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| **Name:**<br>**Enrolment No:** | UPES |

**UNIVERSITY OF PETROLEUM AND ENERGY STUDIES**
**End Semester Examination, April/May 2018**

**Course: Robotics Control System** **Semester: II**
**Program: M.Tech ARE**
**Time: 03 hrs.** **Max. Marks: 100**

**Instructions:**

**SECTION A**

| S. No. | All questions are compulsory. (5x4=20) | Marks | CO |
|---|---|---|---|
| Q 1 | What are the objectives in the design of control system.Differentiate between regulation and tracking of a system? | 4 | CO1 |
| Q 2 | Differentiate between linear and nonlinear neural networks? | 4 | CO1 |
| Q 3 | What are the limitations of linearization of a system. What is the need of nonlinear system analysis? | 4 | CO3 |
| Q 4 | Differentiate between autonomous and non autonomous system with some example? | 4 | CO2 |
| Q 5 | What do you understand by sigmoidal activation function for nonlinear neural network? | 4 | CO4 |
| | **SECTION B** | | |
| Q 6 | What do you understand by robust control? Draw the block diagram consisting of all nonlinearities and disturbances and obtain the transfer function. | 10 | CO4 |
| Q 7 | For a dynamical system $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} x_2 \\ x_1 - x_2 \sin x_1 \end{bmatrix}$<br>(a) Find the equilibrium point for this system.<br>(b) Linearize the system about the found equilibrium point.<br>(c) Determine if the linearized system is stable, asymptotically stable or unstable. | 10 | CO2 |
| Q8 | What do you understand by Fuzzy PID Controller. Obtain the derivation for discrete time system. How the rule can be made in fuzzy control? | 10 | CO2 |
| Q 9 | The state equation of a linear time invariant system is given below: | 10 | CO2 |

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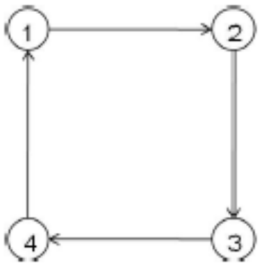
| | $\begin{bmatrix}\dot{x_1}\\ \dot{x_2}\end{bmatrix} = \begin{bmatrix}-2 & 0\\ 1 & -1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}0\\ 1\end{bmatrix}$u<br>Where u ≥0.<br>Determine the following<br>(i) The state transition matrix<br>(ii) $Controllability$ and Observability of the system. | | |
| | **SECTION-C** | | |
| Q10(a) | Consider the four robot are connected in the following manner shown in fig 1.<br>  <br><br>Fig 1<br>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. | **10** | **CO3** |
| Q10(b) | Explain the concept of completely controllable and completely observable system with respect to eigen value? How is Pole Placement technique better Compared to the normal Eigen value technique. | **10** | **CO2** |
| Q 11 | Consider a dynamical system that consists of a cart with an inverted pendulum attached to it as depicted in figure 3.<br>(i)Write the Lagrange equation of motion for the system.<br>(ii)Represent the obtained model in the state space format using the state variables<br>$X_1$=X, $X_2$= $\dot{x}$, $X_3$=θ, $X_4$=$\dot{\theta}$ | **20** | **CO2** |

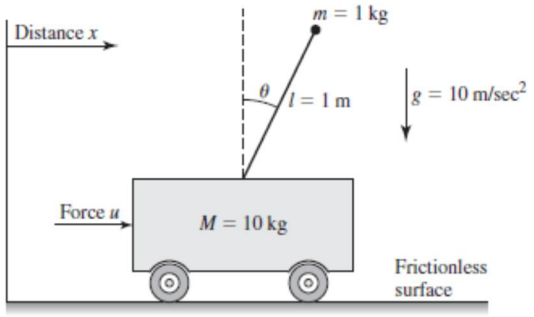

Distance $x$
$m = 1$ kg
$\theta$
$l = 1$ m
$g = 10$ m/sec$^2$
Force $u$
$M = 10$ kg
Frictionless surface

Figure 3

Set 2

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**Instructions:**

**SECTION A**

| S. No. | All questions are compulsory. (5x4=20) | Marks | CO |
|---|---|---|---|
| Q 1 | What do you understand by feedback control system. What are nonlinearity present in the feedback control system. | 4 | CO1 |
| Q 2 | For the following scalar nonlinear function $\dot{x} = -x^3 + u$ using Lyapunov approach comment on the stability? | 4 | CO3 |
| Q 3 | What do you understand by Luenberger observer. How does the stability change in this case. | 4 | CO3 |
| Q 4 | What are the objectives in the design of control system.? Differentiate between regulation and tracking of a system? | 4 | CO4 |
| Q 5 | Construct the rule base of fuzzy controller for any system and explain the architecture of Mamdani type Fuzzy Logic Control. | 4 | CO4 |

**SECTION B**

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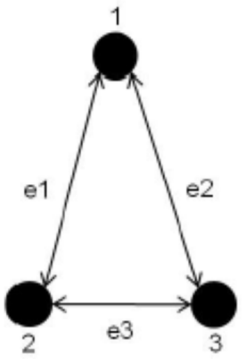
| Q 6 | Consider the three robot are connected in the following manner shown in fig 1.<br>  <br><br>Fig1 | 10 | CO3 |

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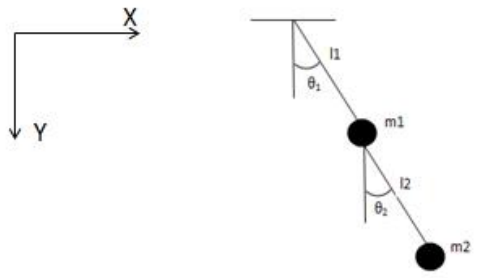
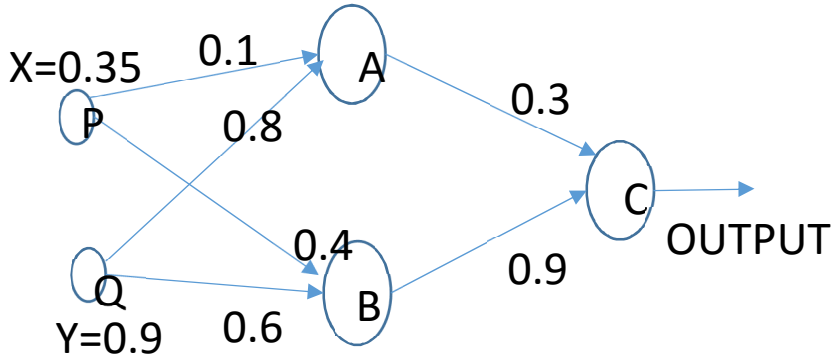
| | Obtain the adjacency and Laplacian matrix and comment on the stability using Lyapunov Method. | | |
| Q 7 | What do you understand by Adaptive control. Differentiate between direct and indirect adaptive control? | **10** | **CO4** |
| Q8 | Derive the back propagation algorithm for an MLN with three layers. Use generalized delta rule. | **10** | **CO1** |
| Q 9 | How fuzzy logic controller is differentiated form PID Controller. Explain with the closed loop controller diagram. | **10** | **CO1** |
| | **SECTION-C** | | |
| Q 10 | 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 $\theta_1, \theta_2$ respectively.<br>  <br><br>Fig 2 | **20** | **CO2** |
| Q 11 | Apply the fundamental principle of back propagation algorithm and design the neural controller and calculate the error of the structure shown in figure 3.<br>  <br> | **20** | **CO4** |

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| | **Figure 3**<br><br>Assume neuron have sigmoidal activation function and target is 0.5. | | |