CBCS SCHEME

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18MT34

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

Time: 3 hrs. Max. Marks: 100

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

1 a. Compare open loop and closed loop control system. **(10 Marks)**

b. For the Fig Q1(b) shown below, determine TF $\frac{x_2(s)}{x_1(s)}$.

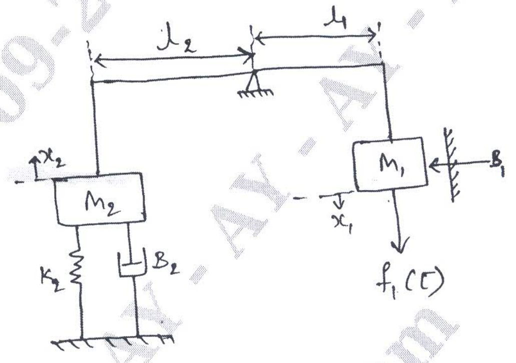

Fig Q1(b) **(10 Marks)**

2 a. Draw the analogous circuits using F-V and F-I analogy for the mechanical system shown below Fig Q2(a)

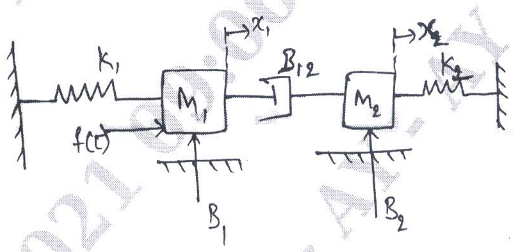

Fig Q2(a) **(12 Marks)**

b. Obtain $\frac{C(s)}{R(s)}$ using Block diagram reduction rules for the Fig Q2(b) shown below :

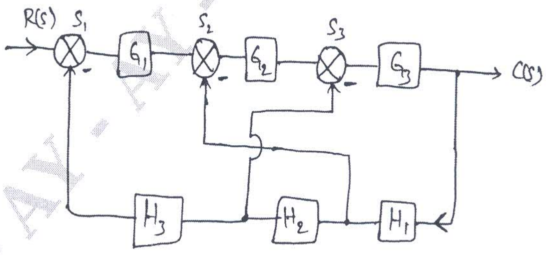

Fig Q2(b) **(08 Marks)**

3 a. Construct the SFG for the set of system equations : $y_2 = G_1y_1 + G_3y_3$; $y_3 = G_4y_1 + G_2y_2 + G_5y_3$; $y_4 = G_6y_2G_7y_3$ where $y_4$is output

Find transfer function. $\boxed{y_4/y_1}$ Using Maron's Gain formula **(10 Marks)**

b. For the SFG shown in Fig Q3(b) below, find $\frac{C(s)}{R(s)}$ by Maron's Gain Formula.

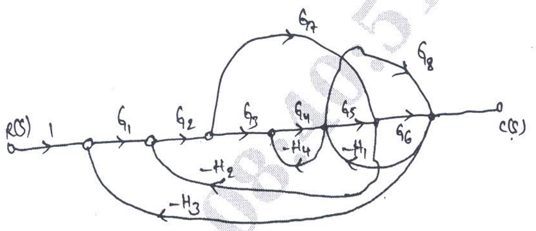

Fig Q3(b) (10 Marks)

4 a. With a neat output versus time graph define the following i) Delay Time (t_d) ii) Rise time (t_r) iii) Peak time (t_p) iv) Maximum overshoot (M_P) (10 Marks)

b. For a system having $G(s) = \frac{15}{(s+1)(s+3)}, H(s) = 1$. Determine :

i) Characteristics equation ii) w_n and ξ [natural frequency and damping factor]
iii) Time at which first undershoot will occur iv) Time period of oscillations related to w_d
v) Number of cycles output will perform before setting down for $\pm 2\%$ tolerance. (10 Marks)

5 a. Define the following : i) Absolute stability ii) Relative stability iii) Conditionally stable iv) Marginally stable. (04 Marks)

b. For unity feedback system $G(s) = \frac{k}{s(1+0.4s)(1+0.25s)}$ find the range of values of k, marginal value k and frequency of oscillation (w). (08 Marks)

c. For a system with C.E – characteristics equation $F(s) = s^6 + 3s^5 + 4s^4 + 6s^3 + 5s^2 + 3s + 2 = 0$. Examine stability. (08 Marks)

6 a. State the advantages and limitation of frequency domain approach. (08 Marks)

b. Explicitly discuss the correlation between time and frequency response of a second order system. Obtain the expression for resonant peak. (12 Marks)

7 Draw the appropriate root locus diagram for the closed loop system whose transfer function is given by G(s). $(H(s) = \frac{k}{s(s+2)(s^2+6s+25)}$ comment on stability. (20 Marks)

8 Sketch Bode plot for the transfer function $G(s) = \frac{k.s^2}{(1+0.25)(1+0.025)}$. Determine valve of 'k' for gain cross over frequency to be 5 rads^{-1}. (20 Marks)

9 a. Define : i) State variable ii) State vector iii) State space iv) State trajectory. (08 Marks)

b. List the advantages of state variable analysis. (05 Marks)

c. Obtain the transfer function : If $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -5 & -1 \\ 3 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 2 \\ 5 \end{bmatrix} u \; y = [12] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$ (07 Marks)

10 a. Lit the properties of state transition matrix and write the equation for transfer function from state model. (10 Marks)

b. Consider a control system with state model

$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 2 \end{bmatrix} u \; ; \begin{bmatrix} x_1(0) \\ x_2(0) \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$ u = unit step. Compute the state transfer matrix and there from find the state response i.e., x(t) (10 Marks)