

6TH SEM/ ETC & TELECOMM./ETC & COMMUNICATION/2022(S)

TH2 Control Systems & Component

Full Marks: 80

Time- 3 Hrs

Answer any **Five** Questions including Q No.1& 2

Figures in the right-hand margin indicates marks

1. Answer **All** questions 2 x 10

- a. Write the effects of negative feedback on gain, bandwidth, stability and sensitivity of a control system.
- b. Define transfer function of a SISO system. Write any two properties of transfer function.
- c. Determine the type and order of unity feedback system with loop transfer function

$$G(s) = \frac{25(s+3)}{s^3(s+1)(s^2+s+2)}$$

- d. Determine time constant and 2% settling time of the system whose time response is given by $c(t) = 10(1 - e^{-0.5t})u(t)$.
- e. What are the conditions for an LTI system to be BIBO (bounded input bounded output) stable?
- f. For the system with loop transfer function $G(s)H(s) = \frac{10}{s(s+2)}$ find
 - I. Centroid
 - II. Number of asymptotes.
- g. Define Nyquist stability criterion.
- h. Plot the poles and zeros of $G(s) = \frac{(s+1)}{s(s^2+4)}$ on s plane.
- i. Write the effects of adding poles and zeros to the loop transfer function on root loci.
- j. Find the impulse response of a system with transfer function $G(s) = \frac{2}{s+3}$.

2. Answer **Any Six** Questions 6 x 5

- a. Define the standard test signals used in control system. Write their Laplace Transforms.
- b. Determine the stability of a system using Routh Hurwitz (RH) criteria whose characteristics equation is given by

$$2s^4 + s^3 + 3s^2 + 5s + 10 = 0$$

- c. The open loop transfer function of a unity feedback system is given by

$$G(s) = \frac{120}{s^2(s+4)(s^2+3s+12)}$$

Determine the following

- I. Static error coefficients
- II. Steady state error of the system for an input $r(t) = 2 + 5t + 2t^2, t \geq 0$

- d. Realize a PI controller using OPAMP and write its features.
- e. Differentiate between open loop and closed loop control system.
- f. Calculate the phase margin (PM) of a system having loop transfer function

$$G(s)H(s) = \frac{2\sqrt{3}}{s(s+1)}$$

- g. A network is described by the state model as

$$\dot{x}_1 = 2x_1 - x_2 + 3u$$

$$\dot{x}_2 = -4x_2 - u$$

$$y = 3x_1 - 2x_2$$

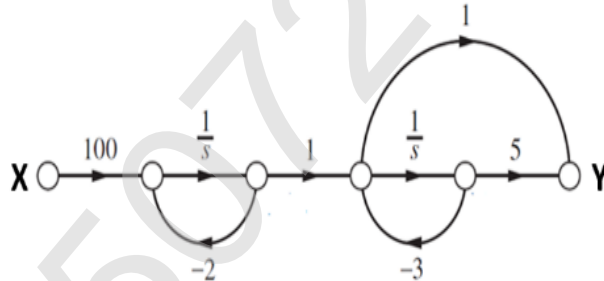
Find the transfer function $H(s) = \frac{Y(s)}{U(s)}$

3. For a unity feedback system, the loop transfer function is given by 10

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

- I. Plot the root locus for $0 < K < \infty$
- II. Comment on closed loop stability of the system

4. Determine $\frac{Y}{X}$ using Mason's gain formula for the Signal Flow Graph given below 10



5. The loop transfer function of a system is given by $G(s) = \frac{K}{s(1+s)(1+2s)}$ 10

- I. Draw the Nyquist plot for $-\infty < \omega < \infty$
- II. Comment on closed loop stability of the system

6. Derive the expressions for rise time and peak overshoot for unit step response of the under damped second order prototype system. 10

7. Find the transfer function, $\frac{E_o(s)}{E_i(s)}$ of the network shown below. 10

