Faculty of Computers and Artificial Intelligence
Final Exam

Department: IT and CS
Course Name: Computer Graphics
Course Code: IT361
Instructor(s): Prof. Reda El-Khoribi

Date: 13/6/2022
Duration: 2 hours
Total Marks: 60

تعليمات هامة

- حيازة الهاتف المحمول مفتوحا داخل لجنة الامتحان يعد حالة غش. وإذا كان ضروريا الدخول به فيوضع مغلقا في الحقائب.
- لا يسمح بدخول سماعة الأذن أو البلوتوث.
- لا يسمح بدخول أي كتب أو ملازم أو أوراق داخل اللجنة والمخالفة تعتبر حالة غش.

Question 1

a) For a circle with radius R and centered about the origin, if its 1st octant is to be sampled starting from the topmost pixel (R, 0):

b) Write the midpoint test expression used to see if the midpoint is in or out of the circle boundary in the Bresenham's algorithm. Write the algorithm that uses the second order difference of the mid-point test function to sample the circle using only integer operations.

c) Trace the mid-point line drawing algorithm for drawing the line with end points **(1, 7), (9, 12)**. Summarize your traces in a table like the following:

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

Question 2

a) For a parabola with axis parallel to the y-axis and defined by the following equation: $y = a + b(x - c)^2$

i) Write an algorithm to draw the parabola with a given start and end x-coordinates and the parameters a,b,c. Be sure that curve is 8-connected.
void DrawParabola(x1, x2, a, b, c).

ii) Derive an iterative algorithm to reduce the time complexity of drawing the parabola

b) Write an algorithm to fill-in the area of intersection between the two circles (X_{c1}, Y_{c1}, R_1) and (X_{c2}, Y_{c2}, R_2)

c) Trace the Cohen-Sutherland algorithm while clipping the line with end points $(80, 600)$ and $(250, 50)$ against a rectangular window with: (XLEFT=100, XRIGHT=400, YBOTOM=200, YTOP=500) if the algorithm tests window edges in the following sequence: LEFT, BOTTOM, TOP, RIGHT

Question 3

a) Write a homogeneous transformation matrix to:

- Rotate a 2D object about the origin axis with a rotation angle of 45° clockwise.
- Shear a 2D object in the direction (0.6, 0.8) with a shearing factor of 3
- Scale 3D object with respect to a fixed point (30, 50, 40) where the scaling factors in x, y and z directions are 0.4, 0.5 *and* 0.2 respectively.
- Rotate an object about the line from the origin to the point (2, 2, 1) with an angle 45° anti-clockwise.
- Find the orthogonal projection of an object on the plane passing through the point (2, 3, 1) and its normal is in the direction (0.8, 0, 0.6)

b) Derive an algorithm to get the camera position and orientation from the camera view matrix.

c) Write a hidden surface removal algorithm

d) A triangular front face with vertices (3, 7, 2), (6,5,3), (4,2,7) ordered in the anti-clockwise direction with respect to a viewer looking at this face. Use the hidden surface removal algorithm to determine whether the face is visible with respect to a viewer standing at position (5,2,1)

Question 4

a) Show how the frustum projection matrix is computed from the clipping volume parameters (LEFT, RIGHT, BOTTOM, TOP, NEAR, and FAR)

b) Given the following camera view, clipping volume, and viewport parameters:

Camera view parameters	COP = (-1, 0, 1) TP = (1, 2, 2) VUP= (1, 1, 0)
Frustum projection parameters	LEFT=-10, RIGHT=10, BOTTOM=-5, TOP=10, NEAR=5, FAR=10
Viewport mapping parameters	LEFT= 0, TOP=0, WIDTH=600, HEIGHT=400

i. Compute the camera view matrix.
ii. Compute the frustum projection matrix
iii. Compute the viewport mapping matrix
iv. Compute the coordinates of the world point (2, 2, 3) relative to the camera.

Show whether he point (2, 2, 3) will appear on the screen or not and find its screen coordinates if it should appear.

Best wishes