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ME 4K03 Assignment 5

2R robot, one motion segment.

$\theta_1(0) = -10°$ $\theta_1(t_f) = 20°$ $\ddot{\theta}_{d1} = 20\ °/s^2$ $t_f = 2.5\ s$

$\theta_2(0) = 25°$ $\theta_2(t_f) = 100°$ $\ddot{\theta}_{d2} = 80\ °/s^2$

a) $t_b = ?$ $\dot{\theta}_{max} = ?$ for each joint

$$t_{bj} = \frac{t_f}{2} - \frac{\sqrt{\ddot{\theta}_{dj}^2 t_f^2 - 4\ddot{\theta}_{dj}(\theta_{fj} - \theta_{ij})}}{2|\ddot{\theta}_{dj}|} \quad \text{for } j = 1, 2$$

$$t_{b1} = \frac{2.5}{2} - \frac{\sqrt{20^2(2.5)^2 - 4(20)(20+10)}}{2(20)}$$

$$\boxed{t_{b1} = 1\ s}$$

$$t_{b2} = \frac{2.5}{2} - \frac{\sqrt{80^2(2.5)^2 - 4(80)(100-25)}}{2(80)}$$

$$\boxed{t_{b2} = 0.4594\ s}$$

$$\dot{\theta}_{max,j} = \ddot{\theta}_{dj} t_{bj} \quad \text{for } j = 1, 2$$

$$\dot{\theta}_{max,1} = (20)(1) = \boxed{20\ °/s}$$

$$\dot{\theta}_{max,2} = (80)(0.4594) = \boxed{36.75\ °/s}$$

b) $\theta_1(1.5) = ?$ $\theta_2(1.5) = ?$

for joint 1:

$(t_f - t_b) \leq 1.5 \leq t_f$ so

$\theta_1(1.5) = \theta_{f1} - \frac{1}{2}\ddot{\theta}_{d1}(t_f - t)^2$

$\theta_1(1.5) = 20 - \frac{1}{2}(20)(2.5 - 1.5)^2$

$\boxed{\theta_1(1.5) = 10°}$

for joint 2:

$t_b < 1.5 < (t_f - t_b)$

$\theta_2(1.5) = \theta_2(0) + \frac{1}{2}\ddot{\theta}_{d2} t_{b2}^2 + \ddot{\theta}_{d2} t_{b2}(t - t_{b2})$

$\theta_2(1.5) = 25 + \frac{1}{2}(80)(0.46)^2 + (80)(0.46)(1.5 - 0.46)$

$\boxed{\theta_2(1.5) = 71.69°}$