Cairo University

Faculty of Computers and Information

Final Exam

Department:
Course Name: Computer Graphics
Course Code: IT331
Instructor(s): Prof. Reda El-Khoribi

Date: 26-5-2019
Duration: 2 hours
Total Marks: 60

تعليمات هامة

- حيازة التيلفون المحمول مفتوحا داخل لجنة الأمتحان يعتبر حالة غش تستوجب العقاب وإذا كان ضرورى الدخول بالمحمول فيوضع مغلق فى الحقائب.
- لا يسمح بدخول سماعة الأذن أو البلوتوث.
- لايسمح بدخول أي كتب أو ملازم أو أوراق داخل اللجنة والمخالفة تعتبر حالة غش.

Question 1

[a] Derive the Bresenham's midpoint algorithm for drawing lines with slopes greater than one. Write the algorithm.

[b] Trace the mid-point line drawing algorithm for drawing the line with end points **(8, 9)**, **(12, 19)**. Summarize your traces in a table like the following:

Initial decision: $d_{initial} =$ -2		
Change in decision when d<0: $d_1 =$ -12		
Change in decision when d>0: $d_2 =$ 8		
Traces		
X	**Y**	**Decision variables**

[c] Derive an efficient mid-point-based algorithm to draw the curve segment:

$$y = 600 - 0.01(x - 200)^2, x \in [0,400]$$

Question 2

[a] Describe the Sutherland-Hdgeman algorithm of polygon clipping.

[b] Derive an algorithm to compute the intersection between a line segment and the ellipse:

$$.\frac{(x-x_c)^2}{a^2} + \frac{(y-y_c)^2}{b^2} = 1$$

[c] Trace the Cohen-Sutherland algorithm while clipping the line with end points $(80, 0)$ and $(30, 50)$ against a rectangular window with: (XLEFT=10, XRIGHT=40, YBOTOM=20, YTOP=40) if the algorithm tests window edges in the following sequence: LEFT, BOTTOM, TOP, RIGHT

Question 3

Write a homogeneous transformation matrix (or product of matrices) to:

- Rotate an object about the x axis with a rotation angle of 30° clockwise.
- Scale 3D object with respect to a fixed point (3, 2, 8) where the scaling factors in x, y and z directions are $2, 0.5$ and 3 respectively.

X=x+tx = 50=22+28

Y=y+ty = 29=29+0

Z=z+tz =

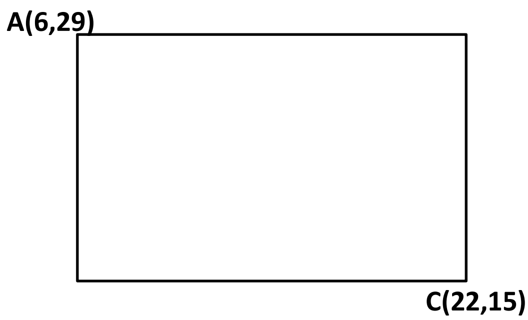

Figure 1

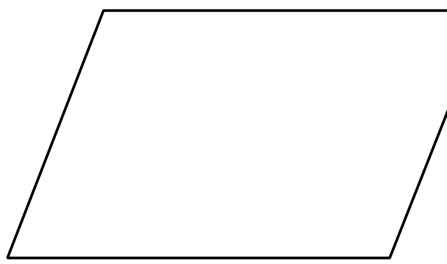

Figure 2

- Transform Figure 1 into Figure 2 as shown below.
- Map the sphere $(x-30)^2 + (y-40)^2 + (z-25)^2 = 625$ to the ellipsoid:

$$\frac{(x-25)^2}{25} + \frac{(y-40)^2}{49} + \frac{(z-15)^2}{100} = 1$$

- Find the orthogonal projection of an object the plane passing through the points (2, -3, 1), (2, 0, 1) and (0, 1, 0)

Question 4

[a] Assume you are working with three coordinate systems: object, world, and camera space. The basis vectors of object space have world coordinates (1, 0, 0), (0, 0, −1), and (0, 1, 0). The origin of object space has world coordinates (0, 0, 10). The basis vectors of camera space have world coordinates $\left(\frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}\right)$, $\left(\frac{-1}{\sqrt{2}}, 0, \frac{1}{\sqrt{2}}\right)$ and $\left(\frac{1}{\sqrt{6}}, \frac{-2}{\sqrt{6}}, \frac{1}{\sqrt{6}}\right)$. The origin of camera space has world coordinates (5, 9, −4).

Write the 4 × 4 matrices that transform object to world coordinates, camera to world coordinates, world to camera coordinates, and object to camera coordinates.

What are the camera coordinates of the origin of object space?

[b] Given the following camera view parameters:

COP = (-1, -1, 1)   VPN = (2, 1, -1)   VUP= (1, 1, 1)

The clipping volume parameters are:

LEFT=-10, RIGHT=10, BOTTOM=-5, TOP=10, NEAR=5, FAR=20:

i. Compute the camera view matrix.

ii. Compute the coordinates of the world point (15, 4, 18) relative to the camera

Determine whether the world point (5, 4, 8) will be clipped out in cases when the used camera is: (i) Parallel camera (ii) Perspective camera

Best Wishes

Reda El-Khoribi