PHILIPS CTT Hogeschool van Utrecht

Systeem en Regeltechniek
FMT / Mechatronica

Deel 1: Inleidende verkenning

Exercise: Modelling mass-spring system

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Cursus Systeem en Regeltechniek
Overzicht

Deel 1 *Wo. 14-04*
- Blok 1. Inleiding
- Blok 2. Basisprincipes modelvorming massa-veersystemen
- Blok 3. De regelaar als veer-demper combinatie

Deel 2 *Wo. 21-04* **Basisbegrippen regeltechniek**

Deel 3 *Wo. 28-04* **Vervolg regeltechniek**

Deel 4 *Wo. 12-05* **Stabiliteit van regelsystemen**

Deel 5 *Wo. 19-05* **Toepassing: PID regelaarontwerp**

Deel 6 *Wo. 26-05* **Extra regeltechniek**

20-sim exercise

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What is 20-sim?

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Introduction 20-sim

- Modelling package with emphasis on Control
- Iconic models - direct representation of mechanical system components
- Universal analysis environment for controlled (mechanical) systems
- Developed at University Twente (TUTSIM)

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Program structure

- Input:
  “20-sim Editor”
- Analysis:
  “20-sim Simulator”
- Output:
  “20-sim Linear System Editor”

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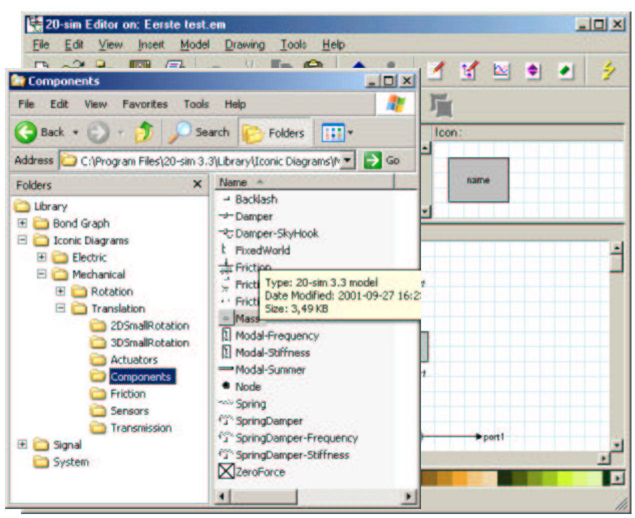
Program structure - Input

“Editor”:

- graphical input
- entry of electrical, mechanical and control components



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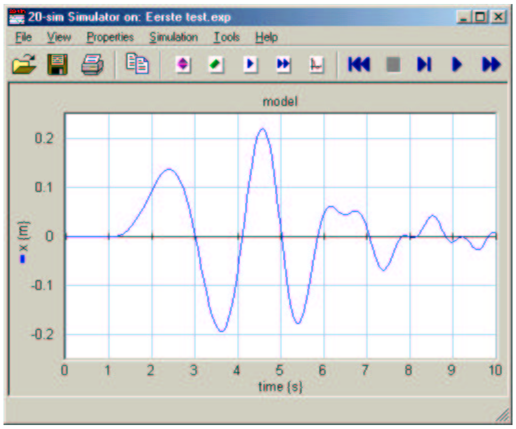
Program structure - Analysis

"Simulator":

- Time domain simulation (run)
- Time simulation output in plot
- Linearisation for frequency domain



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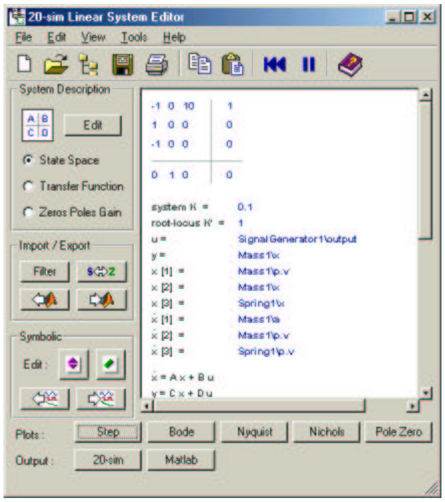
Program structure - Output

"Linear System Editor":

- Linear system representations
- Frequency response
- Plots:
  - Step
  - Bode / Nyquist / Nichols
  - Pole Zero map
- Other Tools



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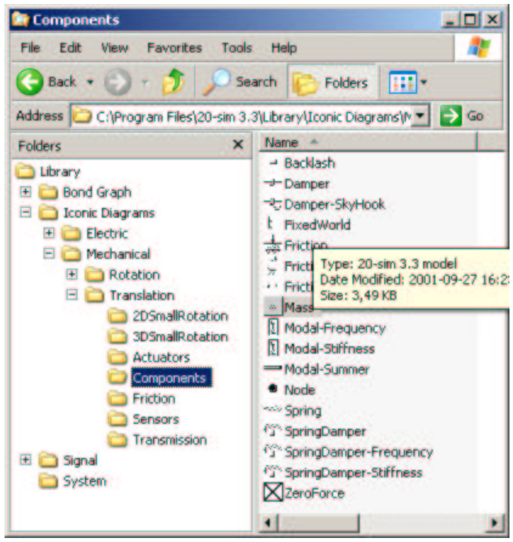
Basic Elements Mechatronic Library



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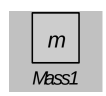
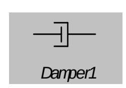
Basic Elements Mechatronic Library

- **Mass**
  - **Parameter: M = mass [Kg]**
  - **Single 1-dimensional mass**



- **Spring**
  - **Parameter: S = Stiffness (N/m)**
  - **position difference → force difference**
  - **$\Delta F = S * \Delta X$**

- **Damper**
  - **Parameter: D = damping [Ns/m]**
  - **velocity difference → force difference**
  - **$\Delta F = D * \Delta V$**



- **Mechanical ground**

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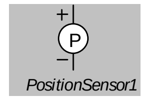
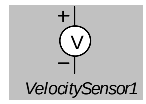
Sensors

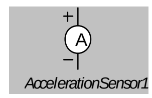
- **Position sensor**
  position → voltage (1 V/m)



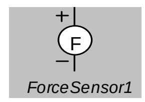
- **Velocity sensor**
  velocity → voltage (1 Vs/m)



- **Acceleration sensor**
  acceleration → voltage (1 Vs^2/m)



- **Force sensor**
  force → voltage (1 V/N)



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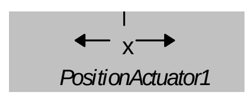
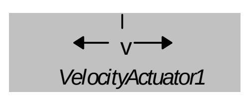
Actuators

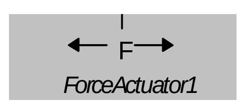
- **Position actuator**
  voltage → position (1 m/V)



- **Velocity actuator**
  voltage → velocity (1 m/sV)



- **Force actuator**
  voltage → force (1 N/V)



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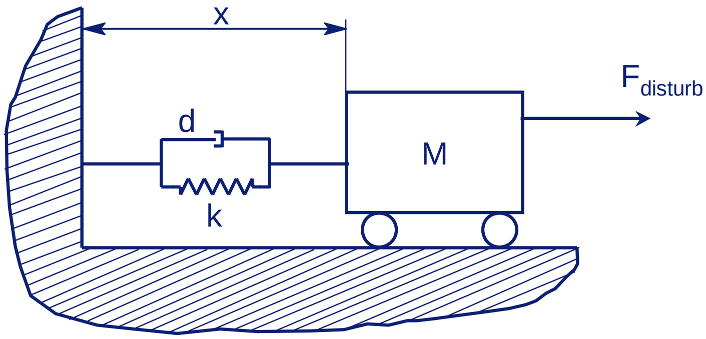
Exercise

Model the following mass-spring system in 20-sim:



M = 10 kg; k = 1500 N/m; d = 20 Ns/m

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Questions / assignments

- Compute the eigenfrequency by hand
- Compute the relative damping by hand
- Apply a disturbance force F = 1 N
- Run a simulation of the model
- Check the eigenfrequency and damping
- Vary the parameters M, k, d and investigate effect on response
- Double M and change k such that natural frequency remains the same
- Double k and change d such that relative damping remains the same