Enrollment No: _____ Exam Seat No:_____

C.U.SHAH UNIVERSITY

Summer Examination-2019

Subject Name: Control System Engineering

Subject Code: 4TE04CSE1 **Branch: B.Tech (EC)**

Semester: 4 **Date: 24/04/2019** **Time: 02:30 To 05:30** **Marks : 70**

Instructions:

(1) Use of Programmable calculator & any other electronic instrument is prohibited.
(2) Instructions written on main answer book are strictly to be obeyed.
(3) Draw neat diagrams and figures (if necessary) at right places.
(4) Assume suitable data if needed.

Q-1 **Attempt the following questions:** **(14)**

a) Define control system. Enlist fundamental components of a general closed loop system. **[01]**

b) State formula of steady state error for a typical closed loop control system. Mention the values of velocity error co-efficient for type-0, type-1 and type-2 control systems. **[01]**

c) Write Mason's Gain Formula. Explain the significance of the same. **[01]**

d) Define any two-time response specifications for a typical control system. **[01]**

e) A unity negative feedback system has two poles, two zeros and a variable gain K. The zeros are located at -2 and -1 while poles are located at -0.1 and +1. Write the 'open loop transfer function' for the same. **[01]**

f) Mention at least two types of proportional control systems. **[01]**

g) Identify the number of poles and zeros in the given transfer function. **[01]**

$$G(s) = \frac{64(s+2)}{s(s+0.5)(s^2+3.2s+64)}$$

h) Write standard characteristic equation of a 2nd order system. **[01]**

i) Define: (i) Gain Margin, (ii) Phase Margin **[01]**

j) Mass in force voltage analogy is analogous to _____ and spring constant in force voltage analogy is analogous to _____. **[01]**

k) Define: (i) Rise Time, (ii) Peak Time. **[01]**

l) What are lead-lag compensators? **[01]**

m) Mention standard test signals in control system. **[01]**

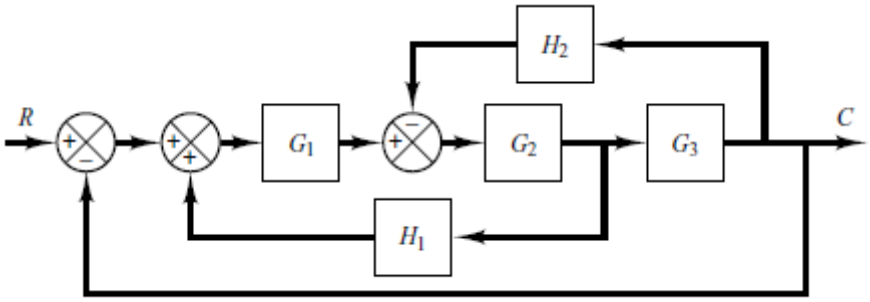
n) Define 'state variables' in control system. **[01]**

Attempt any four questions from Q-2 to Q-8

Q-2 **Attempt all questions** **(14)**

(a) Explain in detail about the block diagram reduction rules. **[07]**

(b) Reduce the given block diagram in to a single block of equivalent transfer function. **[07]**



Q-3 **Attempt all questions** **(14)**

(a) Obtain unit step response of a first order system. Back your answer with a suitable plot showing variation of output with time. **[07]**

(b) Write transfer function of a typical second order system ξ=0.6 and ω_n = 5 rad/s. Obtain (i) rise time, (ii) peak time, (iii) peak overshoot and (iv) settling time for 2% criterion and (v) settling time for 5% criterion. **[07]**

Q-4 **Attempt all questions** **(14)**

(a) Obtain unit step response of a second order system. Back your answer with a suitable plot showing variation of output with time. **[07]**

(b) For the given characteristic equation, determine the range of K for stability. **[07]**

$$s^4 + Ks^3 + s^2 + s + 1 = 0$$

Q-5 **Attempt all questions** **(14)**

(a) For the negative feedback system given below, plot root locus and then determine the value of K such that damping ratio is 0.5. **[07]**

$$G(s) = \frac{K}{s(s+1)(s+2)}, \qquad H(s) = 1$$

(b) Draw the bode diagram for the following transfer function. **[07]**

$$G(j\omega) = \frac{10(j\omega + 3)}{(j\omega)(j\omega + 2)\left[(j\omega)^2 + j\omega + 2\right]}$$

Make necessary corrections for that the log-magnitude curve is accurate.

Q-6 **Attempt all questions** **(14)**

(a) For the negative feedback system given below, plot root locus **[07]**

$$G(s) = \frac{K(s+2)}{s^2 + 2s + 3}, \qquad H(s) = 1$$

(b) Draw the bode plot for the following transfer function. **[07]**

$$G(j\omega) = \frac{e^{-j\omega L}}{1 + j\omega T}$$

Q-7 **Attempt all questions** **(14)**

(a) The stability of the given open loop transfer function depends on the relative magnitudes of T_1 and T_2. Draw Nyquist plots and determine the stability of the system. **[07]**

$$G(s)H(s) = \frac{K(T_2 s + 1)}{s^2(T_1 s + 1)}$$

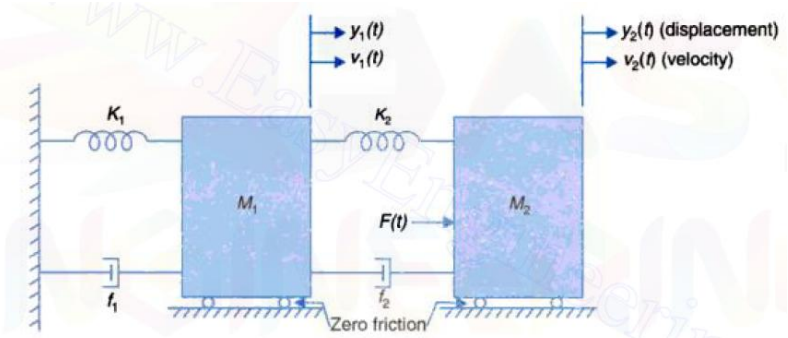
(b) Consider the system given by **[07]**

$$\frac{Y(s)}{U(s)} = \frac{s+3}{s^2+3s+2}$$

Obtain the state space relation in the controllable conical form, observable conical form and diagonal conical form.

Q-8 **Attempt all questions** **(14)**

(a) For the mechanical system shown in figure, obtain its free body diagram and thus obtain its analogous electrical network using any convenient analogy. **[07]**



(a) A mechanical system

(b) For the electrical network shown in figure, (i) mention the state variables in the system, (ii) draw signal flow graph from in terms of state variables defined in part (i), (iii) from signal flow graph, determine the state variable equations. **[07]**