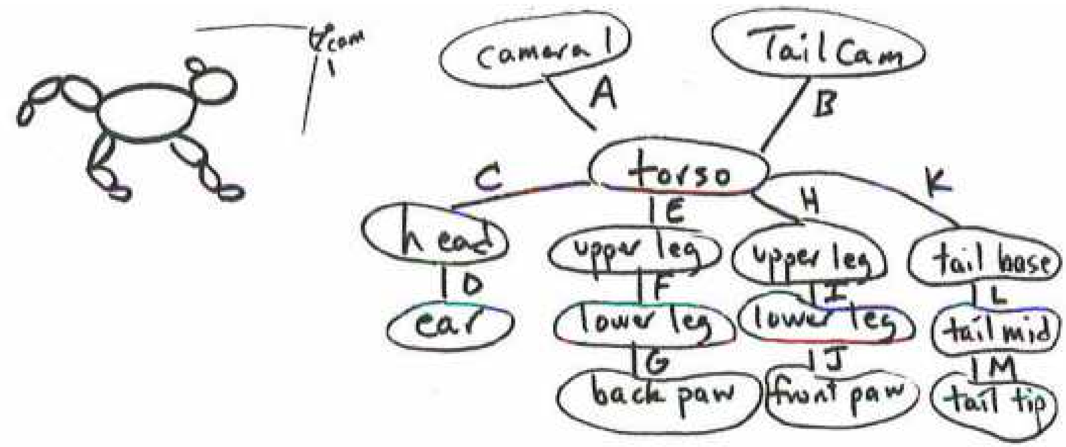
CS174A Assignment 2 - Part 1
Written Section: Physical Simulations and Projections

Out: Wednesday October 25th, 2017 **Value:** 5% of final grade
Due: Wednesday November 8th, 2017 11:59 pm **Total Points**: 120

1. (8 pts) The transformation matrices in the following scene graph define the relative transformations of each body part with respect to its parent.



   a) (4 pts) Your cat wants an earring, because all the other kitties have one. You should draw it as an offset with respect to the coordinate system of the ear. Give the expression for the composite transformation that should be in the modelview matrix to get from the viewing coordinate to the ear coordinate system, or equivalently the matrix that takes a point specified in ear coordinates and transforms it to viewing coordinates.

   b) (4 pts) You want to add a TailCam, a second camera that let's you see what things would look like from a point of view of the end of your cat's tail. (You will get dizzy when your cat sees a mouse and lashes its tail!) Give the expression for the composite transformation that you should use for **B,** the viewing matrix for the TailCam. (**B** is the V2W matrix from the coordinate frame point of view, and the W2V matrix from the point/object point of view.)

2. (10 pts) How do you compute the position of a particle using explicit Euler?

3. (10 pts) How do you compute the total forces on a node in a mass-spring system? What are the function calls as specified in lecture.

4. (12 pts) Specify the internal forces that one would have to implwement associated with:
   a. Mass-spring model with a non-zero length spring
   b. Cloth – Viscoelasticity – Mass-Springs Model
   c. Heating and Melting Deformable Models – Mass-Springs Model

d. Liquids – Particle Models

5. (10 pts) An external force of $(2, 14.7, -5)^T$ is applied to a particle (mass=1) located at $(0, 0, 0)^T$ at t=0. Give the position of the particle at the time it hits the ground by computing it iteratively and using explicit Euler (dt=1). Assume gravity is $9.8 m/s^2$

6. (10 pts) Give the camera/viewing transformation matrix for an eye position $(2,10,3)^T$, a lookat point $(-2, 2, 0)^T$ and an up vector $(-1,-1,0)^T$.

7. (10 pts) Give the perspective projection matrix with a near plane of 1, far plane of 100, a horizontal field of view of 30°, and an aspect ratio of 1:2.

8. (10 pts) Give the NDC-to-display transformation matrix for a viewport 200 pixels wide and 200 pixels high, with the origin in the upper left of the display.

9. (10 pts) A tetrahedron has vertices $(3, 2, 1, 1)^T$, $(0, 0, -3, 1)^T$, $(-2, -1, 2, 1)^T$, and $(1, 5, -1,1)^T$ in world coordinates. Give its coordinates in the camera coordinate system, after the viewing transformation from problem 6 above has been applied to the points in world coordinates.

10. (10 pts) Then give the tetrahedron coordinates in the clipping coordinate system, after the perspective warp for the frustum specified in problem 7 has been applied to the tetrahedron points in camera coordinates (that is, the answer from problem 9).

11. (10 pts) Then give its coordinates in the normalized device coordinate system, after the perspective divide has been applied to the answer from problem 10.

12. (10 pts) Finally, give the point coordinates in the display coordinate system, after the viewport transformation of problem 8 has been applied to the answer from problem 11.