Narzędzia wspomagające projektowanie UR – SISO Design



Matlab+Control+...

Funkcje dla modeli LTI (wywoływane z linii komend) – Matlab+Control:

- Itiview(obiekt LTI) okno pt.: "LTI Viewer"
- pidtune(obiekt LTI, typ_regulatora) nastawy na ekranie
- sisotool(obiekt LTI) okno pt.: "Control and Estimation Tools Manager", (oraz "SISO Design", "LTI View")

Interaktywne interfejsy użytkownika wspomagające projektowanie - Matlab

 Linear Analysis Tools okno pt. "Linear Analysis Tools" moduły: Matlab + Simulink + Simulink Control Design + Control wywołanie: -schemat → Tools → Control Design → Linear Analysis 	\rightarrow LA \rightarrow SCD/2.2
 PID Tuner okno pt. "PID Tuner" moduły: Matlab + Simulink + Simulink Control Design + Control wywołanie: <i>blok PID (Simulink/Continues)</i> → <i>okno parametrów bloku</i> → <i>PID Tuner</i> 	→ PID_Tuner
 Compensator Design (SISO Design) okno pt. "Control and Estimation Tools Manager" (oraz "SISO Design", "LTI View") moduły: Matlab + Simulink + Simulink Control Design + Control wywołanie: schemat → Tools → Control Design → Compensator Design → okno Control and Estimation Manager → Tune Block Response Optimization 	→ SCD/2.1
 okno pt. "Response Optimization" moduły: Matlab + Simulink + Simulink Optimization Design + Optimization wywołanie: 	$\begin{array}{l} \rightarrow \ SDO \\ \rightarrow \ SDO \\ \rightarrow \ SCD/1 \end{array}$
 Schemat → Tools → Response Optimization blok Check (Simulink Optimization Design) → okno parametrów bloku → Response Optimization Check Against Reference, Check Custom Bounds, Check Step Response Characterisitics blok Check (Simulink Control Design) → okno parametrów bloku → Response Optimization Check Bode Characteristics, Check Gain and Phase Margins, Check Linear Step Response Characteristics Check Nichols Characteristics, Check Pole-Zero Characteristics, Check Singular Value Characteristics 	sitics

Narzędzia wspomagające projektowanie - Matlab

Matlab Product Family:



- 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
 - Itiview
 - pidtool
 - sisotool, sisoinit



help control



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

```
PID Tunner
```

```
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]) Wspomaganie doboru nastaw PID



Projektowanie wybranego układu regulacji dla obiektu LTI (układ SISO)

Matlab + Simulnik

grzejnik_PI			
File Edit View Simulation Format T	ools Help		
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	Profiler		
	Requirements	•	
100%	Inspect Logged Signals Signal & Scope Manager		//
	Control Design	•	Model Discretizer
	Data Object Wizard	T	

Matlab + Simulnik + Simulink Control Design + Control

Linear Analysis

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inputs, and 2	2 states.			A X
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Wywołanie: schem \rightarrow Tools

- → Control Desi
- → Linear Ana

Linearyzacja i anal



Matlab + Simulink + Simulink Control Design + Control

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Control and Estimation TM (SISO Desgin)



Matlab + Simulink + Simulink Optimization Design + Optimization

Response Optimization

DESIGN OPTIMIZATION	RESP	PONSE OPTIMIZA	ATION	PLOT			3	- 🖽 📖	BE
Design Variables Set:	☑ None ▾ ∠ ☑ None ▾ ∠	New 👻	Evaluate Requirements	Data to Plot:	▲ Add Plot	Plot rurrent Response	Options	Optimize	Close Tab
VARIABLES	S	REQUIR	REMENTS		PLOTS		OPTIMIZ	ATION	CLOS.
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np. Check [Linear] Step Response Characterisitics Linearyzacja i projektowanie układu SISO

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

blok PID + Tune

PI_rz1*	Function Block Parameters: PID Controller	
File Edit View Display Diagram Simulation Analysis C	Main PID Advanced Data Types State Attributes	A
	Controller parameters	
	Proportional (P): 1	Compensator formula
	Integral (I): 1	n_1
		Tune
Step Add PID Controller Transfer Fcn Scope		
	Initial conditions	
PID Tuner (PI_rz1/PID Controller)		
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		[
Plot: Step Response: Reference tracking	▼ Show block response	Hide parameters 🛛 💠
	Controller parameter	
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1	D	
ep 0.0	Performance and rob	ustness
₫ 0.6		Tuned Block
	Rise time	1.3 seconds 2.2 seconds
0.4//	Overshoot	4.34 seconds 3.91 seconds 11.6 % 0 %
02	Peak	1.12 1
	Block response Gain margin	Inf dB @ NaN rad/s Inf dB @ NaN rad/s
	Closed-loop stability	Stable Stable
U 1 2 3 4 5 Time (see	nds)	

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

funkcja pidtune



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

sisotool

<pre>s=tf('s'); C=1/(1ta:1);</pre>	🙀 Control and Estimation Too	Is Manager						
G=1/(1×3+1);	File Edit Help							
Kp=1; Ki=1; R=Kp+Ki/s;	6 🖬 🤊 🕫							
<pre>Kp=1; Ki=1; R=Kp+Ki/s; %Gz=feedback(G*R,1); sisotool(G,R) </pre>	Workspace SISO Design Task The Design History	Architecture Compensator Editor Graphical Tuning Automated Tuning Design method: PID Tuninq Compensator C = 1.6046 x = 1.6046 * 0.29 + 1.6046/s = 0.465334 + 1.6046/s Specifications Uning method: Robust response time Design options Controller Type: P I PI PD PID Ø Design with first order derivative filter Design mode: Automatic (balanced performance and robustness) Update Compensator 						
		Show Architecture Store Design Help						

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

funkcja pidtune



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

blok PID + Tune

im Simulation Analysis Code Tools Help	Function Block Parameters: PID Controller		
	Main PID Advanced Data Types	State Attributes	
PI_rz10to	Controller parameters Proportional (P): 1		Compensator formula
Step Add PID Controller Transfer Fcn Delay Scope Delay Scope Delay Scope Delay Scope Delay Scope Delay Scope	Integral (I): 1 Initial conditions	Tune	$P+I\frac{1}{s}$
PID Tuner (PI_rz10to/PID Controller)			
🔄 📴 🔍 🔍 🐑 📰 🌼 🧶 Design mode: Time domain 🔹	Form: Parallel Type: PI		
		Controller parameters	Rinsk
		P 0.55219 1 I 0.14064 1 D N	BIOCK
pp 1		Performance and robustness	
₩ 0.8		Tuned	Block
0.6	Block response	Rise time 13.2 seconds 3 Settling time 45.6 seconds 7 Overshoot 10.5 % 6 Peak 1.1 1 Gain margin 28.4 dB @ 1.47 rad/s 1	.29 seconds 1.5 seconds 3.8 % .64 4 dB @ 0.798 rad/s
	100 120 140	Phase margin 60 deg @ 0.105 rad/s 1 Closed-loop stability Stable 5	7 deg @ 0.316 rad/s itable

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

sisotool

<pre>s=tf('s');</pre>	Model time delays are approximated in the root locus	plot. View or modify	
<pre>Gp=1/(10*s+1)*exp(-s); Gp=1/(10*s+1)*pade(exp(-s),1) Kp=1; Ki=1;</pre>	SISO Tool Preferences	×	
R=Kp+Ki/s;	Units Time Delays Style Options I	Line Colors	
<pre>%aproksymacja automatyczna sisotool(G,R)</pre>	Approximation Specify the Pade approximation order for tools systems with delays.	that do not support	
<pre>%aproksymacja ręczna sisotool(Gp,R)</pre>	Pade order 2		
Control and	Estimation Tools Manager		
File Edit H	Help		
6 🖬 🤊	C.		
SISO Desi	sign Task gn History Architecture Compensator Design method: PID Tunin Compensator C Specifications Tuning method: Design options Controller Ty Design mode	Editor Graphical Tuning Analysis Plots q	Automated Tuning 064*3.9 + 0.14064/s 8496 + 0.14064/s D O PID re filter and robustness) • Update Compensator Help 18