UNIVERSITY OF RUHUNA

BACHELOR OF COMPUTER SCIENCE GENERAL DEGREE

LEVEL II (SEMESTER I) EXAMINATION - AUGUST 2017

CSC2143 – Computer Graphics and Image Processing (Theory) **Duration: 2 hours**

Answer **all** questions

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1)

a) Write down the midpoint circle drawing algorithm in step form.

b) Given a circle of radius 11, demonstrate the midpoint circle drawing algorithm by determining positions along the circle octant in the first quadrant from x = 0 to x = y.

c) A circle can be defined as the set of points which are all at a given distance r from a center position (x_c, y_c). For any circle point (x, y), this distance relationship can be expressed by the Pythagorean theorem in Cartesian coordinates as $(x - x_c)^2 + (y - y_c)^2 = r^2$. We can use this equation to compute the position of points on a circle circumference by stepping along the x axis in unit steps from $x_c - r$ to $x_c + r$ and computing the corresponding y values at each position as $y = y_c \pm \text{sqrt}\{r^2 - (x_c - x)^2\}$. Briefly explain the drawbacks of using this approach for circle drawing.

2)

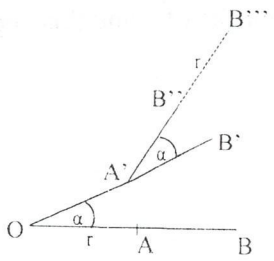
a)

i. **Derive** the transformation matrix for rotation of a point around the origin by an angle of α (> 0) in anticlockwise order.

ii. **Write down** the transformation matrix for translation of a point by p (> 0) along positive direction of x-axis and q (> 0) along positive direction of y-axis.

b) A point needs to be rotated around a fixed point (a, b) in anticlockwise order. Derive the composite transformation matrix using the derived matrices of (2) (a) (i) and (2) (a) (ii).

c) A robot arm initially rests at position OAB along x-axis as shown in the figure where OA = r. Here O is the origin of the coordinate system. Then the robot arm is rotated around O by angle α in anticlockwise order and takes OA'B' position. Then B' is rotated around A' by angle α in anticlockwise order and takes OA'B'' position. After that the length of the arm part A'B'' is increased by r such that it takes OA'B''' position. Note that all the movements of the robot arm are restricted to the same plane. Use the derived matrices in above (2) (a) and (2) (b) to answer following questions.



i. **Derive** the composite transformation matrix for the transformation BB''.

ii. **Derive** the composite transformation matrix for the transformation BB'''.

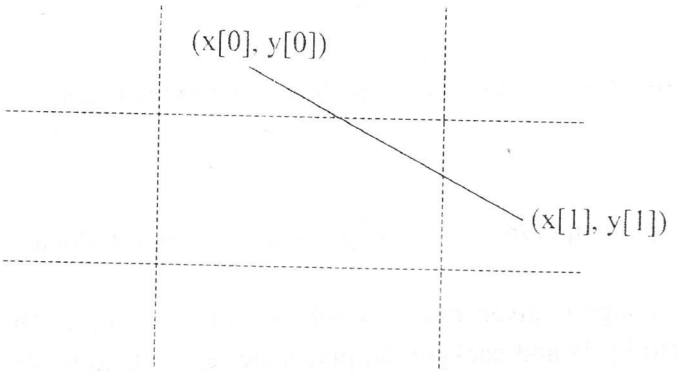
iii. Let $\alpha = 30^0$ and r = 1. Compute the coordinates of B''' if AB = 2 using the matrix derived in (2) (c) (ii).

3)

a) Write down the lemma which is used to develop the interior points' algorithm which is used for finding the convex hull of a planer set of points.

b) The coordinates of two clusters are {(1, 3), (1, 6), (2, 5)} and {(6, 2), (6, 3), (7, 3), (8, 1)}. The clustering algorithm **A** gave two centers of each cluster as (1, 4) and (7, 2) respectively. The clustering algorithm **B** gave two centers of each cluster as (2, 4) and (6, 1) respectively. Find which algorithm gives better results by using mean squared error method.

c) Demonstrate how Cohen Sutherland algorithm works for the line segment shown in the following figure. Note that it intersects only with RIGHT and TOP boundaries.

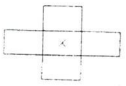


4)

a) Following figure shows a binary image which contains an object. The object pixels are represented by 1s and background pixels are represented by 0s.

0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	0	0	0	0	0
0	0	0	1	1	1	0	1	0	0
0	0	0	1	1	1	1	1	0	0
0	0	1	1	1	1	1	0	0	0
0	0	1	1	1	1	0	0	0	0
0	0	0	1	1	0	0	0	0	0
0	0	0	1	1	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

i. **Erode** the object using following structuring element.



ii. **Dilate** the object using following structuring element.

b) Briefly explain **opening** and **closing** operators in morphological image processing.

c) A binary image is given below which contains an object. The object pixels are represented by 1s and background pixels are represented by 0s. Explain a method to get the **outline** of the object in the given image. Show the values of the pixels at the end of each step of your method.

0	0	0	0	0	0	0
0	0	1	1	0	1	0
0	1	1	1	1	1	0
0	1	1	1	1	1	0
0	0	1	1	1	1	0
0	0	0	1	1	1	0
0	0	0	0	0	0	0

d)

i. Define the **histogram** of a gray scale image in image processing.

ii. Explain the process of **histogram equalization** in image processing.