

CBCS Scheme

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15EC43

Fourth Semester B.E. Degree Examination, June/July 2018 Control Systems

Time: 3 hrs.

Max. Marks: 80

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

- 1 a. Write the differential equations for the mechanical system shown in Fig.Q1(a) and obtain F-V analogy. (06 Marks)

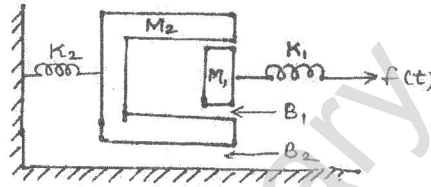


Fig.Q1(a)

- b. Differentiate between open loop control system and closed-loop control system. (06 Marks)
c. For the rotational system shown in Fig.Q1(c). Draw torque-voltage analogous circuit. (04 Marks)



Fig.Q1(c)

OR

- 2 a. Reduce the following block diagram of the system shown on Fig.Q2(a) into a single equivalent block diagram by block diagram reduction rules. (06 Marks)

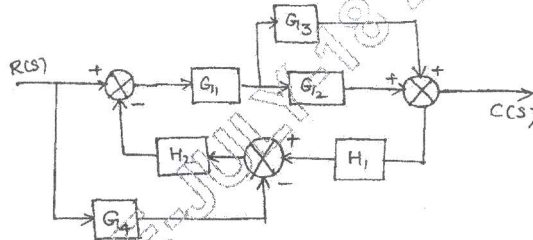


Fig.Q2(a)

- b. Find $\frac{C(s)}{R(s)}$ for the following signal flow graph. [Refer Fig.Q2(b)] (06 Marks)

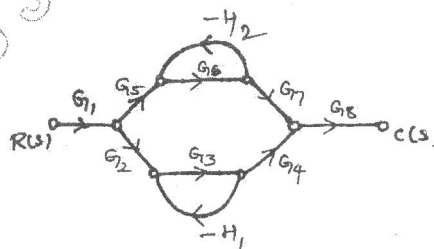


Fig.Q2(b)

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. For the following circuit write the signal flow graph. [Refer Fig.Q2(c)]

(04 Marks)

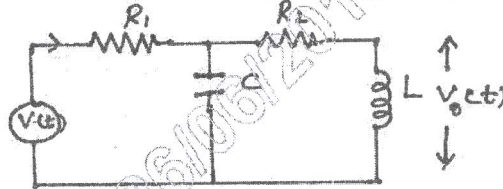


Fig.Q2(c)

Module-2

- 3 a. For the system shown in Fig.Q3(a). Find the : i) system type ii) static error constants k_p , k_v and k_a and iii) the steady state error for an input $r(t) = 3 + 2t$.

(06 Marks)

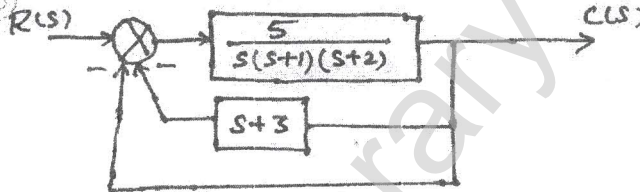


Fig. Q3(a)

- b. Find the step-response, $C(t)$ for the system described by $\frac{C(s)}{R(s)} = \frac{4}{S+4}$. Also find the time constant, rise time and settling time.
- c. Derive the equation for steady state error of simple closed loop system.

(05 Marks)

(05 Marks)

OR

- 4 a. A second order system is represented by the transfer function.

$$\frac{Q(s)}{I(s)} = \frac{1}{JS^2 + fS + K}$$

A step input of 10 Nm is applied to the system and the test results are :

- i) maximum overshoot = 6%
- ii) time at peak overshoot = 1sec
- iii) the steady state value of the output is 0.5 radian.

Determine the values of J, f and K.

(06 Marks)

- b. A system has 30% overshoot and settling time of 5 seconds for on unit step input. Determine: i) The transfer function ii) peak time ' t_p ' iii) output response (assume e_{ss} as 2%).

(06 Marks)

- c. Write the general block diagrams of the following :

- i) PD type of controller
- ii) PI type of controller.

(04 Marks)

Module-3

- 5 a. Determine the ranges of 'K' such that the characteristic equation :

$$S^3 + 3(K+1)S^2 + (7K+5)S + (4K+7) = 0 \text{ has roots more negative than } S = -1. \quad (06 \text{ Marks})$$

- b. Check the stability of the given characteristic equation using Routh's method.

$$S^6 + 2S^5 + 8S^4 + 12S^3 + 20S^2 + 16S + 16 = 0. \quad (06 \text{ Marks})$$

- c. Mention few limitations of Routh's criterion.

(04 Marks)

- 6 a. Sketch the complete root locus of system having, $G(s)H(s) = \frac{K}{S(S+1)(S+2)(S+3)}$. (12 Marks)
- b. Consider the system with $G(S)H(s) = \frac{K}{S(S+1)(S+4)}$. Find whether $S = -2$ point is on root locus or not using angle condition. (04 Marks)

Module-4

- 7 a. The open loop transfer function of a system is $G(s) = \frac{K}{s(1+s)(1+0.1s)}$. Determine the values of K such that i) gain margin = 10 dB ii) phase margin = 24° . Use Bode plot. (10 Marks)
- b. Derive the expression for resonant peak ' M_r ' and corresponding resonant frequency ' ω_r ' for a second-order underdamped system in frequency response analysis. (06 Marks)

OR

- 8 a. Sketch the Nyquist plot for a system with the open-loop transfer function :
 $G(s)H(s) = \frac{k(1+0.5s)(1+s)}{(1+10s)(s-1)}$
Determine the range of values of ' k ' for which the system is stable. (08 Marks)
- b. Write the polar plot for the following open-loop transfer function :
 $G(S)H(s) = \frac{1}{1+0.1s}$. (04 Marks)
- c. Explain Nyquist stability criteria. (04 Marks)

Module-5

- 9 a. Explain spectrum analysis of sampling process. (06 Marks)
- b. Explain how zero-order hold is used for signal reconstruction. (04 Marks)
- c. Find the state-transition matrix for $A = \begin{bmatrix} 0 & -1 \\ +2 & -3 \end{bmatrix}$. (06 Marks)

OR

- 10 a. Obtain an appropriate state model for a system represented by an electric circuit as shown in Fig.Q10(a).

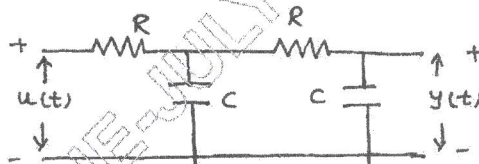


Fig.Q10(a)

- b. A linear time invariant system is characterized by the homogeneous state equation :

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

Compute the solution of homogeneous equation, assume the initial state vector.

$$X_0 = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

- c. State the properties of state transition matrix. (04 Marks)

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