



Third Semester B.E. Degree Examination, Dec.2019/Jan.2020 Control Systems

Time: 3 hrs.

Max. Marks: 80

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

Module-1

- 1 a. Obtain differential equations describing the mechanical system shown in Fig. Q1 (a) and draw electric circuits based on F-V and F-I analogy. (12 Marks)

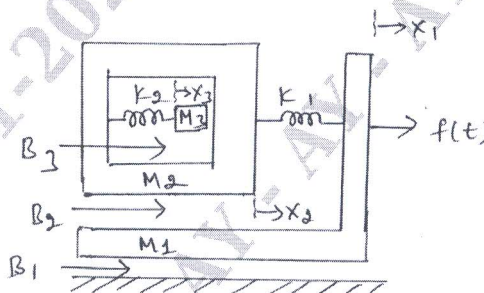


Fig. Q1 (a)

- b. Differentiate between open loop and closed loop systems giving suitable examples. (04 Marks)

OR

- 2 a. Reduce the block diagram shown in Fig. Q2 (a) to a single block $T(S) = C(S)/R(S)$ (08 Marks)

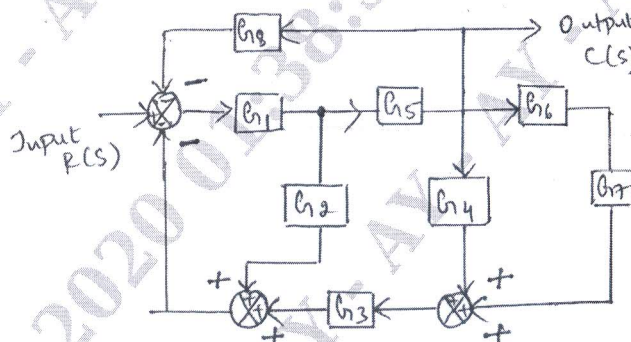


Fig. Q2 (a)

- b. The force voltage analogy of a mechanical translational system is given in Fig.Q2 (b). Obtain its analogous mechanical system. (08 Marks)

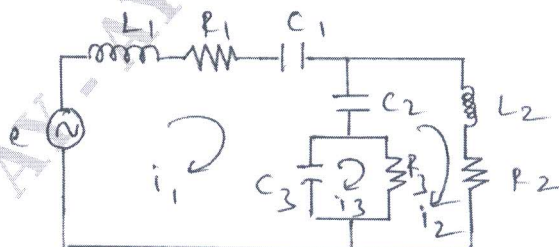


Fig. Q2 (b)

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.

Module-2

- 3 a. Draw the corresponding signal flow graph of given block diagram Fig. Q3 (a) and find $\frac{C(s)}{R(s)}$. (08 Marks)

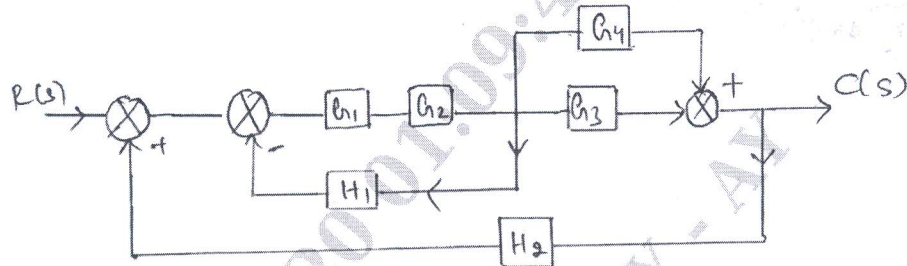


Fig. Q3 (a)

- b. Find the transfer function $T(s) = C(s)/R(s)$ for the signal flow graph shown in Fig. Q3 (b) using Mason's gain formula. (08 Marks)

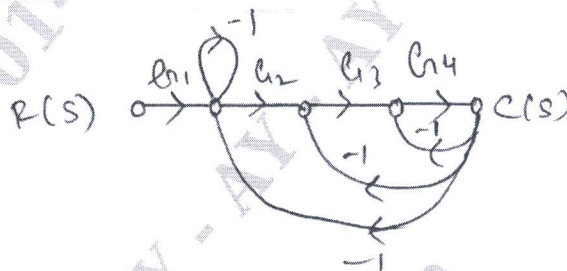


Fig. Q3 (b)

OR

- 4 a. A system is given by differential equation, $\frac{d^2y}{dt^2} + 4\frac{dy}{dt} + 8y = 8x$, where $y = \text{output}$ and $x = \text{input}$. Determine all time domain specifications for unit step input. (08 Marks)
- b. For a unity feedback control system with $G(s) = \frac{64}{s(s+9.6)}$, write the output response to a unit step input. Determine
- The response at $t = 0.1$ sec.
 - Maximum value of the response and the time at which it occurs.
 - Setting time.
- (08 Marks)

Module-3

- 5 a. Using Routh criteria determine stability of following systems:
- Its loop transfer function has poles at $S = 0$, $S = -1$, $S = -3$ and zero at $S = -5$, gain of K of forward path is 10.
 - It is a type one system with an error constant of 10 sec^{-1} and poles at $S = -3$ and $S = -6$
- (10 Marks)
- b. Determine the stability of the system having the characteristic equation using R-H criterion.
- $$s^6 + 2s^5 + 5s^4 + 8s^3 + 8s^2 + 8s + 4 = 0$$
- (06 Marks)

OR

- 6 Draw the root locus diagram for the loop transfer function, $G(s)H(s) = \frac{K}{s(s^2 + 8s + 17)}$. Evaluate the value of K for a system having damping ratio of 0.5 from the diagram. (16 Marks)

Module-4

- 7 a. Write a note on frequency domain specifications. (08 Marks)
- b. Sketch the Bode plot for the transfer function, $G(s) = \frac{Ks^2}{(1+0.2s)(1+0.02s)}$. Determine the value of K for the gain cross-over frequency to be 5 rad/sec. (08 Marks)

OR

- 8 a. The open loop transfer function of a unity negative feedback system is given by, $G(s) = \frac{K(s+3)}{s(s^2+2s+2)}$. Using Nyquist criteria, find the value of K for which the closed loop system is just stable. (08 Marks)
- b. The transfer function of a control system is $G(s) = \frac{1}{s(1+2s)(1+5s)}$. Sketch the polar plot and hence determine the phase cross over frequency and gain margin. (08 Marks)

Module-5

- 9 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 shown in Fig. Q9 (b) choosing the state variables as $i_1(t)$, $i_2(t)$ and $V_c(t)$ (08 Marks)

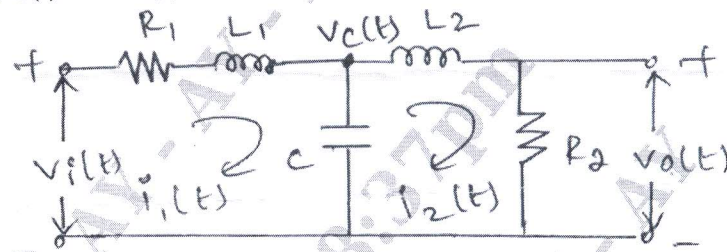


Fig. Q9 (b)

OR

- 10 a. Obtain the state transition matrix for $A = \begin{bmatrix} 0 & -1 \\ 2 & -3 \end{bmatrix}$. (08 Marks)
- b. Obtain the solution of the homogeneous state equation, $\dot{X} = AX$ where $A = \begin{bmatrix} 1 & -2 \\ 1 & -4 \end{bmatrix}$ and $X(0) = \begin{bmatrix} 0.5 \\ 1 \end{bmatrix}$. (08 Marks)
