

**A**

Reg. No. :

--	--	--	--	--	--	--	--	--	--

**Question Paper Code: 94302**

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

Fourth Semester

Electrical and Electronics Engineering

19UEE402 – Control Systems

(Regulations 2019)

Duration: Three hours

Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. The output is said to be zero state response because \_\_\_\_\_ conditions are made equal to zero CO1- U  
(a) Initial (b) Final (c) Steady state (d) Impulse response
2. In a signal flow graph, nodes are represented by small \_\_\_\_\_ CO1- U  
(a) Circles (b) Squares (c) Arrows (d) Pointers
3. If an impulse response of a system is  $e^{-5t}$ , what would be its transfer function? CO2-App  
(a)  $1/s - 5$  (b)  $1/s + 5$  (c)  $(s+1)/(s+5)$  (d)  $(s^2 - 5s)/(s-5)$
4. Transfer function of a system is used to calculate which of the following? CO2-U  
(a) The order of the system (b) The time constant  
(c) The output for any given input (d) The steady state gain
5. Phase margin of a system is used to specify which of the following? CO2-R  
(a) Frequency response (b) Absolute stability  
(c) Relative stability (d) Time response

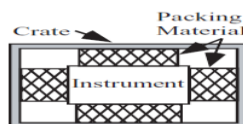
6. The frequency at which the two asymptotic meet in a magnitude plot is called \_\_\_\_\_ CO2- U  
 (a) Resonant peak. (b) Band width (c) corner frequency (d) Resonant frequency
7. Technique is not applicable to nonlinear system? CO3- R  
 (a) Nyquist Criterion (b) Quasi linearization  
 (c) Functional analysis (d) Phase-plane representation
8. Addition of zeros in transfer function causes which of the following? CO3- U  
 (a) Lead-compensation (b) Lag-compensation  
 (c) Lead-lag compensation (d) None of the above
9. A set of variables describes the state of the system is called CO4- U  
 (a) Input variables (b) Output variables (c) State variables (d) None of these
10. State space analysis is applicable to CO4- R  
 (a) Linear system (b) Non linear system  
 (c) MIMO (d) All of these

PART – B (5 x 2= 10 Marks)

11. What are the electrical and mechanical time constants of an electric motor? CO1- U
12. Explain the effect of PI controller on the system performance. CO2- U
13. What is gain cross over frequency CO2- R
14. Explain the necessary and sufficient condition for stability. CO2- U
15. Consider system given by  $Y(s) / U(s) = (s+3) / (s^3+3s+2)$ . Obtain state space representation in controllable form. CO4 -App

PART – C (5 x 16= 80Marks)

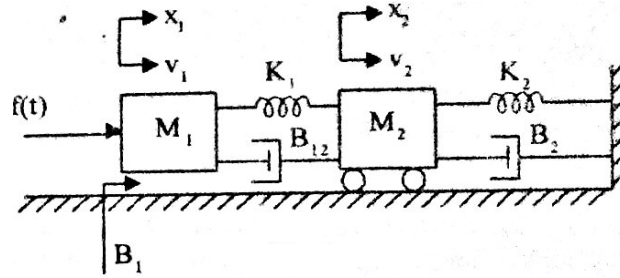
16. (a) A packing crate was designed to protect a fragile instrument during shipment. Assuming that the packing material can be modeled as an ideal linear spring of stiffness,  $k$ , in parallel with an ideal linear damper,  $b$ , and that the instrument of mass,  $m$ , the system can be modeled as shown in Figure. CO1- App (16)



- (a) Develop the free body diagram of the above system  
 (b) Derive the differential equation for the system.

Or

- (b) Write the differential equations governing the mechanical system shown in figure. Construct the force – voltage and force – current electrical analogous circuits and verify by writing mesh and node equations. CO1- App (16)



17. (a) The Unity feedback system is characterized by a open loop transfer function  $G(s)=K/S(S+10)$ . Determine the gain K. So that this system will have a damping ratio of 0.5 for this value of K, settling time, peak overshoot, peak time of the system for unit step input. CO2- App (16)

Or

- (b) The open loop transfer function of a unity feedback system is given by  $G(s) = \frac{K(s+9)}{s(s^2+4s+11)}$ . Sketch the root locus of the system. CO2- App (16)

18. (a) Construct the Bode plot for the following transfer function and obtain the gain and phase cross over frequencies whose

$$G(s) = \frac{20}{s(1+3s)(1+4s)}$$

Or

- (b) Construct the Polar plot for the following transfer function and obtain the gain margin and phase margin whose

$$G(s) = \frac{1}{s(1+s)(1+2s)}$$

19. (a) Construct Routh array and Analyze the stability of the system whose characteristic equation is  $S^6+2S^5+8S^4+12S^3+20S^2+16S+16=0$ . Also determine the number of roots lying on right half of S-plane, left half of s-plane and on imaginary axis. CO2- App (16)

Or

- (b) For a certain system,  $G(s) = \frac{0.025}{s(1+0.5s)(1+0.05s)}$ . Design a suitable lag compensator to give, velocity error constant =  $20\text{sec}^{-1}$  and phase margin =  $40^\circ$ . CO3- C (16)

20. (a) Examine whether the system described by the following state equation is completely state controllable and observable. CO4- Ana (16)

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

$$y = [1 \quad 1 \quad 0] \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

Or

- (b) The transfer function of a control system is given by CO4- App (16)

$$\frac{Y(s)}{U(s)} = \frac{(s + 2)}{(s^3 + 9s^2 + 26s + 4)}$$

Develop state space representation of a system