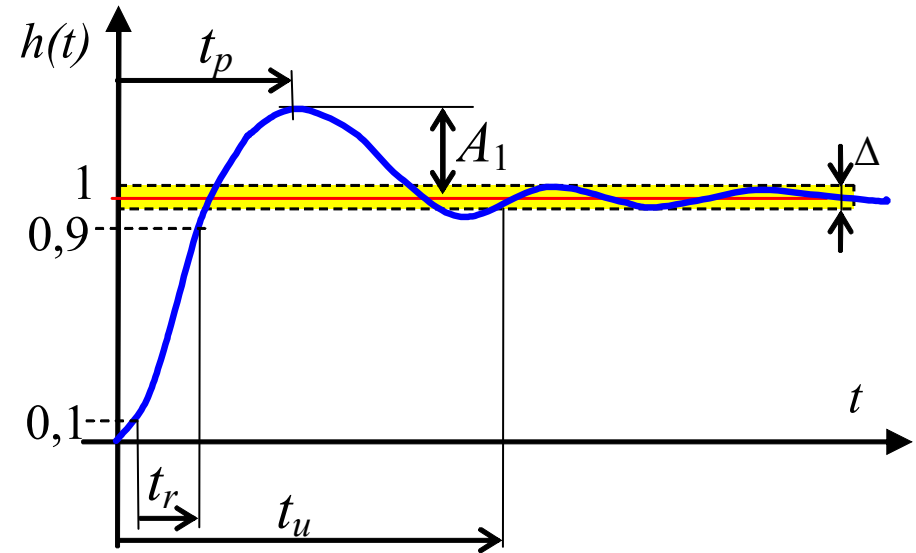
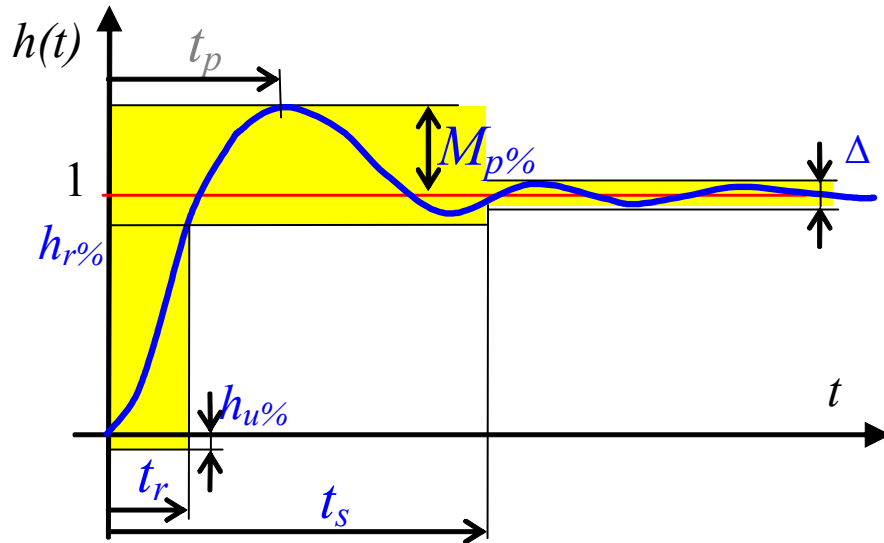


Bezpośrednie wskaźniki jakości



e_s , e_k - uchyb ustalony (końcowy); Δ – tolerancja uchybu

A_1 - przeregulowanie (e_1 - max uchyb dynamiczny)

t_p - czas pierwszego przeregulowania; t_r - czas narostu; t_u - czas regulacji (czas ustalania)

e_s – steady-state error; Δ - percent settling, e.g.= $\pm 1\%$ ($\pm 5\%$)

M_p – overshoot ($M_{p\%}$ - percent overshoot, e.g.=20%);

t_p - peak time; t_r – rise time; t_s – settling time

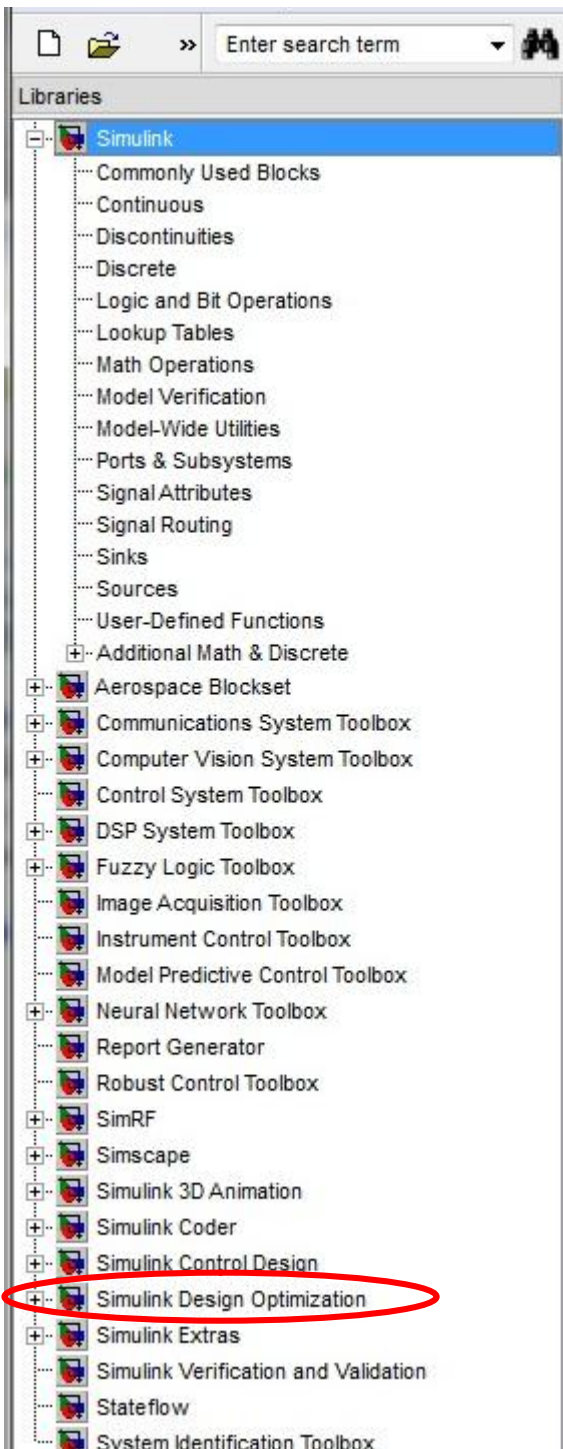
$h_{r\%}$ - percent rise, e.g.=90%; $h_{u\%}$ - percent undershoot, e.g.=1

Simulink Optimization Design - uruchomienie

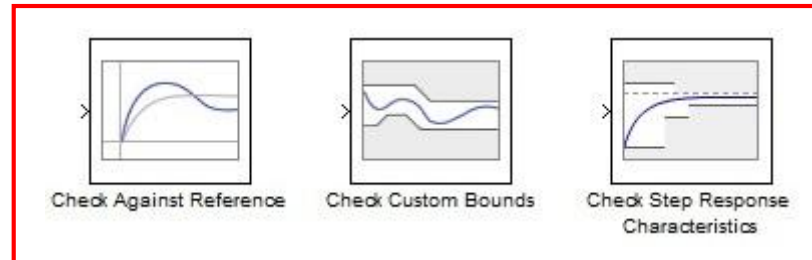
The screenshot displays the MATLAB Simulink environment. On the left, the 'Libraries' pane shows the 'Simulink Design Optimization' toolbox selected and circled in red. The main workspace shows a Simulink model named 'test_sdo4c' with a 'Step' block connected to an 'Add' block. The 'Tools' menu is open, and the 'Response Optimization...' option is circled in red. The 'Tools' menu includes options such as Simulink Debugger, Model Advisor, Model Dependencies, Fixed-Point Tool, Lookup Table Editor, Define Data Classes, Bus Editor, Profiler, Coverage Settings, Requirements, Inspect Logged Signals, Signal & Scope Manager, Code Generation, External Mode Control Panel, Control Design, Parameter Estimation, Report Generator, Compare Simulink XML Files, Data Object Wizard, MPlay Video Viewer, and Run on Target Hardware.

*Matlab + Simulnik + Optimization + Simulink Optimization Design
[lub + Simulink Control Design]*

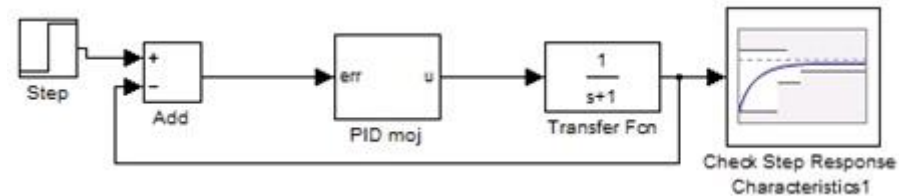
Simulink Optimization Design - bloki



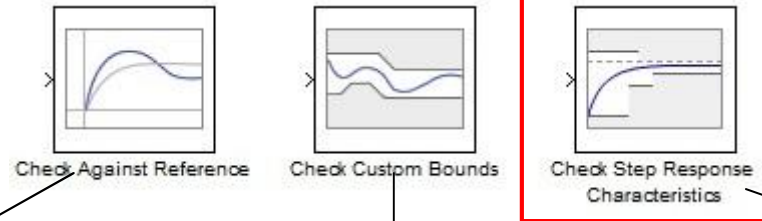
Model Verification



- 1) Wybór bloku
- 2) Podłączenie sygnału



Simulink Optimization Design - bloki



2) Podłączenie sygnału
3) Definicja wskaźników

2

3

Sink Block Parameters: Check Against Reference1

Check Against Reference

Assert that the input signal tracks the specified reference signal.

Bounds Assertion

Include reference signal tracking in assertion

Times (seconds):

Amplitudes:

Absolute tolerance:

Relative tolerance:

Show Plot Show plot on block open **Response Optimization...**

OK Cancel Help Apply

Sink Block Parameters: Check Custom Bounds1

Check Custom Bounds

Assert that the input signal satisfies the specified bounds.

Bounds Assertion

Include upper bound in assertion

Times (seconds):

Amplitudes:

Include lower bound in assertion

Times (seconds):

Amplitudes:

Enable zero-crossing detection

Show Plot Show plot on block open **Response Optimization...**

OK Cancel Help Apply

Sink Block Parameters: Check Step Response Characteristics1

Check Step Response Characteristics

Assert that the input signal satisfies bounds specified by step response characteristics.

Bounds Assertion

Include step response bound in assertion

Step time (seconds):

Initial value: Final value:

Rise time (seconds): % Rise:

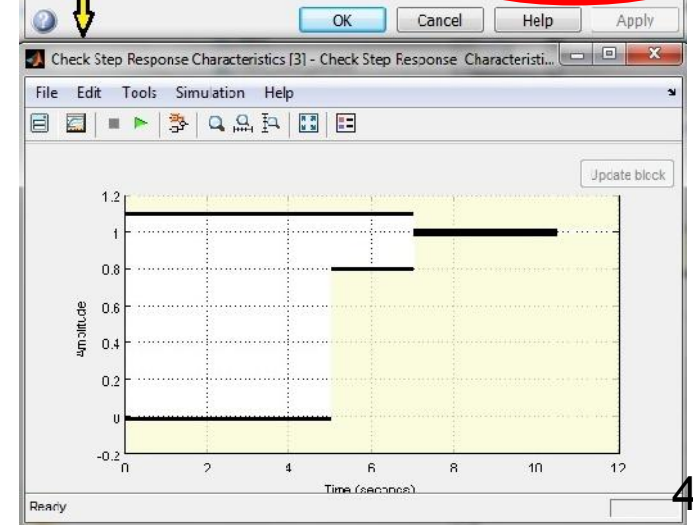
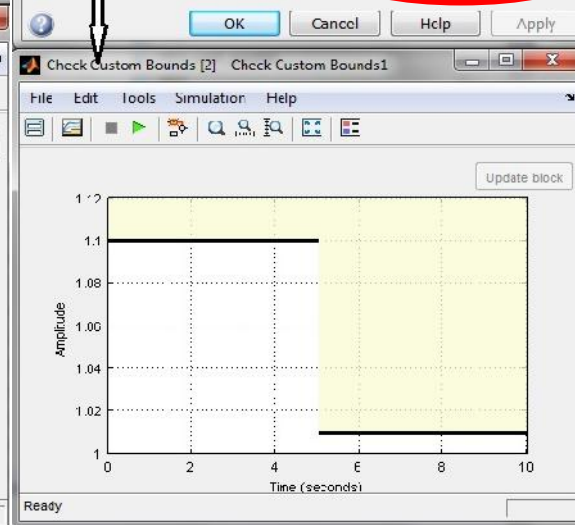
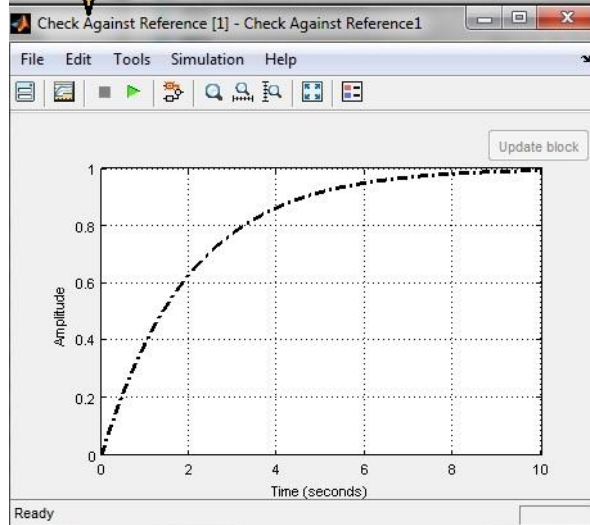
Setting time (seconds): % Settling:

% Overshoot: % Undershoot:

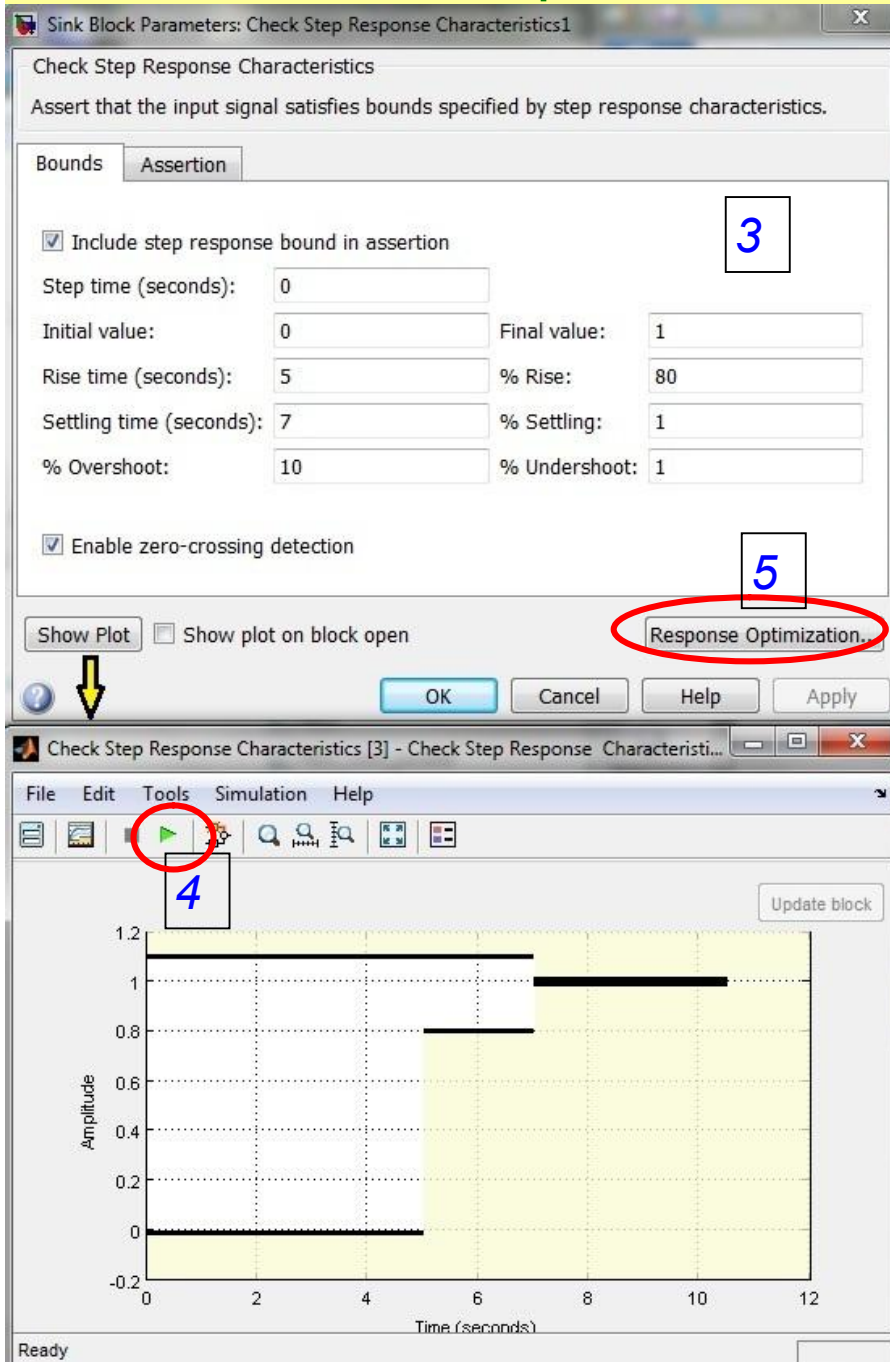
Enable zero-crossing detection

Show Plot Show plot on block open **Response Optimization...**

OK Cancel Help Apply



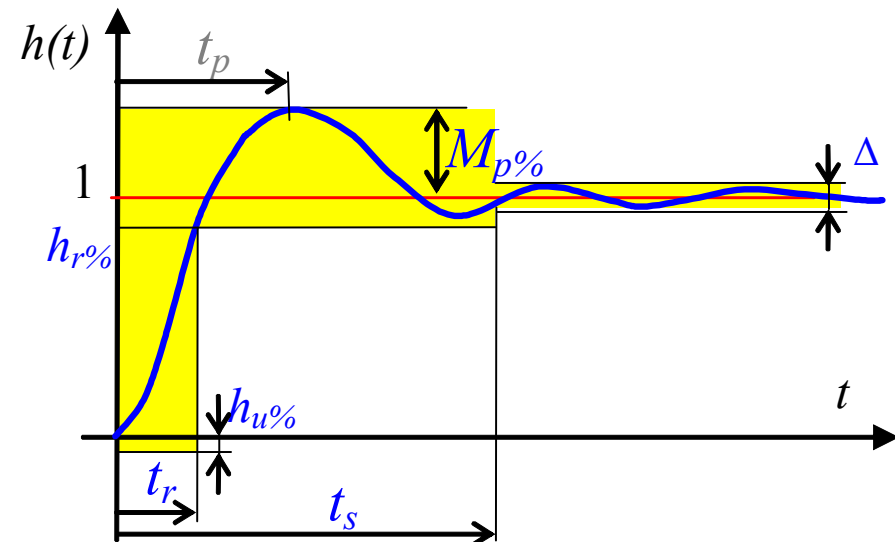
Simulink Optimization Design – blok Step Response



3) Definicja wskaźników
4) Sprawdzenie

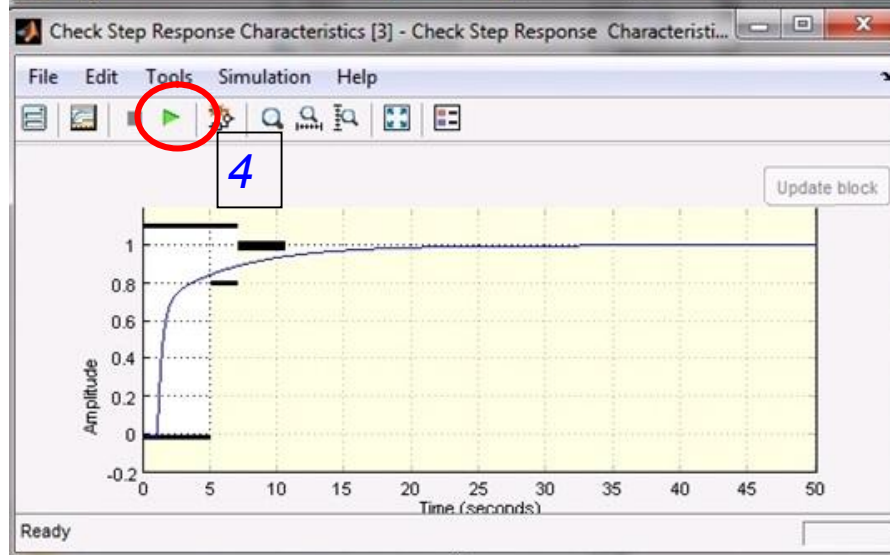
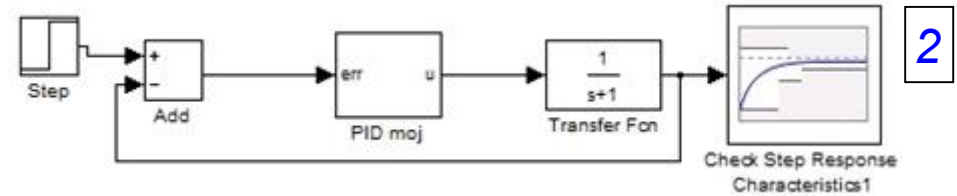
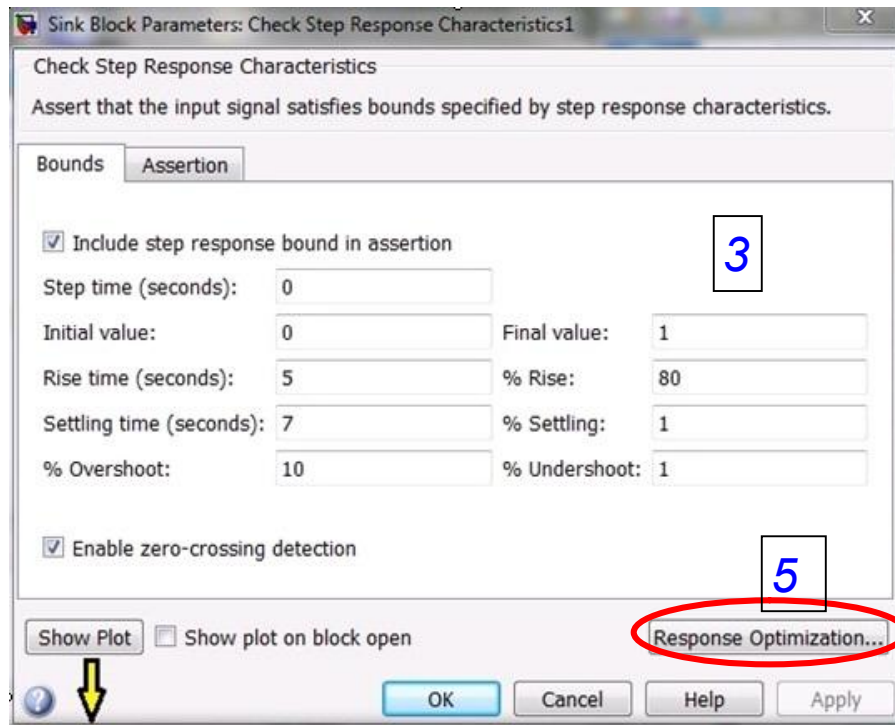
Settling time $t_s = 3$
 Percent settling $\Delta = 1$
 Percent overshoot $M_{p\%} = 20$
 Rise time $t_r = 1$
 Percent rise $h_{r\%} = 90$
 Percent undershoot $h_{u\%} = 1$

Step time = t_0 Final time = t_k
 Initial output = h_0 Final output = h_k



Simulink Optimization Design – Response Optimization

- 4) Sprawdzenie
- 5) Wywołanie Optymal.



Simulink Optimization Design – Response Optimization

The screenshot displays the Simulink Design Optimization interface for a response optimization task. The 'RESPONSE OPTIMIZATION' tab is active. The 'Design Variables Set' is set to 'None', and the 'Uncertain Variables Set' is also 'None'. The 'Data to Plot' dropdown is set to 'No data selected'. The 'Plot Current Response' button is highlighted with a red circle and labeled '4'. The 'Optimize' button is highlighted with a red circle and labeled '7'. The 'Update block' button is visible at the bottom right of the plot area.

The plot area shows a step response graph titled 'test_sdo4/Check Step Response Characteristics1'. The y-axis is labeled 'Amplitude' and ranges from -0.2 to 1.2. The x-axis is labeled 'Time (seconds)' and ranges from 0 to 12. The plot shows a step function that starts at 0, jumps to 1.1 at approximately 5.5 seconds, and then jumps to 1.0 at approximately 7.5 seconds. A yellow shaded region highlights the plot area.

On the left side, the 'Data Browser' shows the workspace structure:

- MATLAB Workspace
- Model Workspace (test_sdo4)
- Design Optimization Workspace
- Variable Preview

Annotations in blue text on the right side of the plot area indicate the steps:

- 5) Wywołanie Optymal.
- [4] Sprawdzenie]
- 6) Wybranie nastaw
- 7) Uruchomienie

Simulink Optimization Design – Response Optimization

- 7) Uruchomienie
- 8) Praca Optymalizatora
- 9) Wyniki

Response characteristics
the input signal satisfies bounds specified by step response characteristics.

Assertion

step response bound in assertion
(seconds): 0
e: 0 Final value: 1
(seconds): 5 % Rise: 90

DESIGN OPTIMIZATION RESPONSE OPTIMIZATION PLOT

Design Variables Set: DesignVars

Uncertain Variables Set: None

Optimize

Time plot 1

test_sdo4c/Check Step Response Characteristics1

Amplitude

Time (seconds)

Design Optimization Workspace

Name	Value
DesignVars	<2x1 para...>
ReqValues	<1x1 struct>

Variable Preview

DesignVars(1,1) =

- Name: 'K'
- Value: 2.8574
- Minimum: -Inf
- Maximum: Inf
- Free: 1

Optimization Progress

Iter	F-count	f(x)	max constraint
0	5	0	3.3828
1	10	0	0.2582
2	15	0	0.0127
3	20	0	0.0022
4	25	0	1.1988e-04

Optimization started 11-Mar-2013 09:48:02
Optimization converged, 11-Mar-2013 09:48:12

Optimized variable values written to 'DesignVars' in the Design Optimization workspace
'test_sdo4c' updated with optimized values
Optimized requirement values written to 'ReqValues' in the Design Optimization workspace

Optimization solver output:

Simulink Optimization Design – Response Optimization

2 Check Step Response Characteristics

Assert that the input signal satisfies bounds specified by step response characteristics.

3 Include step response bound in assertion

Step time (seconds): 0

Initial value: 0 Final value: 1

Rise time (seconds): 5 % Rise: 80

Settling time (seconds): 7 % Settling: 1

% Overshoot: 10 % Undershoot: 1

Enable zero-crossing detection

Show Plot Show plot on block open **5** Response Optimization

4 [Run Button]

6 Design Variables Set: DesignVars

7 Optimize

8 Design Optimization Workspace

Name	Value
K	2
KTi	0.5000
tout	<511x1 do...

9 DesignVars <2x1 param:Continuous>

```

val(1,1) =
    D
    Name: 'K'
    Value: 2
    Minimum: -Inf
    Maximum: Inf
    Free: 1
    Scale: 2
    Info: [1x1 struct]

val(2,1) =
    Name: 'KTi'
    Value: 0.5000
    Minimum: -Inf
    Maximum: Inf
    Free: 1
    Scale: 0.5000
    Info: [1x1 struct]
    
```

Time plot 1

There is no data for test_sdo4c/Check Step Response Characteristics1, use "Plot Current Response" or

test_sdo4c/Check Step Response Characteristics1

Amplitude

Time (seconds)

Update block

test_sdo4c *

File Edit View Simulation Format Tools Help

Step Add PID moj Transfer Fon Check Step Response Characteristics1

Ready 100% ode45