Enrolment No:

UPES
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UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End-Sem Examination, May-June. 2021

Programme Name: B.TECH SoE – All branches | **Semester: IV**

Course Name : Introduction to Robotic Systems | **Time : 03 hrs**

Course Code : MRRS0202 | **Max. Marks : 100**

Nos. of page(s) : 2

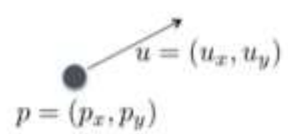
Instructions:

1. **Attempt Section A by typing in your answers in the relevant text box.**
2. **Attempt section B and Section C on A4 size blank sheets. Use graph paper wherever necessary.**
3. **Answer should be neat and clean. Draw a free hand sketch for circuits/tables/schematics wherever required.**

SECTION A [Type the answer] 30 Marks

S. No.		Marks	CO
Q 1	Elucidate the significance of linearizing a mathematical model for controller design.	5	CO1
Q 2	What are the limitations of Proportional controller?	5	CO1
Q 3	How turning is achieved in a differential drive robot.	5	CO1
Q 4	Explain the significance of drift in mobile robotic systems.	5	CO1
Q 5	Name a few sensors used in mobile robots for odometry.	5	CO1
Q 6	Explain the Rendezvous problem in swarm robotics.	5	CO1

SECTION B [Scan and upload] 50 Marks

Q 7	With the help of differential drive robot model obtain the dynamics for obstacle avoidance.	10	CO2
Q 8	State and prove Lyapunov stability theorem. Explain Lyapunov indirect method.	10	CO2
Q 9	For a system governed by state equation: $\dot{x} = ax$. Determine the stability for the system having A matrix: $\begin{bmatrix} 3 & 2 \\ 4 & -1 \end{bmatrix}$	10	CO3
Q 10	Consider the scalar system $\dot{x} = -x^3$, $x \in R$. Comment on the stability at the origin $x_e = 0$.	10	CO3
Q 11	Consider a 2-D robot movement space. If the initial position of a mobile robot can be expressed as $p = (p_x, p_y)$ and the goal coordinates are given as $u = (u_x, u_y)$.  Determine the control problem in state-space form, and identify the matrices A, B &C.	10	CO3

SECTION C [Scan and upload] 20 Marks

Q 12	For a robotics system governed by state equations: $\dot{X} = \begin{bmatrix} 1 & -1 \\ 1 & -2 \end{bmatrix} X + \begin{bmatrix} 2 \\ 1 \end{bmatrix} u$ Design a state feedback controller using $u = -kx$ such that closed-loop poles are located at $[-1, -2]$	20	CO4