Printed Pages: 02 Sub Code: REE-503

Paper Id: 231866 Roll No.

**B. TECH**
**(SEM V) THEORY EXAMINATION 2022-23**
**CONTROL SYSTEM**

***Time: 3 Hours*** ***Total Marks: 70***

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

## SECTION A

**1. Attempt *all* questions in brief. 2 x 7 = 14**

(a) Define transfer function of a control system.
(b) What is Mason's gain formula? Explain.
(c) Discuss the effect of PD and PI controllers on $2^{nd}$order control system performance.
(d) A unity feedback system with open-loop transfer function G(s) =4/[s(s+p)] is critically damped. Calculate the value of p?
(e) Outline the special case of Routh-Hurwitz criterion.
(f) Draw the gain verses frequency plot and explain cut off rate and cut off frequency.
(g) Outline the procedure to draw polar plot.

## SECTION B

**2. Attempt any *three* of the following: 7 x 3 = 21**

(a) Describe the closed loop control system and explain any one example with suitable block diagram.
(b) Discus the time domain specifications and mark them on the response of $2^{nd}$order system when subjected to unit step input.
(c) Determine the value of K such that the roots of the characteristics equation given below lie to the left of line s = -1.
$$s^3 + 10s^2 + 18s + K = 0$$
(d) Demonstrate the significance of gain margin and phase margin on a polar plot. Also, draw and properly label the polar plot for stable and unstable system.
(e) Calculate state transition matrix for A= $\begin{bmatrix} 0 & -1 \\ 2 & -3 \end{bmatrix}$

## SECTION C

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

(a) Discuss the root locus and sketch the loci of the roots of a unity feedback open loop transfer function $G(s)H(S) = \dfrac{K}{s(s+1)(s+3)(s+4)}$

(b) The open loop T.F. of certain unity feedback system is $G(s) = \dfrac{K(s+10)(s+20)}{s^2(s+6)}$

Compute
(i) Range of K for stability
(ii) Marginal value of K
(iii) Location of roots for marginal stability

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

(a) Describe $K_p$, $K_v$ , and $K_a$ and steady state error for a system with open loop transfer function as:

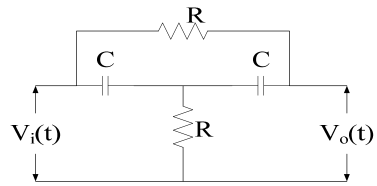
$$G(s)H(s) = \frac{10(s+2)(s+3)}{s(s+1)(s+5)(s+4)}$$

Where the input is $r(t) = 3 + t + t^2$

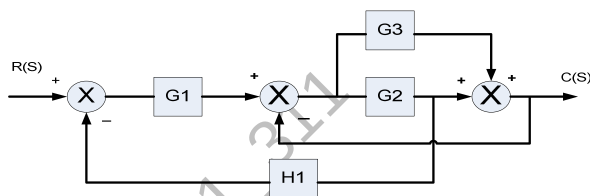
(b) Derive the generalized error coefficients and corresponding steady state error.

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

(a) Using Mason's gain formula and obtain the transfer function of the circuit diagram given below-




(b) Using block reduction technique compute the transfer function of the block diagram given below-




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

(a) Compute the phase crossover frequency and gain margin with open loop transfer function given below by sketching the polar plot. Also compute on stability of the system.

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

(b) Describe the Nyquist contour and Nyquist stability criterion.

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

(a) Differentiate the different types of compensators used in control system.Explain the lead compensator and also derive the relation between maximum lead angle $\Phi_m$ and $\alpha$.

(b) Judge the controllability and observability of a system with $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix}$,

$B = \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix}$ $C = \begin{bmatrix} 10 & 5 & 1 \end{bmatrix}$