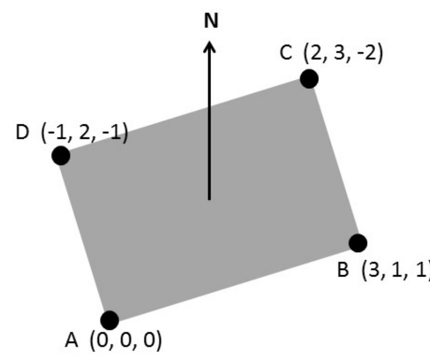
The University of Jordan
King Abdulla II School for Information Technology
Computer Science Department

Computer Graphics – MidTerm Exam – Fall 2014/2015 **Instructor: Dr Jamal Alsakran**

Student Name: **Student ID:**
Section #:

Q1 (3 points, 2 + 1) Given the following polygon composed of the 4 points A, B, C, and D.

(a) Calculate the normal direction **N**



Vector r = B – A = (3, 1, 1)
Vector s = D – A = (-1, 2, -1)

N = r x s = (3, 1, 1) x (-1, 2, -1) = (-3, 2, 7)

$$\begin{bmatrix} i & j & k \\ 3 & 1 & 1 \\ -1 & 2 & -1 \end{bmatrix}$$

(b) Normalize **N**

$$|N| = \sqrt{-3^2 + 2^2 + 7^2} = \sqrt{9 + 4 + 49} = \sqrt{62}$$

$$\hat{N} = (\frac{-3}{\sqrt{62}}, \frac{2}{\sqrt{62}}, \frac{7}{\sqrt{62}})$$

Q2 (12 points, 2 each) Answer each of the following questions

(a) Given a circle center at (0, 0) of radius r = 10, using Midpoint circle algorithm compute P_0:

P_0 = **1 – 10 = -9**

(b) Given the line with endpoints (40, 50) and (20, 0), compute the line slope:

slope = $\frac{\Delta x}{\Delta y} = \frac{0-50}{20-40} = \frac{-50}{-20} = 2.5$

(c) For any given shape centered at ***(cx, cy)***, provide the transformation matrix ***M*** that makes the shape twice as big and stays centered at the same point ***(cx, cy).***

$$M = \begin{bmatrix} 1 & 0 & cx \\ 0 & 1 & cy \\ 0 & 0 & 1 \end{bmatrix} . \begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 1 \end{bmatrix} . \begin{bmatrix} 1 & 0 & -cx \\ 0 & 1 & -cy \\ 0 & 0 & 1 \end{bmatrix}$$

(d) For any given shape, what will happen to the shape when the matrix M = $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ is applied to it?

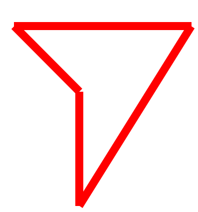
Nothing

(e) Let ***A*** and ***B*** be unit vectors and ***A.B = 0***, what is the angle ***θ*** between **A** and **B**

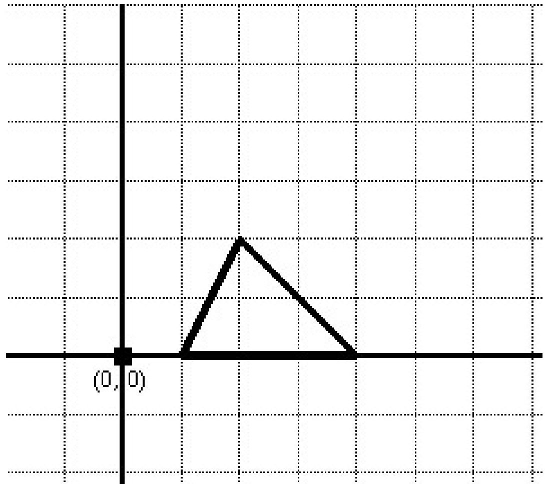
θ = **90**

(f) Draw a concave polygon. What is the smallest number of vertices possible for a concave polygon?

Smallest number of vertices = 4



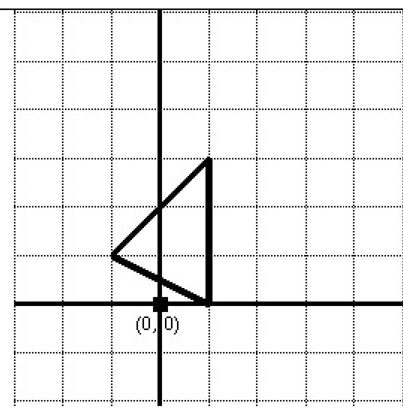
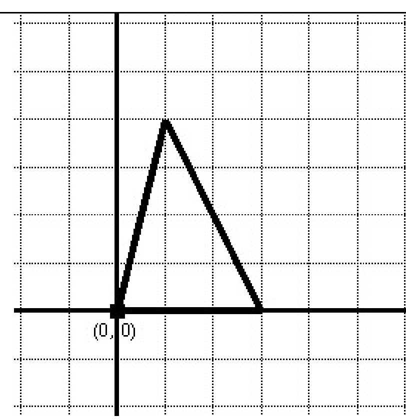
Q3 (10 points, 2 points each) Given the figure below that shows a shape in its initial position

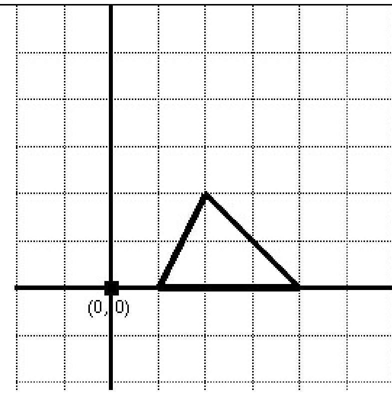


and the transformations:

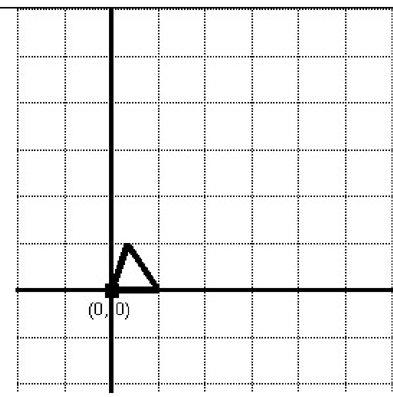
$T(t_x, t_y)$ ➔ Translation matrix
$S(s_x, s_y)$ ➔ Scaling matrix
$R(\theta)$ ➔ Rotation matrix

(a) Draw the shapes that result from applying the following transformations to the initial shape above.

T(1, -1) . R(90)	
S(1, 2) . T(-1, 0)	

T (1, 0) . R(360) . T (-1, 0)	

(b) Write down the matrix M (in symbolic form) to perform the transformation required to generate the figures below.

S (1/3, 1/2).T (-1, 0)	
T (2, 2) . S (2, 2). R(180).T (-1, 0) Or T (4, 2) . S (2, 2). R(180) Or R(180) . S (2, 2). T (-2, -1) Or …