

$$x(t) = a_0 + a_1 t + a_2 t^2 + a_3 t^3$$

$$x(t_0) = x(0) = a_0 + a_1(0) + a_2(0)^2 + a_3(0)^3 = 0.5$$

$$\boxed{a_0 = 0.5}$$

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

$$\dot{x}_2(0) = a_1 + 2a_2(0) + 3a_3(0)^2 = 0$$

$$\boxed{a_1 = 0}$$

$$x_f(t_f) = x(5) = a_0 + a_1(5) + a_2(5)^2 + a_3(5)^3 = 0.5$$

$$0.5 + 25a_2 + 125a_3 = 0.5$$

$$25a_2 + 125a_3 = 0 \quad \text{--- (1)}$$

$$a_2 + 5a_3 = 0$$

$$\dot{x}_f(5) = 2a_2(5) + 3a_3(5)^2 = 0$$

$$10a_2 + 75a_3 = 0$$

$$2a_2 + 15a_3 = 0 \quad \text{--- (2)}$$

$$2a_2 + 15a_3 = 0$$

$$= 2 \times (a_2 + 5a_3) = 0$$

$$5a_3 = 0 \quad a_3 = 0$$

$$a_2 = 0$$

$$\boxed{x(t) = 0.5}$$

$$\dot{x}(t) = 0$$

$$y(t) = a_0 + a_1 t + a_2 t^2 + a_3 t^3$$

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

$$y_0(0) = a_0 + a_1(0) + a_2(0)^2 + a_3(0)^3 = 0$$

$$a_0 = 0$$

$$\dot{y}_0(0) = a_1 + 2a_2(0) + 3a_3(0)^2 = 0$$

$$a_1 = 0$$

$$y_f(5) = a_2(5)^2 + a_3(5)^3 = 0.3$$

$$25a_2 + 125a_3 = 0.3$$

$$a_2 + 5a_3 = 0.012 \quad \text{--- (1)}$$

$$\dot{y}_f(5) = 2a_2(5) + 3a_3(5)^2 = 0$$

$$10a_2 + 75a_3 = 0$$

$$2a_2 + 15a_3 = 0 \quad \text{--- (2)}$$

$$2a_2 + 15a_3 = 0$$

$$2a_2 + 10a_3 = 0.024$$

$$5a_3 = -0.024$$

$$a_3 = -0.0048$$

$$a_2 = 0.012 + 0.024 = 0.036$$

$$y(t) = 0.036t^2 - 0.0048t^3$$

$$\dot{y}(t) = 0.072t - 0.0144t^2$$

θ_{ii}, θ_{ci}

$$\theta_{ci} = \cos^{-1} \left(\frac{x_0^2 + y_0^2 - L_1^2 - L_2^2}{2L_1L_2} \right)$$

$$= \cos^{-1} \left((0.5)^2 + (0.0)^2 - (0.4)^2 / 0.32 \right)$$

$$\cos^{-1} \left(\frac{0.25 - 0.32}{0.32} \right)$$

$$\cos^{-1} (-0.21875)$$

$$\frac{0.25 - 0.32}{0.32}$$

$$\theta_{zi} = 91.25^\circ$$

$$\theta_{ii} = \tan^{-1}(y/x_o) - \tan^{-1}(l_2 \sin \theta_{zi} / l_1 + l_2 \cos \theta_{zi})$$

$$= \tan^{-1}(0/0.5) - \tan^{-1}(0.4 \sin 91.25 / 0.4 + 0.4 \cos 91.25)$$

$$= \tan^{-1}(0) - \tan^{-1}(0.4 * 0.99 / 0.4 + 0.4 * -0.21875)$$

$$= -\tan^{-1}(0.396 / 0.3125)$$

$$= -\tan^{-1}(1.2672)$$

$$= -51.72^\circ$$

$$\theta_{if}, \theta_{zf}$$

$$\theta_{zf} = \cos^{-1} \left(\frac{(0.5)^2 + (0.3)^2 - (0.4)^2}{2 * 0.5 * 0.3} \right)$$

$$= \cos^{-1} \left(\frac{-0.16}{0.3} \right)$$

$$= \cos^{-1}(-0.5) = 120^\circ$$

$$\theta_{if} = \tan^{-1}(0.3/0.5) - \tan^{-1}(0.4 \sin 120 / 0.4 + 0.4 \cos 120)$$

$$= \tan^{-1}(0.6) - \tan^{-1}(0.35 / 0.2)$$

$$30.96^\circ - 60.255^\circ$$

$$= -29.29^\circ$$