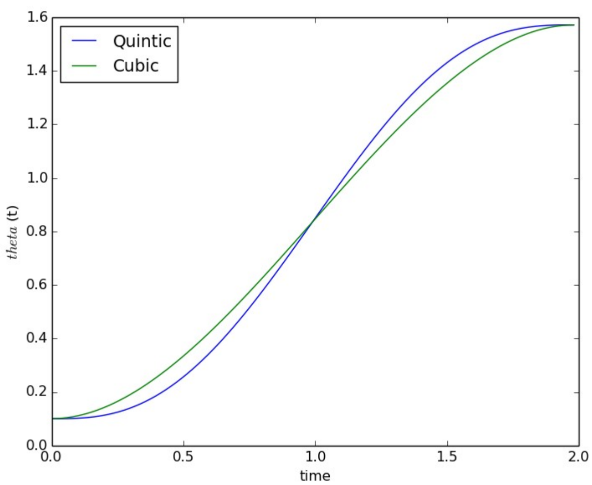
Links to Videos:
Cartesian
https://youtu.be/03BcG0q-evQ
Joint
https://youtu.be/yLitghHrk1Y

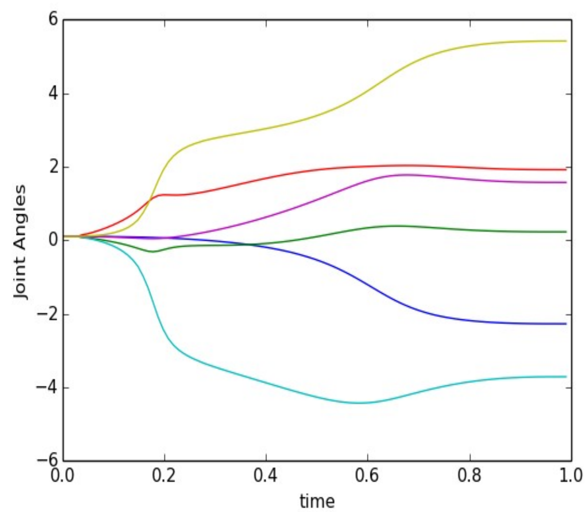
Cartesian Trajectory start and end transformation

Xstart:
```
[[ 0.92165131 -0.38799379  0.00443663 -0.76385111]
 [-0.00735983 -0.02891248 -0.99955485 -0.26818803]
 [ 0.38794935  0.92120839 -0.02950279 -0.12448378]
 [ 0.          0.          0.          1.        ]]
```
Xend:
```
[[  2.22044605e-16  -1.00000000e+00   1.11022302e-16   1.09000000e-01]
 [  1.00000000e+00   2.22044605e-16   3.33066907e-16   2.97000000e-01]
 [ -3.33066907e-16   1.11022302e-16   1.00000000e+00  -2.54000000e-01]
 [  0.00000000e+00   0.00000000e+00   0.00000000e+00   1.00000000e+00]]
```

Joint Trajectory Quintic and Cubic



Joint trajectory with Cartesian Path



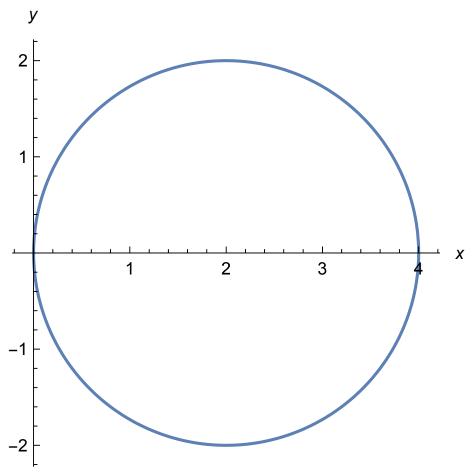
```
Quit[]
```

In[9]:=

```
(* plots a elliptical path in xy plane *)
xc = 2;
yc = 0;
a = 2;
b = 2;
x[s_] = xc - a * Cos[2 * Pi * s];
y[s_] = yc + b * Sin[2 * Pi * s];
Print["Elliptical Path"]
ParametricPlot[{x[s], y[s]}, {s, 0, 1}, AxesLabel → {x, y}]
```

Elliptical Path

Out[16]=



In[33]:=

```
Quit[]
```

In[1]:=

```
(* excersize 2, time derivatives *)
q = {x[t], y[t], z[t]};
x[t] = Cos[2 * Pi * s[t]];
y[t] = Sin[2 * Pi * s[t]];
z[t] = 2 * s[t];
s[t] = t / 4 + 1 / 8 * t^2;
Print["First order derivative of x,y,z"]
dqdt = D[q, t]
Print["Second order derivative of x, y, z"]
ddqddt = D[dqdt, t]
```

First order derivative of x,y,z

Out[7]= $\left\{-2\pi\left(\frac{1}{4}+\frac{t}{4}\right)\mathrm{Sin}\left[2\pi\left(\frac{t}{4}+\frac{t^2}{8}\right)\right],\ 2\pi\left(\frac{1}{4}+\frac{t}{4}\right)\mathrm{Cos}\left[2\pi\left(\frac{t}{4}+\frac{t^2}{8}\right)\right],\ 2\left(\frac{1}{4}+\frac{t}{4}\right)\right\}$

Second order derivative of x, y, z

Out[9]= $\left\{-4\pi^2\left(\frac{1}{4}+\frac{t}{4}\right)^2\mathrm{Cos}\left[2\pi\left(\frac{t}{4}+\frac{t^2}{8}\right)\right]-\frac{1}{2}\pi\,\mathrm{Sin}\left[2\pi\left(\frac{t}{4}+\frac{t^2}{8}\right)\right],\right.$

$\left.\frac{1}{2}\pi\,\mathrm{Cos}\left[2\pi\left(\frac{t}{4}+\frac{t^2}{8}\right)\right]-4\pi^2\left(\frac{1}{4}+\frac{t}{4}\right)^2\mathrm{Sin}\left[2\pi\left(\frac{t}{4}+\frac{t^2}{8}\right)\right],\ \frac{1}{2}\right\}$

```
Quit[]
```

In[30]:=
```
(* Solves for the quintic polynomial coefficients *)
s3[t_] = a0 + a1 * t + a2 * t^2 + a3 * t^3 ;
s5[t_] = a0 + a1 * t + a2 * t^2 + a3 * t^3 + a4 * t^4 + a5 * t^5 ;
c3 = {s3[0] == 0, s3'[0] == 0, s3[T] == 1, s3'[T] == 0};
c5 = {s5[0] == 0, s5'[0] == 0, s5[T] == 1, s5'[T] == 0, s5''[0] == 0, s5''[T] == 0};
Print["Quintic polynomials"]
p5 = Solve[c5[[1]] && c5[[2]] && c5[[3]] && c5[[4]] && c5[[5]] && c5[[6]],
  {a0, a1, a2, a3, a4, a5}]
Print["Cubic Polynomial"]
p3 = Solve[c3[[1]] && c3[[2]] && c3[[3]] && c3[[4]], {a0, a1, a2, a3}]
```

Quintic polynomials

Out[35]= $\left\{\left\{a0 \to 0, a1 \to 0, a2 \to 0, a3 \to \frac{10}{T^3}, a4 \to -\frac{15}{T^4}, a5 \to \frac{6}{T^5}\right\}\right\}$

Cubic Polynomial

Out[37]= $\left\{\left\{a0 \to 0, a1 \to 0, a2 \to \frac{3}{T^2}, a3 \to -\frac{2}{T^3}\right\}\right\}$