Fourth Semester B.E. Degree Examination, June/July 2019
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. Define a control system. Explain the difference between open loop and closed loop control system with example for each. **(06 Marks)**

b. Determine the transfer function $X_2(s)/F(s)$ for the mechanical system shown in Fig.Q.1(b) **(08 Marks)**

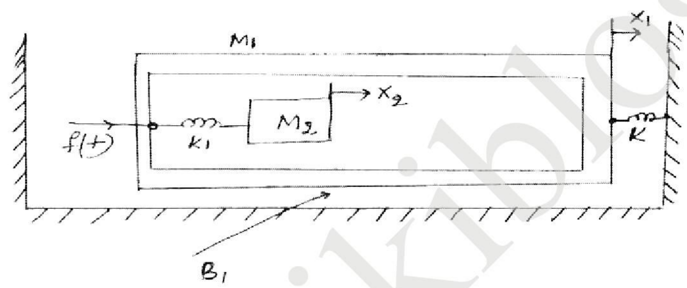

Fig.Q.1(b)

c. State advantages of the block diagram reduction technique. **(02 Marks)**

OR

2 a. Explain the block diagram reduction rules. **(04 Marks)**

b. Obtain C(s)/R(s) using block diagram reduction rules for the Fig.Q.2(b). **(06 Marks)**

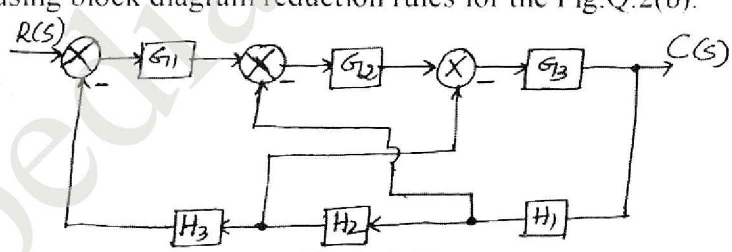

Fig.Q.2(b)

c. Using Mason's gain formula, find the gain of the system in Fig.Q.2(c). **(06 Marks)**

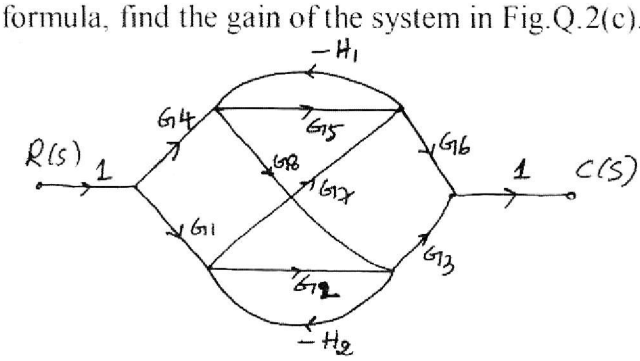

Fig.Q.2(c)

Module-2

3 a. What are disadvantages of static error coefficient method? **(03 Marks)**

b. Find k_p, k_v, k_a and static error for a system with open loop transfer function as:

$$G(s)H(s) = \frac{10(s+2)(s+3)}{s(s+1)(s+5)(s+4)}$$ where the input is $r(t) = 3 + t + t^2$. **(05 Marks)**

c. Derive the expression of unit step response of a second order system (under damped case). **(08 Marks)**

OR

4 a. Derive the expressions for Peak Time (T_P), Peak over short (M_P), Rise Time (T_R) and Settling Time (T_S). **(08 Marks)**

b. For a spring mass damper shown in Fig.Q.4(b) (i), an experiment was conducted by applying a force of 2 Newton's to the mass. The response X(t) was recorded using an xy plotter and the experimental result are shown in Fig.Q.4(b) (ii). Find the value of M, K and B. **(08 Marks)**

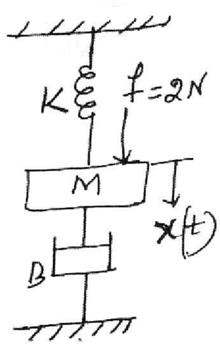

Fig.Q.4(b) (i)

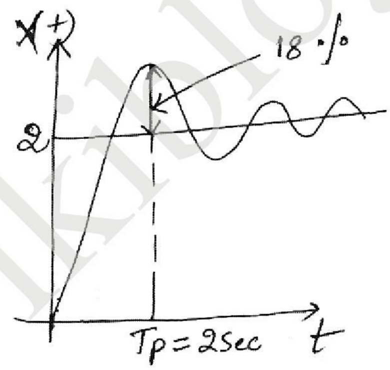

Fig.Q.4(b) (ii)

Module-3

5 a. State and explain Routh-Hurmitz criterion of stability. What are limitations? **(05 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 -1. **(08 Marks**

c. Define absolute stability and marginal stability. **(03 Marks)**

OR

6 a. State the rules for the construction of root loci of the characteristic equation of a feedback control system. **(04 Marks)**

b. Draw the root locus diagram for the loop transfer function:

$$G(s)H(s) = \frac{K}{s(s^2+8s+17)}$$

From the diagram, evaluate the value of K for a system damping ratio of 0.5. **(12 Marks)**

Module-4

7 a. Explain the correlation between time and frequency time for second order system. **(06 Marks)**

b. A unity feedback control system has $G(s) = \frac{80}{s(s+2)(s+20)}$. Draw the bode plot. **(10 Marks)**

OR

8 a. Distinguish between gain margin and phase margin. **(04 Marks)**

b. Draw the complete Nyquist plot of the system whose loop transfer function is given by $G(s) = \dfrac{10}{s^2(s+0.25s)(1+0.5s)}$. And hence determine system is stable or not. **(12 Marks)**

Module-5

9 a. Define state variables and state transition matrix. List the properties of the state transition matrix. **(06 Marks)**

b. For a certain system, when

$X(0) = \begin{bmatrix} 1 \\ -3 \end{bmatrix}$ then $X(t) = \begin{bmatrix} e^{-3t} \\ -3e^{-3t} \end{bmatrix}$ while $X(0) = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$ then $X(t) = \begin{bmatrix} e^{t} \\ e^{t} \end{bmatrix}$. Determine the system matrix A. Also find state transition matrix. **(10 Marks)**

OR

10 a. Obtain the state model for the electrical system as shown in the Fig.Q.10(a), choosing the state variables as $i_1(t)$, $i_2(t)$ and $v_c(t)$. **(06 Marks)**

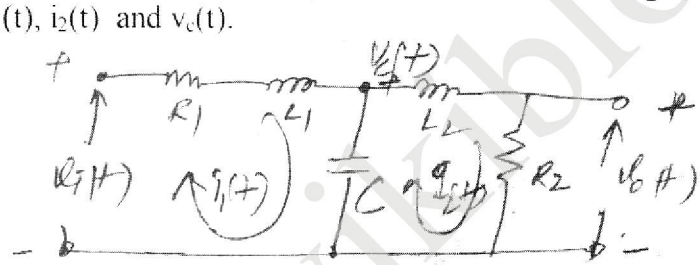

Fig.Q.10(a)

b. State and prove sampling theorem for low pass signals. **(10 Marks)**