Dr. Ravinder Nath 17/11/2023

*National Institute of Technology Hamirpur (H.P.)*

**Department of Electrical Engineering**

*B Tech-cum-Dual Degree (7th Sem.) Electronics & Communication Engineering*

End Semester Theory Examination (November 2023)

EC-411

*Time: 3 hrs*

*Subject: Control System*

*Maximum Marks 50*

Q.1 (a) For the block diagram shown in **Figure 1**, obtain the Transfer Function $Y(s)/R(s)$.

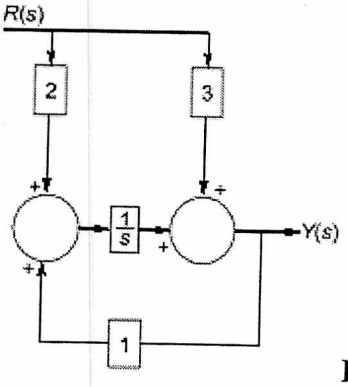


**Figure 1**

(b) A unity feedback system has open loop transfer function $G(s) = \frac{25}{s(s+6)}$. Calculate the percentage peak overshoot for the step-input response of the system.

(c) The unit - step response of a unity feedback system with open loop transfer function $G(s) = \frac{K}{(s+1)(s+2)}$ is shown in **Figure 2**. Find the value of K.

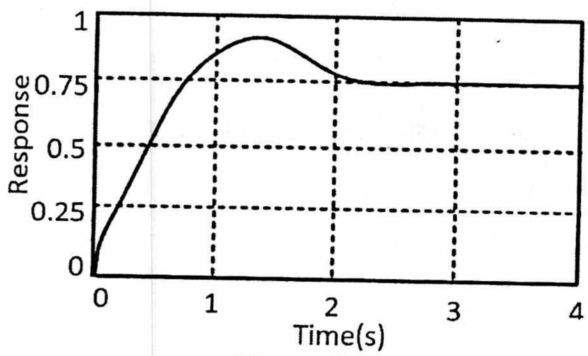


**Figure 2**

(d) The signal flow graph for a system is shown in **Figure 3**. Obtain the transfer function $Y(s)/U(s)$ of the system

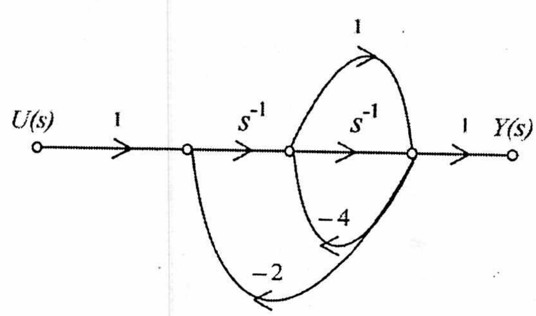


**Figure 3**

(e) A system with the open loop transfer function $G(s) = \frac{K}{s(s+2)(s^2+2s+2)}$ is connected in a negative feedback configuration with a feedback gain of unity. Find the value of K for the closed loop system to be marginally stable.

(f) The magnitude of frequency responses of an underdamped second order system is 5 at 0 rad/sec and peaks to $10/\sqrt{3}$ at $5\sqrt{2}$ rad/sec. Obtain the transfer function of the system.

(g) Consider the state model with system matrix, input matrix, output matrix, and direct transmission matrix as:

$$A = \begin{bmatrix} 0 & 1 \\ -1 & -2 \end{bmatrix},\ B = \begin{bmatrix} 0 \\ 1 \end{bmatrix},\ C = \begin{bmatrix} 3 & -2 \end{bmatrix}, D = 1.$$

For the input, $\sin(\omega t), \omega > 0$. Find the value of $\omega$ for which the steady-state output of the system will be zero.

(h) Write the state space model for the system descried by a differential equation as:

$$\frac{d^3 y(t)}{dt^3} + a_2 \frac{d^2 y(t)}{dt^2} + a_1 \frac{dy(t)}{dt} + a_0 y(t) = u(t)$$ , where u(t) and $y(t)$ are the input and output of the system respectively.

(i) Obtain the Transfer Function of an LTI system described by a state space model as:

$$\dot{X} = \begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -1 & -1 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \end{bmatrix} [u],\quad y = \begin{bmatrix} 0 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

(j) Define state, state variable, state vector, and state space for a LTI system.

**(10×3=30)**

**Q.2** Consider the LTI system described by the state equation

~~$\dot{x}_1(t) = \dot{x}_2(t)$~~ $\dot{x}_1(t) = x_2(t)$

$$\dot{x}_2(t) = -6x_1(t) - 5x_2(t)$$

The initial conditions are $x_1(0) = 0$ and $x_2(0) = 1.0$. Compute at $t = 1$ the value of $x_2(1)$.

**(5)**

**Q.3** Discuss the concepts and applications of P, PI, PD, and PID types of control.

**(5)**

**Q.4** Write short note on any ***two*** of the following:-

(i) Synchros
(ii) AC Servomotors
(iii) Controllability and Observability
(iv) Steady state errors and Error Constants

**(2×5=10)**

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