Reg. No. :

**Question Paper Code : 30808**

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2024

Fourth Semester

Instrumentation and Control Engineering

IC 8451 – CONTROL SYSTEMS

(Common to: Electrical and Electronics Engineering/Electronics and Instrumentation Engineering)

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

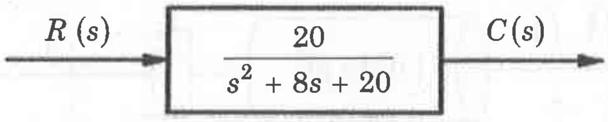
PART A — (10 × 2 = 20 marks)

1. Compare the open loop and closed loop system.

2. Find the transfer function for the system represented by an equation $\frac{dc(t)}{dt} + 5c(t) = r(t)$ Where $c(t)$ is output and $r(t)$ is the input.

3. Define poles and zeros of a transfer function.

4. Find the value of damping ratio ($\zeta$) and report the kind of response expected for the system shown in Figure.




5. Define Gain margin and Phase Margin.

6. Draw the plot of type 1, order 2 system.

7. Write the necessary and sufficient conditions of Routh-Hurwitz criteria.

8. Define Nyquist stability criterion.

9. Define the term controllability and observability.

10. Write the general state space equation of a system.

PART B — (5 × 13 = 65 marks)

11. (a) Find the $G(s) = VL(s)/V(s)$ for the each network shown in Figure 11a.

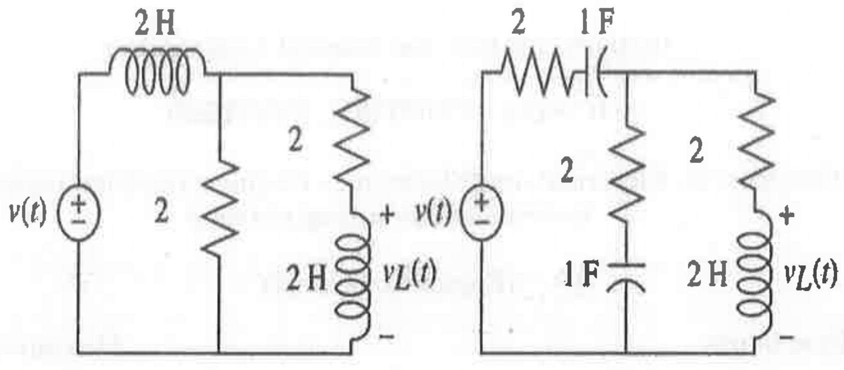



Fig. 11a

Or

(b) Derive the transfer function of AC servo motor.

12. (a) For the system shown in Figure 12a, a step torque is applied at $\theta_1(t)$.

Find:

(i) The transfer function, $G(s)=\theta_2(s)/T(s)$ (7)

(ii) The percent overshoot, settling time and peak time for $\theta_2(t)$ (6)

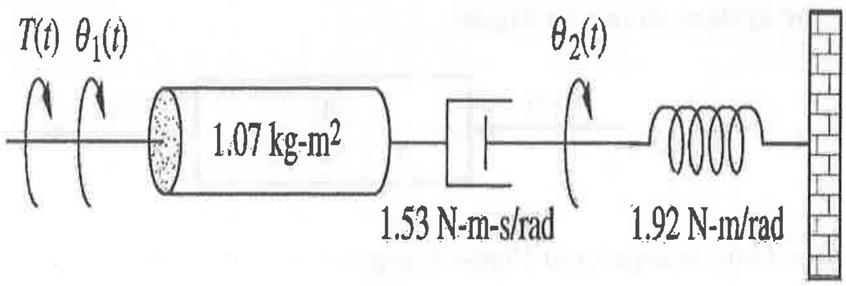



Fig. 12a

Or

(b) For each pair of second-order system specifications that follow, find the location of the second-order pair of poles

(i) %OS = 12%; Ts = 0:6 second (4)

(ii) %OS = 10%; Tp = 5 seconds (4)

(iii) Ts = 7 seconds; Tp = 3 seconds (5)

13. (a) Sketch the bode plot for the following transfer function and determine phase margin and gain margin.

$$G(s)=\frac{10}{s(1+0.4s)(1+0.1s)}$$

Or

(b) Consider a unity feedback system having a open loop transfer function

$G(s)=\dfrac{K}{s(1+0.5s)(1+4s)}$. Sketch a polar plot and determine the value of K so that

(i) Gain Margin is 20 db and (7)

(ii) phase margin is 30°. (6)

14. (a) Using the Routh-Hurwitz criterion for the unity feed-back system given by open loop transfer function,

$$G(s)=\frac{K}{s(s+1)(s+2)(s+6)}$$

(i) Find the range of K for stability (4)

(ii) Find the value of K for marginal stability (4)

(iii) Find the actual location of the closed-loop poles when the system is marginally stable. (5)

Or

(b) Design a lead compensator for a unity feedback system with open loop transfer function, $G(s)=\dfrac{K}{s(s+1)(s+5)}$ to satisfy the following specifications

(i) Velocity error constant, $K_V \geq 50$ (7)

(ii) Phase margin is $\geq$ 20°. (6)

15. (a) Determine whether the system is controllable and observable.

$$\dot{x} = Ax + Bu = \begin{bmatrix} -2 & -1 & -3 \\ 0 & -2 & 1 \\ -7 & -8 & -9 \end{bmatrix} x + \begin{bmatrix} 2 \\ 1 \\ 2 \end{bmatrix} u$$

$$y = Cx = [4\ 6\ 8]\ x$$

Or

(b) Convert the state and output equations shown below in to a transfer function.

$$\dot{x} = \begin{bmatrix} -4 & -1.5 \\ 4 & 0 \end{bmatrix} x + \begin{bmatrix} 2 \\ 0 \end{bmatrix} u(t)$$

$$y = [1.5\ \ 0.625]\ x$$

PART C — (1 × 15 = 15 marks)

16. (a) Given a unity feedback system that has the forward transfer function.

$$G(s) = \frac{K(s-2)(s-4)}{s^2 + 6s + 25}$$

Do the following:

(i) Sketch the root locus. (2)

(ii) Find the imaginary-axis crossing. (2)

(iii) Find the gain, K, at the $j\omega$-axis crossing. (2)

(iv) Find the break-in point. (2)

(v) Find the point where the locus crosses the 0.5 damping ratio line. (2)

(vi) Find the gain at the point where the locus crosses the 0.5 damping ratio line. (3)

(vii) Find the range of gain, K, for which the system is stable. (2)

Or

(b) For a unity feedback system with a forward transfer function

$$G(s) = \frac{K}{s(s+50)(s+120)}$$

Use frequency response techniques to find the value of gain, K to yield a closed-loop step response with 20% overshoot.