KUMARAGURU
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Register Number: ……

B.E DEGREE EXAMINATIONS: NOV/DEC 2014

(Regulation 2009)

Fifth Semester

ELECTRICAL AND ELECTRONICS ENGINEERING

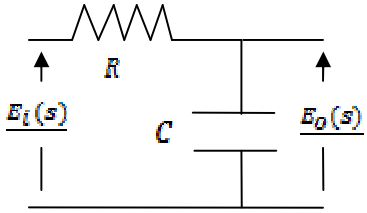
EEE109**:** Control Engineering

Time: Three Hours **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. The transfer function $\frac{E_0(s)}{E_i(s)}$ of a simple $R-C$ integrator circuit shown below is given by

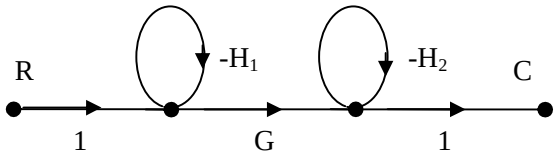


$a = \frac{1}{RC}$

a) $\frac{1}{s-a}$ b) $\frac{1}{s+a}$

c) $\frac{a}{s-a}$ d) $\frac{a}{s+a}$

2. Find the transfer function of the system whose signal flow graph is shown



a) $\frac{G}{1+H_1H_2+H_1+H_2}$ b) $\frac{G}{1-H_1H_2+H_1+H_2}$

c) $\frac{G}{1+H_1H_2-H_1+H_2}$ d) $\frac{G}{1+H_1H_2-H_1-H_2}$

3. For the system with the following transfer function, find the type and order of the system $G(s) = K/s(s+10)$

a) Type 1, 1st order b) Type 1, 2nd order

c) Type 0, 1st order d) Type 0, 2nd order

4. Determine the steady state error for unit step input of a unity feedback system having an open loop transfer function G(s) = 10 / [(s+1) (s+2)].

a) 5 b) 10

c) 1/5 d) 1/6

5. For a type 3 system, the initial slope of Bode plot will be

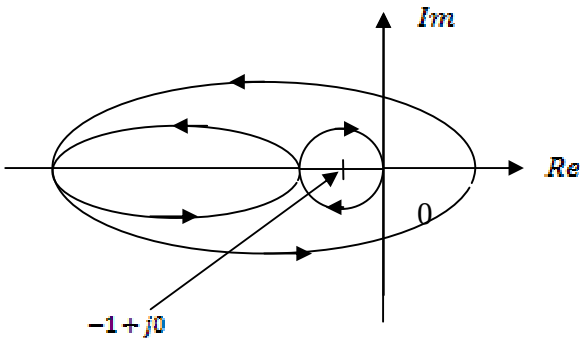
a) $-20\ db$/decade b) $+60\ db$/decade

c) $+20\ db$/decade d) $-60\ db$/decade

6. The damping ratio of a second order system is 0.5. Calculate the resonant peak.

a) 2.154 b) 1.145
c) 1.154 d) 1.415

7. If the poles of a control system lie on the imaginary axis in s-plane the system will be
   a) unstable b) stable
   c) conditionally stable d) marginally stable
8. For the given Nyquist plot, the system is



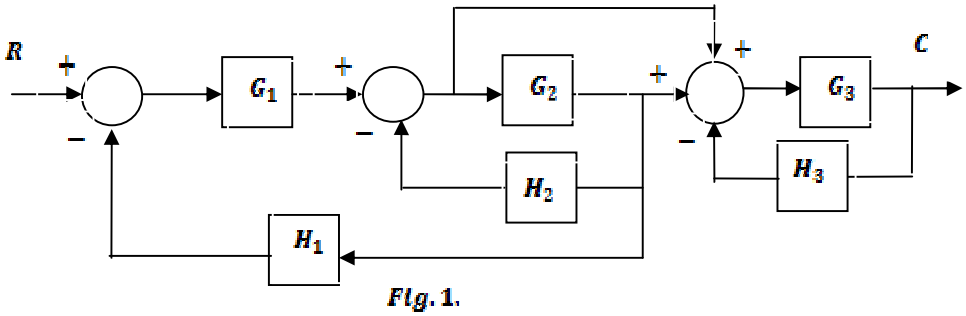
   a) stable b) relatively stable
   c) unstable d) conditionally stable
9. The meeting point of asymptotes with real axis is called
   a) centroid b) break in point
   c) breakaway point d) dominant pole
10. The inductance is not being used to fabricate a lag network because
   a) It has high reactance b) it produces time delay and hysteresis loss
   c) its size is large d) It has low reactance

PART B (10 x 2 = 20 Marks)

11. In force-current analogy give the analogous electrical elements for the rotational mechanical elements
12. Compare the armature and field controlled dc servomotors. Which is most common in use and why?
13. How the system is classified depending on the value of damping?
14. Mention two advantages of generalized error constants over static error constants.
15. Define gain and phase cross-over frequency.
16. How closed loop frequency response is determined from open loop frequency response using M and N circles?
17. State Nyquist stability criterion.
18. What are asymptotes? How will you find the angle of asymptotes?
19. Mention the need for compensating networks.
20. What are the effects and limitations of phase lag control?

PART C (5 x 14 = 70 Marks)

21. a) (i) Obtain the closed-loop transfer function of the system whose block diagram is shown in Fig.1. (9)



Flg. 1.

(ii) Discuss the working of AC servo motor in control systems. (5)

(OR)

b) (i) Draw the force-voltage and force-current analogous electric circuits for the mechanical system shown in fig. 2. (7)

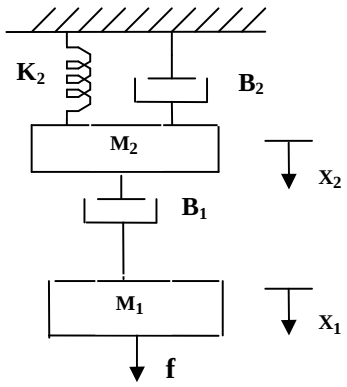


Fig. 2.

(ii) For the signal flow graph shown in Fig. 3, obtain $C(s)/R(s)$ using Mason's gain formula. (7)

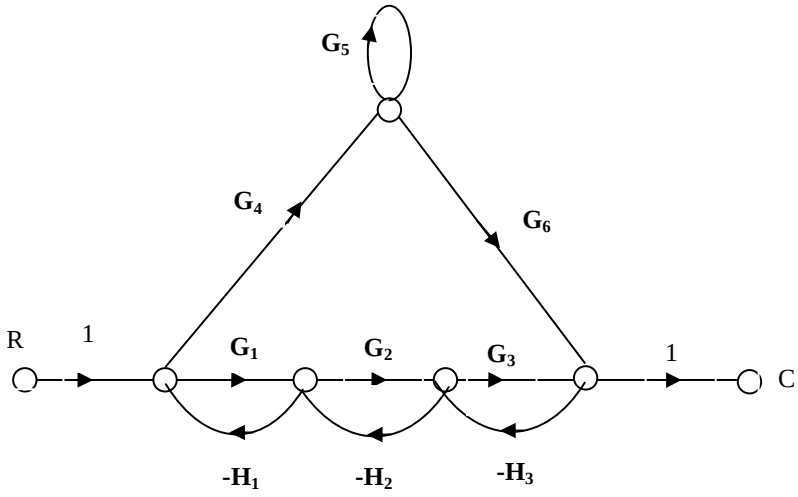


Fig.3

22. a) (i) Prove that the time response of a II order undamped system for unit-step input is given by (7)

$$c(t) = 1 - \cos \omega_n(t)$$

(ii) Determine time response specifications for a unit step input to a unity feedback system having (7)

$$G(s) = \frac{144}{s(s+2)}$$

(OR)

b) (i) The open-loop transfer function of a unity feedback servo system is given by (9)

$$G(s) = 10/s(0.1s+1)$$

Evaluate the static error constants for the system and obtain the steady state error for unit step, ramp, and parabolic inputs

(ii) What is a PID controller and how does it combine the beneficial effect of both PD and PI controller? Does such a controller change the system order? (5)

23. a) Draw the Bode plot of a unity feedback system having

$$G(s) = \frac{10}{s(0.4s+1)(0.1s+1)}$$

Determine GM, PM, ω_{gc}, and ω_{pc}. Comment on the stability of the system.

(OR)

b) (i) Draw the polar plot of the function (9)

$$G(s) = \frac{8}{(s+1)(s+2)}$$

(ii) What is Nichols chart? What are its advantages? (5)

24. a) (i) The characteristic equation of a system is given by $s^4 + 8s^3 + 18s^2 + 16s + 5 = 0$. Determine the stability using Routh-Hurwitz criteria. (7)

(ii) Find the range of values of K for which the system, represented by the following expression, is stable. (7)

$$s^3 + 30s^2 + 600s + 600K = 0.$$

(OR)

b) Sketch the root locus of the system whose open loop transfer function is given by

$$G(s) = \frac{K}{s(s+2)(s+4)}, \quad \text{as } K \text{ varies from } 0 \text{ to } \infty.$$

25. a) (i) Derive the transfer function of a phase-lead compensator. (7)

(ii) Write the procedure for designing a lead compensator using Bode plot. (7)

(OR)

b) Design a suitable lag compensating network for

$$G(s) = \frac{K}{s(s+2)(s+20)}$$

to meet the following specifications

$$K_v = 20\ sec^{-1}; \quad PM \geq 35^\circ$$

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