Bihar Engineering University, Patna

B.Tech. 5th Semester Examination, 2023

Course: B.Tech. *Time: 03 Hours*

Code: 100502 *Subject: Control Systems* *Full Marks: 70*

Instructions:-

(i) The marks are indicated in the right-hand margin.

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

*(iv) Question No. **1** is compulsory.*

Q.1 *Choose the correct answer of the following (Any seven question only):* **[2 x 7 = 14]**

(a) In order to explain stability, it start from the fact that the total response of a system is the sum of the natural response and .....

(i) Forced response (ii) Unforced response

(iii) Drift response (iv) State response

(b) The response shown in Figure 1 is

(i) A Unit Step Signal (ii) A Unit Ramp Signal

(iii) An Impulse Signal (iv) A Sinusoidal Signal

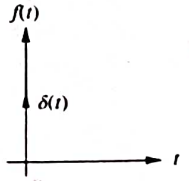

Figure 1: A standard Input Test Signal

(c) The Laplace transform $F(s)$ of $f(t) = tu(t)$ is

(i) $\frac{1}{S}$ (ii) $\frac{1}{S^2}$ (iii) $\frac{1}{S^3}$ (iv) 1

(d) If $F(s) = \frac{2}{(s+1)(s+2)}$ then $F(t)$ is given by

(i) $f(t) = (2e^{-t} - 2e^{-2t})u(t)$ (ii) $f(t) = (2e^{-t} - e^{-2t})u(t)$

(iii) $f(t) = (2e^{-2t} + e^{-2t})u(t)$ (iv) $f(t) = 2e^{-t}u(t)$

(e) The transfer function of the mechanical system shown in Figure 2 is

(i) $\frac{1}{MS^2+fv^s+K^2}$ (ii) $\frac{1}{MS^2+2fv^s}$

(iii) $\frac{1}{2MS^2+2fv^s+2K}$ (iv) $\frac{1}{MS^2+fv^s+K}$

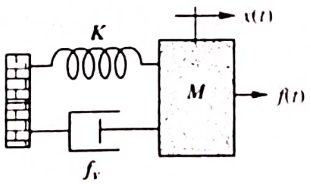

Figure 2 : A Mechanical System

(f) For a state space model given by equations $\dot{x}_1 = 2x_2$; $\dot{x}_2 = -3x_1 - 5x_2 + e^{-t}$ with initial conditions $x_1(0) = 2; x_2(0) = 1$. Eigen values are given by

(i) $-1, -2$ (ii) $-2, -3$

(iii) $-3, -4$ (iv) None of the above

(g) The system given as $T(s) = \frac{K(5+5)}{s(s+1)(s+2)}$ is

(i) A type 0 system (ii) A type 3 system

(iii) A type 1 system (iv) A type 2 system

(h) The phase margin is the change in open – loop phase shift required at ..... to make the closed- loop system unstable

(i) Unit input single (ii) Unity feedback
(iii) Unity gain (iv) Transfer function

(i) In Nyquits diagram we explore mapping of .....

(i) Contours (iii) Configuration Space
(ii) Limit cycles (iv) Phase portraits

(j) If the Characteristics equation of a system is $S^2+2=0$, then the system is:

(i) Critically damped (ii) Overdamped
(iii) Underdamped (iv) Undamped

Q.2 Discuss in detail: (a) PID Controllers (b) Lag-Lead Compensators **[14]**

Q.3 What do you mean by state variables? Write equations for state space representation. Discuss in detail the solution of state equation. Also give formulation for diagonalization of state transition matrix. **[14]**

Q.4 What do you mean by controllabillity and Observabillity? Explain with supporting mathematical formulations. **[14]**

Q.5 (a) Find the closed-loop transfer function, T(s) = C(s)/R(s) for the system shown in Figure 3, using block diagram reduction. **[7]**

(b) Convert the block diagram into a signal flow graph use masons gain formula to obtain the transfer function of the system shown in Figure 3 **[7]**

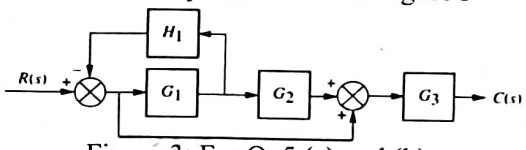

Figure 3: For Q. 5 (a) and (b)

Q.6 (a) Determine the stability of the closed-loop transfer function given as **[7]**

$$T(s) = \frac{10}{s^5 + 2s^4 + 3s^3 + 6s^2 + 5s + 3}$$

(b) Determine the number of right-half-plane poles in the closed-loop transfer function $T(s) = \frac{10}{s^5+7s^4+6s^3+42s^2+8s+56}$ **[7]**

Q.7 Sketch the root locus plot for the system shown in figure 4 **[14]**

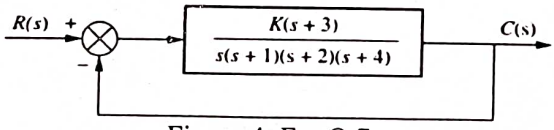

Figure 4: For Q.7

Q.8 Draw the Bode plot of the system shown in figure 5 where **[14]**

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

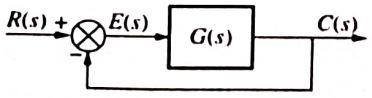

Figure 5: For Q. 8 and Q. 9

Q.9 Sketch the Nyquist diagram for the unity feedback system shown in figure 5 where $G(s) = \frac{(s+2)}{s^2}$ **[14]**