USN

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.

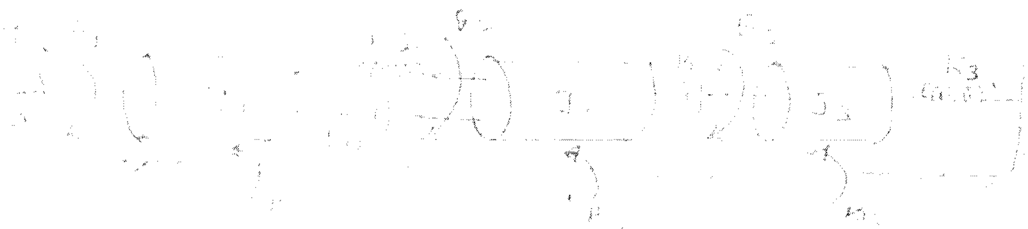

Fig. Q1 (b) **(08 Marks)**

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

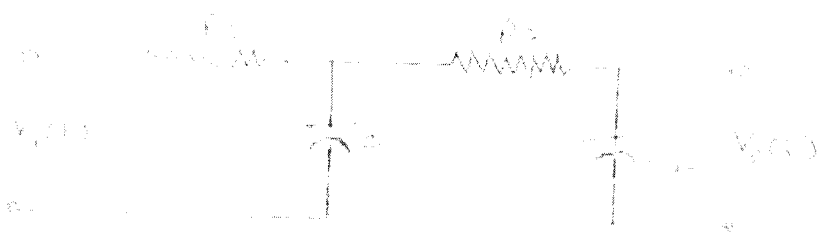

Fig. Q1 (c) **(06 Marks)**

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.

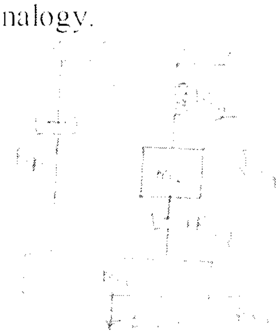

Fig. Q2 (b) **(08 Marks)**

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 $\frac{C(s)}{R(s)}$, 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, $\frac{E_o(s)}{E_i(s)}$ using block diagram reduction techniques.

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

Fig. Q3 (b)

(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).

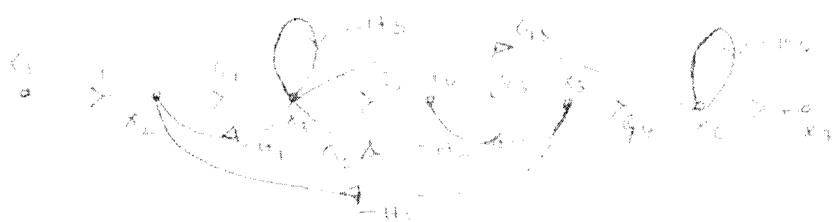

Fig. Q4 (a) **(10 Marks)**

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

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

(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).

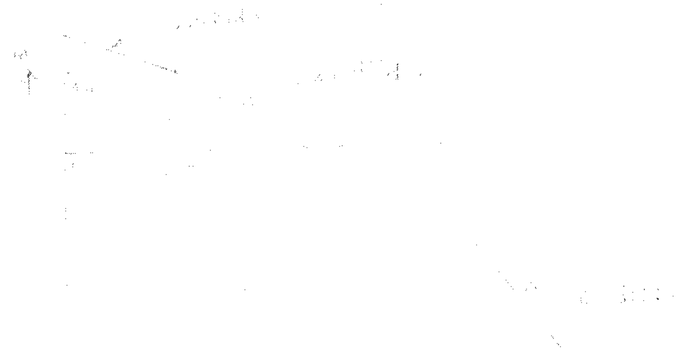

Fig. Q8 (c) (06 Marks)

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 $K_v = 12\,sec^{-1}$ and phase margin as 40°. (10 Marks)

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