Name:

Enrolment No:

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, Dec 2019

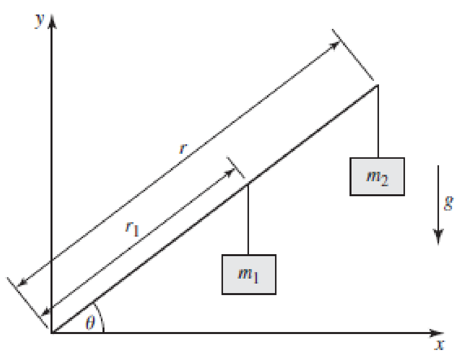
Programme Name: B. Tech **Semester : V**
Course Name : Introduction to Robotics and Automation **Time : 03 hrs**
Course Code : ECEG 3204 **Max. Marks : 100**
Nos. of page(s) :02
Instructions:

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	A frame F has been moved 10 units along the γ– axis and the 5 units along the z- axis reference frame. Find the new location of the frame. $$F = \begin{bmatrix} 0.527 & -0.574 & 0.628 & 5 \\ 0.369 & 0.819 & 0.439 & 3 \\ -0.766 & 0 & 0.643 & 8 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$	**5**	**CO2**
Q 4	What do you mean PD Control. Draw the block diagram considering robot as a system	**5**	**CO4**

SECTION B

Q 5 (a) (b)	Give an example of an automated system, which contains a control system as a part of it? (b) PLCs ladder logic programming is derived from relay logic programming. Justify this statement.	**5** **5**	**CO1**
Q 6	Explain the hierarchical structure of automation in detail. Discuss the importance of each component in brief.	**10**	**CO1**

Q 7	Explain the features and economic benefits of SCADA system. Also list various impacts of SCADA failure in brief.	**10**	**CO1**
Q8 (a) (b)	State and prove Lyapunov stability theorem. Explain Lyapunov direct method? 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**
	SECTION-C		
Q 9 (a) (b)	Obtain the state space model for the θ- r Robot manipulator system and also obtain the lagrange equation of motion?  The Mass m_1=10 Kg, r_1=1 m, m_2= 3 kg . It is assumed that mass m_2 to be located at the end of a position of a telescoping arm that is a variable radial distance r form the hub of a center of rotation. The angle of rotation is θ. The inputs to the system are assumed to be (a) A torque T_θ applied at the hub in the direction of θ. (b) A translational force F_r applied in the direction r. g=10 m/sec^2 is the gravitational constant Explain the following terms? (i)Data logger (ii) Mod bus	**10** **10**	**CO3** **CO1**

	(iii) Telemetry (iv) Trending and Alarm Handling		
Q10 (a) (b)	Explain the architecture of PLC. Also discuss the PLC scan cycle. Develop the ladder logic that will turn on an output light, 15 seconds after switch A has been turned on.	**10** **10**	**CO1**

Set B

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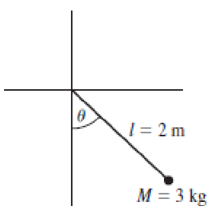
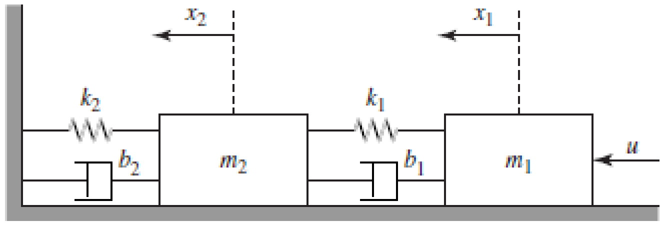
SECTION A

S. No.	All questions are compulsory.	**Marks**	**CO**
Q 1	Classify the system on various basis and comment.	**5**	**CO1**
Q 2	Show that the given system is Nonlinear in Nature. Obtain the dynamic model for the given system as shown in fig.2  	**5**	**CO2**
Q 3	Draw the block diagram of a closed loop control system showing all necessary elements.	**5**	**CO1**
Q 4	A point $p(7,3,1)^T$ is attached to a frame F_{noa} and is subjected to the following transformation. Find the coordinated of the point relative to the reference frame at the conclusion of transformation (1)Rotation of 90^0 about the z- axis. (2) Followed by a rotation of 90^0 about the y- axis (3) Followed by a translation of [4, -3 7]	**5**	**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 $$\dot{x}_1 = x_2$$ $$\dot{x}_2 = -x_1 - bx_2$$ Based on the Lyapunov technique comment on the stability	**10**	**CO4**
Q 8	Obtain the transfer functions for the following systems with state-space models available as: a. $\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}0\\ 1\end{bmatrix}u\ ; \quad y = \begin{bmatrix}1 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + [0]u$	**10**	**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 $$\dot{x}(t) = A(t)\,\mathrm{x}(t) + B(t)u(t)\ .$$ 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	Using euler lagarange approach obtain the modelling for given two link manipulator as shown in figure. 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.	**20**	**CO4**