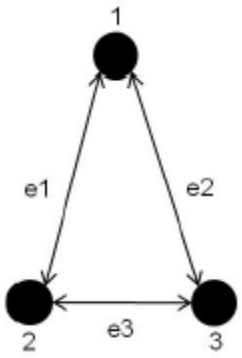
Enrolment No:	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, 2021

Course: Robotics Control System **Semester: II**
Program: M. Tech ARE engineering **Time 03 hrs**
Course Code: ECEG 7006 **Max. Marks: 100**
Instructions:

1. **Attempt all questions serially as per question paper.**
2. **Answer should be neat and clean.**

S. No.	Attempt all questions.	Marks	CO
Q 1	What are the limitations of linearization of a system. What is the need of nonlinear system analysis?	**5**	**CO1**
Q2	The characteristics equation of a system in differential form is $$\ddot{x} - (K+2)\dot{x} + (2K+10)x = 0$$ Find the values of K for which the system is (i) stable (ii) limited stable and (iii) unstable.	**5**	**CO3**
Q3.	What do you understand by many to one mapping with respect to fuzzy logic. What are the typical membership function associated with fuzzy logic.	**5**	**CO2**
Q4	What are the objectives in the design of control system. Differentiate between regulation and tracking of a system?	**5**	**CO1**
Q5	What do you understand by feedback control system. Explain each term consisting in the design of feedback control system?	**5**	**CO1**
Q6	What are the actuator nonlinearities?	**5**	**CO1**
	Section B – 50 Marks		
Q7	Explain the block diagram of computed torque control of robot manipulator with diagram?	**10**	**CO4**
Q 8	How fuzzy control is differentiated from PID controller. Give an example of fuzzy control used in robot manipulator.	**10**	**CO4**
Q 9	Consider the three robot are connected in the following manner shown in fig 1.	**10**	**CO2**

	 Fig1 Obtain the adjacency matrix and comment on the stability using Lyapunov Method.		
Q 10.	(a) State and prove Lyapunov stability theorem. Explain Lyapunov direct method? (b) For the system $\dot{x}_1 = x_2$ $\dot{x}_2 = -x_1 - bx_2$ Based on the Lyapunov technique comment on the stability.	**10**	**CO3**
Q11	Obtain the transfer functions for the following systems with state-space models Available as given below also comment on controllability and observability. $\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}0\\ 1\end{bmatrix}u\,; \quad y = [1 \quad 0]\begin{bmatrix}x_1\\ x_2\end{bmatrix} + [0]u$	**10**	**CO2**
SECTION C, 20 Marks			
Q12 (a)	Given a dynamical system described by $\dot{x} = ax + b\cos(x) + u$ *where* $a, b \in \mathbb{R}$ are known constants (assume a= 2, b =5).Design a robust controller to achieve tracking control $x \rightarrow x_d$	**10**	**CO4**
Q12 (b)	Explain the generalized robot manipulator equation and their properties. Obtain the derivation for position control of robot manipulator?	**10**	