

## Assignment 1

(Deadline: Sep. 30. Late submission will be considered as 0 point.)

1. (30 points)

Consider a trajectory  $\theta = \{x, y, z\}$  is given by  $x = \cos 2\pi s, y = \sin 2\pi s, z = 2s, s \in [0, 1]$ , and its time scaling is  $s(t) = \frac{1}{4}t + \frac{1}{8}t^2, t \in [0, 2]$ . Calculate  $\ddot{\theta}$ .

2. (30 points)

Via points with specified positions, velocities, and accelerations can be interpolated using fifth-order polynomials of time. For a fifth-order polynomial segment between via points  $j$  and  $j + 1$ , of duration  $\Delta T_j$ , with  $\beta_j, \beta_{j+1}, \dot{\beta}_j, \dot{\beta}_{j+1}, \ddot{\beta}_j, \ddot{\beta}_{j+1}$  specified, solve for the coefficients of the fifth-order polynomial.

3. (40 points)

Consider a robot executing a motion of duration  $T = 2$  s. Initially the robot follows a cubic time scaling. At  $t = 1$  s, however, it switches to a fifth-order time scaling. This fifth-order time scaling, beginning at  $t = 1$  s, should match the position, velocity, and acceleration of the cubic time scaling which is ending at that time, i.e.,  $s(1) = \frac{1}{2}, \dot{s}(1) = \frac{3}{4}, \ddot{s}(1) = 0$ . Solve for the complete time scaling  $s(t) : [0, 2] \rightarrow [0, 1]$ .