USN

06ES43

Fourth Semester B.E. Degree Examination, May/June 2010
Control Systems

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Distinguish between open loop and closed loop control systems. Give two examples for each. **(06 Marks)**

b. Write the differential equations for the mechanical rotational system shown in Fig. Q1(b) below. Obtain the torque-current analogy of the system. List all the analogous quantities. **(07 Marks)**

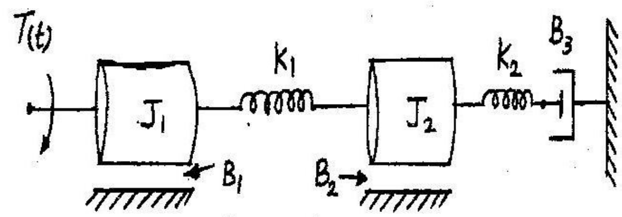

Fig. Q1(b)

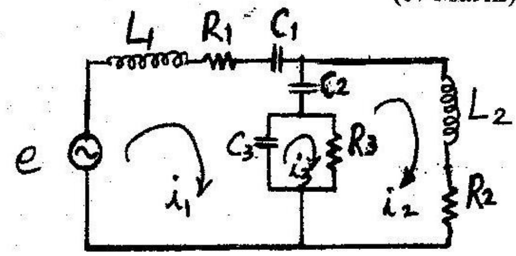

Fig. Q1(c)

c. The force-voltage analogy of a mechanical translational system is given in Fig.Q. 1(c). Obtain its analogous mechanical system. **(07 Marks)**

2 a. Obtain the overall T.F C/R, by the block diagram reduction techniques. Refer Fig. Q2(a). **(10 Marks)**

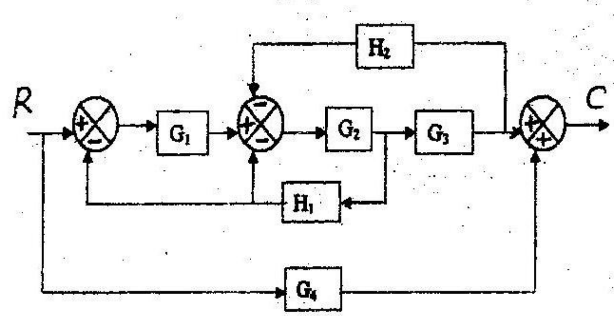

Fig. Q2(a)

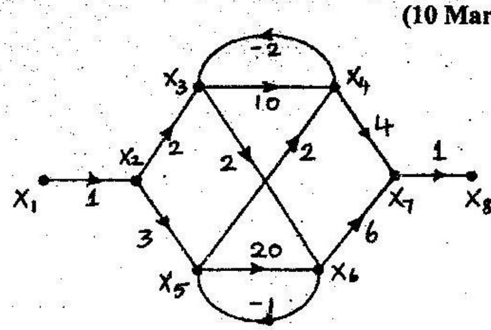

Fig.Q.2 (b)

b. Determine the gain X_8/X_1, of the system described by the signal flow graph given in Fig.Q.2 (b). **(10 Marks)**

3 a. Derive an expression for the unit step response of an underdamped second order system, with usual notations. Sketch this response and mark clearly the rise time t_r, peak time t_p, settling time t_s and peak overshoot M_p. **(08 Marks)**

b. A unity feedback control system is characterized by an open loop T.F, $G(s) = \frac{K}{s(s+\alpha)}$.

Where K and α are positive constants.

i) By what factor the amplifier gain K should be reduced so that the peak overshoot of the unit step response reduces from 75% to 25%?

ii) Find the values of K and α, so that, damping ratio is 0.6 and frequency of damped oscillations is 8 rad / sec. Also find the peak value of the response, when the system is excited by a step of 2V.

iii) If the above open loop T.F. G(s) is multiplied with a factor $(s+\beta)$, and the closed loop poles are located at $-1 \pm j1$, find the values of K, α and β so that the steady state value of error for a ramp input equals 1/10. **(12 Marks)**

4 a. Determine the values of k and a, so that the system shown in Fig.Q.4(a), oscillates at a frequency of 2 rad / sec. **(10 Marks)**

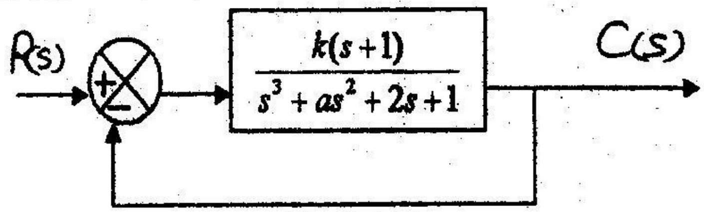

Fig.Q.4(a)

b. The open loop T.F. of a unity feedback control system is given by

$$G(s)=\frac{K}{(s+2)(s+4)(S^2+6s+25)}.$$

Determine the range of values of K for system stability. What is the value of K which gives sustained oscillations? What is the oscillation frequency? **(10 Marks)**

PART – B

5 Sketch the root locus diagram for a unit feedback control system with $G(s)=\frac{K}{s(s^2+8s+17)}$ using the rules of construction and by determining the break away /break in points and the angle of departure. Find the value of K for which the system just oscillates. From the root locus, determine the value of K for a damping ratio of 0.5. **(20 Marks)**

6 a. State and explain Nyquist stability criteria. **(06 Marks)**

b. Discuss the stability of the unity feedback control system with $G(s)=\frac{1}{s^2(1+s)}$ by using Nyquist criteria. If H(s) = 1 + 2s, test the stability of the system. **(14 Marks)**

7 a. A unity feedback control system is characterized by an open loop transfer function $G(s)H(s)=\frac{K}{s(s+1)(0.1s+1)}$. Using Bode plots, find :

i) The value of K to a give gain margin of 10 dB

ii) Value of K to give a phase margin of 24°. **(12 Marks)**

b. Find the T.F of the system whose Bode diagram is given in Fig. Q7(b) **(08 Marks)**

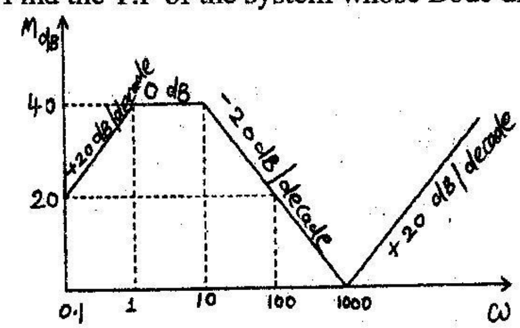

Fig Q7(b)

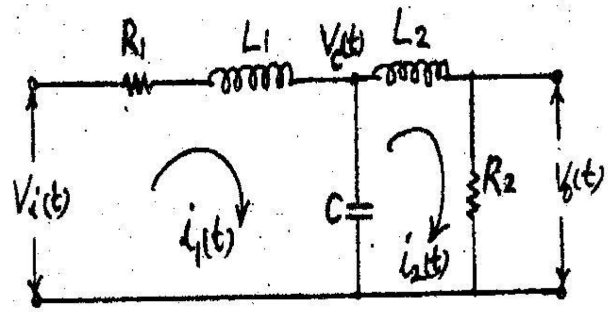

Fig. Q8(b)

8 a. Define state variable and state transition matrix. List the properties of the state transition matrix. **(08 Marks)**

b. Obtain the state model for the electrical system given in Fig. Q 8(b), choosing the state variables as $i_1(t)$, $i_2(t)$ and $v_c(t)$. **(12 Marks)**

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