

## Answers to EE5808 Assignment 2

**Qn 1**

$$5 \quad a) \quad M_{2 \leftarrow 3} = T(0, 20, 0)R_z(45^\circ) \stackrel{2}{=} \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 20 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} \cos 45^\circ & -\sin 45^\circ & 0 & 0 \\ \sin 45^\circ & \cos 45^\circ & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \stackrel{3}{=} \begin{pmatrix} \sqrt{2}/2 & -\sqrt{2}/2 & 0 & 0 \\ \sqrt{2}/2 & \sqrt{2}/2 & 0 & 20 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$$5 \quad b) \quad M_{1 \leftarrow 2} = T(-4, 20, 0)R_z(45^\circ)S(0.5, 0.5, 1.0) \stackrel{2}{=}$$

$$\begin{pmatrix} 0.5\cos 45^\circ & -0.5\sin 45^\circ & 0 & -4 \\ 0.5\sin 45^\circ & 0.5\cos 45^\circ & 0 & 20 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \stackrel{3}{=} \begin{pmatrix} \sqrt{2}/4 & -\sqrt{2}/4 & 0 & -4 \\ \sqrt{2}/4 & \sqrt{2}/4 & 0 & 20 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

10 c)

glTranslatef(2, 0, 0);

Part(); // Part 1

{ glTranslatef(-4, 20, 0); //  $M_{1 \leftarrow 2}$   
 glRotatef(45, 0, 0, 1);  
 glScalef(0.5, 0.5, 1.0);

2' each.

Part(); // Part 2

{ glTranslatef(0, 20, 0);  
 glRotatef(45, 0, 0, 1); //  $M_{2 \leftarrow 3}$

glRotatef(45, 0, 1, 0);

Part(); // Part 3

10 d) refer to the underlined added code

5/5

Qn 2

15 a)

$$\begin{aligned} VRP &= (0, 100, -100) \\ VPN &= (0, 100, -100) \\ VUP &= (1, 0, 0); \end{aligned}$$

or

$$Z_{VC} = (0, \frac{1}{\sqrt{2}}, -\frac{1}{\sqrt{2}})$$

3'

$$VUP \times VPN = \begin{vmatrix} i & j & k \\ 1 & 0 & 0 \\ 0 & 100 & -100 \end{vmatrix} = (0, 100, 100) \quad X_{VC} = (0, \frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}})$$

or  
5'

$$Y_{VC} = Z_{VC} \times X_{VC} = \begin{vmatrix} i & j & k \\ 0 & 1/\sqrt{2} & -1/\sqrt{2} \\ 0 & 1/\sqrt{2} & 1/\sqrt{2} \end{vmatrix} = (1, 0, 0)$$

2'

$$M_{VC \leftarrow WC}^{-1} = \begin{pmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & \frac{1}{\sqrt{2}} & 100 \\ 0 & -\frac{1}{\sqrt{2}} & 0 & -100 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

4'

$$M_{VC \leftarrow WC} = \begin{pmatrix} X_{VC} & -VRP \cdot X_{VC} \\ Y_{VC} & -VRP \cdot Y_{VC} \\ Z_{VC} & -VRP \cdot Z_{VC} \\ 0 & 1 \end{pmatrix} = \begin{pmatrix} 0 & 1/\sqrt{2} & 1/\sqrt{2} & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 1/\sqrt{2} & -1/\sqrt{2} & -200/\sqrt{2} \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

|

10 b)

$$1 = \frac{V_{pz}}{\sqrt{V_{px}^2 + V_{py}^2}}$$

$$(V_{px}, V_{py}) = (1, 1)$$

$$V_{pz} = \sqrt{2} \quad Z^t$$

$$Z_{vp} = -20$$

$$M_{parallel} = \begin{pmatrix} 1 & 0 & -\frac{V_{px}}{V_{pz}} & z_{vp} \frac{V_{px}}{V_{pz}} \\ 0 & 1 & -\frac{V_{py}}{V_{pz}} & z_{vp} \frac{V_{py}}{V_{pz}} \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} = \begin{pmatrix} 1 & 0 & -1/\sqrt{2} & -20/\sqrt{2} \\ 0 & 1 & -1/\sqrt{2} & -20/\sqrt{2} \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \quad 8'$$

c)

5 i)

Use method 2, P1 is the coordinate system.

The transformation is

$$T(30,0,-100)R_y(60^\circ) = \begin{pmatrix} 1/2 & 0 & \sqrt{3}/2 & 30 \\ 0 & 1 & 0 & 0 \\ -\sqrt{3}/2 & 0 & 1/2 & -100 \\ 0 & 0 & 0 & 1 \end{pmatrix} \quad 3'$$

10 ii)

```
void draw_part2(void)
{
    glPushMatrix();
    glTranslatef(30, 0, -100);
    glRotatef(60, 0, 1, 0);

    glRotatef(15, 1, 0, 0); (5')
    Part_2();
}
```

```
    glPopMatrix();
}

void object(void)
{
    glTranslatef(100, 0, 100); (5')
}
```

$$\begin{pmatrix} 1 & 0 & -\frac{\sqrt{2}}{2} & -10\sqrt{2} \\ 0 & 1 & -\frac{\sqrt{2}}{2} & -10\sqrt{2} \\ 0 & 0 & 0 & -20 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

ii) Part 1 2'  
Part 2 4'  
Part 3 4'

```

Part_1 ();
draw_part2 ();
glScalef (-1, 1, 1);
draw_part2 ();
}

```

10 iii)

The underlined code

tans	2
ROT	4
ROT	4

Qn 3

5 a) Parallel projection: all the projection rays are parallel

Perspective projection: all the projection rays pass through the projection reference point (or point of projection)

5 b)  $\alpha$  is the angle the projection rays make with the view plane/projection plane

Cavalier projection:  $\alpha = \tan^{-1} 1$

2

Cabinet projection:  $\alpha = \tan^{-1} 2$

2

5 c)  $Z = -5$ .

3

The equation is expressed in camera coordinates (or viewer coordinates)

2

5 d) `gluLookAt (200, 0, 100, 0, 100, 0, 0, 0, 1);`