Computing a controller using a discrete-time tuning method such that the closed loop's settling time is 10s

Compute and declare my transfer function

The transfer function has the following form:

$$H_f(s) = \frac{K_f}{s(T_f s + 1)}$$

Knowing that my values are Kf = 4 and Tf = 8, the function becomes:

$$H_f(s) = \frac{4}{s(8s + 1)}$$

I declare my transfer function in code:

```
Kf = 4;
Tf = 8;
Hf = tf(Kf,[Tf 1 0]);
```

The settling time for the closed loop should be 10s.

```
ts = 10;
```

Choose a sampling period (half the smallest constant):

```
Ts = 0.5;
```

Calculate the discrete transfer function:

```
Hfz = c2d(Hf,Ts,'zoh');
```

To calculate the imposed closed loop transfer function we first need to calculate T.

```
T = ts/4;
```

The imposed close loop transfer function becomes:

```
Ho = tf(1, [T, 1]);
```

Calculate the discrete imposed closed loop transfer function.

```
Hoz = c2d(Ho,Ts,'zoh')
```

```
Hoz =

    0.1813
  ----------
  z - 0.8187
```

```
Sample time: 0.5 seconds
Discrete-time transfer function.
```

Now we calculate the controller:

```
Hrz = minreal(1/Hfz*Hoz/(1-Hoz))
```

```
Hrz =

  2.961 z - 2.782
  ---------------
    z + 0.9794

Sample time: 0.5 seconds
Discrete-time transfer function.
```

Calculate the final closed loop transfer function:

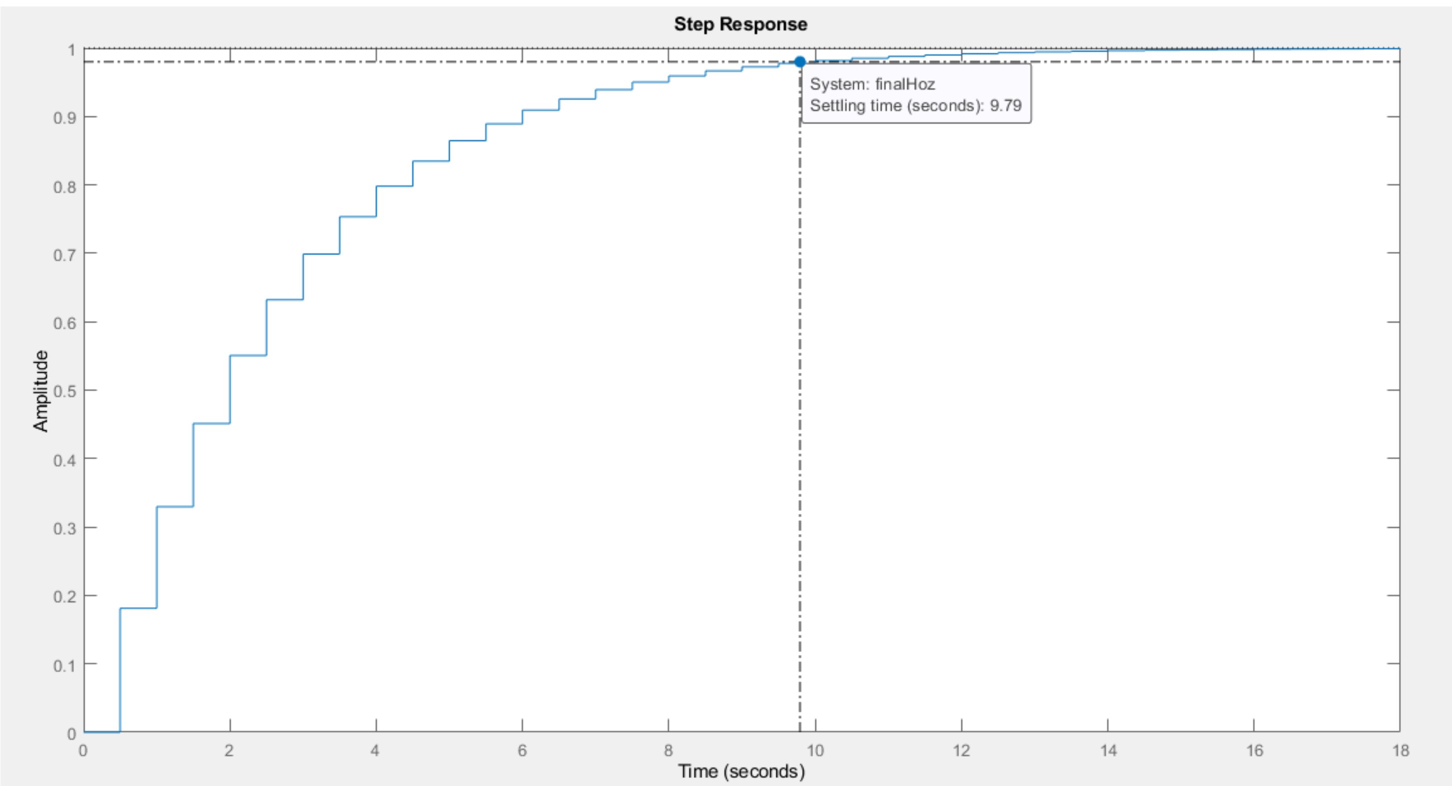
```
finalHoz = minreal(Hrz*Hfz/(1+Hrz*Hfz))
```

```
finalHoz =

  0.1813 z^4 + 0.01449 z^3 - 0.3333 z^2 - 0.01333 z + 0.1534
  -----------------------------------------------------------
  z^5 - 0.7388 z^4 - 1.904 z^3 + 1.432 z^2 + 0.9067 z - 0.693

Sample time: 0.5 seconds
Discrete-time transfer function.
```

```
%step(finalHoz)
```



I try to eliminate ringing:

```
Hrz.Denominator{1}(1,2) = Hrz.Denominator{1}(1,1) + Hrz.Denominator{1}(1,2);
Hrz.Denominator{1}(1,1) = 0
```

```
Hrz =

  2.961 z - 2.782
  ---------------
       1.979

Sample time: 0.5 seconds
Discrete-time transfer function.
```

Calculate the final closed loop transfer function again:

```
finalHoz = minreal(Hrz*Hfz/(1+Hrz*Hfz))
```

```
finalHoz =

  0.0839 z^3 - 0.07546 z^2 - 0.08034 z + 0.07251
  ----------------------------------------------
        z^3 - 2.713 z^2 + 2.449 z - 0.7359

Sample time: 0.5 seconds
Discrete-time transfer function.
```

```
%step(finalHoz)
```