



CBCS SCHEME

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17EC43

Fourth Semester B.E. Degree Examination, Dec.2023/Jan.2024

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 and compare open loop control system with closed loop control system with an example. (04 Marks)
- b. For the mechanical system shown in Fig. Q1 (b), find the transfer function $\frac{X_1(s)}{F(s)}$.

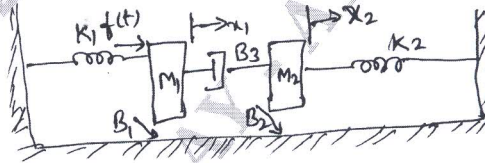


Fig. Q1 (b)

(08 Marks)

- c. Refer Fig. Q1 (c), (i) Draw the mechanical network. (ii) Draw the electrical network based on torque-currents analogy. Give all the relevant performance equations.



Fig. Q1 (c)

(08 Marks)

OR

- 2 a. Refer the mechanical system in Fig. Q2 (a). If mass M is subjected to sudden force of 1 N, what is the final displacement of mass M? Consider : $K = 1 \text{ N/m}$; $B = 0.2 \text{ N-S/m}$ and $M = 1 \text{ kg}$.

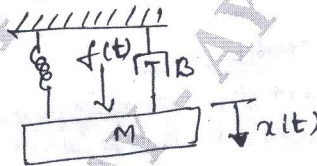


Fig. Q2 (a)

(06 Marks)

- b. Find $M = \frac{Y}{R}$ for the block diagram shown below in Fig. Q2 (b).

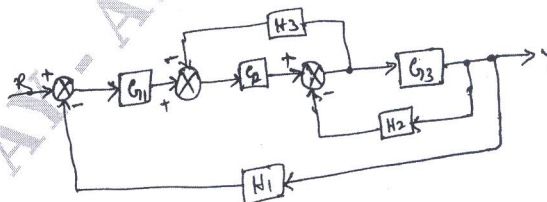


Fig. Q2 (b)

(08 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.

- c. Find $\frac{Y_5}{Y_1}$ and $\frac{Y_2}{Y_1}$ in the signal flow graph shown in Fig. Q2 (c).

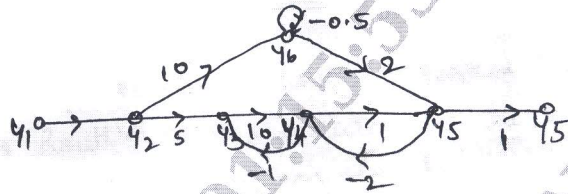


Fig. Q2 (c)

(06 Marks)

Module-2

- 3 a. Explain the following time domain specification of a 2nd order system :
 (i) Rise time (ii) Delay time (iii) Peak time (iv) Peak overshoot. (08 Marks)
- b. Obtain the time response of a 1st order system subjected to unit step input. Plot the response. (06 Marks)
- c. A unity feedback control system is characterized by an open loop transfer function,

$$G(s)H(s) = \frac{K}{s(s+10)}$$
 Determine the system gain K, so that the system will have a damping ratio of 0.5. For this value K, find the rise time, peak time, settling time and peak over shoot. Assume that the system is subjected to a step of 1 V. (06 Marks)

OR

- 4 a. Obtain the steady error E_{SS} of Type - 0, Type - 1 and Type - 2 systems for the standard inputs. (12 Marks)
- b. Explain the effect of PI and PD controller on the performance of a second order control system. (08 Marks)

Module-3

- 5 a. Find the range of K for the system to be stable using RH criterion. $G(s)H(s) = \frac{K(1-s)}{s(s^2 + 5s + 9)}$. (06 Marks)
- b. A unity feedback control system has $G(s) = \frac{K(s+13)}{s(s+3)(s+7)}$ using Routh's criterion calculate the range of K for which the system is (i) Stable (ii) has its closed loop, poles more negative than -0.5 for K = 1. (08 Marks)
- c. Explain the angle and magnitude conditions of root locus and explain their use with suitable example. (06 Marks)

OR

- 6 a. Explain the various rules for the construction of the root locus of a feedback control system. (08 Marks)
- b. For a unity feed back control system $C(s) = \frac{K}{s(s+1)(s+2)}$. Sketch the root locus showing all the details in it. (12 Marks)

Module-4

- 7 a. Define the following terms : (i) Phase margin (ii) Phase cross over frequency (iii) Gain margin (iv) Gain cross over frequency. (08 Marks)

b. A unity Feed back control system has $G(s) = \frac{80}{s(s+2)(s+20)}$. Draw the Bode plot.

Determine GM, PM, W_{gc} and W_{pc} . Comment on stability. (12 Marks)

OR

- 8 a. State and explain Nyquist stability criterion. (08 Marks)

b. For a certain control system $G(s)H(s) = \frac{K}{s(s+2)(s+10)}$. Sketch the Nyquist plot and hence

calculate the range of values of K for stability. (12 Marks)

Module-5

- 9 a. Define the following terms : (i) State (ii) State variable (iii) State space. (06 Marks)

b. Draw the block diagram of a typical system with Digital Controller and explain. (06 Marks)

c. Draw and explain the block diagram of sampled data system and digital data system. (08 Marks)

OR

- 10 a. Obtain the state model of the mechanical system in Fig. Q10 (a).

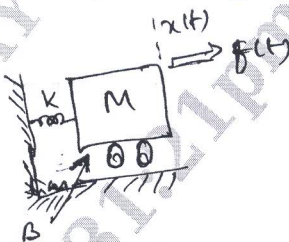


Fig. Q10 (a)

(10 Marks)

- b. Construct the state model for a system characterized by differential equation,

$$\frac{d^3y}{dt^3} + 6\frac{d^2y}{dt^2} + 11\frac{dy}{dt} + 6y = 5u$$

(10 Marks)
