1. $\theta(t) = a_0 + a_1 t + a_2 t^2 + a_3 t^3$

$\theta(0) = 15^\circ \qquad \theta_f(3) = 75^\circ$

Solving for $a_0 \rightarrow a_3$

$15^\circ = a_0 + a_1(0) + \cdots + 0$

$a_0 = 15$ ——— (1)

$75 = 15 + 3a_1 + 9a_2 + 27a_3$

$3a_1 + 9a_2 + 27a_3 = 60$

$a_1 + 3a_2 + 9a_3 = 20$ ——— (2)

assume $\dot{\theta}(0) = 0, \quad \dot{\theta}(3) = 0$

$\dot{\theta}(t) = a_1 + 2a_2 t + 3a_3 t^2$

$0 = a_1 + 2a_2 t^0 + 3a_3 t^2$

$a_1 = 0$ ——— (3)

$0 = a_1^0 + 2a_2 \times 3 + 3a_3 9$

$6a_2 + 27a_3 = 0$

$a_2 = -\frac{27}{6} a_3$ ——— (4)

④ can be substituted in ② to get

$$-\frac{27}{6}a_3 + 9a_3 = 20$$

$$-4.5a_3 + 9a_3 = 20$$

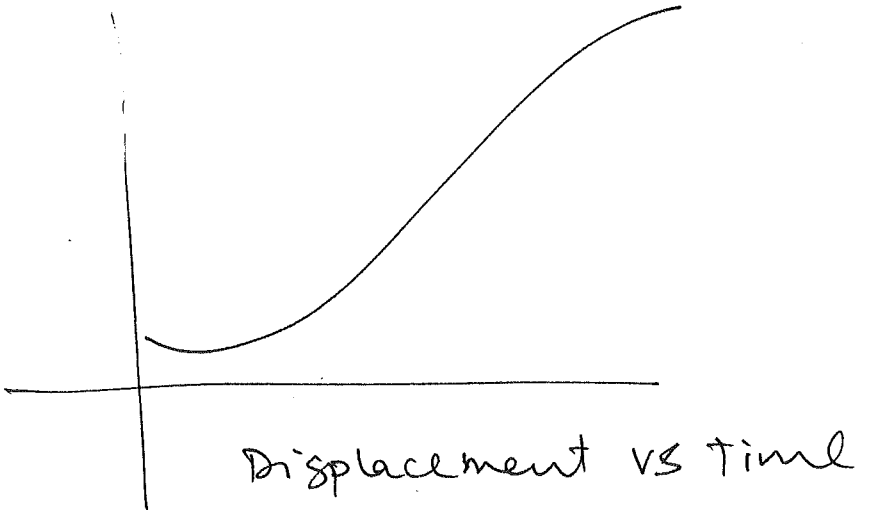
$$4.5a_3 = 20$$

$$a_3 = 20/4.5 = 4.44$$

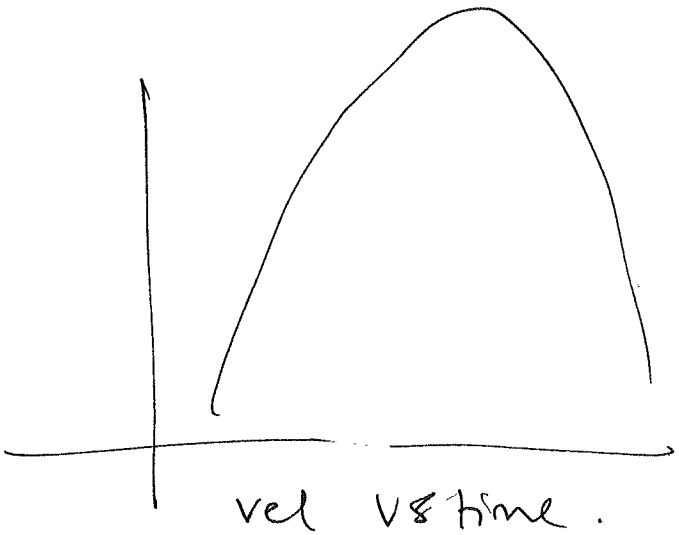
$$a_2 = -\frac{27}{6} 4.5 * 4.44 = 20$$

$$Q(t) = 15 + 20t^2 + 4.5t^3$$

the plot for position should approximately like.



Displacement vs time



vel vs time.

2 a) $\text{Base}_{T_{camera}} = T_1^{-1}$

i) for base to conveyor is

$$T_1^{-1} * T_4$$

(iii) Conveyor to camera is T_4^{-1}

(ii) $T_1^{-1} T_2$

b) $$B_{T_p} = \begin{bmatrix} R_z & \begin{bmatrix} 5 \\ 5 \\ 5 \end{bmatrix} \\ 0 \quad 0 \quad 0 & 1 \end{bmatrix}$$

$\cos\theta = 0 \quad \therefore \quad \theta = -\pi/2$

$-\sin\theta = 1$

Translation is $\begin{bmatrix} 10_x & 5_y & 5_z \end{bmatrix}$

The axis of the ~~camera~~ part is rotated along the Z axis by $-90°$

3)

L. Bank.	Boat	R. Bank
(0, 0)		(3, 3)
(0, 1)	← (0, 2)	(3, 1)
	(0, 1) →	(3, 2)
(0, 2)	← (0, 2)	(3, 0)
	(0, 1) →	(3, 1)
(3, 1)	← (2, 0)	(1, 1)
(2, 1)	(1, 1) →	(2, 2)
(3, 1)	← (2, 0)	(0, 2)
(3, 0)	(0, 1) →	(0, 3)
(3, 2)	← (0, 2)	(0, 1)
(3, 1)	(0, 1) →	(0, 2)
(3, 3)	← (0, 2)	(0, 0)

4) $\theta(0) = 10$

$\theta(1) = 10 + 90 - 60 = 40$

Find E.E. position as $x = l_1 \cos\theta + l_2 \cos\theta$

$y = l_1 \sin\theta + l_2 \sin\theta$.

6) ~~Retrot~~ Problem can be solved by multiplying the weighting vector with the matrix and finding the sum of each row.

Row with maximum sum is the best rated robot.