Daffodil International University

Department of Software Engineering

Faculty of Science & Information Technology

Final Examination, Spring 2024

Course Code: SE 532; Course Title: Introduction to Robotics

Sections & Teachers: 38- A, B; 39- A, B, C, D;

Md Hafizul Imran(HI); Masrufa Tasnim (MT)

Time: 2:00 Hrs **Marks: 40**

Answer ALL Questions

[The figures in the right margin indicate the full marks and corresponding course outcomes. All portions of each question must be answered sequentially.]

1.	a)	You are leading a team that is designing a new limbed robot system for exploration on rugged terrains. The robot must be capable of navigating uneven surfaces, climbing obstacles, and carrying a moderate payload. The design process will follow a typical limbed system development approach, as outlined in the provided content. **Demonstrate** the steps you would take to design this limbed robot system. Discuss what factors you would consider at each step, focusing on the robot's mobility, stability, and capability to carry a payload. Include considerations for conceptual design, detailed design, and evaluation.	[Marks-5]	CLO-2 *Level-2*
	b)	You are tasked with designing a robotic arm for an assembly line that can perform complex tasks such as picking, placing, and welding components. The arm must have multiple joints, allowing for flexible movement in different directions. Given the critical tasks involved, precise control of the arm's movements is essential. **Demonstrate** the process of designing this multi-joint robotic arm, focusing on the choice of actuators and control methods. **Write** the advantages and disadvantages of different actuator types and control methods, and explain how you would ensure the arm operates accurately and reliably.	[Marks-7]	
2.	a)	A point $P(7,3,1)^T$, is attached to a frame F and is subjected to the following transformations. **Compute** the coordinates of the point relative to the reference frame at the conclusion of transformations. 1. Rotation of 90° about the z-axis, 2. Followed by a rotation of 90° about the y-axis, 3. Followed by a translation of [4,-3,7].	[Marks-5]	CLO-2 *Level-3*

	b)	A frame Fnoa is located in the position P. After the following transformation the frame position has changed to Q[2,5,7]T. A rotation along the Z axis by anti-clock 45 degree but before that a translation along all axis by [2,3,5]. After those two, another rotation along the Y axis by 60 degrees followed by a translation along all axis by [3,-5,3]. **Compute** the position P with respect to Q.	[Marks-8]	
3.	a)	You are developing a complex robotics application in ROS, and your team needs to visualize the robot's movements in a 3D environment to ensure proper operation. Additionally, you want to test the robot's behavior in a simulated environment before deploying it in the real world. **Evaluate** the ROS tools that are commonly used for 3D visualization and simulation.	[Marks-5]	CLO-3 *Level-5*
	b)	You are tasked with developing a ROS-based application for a robot that involves several sensors and actuators. The system should be able to communicate among different nodes to perform specific tasks. Your team decides to implement a communication model that uses both topics and services. Explain the software framework for implementing ROS in this actuator and **consider** which operating system will be the best to use for the ROS-based application.	[Marks-5]	
	c)	You are working on a project that requires controlling multiple servo motors simultaneously using an Arduino. The project involves a robotic arm with five joints, each controlled by a separate servo motor. The joints need to move to specific positions to achieve the desired arm movement pattern. **Recommend** an Arduino sketch that initializes five servo motors on different pins and controls their movements. The code should: • Attach each servo motor to a different digital pin. • Move all five servo motors to three distinct positions: 0 degrees, 90 degrees, and 180 degrees. • Include a delay of two seconds between each movement to allow the servos to complete their motion. • Repeat the movement pattern in a loop. Your answer should demonstrate how to initialize and control multiple servo motors, using appropriate functions and delays to manage their movements.	[Marks-5]	