Daffodil International University
Department of Computer Science and Engineering
Faculty of Science & Information Technology
Final Examination, Spring 2023
Course Code: CSE426   **Course Title: Principles of Robotics**
Level: 4   Term: 3   Batch: 54

Time: 2 Hours   **Full Marks: 40**

Answer all the following questions
[All portions of each question must be answered sequentially]

SL	Questions	Marks	CO
1	a) According to robot characteristics, robots need movements to perform any physical task. Using the Fleming left hand rule, explain the working principle of the DC motor in detail with necessary figures.	[5]	CO1
2	**a)** What is inverse kinematics? Write down the DH notation parameters.	[3]	CO2
	Consider a robotic manipulator with four revolute joints. The Denavit-Hartenberg (DH) notation is commonly used to represent the kinematics of robotic manipulators. For the given manipulator, the following DH parameters are provided:		
	$\theta_1 = \pi/4$, $d_1 = 0.2$ m, $a_1 = 0.1$ m, $\alpha_1 = \pi/2$ $\theta_2 = \pi/3$, $d_2 = 0.3$ m, $a_2 = 0.2$ m, $\alpha_2 = 0$ $\theta_3 = -\pi/6$, $d_3 = 0$, $a_3 = 0.3$ m, $\alpha_3 = \pi/2$ $\theta_4 = \pi/2$, $d_4 = 0$, $a_4 = 0$, $\alpha_4 = 0$		
	where θ represents the joint angle, d represents the link offset along the z-axis, a represents the link length along the x-axis, and α represents the link twist along the z-axis.		
	Using the DH parameters above, answer the following questions:		
	b) Determine the forward kinematics of the end-effector in terms of the base frame using above DH parameters.	[5]	
	c) Use the obtained matrix from question (b) and calculate the orientation of the end-effector represented angles (roll, pitch, yaw).	[5]	
3	a) We must control our robot motor speed to perform any task perfectly. Now Implement PWM to control a DC motor in C++, also describe the theoretical background of PWM.	[5]	CO3

4	a) Using ROS architecture describe action Server and action client with necessary example.	[5]	CO3
	b) To develop and run any application we always need to use shell command. Write-down at least tens of ROS shell commands.	[2]	
5	In industry there are lots of use cases for AGV that moves by following black lines. Every year different country and robotics organizations are being organized national and international line following robot challenges. a. Based on your learning form Principles of robotics course, Sketch a robot model for industrial use or competition purpose. b. Design and implement the necessary algorithms into your robot to perform in the following trac shown in Figure 01. Figure: 01 OR Design and implement any robotics project with necessary algorithms and circuit diagram.	[3] [7]	CO4