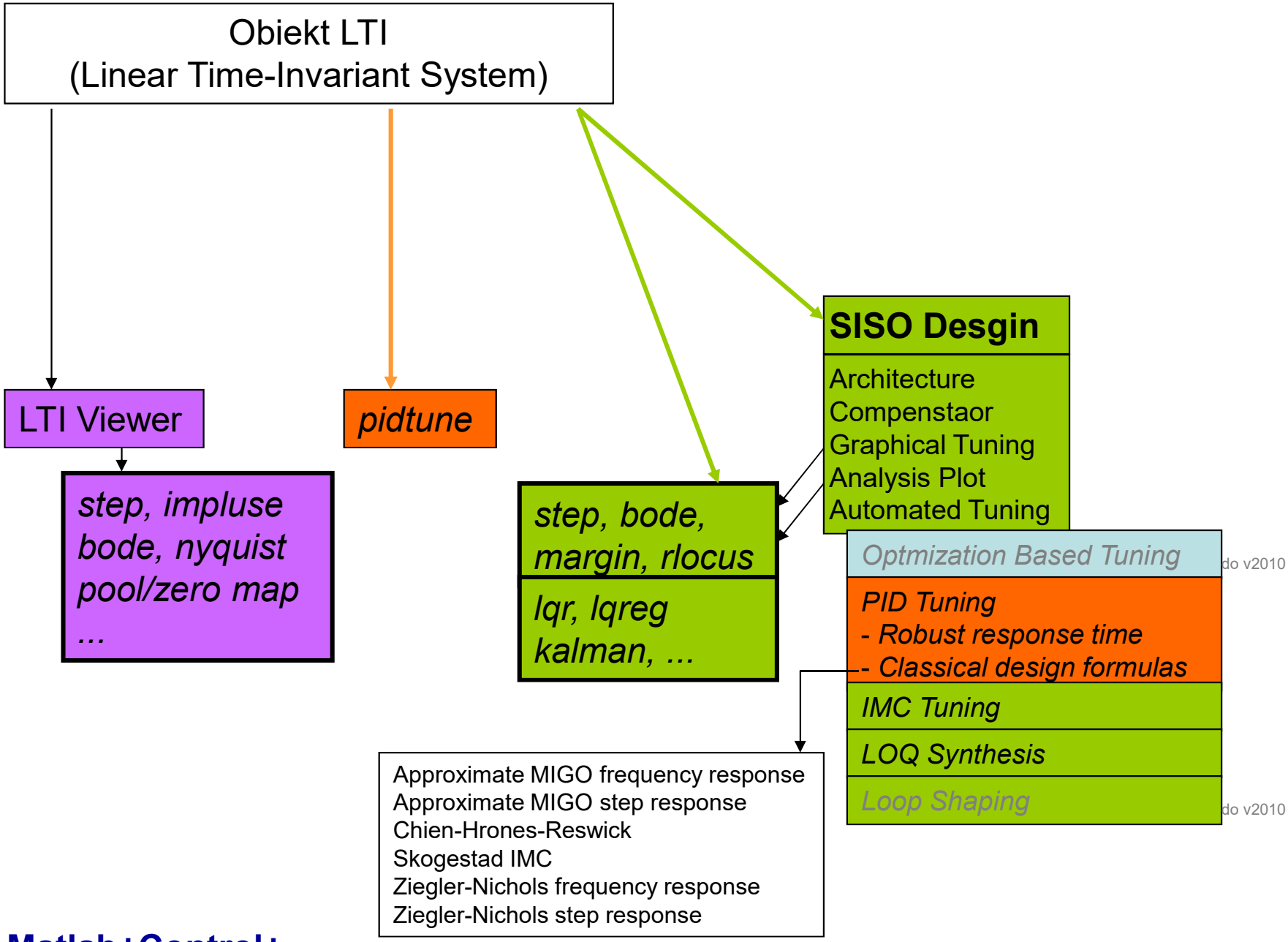
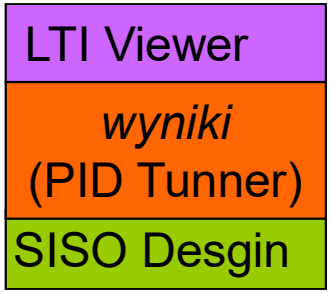
Narzędzia wspomagające projektowanie UR – SISO Design



Matlab + Control

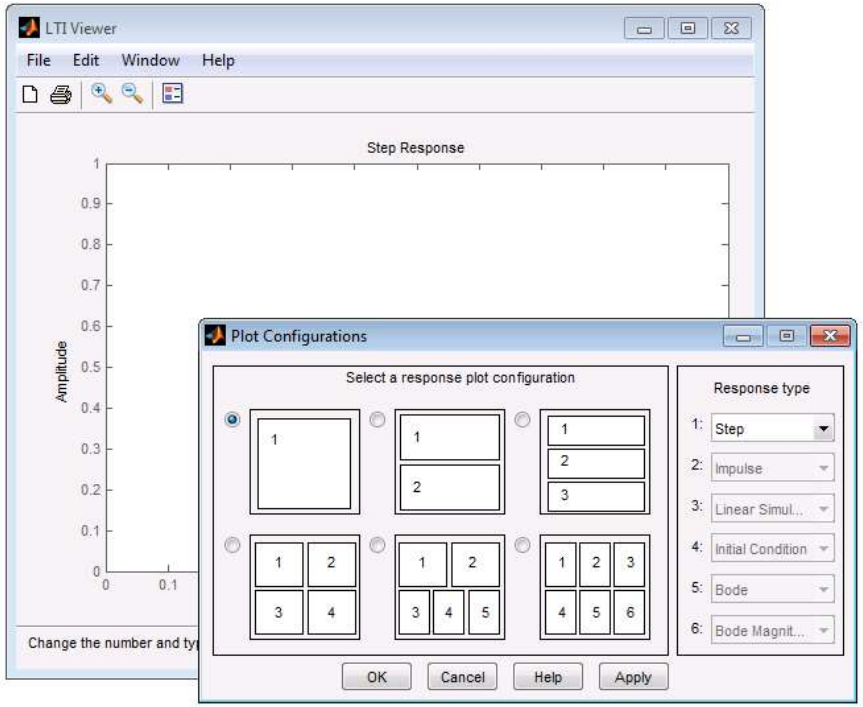
- modele (transfer function, state-space, pole-zero-gain, frequency-response)
- konwersje
- połączenia (series, parallel, feedback, …)
- funkcje (step response, Bode, Nyquist, ..)
- metody projektowania (Root locus, Bode diagram, LQR, LQG, …)
- narzędzia interaktywne
    - ltiview
    - pidtool
    - sisotool, sisoinit



help control

Matlab + Control

LTI Viewer



Wywołanie z linii komend: ltiview(obiekt LTI)
Analiza obiektów LTI (linowych, stacjonarnych)

regul = pidtune(obiekt, typ_reg)

[regul info] = pidtune(obiekt, typ_reg)

obiekt= model tf, ss, zpk, np.: obiekt=tf(1, [1 1])

typ_reg = ('p', 'i', pi', 'pd', 'pdf', 'pid', 'pidf')

regul= Kp + Ki * 1/s

with Kp=0.473, Ki=1.6

Continues-time PI controller in parrallel form

info= Stable: 1

CrossoverFrequency: 1.1237

PhaseMargin: 60.0000

[regul info] = pidtune(obiekt, typ_reg, opcje)

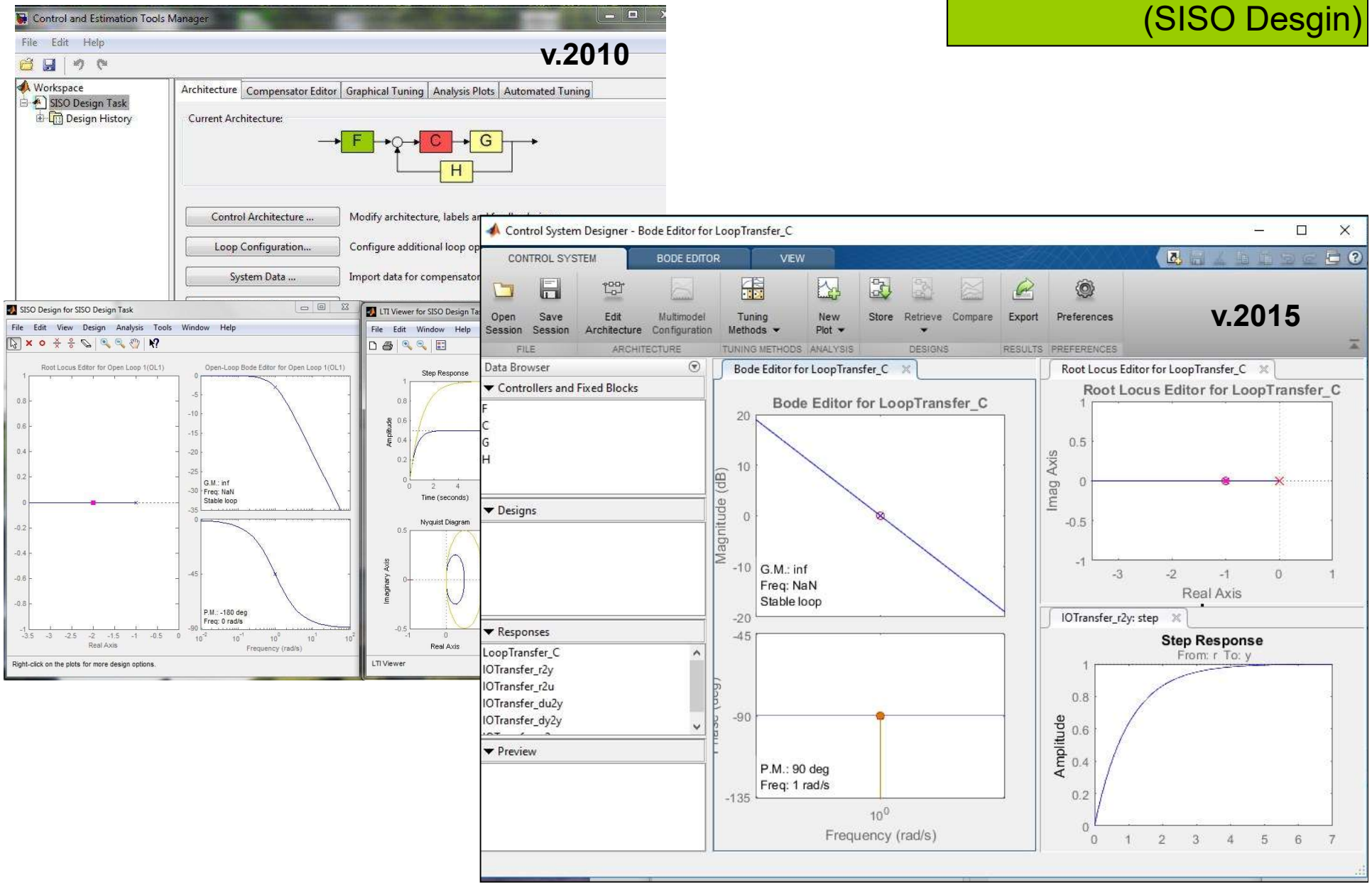
opcje = pidtuneOptions('CrossoverFrequency',1.2,'PhaseMargin',45);

[C info] = pidtune(obiekt,typ_reg, opcje)

Wywołanie z linii komend: pidtune(obiekt LTI, typ_reg [,opcje])

Matlab + Control

Control and Estimation TM
(SISO Desgin)



Wywołanie z linii komend: sisotool(obiekt LTI)
Projektowanie wybranego układu regulacji dla obiektu LTI (układ SISO)

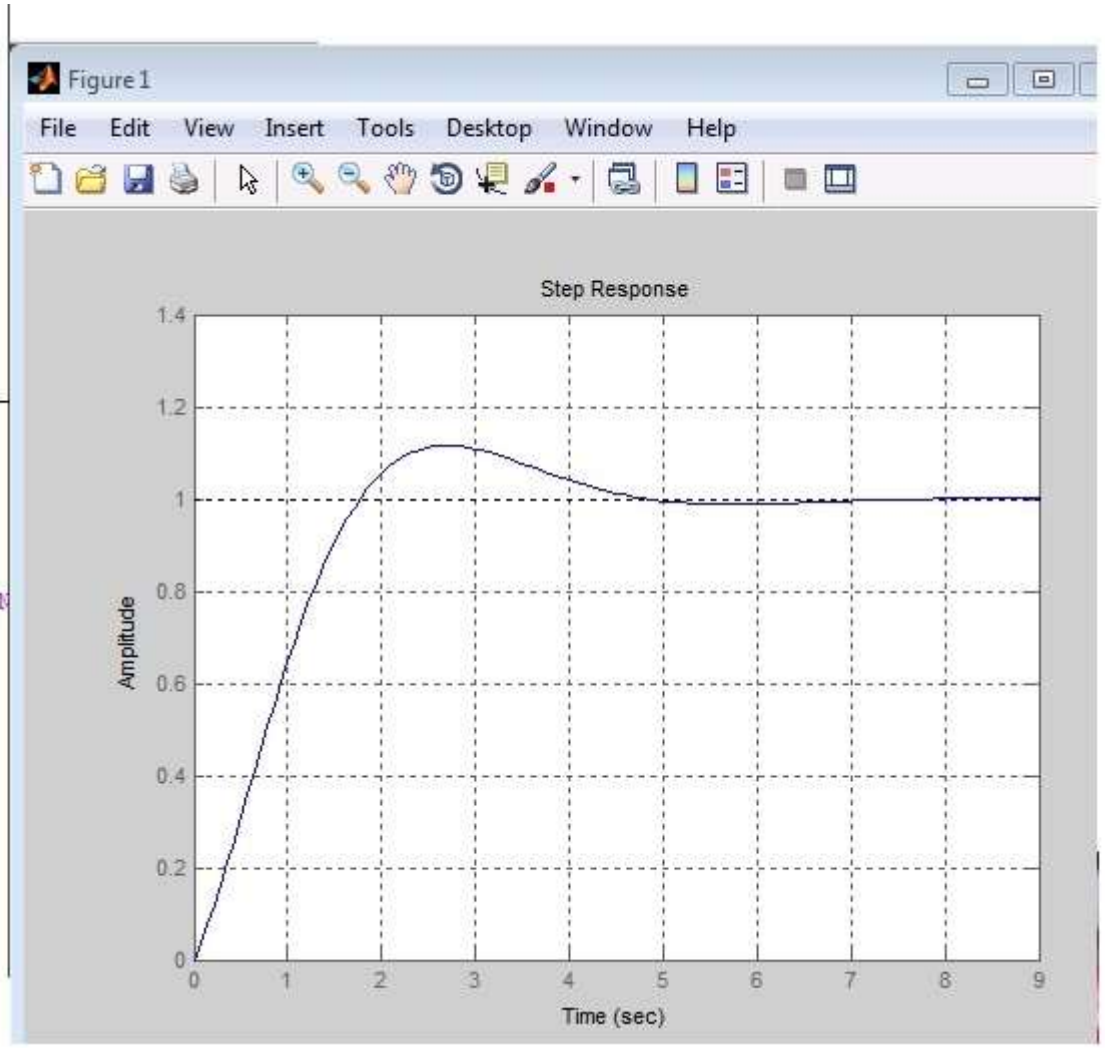
Przykład 1: obiekt = 1/(s+1), regulator = Kp + Ki/s

funkcja pidtune

```
close all, clear all
s=tf('s');
K1=1; T1=1;
G1=K1/(T1*s+1);

[C,info]=pidtune(G1,'pi')
R=C;                                  %1.sposob
%Kp=C.Kp; Ki=C.Ki; R=Kp+Ki/s;         %2.sposob
Gz1=feedback(G1*R,1);
step(Gz1);
stepinfo(Gz1), %allmargin(G1*R) i info
```

```
Continuous-time PI controller in parallel form:
                1
Kp + Ki * ---                                   i;
                s
with Kp = 0.47319, Ki = 1.6046
info =                                          (ZN
                 Stable: 1
    CrossoverFrequency: 1.1237
           PhaseMargin: 60.0000
ans =
        RiseTime: 1.3003
    SettlingTime: 4.3377
     SettlingMin: 0.9053
     SettlingMax: 1.1158
       Overshoot: 11.5817
      Undershoot: 0
            Peak: 1.1158
        PeakTime: 2.7063
```



W Simulinku: blok PID + PID Tuner

Przykład 1: obiekt = 1/(s+1), regulator = Kp + Ki/s

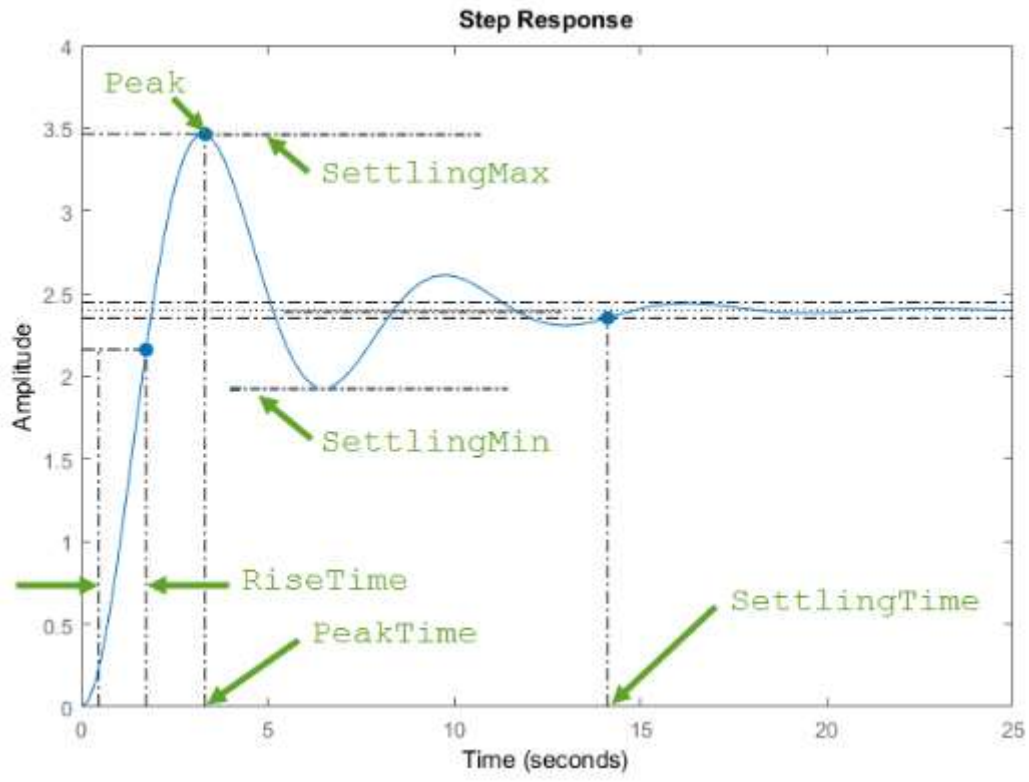
funkcja pidtune

```
close all, clear all
s=tf('s');
K1=1; T1=1;
G1=K1/(T1*s+1);

[C,info]=pidtune(G1,'pi')
R=C;                                  %1.sposob
%Kp=C.Kp; Ki=C.Ki; R=Kp+Ki/s;         %2.sposob
Gz1=feedback(G1*R,1);
step(Gz1);
stepinfo(Gz1), %allmargin(G1*R) i info
```

```
Continuous-time PI controller in parallel form:
                1
Kp + Ki * ---                                   i;
                s
with Kp = 0.47319, Ki = 1.6046
info =                                          (Z
                  Stable: 1
    CrossoverFrequency: 1.1237
           PhaseMargin: 60.0000
ans =
        RiseTime: 1.3003
    SettlingTime: 4.3377
     SettlingMin: 0.9053
     SettlingMax: 1.1158
       Overshoot: 11.5817
      Undershoot: 0
            Peak: 1.1158
        PeakTime: 2.7063
```

Definicje parametrów



Overshoot = (SettlingMax – xk)/(xk-xp) *100%

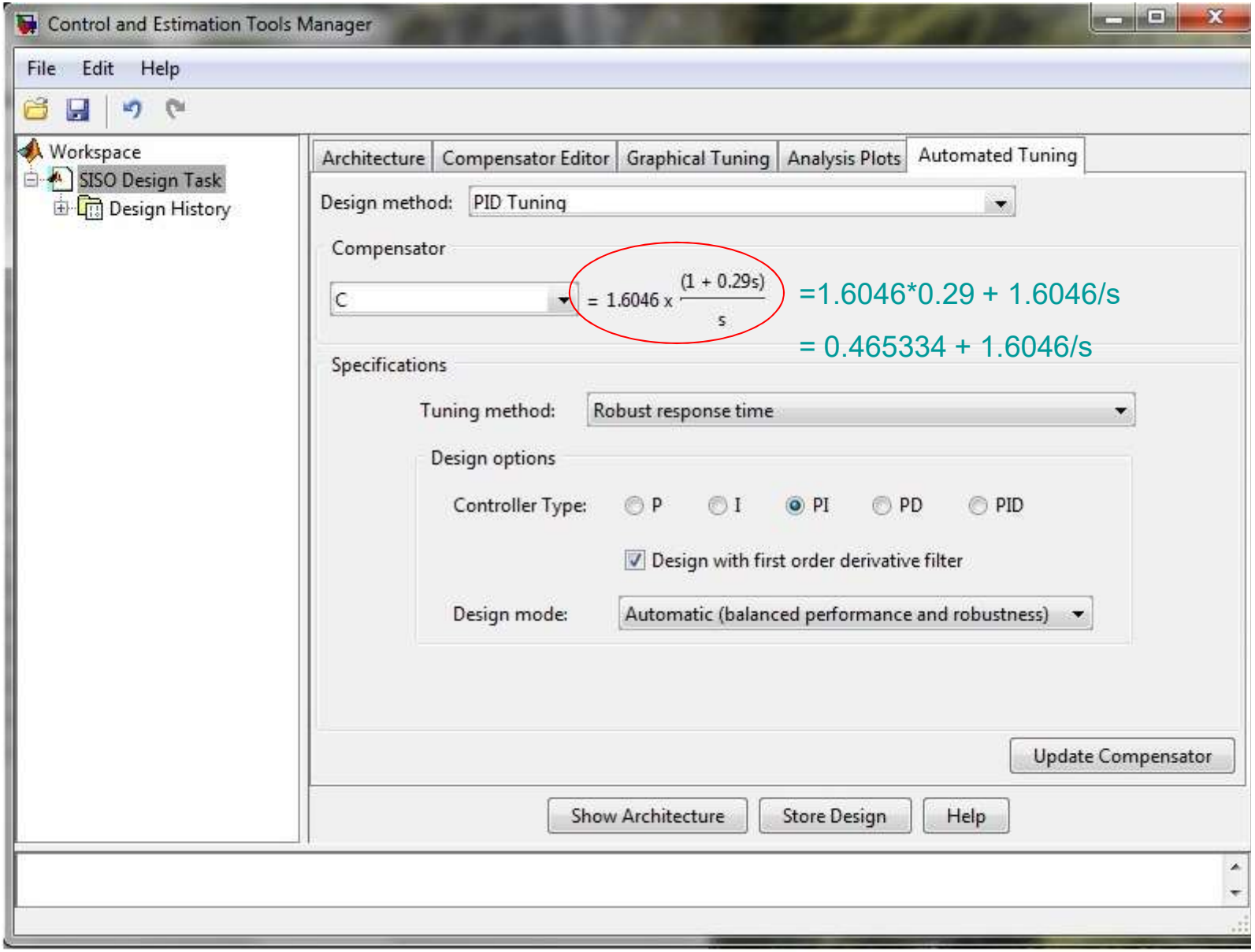
Przykład 1: obiekt = 1/(s+1), regulator = Kp + Ki/s

sisotool

```
s=tf('s');
G=1/(1*s+1);

Kp=1; Ki=1;
R=Kp+Ki/s;

%Gz=feedback(G*R,1);
sisotool(G,R)
```



=1.6046*0.29 + 1.6046/s

= 0.465334 + 1.6046/s

Przykład 2: obiekt = 1/(10s+1)*exp(-s), regulator = Kp + Ki/s

funkcja pidtune

PI_rz10to_txt.m

```
s=tf('s');
G=1/(10*s+1)*exp(-s);
Kp=1; Ki=1;
R=Kp+Ki/s;
[C info]= pidtune(G,'pi')
R=C;
Gz=feedback(G*R,1);
step(Gz)
stepinfo(Gz)
```

Command Window

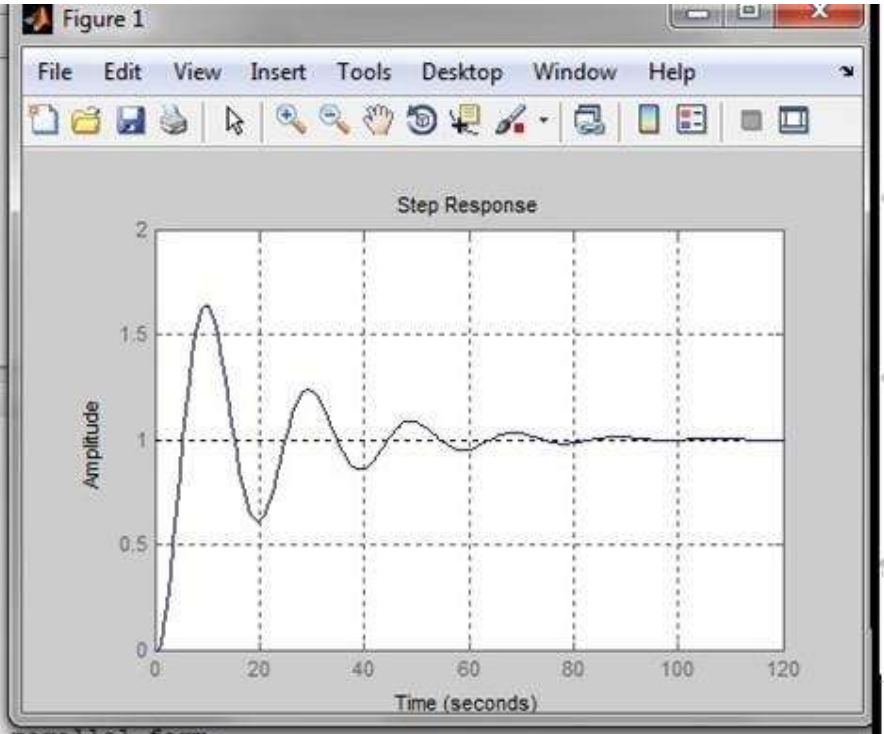
```
C =

             1
  Kp + Ki * ---
             s

  with Kp = 0.552, Ki = 0.141

Continuous-time PI controller in parallel form.

info =
                 Stable: 1
    CrossoverFrequency: 0.1049
           PhaseMargin: 60.0000
ans =
        RiseTime: 3.2878
    SettlingTime: 71.4931
     SettlingMin: 0.6121
     SettlingMax: 1.6382
       Overshoot: 63.8171
      Undershoot: 0
            Peak: 1.6382
        PeakTime: 9.5895
>>
```




```
s=tf('s');
G=1/(10*s+1)*exp(-s);
Gp=1/(10*s+1)*pade(exp(-s),1);
Kp=1; Ki=1;
R=Kp+Ki/s;

%Matlab > R2010b
[C info]= pidtune(G,'pi') R=C;
Gz=feedback(G*R,1);
step(Gz)
stepinfo(Gz)

%zawsze
[C info]= pidtune(Gp,'pi') R=C;
Gz=feedback(Gp*R,1);
step(Gz)
stepinfo(Gz)
```

```
             1
  Kp + Ki * ---
             s

  with Kp = 0.61518, Ki = 0.15101

info =

                 Stable: 1
    CrossoverFrequency: 0.1110
           PhaseMargin: 60.0000
ans =

        RiseTime: 3.3021
    SettlingTime: 71.3813
     SettlingMin: 0.6148
     SettlingMax: 1.6368
       Overshoot: 63.6762
      Undershoot: 1.8514
            Peak: 1.6368
        PeakTime: 9.7800
```

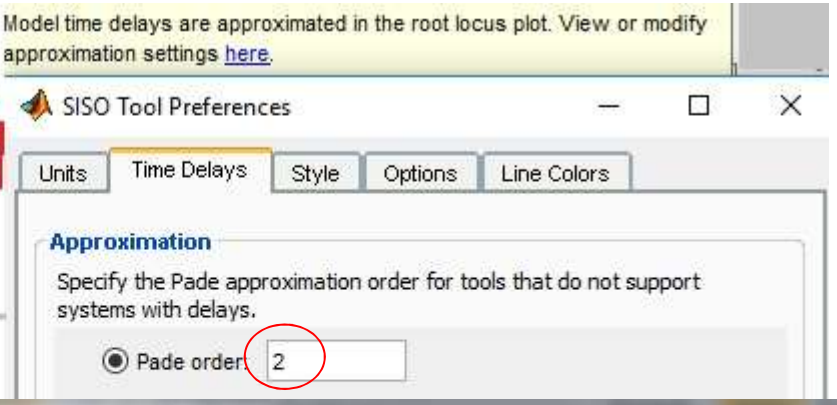
Przykład 2: obiekt = 1/(10s+1)*exp(-s), regulator = Kp + Ki/s

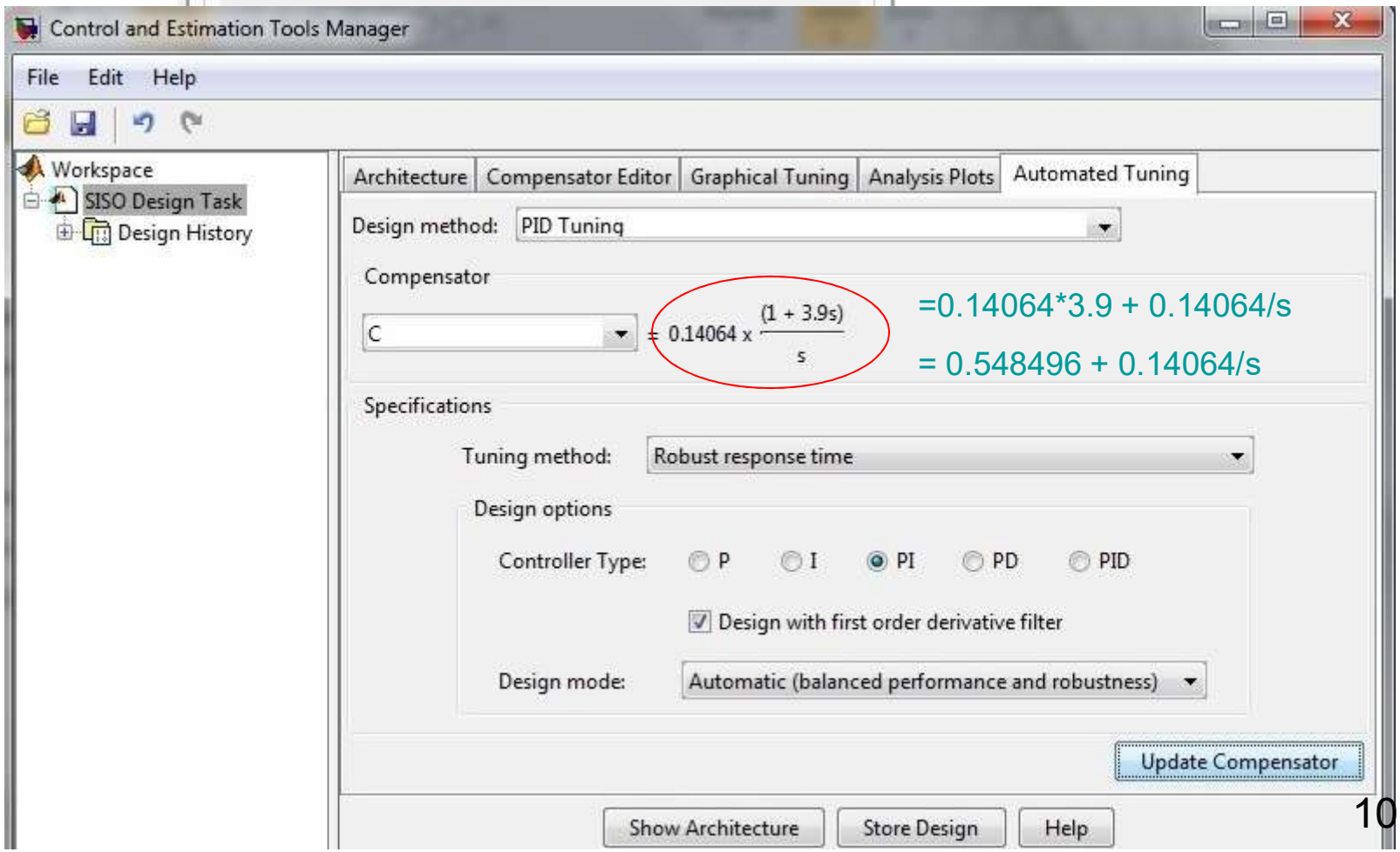
sisotool

```
s=tf('s');
G=1/(10*s+1)*exp(-s);
Gp=1/(10*s+1)*pade(exp(-s),1);
Kp=1; Ki=1;
R=Kp+Ki/s;

%aproksymacja automatyczna
sisotool(G,R)

%aproksymacja ręczna
sisotool(Gp,R)
```





=0.14064*3.9 + 0.14064/s

= 0.548496 + 0.14064/s