Name: **Enrolment No:**	UPES UNIVERSITY OF TOMORROW

UPES

End Semester Examination, May 2023

Course: Control systems — **Semester: IV**

Program: B.Tech. Electrical Engineering — **Time : 03 hrs.**

Course Code: ECEG 2031 — **Max. Marks: 100**

SECTION A

(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	The Laplace transform of impulse response of a control system gives the transfer function of that function. Do you agree with the sentence? Justify your answer.	**4**	**CO1**
Q 2	Differentiate the transfer function and state space approach for a system.	**4**	**CO2**
Q 3	Which type of controller is handy to counter act with steady state error?	**4**	**CO3**
Q 4	The principle of homogeneity and additivity is applied to which types of systems and why?	**4**	**CO1**
Q 5	Brief the concept of open loop and closed loop system and give the three practical examples for both categories.	**4**	**CO1**

SECTION B

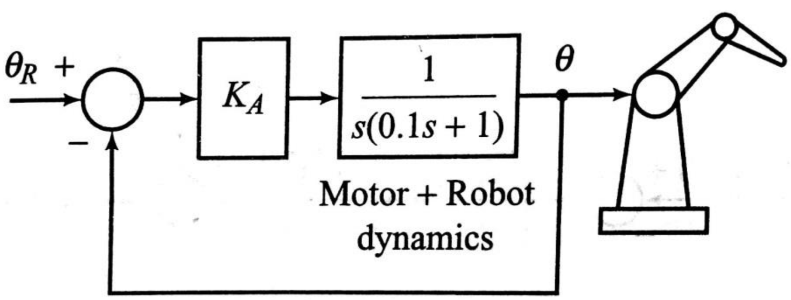
(4Qx10M= 40 Marks)

S. No.		Marks	CO
Q 6	Consider the following characteristic equation of a control system: s^4 + 3s^3 + 3s^2 + 2s + 1 = 0 a) Use the Routh-Hurwitz criterion to determine the stability of the system. State the conditions for stability and identify the number of roots in the right-half plane. b) Modify the system by adding a proportional control gain K in the forward path. Derive the new characteristic equation of the closed-loop system in terms of K. c) Use the Routh-Hurwitz criterion to determine the range of values of K for which the closed-loop system is stable. State the conditions for stability and identify the critical value of K at which the system becomes marginally stable.	**10**	**CO2**
Q 7	A second-order system with transfer function is given as G(s) = 5 / (s^2 + 2s + 5) a) Find the natural frequency (ωn) and damping ratio (ζ) of the system. b) Determine the rise time (tr), peak time (tp), and percent overshoot of the system's step response.	**10**	**CO3**

<table>
<tr><td></td><td>c) Find the steady-state error of the system to a step input. Assume that the input has a magnitude of 1.</td><td></td><td></td></tr>
<tr><td>Q 8</td><td>A second order transfer function is G(s) = K(s+3)/(s^2+5s+6).
a) Sketch the root locus for this system as K varies from 0 to infinity.
b) Determine the value of K at the breakaway point(s) of the root locus.
c) Determine the value of K at the intersection point(s) of the root locus with the imaginary axis.
OR
A unity feedback control system has an open loop transfer function,

$$G(s) = \frac{K}{s(s+4)(s^2+8s+32)}$$

Make a rough sketch of the root locus plot of the system, explicitly identifying the centroid, the asymptotes, the breakaway points, the departure angles from poles of G(s) and jω axis crossover points.</td><td>10</td><td>CO3</td></tr>
<tr><td>Q 9</td><td>Assume that control of one of the axes of a robot can be represented by the block diagram of figure below:



Determine the amplifier gain K_A so that the robot reaches steady state in this axis in minimum time with no overshoot.</td><td>10</td><td>CO2</td></tr>
<tr><td colspan="4">SECTION-C
(2Qx20M=40 Marks)</td></tr>
<tr><td>Q 10</td><td>The open loop transfer function of a unity feedback control system is given by

$$G(s) = \frac{200}{s^2(1+0.5s)(1+0.2s)}$$

a) Sketch the Bode plot for the magnitude and phase of G(s) over the frequency range 0.01 rad/s to 100 rad/s.

b) Determine the gain margin and phase margin of the system.</td><td>20</td><td>CO4</td></tr>
</table>

	c) If a unity feedback is used, determine the closed-loop transfer function and sketch the Bode plot for the magnitude and phase of the closed-loop transfer function.		
Q 11	A state space model is given; $\dot{X} = \begin{bmatrix} 0 & 0 & -2 \\ 0 & 1 & 0 \\ 1 & 0 & 3 \end{bmatrix} X\ ; X(0) = \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}$ Find the solution for homogenous state equation. **OR** A state space model is given below ẋ(t) = Ax(t) + Bu(t) y(t) = Cx(t) where: A = [-1 0 0] [0 -2 0] [1 1 -1] B = [1;0;1] C = [1 0 0] Determine whether the system is controllable, observable, both, or neither. Justify your answer.	**20**	**CO5**