CS184 Fall 98 **Homework 1** **Out: Oct 2, 1998**
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This Homework is due in class on Friday October 9th. It will be graded. Make sure you include your name and section number on your answer sheet.

1. Consider a triangle in the plane defined by points a, b, c. Fix a and b, and suppose that the lengths l_1 of ac and l_2 for bc are varied. Derive the forward kinematic equations that express the position of $c = (c_x, c_y)$ as functions of l_1 and l_2. This kind of manipulator is different from most. Its called a parallel manipulator. Its forward kinematics are hard, but inverse kinematics is easy (deriving l_1 and l_2 from c is trivial).

2. The Inertia matrix I for a block with dimensions X, Y, Z is

$$I = \frac{M}{12} \begin{pmatrix} Y^2 + Z^2 & 0 & 0 \\ 0 & X^2 + Z^2 & 0 \\ 0 & 0 & X^2 + Y^2 \end{pmatrix}$$

   where M is the mass of the block. Suppose the block is rotated 90° about the x-axis. What is the new matrix? Check your answer using the formula $I = RI_0R^T$.

3. Recall that the Euler equation for rotation of a rigid body is

$$T = I\alpha + \omega \times I\omega$$

   Assume that I is a diagonal matrix (as in the last example), with distinct values along the diagonal. Assume $T = 0$, for what values of ω does the block make a simple rotation (i.e. $\alpha = 0$)?

4. Let B be a block whose orientation is specified by the matrix R, and suppose that orientation is a 90° rotation about the z-axis. Now suppose that the object starts to spin with $\omega = (2, 2, 0)$. What is dR/dt?