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10ME/PM82

Eighth Semester B.E. Degree Examination, Aug./Sept. 2020
Control Engineering

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Write the difference between open loop and closed loop control system and give one example for each. **(06 Marks)**

b. What are the requirements of an ideal control system? **(06 Marks)**

c. With block diagram, explain proportional plus integral plus differential (PID) controller and state its characteristics. **(08 Marks)**

2 a. Derive the transfer function of an armature DC motor. The field current is maintained constant during operation. Assume the armature coil has a back emf. $e_b = K_b \frac{d\theta}{dt}$ and coil current produces torque $T = K_m \tau_a$ on the rotor, K_b and K_m are the back emf constant and motor torque constant respectively. **(10 Marks)**

b. Obtain the differential equation for the mechanical system shown in Fig. Q2 (b) and draw the equivalent mechanical system. Also draw the analogous electrical network based on:
(i) Force –Voltage analogy (ii) Force-Current Analogy. **(10 Marks)**

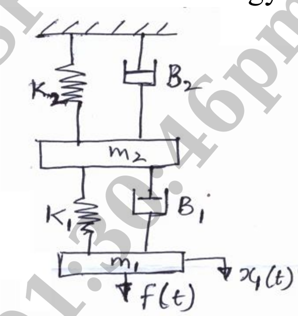

Fig. Q2 (b)

3 a. Reduce the block diagram shown in Fig. Q3 (a) and obtain transfer function $\frac{C(s)}{R(s)}$. **(10 Marks)**

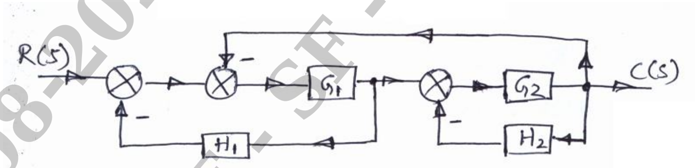

Fig. Q3 (a)

b. Using Mason's Gain formula find the transfer function of signal flow graph shown in Fig. Q3 (b). **(10 Marks)**

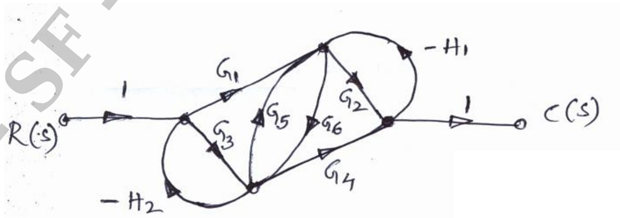

Fig. Q3 (b)

4 a. Obtain an expression for time response of the first order system subjected to unit step input. **(08 Marks)**

b. A unity feedback system is characterized by an open loop transfer function $G(s)H(s) = \dfrac{K}{s(s+10)}$. Determine the system gain K, so that the system will have a damping ratio of 0.5. For this value of K, find peak time, settling time and peak overshoot for a unit step input. **(08 Marks)**

c. Examine the stability of system whose characteristic equation is $s^4 + 2s^3 + 3s^2 + 8s + 2 = 0$ using R-H criteria. **(04 Marks)**

PART – B

5 a. Sketch polar plot for the transfer function $G(s)H(s) = \dfrac{12}{s(s+1)(s+2)}$. **(08 Marks)**

b. Obtain Nyquist diagram for the system shown in Fig. Q5 (b) and ascertain its stability. **(12 Marks)**

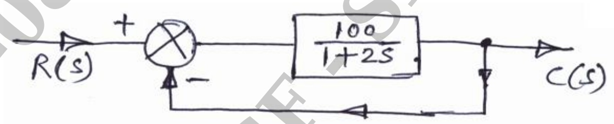

Fig. Q5 (b)

6 Sketch the Bode plot for a unity feed back system whose open loop transfer function is given by,

$$G(s)H(s) = \frac{10}{s(1+s)(1+0.02s)}.$$

From the Bode plot, determine
- (i) Gain and phase cross over frequencies
- (ii) Gain and phase margins
- (iii) Comment on the stability of the closed loop system. **(20 Marks)**

7 Sketch the root locus for a negative feedback system whose open loop transfer function is given by,

$$G(s)H(s) = \frac{K}{s(s+3)(s^2+3s+4.5)}.$$

Comment on the stability of the system. **(20 Marks)**

8 a. Write notes on: (i) Lead compensator (ii) Lag compensator. **(14 Marks)**

b. Verify whether the following system is observable or not.

$$\begin{Bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{Bmatrix} = \begin{bmatrix} -5 & 4 \\ -6 & 5 \end{bmatrix} \begin{Bmatrix} x_1 \\ x_2 \end{Bmatrix} + \begin{Bmatrix} 1 \\ 1 \end{Bmatrix} u \text{ and } y = \{-2 \quad 3\} x$$ **(06 Marks)**

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