CSE

Computer Graphics
Fall 2016 Midterm

UTA

NAME:

Prob #	1	2	3	4	5	6
Points	12	16	24	18	12	18

Time: 80 Minutes

NOTES:

a. **Credit is only given to the correct numerical values.**
b. **All numerical values must be calculated with three digits of accuracy after the decimal point.**
c. **Do not write on the back side of the papers.**

1. Points **A(-1,12)** and **B(60,6)** are given in a two dimensional world coordinate system. Find the coordinates of the points A and B on the screen after they have been mapped from window to viewport.

   $x_{wmin} = -40$ $y_{wmin} = 5$ $x_{wmax} = 360$ $y_{wmax} = 15$

   Normalized device coordinate of the viewport:

   $x_{vmin} = 0.25$ $y_{vmin} = 0.1$ $x_{vmax} = 0.5$ $y_{vmax} = 0.6$

   The origin of the screen coordinate system is defined in the **upper left** corner of the screen and the screen resolution is 800 by 600.
   Use **truncation** to convert from float to integer.

Screen coordinates of point A after mapping are:
Screen coordinates of point B after mapping are:

2. Equations of plane *P* and line L are given as:

   Plane P: $\mathbf{5x + 6y + 7z - 11 = 0}$

   Line L : $\begin{cases} \boldsymbol{x(t) = 2} \\ \boldsymbol{y(t) = -3\mathrm{t}} \\ \boldsymbol{z(t) = 4t + 3} \end{cases}$

   a. Find the point of intersection of line L with plane P.

      Intersection point of line L and plane p is: ________________________________

   b. Find the equation of plane P after it has been translated by

      $\boldsymbol{dx = 6}$, $\boldsymbol{dy = 9}$, $\boldsymbol{dz = -2}$

Equation of plane P after translation is:

__________ x + __________ y + __________ z + ___________ =0

3. The viewing parameters for a perspective projection are given as

VRP(WC)=(2,6,3) VPN(WC)=(6,0,0)
VUP(WC)=(0,3,4) PRP (VRC)=(3,6,-10)
u_{min} (VRC) = 1 u_{max} (VRC) = 11
v_{min} (VRC) = -1 v_{max} (VRC) = 3
n_{min} (VRC) = 10 n_{max} (VRC) = 40

a. Find the sequence of transformations which will transform this viewing volume into a standard perspective view volume which is bounded by the planes: x=z ; x=-z ; y=z ; y=-z ; z=1 (Complete the blank matrices)
b. Find the zmin after all transformations are done.

Matrix #2: Rx

1	0	0	0
0	1	0	0
0	0	1	0
0	0	0	1

Matrix #1: Translate

1	0	0	-2
0	1	0	-6
0	0	1	-3
0	0	0	1

Matrix #4: Rz

Matrix #3: Ry

Matrix #6 Shear

Matrix #5: Translate

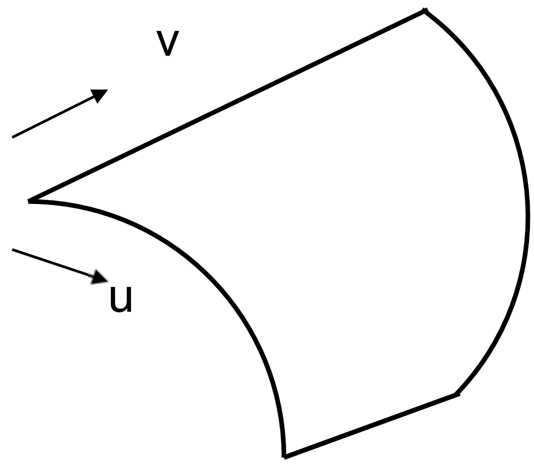
1	0	0	-3
0	1	0	-6
0	0	1	10
0	0	0	1

Matrix #8 Scale

Matrix #7 Scale

Zmin=

4. A curved surface is quadric in the u direction and linear in the v direction



The parametric equation of the curve corresponding to v=0 is given as:

$$C(u) = 9u^2 + 4u - 2$$

The parametric equation of the curve corresponding to v=1 is given as:

$$C(u) = -7u^2 + 8u + 12$$

Find the coefficient matrix C for this surface.

5. Equation of a cubic curve is given as:

   $$\mathbf{C(t) = 6t^3 + 9t^2 - 12\,t + 8}$$

   Find the numerical values of the Bezier geometry vector for this curve.

6. Given the equation of a parametric surface

$$x(u,v) = 40u^2v + 20uv + 9$$

$$y(u,v) = 8u^2 - 10uv + 11$$

$$z(u,v) = 20u^2v - 10u^2 + 6$$

Find the normal to this surface at u=0.5 and v=0.2

Hint: Find the tangect vectors in u and v directions and then find the cross product of these two vectors.

Tangent vector in the u direction at point u=0.5 and v=0.2 is: ________________

Tangent vector in the v direction at point u=0.5 and v=0.2 is: ________________

Normal vector at point u=0.5 and v=0.2 is: ________________

$$R_z(\theta) = \begin{bmatrix} \cos\theta & -\sin\theta & 0 & 0 \\ \sin\theta & \cos\theta & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad R_y(\theta) = \begin{bmatrix} \cos\theta & 0 & \sin\theta & 0 \\ 0 & 1 & 0 & 0 \\ -\sin\theta & 0 & \cos\theta & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad R_x(\theta) = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos\theta & -\sin\theta & 0 \\ 0 & \sin\theta & \cos\theta & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$M_{Hermite} = \begin{bmatrix} 2 & -3 & 0 & 1 \\ -2 & 3 & 0 & 0 \\ 1 & -2 & 1 & 0 \\ 1 & -1 & 0 & 0 \end{bmatrix} \quad M_{Bezier} = \begin{bmatrix} -1 & 3 & -3 & 1 \\ 3 & -6 & 3 & 0 \\ -3 & 3 & 0 & 0 \\ 1 & 0 & 0 & 0 \end{bmatrix}$$

Rotate a vector around x axis until it lies in the xz plane

$$V = \begin{bmatrix} a \\ b \\ c \\ 1 \end{bmatrix} \qquad R_x = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \frac{c}{\sqrt{b^2+c^2}} & \frac{-b}{\sqrt{b^2+c^2}} & 0 \\ 0 & \frac{b}{\sqrt{b^2+c^2}} & \frac{c}{\sqrt{b^2+c^2}} & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Rotate a vector around y axis until it lies in the yz plane

$$V = \begin{bmatrix} a \\ b \\ c \\ 1 \end{bmatrix} \qquad R_y = \begin{bmatrix} \frac{c}{\sqrt{a^2+c^2}} & 0 & \frac{-a}{\sqrt{a^2+c^2}} & 0 \\ 0 & 1 & 0 & 0 \\ \frac{a}{\sqrt{a^2+c^2}} & 0 & \frac{c}{\sqrt{a^2+c^2}} & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Rotate a vector around z axis until it lies in the yz plane

$$V = \begin{bmatrix} a \\ b \\ c \\ 1 \end{bmatrix} \qquad R_z = \begin{bmatrix} \frac{b}{\sqrt{a^2+b^2}} & \frac{-a}{\sqrt{a^2+b^2}} & 0 & 0 \\ \frac{a}{\sqrt{a^2+b^2}} & \frac{b}{\sqrt{a^2+b^2}} & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

How to convert a general perspective view volume into canonical perspective volume

Step 1: Translate VRP to origin
Step 2: Rotate VPN around x until it lies in the xz plane with positive z
Step 3: Rotate VPN around y until it aligns with the positive z axis.
Step 4: Rotate VUP around z until it lies in the yz plane with positive y
Step 5: Translate PRP (COP) to the origin
Step 6: Shear such that the center line of the view volume becomes the z axis
Step 7: Scale such that the sides of the view volume become 45 degrees
Step 8: Scale such that the view volume becomes the canonical perspective volume