Karlsruher Institut für Technologie

Modeling and Simulation, Winter Term 2020/21

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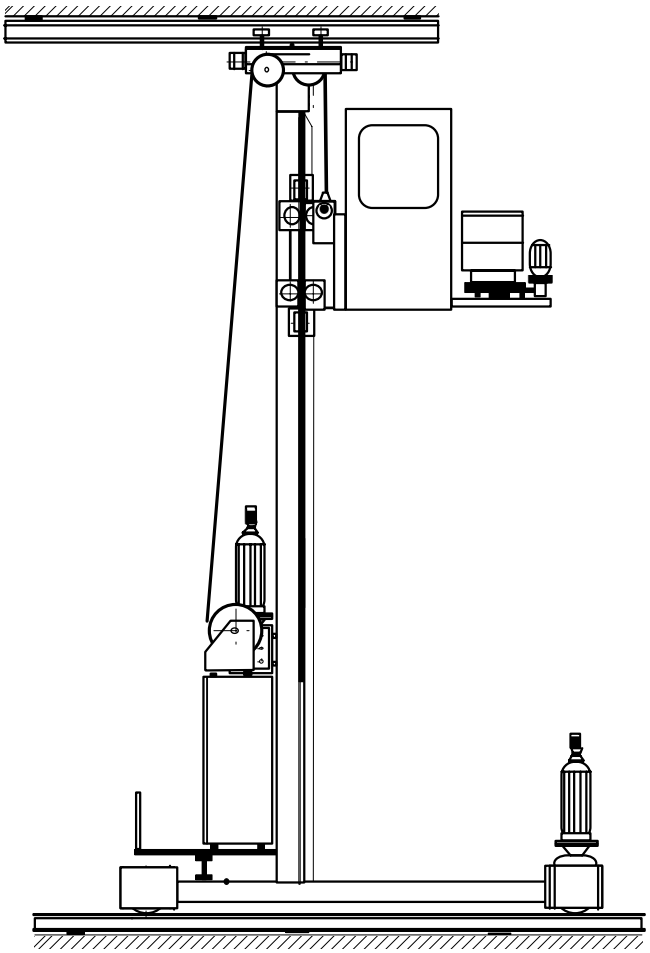
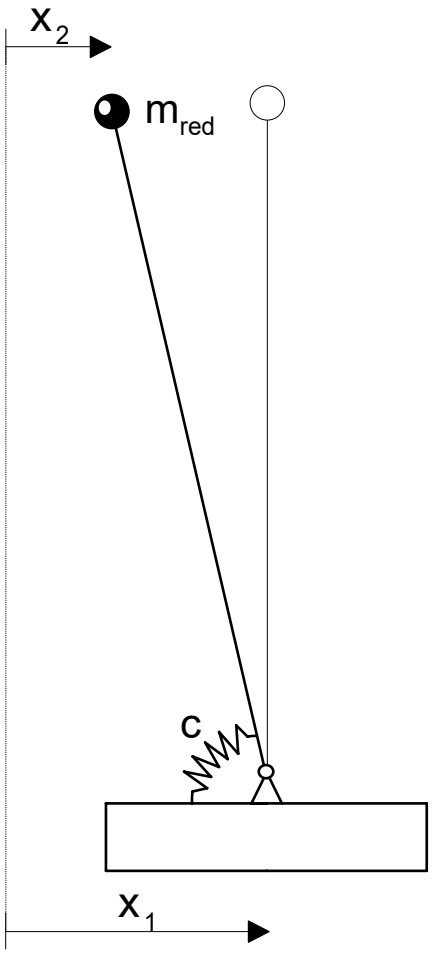
Exercise Number 14

Topic: **Experimental Design Based on a Single-Mass Oscillator Model of a Stacker Crane**

In the development of a new stacker crane, a lightweight construction was considered, which resulted in different parameters for the modeling.



Stacker crane [1]



Mechanical Model

Mass of lifting carriage:	m_{Hw}	$= 450\,kg$
Pay load mass:	m_L	$= 560\,kg$
Mast height:	l_M	$= 23\,m$
Equivalent spring stiffness:	c	$= 22000\,\frac{N}{m}$
Reduced mast mass:	$m_{M,red}$	$= 750\,kg$
Maximum acceleration:	a	$= 1.5\,\frac{m}{s^2}$

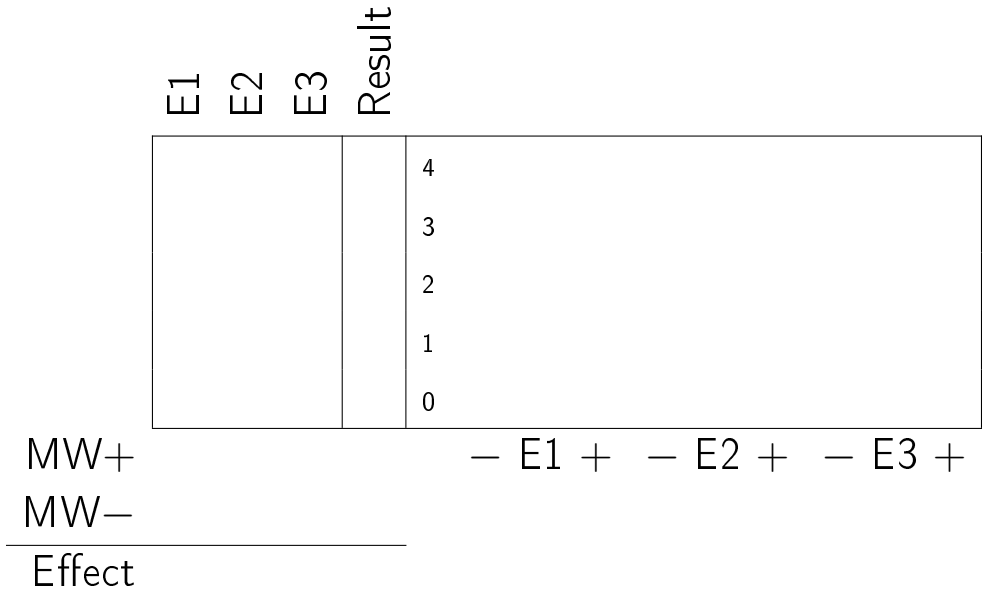
The stacker crane has been modeled as an undamped single-mass oscillator.

[1] Image source: Bopp W.: Untersuchung der statischen und dynamischen Positionsgenauigkeit von Einmast-Regalbediengeräten; Wissenschaftliche Berichte des Instituts für Fördertechnik, Heft 40, Karlsruhe, Juli 1993

Examine the maximum acceleration occurring in x_2.
The stimulation and the delay is always a vibration optimal square acceleration.
The controllable input variables and their value ranges in your model are:

- Pay load (0 to 560 kg, Increment: Random)
- Lifting height (1 to 22 m, Increment: 1,5 m)
- Travel time (2 to 30 s, Increment: 2 s)

First, set a suitable experimental plan and examine the influence of each input variable.



1. Which input has the greatest influence on the acceleration occurring in x_2?
2. The experiments on the model should ensure actual operating conditions of the new stacker crane. Verify that no accelerations above $3g$ occur throughout the application range. Use the Monte Carlo Method to look at 200 random combinations.

Useful Matlab functions: `rand` to create random numbers, `scatter3` to visualize the results in 2.