CBCS SCHEME

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15EE61

Sixth Semester B.E. Degree Examination, July/August 2021
Control Systems

Time: 3 hrs. Max. Marks: 80

Note: ***Answer any FIVE full questions.***

1 a. Define transfer function of a system. List the properties of transfer function approach. **(06 Marks)**

b. For the mechanical system shown in the Fig. Q1 (b). Write the differential equation governing its behavior, draw its mechanical network and its electrical equivalent network using force current analogy. **(10 Marks)**

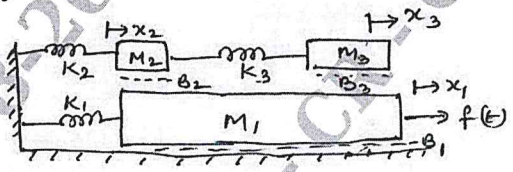

Fig. Q1 (b)

2 a. Distinguish between open loop and closed loop control systems. **(04 Marks)**

b. What is a syncro? What is a syncro-pair? What are they used for? What is electrical zero position for syncro transmitter? **(06 Marks)**

c. For the system shown in Fig. Q2 (c), find the transfer function, $G(s) = \frac{Q_2(S)}{T(S)}$. Consider $J = 1\ kgm^2$, $K_1 = 1$ Nm/rad, $K_2 = 1$ Nm/rad, $B_1 = 1$ Nm/r/s, $B_2 = 1$ Nm/r/s. **(06 Marks)**

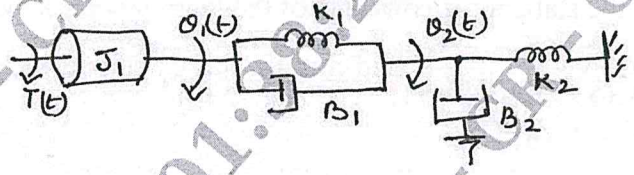

Fig. Q2 (c)

3 a. Using block diagram reduction technique find the overall transfer function of the system represented by the block diagram, shown below in Fig. Q3 (a). **(06 Marks)**

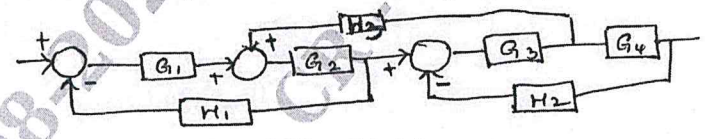

Fig. Q3 (a)

b. Explain the Masons Gain formula to find the overall transfer function of a signal flow graph. **(05 Marks)**

c. Draw the signal flow graph for the system of equations given below and list all the forward path gains and loop gains.

$$X_2 = G_1X_1 - H_1X_2 - H_2X_3 - X_6H_6$$
$$X_3 = G_1X_1 + G_2X_2 - X_3H_3$$
$$X_4 = G_2X_2 + G_3X_3 - H_4X_5$$
$$X_5 = G_4X_4 - H_5X_6$$
$$X_6 = G_5X_5$$

(05 Marks)

4 a. Draw the signal flow graph of the block diagram given in Fig. Q4 (a) and hence obtain the overall transfer function from the SFG. **(10 Marks)**

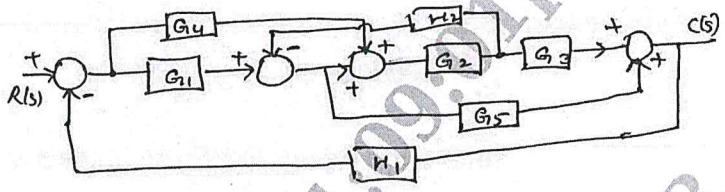

Fig. Q4 (a)

b. Obtain the transfer function of the block diagram shown in Fig. Q4 (b) using block diagram reduction technique. Clearly explain the steps taken. **(06 Marks)**

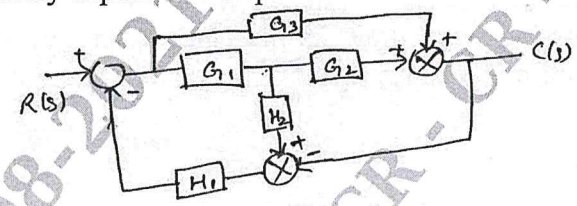

Fig. Q4 (b)

5 a. Define and derive expressions for the peak time of response and maximum overshoot for a under damped second order system from its unit step response. **(08 Marks)**

b. The open loop transfer function of a unity negative feedback system has,

$$G(s) = \frac{K}{S(1+ST)}.$$

Determine the factor by which the gain K must be multiplied so that the maximum overshoot of unit step response is reduced to 25% from 75%. **(08 Marks)**

6 a. Evaluate the static error constants of the unity feedback system with,

$$G(S) = \frac{K}{S^2(S+20)(S+30)}$$ and find the steady state error when the system is subjected to an input $r(t) = 5 + 6t + 3t^2$. **(06 Marks)**

b. Determine the value of 'K' and 'a' so that the system shown in the figure oscillates at a frequency of $2r/s$ using R – H criterion. **(10 Marks)**

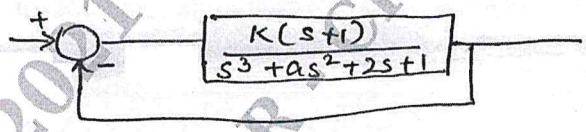

Fig. Q6 (b)

7 What is root locus? Sketch the root locus for a negative feedback system whose OLTF is given by $G(s)H(s) = \frac{K}{S(S+1)(S+2)(S+3)}$. Clearly mark all the points. Also find the value of K at $\delta = 0$, $\delta = 1$, $\delta = 0.6$. **(16 Marks)**

8 a. Briefly explain and define the frequency domain specifications. **(06 Marks)**

b. Sketch the Bode plots showing the magnitude in dB and phase angle in degrees for the system whose OLTF $= \frac{2000}{S(S+2)(S+100)}$. Determine the gain cross over frequency, phase crossover frequency, gain margin, phase margin and comment on the stability of the system. **(10 Marks)**

9 a. Discuss the stability of a unit feedback control system with open loop transfer function, $GH = \frac{450}{S(S+2)(S+10)}$ using Nyquist stability criterion. **(10 Marks)**

b. Explain the principle of arguments. **(06 Marks)**

10 a. What is the necessity of controllers? Obtain the transfer function of PID controllers. List the characteristics of PID controllers. **(08 Marks)**

b. What is a compensator? Obtain the transfer function of a lead compensator and draw its pole-zero plot. **(08 Marks)**

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