EASTERN UNIVERSITY, SRI LANKA

DEPARTMENT OF MATHEMATICS

THIRD EXAMINATION IN SCIENCE - 2016/2017

FIRST SEMESTER (Mar./Apr., 2019)

CS 301 - COMPUTER GRAPHICS

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

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

   (b) Differentiate *Raster scan display* and *Random scan display*. [20%]

   (c) Explain the term *scan conversion* in relation to computer graphics. [20%]

   (d) Consider the *Bresenham circle* drawing algorithm:

      i. Derive the necessary equations involved to generate a *Bresenham circle*. [20%]

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

      iii. Apply the algorithm to obtain all the pixel co-ordinates to draw the first quarter of the circle of radius $r = 8$ with center at $(4, 3)$. [15%]

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

      i. Translation with distances tx and ty for the x and y co-ordinates, respectively. [10%]

      ii. Clock-wise rotation about the origin with an angle α. [10%]

      iii. Reflection about X axis. [10%]

      iv. Reflection about Y axis. [10%]

(b) i. Show that the following matrix for reflection about a line with slope s and y inte
$(0, c)$

$$M_L = \frac{1}{s^2+1}\begin{bmatrix} 1-s^2 & 2s & -2cs \\ 2s & s^2-1 & 2c \\ 0 & 0 & s^2+1 \end{bmatrix}$$

ii. Reflect a diamond-shaped polygon whose vertices are A(-1,0), B(0,-2), C(1,0)
D(0,2) about:

α. The horizontal line y = 2,

β. The vertical line x = 2, and

γ. The line y = x + 2.

3. (a) Define the terms *window* and *viewport* 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 $(-3, 1)$ and the top right corner is
and IJ be a straight line with I = (-4, 2) and J = (-1, 7). Apply the above algo
to clip IJ against W.

(d) Explain clearly how you would use the *Sutherland-Hodgeman polygon clipping* meth
clip the polygon $ABCDE$ against the window $PQRS$. The coordinates of the po
are $A(80, 200)$, $B(220, 120)$, $C(150, 100)$, $D(100, 30)$, and $E(10, 120)$. Coordina
the window are $P(200, 50)$, $Q(200, 150)$, $R(50, 150)$, and $S(50, 50)$. Find the coordi
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 of the object on XY-plane, and draw the projection. [25%]

(c) Give the corresponding matrices (in homogeneous system) for each of the following three dimensional transformations in computer graphics.

i. Translation with distances dx, dy, and dz for the x, y, and z co-ordinates, respectively. [10%]

ii. Counter clock-wise rotation about x axis with the angle α. [10%]

iii. Counter clock-wise rotation about y axis with the angle β. [10%]

(d) Transform the given homogeneous co-ordinate point $P[3, 2, 1]$ by the following sequence of operations:

i. Translate by (-1, -1, -1) for the x, y, and z co-ordinates, respectively. [10%]

ii. Rotate by $+30°$ about x-axis and $+45°$ about y axis. [10%]

iii. Find the final position of P after the operations (i) and (ii). [10%]