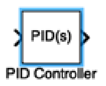
4.2.5. PID Autotuning in MATLAB

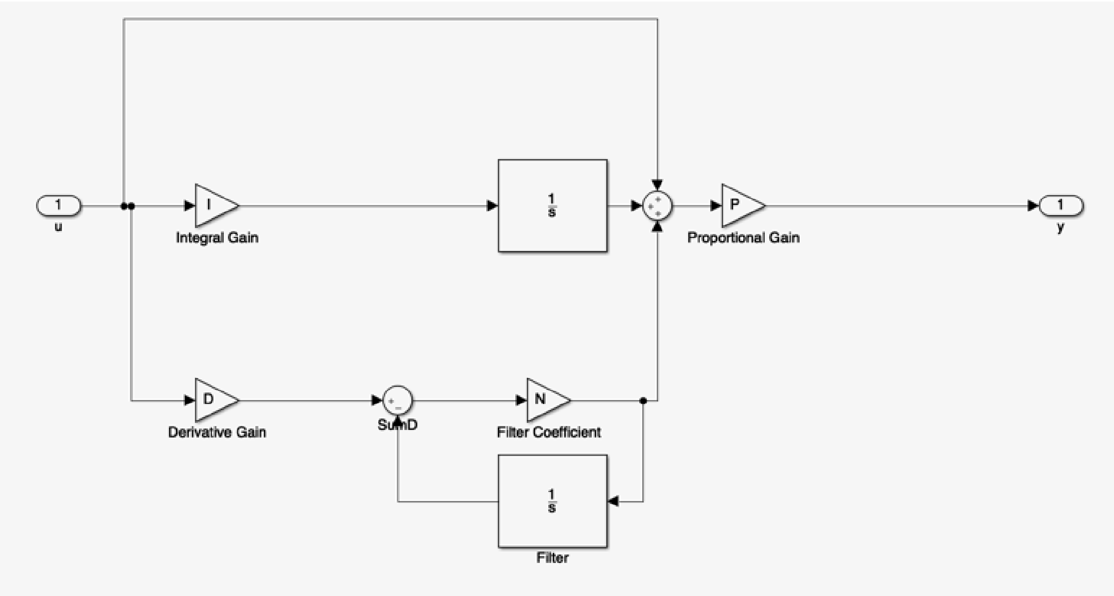
This section is yet to be written. In the meantime, please review this detailed tutorial from the [Control Systems Tutorial in MATLAB and Simulink](#).

4.2.5.1. MATLAB’s PID Block

MATLAB has introduced a PID block that can be used either from the command-line or within Simulink. The benefit of this block is that it can be used to autotune the PID compensator parameters in-loop.



The continuous-time PID block is to be found in the **Continuous Systems** library in Simulink. The block diagram is as shown below.



The transfer function of the PID is

$$D_{\text{PID}} = P\left(1 + I\frac{1}{s} + D\frac{N}{1 + N\frac{1}{s}}\right)$$

which reduces to

$$D_{\text{PID}} = P\left(1 + I\frac{1}{s} + D\frac{sN}{s + N}\right)$$

By comparison with the standard PID

$$D_{\text{PID}}(s) = K_{\text{prop}}\,(1 + T_D\,s + 1/(T_I\,s))$$

where $\$P = K_{\text{prop}}\$$

$$T_D = ND$$

$$T_I = 1/I$$

There is an extra pole at $s = -N$ which is there to limit the high-frequency gain of the Proportional+Derivative term.

In addition to the pole at the origin which is introduced by the integral term, The MATLAB PID has a proportional gain, two zeros, and an additional pole. Thus there are four parameters which can be adjusted to give a range of possible structures.

4.2.5.2. Autotuning the PID

Let us repeat the previous example ([See 4.2 Manual Tuning](#)).

Here we have:

$$G(s) = \frac{1}{5s^2 + 6s + 1}$$

and we ended up with

$$D_{\text{PID}} = K_{\text{prop}}\left(1 + T_D\,s + \frac{1}{T_s}\right)$$

with $K_{\text{prop}} = 19, T_D = 4/19, T_I = 2$.

Setting the PID with the equivalent values

```
imatlab_export_fig('print-svg')  % Static svg figures.
```

```
P = 19; D = 4/19; I = 2;
D = pidstd(P, I, D)
```

```
D =
```

```
            1      1

  Kp * (1 + ---- * --- + Td * s)

            Ti     s

  with Kp = 19, Ti = 2, Td = 0.211

Continuous-time PID controller in standard form
```

In MATLAB we use

```
s = tf('s');
G = 1/(5*s^2 + 6*s + 1)
```

```
G =

        1

  ---------------

  5 s^2 + 6 s + 1

Continuous-time transfer function.
```

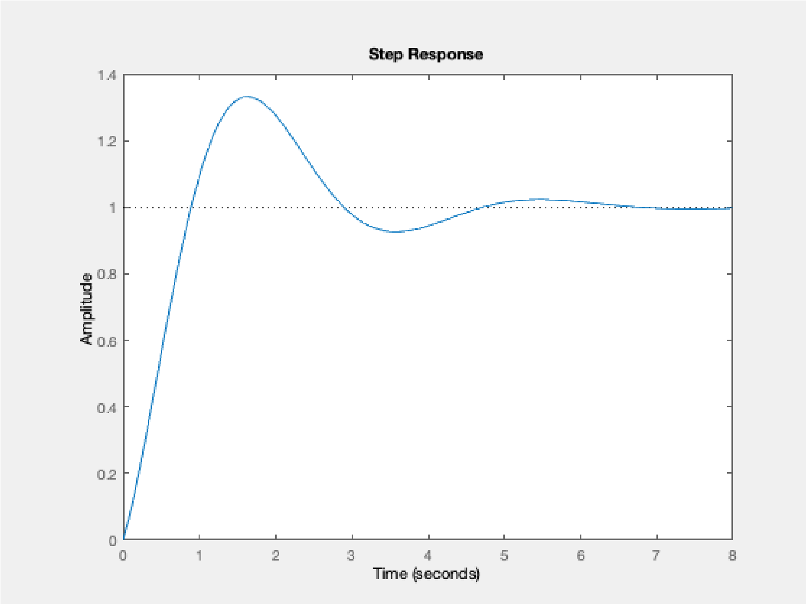
```
Go = series(D,G)
```

```
Go =

  4 s^2 + 19 s + 9.5

  ------------------

  5 s^3 + 6 s^2 + s

Continuous-time transfer function.
```

```
Gc = feedback(Go,1)
```

```
Gc =

      4 s^2 + 19 s + 9.5

  ---------------------------

  5 s^3 + 10 s^2 + 20 s + 9.5

Continuous-time transfer function.
```

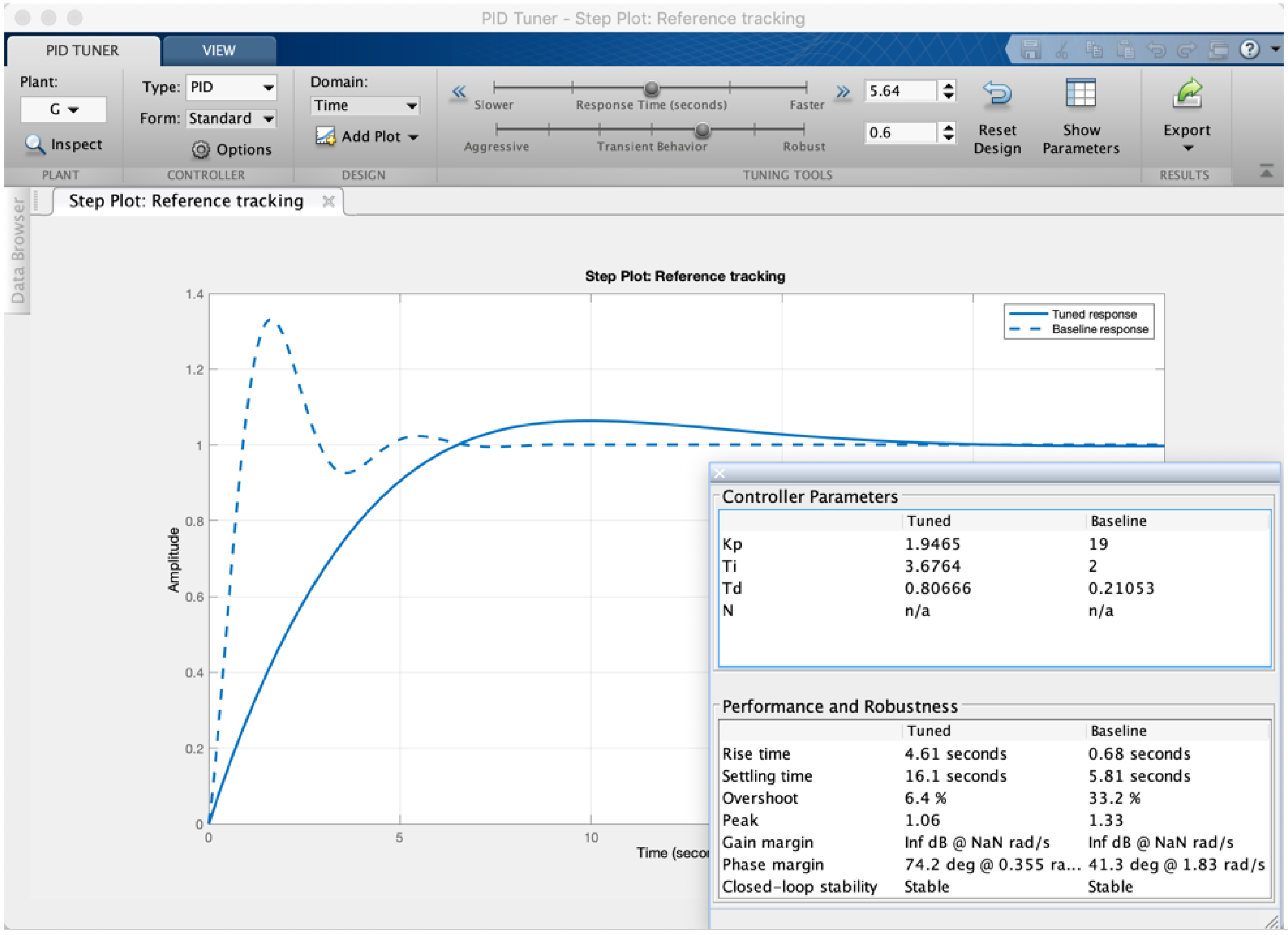
```
step(Gc)
```



We can now use this design as a baseline for autotuning the PID

```
pidTuner(G,D)
```

Results are:



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