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

Question Paper Code: 41352

B.E. / B.Tech. DEGREE EXAMINATION, MAY 2017

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. The principles of homogeneity and superposition are applied to
   (a) Linear time variant systems (b) Non-linear time variant systems
   (c) Linear time invariant systems (d) Non-linear time invariant systems

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 impulse response of the system is $5e^{-10t}$. Its step response is equal to
   (a) $0.5e^{-10t}$ (b) $(1-e^{-10t})$
   (c) $0.5(1-e^{-10t})$ (d) $(1-e^{-10t})$

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

5. Which one of the following statements regarding the stability of a feedback control system is correct?
   (a) Gain Margin (GM) gives complete information about the relative stability of the system
   (b) Phase Margin (PM) gives complete information about the relative stability of the system

(c) GM and PM together gives information about the relative stability of the system

(d) Cross over frequencies give information about the relative stability of the system

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 characteristic equation of a feedback control system is $s^3 + Ks^2 + 5s + 10 = 0$. For the system to be critically stable the value of 'K' should be

   (a) 1 (b) 2 (c) 3 (d) 4

8. The Phase lead compensation is used to

   (a) Increase in rise time and decrease overshoot

   (b) Decrease both rise time and overshoot

   (c) Increase both rise time and overshoot

   (d) decrease in rise time and increase overshoot

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) $e^{At}x(0)$

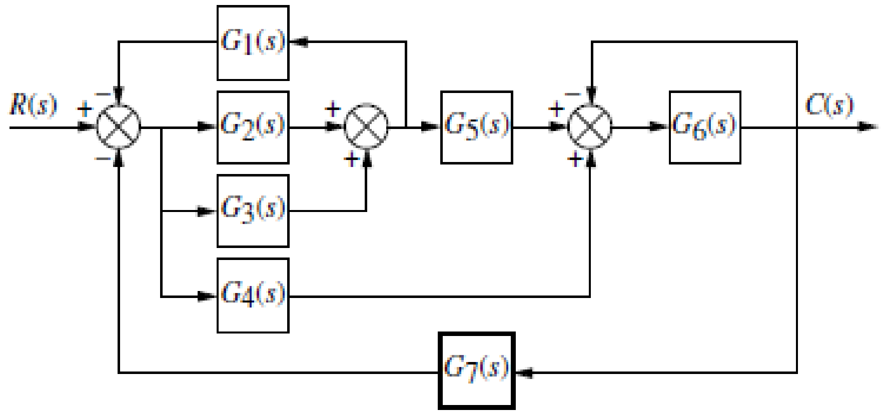
    (c) Laplace inverse of [$(SI - A)^{-1}$] (d) Laplace inverse of $[(SI - A)^{-1}X(0)]$

PART - B (5 x 2 = 10 Marks)

11. Define mathematical modeling of a dynamical system.
12. Derive the rise time of second order under-damped system.
13. What are the advantages of frequency response design?
14. Define absolute stability and relative stability.
15. What are the properties of state transition matrix?

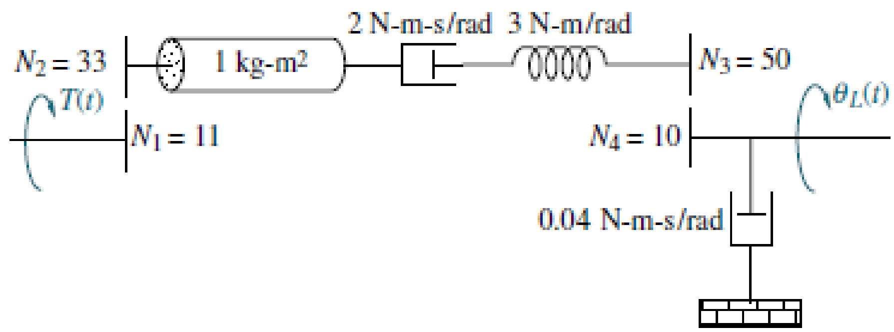
PART - C (5 x 16 = 80 Marks)

16. (a) Find the equivalent transfer function for the system shown below using block diagram reduction technique. (16)



Or

(b) For the rotational mechanical system shown in figure, find the transfer function. Also find the torque-current analogues circuit. (16)



17. (a) A unity feedback system has a loop transfer function $\dfrac{K}{s(s+3)(s^2+4s+7.84)}$

Sketch the root locus plot and determine the following: (i) Centroid and angle of asymptotes (ii) Angle of departure of root loci from the poles (iii) Break away point if any, The value of K and the frequency at which root loci cross the imaginary axis. (16)

Or

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

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

18. (a) Compare the properties of different phase compensators. Realize them using electrical network. (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 $G(s) = \frac{K}{s(1+0.1s)(1+0.5s)}$.

Determine the range of value of *'K'* for the stability. (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) (i) Obtain the state space representation of this system in three canonical forms $T(s) = \frac{5(S+4)}{S^3+10S^2+31S+20}$. (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)