Shahjalal University of Science and Technology
Institute of Information and Communication Technology (IICT)
4^{th} year 2^{nd} Semester Final Examination - 2021
Session—2018-19 Course No.—SWE 423
Course Title—Computer Graphics & Image Processing
Time—3 Hours Credit: 3.00 Total Marks#100

Part A

1. Answer the following Questions (Any Five). $5 \times 2 = 10$

   (a) What is the resolution of an image?

   (b) If we use direct coding with 8 bits per primary color, how many possible colors do we have for each pixel?

   (c) What do you require for 3D viewing an object? Mathematically how do you specify the view plane?

   (d) Ideally view volume is infinite but in reality we prefer to use a finite volume, why?

   (e) How do you specify the finite view volume?

   (f) If $d_i = -3$, $x_i = 3$, $y_i = 2$ what will be the x_{i+1} *and* y_{i+1} for Bresenham's line drawing algorithm?

   (g) The direct coding method is flexible in that it allows the allocation of a different number of bits to each primary color. If we use 5 bits each for red and blue and 6 bits for green for a total of 16 bits per pixel, how many possible simultaneous colors do we have?

2. Answer the following Questions (Any Four). $4 \times 5 = 20$

   (a) Under the standard perspective transformation P_{erk}, what is the projected image of a point in the place $z = -d$? What does this anomaly called?

   (b) Given points $P_1(1, 2, 0)$, $P_2(3, 6, 20)$ and $P_3(2, 4, 6)$ and a viewpoint $C(0, 0, -10)$, determine which points obscure the others when viewed from C.

   (c) When eight-way symmetry is used to obtain a full circle from pixel coordinates generated for the first octant, certain pixels are set or plotted twice. This phenomenon is sometimes referred to as over-strike. How to remove this over-strike phenomenon?

   (d) Compare between 'Brasenham's', and 'Direct' line drawing approach.

   (e) What steps are required to plot a dashed circle? Modify Brasenham's circle drawing algorithm to achieve this.

   (f) Apply Bresenham's line algorithm to draw a line from (2,3) to (8,12). Show the steps and the resulting pixel coordinates.

3. Answer the following Questions (Any TWO). $2 \times 10 = 20$

   (a) Let R be a rectangular window whose lower left-hand corner is at L(-3,1) and upper right-hand corner is at R(2,6).

      [i] Find the region codes for the endpoints $A(-2, 3) \rightarrow B(1, 2)$, $C(-4, 7) \rightarrow D(-2, 10)$ and $E(-4, 2) \rightarrow F(-1, 7)$.

      [ii] Find the clipping categories for the line segment in part-i.

      [iii] Use the Cohen-Sutherland algorithm to clip the line segments in part-i.

   (b) Triangle ABC where the vertices of $\triangle ABC$ are A(-1,-3), B(-4,-1), and C(-6,-4) undergoes a composition of transformations described as: a translation 10 units to the right, then a reflection in the x-axis. After all the transformations are applied what will be the triangle coordinates?

   (c) Reflect the diamond-shaped polygon whose vertices are A(-1, 0), B(0, -2), C(1, 0), and D(0, 2) about the horizontal line $y = 3$.

Part B

4. Answer the following Questions (Any Five). $5 \times 2 = 10$

   (a) What is "Histogram Equalization" in image processing?

   (b) What is region code? What does each bit represent?

   (c) What is "Analog Image"?

   (d) Find the transformation that scales (with respect to the origin) by 'a' units in the X direction for point P(x,y).

   (e) What are the conditions for the clipping candidate in the Cohen-Sutherland algorithm?

   (f) How do you model an object in computer graphics?

   (g) What are the geometric forms used for modeling of objects?

5. Answer the following Questions (Any Four). $5 \times 4 = 20$

   (a) Find the normalization transformation that maps a window whose lower left corner is at (1,1) and upper right corner is at (3,5) onto a viewport that is the entire normalized device screen.

   (b) What are the types of Image Compression Techniques? Differentiate between them.

   (c) Apply Cohen-Sutherland line clipping to clip a line segment with endpoints $(-5, 4)$ and $(7, 10)$ against a window with corners $(-3, 8)$ and $(5, 6)$.

   (d) The matrix $\begin{pmatrix} 1 & a \\ b & 1 \end{pmatrix}$ defines a transformation called a simultaneous shearing or shearing for short. The special case when $b = 0$ is called shearing in the x direction. When $a = 0$ we have shearing in the y direction. Illustrate the effect of these shearing transformations on the square A(0,0), B(1,0), C(1,1), and D(0,1) when a=2 and b=3. Draw suitable diagrams.

   (e) Tilting is defined as a rotation about the x-axis followed by a rotation about the y-axis: (i) find the tilting matrix; (ii) does the order of performing rotation matter? Show mathematically.

   (f) Show that $S_{a,b} \cdot S_{c,d} = S_{c,d} \cdot S_{a,b} = S_{ac} \cdot S_{bd}$.

6. Answer the following Questions (Any Two). $2 \times 10 = 20$

   (a) Use the Cohen-Sutherland algorithm to clip two lines P1(35,10)- P2(65,40) and P3(65,20)-P4(95,10) against a window A(50,10), B(80,10), C(80,40) and D(50,40). Also, find the clipping position.

   (b) Find a transformation A_V which aligns a given vector V with the vector K along the positive z axis.

   (c) Under the standard perspective transformation P_{erk}, what is the projected image of the line segment joining $P_1(-1, 1, -2d)$ to $P_2(2, 2, 0)$. Use suitable figures.

Computer Graphics TT 01

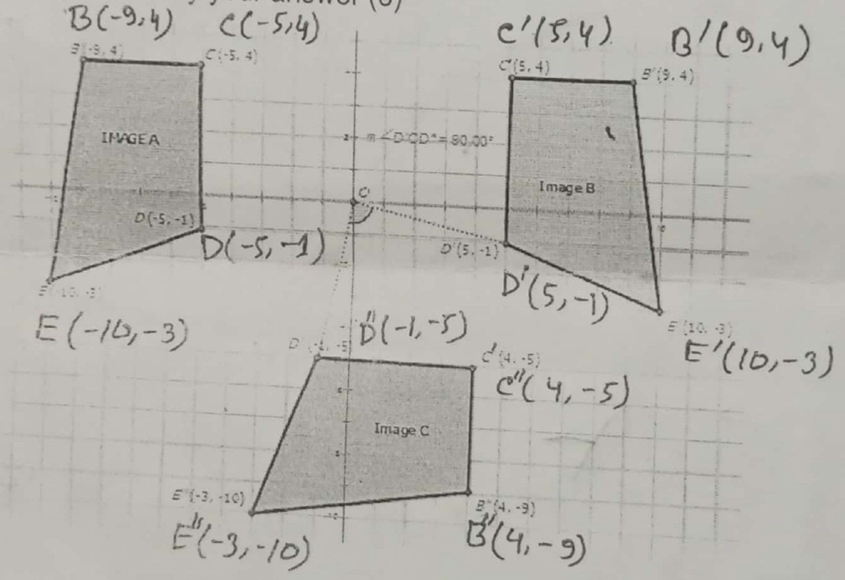
Full Marks: 20 | Course Code: SWE 423 | Time: 40 mins

1. What is 8-way symmetry for a Circle? Explain. (2+2)

2. In Brasenham's Circle drawing algorithm, we defined the decision variable $d\_i = D(T) + D(S)$ where T is the top pixel and S is the lower. Is there any chance that $d\_i = 0$ but pixels S and T are not equally far from the true circle? Justify your answer. (5)

3. Modify the "Midpoint circle drawing" algorithm pseudocode to draw a dashed circle. A "dashed circle" generally refers to a circular shape or outline where the perimeter is represented by a dashed or dotted line rather than a solid line. (5)

4. Define the possible steps & find the composite matrix to transform 'Image A' to 'Image C'. Verify your answer (6)



initial variable, $x = 0$, $y = r$

decision variable, $(1 - r)$

$A \times B \times C$

$= A \times (B \times C)$

$c = y - m(x_k + 1)$

$= y - \frac{\Delta y}{\Delta x}(x_k + 1)$

$= \Delta x\, y - \Delta y\, x_k - \Delta y$

Shahjalal University of Science and Technology
Software Engineering
Institute of Information and Communication Technology
4th Year 2nd Semester Final Examination' (Session: 2016-17)

Course Code: SWE 423 Credits: 3 Course Title: Computer Graphics and Image Processing

Time: 2 hrs Total Marks: 50

Group A
[Answer all the questions]

1. Answer any TWO **2x2.5=5**

a) Write the basic differences between Sutherland-Hodgeman and Weiler-Atherton Algorithm.

b) Compute the size of a 640 X 480 image at 240 pixels per inch.

c) Give real life examples of co-ordinate transformation.

2. Answer any TWO **2x10=20**

a) I. Write the differences between DDA line drawing and Bresenham's Line Drawing algorithm. **2+3+5 =10**

II. What do you understand by composite transformation? Explain with example.

III. The endpoints of a given line are (0,0) and (6,18). Compute each value of y as x steps from 0 to 6 and plot the results.

b) I. Perform a 45° rotation of triangle A(0,0), B(1,1), C(5,2) about a point P(-1,-1) **5+5=10**

II. Let $S_x = \frac{vx_{max} - vx_{min}}{wx_{max} - wx_{min}}$ and $S_y = \frac{vy_{max} - vy_{min}}{wy_{max} - wy_{min}}$. Express window-to-viewport mapping in the form of a composite transformation matrix.

c) I. What do you understand by polygon and polylines? Explain their differences. **2+3+5 =10**

II. What are 4 connected and 8 connected pixels. Explain with possible diagrams and examples.

III. Clipping against rectangular windows whose sides are aligned with the x and y axes involves computing intersections with vertical and horizontal lines. Find the intersections of a line segment P_1P_2 [joining $P_1(x_1,y_1)$ to $P_2(x_2,y_2)$] with
(a) the vertical line $x = a$ and
(b) the horizontal line $y = b$.

Group B

[Answer all the questions]

3. Answer any TWO **2x2.5=5**

a) Name two algorithms that can be used to find out the visible portion of given lines in a certain viewport.

b) What is the resolution of an image?

c) What do you understand by window to viewport mapping?

4. Answer any TWO **2x10=20**

a) I. Give two real life examples of scaling transformation. **2+3+5 =10**

II. What do you understand by Circle Symmetry property?

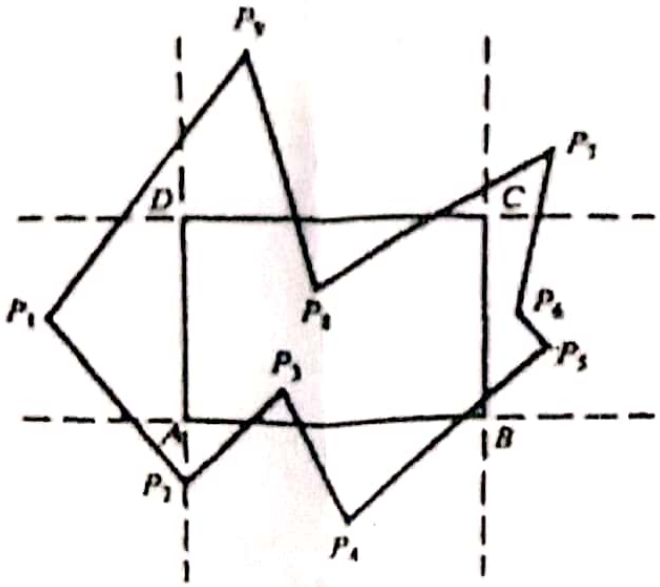
III. Find the normalization transformation that maps a window whose lower left corner is at (1,1) and upper right corner is at (3,5) onto -
(a) a viewport that is the entire normalized device screen and
(b) a viewport that has lower left corner at (0,0) and upper right corner at (½,½).

b) I. Define translation. **2+3+5 =10**

II. How can we determine whether a point P(x,y) lies to the left or to the right of a line segment joining the points $A(x_1,y_1)$ and $B(x_2,y_2)$. Explain with necessary diagrams.

III. Magnify the triangle with vertices A(0,0), B(1,1), and C(5,2) to twice its size while keeping C(5,2) fixed.

c) **5+5=10**



I. Clip the above polygon using Sutherland-Hodgeman algorithm. Show the figures at each step.

II. Describe the transformation M_L which reflects an Object about a line L. Draw necessary diagrams.

TT#02	Computer Graphics and Image Processing (SWE 335)	
Marks: 10		Time: 25 mins

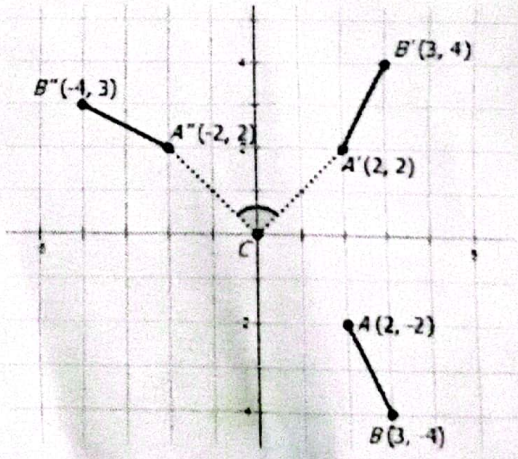
1. Find the matrix to reflect any 2D vector across $y = (-x)$. What are the new coordinates of the point P(2,3) after reflection? 2

2. Show that rotation of a vector by Π has the same result as multiplication of the vector by the inversion matrix, 2

$$M = \begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix}$$

3. Describe the transformations in the diagram below. The transformation flow is defined as: 6

$AB \rightarrow A'B' \rightarrow A''B''$



TT#01	Computer Graphics and Image Processing (SWE 335)	
Marks: 10		Time: 25 mins

1. What does Rasterization mean? **1**

2. We have a 1024 x 768 inch image at a resolution of 300 PPI, what would be the pixel count of that image? **1**

3. Briefly explain the concept of octant symmetry used in the Midpoint Circle Algorithm. **2**

4. Indicate which raster locations would be chosen by the Midpoint Circle Algorithm when scan-converting a circle for the given equation of: **6**

$$(x - 15)^2 + (y - 10)^2 = 60$$