$$8c_1c_2 + 8c_1c_{23} - 5s_1 = x \Rightarrow 8c_1\overbrace{(c_2 + c_{23})}^{k} - 5s_1 = x \quad -(1)$$
$$8s_1c_2 + 8s_1c_{23} + 5c_1 = y \Rightarrow 8s_1(c_2 + c_{23}) + 5c_1 = y \quad -(2)$$
$$8s_2 + 8s_{23} + 13 = z \Rightarrow 8s_2 + 8s_{23} + 13 = z \quad -(3)$$

- $(1)^2 + (2)^2 \Rightarrow x^2 + y^2 = 64k^2 + 25 \quad -(4)$
- $(x + 5s_1)^2 + (y - 5c_1)^2 = 64k^2 \quad -(5)$

From (4) & (5), $xs_1 - yc_1 = -5$

$$\theta_1 = \operatorname{asin}\left(\frac{-5}{\sqrt{x^2+y^2}}\right) + \operatorname{atan2}(y, x)$$

$k = c_2 + c_{23} = \dfrac{x + 5s_1}{8c_1}$, subs. θ_1 we get k

$$k = c_2 + c_{23} \quad -(6)$$

$$\left(\frac{z-13}{8}\right) = s_2 + s_{23} \quad -(7) \quad [\text{From } (3)]$$

- $(6)^2 + (7)^2 \Rightarrow k^2 + \left(\dfrac{z-13}{8}\right)^2 = 2 + 2\cos\theta_3$

$$\theta_3 = \operatorname{acos}\left(\frac{k^2 + \left(\frac{z-13}{8}\right)^2 - 2}{2}\right) \quad -(8)$$

- $(6)^2 - (7)^2 \Rightarrow k^2 - \left(\dfrac{z-13}{8}\right)^2 = 2\cos(2\theta_2 + \theta_3)(1 + \cos\theta_3)$

$$\theta_2 = \left(\operatorname{acos}\left[\frac{k^2 - \left(\frac{z-13}{8}\right)^2}{2(1+\cos\theta_3)}\right] - \theta_3\right)/2 \quad -(9)$$

R36 =

```
[ c4*c5*c6 - s4*s6, - c6*s4 - c4*c5*s6, -c4*s5]
[ c4*s6 + c5*c6*s4,   c4*c6 - c5*s4*s6, -s4*s5]
[           c6*s5,              -s5*s6,     c5]
```

```
if R36(3,3) == 1
            theta5 = 0;
            theta4 = 0;
            theta6 = atan2(R36(2,1), R36(1,1));
        else
            theta5 = acos(R36(3,3));
            theta6 = atan2(-R36(3,2), R36(3,1));
            theta4 = atan2(-R36(2,3),-R36(1,3));
        end
```