

KATHMANDU UNIVERSITY  
End Semester Examination  
June/July, 2023

Marks Scored:

Level : B.E.

Year : III

Exam Roll No. :

Time: 30 mins.

Course : COEG 301

Semester : II

F. M. : 10

Date : 07 JUL 2023

Registration No.:

SECTION "A"

[20 Q. × 0.5 = 10 marks]

Encircle the most appropriate option to the following questions.

1. A signal that tends to adversely affect the value of the output of the system is called.....  
a. feedback  
b. disturbance  
c. controlled variable  
d. manipulated variable
2. To the system with  $G(s)H(s) = \frac{K}{(sT+1)}$  if a pole at origin is added for a polar plot .....  
a. whole plot is rotated by  $90^\circ$   
b. only the  $\omega=0$  value is rotated by  $90^\circ$   
c. whole plot is rotated by  $180^\circ$   
d. only the  $\omega=\infty$  value is rotated by  $90^\circ$
3. For a force current analogous system the damper constant is similar to  
a. Capacitance in an electrical circuit  
b. Resistance in an electrical circuit  
c. Conductance in an electrical  
d. Inductance in an electrical circuit
4. The steady state error for a type 1 system with ramp input is.....  
a. 0  
b. 1  
c.  $\infty$   
d. constant
5. The asymptotic approximation of the log-magnitude v/s frequency plot of a system containing only real poles and zeros is shown in figure-1. Its transfer function is  
a.  $10(s+5)/s(s+2)(s+25)$   
b.  $80(s+5)/s^2(s+2)(s+25)$   
c.  $100(s+5)/s(s+2)(s+25)$   
d.  $1000(s+5)/s^2(s+2)(s+25)$

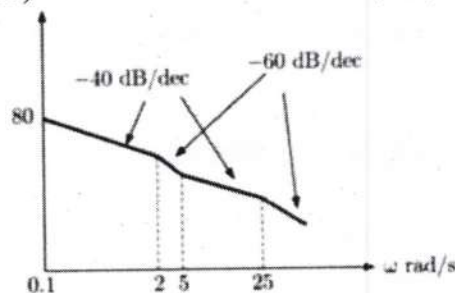


Figure-1

6. For the block diagram shown in figure-2, the transfer function  $C(s)/R(s)$  is equal to  
 a.  $\{s^2+1\}/s^2$       b.  $\{s^2+s+1\}/s^2$       c.  $\{s^2+s+1\}/s$       d.  $1/\{s^2+s+1\}$

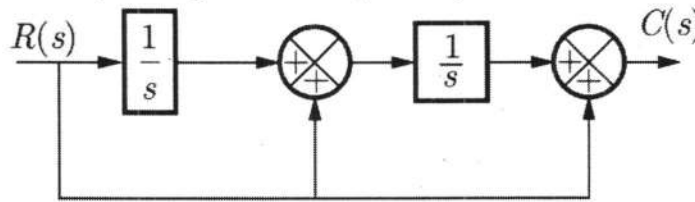


Figure-2

7. The transfer function  $C(s)/R(s)$  for the signal flow graph shown in figure-3 is .....  
 a. 1      b. 0.96      c. 24      d. 264

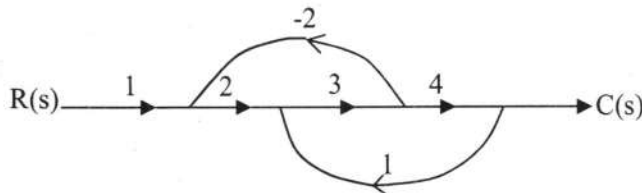


Figure-3

8. Given a unity feedback control system with  $G(s) = K/\{s(s+4)\}$ , the value of K for a damping ratio of 0.5 is  
 a. 1.      b. 16.      c. 32.      d. 64.
9. For gear train if  $N_1 = 40$  and  $N_2 = 20$ , then  $T_1:T_2$  is  
 a. 2:1      b. 1:2      c. 20:1      d. 20:4
10. A mechanical system is described by the equation  $10\ddot{y} + 5\dot{y} + 4y = u$ . Considering  $y$  and  $\dot{y}$  as the state variables and  $u$  as input variable the input matrix is .....  
 a.  $\begin{bmatrix} 0 \\ 0.1 \end{bmatrix}$       b.  $\begin{bmatrix} 0 \\ 0.2 \end{bmatrix}$       c.  $\begin{bmatrix} 0 \\ 0.5 \end{bmatrix}$       d.  $\begin{bmatrix} 0 \\ 0.4 \end{bmatrix}$
11. For a system with open loop transfer function  $G(s)H(s) = \frac{K}{s(s+2)(s+2+j4)(s+2-j4)}$  the asymptotes of the root locus intersect on the real axis at.....  
 a. -1.75      b. -1.5      c. -1.25      d. -1
12. The Nyquist plot of a system with the transfer function  $G(s) = \frac{K}{(sT_1+1)(sT_2+1)}$  will be as in figure .....  
 a. 4.a      b. 4.b      c. 4.c      d. 4.d

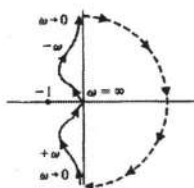


Figure 4.a

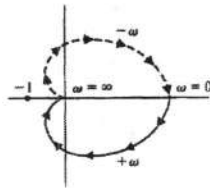


Figure 4.b

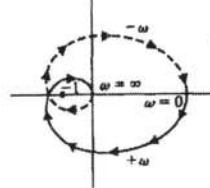


Figure 4.c

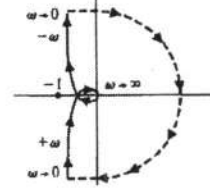


Figure 4.d



**SECTION "B"**  
[5Q. × 8 = 40 marks]

Attempt *ANY FIVE* questions. Assume necessary data if required.

1. a. A motor and generator are set up to drive a load as shown in figure-1. The generator output voltage is  $e_g(t) = K_f i_f(t)$ , where  $i_f(t)$  is the generator's field current. Assume  $K_f = 20\Omega$  for generator. For the dc motor assume  $K_t = 1 \text{ N-m/A}$  and  $K_b = 1 \text{ V-s/rad}$ . Obtain the transfer function  $G(s) = \theta_0(s) / E_i(s)$  of the system. [5]

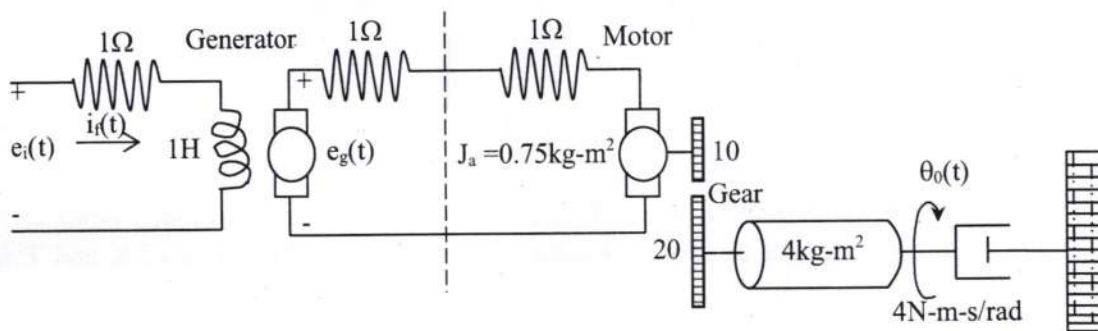


Figure-1

- b. Simplify the block diagram shown in Figure-2 and obtain the closed-loop transfer function  $C(s)/R(s)$ . [3]

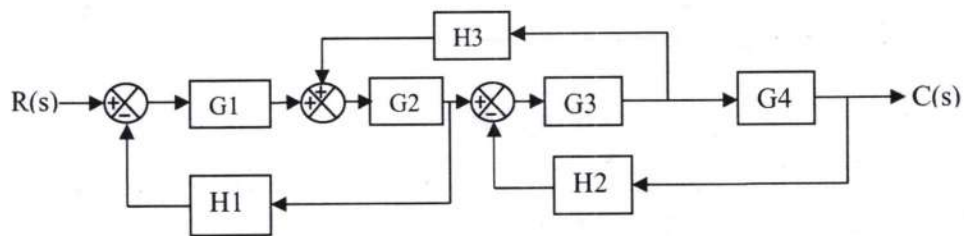


Figure-2

2. a. For the system with  $G(s) = \frac{100}{s^2(s+1)(s+0.1)}$  and  $H(s) = 1$ , find the steady state error  $e_{ss}$  if  $r(t) = 10 + 2t + 50t^2$ . [2]
- b. Sketch the root loci for the system shown in figure-3. [6]

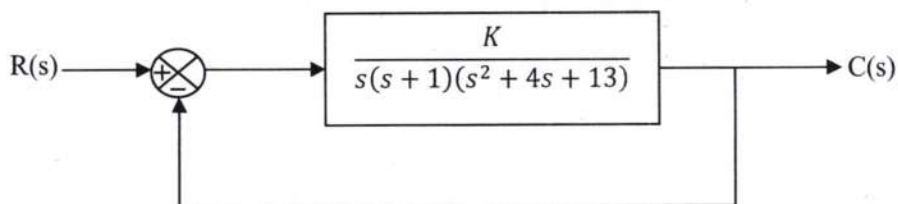


Figure-3

3. a. Consider the liquid-level system shown in figure-4. In the system,  $Q_1$  and  $Q_2$  are steady-state inflow rates and  $H_1$  and  $H_2$  are steady-state heads. The quantities  $q_{i1}$ ,  $q_{i2}$ ,  $h_1$ ,  $h_2$ ,  $q_1$ , and  $q_o$  are considered small. Obtain a state-space representation for the system when  $h_1$  and  $h_2$  are the outputs and  $q_{i1}$  and  $q_{i2}$  are the inputs. [4]

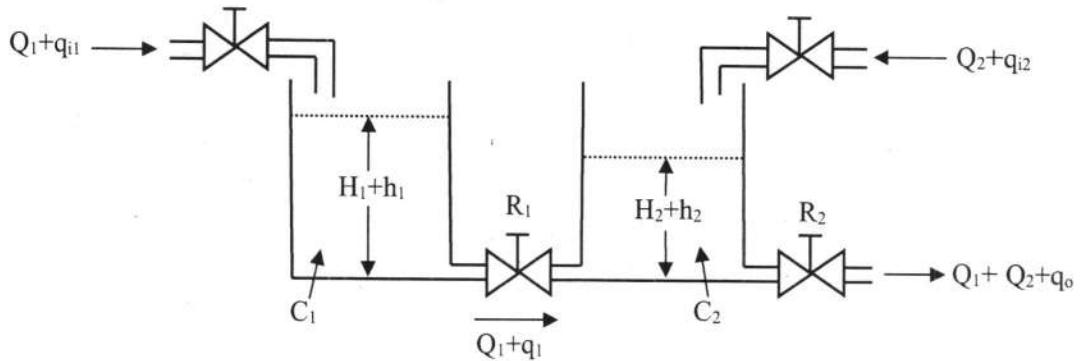


Figure-4

- b. When the system shown in figure 5(a) is subjected to a unit-step input, the system output responds as shown in figure 5(b). Determine the values of  $K$  and  $T$  from the response curve. [4]

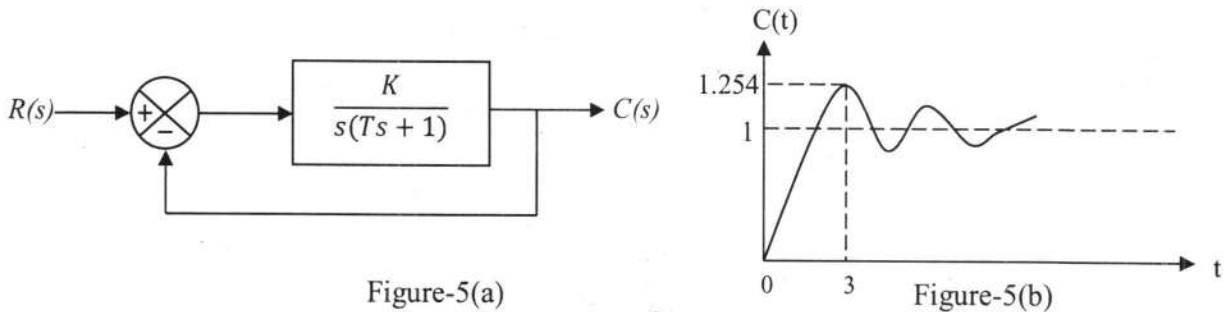


Figure-5(a)

Figure-5(b)

4. The forward path transfer function of a control system is given by  $G(s) = \frac{K}{s(s+2)(s+20)}$ . Design a suitable lag compensator having phase margin  $\geq 35^\circ$  and  $k_v = 20 \text{ sec}^{-1}$ . Use Bode plot for the design. [8]
5. a. Consider a unity-feedback control system with the following open-loop transfer function  $G(s) = \frac{1}{s^3 + 0.2s^2 + s + 1}$ . Draw a Nyquist plot of  $G(s)$  and examine the stability of the system. [5]

- b. Consider the thin, glass-wall, mercury thermometer system shown in figure-6. Assume that the thermometer is at a uniform temperature (ambient temperature) and that at  $t = 0$  it is immersed in a bath of temperature  $\theta_b$  (which may be constant or changing) measured from the ambient temperature. Define the instantaneous thermometer temperature  $\theta$  so that  $\theta$  is the change in the thermometer temperature satisfying the condition that  $\theta(0) = 0$ . Determine the transfer function  $\theta(s)/\theta_b(s)$ . [3]

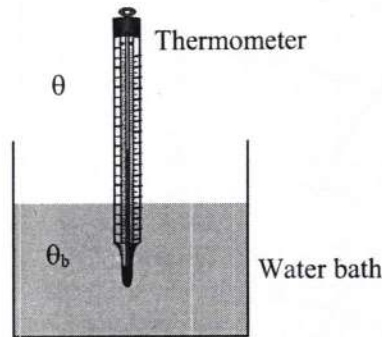


Figure-6

6. a. Obtain the overall transfer function of the system shown in the figure-7 using Mason's gain formula. [4]

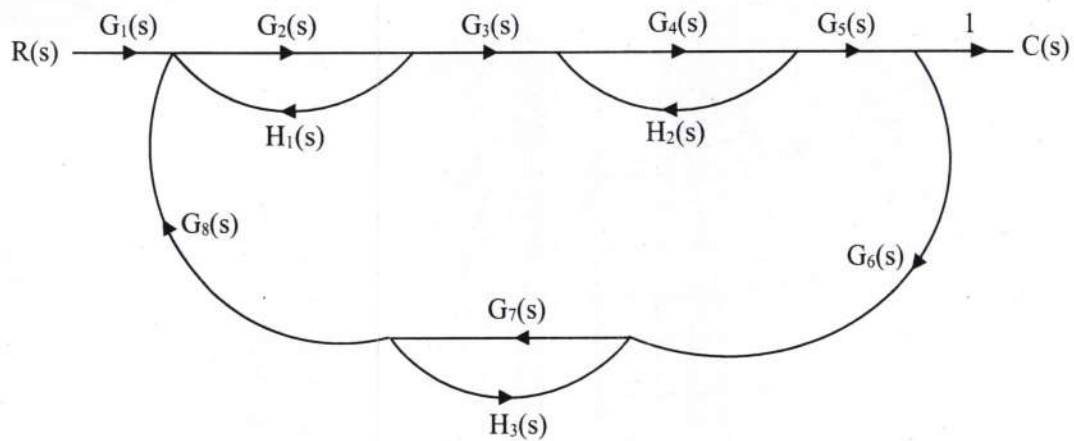


Figure-7

- b. The Nichols plot for a unity feedback system is shown in figure-8. Determine the resonant peak, resonant frequency, system bandwidth, phase margin and gain margin of the system. [4]

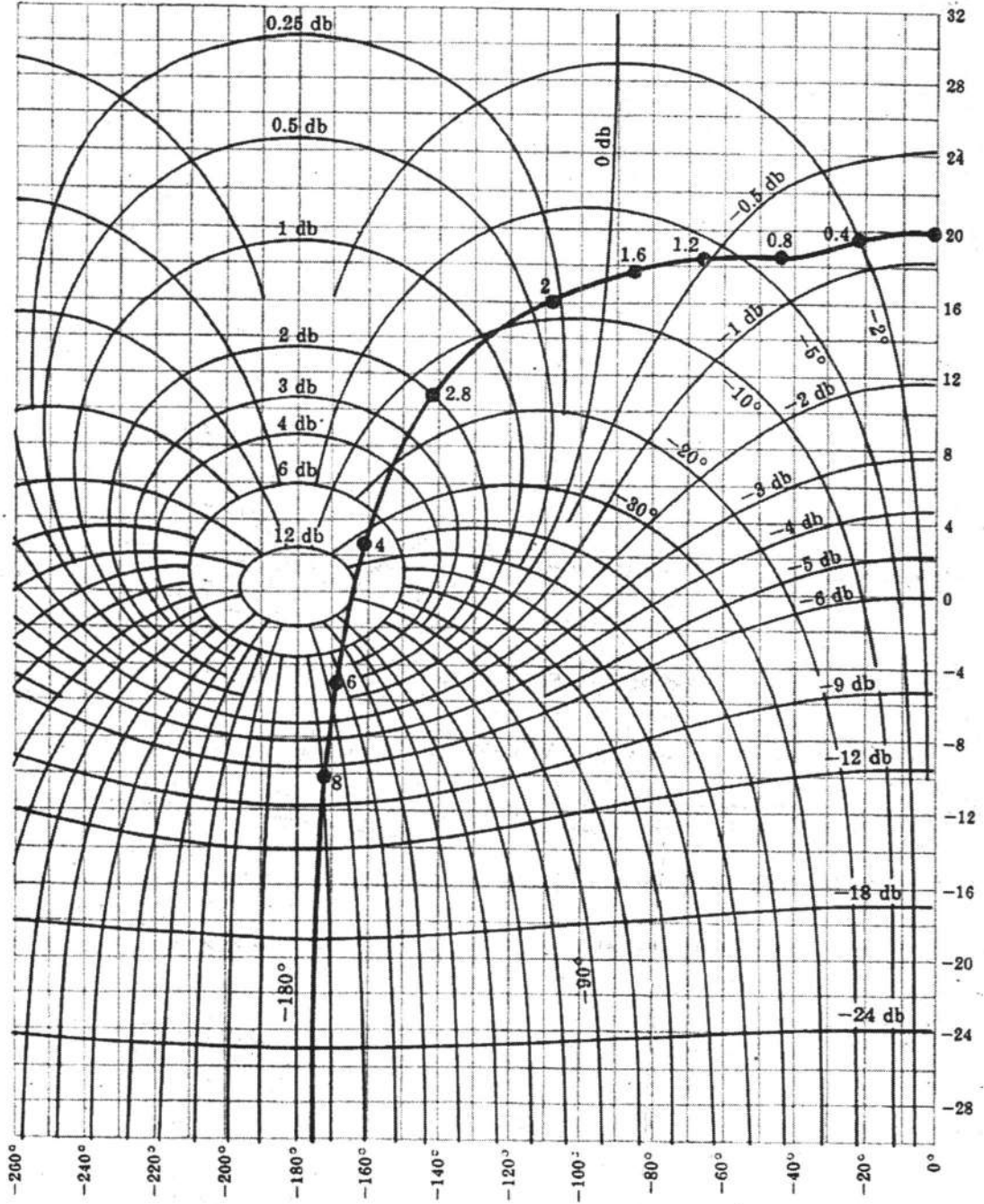


Figure-8