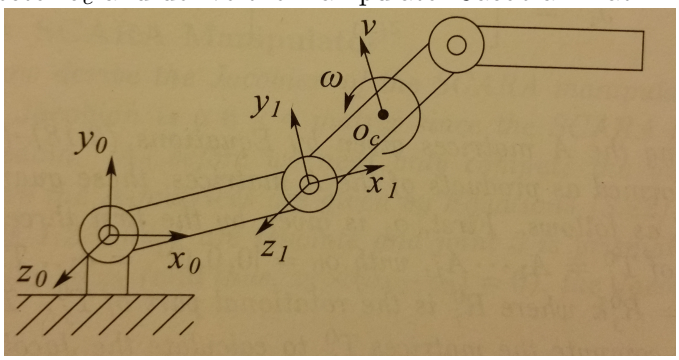
Homework 6c (Problem numbers from textbook)

4.16 For the three-link planar manipulator shown below, consider the point (o_c) at the center of link 2. Compute the vector o_c and derive the manipulator Jacobian matrix.



4.17 Compute the Jacobian J_{11} for the 3-link elbow manipulator shown below and show that it is

$$J_{11} = \begin{bmatrix} -a_2 s_1 c_2 - a_3 s_1 c_{23} & -a_2 s_2 c_1 - a_3 s_{23} c_1 & -a_3 c_1 s_{23} \\ a_2 c_1 c_2 + a_3 c_1 c_{23} & -a_2 s_1 s_2 - a_3 s_1 s_{23} & -a_3 s_1 s_{23} \\ 0 & a_2 c_2 + a_3 c_{23} & a_3 c_{23} \end{bmatrix}$$

Show that the determinant of this matrix is

$$\det J_{11} = a_2 a_3 s_3 (a_2 c_2 + a_3 c_{23})$$