Quiz Chapter 9 through 9.3

Trajectory Generation

```
addpath('C:\Users\Lenovo\Documents\MATLAB\Modern Robotics\mr')
```

Question 1

Question 2

10*(t/T)^3-15*(t/T)^4+6*(t/T)^5

Question 3

7

Question 4

Question 5

Given a total travel time T=5 and the current time t=3, use the function QuinticTimeScaling in the given software to calculate the current path parameter s, with at least 2 decimal places, corresponding to a motion that begins and ends at zero velocity and acceleration.

```
Tf = 5;
t = 3;
s = QuinticTimeScaling(Tf,t)
```

```
s = 0.6826
```

```
% 0.6826
```

Question 6

Use the function ScrewTrajectory in the given software to calculate a trajectory as a list of N=10 $SE(3)$ matrices, where each matrix represents the configuration of the end-effector at an instant in time. The first matrix is:

$$X_{\text{start}} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

and the 10th matrix is

$$X_{\text{end}} = \begin{bmatrix} 0 & 0 & 1 & 1 \\ 1 & 0 & 0 & 2 \\ 0 & 1 & 0 & 3 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

The motion is along a constant screw axis and the duration is $T_f = 10$. The parameter methodmethod equals 3 for a cubic time scaling. Give the 9th matrix (one before X_{end}) in the returned trajectory. The maximum allowable error for any matrix entry is 0.01, so give enough decimal places where necessary.

```
clear; clc;
Xstart = [[1 ,0, 0, 0]; [0, 1, 0, 0]; [0, 0, 1, 0]; [0, 0, 0, 1]];
Xend = [[0, 0, 1, 1]; [1, 0, 0, 2]; [0, 1, 0, 3]; [0, 0, 0, 1]];
Tf = 10;
N = 10;
method = 3;
traj = ScrewTrajectory(Xstart, Xend, Tf, N, method)
```

```
traj = 1×10 cell
```

...

	1	2	3	4	5	6	7	8
1	4×4 double	4×4 double	4×4 double	4×4 double	4×4 double	4×4 double	4×4 double	4×4 double

```
% [[0.0423, -0.0406, 0.9983, 0.9331],[0.9983,    0.0423,    -0.0406, 1.9720],
[-0.0406, 0.9983, 0.0423, 2.8891],[0,0,0,1]]
```

Question 7

Referring back to Question 6, use the function CartesianTrajectory in the MR library to calculate another trajectory as a list of *N*=10 *SE*(3) matrices. Besides the same *X*start, *X*end, *Tf* and *N*=10, we now set method to 5 for a quintic time scaling. Give the 9th matrix (one before *X*end) in the returned trajectory. The maximum allowable error for any matrix entry is 0.01, so give enough decimal places where necessary.

```
method7 = 5;
traj7 = CartesianTrajectory(Xstart, Xend, Tf, N, method7)
```

```
traj7 = 1×10 cell
```

...

	1	2	3	4	5	6	7	8
1	4×4 double	4×4 double	4×4 double	4×4 double	4×4 double	4×4 double	4×4 double	4×4 double

```
% [[0.0140, -0.0138, 0.9998, 0.9885],[0.9998,    0.0140, -0.0138, 1.9769],[-0.0138,
0.9998, 0.0140, 2.9654],[0,0,0,1]]
```