

## 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)

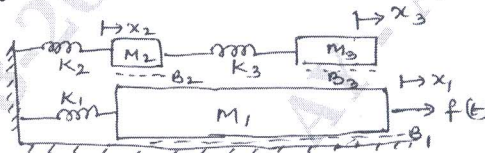


Fig. Q1 (b)

- 2 a. Distinguish between open loop and closed loop control systems. (04 Marks)
- b. What is a synchro? What is a synchro-pair? What are they used for? What is electrical zero position for synchro 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  $J = 1 \text{ kgm}^2$ ,  $K_1 = 1 \text{ Nm/rad}$ ,  $K_2 = 1 \text{ Nm/rad}$ ,  $B_1 = 1 \text{ Nm/r/s}$ ,  $B_2 = 1 \text{ Nm/r/s}$ . (06 Marks)

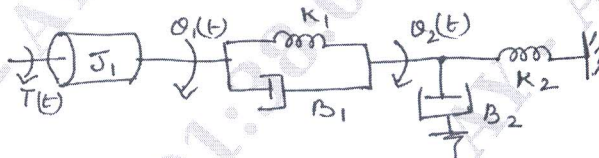


Fig. Q2 (c)

- 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)

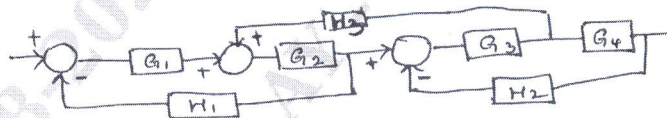


Fig. Q3 (a)

- 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.

$$X_2 = G_1 X_1 - H_1 X_2 - H_2 X_3 - X_6 H_6$$

$$X_3 = G_1 X_1 + G_2 X_2 - X_3 H_3$$

$$X_4 = G_2 X_2 + G_3 X_3 - H_4 X_5$$

$$X_5 = G_4 X_4 - H_5 X_6$$

$$X_6 = G_5 X_5$$

(05 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.  
2. Any revealing of identification, appeal to evaluator and/or equations written eg, 42+8 = 50, will be treated as malpractice.

- 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)

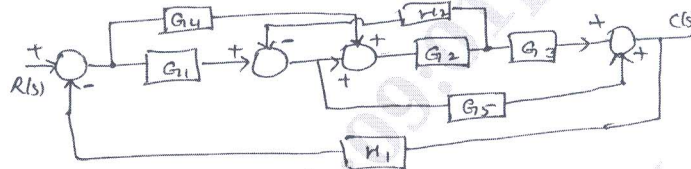


Fig. Q4 (a)

- 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)

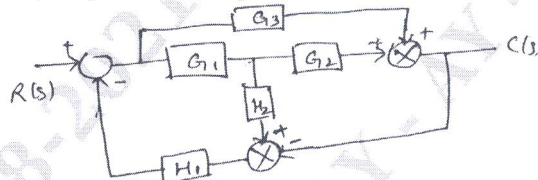


Fig. Q4 (b)

- 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)

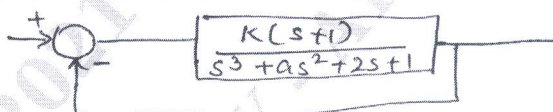


Fig. Q6 (b)

- 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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