Reg. No. : | | | | | | | | | | |

Question Paper Code: 45302

B.E. / B.Tech. DEGREE EXAMINATION, MAY 2022

Fifth Semester

Electrical and Electronics Engineering

14UEE502 - CONTROL SYSTEMS

(Regulation 2014)

Duration: Three hours   Maximum: 100 Marks

Answer ALL Questions
(Polar Graph sheets to be provided)

PART A - (10 x 1 = 10 Marks)

1. In force-current analogy, the mass is analogous to ___________
   (a) capacitance   (b) inductance   (c) conductance   (d) flux linkage

2. Signal flow graphs can be used to represent
   (a) only linear systems
   (b) only nonlinear systems
   (c) both linear and nonlinear systems
   (d) time invariant as well as time varying systems

3. The undamped systems, the damping ratio is
   (a) $\zeta = 0$ (b) $\zeta = 1$ (c) $\zeta < 1$ (d) $\zeta > 1$

4. The Terzaghi's general bearing capacity equation is represented as
   (a) qf = 5.7 c + $\bar{\sigma}$ (b) qf = c Nc + $\bar{\sigma}$. Nq + 0.5γBNγ
   (c) qf = c Nc + $\bar{\sigma}$. Nq   (d) qf = c Nc

5. The relation between resonant frequency and undamped natural frequency is
   (a) $\omega_r = \omega_n\sqrt{1-2\zeta^2}$ (b) $\omega_n = \omega_r\sqrt{1-2\zeta^2}$
   (c) $\omega_r = \omega_n\sqrt{2\zeta^2-1}$ (d) $\omega_n = \omega_r\sqrt{2\zeta^2-1}$

6. The Phase Margin of the system is 0^0. It represents a
   (a) Stable system (b) Unstable system
   (c) Conditionally stable system (d) Marginally stable system

7. The number of sign changes in the element of the first column of the routh array denotes
   (a) the number of zeros of the closed loop system in the RHP
   (b) the number of poles of the closed loop in the RHP
   (c) the number of zeros of the closed loop system in the LHP
   (d) the number of poles of the closed loop in the LHP

8. A lead compensator
   (a) improves the steady state accuracy (b) reduces the bandwidth
   (c) increases the bandwidth (d) reduces the speed of response

9. The number of state variable of a system is equal to
   (a) the number of integrators present in the system
   (b) the number of differentiators present in the system
   (c) the sum of the number of integrators and differentiators present in the system
   (d) none of the these

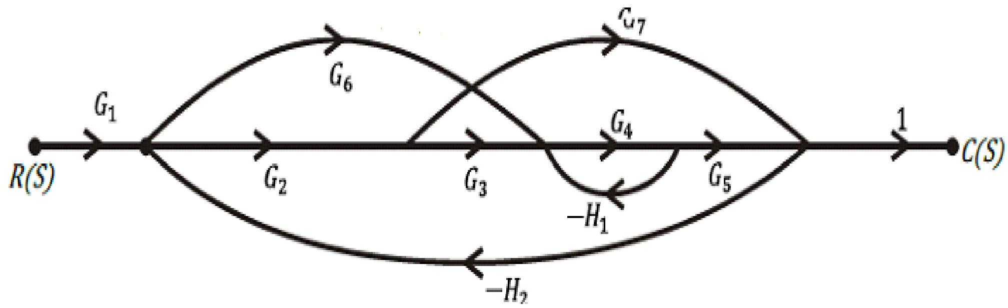
10. The state transition matrix for the system $\dot{x} = Ax$with initial state x (0) is
    (a) $(SI - A)^{-1}$ (b) $e^{At}x(0)$
    (c) Laplace inverse of [$(SI - A)^{-1}$] (d) Laplace inverse of $[(SI - A)^{-1}X(0)]$

PART - B (5 x 2 = 10 Marks)

11. Write Masons' Gain Formula.
12. What are the transient and steady state response of a control system?
13. State phase and gain margin.
14. Define compensator and list the types of compensators.
15. What is Observability?

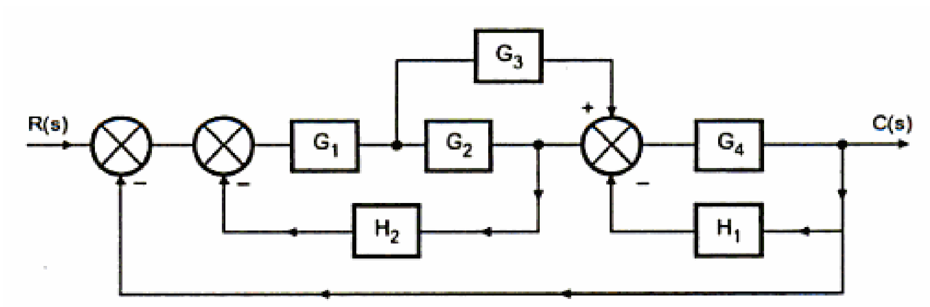
PART - C (5 x 16 = 80 Marks)

16. (a) Obtain the closed loop transfer function C(S) / R(S) by using Mason's Gain Formula. (16)



Or

(b) (i) Obtain the closed loop transfer function $C(s)/R(s)$ of the system whose block diagram is shown in figure. (16)



17. (a) A positional control system with velocity feedback $G(s) = \frac{16}{s(s+0.8)}$, $H(s)=Ks+1$. What is the response C(t) to the unit step input .Given that damping ratio = 0.5 . Also calculate rise time , Peak time , Maximum overshoot and settling time. (16)

Or

(b) Sketch the Root Locus of the control system whose forward path transfer function is

$$G(s) = \frac{K}{s(s+2)(s+5)}.$$ (16)

18. (a) Plot the Bode diagram for the following transfer function and obtain the gain and phase cross over frequencies. G(S) = 10/ S (1+0.4S) (1+0.1S). (16)

Or

(b) Derive the expression for constant M and N circles. Show that their loci are circles. (16)

19. (a) Design a lead compensator for a unity feedback system with $G(s) = \frac{4}{s(s+2)}$, so that the static velocity error constant Kv is 20 sec^{-1}, the phase margin is at least 50° and the gain margin is at least 10 dB. (16)

Or

(b) The open loop transfer function of an uncompensated system is $G(s) = \frac{K}{S(S+4)(S+80)}$ Design a phase lag compensator to get a Phase margin of 33° and velocity error of $K_v = 30\ sec^{-1}$. (16)

20. (a) Evaluate controllability and observability of the following state models. (16)

$$a)\ A = \begin{bmatrix} -2 & 1 \\ 1 & -2 \end{bmatrix},\quad B = \begin{bmatrix} 1 \\ 0 \end{bmatrix},\quad C = [1\ \ -1]$$

$$b)\ A = \begin{bmatrix} -1 & 0 & 0 \\ 0 & -2 & 0 \\ 0 & 0 & -3 \end{bmatrix},\quad B = \begin{bmatrix} 1 & 0 \\ 1 & 2 \\ 2 & 1 \end{bmatrix},\quad C = \begin{bmatrix} 1 & 1 & 2 \\ 3 & 1 & 5 \end{bmatrix}$$

$$c)\ A = \begin{bmatrix} 0 & 0 & 0 \\ 1 & 0 & -3 \\ 0 & 1 & -4 \end{bmatrix},\quad B = \begin{bmatrix} 40 \\ 10 \\ 0 \end{bmatrix},\quad C = [0\ \ 0\ \ 1]$$

Or

(b) The state space representation of a system is given by.

$$\begin{pmatrix} \dot{x}1 \\ \dot{x}2 \\ \dot{x}3 \end{pmatrix} = \begin{pmatrix} -2 & 1 & 0 \\ 0 & -3 & 1 \\ -3 & -4 & -5 \end{pmatrix}\begin{pmatrix} x1 \\ x2 \\ x3 \end{pmatrix} + \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix} u$$

$$Y = (0\ 1\ 0)\begin{pmatrix} x1 \\ x2 \\ x3 \end{pmatrix}$$ obtain the transfer function. (16)