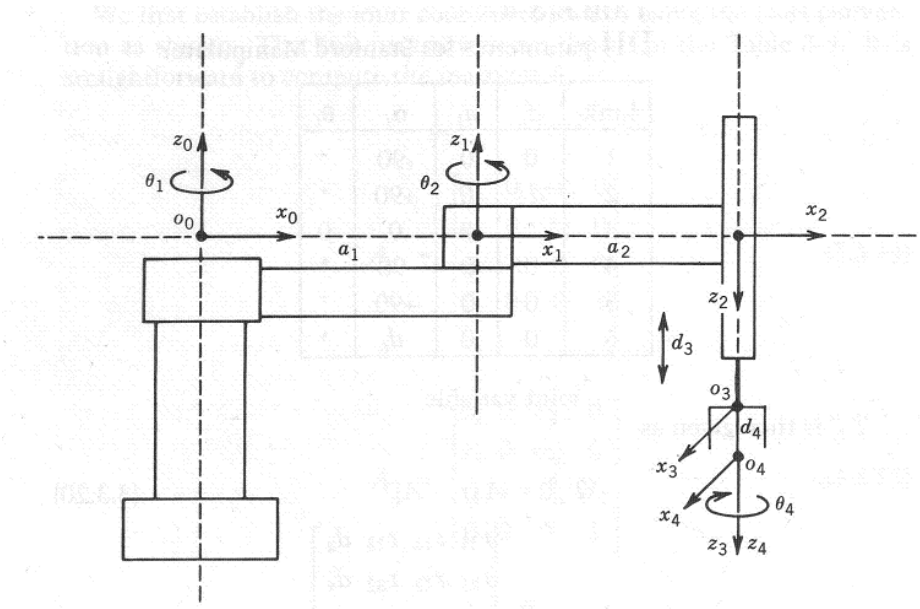
7MR10040: Medical Robotics: Theory and Applications
Semester 1

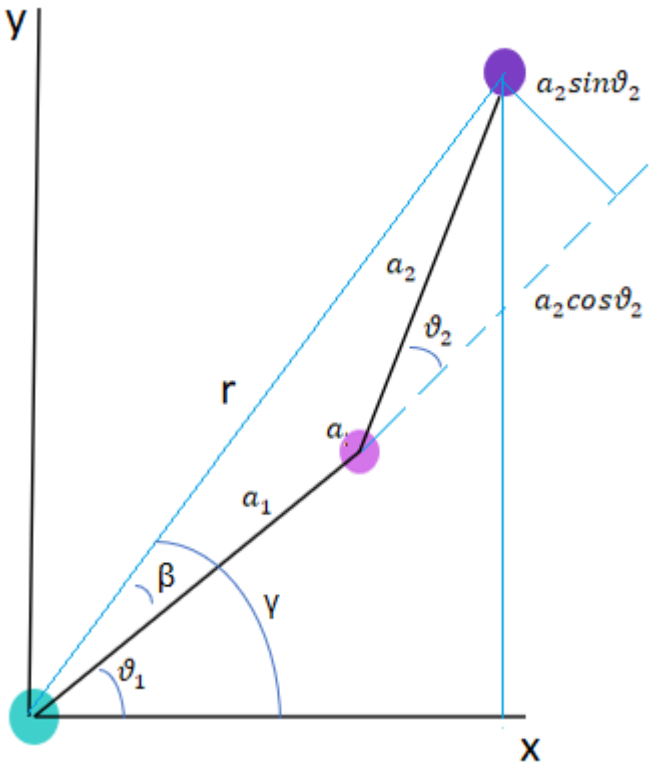
# Assignment 5

Written by Alexandros Megalemos

## Question 1

**Derive the inverse kinematics equations**



$$\vartheta_2 = atan2\left(\pm\sqrt{1 - cos\vartheta_2^2}, cos\vartheta_2\right)$$

$$\vartheta_1 = \gamma - \beta = \ atan2(y, x) - atan2(a_2 sin\vartheta_2, a_1 + a_2 cos\vartheta_2)$$

$$\vartheta_4 = \ \vartheta_1 + \ \vartheta_2 + \vartheta_u$$

$$d_3 = \ d_4 - d_{gp}$$

$Where$:

$Using\ the\ law\ of\ cosines$:

$$cos\vartheta_2 = \frac{x^2 + y^2 - a_1^2 - a_2^2}{2a_1 a_2}$$

$and$:

$$\beta = atan2(a_2 sin\vartheta_2, a_1 + a_2 cos\vartheta_2)$$

$$\gamma = atan2(y, x)$$

$d_4 = \ the\ distance\ between\ the\ ground\ and\ o_3$

$d_{gp} = \ the\ distance\ between\ the\ ground\ and\ o_4$

$\vartheta_u\ is\ an\ angle\ given\ by\ the\ user\ or\ zero\ as\ there\ is\ no\ orientation\ matrix\ for\ the\ object\ or\ point\ rotation.\ If\ we\ had\ an\ orientation\ matrix\ then\ perhaps$

$\vartheta_4 = \ \vartheta_1 + \ \vartheta_2 - atan2(X_i, Y_i)\ \ where\ X_i and\ Y_i\ describe\ the\ orientation\ of\ the\ point$