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18EE61

Sixth Semester B.E. Degree Examination, July/August 2022
Control Systems

Time: 3 hrs.

Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1   a. Write the comparison between open loop and closed loop control system with example.

(06 Marks)

  b. For the mechanical system shown in Fig. Q1 (b). Draw the electrical equivalent network based on torque-voltage analogy.
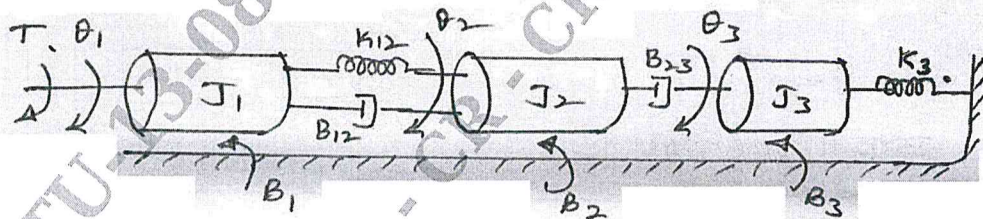

Fig. Q1 (b)   (08 Marks)

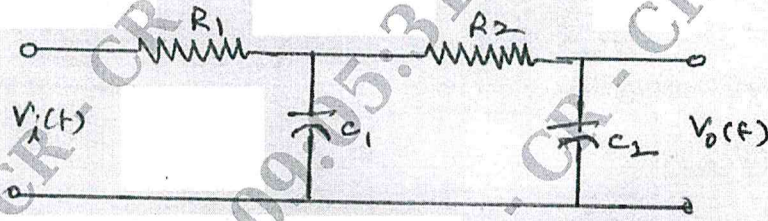 c. For the electrical network shown in Fig. Q1 (c), obtain the transfer function $\dfrac{V_0(s)}{V_i(s)}$.

Fig. Q1 (c)   (06 Marks)

OR

2   a. Define Transfer function. Also derive the transfer function relating displacement and excitation voltage drop for the armature controlled D.C.motor.   (06 Marks)

  b. Obtain the mathematical model for the mechanical system shown in Fig. Q2 (b). Draw the electrical equivalent based on F-I analogy.
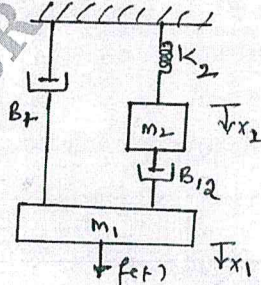

Fig. Q2 (b)   (08 Marks)

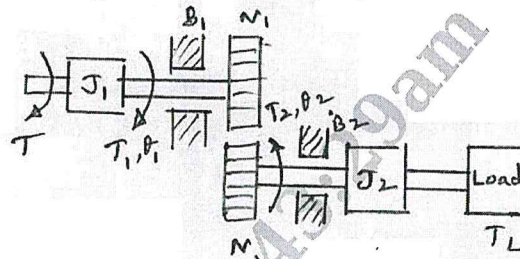c. Write the torque equation of the gear train shown in Fig. Q2 (c).

Fig. Q2 (c)   **(06 Marks)**

Module-2

3 a. Using block diagram, reduction technique obtain transfer function $\dfrac{C(s)}{R(s)}$, whose block diagram shown in Fig. Q3 (a).
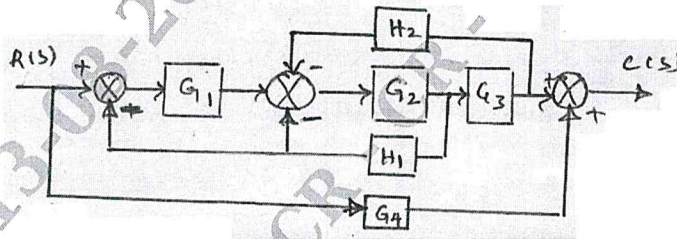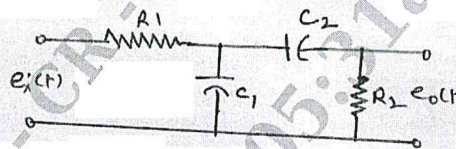

Fig. Q3 (a)   **(10 Marks)**

b. Draw a block diagram for the electric circuit shown in Fig. Q3 (b) and hence evaluates Transfer function, $\dfrac{E_o(s)}{E_i(s)}$ using block diagram reduction techniques.

Fig. Q3 (b)

$R_1 = 100\ K\Omega$
$R_2 = 1\ M\Omega$
$C_1 = 10\ \mu F$
$C_2 = 1\ \mu F$

(10 Marks)

OR

4 a. Using Mason's gain formula determine the Transfer function of the given signal flow graph shown in Fig. Q4 (a).
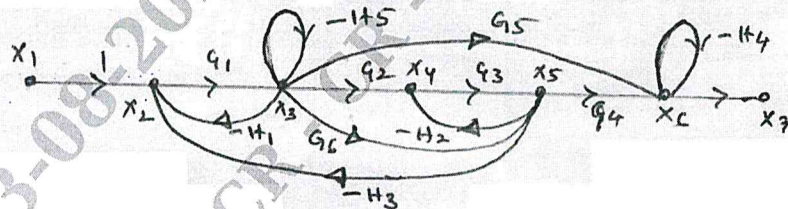

Fig. Q4 (a)   **(10 Marks)**

b. A system is described by the following set of linear equation. Draw the signal flow graph and obtain the Transfer function $\dfrac{X_5}{X_1}$.

$$X_2 = a_{12}X_1 + a_{22}X_2 + a_{32}X_3$$
$$X_3 = a_{23}X_2 + a_{43}X_4$$
$$X_4 = a_{24}X_2 + a_{34}X_3 + a_{44}X_4$$
$$X_5 = a_{25}X_2 + a_{45}X_4$$

(10 Marks)

Module-3

5 a. Define time domain specifications of the second order system with diagram. **(05 Marks)**

b. A unity feedback system is characterized by an open loop Transfer Function $G(s) = \dfrac{K}{s(s+10)}$. Determine the gain 'K', so that system will have a damping ratio of 0.5. For the value of K determine the settling time, peak, overshoot, time to peak overshoot for a unit step input. **(07 Marks)**

c. Open loop Transfer Function of a unity feedback system is given by $G(s) = \dfrac{K}{s(1+TS)}$, where K and T are positive constants. By what factor should the amplifier gain 'K' be reduced so that peak overshoot of a unit step response of the system is reduced from 75% to 25%. **(08 Marks)**

OR

6 a. A certain feedback control system is described by the following Transfer Function. $G(s) = \dfrac{K}{s^2(s+20)(s+30)}$, H(s) = 1. Determine order of system, Type number, Steady state error co-efficients and also determine the value of K to limit the steady state. Error 8 unit due to input $r(t) = 1 + 10t + 30t^2$. **(05 Marks)**

b. For the characteristic equation given below. Determine the number of roots of the characteristics equation in the RHS of S-plane $s^6 + 3s^5 + 5s^4 + 9s^3 + 8s^2 + 6s + 4 = 0$ **(07 Marks)**

c. A unity feedback control system is characterized by the open loop transfer function, $G(s) = \dfrac{K(s+13)}{s(s+3)(s+7)}$. Using R.H. criteria (i) Calculate the range of K for the system to be stable (ii) Determine the value of K which will cause sustained frequency of oscillations in the closed loop system. What are the corresponding oscillation frequencies? **(08 Marks)**

Module-4

7 a. Draw the complete root locus plot for the system $G(s)H(s) = \dfrac{K}{s(s+2)(s+4)}$. Find the range of K, so that damping ratio of the closed loop system is 0.5. **(10 Marks)**

b. Draw the complete root locus for the system with $G(s)H(s) = \dfrac{K}{s(s+6)(s^2+4s+13)}$. Comment on stability. **(10 Marks)**

OR

8 a. The open loop transfer function of an unity feedback is $G(s) = \dfrac{K}{s(s+a)}$. (i) Find the value of 'K' and 'a'. So that resonant peak = 1.04 and resonant frequency = 11.5 rad/sec (ii) for the value of 'K' and 'a' found in part (i). Calculate the settling time and Bandwidth of the system. **(06 Marks)**

b. Draw the Bode plot for the system having, $G(s) = \dfrac{10}{s(1+0.1s)(1+0.5s)}$, $H(s) = 1$ Determine the (i) Gain cross over frequency (ii) Phase crossover frequency (iii) Gain margin (iv) Phase margin. **(08 Marks)**

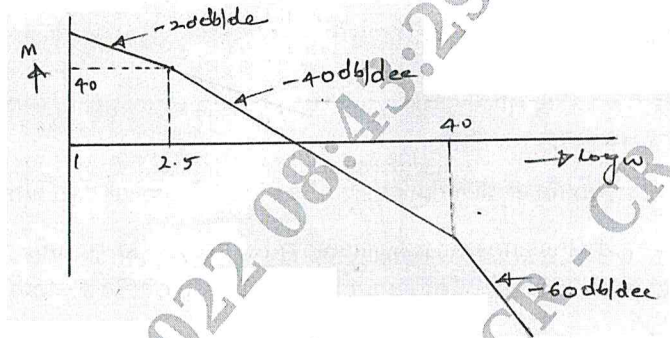c. Find the open loop transfer function of a system whose approximate plot is as shown in Fig. Q8 (c).

Fig. Q8 (c)　　　　　　　　　　　　　　　(06 Marks)

Module-5

9　a. The open loop transfer function of a control system is $G(s)H(s) = \dfrac{1}{s(s+2)(s+10)}$. Sketch the Nyquist plot and calculate the value of K. (10 Marks)

b. What is controller? Explain the effect of P, I, PI and PID controller of a second order system. (10 Marks)

OR

10　a. Explain the step by step procedure of Lag compensating network. (10 Marks)

b. Design a Lead Compensator for a unity feedback system with an open loop transfer function $G(s) = \dfrac{K}{s(s+1)}$ for the specification of velocity error constant $K_v = 12\,\text{sec}^{-1}$ and phase margin as 40°. (10 Marks)

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