Assignment 4

1. One reason that homogeneous coordinates are attractive is that the 3D points at infinity in cartesian coordinates can be explicitly represented by homogeneous coordinates. How can this be done? **[2]**

2. In 3D, show $R_z(\theta_1).R_z(\theta_2) = R_z(\theta_2).R_z(\theta_1)$. What does this tell about the properties of rotation around coordinate axes? Show that $R_z(\theta_1 + \theta_2) = R_z(\theta_1).R_z(\theta_2)$. Using this property show that rotation about any arbitrary axis denoted by R also follows the property, $R(\theta_1).R(\theta_2) = R(\theta_2).R(\theta_1) = R(\theta_1 + \theta_2)$. **[10]**

3. Derive the scaling matrix for scaling an object by a scale factor 3 along an arbitrary direction given by vector $u = (1, 2, 1)$ rooted at $(5, 5, 5)$. **[8]**

4. A viewer is defined by the following. (a) Eye position: $(0, 0, 0)$, (b) View Up Vector: $(0, 2, 0)$, (c) Direction of the View Vector: $(0, 1, 2)$, (d) Equation of the image plane: $x+y+z = 6$. Find the perspective projection matrix for this viewer. Find what would be projected coordinates of a point $P = (10, 4, 6)$ for this viewer. **[10]**
   Hint: The direction of the normal of a plane with equation $ux + vy + wz = t$ is given by (u, v, w).

5. We want to find the rotation matrix R for rotation about an arbitrary axis rooted at origin but with direction $u = (u_x, u_y, u_z)$. We learnt in class that R found by defining a coordinate axis with u as the z-axis is equivalent to two rotations, R_x followed by R_y around x and y axis respectively. Prove this.**[10]**