Reg. No. :

Question Paper Code : 40722

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2021.

Fourth Semester

Electrical and Electronics Engineering

IC 8451 — CONTROL SYSTEMS

(Common to: B.E. Electronics and Instrumentation Engineering/ B.E. Instrumentation and Control Engineering)

(Regulations 2017)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Find the overall transfer function of the block diagram shown in Figure 1

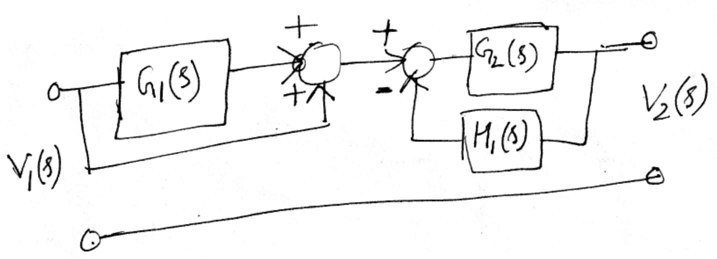

Figure 1

2. Find the transfer function of RC network shown in Figure 2

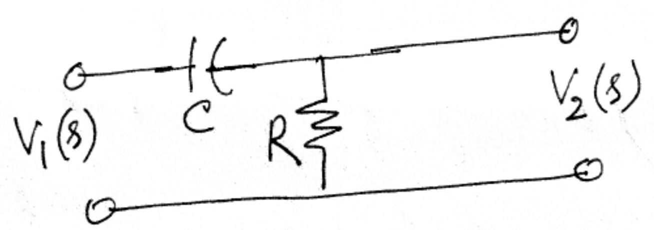

Figure 2

3. What are the standard test signals for time response analysis of control systems? Give their mathematical representations and Laplace transforms.

4. Define breakaway points and angle of departure.

5. Establish correlation between time-domain and frequency domain specifications for a second order system.

6. What will be magnitude and phase of Bode plot when the transfer function has factors of the form $\frac{K}{S^{\gamma}}$? $\gamma = 1,2,3$

7. What are the special cases of Routh stability test?

8. Define Gain Margin and Phase margin.

9. Define Controllability and observability.

10. Give state variable representation in controllable and observable phase variable form.

PART B — (5 × 13 = 65 marks)

11. (a) Reduce the block diagram shown in Figure 3

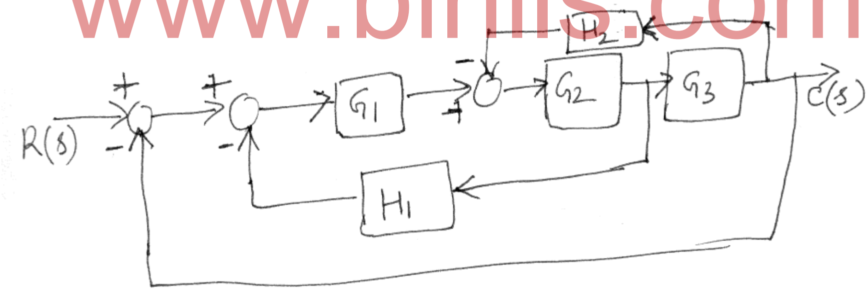

Figure 3

Or

(b) Draw the signal flow graph of the system shown in Figure. 3 and obtain overall transfer function.

12. (a) Define error coefficients and explain how it is related to steady state error.

Or

(b) Explain PID controller and its effect on the system response.

13. (a) Consider the transfer function

$$G(s) = \frac{1000(s+3)}{s(s+12)(s+50)}$$

Draw its Bode plot (Straight line plot magnitude only) with following details.

(i) Break frequency (4)

(ii) Contribution in dB of each of the factors. (4)

(iii) Composite plot (5)

Or

(b) Consider the following transfer function

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

Sketch a polar plot.

14. (a) The open-loop transfer function of a unity feedback system is given by

$$G(s)H(s) = \frac{K}{s(s^2+s+4)}$$

Determine the range of K for stability by Routh-Hurwitz criterion.

Or

(b) Consider the system in part (a). Determine the range of K for stability by Nyquist stability criterion.

15. (a) Consider the system described by

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} x(t) + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u(t)$$

$$y = \begin{bmatrix} 1 & 0 \end{bmatrix} x(t)$$

(i) Determine the state transition matrix (STM) (10)

(ii) Give three methods name to calculate STM. (3)

Or

(b) Given a system described by

$\dot{x} = Ax + Bu$

$y = cx$

Where $A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}; B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}; C = \begin{bmatrix} 1 & 1 \end{bmatrix}$

Investigation whether the system is

(i) Controllable/uncontrollable (5)

(ii) Observable/Unobservable (5)

(iii) Stable/Unstable (3)

PART C — (1 × 15 = 15 marks)

16. (a) Consider a system with an open-loop transfer function of $G(s) = \dfrac{K}{s(s+1)(s+4)}$

Design a compensator to meet the following specifications. (10)

(i) Damping ratio $z = 0.5$

(ii) Settling time $t_s = 10\,\text{sec}$

(iii) Velocity error constant $k_v \geq 5\,\text{sec}^{-1}$

Draw the root locus of compensated system. (5)

Or

(b) Consider system described in part (a) with following specifications.

(i) Damping ratio $z = 0.4$

(ii) Settling time $t_s = 10\,\text{sec}$

(iii) $K_v \geq 5\,\text{sec}^{-1}$

(i) Convert the above specifications in equivalent specifications in frequency domain. (5)

(ii) Design a lag compensator to meet the specifications. (10)

———————