Experimental Data of the Three-Mass Oscillator

Overview of the Downloadable Data
These data **should only be used as companion data for the book Identification of Dynamic Systems.** Using these data without a profound knowledge of the identification methods as described in the book will lead to useless and/or erroneous results.

The given measurements of the Three-Mass Oscillator **must be pre-processed** in order to obtain optimal results.

**The measurements have furthermore been sampled with very small sample times** in order to allow the user to downsample the data and hence adjust the sample rate and investigate the influence of the sample time on the results. Using the data directly with such heavy oversampling can result in numerical problems.
Some measurements have been conducted **on purpose** in such a **way that they do not provide useful results** as e.g. the input sequence does not excite the relevant system dynamics.

Please consult the appropriate sections in the book to see detailed discussions of the suitability of the input sequences.
### File Structure

<table>
<thead>
<tr>
<th>Variable</th>
<th>Name</th>
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<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>time</td>
<td>Motor Torque</td>
<td>MM</td>
</tr>
<tr>
<td>$\varphi_1$</td>
<td>phi1</td>
<td>$d\varphi_1 / dt$</td>
<td>dphi1</td>
</tr>
<tr>
<td>$\varphi_2$</td>
<td>phi2</td>
<td>$d\varphi_2 / dt$</td>
<td>dphi2</td>
</tr>
<tr>
<td>$\varphi_3$</td>
<td>phi3</td>
<td>$d\varphi_3 / dt$</td>
<td>dphi3</td>
</tr>
<tr>
<td>Sample Time</td>
<td>T0</td>
<td>Factor $\mu$ for PRBS</td>
<td>mue</td>
</tr>
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<td>T0</td>
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<td>mue</td>
</tr>
</tbody>
</table>

Non-Periodic Test Signals

\[ u(t) \]

\[ u_0 \]

\[ T \]

**Excitation**: Impulse, i.e. approximation by a short step of duration 0.1s and height 5 Nm over an offset of 0.7 Nm (total height 5.7 Nm). The impulse response is measured for comparison with methods that provide an impulse response as a model.

**Sample Time**: 0.003 s

**Files**:  
- `impulse_response`

Excitation: Square pulse of length 0.05 s and height 3 Nm over an offset of 0.7 Nm (total height 3.7 Nm)

Sample Time: 0.003 s

Files:
• square_T_0050_r_1
**Excitation:** Negative square pulse of length 0.15 s and height -3 Nm over an offset of -0.7 Nm (total height -3.7 Nm)

**Sample Time:** 0.003 s

**Files:**
- square_T_0150_l_1
- square_T_0150_l_2
- square_T_0150_l_3
- square_T_0150_l_4
Excitation: Negative square pulse of length 0.15 s and height -3 Nm over an offset of -0.7 Nm (total height -3.7 Nm)

Sample Time: 0.003 s

Files:
- square_T_0150_l_5
Excitation: Square pulse of length 0.15 s and height 3 Nm over an offset of 0.7 Nm (total height 3.7 Nm)

Sample Time: 0.003 s

Files:
- `square_T_0150_r_1`
- `square_T_0150_r_2`
- `square_T_0150_r_3`
- `square_T_0150_r_4`
**Excitation:** Square pulse of length 0.15 s and height 3 Nm over an offset of 0.7 Nm (total height 3.7 Nm)

**Sample Time:** 0.003 s

**Files:**
- `square_T_0150_r_5`
**Excitation**: Square pulse of length 0.21 s and height 3 Nm over an offset of 0.7 Nm (total height 3.7 Nm)

**Sample Time**: 0.003 s

**Files**:
- `square_T_0210_r_1`
**Excitation:** Square pulse of length 0.315 s and height 3 Nm over an offset of 0.7 Nm (total height 3.7 Nm)

**Sample Time:** 0.003 s

**Files:**
- `square_T_0315_r_1`
**Excitation:** Square pulse of length 0.465 s and height 3 Nm over an offset of 0.7 Nm (total height 3.7 Nm)

**Sample Time:** 0.003 s

**Files:**
- `square_T_0465_r_1`
**Excitation:** Square pulse of length 0.740 s and height 2.5 Nm over an offset of 0.7 Nm (total height 3.2 Nm)

**Sample Time:** 0.003 s

**Files:**
- `square_T_0740_r_1`
Square Pulse 1.000 s

**Excitation**: Square pulse of length 1.000 s and height 2 Nm over an offset of 0.7 Nm (total height 2.7 Nm)

**Sample Time**: 0.003 s

**Files**:
- `square_T_1000_r_1`

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Excitation: Negative step at time $t=10\text{ s}$ and height $-1.1\text{ Nm}$ over an offset of $-0.5\text{ Nm}$ (total height $-1.6\text{ Nm}$)

Sample Time: $0.003\text{ s}$

Files:
- `step_l_1`
- `step_l_2`
- `step_l_3`
- `step_l_4`
**Excitation:** Negative step at time $t=10$ s and height $-1.1$ Nm over an offset of $-0.5$ Nm (total height $-1.6$ Nm)

**Sample Time:** 0.003 s

**Files:**
- `step_l_5`
Step (1/2)

Excitation: Negative step at time $t=10$ s and height 1.1 Nm over an offset of 0.5 Nm (total height 1.6 Nm)

Sample Time: 0.003 s

Files:
- `step_r_1`
- `step_r_2`
- `step_r_3`
- `step_r_4`
**Excitation:** Step at time $t=10$ s and height 1.1 Nm over an offset of 0.5 Nm

**Sample Time:** 0.003 s

**Files:**
- step_r_5
**Excitation:** Triangular pulse of length 0.933 s and height 3 Nm over an offset of 0.7 Nm (total height 3.7 Nm)

**Sample Time:** 0.003 s

**Files:**
- `triangle_T_0933_1`
PRBS Signals

Shift Pulses

Excitation: PRBS with $\mu=17$ and values 0.8 Nm and 1.6 Nm

Sample Time: 0.003 s

Files:
- prbs_mu17_r_1
- prbs_mu17_r_2
- prbs_mu17_r_3
**Excitation:** PRBS with $\mu=50$ and values $0.8 \text{ Nm}$ and $1.6 \text{ Nm}$

**Sample Time:** $0.003 \text{ s}$

**Files:**
- prbs_mu50_r_1
- prbs_mu50_r_2
- prbs_mu50_r_3
- prbs_mu50_r_4
Excitation: PRBS with $\mu=50$ and values 0.8 Nm and 1.6 Nm

Sample Time: 0.003 s

Files:
- prbs_mu50_r_5
- prbs_mu50_r_6
- prbs_mu50_r_7
- prbs_mu50_r_8
**Excitation:** PRBS with $\mu=70$ and values 0.8 Nm and 1.6 Nm

**Sample Time:** 0.003 s

**Files:**
- `prbs_mu70_r_1`
- `prbs_mu70_r_2`
- `prbs_mu70_r_3`
**Excitation**: PRBS with $\mu=105$ and values 0.8 Nm and 1.6 Nm

**Sample Time**: 0.003 s

**Files**:
- `prbs_mu105_r_1`
- `prbs_mu105_r_2`
- `prbs_mu105_r_3`
**Excitation:** PRBS with $\mu=155$ and values 0.8 Nm and 1.6 Nm

**Sample Time:** 0.003 s

**Files:**
- prbs_mu155_r_1
- prbs_mu155_r_2
- prbs_mu155_r_3
**PRBS with μ=333**

**Excitation**: PRBS with μ=333 and values 0.8 Nm and 1.6 Nm

**Sample Time**: 0.003 s

**Files**:
- prbs_mu333_r_1
- prbs_mu333_r_2
- prbs_mu333_r_3
Periodic Signals

Test Signal Generator

\[ u_0 \sin \omega_0 t \]

\[ u_0 \cos \omega_0 t \]

Process

\[ y_n(t) \]

\[ \phi_{uy}(0) \]

\[ \phi_{uy}(T_P/4) \]

\[ \int_{0}^{n T_P} \frac{1}{n T_P} \int_{0}^{n T_P} ... dt \]

\[ \int_{0}^{n T_P} \frac{1}{n T_P} ... dt \]
### File Structure

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<thead>
<tr>
<th>Variable</th>
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<tbody>
<tr>
<td>$\omega$</td>
<td>$\omega$</td>
<td>rad/sec</td>
</tr>
<tr>
<td>Amplitude</td>
<td>amplitude_osc</td>
<td>rad/s Nm</td>
</tr>
<tr>
<td>Phase</td>
<td>phase_osc</td>
<td>rad</td>
</tr>
</tbody>
</table>
**Excitation:** Sinusoidal excitation and evaluation with the orthogonal correlation

**Data Points:** 68 data points between 0.1 rad/sec and 40 rad/sec.

**Files:**
- `freq_resp`

Evaluation with FR-LS for Continuous-Time Model

- Use data set `freq_resp`

- No further pre-processing necessary
Scheme of the Three-Mass Oscillator

Files

three-mass-oscillator-scheme.png
three-mass-oscillator-scheme.eps