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Question Paper Code: 41352

B.E. / B.Tech. DEGREE EXAMINATION, NOV 2016

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 steady state error of a type 2 system with ramp input is
   (a) infinity (b) zero (c) 1 (d) -1

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. An n x n matrix is said to be nonsingular if the rank of the matrix is r is

   (a) $r \neq n$ (b) $r = n$ (c) $r = n/2$ (d) $r = 2n$

PART - B (5 x 2 = 10 Marks)

11. Define transfer function.

12. How will you find the root locus on real axis?

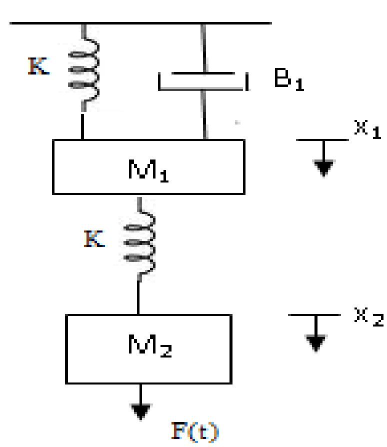
13. Define gain margin and phase margin.

14. What are the characteristics of lag compensation? When lag compensation is employed?

15. State the properties of the state transition matrix.

PART - C (5 x 16 = 80 Marks)

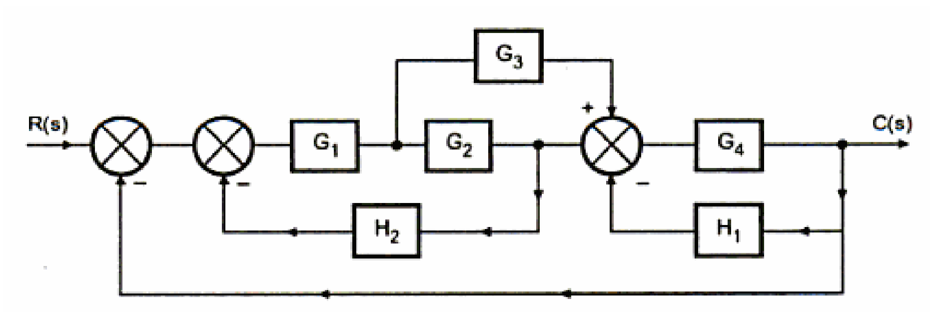
16. (a) (i) Obtain the transfer function $\frac{X_2(s)}{F(s)}$ of the given mechanical translational system. (8)



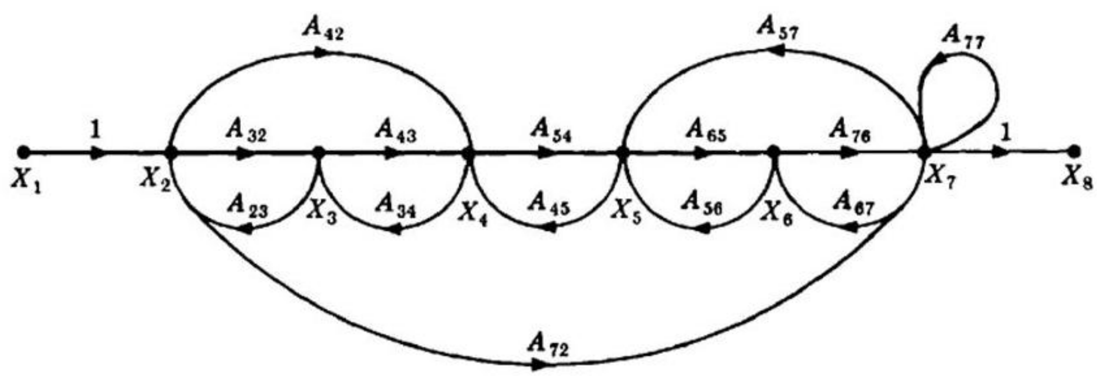
(ii) Derive the expression for transfer function of armature controlled DC servomotor. (8)

Or

(b) (i) Obtain the closed loop transfer function $C(s)/R(s)$ of the system whose block diagram is shown in figure. (10)



(ii) Consider the signal flow graph given in figure. Identify *(a)* forward path, *(b)* individual loop. (6)



17. (a) (i) The forward path transfer function of a certain unity negative feedback control system is $G(s)$. The system is subjected to unit step input. From the transient response curves, it is observed that the system peak overshoot is 20% and the time at which it occurs is $\pi/2$ *sec*. Determine the closed loop transfer function of the system. (8)

(ii) A certain unity negative feedback control system has the following forward path transfer function $G(s) = \frac{K(s+2)}{s(s+5)(4s+1)}$. The input applied is $r(t) = 1 + 3t$. Find the minimum value of K, so that the steady state error is less than 1. (8)

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) Sketch the Bode plot for the following transfer function and determine the system gain margin and phase margin. $G(s)=\dfrac{10}{s(1+0.5s)(1+0.05s)}$. (16)

Or

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

19. (a) Sketch the Nyquist plot for the open loop transfer function is $G(s)=\dfrac{K}{s(1+0.1s)(1+0.5s)}$.

Determine the range of value of *'K'* for the stability. (16)

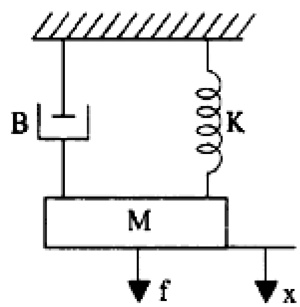
Or

(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 $K_v \geq 50$

(ii) phase margin is $\geq 20^0$ (16)

20. (a) (i) Obtain the state space representation for the mechanical system shown in figure. taking the displacement and velocity of the mass as state variables. (8)



(ii) Compute the state transition matrix e^{At} for the state model whose system matrix $A=\begin{bmatrix}0 & 1\\ -1 & -2\end{bmatrix}$. (8)

Or

(b) Determine whether the system described by the following state equation is completely state controllable and observable.

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\\ \dot{x}_3\end{bmatrix}=\begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ 0 & -2 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}+\begin{bmatrix}0\\ 0\\ 1\end{bmatrix}u; \qquad y=\begin{bmatrix}1 & 1 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}$$ (16)