

B. TECH.
(SEM VI) THEORY EXAMINATION 2018-19
CONTROL SYSTEM I

Time: 3 Hours

Total Marks: 70

Note: 1. Attempt all Sections. If require any missing data; then choose suitably.

SECTION A

1. Attempt all questions in brief.

2 x 7 = 14

- a. Write the condition for the system to be controllable.
- b. Compare an open loop control system with a close loop control system.
- c. What do mean by type and order of the system?
- d. State the effect of adding a zero to the forward path transfer function of the system.
- e. Differentiate between transient response and steady state response of a system.
- f. What will be the steady state error of the type 1 system, when subjected to unit parabolic input?
- g. State the relation between unit step and unit ramp signal.

SECTION B

2. Attempt any three of the following:

7 x 3 = 21

- a. (i) Establish the correlation between time domain response and frequency domain response of a system (5+2)
(ii) Define the terms: Settling time and Phase Margin
- b. Draw the block diagram of a standard second order control system in closed loop form and derive the relation for its time response when subjected to unit step input.
- c. (i) Construct state model for the system characterized by the following differential equation: (3+4)

$$\frac{d^3 y}{dt^3} + 6 \frac{d^2 y}{dt^2} + 11 \frac{dy}{dt} + 6y = 4$$

(ii) Check controllability and observability of the following system:

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix} \quad B = \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} \quad C = [10 \quad 5 \quad 1]$$

- d. (i) The open loop transfer function of a control system is given below

$$G(s)H(s) = \frac{2(s^2 + 3s + 20)}{s(s+2)(s^2 + 4s + 10)}$$

Determine static error coefficient and steady state error for the input given as

$$(1) 5 \quad (2) 4t \quad (3) 4t^2/2$$

- (ii) Using Routh- Hurwitz criterion, discuss the stability of the following characteristic equation

$$F(s) = s^6 + 3s^5 + 6s^4 + 12s^3 + 12s^2 + 12s + 8 \quad (3+4)$$

- e. The open loop transfer function of a unity feedback system is

$$G(s) = \frac{25}{s(s+5)}$$

- Find i) Natural frequency of oscillation ii) Damped frequency of oscillation
iii) Damping ratio iv) Maximum overshoot of unit step input.

SECTION C

3. Attempt any *one* part of the following: 7 x 1 = 7

(a) Using Bode Plot, comment on the stability of the following unity feedback open loop transfer function

$$G(s) = \frac{50}{(s+1)(s+2)}$$

(b) Use Bode Plot to determine the gain K for the open loop transfer function given below so that gain margin is 15 dB

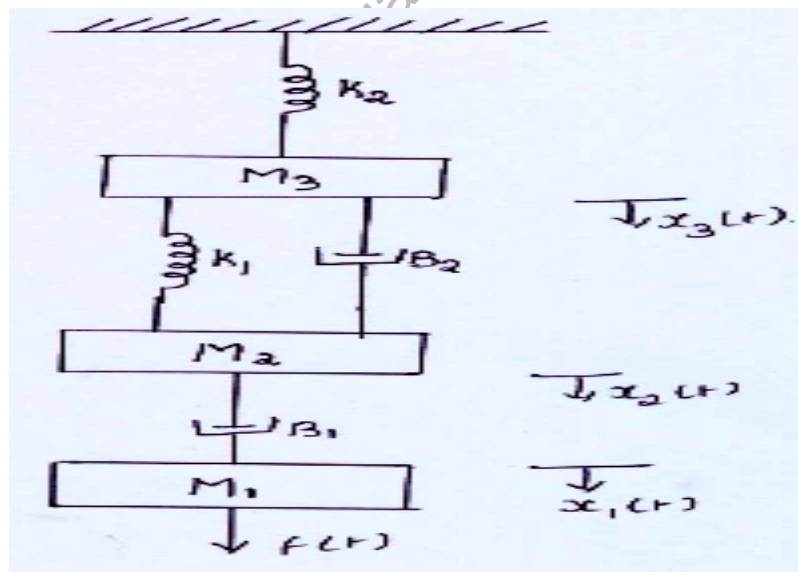
$$G(j\omega)H(j\omega) = \frac{K}{j\omega(0.1\omega+1)(j\omega+2)}$$

4. Attempt any *one* part of the following: 7 x 1 = 7

(a) Using Nyquist plot determine (a) Phase crossover frequency (b) Gain crossover frequency for

$$G(s)H(s) = \frac{2.5K}{s(0.4s+1)(0.2s+1)}$$

(b) Draw the analogous electrical circuit for the system shown below. Use F-V and F-I analogy. All the symbols have usual meaning.



5. Attempt any *one* part of the following: 7 x 1 = 7

(a) Elaborate the step wise procedure for plotting the root locus of a given open loop transfer function.

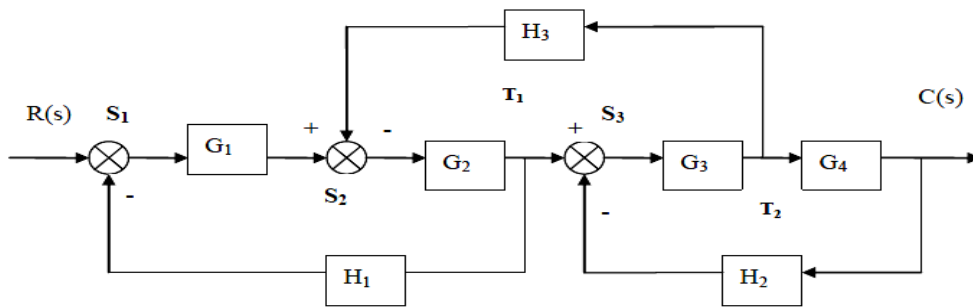
(b) Sketch the root locus for the open loop transfer function of a unity feedback control system given below

$$G(s) = \frac{K}{s(s+1)(s+3)}$$

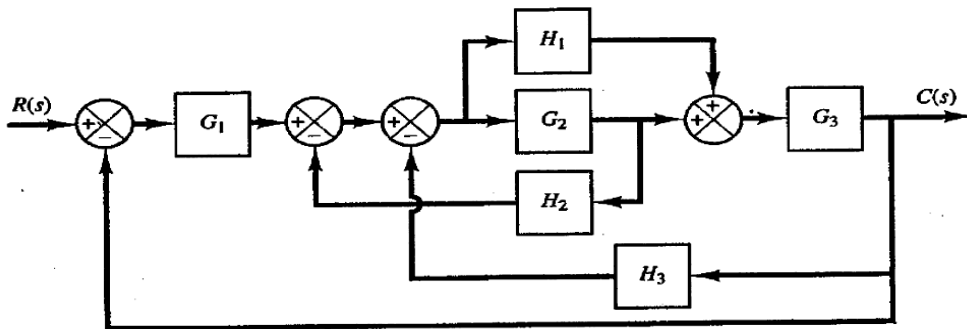
6. Attempt any *one* part of the following:

7 x 1 = 7

(a) For the following block diagram, determine over all transfer function using block diagram reduction technique



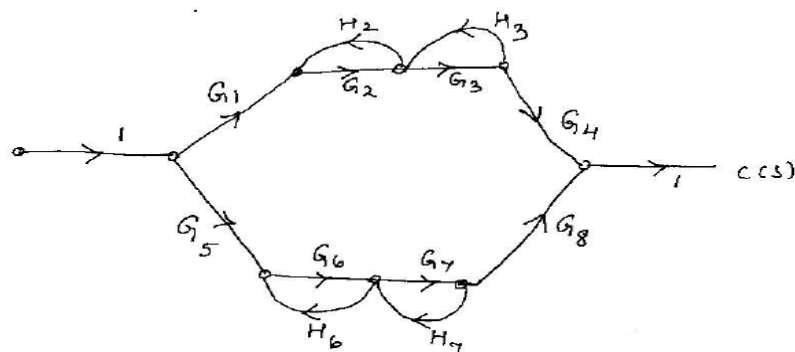
(b) Find overall transfer function using signal flow graph:



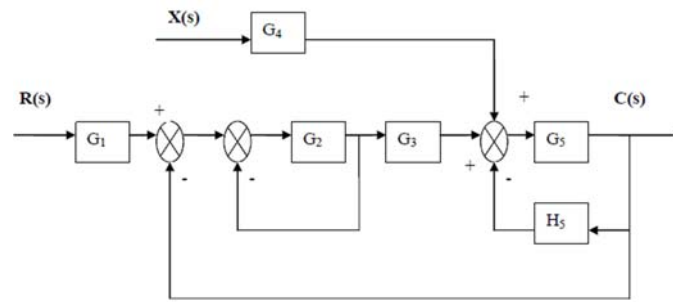
7. Attempt any *one* part of the following:

7 x 1 = 7

(a) Using Mason's Gain Formula, find over all transfer function for the following system



(b) Using block diagram reduction technique, find over all transfer function for the following system



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