GURU NANAK INSTITUTE OF TECHNOLOGY

An Autonomous Institute under MAKAUT

2022

Control System – II

EE603

TIME ALLOTTED: 3HR **FULL MARKS:70**

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable

GROUP – A

(Multiple Choice Type Questions)

Answer any ***ten*** from the following, choosing the correct alternative of each question: **10×1=10**

			Marks	CO No
1.	(i)	A system is represented by a single input, 3 state variables and 2 outputs. The matrix C should have an order of a) 2×1 b) 2×3 c) 3×2 d) none of these	1	CO1
	(ii)	Which of the following is categorized as memory type nonlinearity: a) backlash b) dead zone c) ideal relay d) saturation	1	CO1
	(iii)	Phase plane analysis is generally restricted to a) Second order system b) Third order system c) First order system d) Any order system	1	CO3
	(iv)	The Eigen values of the matrix $A = \begin{bmatrix} 0 & 2 \\ 2 & 0 \end{bmatrix}$ is a) 2, -2 b) 2j, -2j c) -2, -2 d) 2, 2	1	CO2
	(v)	The point (-1+j2) in the s-plane is mapped in the z plane. The location of the point is 1 a) inside the unit circle b) outside the unit circle c) on the unit circle d) can't be placed in Z plane	1	CO1

(vi) The faithful reconstruction of a signal on account of sampling is obtained if — 1 — CO4
a) $\omega_s=\omega_1$
b) $\omega_s \geq 2\omega_1$
c) $\omega_s \leq 2\omega_1$
d) None of these

(vii) Z Transform of unit step sequence is — 1 — CO4
a) $\frac{z}{z+1}$
b) $\frac{z}{z-1}$
c) 1
d) None of these

(viii) Lyapunov function is — 1 — CO3
a) energy function
b) work function
c) state function
d) output function

(ix) The example of positive semi definite function is — 1 — CO3
a) $(x_1+x_2)^2$
b) $x_1^2+x_2^2$
c) $-x_1^2-(x_1+x_2)^2$
d) $x_1x_2+x_2^2$

(x) Describing function analysis is based on — 1 — CO3
a) harmonic linearization
b) system linearization
c) degree of non-linearity
d) input-output ratio based on 2nd harmonic

(xi) The describing function for Ideal relay with input $X \sin \omega t$ is — 1 — CO3
a) $\frac{4M}{X}$
b) $\frac{2M}{\pi X}$
c) $\frac{4M}{\pi X}$
d) none of these

(xii) Jury's stability test is carried out to check the stability of a — 1 — CO4
a) discrete time system
b) linear time invariant system
c) linear time variant system
d) non linear system

GROUP – B
(Short Answer Type Questions)
Answer any ***three*** from the following: **3×5=15**

		Marks	CO No
2.	Obtain state model of the system given by the following transfer function using Direct Decomposition method. $\frac{Y(s)}{U(s)}=\frac{s+2}{s^3+5s^2+3s+5}$	5	CO2
3.	Justify that when a transistor circuit is operated only in Cut-off and saturation zone it behaves like a simple relay	5	CO3

4. Show that the following quadratic form is positive definite — 5 — CO3

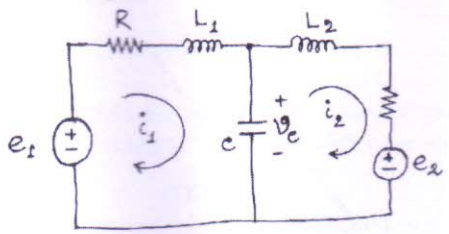
$$V(X) = 8x_1^2 + x_2^2 + 4x_3^2 + 2x_1x_2 - 4x_1x_3 - 2x_2x_3$$

5. Solve the following differential equation: — 5 — CO4

x(k+2) + 3 x(k+1) + 2 x(k) = 0.

given, x(0) = 0; x(1) = 1

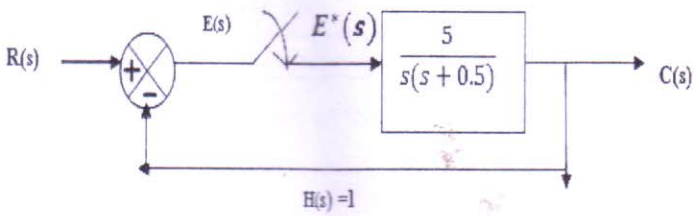
6. Obtain the state equation of the given electrical network in the standard form. — 5 — CO1



GROUP – C
(Long Answer Type Questions)

Answer any *three* from the following: **3×15=45**

			Marks	CO No
7.	(a)	Determine the pulse transfer function and stability of the sampled data control system shown in Figure for sampling time T = 0.5 second.	8	CO4



(b) For a discrete time system — 7 — CO4

x (k+2) + 5x (k+1) + 6x (k) = u (k)

Find the State Transition Matrix.

8. (a) Check the controllability and observability of the system — 7 — CO2

$$\boldsymbol{A} = \begin{bmatrix} 0 & 1 & 0 \\ 1 & 0 & 5 \\ 0 & -1 & -4 \end{bmatrix}; \boldsymbol{B} = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}; \boldsymbol{C} = [1 \quad 0 \quad 0]; \boldsymbol{D} = 0$$

(b) Consider a system defined by — 8 — CO1

$$\dot{x} = Ax + Bu$$

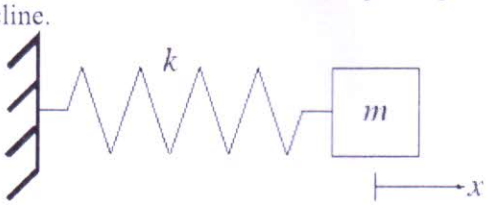
where $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -5 & -6 \end{bmatrix}$ $B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$

It is desired to have eigen values at

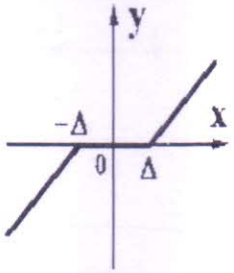
$s_1, s_2 = -2 \pm j4$ and $s_3 = -10$.

By using state feedback control u = -kx, Determine the necessary feedback gain matrix (k) and the control signal (u).

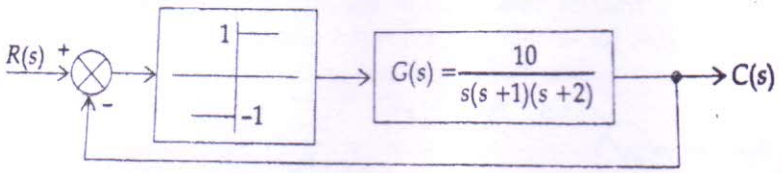
9. (a) Consider a Spring Mass system as shown in figure where k = m = 1. Determine the Differential equation for the system and sketch the phase portrait of the system by using method of Isocline. — 6 — CO3



	(b)	State Lyapunov's main Stability Theorem.	5	CO3
	(c)	Test if the following quadratic function $V(x)$ is positive definite. Given $V(x) = 9x_1^2 + 4x_2^2 + x_3^2 + 2x_1x_2 - 2x_2x_3 - 4x_1x_3$.	4	CO3
10.	(a)	Determine the describing function of the non-linear element shown in the figure having a dead zone followed by linear characteristics.	7	CO3



	(b)	Determine the amplitude and frequency of the limit cycle of the non-linearity shown in Figure. The describing function of an ideal relay is given by GD (X, jω) = $\frac{4M}{\pi X}$ and angle 0^0 (zero degree).	8	CO3



11.		Write short notes on the following: (Any three)	3x5=15	
	(a)	Sampling Process	5	CO4
	(b)	Aliasing effect in discrete time signal	5	CO3
	(c)	Limit Cycle	5	CO3
	(d)	Jump Resonance	5	CO3