32

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

MID SEMESTER EXAMINATION — WINTER SEMESTER, 2022-2023

DURATION: 1 HOUR 30 MINUTES — FULL MARKS: 75

CSE 4551: Computer Graphics and Multimedia Systems

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer **all 3 (three)** questions. Figures in the right margin indicate full marks of questions whereas corresponding CO and PO are written within parentheses.

1. a) Using DDA based algorithm, generate the set of points to draw a line between the two points $(-3, -2)$ and $(-9, -4)$. — 6 (CO1) (PO1)

   b) Derive the appropriate Bresenham's algorithm to generate the set of points to draw a line between the two points $(0, 0)$ and $(3, 9)$. Using your derived algorithm, generate the set of points while showing the value of decision variable, d and the directional change in every step. — 8 + 6 (CO3) (PO2)

   c) Can there be any case where the set of points generated by a Bresenham's algorithm will be different than the ones generated by a DDA based algorithm? With suitable example and/or reasoning, justify your choice. — 5 (CO2) (PO2)

2. A robotic arm, made of inflatable rubber material, is linked in a kinematic chain as shown in Figure 1. As it is made of rubber material, each node is capable of stretching uniformly up to 1.5 times. The offsets, initial orientations, and constraints for each of the nodes and the final actuator are given in the Figure 1. Based on the given information, answer the following questions:

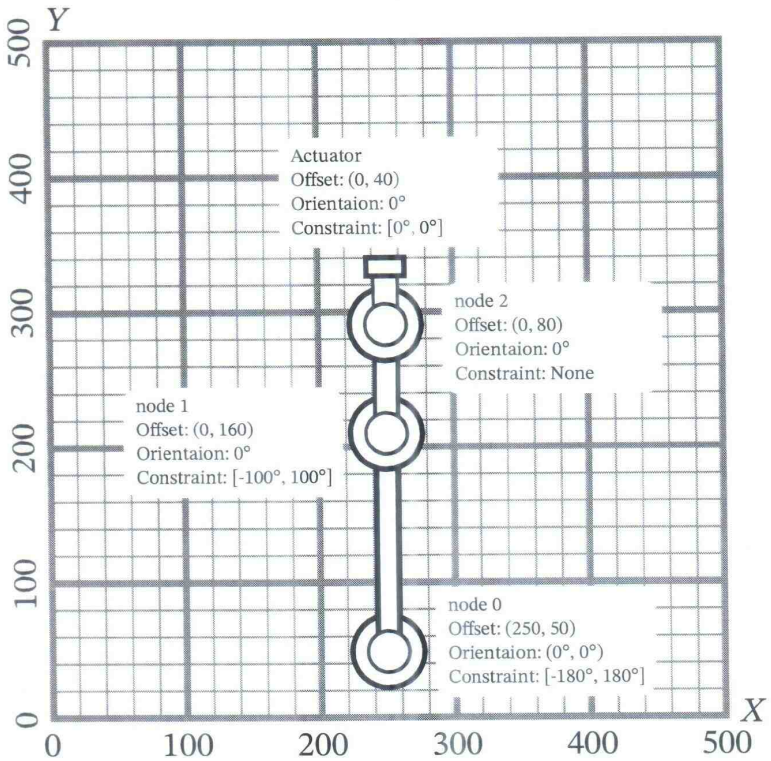

Figure 1: Robotic arm layout for Question 2

a) Consider the list of transformations for each of the nodes given in Table 1: 12 (CO1) (PO1)

Table 1: Kinematic chain of robotic arm for Question 2

Node	List of Transformations
node 0	Rotate clockwise by 190°
node 1	Rotate counter-clockwise by 90° Scale up 1.2× uniformly
node 2	Rotate counter-counter clockwise by 45°

Keeping the constraints in mind, derive the world coordinates of each of the nodes and the actuator. Show necessary calculations in each stage.

b) Consider that all the rotational constraints for the nodes are removed and the nodes cannot scale up via inflation anymore. Now, mathematically or conceptually derive an equation or a system, which given a target point in the world coordinate, can verify whether it would be under-constrained or over constrained when attempting to reach by the robotic arm using Inverse Kinematics (IK). 8 (CO2) (PO2)

c) What kind of difficulties may arise if direct world coordinate geometry is used instead of Forward Kinematics (FK) and hierarchical modeling to calculate the transformations of the robotic arm? Explain with appropriate justification. 5 (CO1) (PO2)

3. a) A cubic Bézier curve, $\vec{\gamma}(t)$, is drawn using the four control points, $(1, 5)$, $(3, 1)$, $(7, 1)$, and $(7, 3)$. Find out the $\vec{\gamma}(1/2)$, $\vec{\gamma}(1/4)$, and $\vec{\gamma}(1/8)$ points, both visually and mathematically, using De Casteljau's algorithm. The visual calculation does not need to be accurate, but should roughly match proportions. 4 + 6 (CO1) (PO1)

b) Suppose you need to draw the cubic control polygon of the Bézier curve in Question 3.a). However, you are allowed to use only a single cubic B-spline curve to draw all the lines in the polygon. A B-spline curve can pass through four or more points. With appropriate reasoning, describe how you may perform the drawing using a cubic B-spline curve. Along with it, mention the sets of points for drawing the curve. 5 + 3 (CO2) (PO2)

c) With a proper example, describe how displacement mapping along with subdivision surface helps in modeling complex geometry in computer graphics. 7 (CO1) (PO1)