Computing the controller Hr(s) using the Guilleman-Truxal method

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:

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

```
Hf =
 
      4
  ---------
  8 s^2 + s
 
Continuous-time transfer function.
```

I choose values for σ and t_r^*

The controller needs to satisfy the following specifications:

$\varepsilon_{\mathrm{stp}}$ = 0

$t_r^* \leq 40\,\mathrm{sec}$

$\sigma^* \leq 15\%$

$c_v \geq 0.2$

$\Delta w_b^* \leq 2\,\frac{\mathrm{rad}}{\mathrm{sec}}$

From this specifications I can choose σ and t_r^* as:

```
overshoot = 0.1;
settlingTime = 20;
```

I first calculate $H_o(s)$ (closed loop transfer function) parameters using the following formulas:

$$\xi = \frac{|\ln(\sigma)|}{\sqrt{\ln(\sigma)^2 + \pi^2}}$$

```
zetta = abs(log(overshoot))/sqrt(log(overshoot)^2+pi^2);
```

$$w_n = \frac{4}{t_r \xi}$$

```
Wn = 4/settlingTime/zetta;
```

$$c_v = \frac{w_n}{2\xi}$$

```
Cv = Wn/2/zetta;
```

$$\varepsilon_{\text{stv}} = \frac{1}{c_v}$$

```
Estv = 1/Cv;
```

$$\Delta w_b = w_n \sqrt{1 - 2\xi^2 + \sqrt{2 - 4\xi^2 + 4\xi^4}}$$

```
deltaWb = Wn*sqrt(1-2*zetta^2+sqrt(2-4*zetta^2+4*zetta^4));
```

I check if the specifications are met

```
Cv
```

```
Cv = 0.2862
```

0.2862 $\geq$ 0.2 "True"

```
deltaWb
```

```
deltaWb = 0.3924
```

0.3924 $\leq$ 2 "True"

I construct my closed loop transfer function

The closed loop transfer function has the following form:

$$H_o(s) = \frac{w_n^2}{s^2 + 2\xi w_n s + w_n^2}$$

I declare it in code using the values calculated before

```
Ho = tf(Wn^2,[1 2*zetta*Wn Wn^2])
```

```
Ho =

        0.1145
  --------------------
  s^2 + 0.4 s + 0.1145

Continuous-time transfer function.
```

I compute the controller transfer function

I use the formula:

$$H_R(s) = \frac{1}{H_f(s)} * \frac{H_o(s)}{1 - H_o(s)}$$

```
Hr = minreal(1/Hf*Ho/(1-Ho))
```

```
Hr =

  0.2289 s + 0.02862
  ------------------
       s + 0.4

Continuous-time transfer function.
```

I ploted the closed loop system response using command:

step(feedback(Hr*Hf,1))

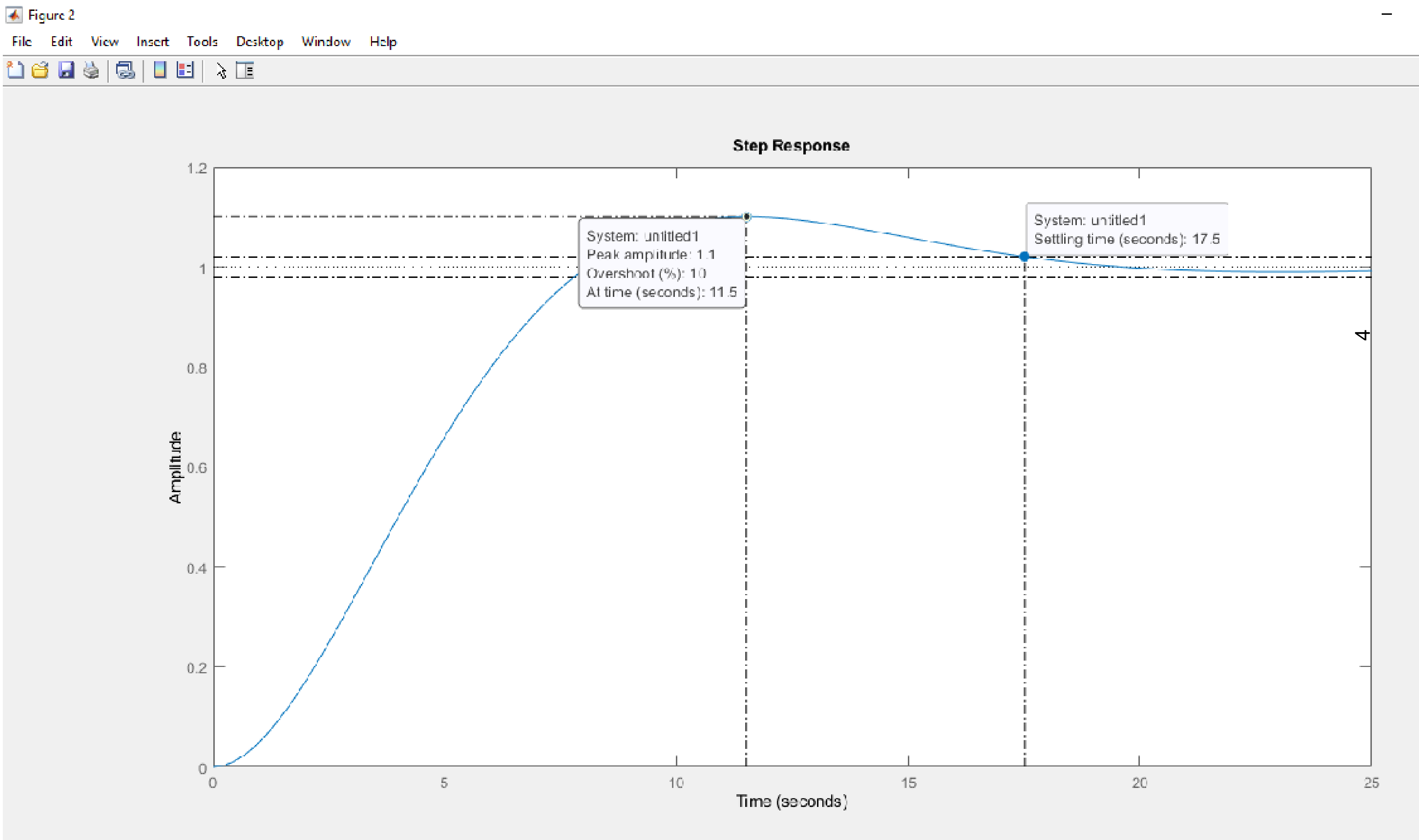
Figure 2
File Edit View Insert Tools Desktop Window Help
Step Response
System: untitled1
Peak amplitude: 1.1
Overshoot (%): 10
At time (seconds): 11.5
System: untitled1
Settling time (seconds): 17.5
Amplitude
Time (seconds)
0
0.2
0.4
0.6
0.8
1
1.2
0
5
10
15
20
25