Prof. Bernd Finkbeiner, Ph.D.
Dipl.-Inf. Rüdiger Ehlers
Markus Rabe, M.Sc.
Sebastian Hahn, B.Sc.

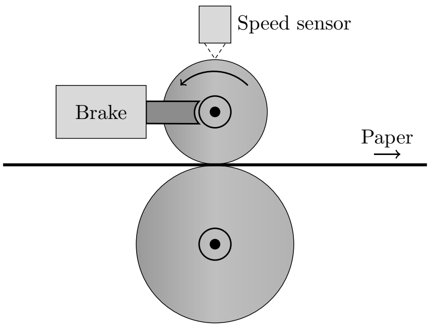
Summer term 2012
Problem Set 1
Due: Wednesday, 25th April 2012

Embedded Systems

Please indicate your **name**, **matr. number**, **email address**, and which **discussion session** you have been allocated to. We encourage you to collaborate in **groups** of up to **three** students. Only one submission per group is necessary.

Problem 1: Printing Machine

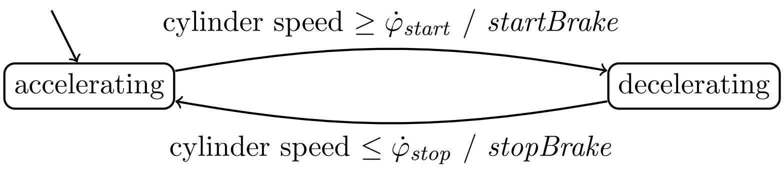
Consider the printing machine depicted below. The impression cylinder, having a diameter of 300 mm, is constantly accelerated by between 80 to 100 rotations per square minute. Assume that the paper does not accelerate or decelerate the cylinder. The surface speed of the cylinder must not deviate by more than 0.01 percent from the speed of the paper in order to keep the print at a high quality (and the paper stream intact). To keep the cylinder at an allowed speed, a brake is used. Switching the brake on or off takes 10 milliseconds. While the brake is active, the cylinder is decelerated by between 200 and 300 rotations per square minute (as an an additional effect to the acceleration). A sensor is available to measure the speed of the cylinder (in rotations per minute).



Use the modeling tools that you acquired in the first lecture to model the dynamics of this system in braking or non-braking mode, leaving the paper speed v as a variable. Derive the evolution of orientation, angular velocity, and angular acceleration.

For each of $v \in \{100\ km/h, 200\ km/h, 300\ km/h\}$, compute suitable values for $\dot{\varphi}_{start}$ and $\dot{\varphi}_{stop}$ for the following finite-state machine such that the machine matches the speed of paper by a deviation of at most 0.01 percent:

input: *cylinder speed* : $\mathbb{R}$
outputs: *startBrake*, *stopBrake* : pure

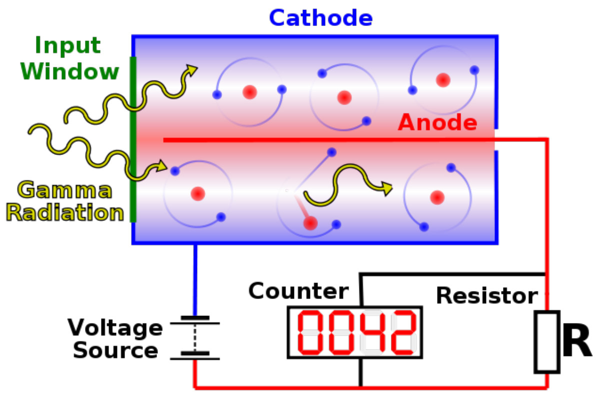


Problem 2: Geiger-Müller Counter

A. You are supposed to model the counter unit for a Geiger-Müller counter that counts how many *events* occur during one second as an extended FSM. An event is a discharge of the device due to ionizing radiation. As can be seen in the drawing below, the input to the counter is a voltage level. Whenever an event is detected there is a significant peak in the measured voltage level. Peaks over a given threshold V_{min} should be counted by the counter. After each second the display should be updated to show the number of events that occurred during the last second.

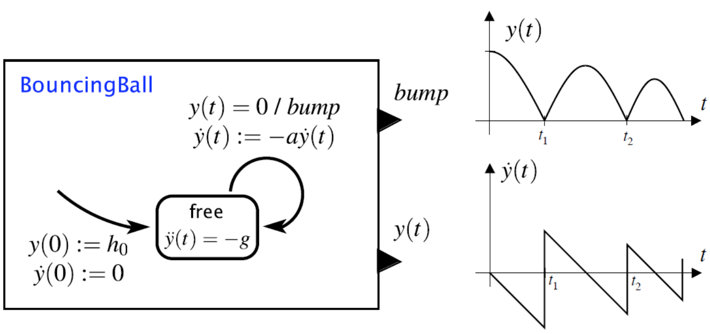
B. After each measured event there is a so called *dead time* of about 100 microseconds during which no further events can be measured. How much may this effect distort your measurements? Can you give the expected number of occurrences of ionizing radiation given the number of measured events?

If you are not familiar with the working principle of Geiger-Müller counters you might want to read the Wikipedia article.[1]



Problem 3: Bouncing Ball

The following FSM from the book "Introduction to Embedded Systems" models a bouncing ball. It has a number of limitations and even a serious flaw in the sense that it allows for clearly unintended behaviour. Discuss and repair.



[1] http://en.wikipedia.org/wiki/Geiger-Müller_tube