Name: **Enrolment No:**	

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2022

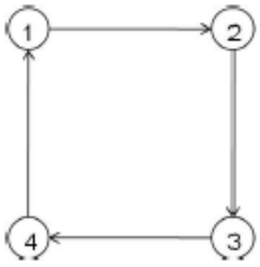
Course: Control System Engineering **Semester: III**
Program: M. Tech Automation and Robotics **Time : 03 hrs.**
Course Code: ECEG 7025 **Max. Marks: 100**

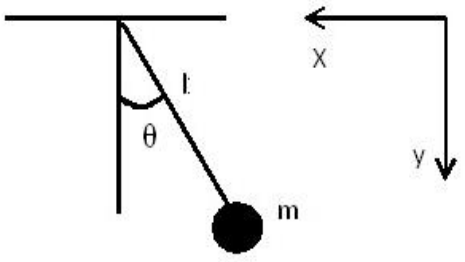
Instructions: Attempt all questions.

SECTION A
(5Qx4M=20Marks)

S. No.	Attempt all questions.	Marks	CO
Q 1	Draw the block diagram of a closed-loop control system showing all necessary elements.	**4**	**CO1**
Q2	Classify the system on various basis and comments.	**4**	**CO1**
Q3	What do you understand by control system design? Explain the types of control system design?	**4**	**CO1**
Q4	What do you understand by set point control?	**4**	**CO2**
Q 5	What are the actuator nonlinearities?	**4**	**CO3**

SECTION B
(4Qx10M= 40 Marks)

Q 6	Consider the four robots 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.	**10**	**CO2**

Q7	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 8	Elucidate the mathematical equation of PID controller. What is the advantage of PI controller over PD controller?	**10**	**CO3**
Q 9	For single link manipulator as shown in fig, obtain the modeling in sate space format.  **OR** 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** **10**	**CO2**
	SECTION-C **(2Qx20M=40 Marks)**		
Q 10 (a)	Obtain the transfer functions for the following systems with state-space models available as: a. $\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}0\\ 1\end{bmatrix}u\,;\quad y=[1\quad 0]\begin{bmatrix}x_1\\ x_2\end{bmatrix}+[0]u$	**10**	
(b)	Explain the concepts of observability and controllability with reference to linear time invariant systems. Find the controllability of the system described by the state equation. $$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}\begin{pmatrix}0 & 1\\ -2 & 0\end{pmatrix}\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}0\\ 3\end{bmatrix}u$$	**10**	**CO4**

Q11 (a)	State and prove Lyapunov stability theorem. Explain Lyapunov direct method?	**10**	
(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. **OR** Explain the generalized robot manipulator equation and their properties. Obtain the derivation for position control of robot manipulator?	**10** **20**	**CO3**