12 JAN 2023

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

Question Paper Code	11639

B.E. / B.Tech. - DEGREE EXAMINATIONS, NOV/DEC 2022

Fifth Semester

Instrumentation and Control Engineering

(Common to Electronics and Instrumentation Engineering)

20ICEL502 - ADVANCED CONTROL SYSTEMS

(Regulations 2020)

(Graph sheets need to be provided)

Duration: 3 Hours — Max. Marks: 100

PART - A (10 × 2 = 20 Marks)

Answer ALL Questions

		Marks, K-Level,CO
1.	Define State of a system and State variables.	2,K1,CO1
2.	List the advantages of state space model over transfer function model approach.	2,K1,CO1
3.	Discuss the need for design of integral controller.	2,K1,CO2
4.	What is the objective of a separation principle?	2,K1,CO2
5.	What are linear and nonlinear systems? Give examples.	2,K1,CO3
6.	What is dead-zone?	2,K1,CO3
7.	Explain hysteresis and backlash.	2,K1,CO4
8.	Define stability of a system.	2,K1,CO4
9.	Define optimal control.	2,K1,CO5
10.	What are performance measures in optimal control?	2,K1,CO5

PART - B (5 × 13 = 65 Marks)

Answer ALL Questions

11. a) A linear time invariant system is characterized by homogeneous state equation $\begin{matrix} X1 \\ X2 \end{matrix} = \begin{Vmatrix} 1 & 0 \\ 1 & 1 \end{Vmatrix} \begin{matrix} X1 \\ X2 \end{matrix}$. Compute the solution of the homogeneous equation assuming the initial state vector $X_o = \begin{matrix} 1 \\ 0 \end{matrix}$ — 13,K2,CO1

OR

b) If the state equation is given by $X = \begin{bmatrix} 0 & 6 & -5 \\ 1 & 0 & 2 \\ 3 & 2 & 4 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \\ 2 \end{bmatrix} U$ and output equation by $Y = [1 \quad 2 \quad 3] \begin{matrix} X1 \\ X2 \\ X3 \end{matrix}$, find the controllability and observability of the system. — 13,K2,CO1

12. a) Consider a linear system described by the transfer function $\frac{Y(S)}{U(S)} = \frac{10}{S(S+1)(S+2)}$. Design feedback controller with a state feedback so that the closed loop poles are placed at -2, $-1 \pm j1$. *13,K2,CO2*

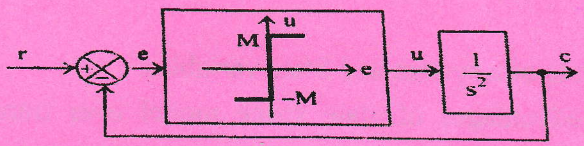
OR

b) Illustrate with a neat block diagram and derivation how the separation principle accomplishes its objective of attaining stability. *13,K2,CO2*

13. a) A linear second order servo system and its associated parameters are given by the equation $\ddot{e} + 2\zeta\omega_n\dot{e} + \omega_n^2 e = 0$ where $\zeta = 0.15$ and $\omega_n = 1$ rad/sec with $e(0) = 1.5$ and $\dot{e}(0) = 0$. Determine the singular point and construct the phase trajectory using the method of isoclines. *13,K2,CO3*

OR

b) Consider a system with an ideal relay as shown below. Determine the singular point and also construct the phase trajectory for the initial condition $c(0)=2$ and $\dot{c}(0)=1.5$. Take r=2 volts and M=1.2 volts. *13,K2,CO3*



14. a) Derive the describing function for Backlash nonlinearity. *13,K2,CO4*

OR

b) Formulate the describing function of saturation nonlinearity. *13,K2,CO4*

15. a) (i) State Lyapunov's stability theorem. *3,K1,CO5*
(ii)Use lyapunov analysis and determine the stability of the equilibrium state. *10,K2,CO5*

OR

b) Design and apply the optimal control problem for any one example. *13,K2,CO5*

PART - C (1 × 15 = 15 Marks)

16. a) Illustrate the significance of optimization technique and describe the formulation of an optimal control problem with an example. *15,K2,CO5*

OR

b) Consider a unity feedback system as shown in figure below having saturating amplifier with gain k. Determine the maximum value of k for which the system will stay stable. *15,K2,CO4*