Set A

Name: **Enrolment No:**	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

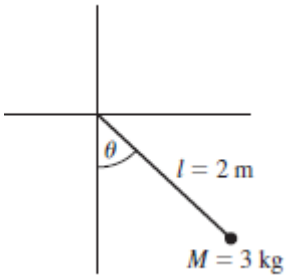
End Semester Examination, May 2019

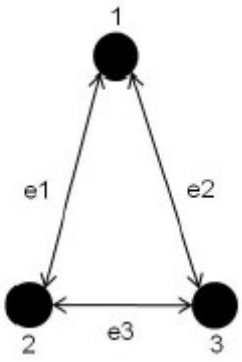
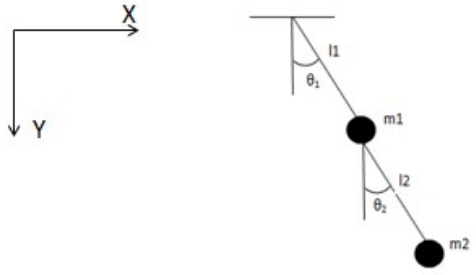
Programme Name: M. Tech ARE **Semester : II**
Course Name :Robotics Control System **Time : 03 hrs**
Course Code : ECEG 7006 **AMax. Marks : 100**
Nos. of page(s) :
Instructions:

SECTION A

S. No.	All questions are compulsory.	Marks	CO
Q 1	What are the objectives in the design of control system.	5	CO1
Q 2	Draw the block diagram of typical industrial control system. Why PID is used most widely industrial Process. Also compare the features from other control technique.	5	CO2
Q 3	What do you understand by many to one mapping with respect to fuzzy logic. What are the typical membership function associated with fuzzy logic. Explain all the membership function with their diagram?	5	CO1
Q 4	What do you mean PD Control. Draw the block diagram considering robot as a system	5	CO1

SECTION B

Q 5	Show that the given system is Nonlinear in Nature. Obtain the dynamic model for the given system as shown in fig.2 	10	CO3
Q 6	For a dynamical system	10	CO2

	$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} x_2 \\ x_1 - x_2 \sin x_1 \end{bmatrix}$ (a) Find the equilibrium point for this system. (b) Linearize the system about the found equilibrium point. (c) Determine if the linearized system is stable, asymptotically stable or unstable.		
Q 7	Consider the three robot are connected in the following manner shown in fig 1.  Fig1 Obtain the adjacency matrix and comment on the stability using Lyapunov Method.	**10**	**CO4**
Q8	(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 stabily.	**10**	**CO3**
	SECTION-C		
Q 9	(a)Using euler lagarange approach obtain the modelling for given two link manipulator as shown in figure 3. Assuming system is lumped in nature. The mass of first and second link is m_1, m_2 and the link length is l_1, l_2 respectively. The angle from the first and second link are θ_1, θ_2 respectively.  	**10**	**CO2**

	(b) What do you understand by fuzzy logic control? Explain the working of fuzzy PI controller.	**10**	**CO4**
Q10	Given a dynamical system described by $\dot{x} = ax + b\cos(x) + u \; where \; a, b \in R$ are known constants (assume a= 2, b =5) Design a robust controller to achieve tracking control $x \rightarrow x_d$	**20**	**CO4**

Set B

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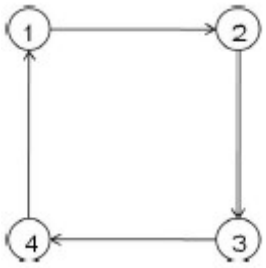
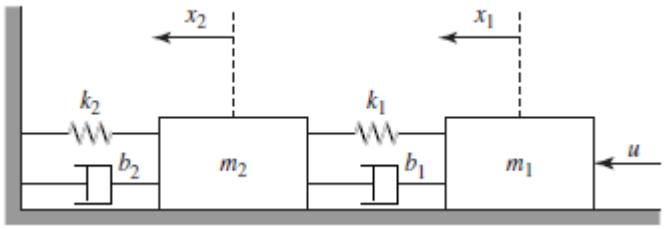
SECTION A

S. No.	All questions are compulsory.	Marks	CO
Q 1	What are the objectives in the design of control system.	7	CO1
Q 2	Explain the concept of completely controllable and completely observable system with respect to eigen value?	7	CO2
Q 3	What do you understand by membership function in fuzzy logic. Explain with some example?	8	CO1
Q 4	What are the limitations of linearization of a system. What is the need of nonlinear system analysis?	8	CO1

SECTION B

Q 5	Given the unity feedback control system with $G(s) = \frac{K}{s(s+a)}$ Find the value of K and a to yield K_v (velocity constant) and 20 % peak overshoot.	10	CO3
Q 6	Explain the PID controller along with the block diagram and mathematical equation. What are the advantages of PID controller over P, PI and PD controllers?	10	CO2
Q 7	(a) State and prove Lyapunov stability theorem. Explain Lyapunov direct method? (b) For the system	10	CO4

	$\dot{x}_1 = x_2$ $\dot{x}_2 = -x_1 - bx_2$ Based on the Lyapunov technique comment on the stabily.		
Q 8	Consider the four robot are connected in the following manner shown in fig 1.  Fig 1 Using graph theory, obtain the vector matrix and comment on the stability using Lyapunov function. Assume $x_i(t)$ represents the state of each agent.		**CO3**
	SECTION-C		
Q 9	Consider the system as shown in figure, which is composed of two masses moving on a smooth that is frictionless – horizontal plane .The spring is linear they obey hooks law Force = K X extension, where K is a constant called the force constant of the spring. In addition to the springs the masses are joined by linear dampers. In a linear damper, the force is proportional to the velocity of one end of the damper relative to the other end. The proportionality constant is called the damping coefficient. Here damping coefficients are b_1 and b_2 respectively. A Force u is applied to the right end mass. Obtain the system state space model in the form $\dot{x}(t) = A(t)\,x(t) + B(t)u(t)$. Determine under what condition in terms of K_1, the system model is controllable for m_1= m_2= 1 kg, b_1 =b_2=1 Nsec/m and K_2= ¼ N/m/  	**20**	**CO2**
Q 10	(a)Consider the dynamics of single link manipulator as given by	**20**	**CO4**

	$\dot{x}_1 = x_2$ $\dot{x}_2 = -\frac{g}{l}\sin(x_1) + \frac{1}{ml^2}\tau$ Where $x_1 = \theta$ is the angle of the manipulator from the vertical, $x_2 = \dot{\theta}$ is the angular velocity of the manipulator, and τ is the control torque. The parameter are given as m=1 kg, and g=10m/s^2. Find out a T-S fuzzy model of the above system. (b) What do you understand by fuzzy logic control? Explain the working of fuzzy PI controller.		