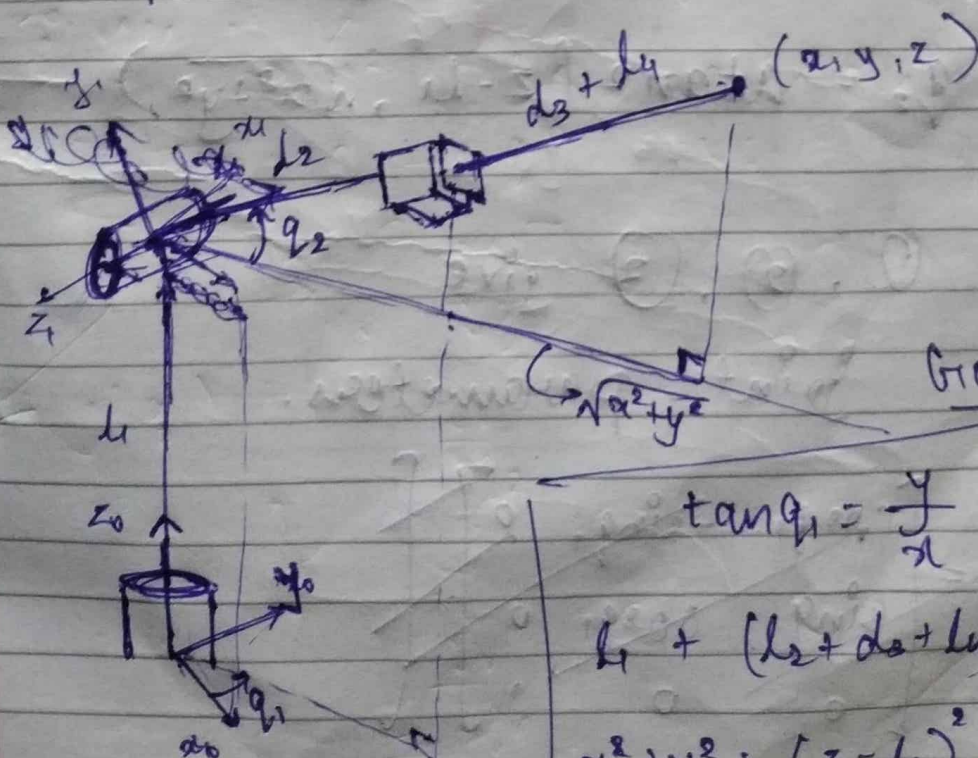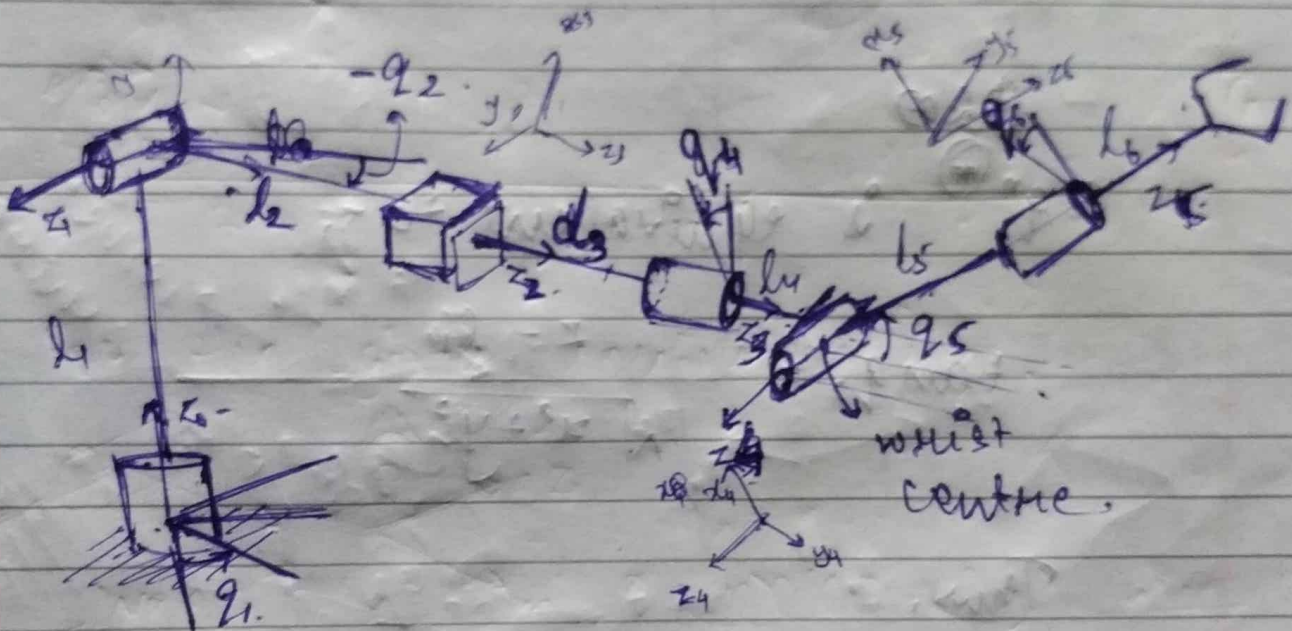# ME639

ASSIGNMENT-4

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Geometric constraints:

$$\tan q_1 = \frac{y}{x}$$

$$l_1 + (l_2 + d_3 + l_4)\sin q_2 = z \quad \text{(*)}$$

$$x^2 + y^2 + (z - l_1)^2 = (l_2 + d_3 + l_4)^2$$

Thus,

$$q_1 = atan2(y, x) \quad \text{(1)}$$

$$d_3 = \sqrt{(x^2 + y^2 + (z-l_1)^2)} - l_2 - l_4 \quad \text{(2)}$$

Eq^{(3)} is equivalent to,

$$\tan q_2 = \frac{z - l_1}{\sqrt{x^2 + y^2}}$$

Thus,

$$q_2 = atan2(z - l_1, \sqrt{x^2 + y^2}) \quad \text{(3)}$$

Eq^n (1), (2), (3) give

joint parameters.

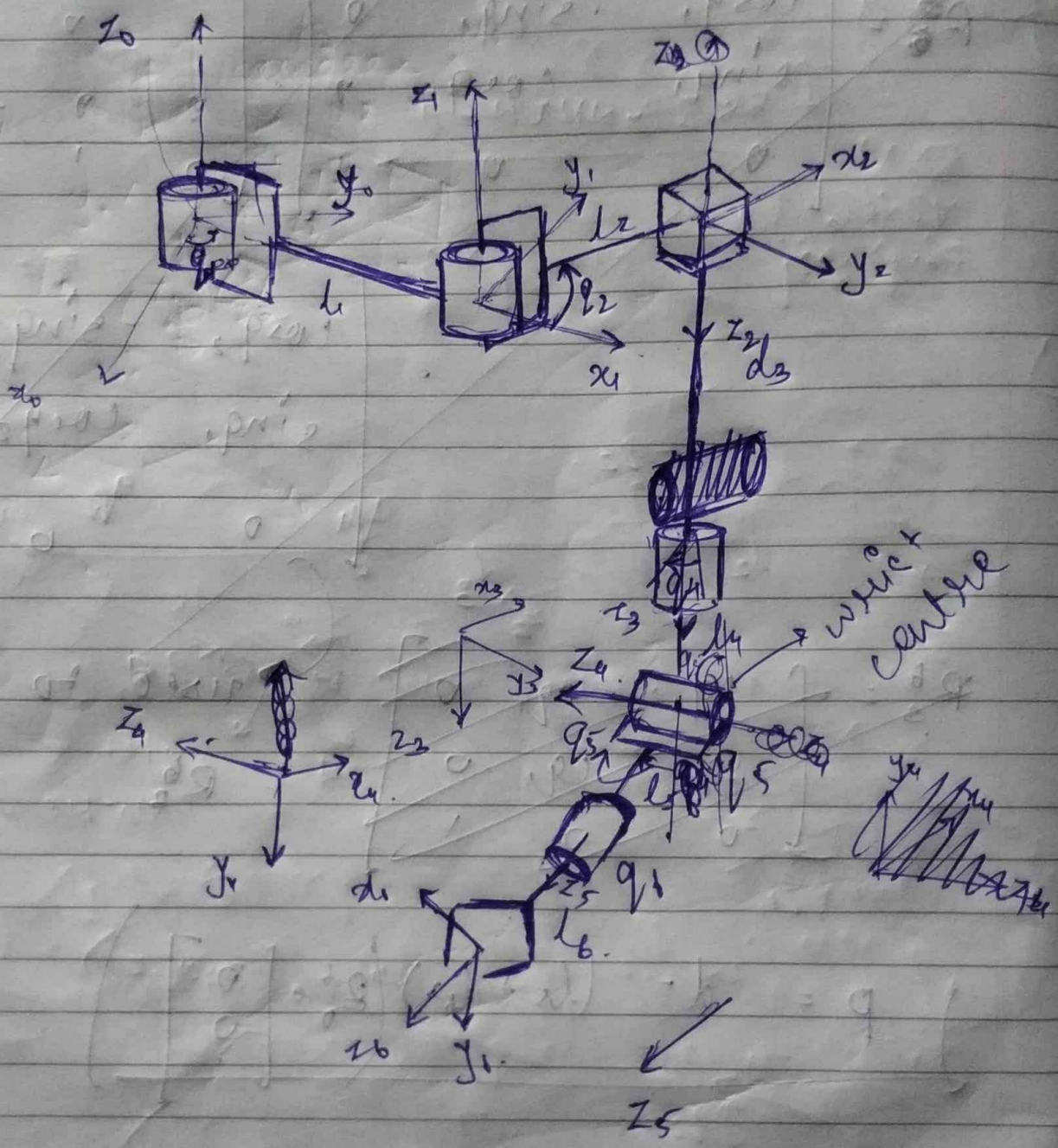$$R_3^0 = \begin{bmatrix} \cos q_1 & -\sin q_1 & 0 \\ \sin q_1 & \cos q_1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$
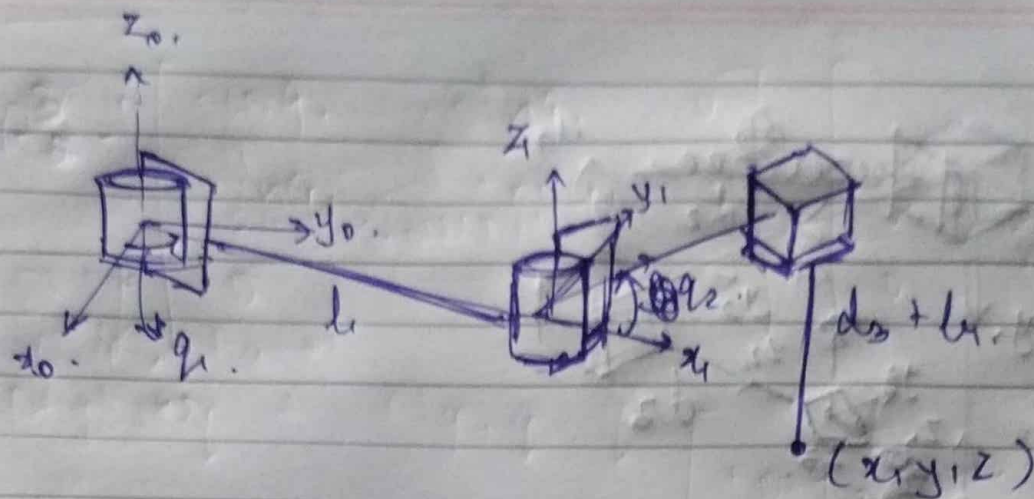
$$P = d - (l_5 + l_6)\left(R_0^5 \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}\right)$$

$$R_0^5 = R_{z,q_1} R_{x,90} R_{z,q_3} R_{z,90} R_{x,90}$$

$\rightarrow$ used in code.

2)

z_0

z_1

z_3 ③

y_0

y_1

x_2

l_2

y_2

q_1

l_1

q_2

x_0

x_1

z_2

d_3

q_4

wrist centre

x_3

l_4

z_4

x_3

y_3

z_3

z_4

x_4

z_3

q_5

y_4

l_4

z_4

y_4

x_4

q_6

d_4

z_5

q_6

l_6

z_6

y_6

z_5

Thus,

$$z = -(d_3 + l_4)$$

$$\Rightarrow d_3 = -z - l_4 \quad\underline{\qquad} \quad ①$$

$$q_2 = \cos^{-1}\left(\frac{x^2 + y^2 - l_1^2 - l_2^2}{2 l_1 l_2}\right) \quad\underline{\qquad} \quad ③$$

$$q_1 = \tan^{-1}\left(\frac{y}{x}\right) - \tan^{-1}\left(\frac{l_2 \sin q_2}{l_1 + l_2 \cos q_2}\right)$$

$$\underset{\curvearrowright ②}{\qquad\qquad}$$

$$R_0^3 = R_{z,q_1}\, R_{z,q_2}\, R_{x,180°}$$

$$R_0^3 = R_{z,q_1 + q_2}\, R_{x,180°}$$

z

d_1

de

x_1

a

y_2

z_2

y_1

y_3

d_3

d_1

z_1

z_3

x_0

y_0