time for unit step response is 1.8 sec. (8)

(ii) Obtain the impulse and step responses of the following unity feedback control system with open loop transfer function $G(s) = \frac{6}{s(s+5)}$. (8)

Or

(b) (i) For the unity feedback system whose forward path transfer function $G(s) = \frac{1}{s(s+1)}$ and the input signal is $r(t) = 4 + 6t + 2t^3$. Find the generalized error coefficients and steady state error. (10)

(ii) Explain the effect of P, PI and PID controllers on the system performances. (6)

13. (a) (i) The closed loop transfer function of a system $\frac{C(s)}{R(s)} = \frac{81}{s^2 + 7s + 81}$. Calculate the values of resonant frequency resonant peak and band width. (8)

(ii) Explain the correlation between frequency domain and time domain specifications. (8)

Or

(b) (i) Define the following:

(1) Gain margin

(2) Gain cross over frequency

(3) Phase margin

(4) Phase cross over frequency. (8)

(ii) The open loop transfer function of a unity feedback system is $G(s) = \frac{1}{s(s+1)(2s+1)}$. Sketch the polar plot and determine the gain margin and phase margin. (8)

14. (a) (i) Explain the concept of stability based on the location of poles. (4)

(ii) Sketch the Nyquist plot and comment on closed loop stability of a system whose open loop transfer function is $G(s) = \frac{10}{s^2\,(s+2)}$. (12)

Or

(b) (i) Test the stability for the system with characteristic equation $s^3 + 5s^2 + 6s + 30 = 0$ using Routh's Hurwitz. (4)

(ii) Draw the root locus for a unity feedback system having open loop transfer function $G(s) = \frac{K}{s(s^2 + 8s + 36)}$. (12)

15. (a) (i) Explain the different types of compensation techniques. (6)

(ii) A unity feedback system has the open loop transfer function $G(s) = \frac{K}{s(s+2)}$. Design a lead compensator for the system to achieve the following specifications. Velocity error constant $K_v \geq 12\,\text{sec}^{-1}$ and phase margin $\Phi_{pm} \geq 45°$. (10)

Or

(b) (i) Explain the performance characteristics of Lead, Lag, Lag-Lead compensators. (6)

(ii) A unity feedback system has the open loop transfer function $G(s) = \frac{K}{s(1+2s)}$. Design a lag compensator so that the phase margin is $40°$ and the steady state error for ramp input is less than or equal to 0.2. (10)
