Printed Pages: 04 **EIC501**

Paper Id	1	3	2	5	1	1	**Roll No.**										

B TECH

(SEM-V) THEORY EXAMINATION, 2018-19

CONTROL SYSTEM-I

Time: 3 Hours ***Max. Marks: 100***

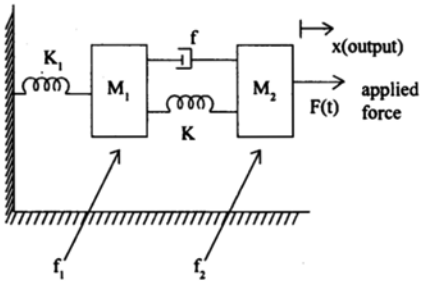
Note: *Be precise in your answer. In case of numerical problem assume data wherever not provided*

SECTION – A

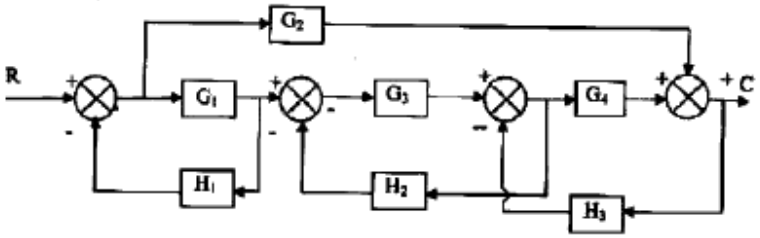
1. **Attempt all parts of the following questions:** **2×10=20**
   - **(a)** What is an asymptote?
   - **(b)** Define transfer function.
   - **(c)** What is the general effect of adding a pole to the forward path transfer function?
   - **(d)** Compare open loop and closed loop control systems.
   - **(e)** Give Mason's Gain formula.
   - **(f)** What is steady-state error?
   - **(g)** Write the analogous electrical elements in force voltage analogy for the elements of mechanical translational system?
   - **(h)** Define damping ratio.
   - **(i)** What is phase margin and gain margin?
   - **(j)** Why negative feedback is invariably preferred in closed loop system?

SECTION B

2. **Attempt any three parts of the following questions:** **3×10=30**
   - **(a)** Obtain the transfer functions of the mechanical systems and the analogous electrical circuit shown in the figure below:



(b) Reduce the block diagram shown below to a single block and find the overall transfer function.

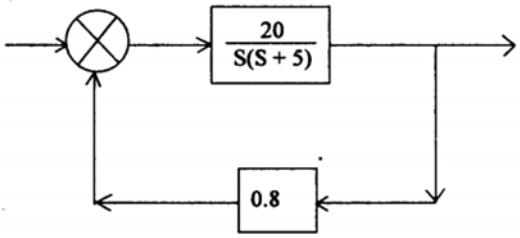


(c) Determine the ranges of K such that the characteristics equation

$$s^3 + 3(K+1)s^2 + (7K+5)s + 4K + 7 = 0$$

has roots more negative than s= -1.

(d) Determine the sensitivity of the system given in the figure below with respect to feedback path transfer function at $\omega = 2.0\ rad/s$.



(e) Determine the type and order of the unity feedback control systems whose open-loop transfer functions is

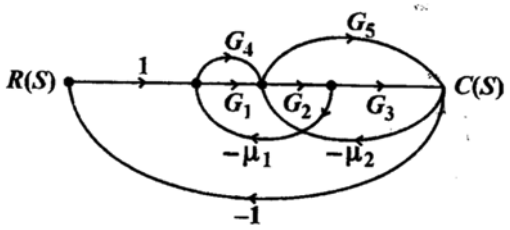
$$G(S) = \frac{K}{s(s^2 + 4s + 200)}$$

Find also the static error coefficients and the errors for unit step and unit ramp inputs.

SECTION C

3. Attempt any one part of the following question: 1×10=10

(a) Determine the overall transfer function from the signal flow graph shown in figure using the Mason's gain formula.



(b) Establish the correlation between time response and frequency response analysis and suitably explain with diagrams.

4. Attempt any one part of the following question: 1×10=10

(a) For the following state equation, determine the transfer function Y(s)/U(s).

$$\begin{bmatrix}\dot{X}_1\\ \dot{X}_2\end{bmatrix} = \begin{bmatrix}1 & 0\\ 1 & 1\end{bmatrix} + \begin{bmatrix}X_1\\ X_2\end{bmatrix} + \begin{bmatrix}1\\ 1\end{bmatrix} u$$

Where u(t) is a unit step occuring at t=0 and $X^T(0)$=[1 0].

(b) For the open loop transfer function

$$G(s)H(s) = \frac{10}{s(1+0.2s)}$$

Design a suitable compensator such that the system will have a phase margin of at least 45°.

5. Attempt any one part of the following question: 1×10=10

(a) Discuss Nyquist Stability criterion in detail. Also sketch the Nyquist plot for the system with

$$G(S)H(S) = \frac{(1+0.5s)}{s^2(1+0.1s)(1+0.02s)}$$

Comment on the stability and find the value of gain margin.

(b) . A unity feedback system has an amplifier with gain Ka=10 and gain ratio G(S) = 1 / S (S+2) in the feed forward Path. A derivative feedback ,H(S)=SK_0 is introduced as a minor loop around G(S).Determine the derivative feedback constant ,K_0 ,so that the system damping factor is 0.6.

6. Attempt any one part of the following question: **1×10=10**

(a) Draw the Bode plot for the transfer function

$$G(s) = \frac{36(1 + 0.2s)}{s^2(1 + 0.05s)(1 + 0.01s)}$$

From the bode plot determine:

(i) Phase crossover frequency.

(ii) Gain crossover frequency

(iii) Gain Margin

(iv) Phase Margin.

(b) What is state transition matrix? Write its properties. Derive its expression in time and Laplace domains.

7. Attempt any one part of the following question: **1×10=10**

(a) Derive the time response of a second order system subjected to unit step input**.**

(b) For the following state equation, determine the transfer function between Y(s)U(s) according to the formula:

$$\frac{Y(s)}{U(s)} = (C[SI - A]^{-1}B + D$$

$$A = \begin{bmatrix} 0 & 3 \\ -2 & -3 \end{bmatrix}, B = \begin{bmatrix} 0 \\ 3 \end{bmatrix}$$

$$C = [1\ 0]\ \ and\ \ D = 1$$