# CPSC 314
# Assignment 1

due: Friday, February 3, 2006 (in class)
Worth 9% of your final grade.

Purpose: (a) to test your understanding of geometric transformations; (b) to apply this towards building a hierarchical articulated figure animation.

Answer the questions in the spaces provided on the question sheets. If you run out of room for an answer, continue on the back of the page.

Name: _____

Student Number: _____

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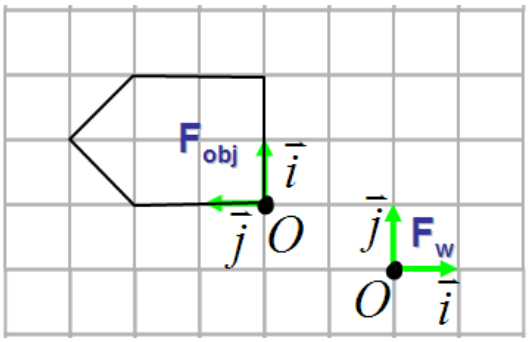
1. Composing Transformations




(a) (2 points) Give the $4 \times 4$ matrix $M$ that implements the transformation shown above. Assume that the $z$ values remain unchanged.

(b) (2 points) Given $M = Trans(a, b, 0)Rot(z, \theta_1)$, provide the values of $a, b, \theta_1$ that would implement the given transformation.

(c) (2 points) Given $M = Rot(z, \theta_2)Trans(c, d, 0)$, provide the values of $c, d, \theta_2$ that would implement the given transformation.

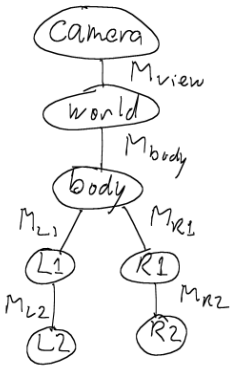
2. (3 points) Give the $4 \times 4$ modeling transformation matrix that results from the following OpenGL commands. Show the reasoning or steps used to arrived at your answer.

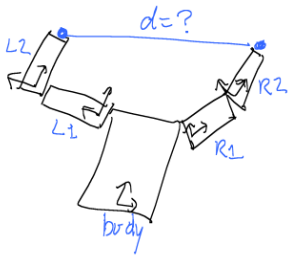
```
glLoadIdentity();
glTranslate(2,3,0);
glRotatef(90,0,0,1);
glPushMatrix();
  glScale(2,2,2);
  glTranslate(1,0,0);
glPopMatrix();
glRotatef(90,0,0,1);
```

3. (3 points) Suppose that you know the basis vectors and origin of coordinate systems $A$ and $B$, as expressed in a third coordinate system. $A$ has basis vectors $(u, v, w)$ and origin $a$, and $B$ has basis vectors $(i, j, k)$ and origin $b$. Develop an expression for converting form coordinate system $A$ to coordinate system $B$. I.e., find $M$ where $P_B = MP_A$. Refer to the individual components of $u$ as $u_x, u_y, u_z$, etc.

4. (3 points) Determine the viewing transformation, $M_{view}$, that takes points from WCS (world coordinates) to VCS (viewing or camera coordinates) for the following camera parameters:
$P_{eye} = (20, 10, 10), P_{ref} = (0, 0, 0), V_{up} = (0, 0, 1)$.

5. (3 points) Consider a simple robot and its scene graph, as shown below. Assume all the transformations are known. The left and right 'hands' of the robot are located at (30,0,0) in their respective local coordinate frames (units are in cm). Determine how to compute the distance between the left and right hands of the robot.



6. (5 points) In this question, you will write the OpenGL code to draw a simple 2D dog model using a basic block as a drawing primitive. First write a C function called `DrawBlock(w,h)` which draws a block of width `w` and height `h` using the `GL_POLYGON` primitive. Write your function so that it leaves the current transformation matrix unaltered upon exiting.

   Now write the C function called `DrawDog(x,y,a1,a2,a3,a4,a5,a6)`, where the parameters and dimensions are as indicated in the figure below. All drawing should be done by making calls to `DrawBlock()`. Your drawing function should leave the current transformation matrix unaltered upon exit. The required dimensions are: body $5 \times 3$; head $1 \times 3$, leg segments $1 \times 3$.