EASTERN UNIVERSITY, SRI LANKA

DEPARTMENT OF MATHEMATICS

THIRD EXAMINATION IN SCIENCE - 2015/2016

FIRST SEMESTER (May/June, 2018)

CS 301 - COMPUTER GRAPHICS

Answer all questions **Time Allowed: Two hours**

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1. (a) Define in your own words what a *computer graphics* is. [10%]

   (b) Briefly describe three applications of computer graphics. [15%]

   (c) Consider the *Midpoint circle* algorithm:

      i. Derive the necessary equations to generate *Midpoint circle* algorithm. [15%]

      ii. Write the *Midpoint circle* algorithm. [15%]

      iii. Apply the algorithm to obtain all the pixel co-ordinates to draw the first quarter of the circle of radius, $r = 6$ with center $(3, 2)$. [15%]

   (d) Describe how the *Midpoint ellipse* algorithm can be used to generate an ellipse. [30%]

2. (a) Give the corresponding matrices (in homogeneous system) for each of the following two dimensional transformations in computer graphics.

      i. Translation with distances dx and dy for the x and y co-ordinates, respectively. [08%]

      ii. Clock-wise rotation about the origin with the angle α; [08%]

      iii. Scaling about origin. [08%]

      iv. Reflection about Y axis. [08%]

(b) The following Figure (a) depicts a 2-*dimensional* transformation applied to a unit shape having sides AB, BC, CD and DA. With A at $(0, 2\sqrt{3})$, B at $(-3, -\sqrt{3})$, C at $(0, 0)$ and D at $(3, -\sqrt{3})$. The composite transformation can be described as a combination of basic transformations.

i. Find the values of a and b. [08%]

ii. Derive corresponding transformation matrices to build the fish shape in Figure (b). (Draw the shape in every step.) [25%]

iii. Find out the coordinates of every vertex in Figure (b). [15%]

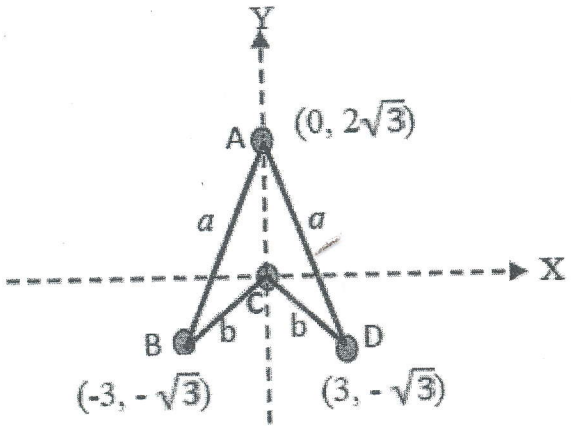

Figure (a)

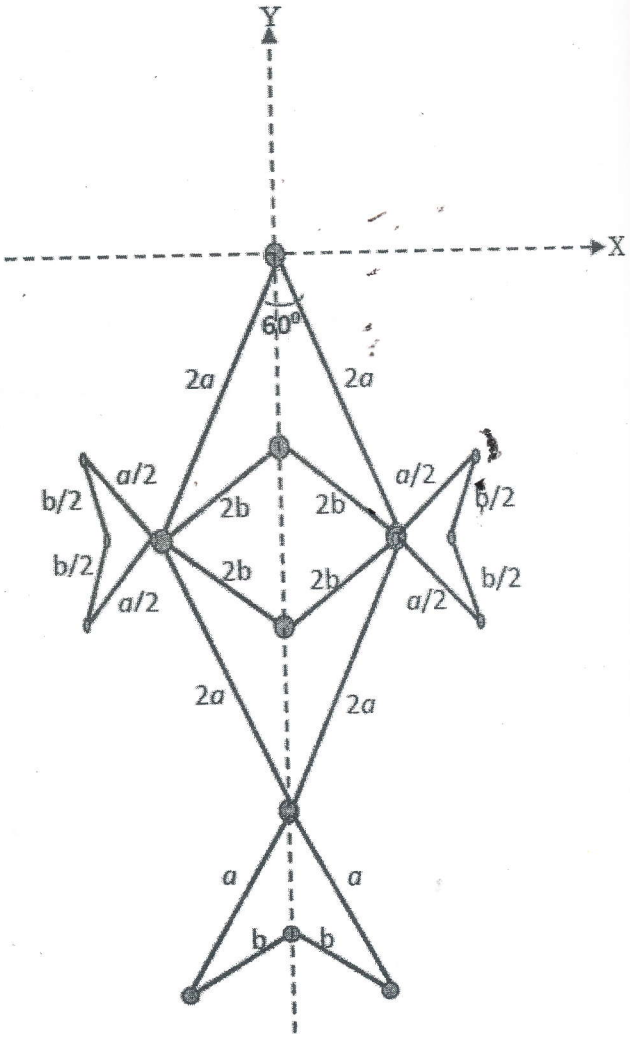

Figure (b)

iv. Clearly explain, How to draw the following Figure(c) using the previous question. [20%]

(You should write corresponding matrices)

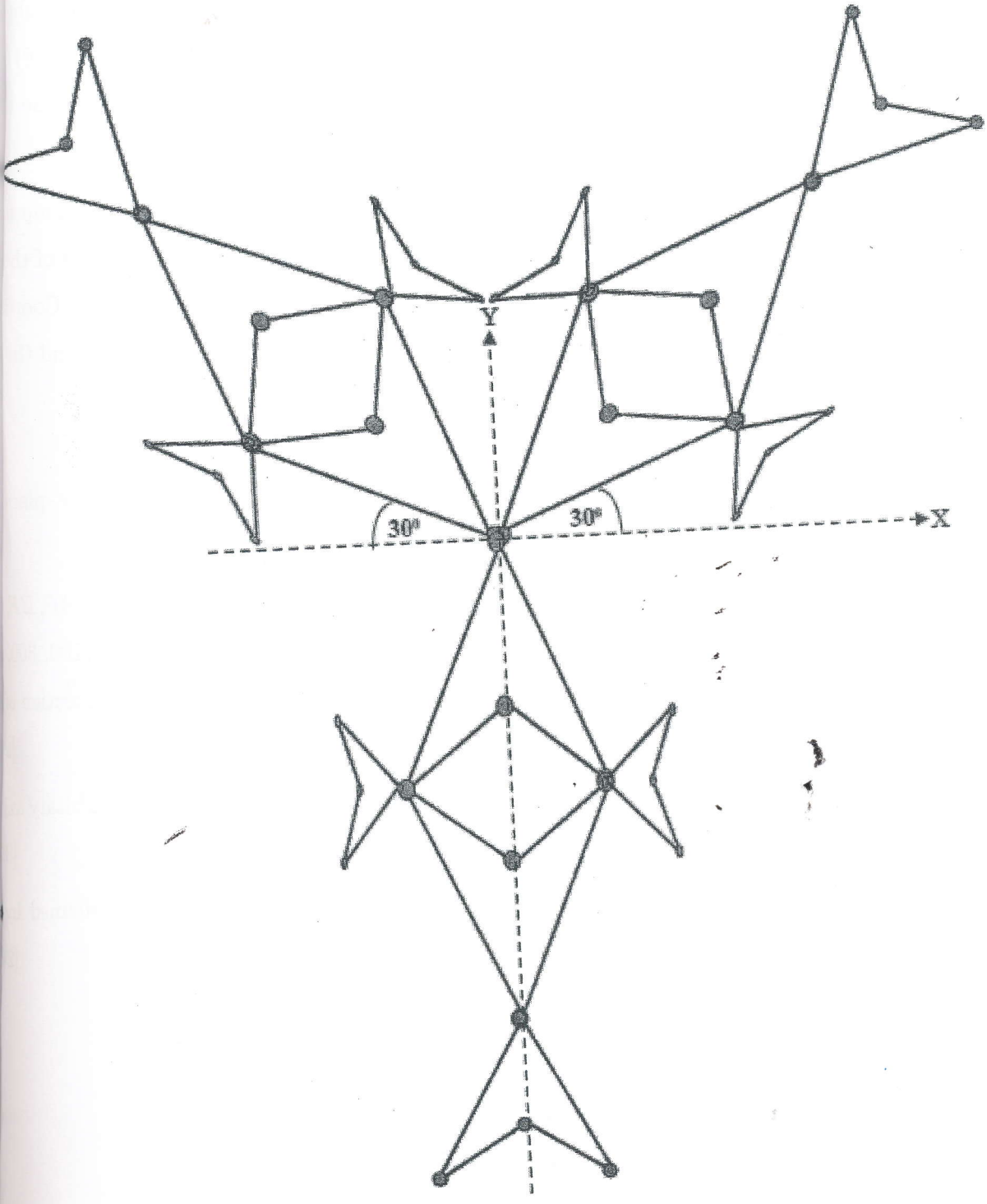

Figure (c)

3. (a) Define the terms *Viewport* and *Clipping* in relation to computer graphics.

(b) Write down the *Liang-Barsky Line clipping* method.

(c) Let W be a window whose bottom-left corner is $(100, 100)$ and the top right co is $(200, 200)$ and IJ be a straight line with $I = (50, 50)$ and $J = (150, 250)$. A the above algorithm to clip IJ against W, and count in how many steps the clip completes.

(d) Explain clearly how you would use the *Sutherland-Hodgeman polygon clipping* meth to clip the polygon $ABCDE$ against the window $PQRS$. The coordinates of the po gon are $A(80, 200)$, $B(220, 120)$, $C(150, 100)$, $D(100, 30)$, and $E(10, 120)$. Coordina of the window are $P(200, 50)$, $Q(50, 150)$, $R(200, 150)$, and $S(50, 50)$. Find the coo dinates of all vertices of the clipped polygon.

4. (a) Describe briefly the orthographic parallel projection of an object on to XY-plane. Derive the corresponding projection matrix.

(b) Consider the object formed by lines $AB, BC, CD, DA, AE, BE, CE, DE, AF, BF$ and DF; where $A(0, 0, 0)$, $B(200, 0, 0)$, $C(200, 0, 100)$, $D(0, 0, 100)$, $E(100, 300$ $F(100, 200, 50)$. Apply your matrix to find the orthographic parallel projection o object on XY-plane, and draw the projection.

(c) Explain clearly how you would rotate a 3-*dimensional* object about an arbitary axi space and derive the rotation matrix.

(d) Find the new coordinates of a unit cube 90° rotated about an axis defined by endpoints $P(2, 1, 0)$ and $Q(3, 3, 1)$.