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

# Question Paper Code: 44501

B.E. / B.Tech. DEGREE EXAMINATION, NOV 2019

Fourth Semester

Electronics and Instrumentation Engineering

14UEI401 - CONTROL ENGINEERING

(Regulation 2014)

Duration: Three hours | Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. Which of the following system is not an example of closed loop system?

   (a) Traffic light controller
   (b) Action of human being in walking
   (c) Home heating system
   (d) DC motor speed control

2. In force-voltage analogy, spring constant is analogous to

   (a) Voltage   (b) Reciprocal of capacitance
   (c) Capacitance   (d) Charge

3. State the order and type number of the system for the given open loop $G(s) = \dfrac{10}{s(1+0.4s)(1+0.1s)}$ transfer function

   (a) 0, 3   (b) 1, 3   (c) 3, 2   (d) 3, 1

4. Which of the following characteristics does it have, the given closed loop transfer function $\dfrac{C(s)}{R(s)} = \dfrac{121}{s^2+132s+121}$ of a system

   (a) Over damped system and setting time 1.1s
   (b) Under damped system and setting time 0.6s
   (c) Critically damped system and setting time 0.8s
   (d) Under damped system and setting time 0.707s

5. Phase margin of a system is used to specify which of the following?

(a) Frequency response (b) Absolute stability
(c) Relative stability (d) Time response

6. At the gain cross over frequency, $\omega$=5 rad/s, $\angle G(j\omega)H(j\omega) = -170^{\circ}$. The phase margin is

(a) -10º (b) 10º (c) -170º (d) 170º

7. If the poles of a system lie on the imaginary axis, the system will be

(a) stable (b) unstable
(c) marginally stable (d) Conditionally stable

8. Normal Routh array indicates

(a) non zero elements in the first column (b) row of all zeros
(c) first column element of the row is zero (d) row of all ones

9. Number of ___________ in a state diagram of discrete time system is equal to number of state variables.

(a) integrators (b) state variables
(c) phase variables (d) unit delay

10. The state variable approach is applicable to

(a) Only linear time in-variant systems
(b) Linear time in-variant as well as time varying systems
(c) Linear as well as non linear systems
(d) All type of systems

PART - B (5 x 2 = 10 Marks)

11. Define transfer function.

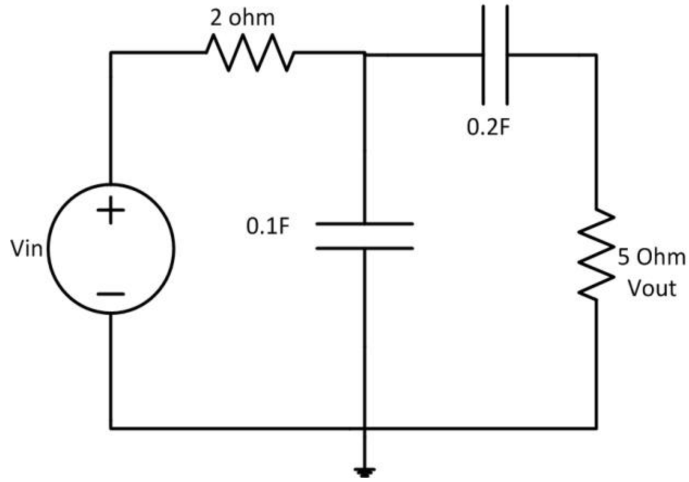
12. List the test signals used to find the time response in control systems.

13. Show the polar plot of $G(s) = \dfrac{1}{s^2(1+sT_1)(1+sT_2)(1+sT_3)}$.14. The characteristics equation of a system is given by $3s^4 + 10s^3 + 5s^2 + 2 = 0$. Conclude the stability of the system.

15. List the properties of state transition matrix.

PART - C (5 x 16 = 80 Marks)

16. (a) (i) For the electrical circuit in figure-1, Find the transfer function $\frac{V_{out}(s)}{V_{in}(s)}$ (16)




Or

(b) Determine the transfer function *C (s) / R (s)* of the system shown in Figure. 2. (16)

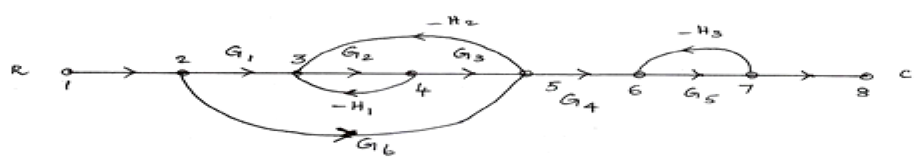



**Figure 2**

17. (a) Consider a unity feedback system with a closed loop transfer function C(s)/R(s)= (Ks+b)/($s^2$+as+b).Determine the open loop transfer function G(s).Show that the steady state error with unit ramp input is given by (a-k)/b. (16)

Or

(b) (i) A certain negative feedback control system has the following forward path transfer function $G(s)=\frac{K}{s(s+1)}$. The feedback path has the following transfer function $H(s)=1+K_h(s)$. Determine the value of K and $K_h$ so that the maximum overshoot for unit step input is 0.2 and it occurs at time t=1 sec. With these values of K and $K_h$ determine the rise time and setting time. (8)

(ii) The forward path transfer function of a unity feedback type-1, second order system has a pole at -2. The nature of gain K is so adjusted that damping ratio is 0.4. Find the Steady state error when the input is $r(t) = 1 + 4t$. (8)

18. (a) Explain the design procedure involved in the design of lag compensator. (16)

Or

(b) A unity feedback system has an open loop transfer function $G(s) = \dfrac{K}{s(1+2s)}$.

Design a suitable lag compensator so that phase margin is 40° and steady state error for ramp input is less than or equal to 0.2. (16)

19. (a) Determine the stability of a system, whose characteristics equation is given by $s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$. Also find the number of roots lying in the LHS, RHS and imaginary axis of s-plane. (16)

Or

(b) The open loop transfer function of a closed loop system with unity feedback is $G(s) = \dfrac{K}{(s+2)(s+4)(s^2+6s+25)}$. By applying the Routh criterion, discuss the stability of the closed loop system as a function of K. Determine the values of K which will cause sustained oscillations in the closed loop system and also find the corresponding oscillation frequencies. (16)

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

$$A=\begin{bmatrix} 0 & 0 & 1 \\ -2 & -3 & 0 \\ 0 & 2 & -3 \end{bmatrix};\ B=\begin{bmatrix} 0 \\ 2 \\ 0 \end{bmatrix};\ C=\begin{bmatrix} 1 & 0 & 0 \end{bmatrix}.$$ (16)

Or

(b) For a system represented by state equation $\dot{X}(t) = AX(t)$. The response is

$$X(t) = \begin{bmatrix} e^{-2t} \\ -2e^{-2t} \end{bmatrix} \text{ when } X(0) = \begin{bmatrix} 1 \\ -2 \end{bmatrix} \text{ and } X(t) = \begin{bmatrix} e^{-t} \\ -e^{-t} \end{bmatrix} \text{ when } X(0) = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$$

Determine the system matrix A and state transition matrix. (16)