Control and Stability in Wind Energy Converters Using Transfer Function Analysis

Assignment 2: Current Control

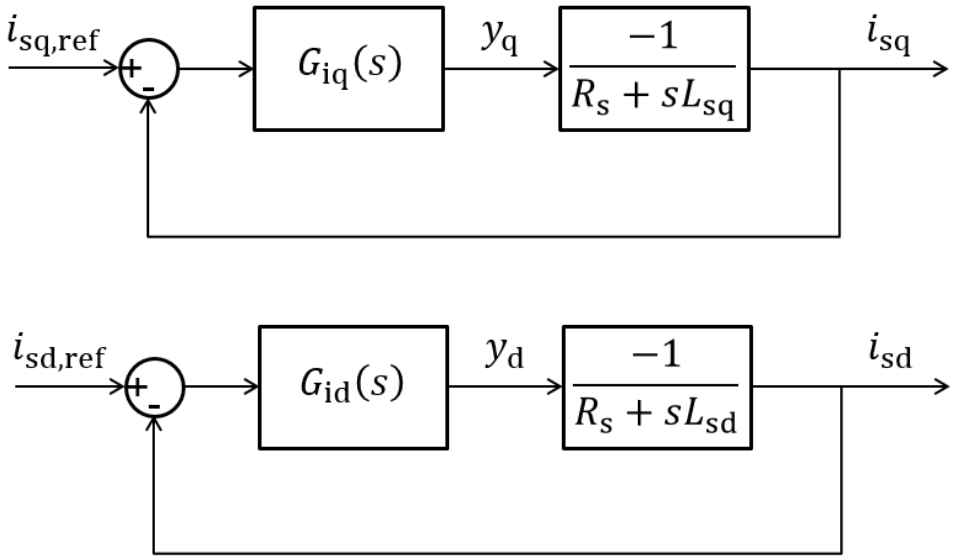
Renewable Energy Technology in Electric Networks WS 2020/2021

M.Sc. Stefan Häselbarth
Chair of Sustainable Electric Networks and Sources of Energy
Technische Universität Berlin

Assignment 2: Task 1

Calculate the current controller parameters $K_{d,I}$, $K_{d,P}$, $K_{q,I}$, and $K_{q,P}$ for τ_i = 3 ms. Include the results in the report.

1. Implement the model of the current control loops for *d*-axis and *q*-axis in Simulink. Show the implemented model in your report.



Assignment 2: Task 1

Validate your controller parameters for two operating points of the wind energy conversion system. Apply a step down of -25 A for i_{sq} and -3 A for i_{sd} after one second of simulation time.

1. First, take the reference currents for the rated operating point.
   Second, chose a different operating point suitable to the given step down.
   Run the simulation and plot reference and measured currents.

2. Explain your choice of the second operating point with regard to the step size and the validity of the linear model.

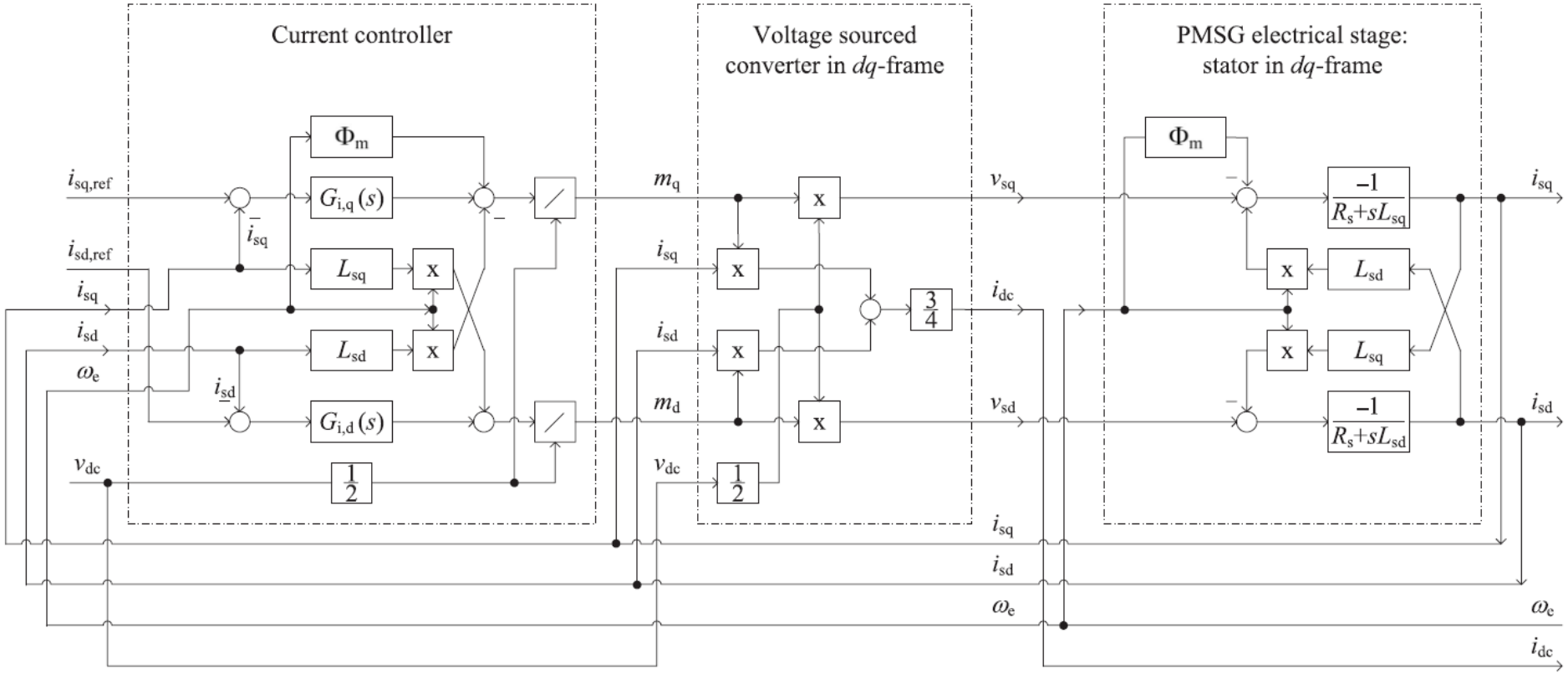
3. With regard to the steps, please mark time constant τ_i in each of your plots. Is the value of the measured current at this time point as expected? Justify your answer also by calculations.

4. Is the current controller behavior dependent on the operating point? Please give a reason for your answer.

Assignment 2: Task 2

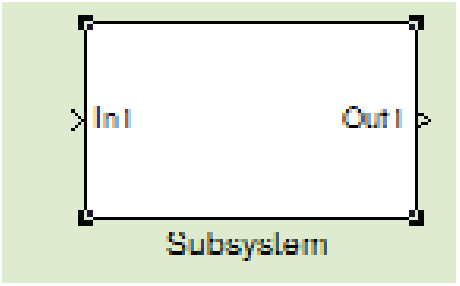
Implement the following block diagram in Simulink (Paper: Fig. 17).

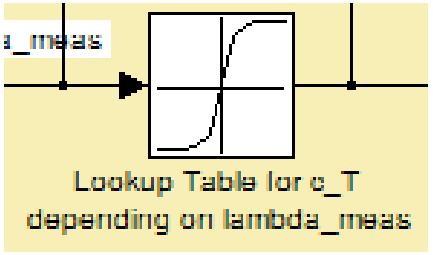
- Plot reference and measured currents for the rated operating point.
- Moreover, plot m_d, m_q and v_{sd}, v_{sq}.
- Plot the resulting current i_{dc} and verify with regard to v_{dc} and the expected power generation for this operating point that this value is as expected.

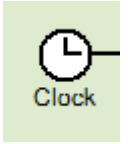


Simulink: Useful blocks for the assignments

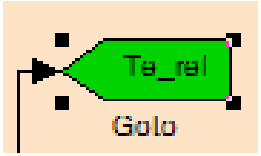
- Constant, Gain, Product, Sum, Integrator, Transfer Fcn, Fcn
- Subsystem
- Lookup table, clock
- From, goto
- Scope
- To file

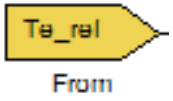


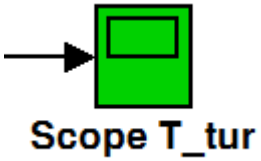


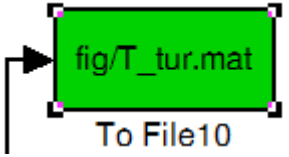


- Open a new Simulink file and insert these blocks from the Simulink library into the file by drag & drop.



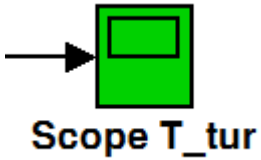




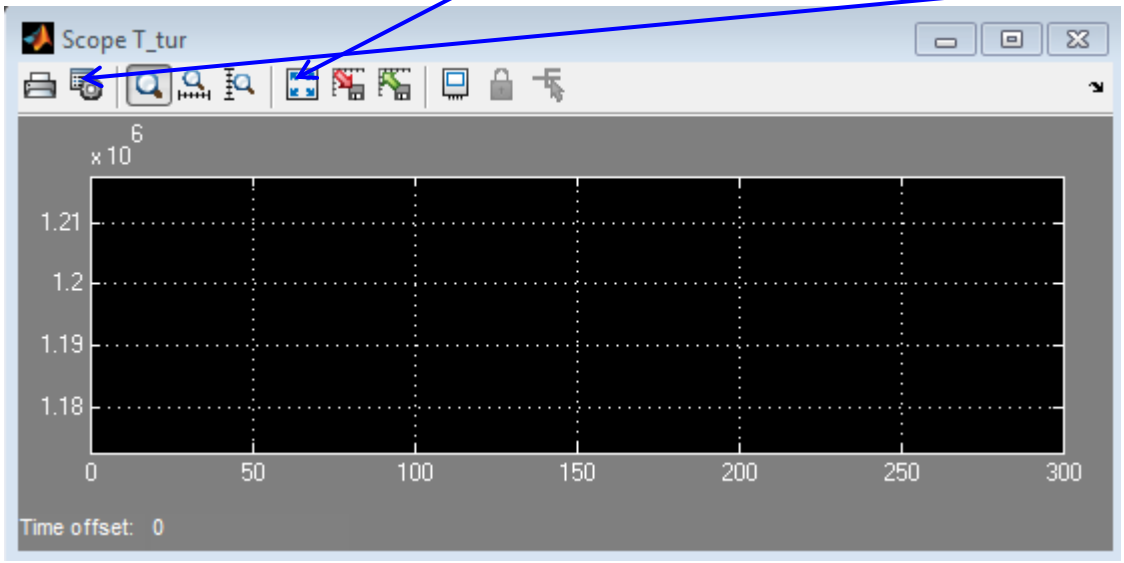


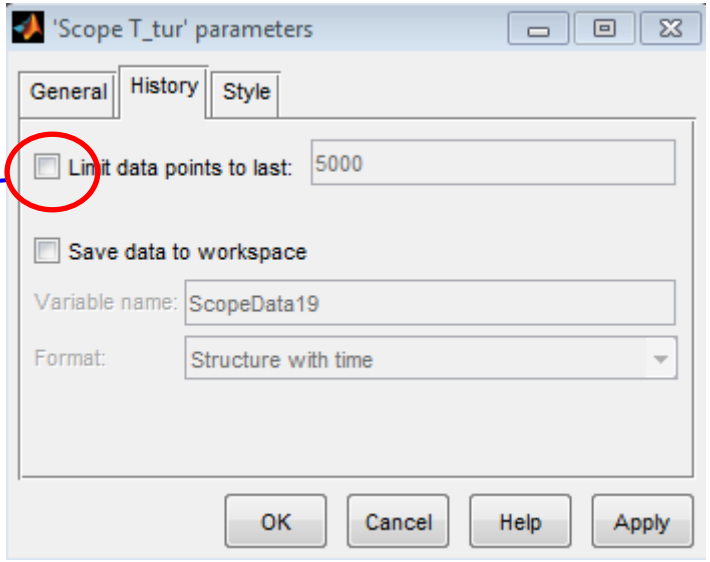
Background: Blocks for the Simulink Model

- The scope displays the variable where it is connected to.



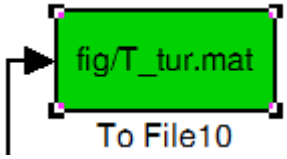
Full display



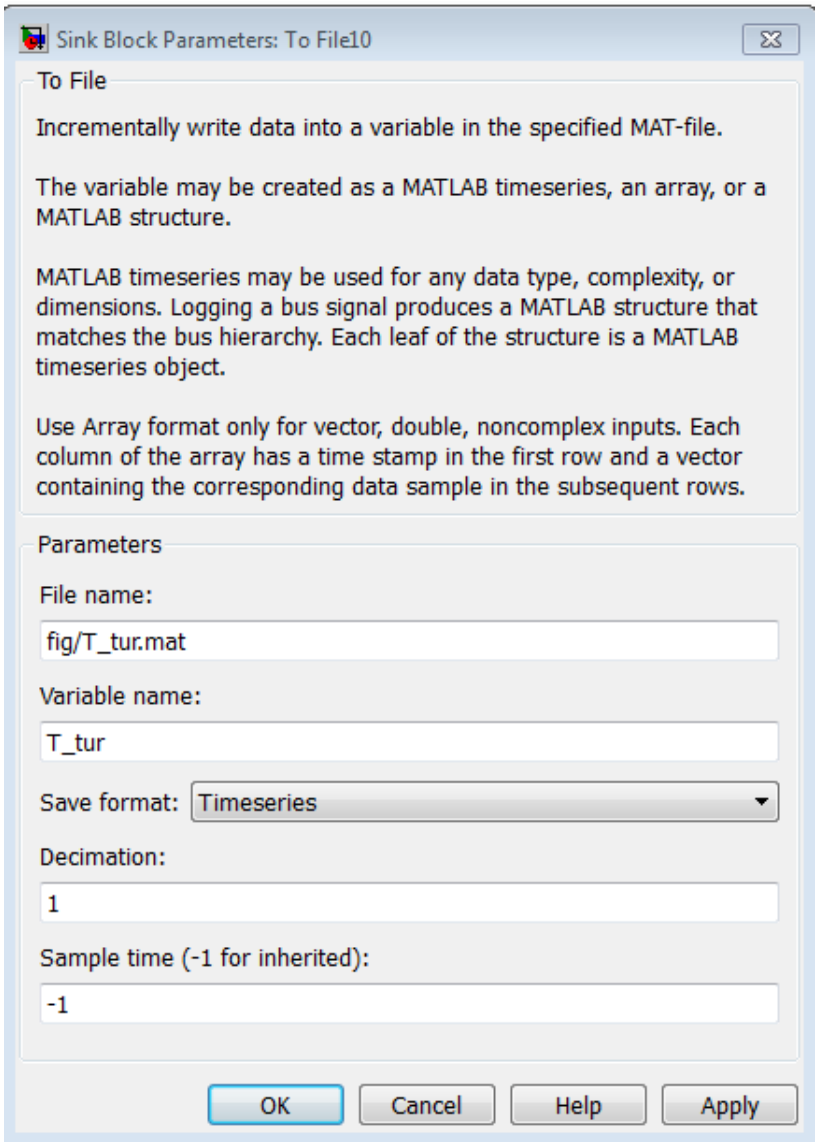


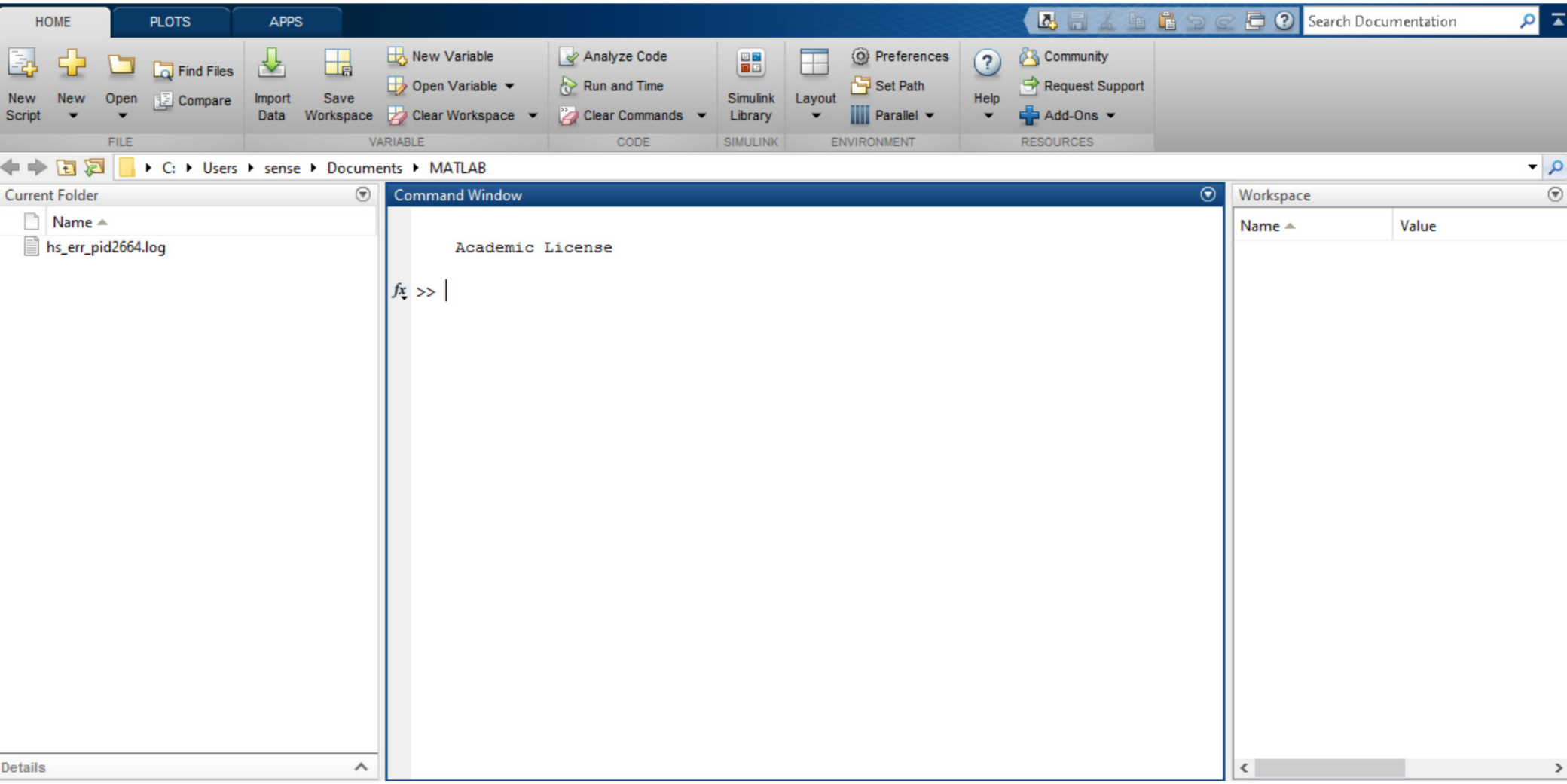
Background: Blocks for the Simulink Model

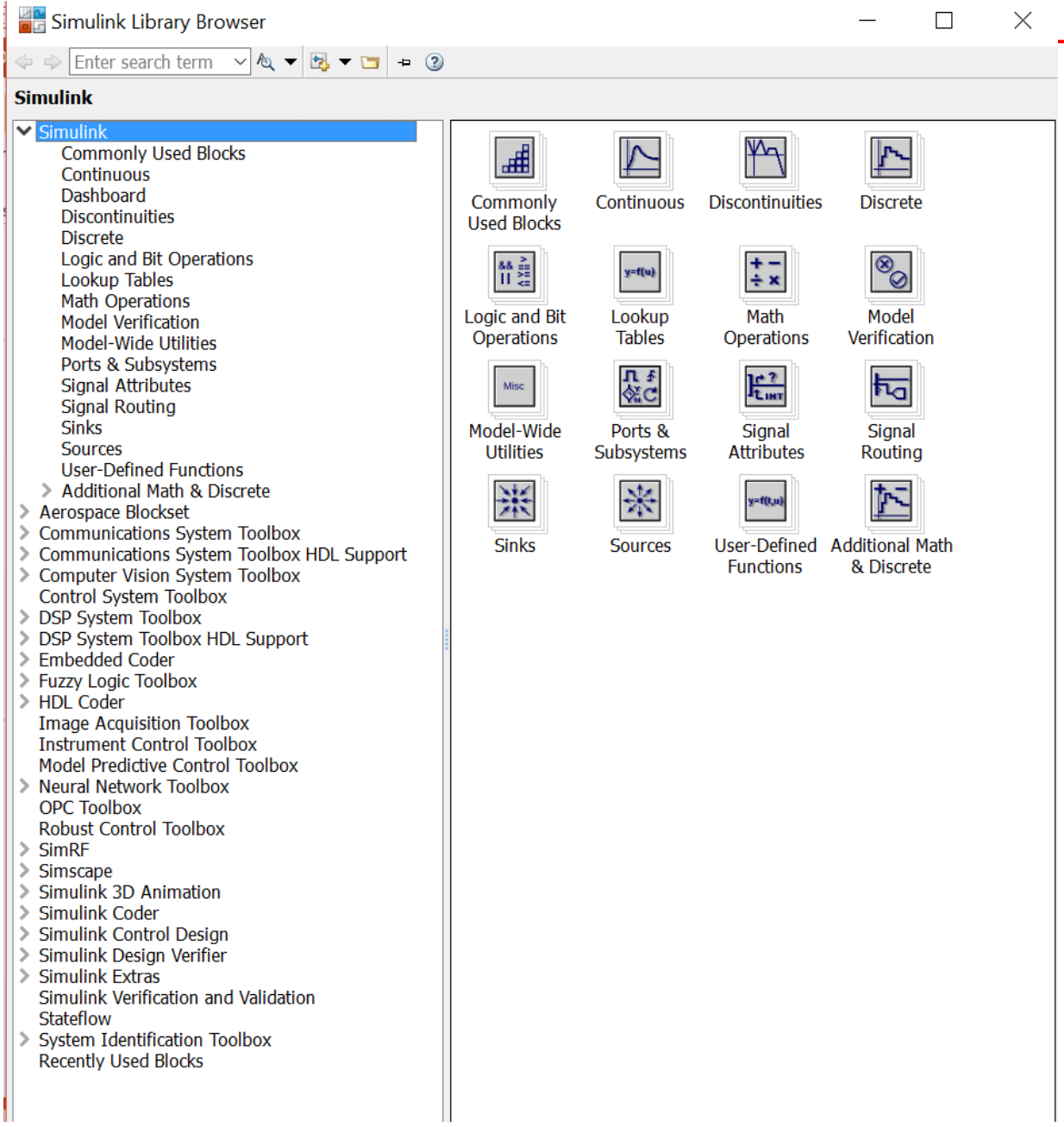
- „To File“ block is used to write the data into a file.
- Example: fig/T_tur.mat → the variable T_tur is written into a .mat file located in the folder „fig“ (this folder needs to be created by yourself before simulation in the same folder where your .m file and the .mdl file are.)



- To plot variable versus time: open the .m file
- Enter: load fig/T_tur.mat
- Enter: plot(T_tur.Time, T_tur.Data);




HOME
PLOTS
APPS
Search Documentation
New Script
New
Open
Find Files
Compare
Import Data
Save Workspace
New Variable
Open Variable
Clear Workspace
Analyze Code
Run and Time
Clear Commands
Simulink Library
Layout
Preferences
Set Path
Parallel
Help
Community
Request Support
Add-Ons
FILE
VARIABLE
CODE
SIMULINK
ENVIRONMENT
RESOURCES
C: ▸ Users ▸ sense ▸ Documents ▸ MATLAB
Current Folder
Name
hs_err_pid2664.log
Details
Command Window
Academic License
>>
Workspace
Name
Value


Simulink Library Browser
Enter search term
Simulink
Simulink
Commonly Used Blocks
Continuous
Dashboard
Discontinuities
Discrete
Logic and Bit Operations
Lookup Tables
Math Operations
Model Verification
Model-Wide Utilities
Ports & Subsystems
Signal Attributes
Signal Routing
Sinks
Sources
User-Defined Functions
Additional Math & Discrete
Aerospace Blockset
Communications System Toolbox
Communications System Toolbox HDL Support
Computer Vision System Toolbox
Control System Toolbox
DSP System Toolbox
DSP System Toolbox HDL Support
Embedded Coder
Fuzzy Logic Toolbox
HDL Coder
Image Acquisition Toolbox
Instrument Control Toolbox
Model Predictive Control Toolbox
Neural Network Toolbox
OPC Toolbox
Robust Control Toolbox
SimRF
Simscape
Simulink 3D Animation
Simulink Coder
Simulink Control Design
Simulink Design Verifier
Simulink Extras
Simulink Verification and Validation
Stateflow
System Identification Toolbox
Recently Used Blocks
Commonly Used Blocks
Continuous
Discontinuities
Discrete
Logic and Bit Operations
Lookup Tables
Math Operations
Model Verification
Model-Wide Utilities
Ports & Subsystems
Signal Attributes
Signal Routing
Sinks
Sources
User-Defined Functions
Additional Math & Discrete