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17EC43

Fourth Semester B.E. Degree Examination, June/July 2019
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. Define control system. Compare open loop and closed loop control system. **(06 Marks)**

b. Find the transfer function $\frac{I(s)}{Ui(s)}$ for the circuit shown in Fig.Q.1(b) and K is the gain of an ideal amplifier. **(06 Marks)**

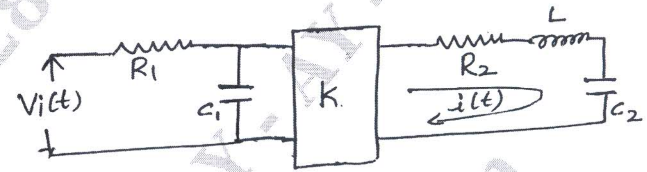

Fig.Q.1(b)

c. The system block diagram is shown in Fig.Q.1(c). Find $\frac{C(s)}{N(s)}$ if R(s) = 0 using block diagram reduction technique. **(08 Marks)**

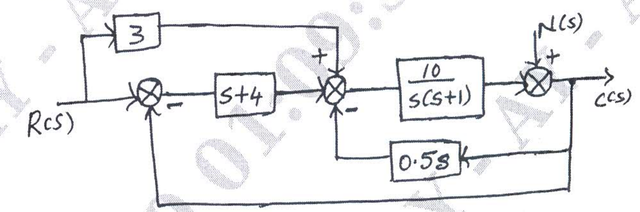

Fig.Q.1(c)

OR

2 a. Define signal flow graph and list the properties of signal flow graph. **(06 Marks)**

b. Find $\frac{C(s)}{R(s)}$ for the signal flow graph shown in Fig.Q.2(b) using Mason's gain formula. **(06 Marks)**

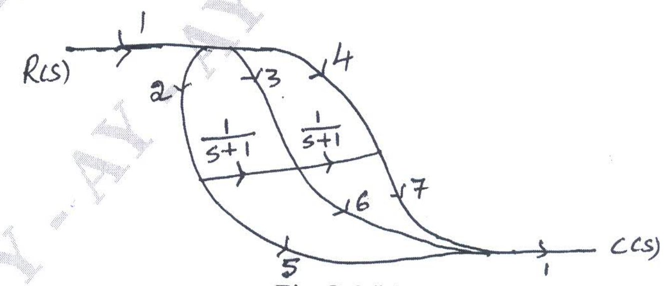

Fig.Q.2(b)

c. For the mechanical system shown in Fig.Q.2(c) i) Draw mechanical network ii) Write differential equations iii) Write the force-to-voltage analogous electric network. **(08 Marks)**

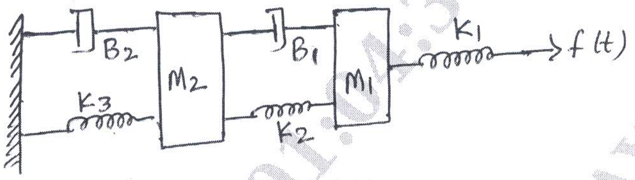

Fig.Q.2(c)

Module-2

3 a. List the standard test input signals used for analysis and evolution of control system. Also write the Laplace transform of corresponding inputs. **(04 Marks)**

b. Find the positional error (k_p), velocity error (k_v) and acceleration error (k_a) coefficients for a unity feed back system with open loop transfer function $G(s)H(s) = \frac{K}{s^2(s+20)(s+30)}$. Also find 'K' to limit the steady state error to 5 units due to input $r(t) = 1 + 10t + 20t^2$. **(08 Marks)**

c. A system is given by differential equation $\frac{d^2y(t)}{dt^2} + 4\frac{dy(t)}{dt} + 8y(t) = 8x(t)$, where y(t) = output and x(t) = input, obtain the output response to step input. For the same calculate: Peak time, Rise time and Peak overshoot. **(08 Marks)**

OR

4 a. Draw the block diagram of PID controller and explain briefly. **(04 Marks)**

b. A unity feedback system has $G(s) = \frac{40(s+2)}{s(s+1)(s+4)}$.

Find: i) Type of the system ii) All error coefficients iii) Error for Ramp input with magnitude 4. **(08 Marks)**

c. A system has 30% overshoot and settling time of 5 seconds for an unit step input. Determine: i) The transfer function ii) Peak time (T_P) iii) Output response (Assume C_{ss} as 2%). **(08 Marks)**

Module-3

5 a. A system with characteristics equation $s^6 + 3s^5 + 4s^4 + 6s^3 + 5s^2 + 3s + 2 = 0$. Examine stability using Routh's Hurwitz criterion. **(08 Marks)**

b. Sketch the complete root locus for the system having $G(s)H(s) = \frac{K}{s(s^2+8s+17)}$, from the root locus diagram, evaluate the value of K for a system damping factor of 0.5. **(12 Marks)**

OR

6 a. The open loop transfer function of a unity feedback system is $G(s) = \frac{K(s+2)}{s(s+3)(s^2+5s+10)}$

i) Find the value of 'K' so that the steady state error for the input r(t) = t u(t) is less than or equal to 0.01.

ii) For the value of K found in part (i) Verify whether the closed loop system is stable or not using R.H criterion. **(08 Marks)**

b. A feedback control system has open loop transfer function $G(s)H(s) = \frac{K}{s(s+3)(s^2+3s+2)}$.

Sketch the complete root locus and comment on stability. **(12 Marks)**

Module-4

7 a. For a closed loop control system $G(s) = \frac{100}{s(s+8)}$ $H(s) = 1$. Determine the resonant peak and resonant frequency. **(04 Marks)**

b. Draw the polar plot whose open loop transfer function is $G(s)H(s) = \frac{1}{1+0.1s}$. **(06 Marks)**

c. Using Nyquist stability criterion, investigate the closed loop stability whose open loop transfer function is given by $G(s)H(s) = \frac{100}{(s+1)(s+2)(s+3)}$. **(10 Marks)**

OR

8 a. Explain lead-lag compensator. **(04 Marks)**

b. Explain Nyquist stability criterion. **(06 Marks)**

c. Sketch the Bode plot for a unity feed back system $G(s) = \frac{K}{s(s+2)(s+10)}$. Determine marginal value of 'K' for which system will be marginally stable. Using bode plot. **(10 Marks)**

Module-5

9 a. Explain spectrum analysis of sampling process. **(06 Marks)**

b. State the properties of state transition matrix. **(06 Marks)**

c. Consider the system having state model

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -3 & 1 \\ -2 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u \quad \text{and} \quad y = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

with D = 0. Determine the transfer function of the system. **(08 Marks)**

OR

10 a. Obtain the state model of the electrical system shown in Fig.Q.10(a). **(06 Marks)**

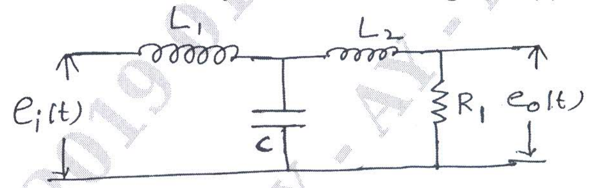

Fig.Q.10(a)

b. Obtain the state model for the system represented by the differential equation

$$\frac{d^3y(t)}{dt^3} + \frac{6d^2y(t)}{dt^2} + 11\frac{dy(t)}{dt} + 10y(t) = 3u(t)$$ **(06 Marks)**

c. Find the state transition matrix for $A = \begin{bmatrix} 0 & -1 \\ 2 & -3 \end{bmatrix}$. **(08 Marks)**

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