**Shahjalal University of Science and Technology**
**Department of Computer Science and Engineering**
**3rd Year 2nd Semester Final Examination' Dec 2021 (Session: 2018-19)**
**Course Code: CSE 373 Credits: 3 Course Title: Computer Graphics**
**Time: 3 hrs Total Marks: 100**

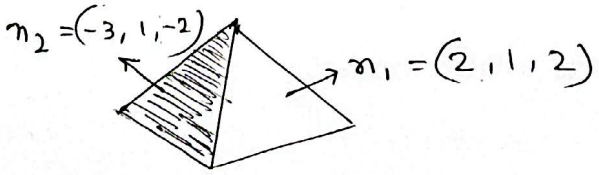
## Group A
*[Answer all the questions]*

**1. Answer any FIVE** **5x2=10**

a) Define sampling and quantization.
b) What do you understand by object space and image space?
c) In the RGB model, what color do we have along the diagonal running from the origin to the (1,1,1) point?
d) Give an example of such a string that stays the same even after compressing using Run-Length Encoding.
e) Find the perspective projection onto the view plane z=d where the center of the projection is the origin(0,0,0).
f) During Scan-Conversion, which one of the following two will produce less aliasing effect? Why?
$(x', y') = Floor(x + 0.5, y + 0.5)$ or $(x', y') = Floor(x, y)$
g) Can we use exactly the same Midpoint Ellipse algorithm for scan converting a circle? Why or why not?
h) How can you detect any vertics in a polygon as a monotonously increasing point?

**2. Answer any FOUR** **4x5=20**

a) Find the coordinates of the color that remains the same both in RGB and CMY models, using the necessary calculation. **5**
b) What is the total storage required for an image of 512×640 that uses a lookup table containing 1024 colors and each color containing 3 bits for Red, 4 bits for Green, and 5 bits for Blue? **5**
c) *Mathematically* how do you determine whether a surface is back facing or front facing? The normal n1 an n2 of two surfaces and the view point V is shown in the following figure. Determine which surface is back facing. **5**




d) What are the shortcomings of direct use of the equation and DDA algorithm for scan converting a line? How does Bresenham's line algorithm overcome these? **5**
e) Write the basic steps of scan converting an ellipse rotated $\theta°$ counter-clockwise and centered at *(h,k)* point. **5**
f) Briefly discuss 3 types of anti-aliasing techniques. **5**

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

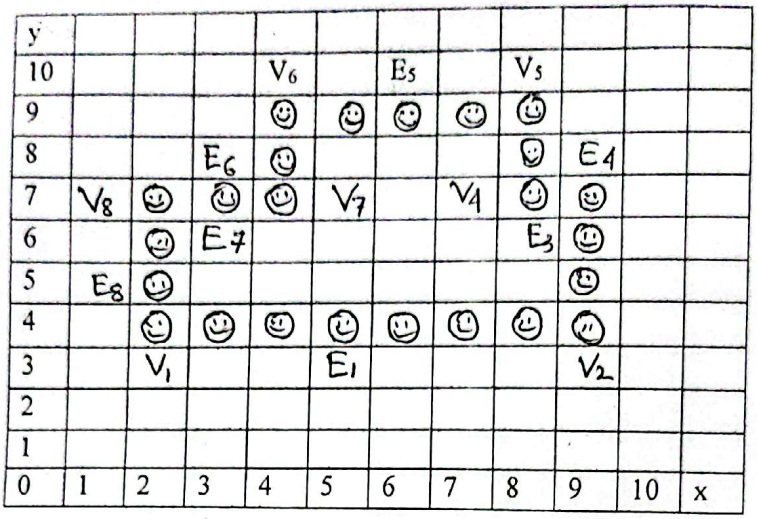
a) Let's assume we've cut out a sub-image from the center of an image. The initial image has an aspect ratio of 4:5 and contains 327,680 pixels. The aspect ratio of the sub-image is inverse of the initial image and the sub-image contains $\frac{1}{4}th$ of the total pixels of the initial one. **5+5**

i) Find the lower-left corner of the sub-image (the upper-left corner of the initial image is the origin).

ii) What is the maximum size of the sub-image that could be cut out from the center, in the same manner, having an inverse aspect ratio of the initial image?

b) i) Indicate which raster locations would be chosen by Bresenham's algorithm when scanning converting a line from pixel coordinate from (4,5) to (11,9). 8+2
ii) Plot the rastered pixels.

c) The coordinates of the vertices of a polygon are shown in the figure 6+4
i) Write the initial edge list for the polygon.
ii) State which edges will be active on scan lines =6,7,8,9 and 10.



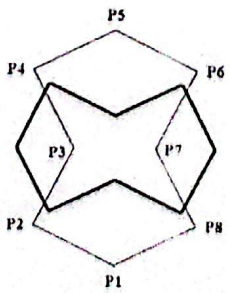

**Group B**
*[Answer all the questions]* 5x2=10

4. **Answer any FIVE**

a) Mirroring against which line reverses the coordinates i.e. $M_L(x, y) = (y, x)$?
b) What is the transformation matrix for translating an object's center from (2,3) to (6,5)?
c) Find the transformation for mirror reflection of a point P(x,y,z) with respect to the xy plane. Use suitable figures.
d) *During line clipping, which would need less computation between Cohen-Sutherland and Midpoint Subdivision in the worst case? Why?*
e) *Is the point (2,3) to the left or to the right of the directed line segment from (-3,0) to (0,-3)?*
f) What is the relationship among the rotations $R_\theta$ $R_{-\theta}$ $R_\theta$?
g) After scaling with respect to any arbitrary point *(x,y,z),* which point isn't transformed to a new position?
h) What is isometric projection?

5. **Answer any FOUR** 4x5=20

a) Which transformation is itself its inverse transformation? Provide mathematical proof. 1+4
b) A rectangle is defined by its vertices in counter-clockwise(CCW) direction: 5
$$V = \{(0,0), (0,4), (4,4), (4,0)\}$$
Find the coordinates, after rotating it by 45° CCW with respect to its center.
c) Find the window to viewport mapped coordinates of a triangle {(4,5),(4,8),(8,5)} where $wx_{min} = 10, wx_{max} = 80, wy_{min} = 20, wy_{max} = 100$ and $vx_{min} = 30, vx_{max} = 60, vy_{min} = 50, vy_{max} = 80$ 5
d) Find the clipped polygon showing the chronological steps using the Weiler-Atherton algorithm. 5



The bolded one is the clipping polygon.

e) Let's say, we performed $\theta_x$ rotation about the $x$-axis and $\theta_y$ rotation about $y$-axis. Does the order matter, i.e. is $R_{\theta_x,I}.R_{\theta_y,J} = R_{\theta_y,J}.R_{\theta_x,I}$ ? Show mathematically. **5**

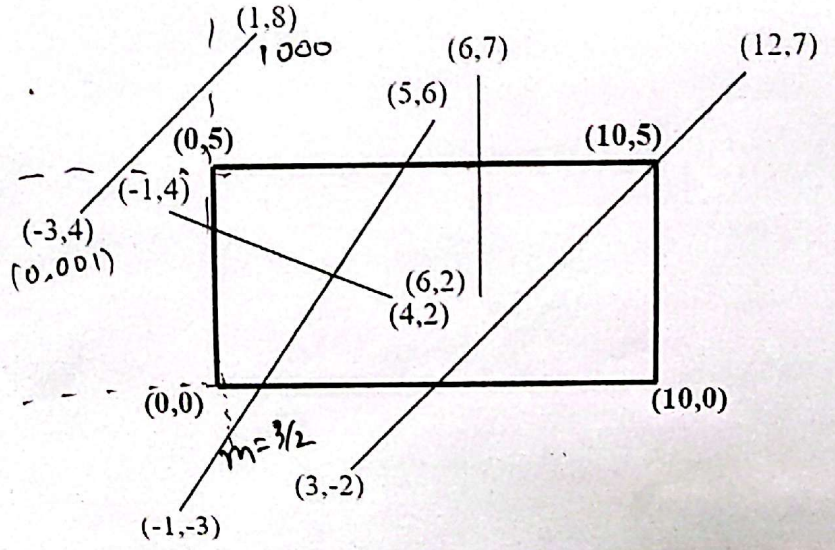
f) Describe 3 perspective projection anomalies. **5**

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

a) The matrix given below defines a transformation called a simultaneous shearing. The special case when b = 0 is called shearing in the $x$-direction. When a = 0, we get 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. **10**

$$\begin{bmatrix} 1 & a \\ b & 1 \end{bmatrix}$$

b) You're given a rectangular window and some line segments to be clipped in the following figure. Apply the Cohen-Sutherland algorithm to clip these line segments using the window. **10**




Draw the final result after you're done.

c) Let's assume, we want to rotate a point, $P(x,y,z)$ with respect to an arbitrary line, $v = aI + bJ + cK$. The passes through a point $Q(p, q, r)$. Write the composite transformation of the rotation along that line showing the necessary details. **10**