Answers to Assignment 3

Qn 1

```
GLdouble  XC;

glMatrixMode (GL_MODELVIEW);
glLookAt (XC, 0, 100, 20, 0, 20, 0, 1, 0);


void animate ( void )
{
    double       t;
    double operation_time  = 2000.0;

    t = glutGet (GLUT_ELAPSED_TIME);

    XC = 100.0 + 100.0 * (1 - pow(cos ( PI * t/(2.0 * operation_time) ), exponent) );

    glutPostRedisplay ();
}
```

Qn 2

a)

```
glEnable (GL_LIGHTING);
GLdouble V1 [ ] = {0.0, 1.0, 0.0, 0.0}
GLdouble V2 [ ] = {0.5, 0.5, 0.5, 1.0}
glLightfv (GL_LIGHT1, GL_POSITION, V1);
glEnable (GL_LIGHT1);
glLightfv (GL_LIGHT1, GL_AMBIENT, V2);
glLightfv (GL_LIGHT1, GL_DIFFUSE, V2);
glLightfv (GL_LIGHT1, GL_SPECULAR, V2);
```

b)

```
GLdouble V3 [ ] = {0.1, 0.1, 0.1, 1.0}
GLdouble V4 [ ] = {0.3, 0.3, 0.3, 1.0}
GLdouble V5 [ ] = {0.9, 0.9, 0.9, 1.0}
glMaterialfv (GL_FRONT_AND_BACK, GL_AMBIENT, V3);
glMaterialfv (GL_FRONT_AND_BACK, GL_DIFFUSE, V4);
glMaterialfv (GL_FRONT_AND_BACK, GL_SPECULAR, V5);
glMaterialf  (GL_FRONT_AND_BACK, GL_SHININESS, 2.0);
```

c)

$L = (0, 1, 0)$
$I_a = 0.5$
$I_l = 0.5$
$k_a = 0.1$
$k_d = 0.3$
$k_s = 0.9 \quad n_s = 2$

$V = |(100,0,100) - (0,0,0)| = \left(\dfrac{1}{\sqrt{2}}, 0, \dfrac{1}{\sqrt{2}}\right)$

$N = \left(\dfrac{1}{\sqrt{2}}, \dfrac{1}{\sqrt{2}}, 0\right)$

$R = 2(N \cdot L)N - L = (1,0,0)$

$I = k_a I_a + k_d I_l (N \cdot L) + k_s I_l (V \cdot R)^{n_s}$

$= (0.1)(0.5) + (0.3)(0.5)\left(\dfrac{1}{=}\right) + (0.9)(0.5)\left(\dfrac{1}{=}\right)$

$= 0.381066017$

d) Phong shading

Because $k_s \gg k_d$, the object is specular so ... that the specular highlight is not missing. (Or any other reasonabl...

Qn 3

a)

$I_D = \dfrac{1}{5}I_C + \dfrac{4}{5}I_A = \dfrac{1}{5}(1.0) + \dfrac{4}{5}(0.5) = 0.6$

b)

$x_D = \dfrac{1}{5}x_C + \dfrac{4}{5}x_A = \dfrac{1}{5}(10) + \dfrac{4}{5}(0) = 2$
$x_E = 10$

$N_P(x) = \dfrac{x-2}{8}N_E + \dfrac{10-x}{8}N_D = \dfrac{(x-1)-2}{8}N_E + \dfrac{10-(x-1)}{8}N_D + \dfrac{N_E - N_D}{8}$

$\qquad\qquad = N_P(x-1) + \dfrac{(0,1,-1)}{8}$

Qn 4

a)

$N \cdot V = 0.5 > 0 \implies$ Front face

Back face detection (or culling)

b)

i) Since the number of Z buffer operations is proportional to the number of pixels being projected, the number of Z buffer operations are

$$(30)(100)(100)(500) = 1.5 \times 10^8$$

ii) For each of the 2560×1440 pixel, we send out a pixel ray and test whether it intersects the 30 spheres, therefore the number of intersection calculations are

$$(2560)(1440)(30) = 1.10592 \times 10^8$$

iii) For each of the 30 objects, there are 100×100 quadrilaterals or $100 \times 100 \times 2$ triangles. Thus, the numbe

$$(2560)(1440)($$