# 1 Fixed Functions in Graphic Pipeline

## 1.1 Rasterization

Addition Fomulars:

$$\cos(x+y) = \cos x \cos y - \sin x \sin y$$
$$\sin(x+y) = \sin x \cos y + \cos x \sin y$$

2D rotate matrix:

$$\begin{bmatrix} \cos\alpha & -\sin\alpha \\ \sin\alpha & \cos\alpha \end{bmatrix}$$

2D matrix to rotate a vector 90 degress counter-clockwise:

$$\begin{bmatrix} 0 & 0 \\ -1 & 0 \end{bmatrix}$$

To judge vector v1 is pointing to the right side of vector v0:

$$\left(\begin{bmatrix} 0 & 0 \\ -1 & 0 \end{bmatrix}\overrightarrow{v_0}\right) \cdot \overrightarrow{v_1} > 0$$

In OpenGL, default visiable triangles are counter-clockwise, thus left side of three edges form the triangle aera.

## 1.2 Coordinate System Transform

Describe (u,v,w) space axis in (x,y,z) space:

$$\begin{bmatrix} \overrightarrow{u} & \overrightarrow{v} & \overrightarrow{w} \end{bmatrix} = \begin{bmatrix} \overrightarrow{x} & \overrightarrow{y} & \overrightarrow{z} \end{bmatrix} \times \begin{bmatrix} x_u & x_v & x_w \\ y_u & y_v & y_w \\ z_u & z_v & z_w \end{bmatrix} = \begin{bmatrix} \overrightarrow{x} & \overrightarrow{y} & \overrightarrow{z} \end{bmatrix} \times \mathbf{P}$$

# 2 Linear Algebra

## 2.1 Cross Product

Cross product definition differs in right-hand coordinate system and left-hand coordinate system ensuring that:

$$\overrightarrow{x} \times \overrightarrow{y} = \overrightarrow{z}$$
$$\overrightarrow{y} \times \overrightarrow{z} = \overrightarrow{x}$$
$$\overrightarrow{z} \times \overrightarrow{x} = \overrightarrow{y}$$

From this, it can be inferred that:

$$\begin{bmatrix} a_1 \\ a_2 \\ a_3 \end{bmatrix} \times \begin{bmatrix} b_1 \\ b_2 \\ b_3 \end{bmatrix} = \left(a_1\overrightarrow{x} + a_2\overrightarrow{y} + a_3\overrightarrow{z}\right) \times \left(a_1\overrightarrow{x} + a_2\overrightarrow{y} + a_3\overrightarrow{z}\right) = \begin{vmatrix} \overrightarrow{x} & \overrightarrow{y} & \overrightarrow{z} \\ a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \end{vmatrix}$$