Homework 1: Plant Modeling and Block Diagrams

Note: This homework assignment has to be returned until Thursday 23.02.2012, 15:40.

Problem 1:

We examine the active suspension system shown in the following figure. It connects the vehicle body with mass m and the wheel of the car and consists of a spring with the spring constant c and a hydraulic cylinder with surface A. The suspension system is actuated by the electrohydraulic converter that generates the pressure difference Δp from given input voltage u. In general, the goal of the suspension system is to keep the displacement x from the rest position small (ideally 0) despite of a bumpy surface. This measure increases the ride comfort of the car. Our first task is to model the active suspension system.



- **a.** Decide which of the shown physical variables represent the input signal, output signal and disturbance signal.
- **b.** Determine the differential equations that describe the dynamic behavior of the active suspension system.

<u>Hint:</u> Use the following physical relations

- $m\ddot{x} = F_{\Sigma}$, whereby F_{Σ} is the sum of all vertical forces that act on the car body
- $F_{\text{spring}} = mg + c(h x)$ (spring force)
- $F_{\text{cylinder}} = A\Delta p$ (hydraulic cylinder force)
- $F_{\text{body}} = mg$ (vehicle body force)
- **c.** Develop a block diagram that describes the active suspension system.