

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)

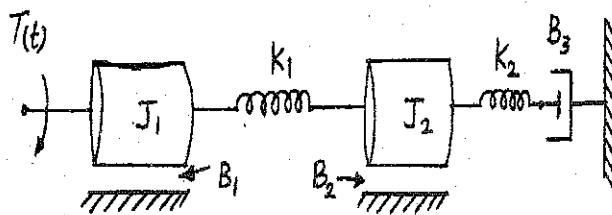


Fig. Q1(b)

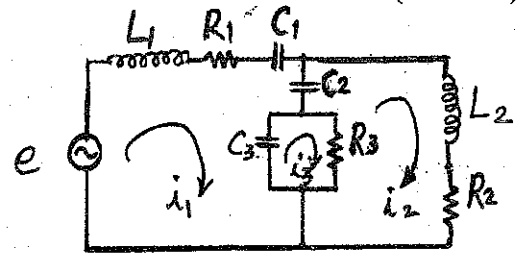


Fig. Q1(c)

- 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)

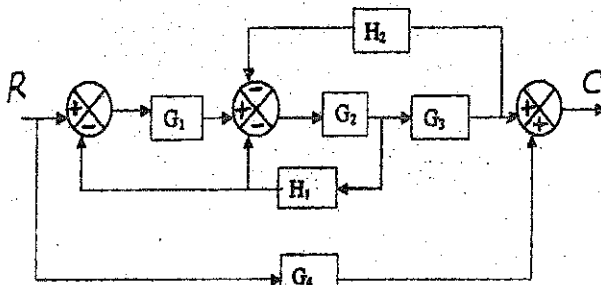


Fig. Q2(a)

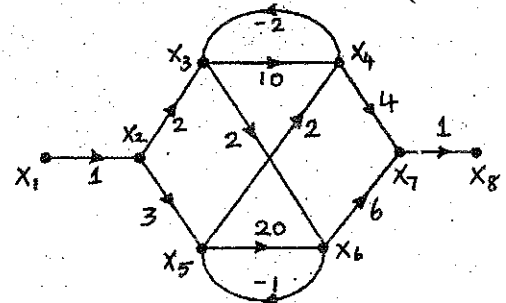


Fig. Q.2 (b)

- 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)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
 2. Any revealing of identification, appeal to evaluator and/or equations written eg. 42+8 = 50, will be treated as malpractice.

- 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)

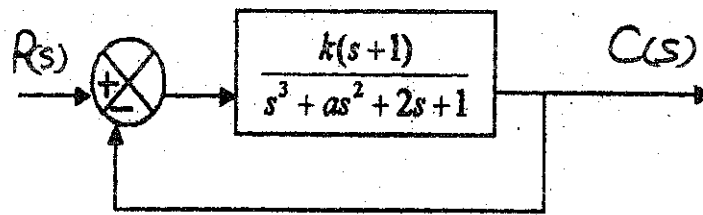


Fig.Q.4(a)

- 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 give a 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)

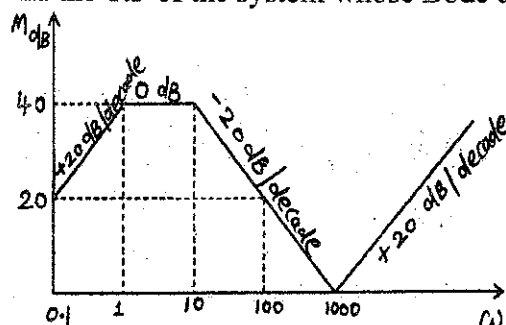


Fig Q7(b)

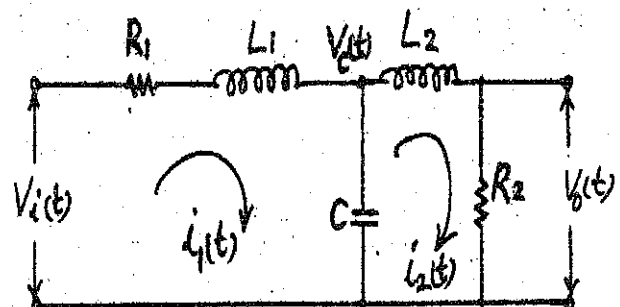


Fig. Q8(b)

- 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)