Roll No.												

PRESIDENCY UNIVERSITY

BENGALURU
SET-C

End - Term Examinations – December 2025

Date: 09- 12-2025 **Time:** 01:00pm – 04:00pm

School: SOCSE	**Program:** Information Science & Engineering (AI And Robotics)	
Course Code : RAI3404	**Course Name:** Robotic system Design	
Semester: VII	**Max Marks**: 100	**Weightage**: 50%

CO - Levels	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Marks	**24**	**24**	**26**	**26**	**----**

Instructions:

(i) Read all questions carefully and answer accordingly.

(ii) Do not write anything on the question paper other than roll number.

Part A

Answer ALL the Questions. Each question carries 2marks. **10Q x 2M=20M**

1.	Summarize the key advantages of using Ubuntu over other operating systems for ROS development.	**2 Marks**	**L2**	**CO1**
2.	Discuss the importance of DDS Middleware in ROS2 communication.	**2 Marks**	**L2**	**CO1**
3.	Apply the concept of coordinate frames in URDF to explain robot localization using TF trees.	**2 Marks**	**L3**	**CO2**
4.	Construct a simple Xacro macro to parameterize wheel dimensions.	**2 Marks**	**L3**	**CO2**
5.	Model a GPS-denied navigation scenario and specify suitable sensors for reliable localization.	**2 Marks**	**L3**	**CO3**
6.	Select a SLAM technique that best supports navigation through both crowded and open areas.	**2 Marks**	**L3**	**CO3**
7.	Demonstrate how a robot corrects its map when revisiting a previously mapped location using the GMapping algorithm.	**2 Marks**	**L3**	**CO3**

8.	Produce a basic workflow with MoveIt and ROS for a pick-and-place robot.	**2 Marks**	**L3**	**CO4**
9.	Prepare a step-by-step strategy for calibrating a camera in ROS-based vision systems.	**2 Marks**	**L3**	**CO4**
10.	Choose the most efficient deep learning model (YOLO, SSD, Faster R-CNN, EfficientDet) for real-time multi-object detection in a warehouse and justify your choice.	**2 Marks**	**L3**	**CO4**

Part B

Answer the Questions. **Total Marks 80M**

11.	**a.**	Explain the step-by-step process of designing a robotic system in ROS2—from node creation to system deployment.	**10 Marks**	**L2**	**CO1**
	b.	Explain, using basic code and steps, how to set up Python ROS 2 subscriber and publisher nodes with rclpy for the 'chatter' topic, describing the initialization and shutdown procedures.	**10 Marks**	**L2**	**CO1**
		Or			
12.	**a.**	Explain the architecture of ROS2 and discuss the purpose and function of each layer in the system.	**10 Marks**	**L2**	**CO1**
	b.	Explain what is meant by a ROS distribution.Discuss how ROS2 enhances real-time capabilities compared to ROS1, focusing on the major architectural and design improvements that enable these advancements.	**10 Marks**	**L2**	**CO1**

13.	**a.**	Prepare and operate a working URDF/Xacro model incorporating joint limits and dynamic properties to ensure safe robot arm operation in Gazebo.	**10 Marks**	**L3**	**CO2**
	b.	Implement and test a differential drive model in Xacro/URDF, demonstrating how wheel velocities determine robot motion behavior in simulation.	**10 Marks**	**L3**	**CO2**
		Or			
14.	**a.**	Prepare a troubleshooting guide for common Gazebo simulation issues such as unstable physics, missing sensors, or robot instability.	**10 Marks**	**L3**	**CO2**
	b.	Compare modular and monolithic URDF robot designs to evaluate their maintainability and scalability.	**10 Marks**	**L3**	**CO2**

15.	**a.**	Demonstrate how the GMapping algorithm uses particle filters to solve the SLAM problem.	**10 Marks**	**L3**	**CO3**

	b.	Prepare an outline of the ROS2 navigation stack, illustrating how global and local planners contribute to robot path planning.	**10 Marks**	**L3**	**CO3**
		Or			
16.	**a.**	Compare Full SLAM and Online SLAM in terms of computational complexity and accuracy.	**10 Marks**	**L3**	**CO3**
	b.	Illustrate the Hector SLAM algorithm and Interpret its differences from particle filter-based methods like GMapping.	**10 Marks**	**L3**	**CO3**

17.	**a.**	Demonstrate how the perception-action cycle operates in a robot vision system, showing the link between sensing, image processing, planning, and action in pick-and-place scenarios.	**10 Marks**	**L3**	**CO4**
	b.	Prepare a custom calibration procedure for an RGB-D camera and discuss how intrinsic/extrinsic parameters affect robot manipulation accuracy.	**10 Marks**	**L3**	**CO4**
		Or			
18.	**a.**	Use feature detection algorithms (e.g., Harris, SIFT, ORB, Shi-Tomasi) to describe how a robot can track key points for industrial vision tasks.	**10 Marks**	**L3**	**CO4**
	b.	Analyze object pose estimation results in a robotic manipulation scenario and explain how position and orientation data influence the robot's control decisions.	**10 Marks**	**L3**	**CO4**