Základní otázka mechatronikova: Kterak PID regulátor naladiti?

Robert Grepl
Ústav mechaniky těles, mechatroniky a biomechaniky
Fakulta strojního inženýrství, Vysoké učení technické v Brně
2015

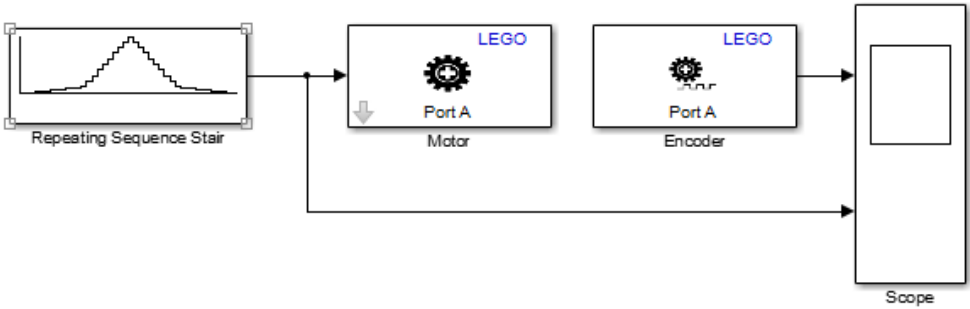
mechatronics laboratory

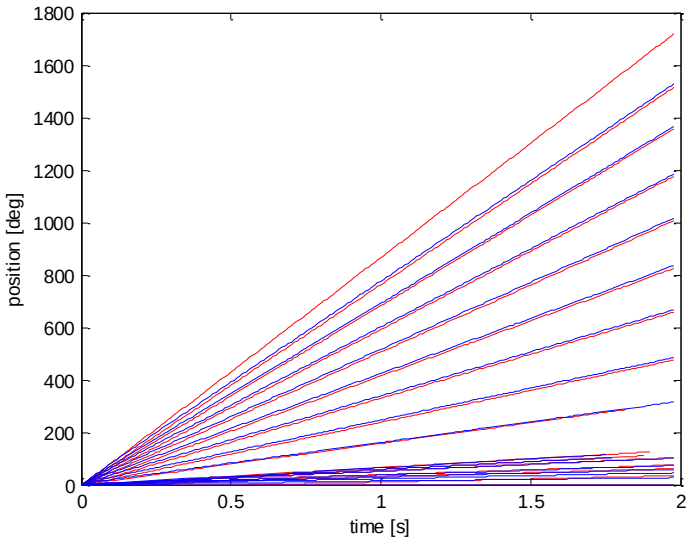
Problem definition

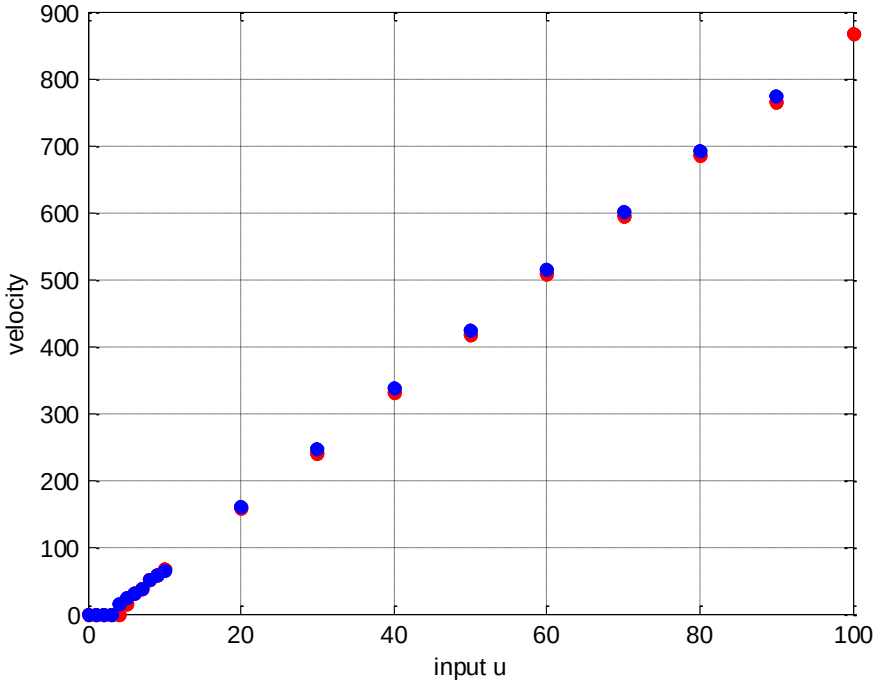
- LEGO Mindstorms
  - brick NXT
  - motor
- How to design position controller?

Voltage – speed characteristics (static)

- constant input u (-100 - +100)
- position (encoder) measured
- slope (derivation) of position calculated based on least squares => speed.

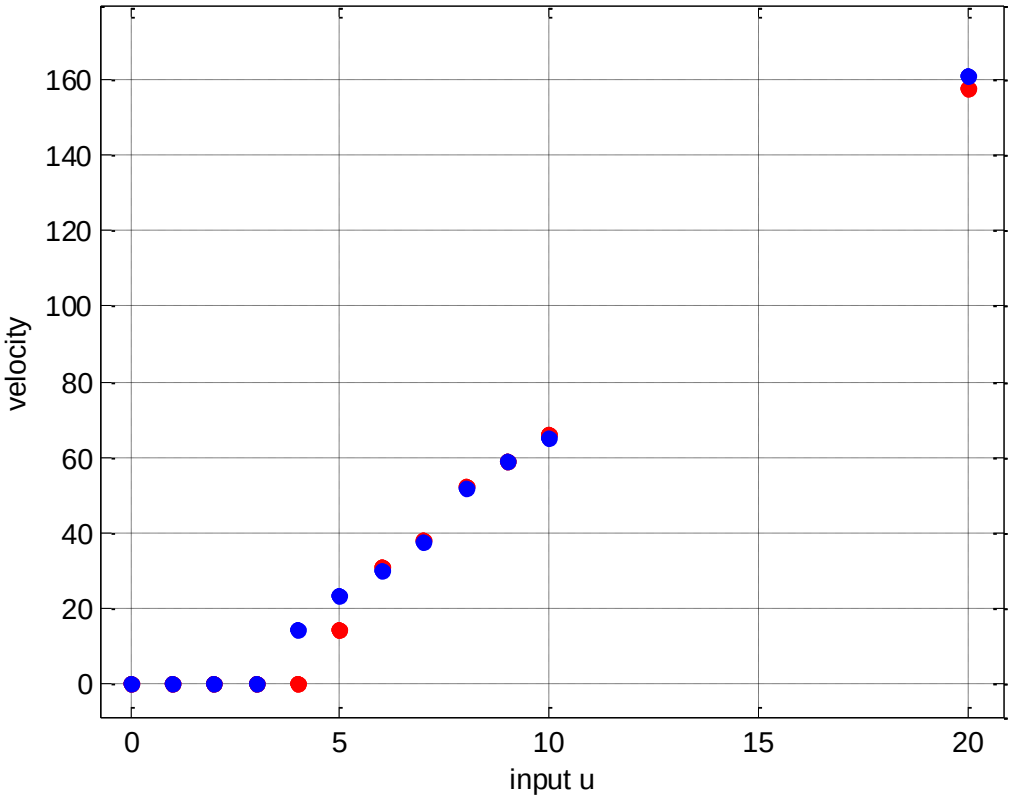


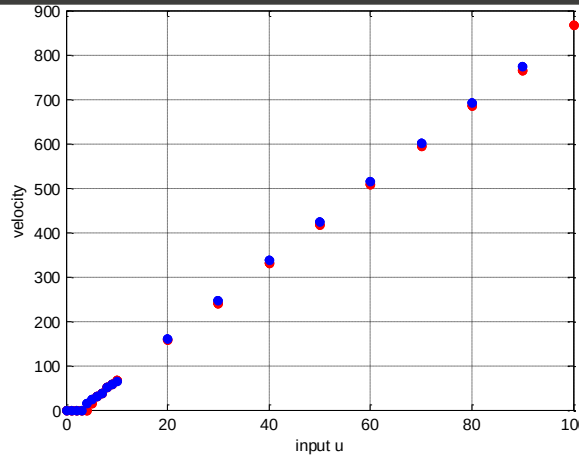




Voltage – speed characteristics (static)

- There is a insensitivity to input (about 4-5 input units).

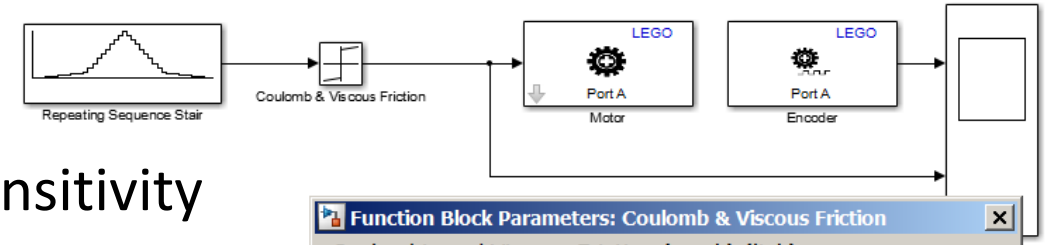


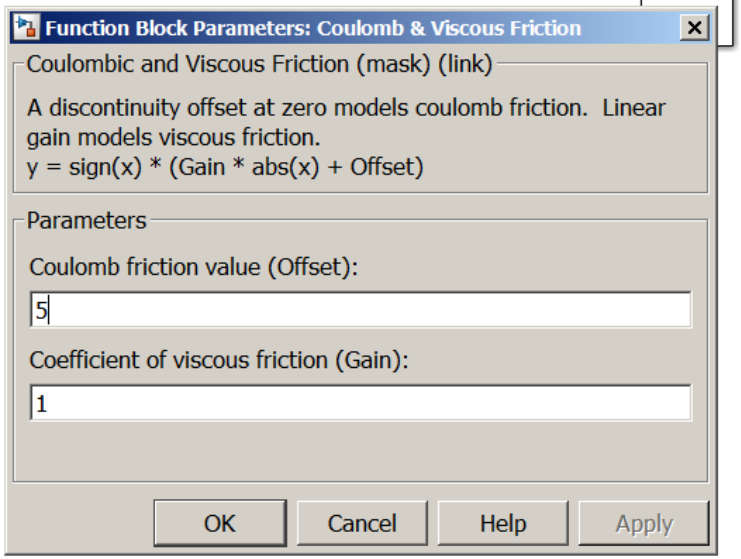


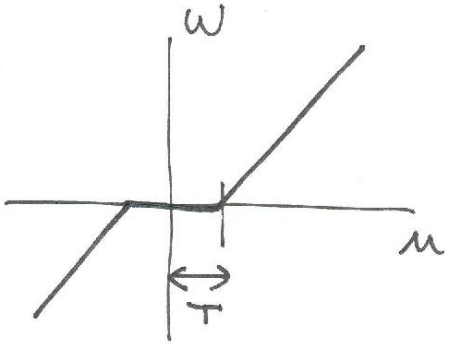
Friction compensation: how-to ...?

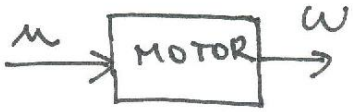
From static characteristics:

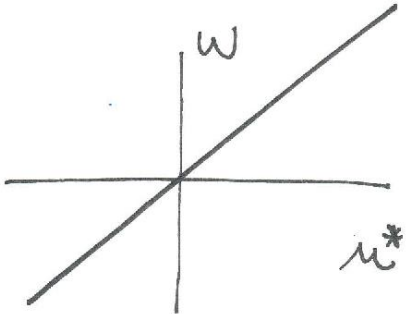
- there is about 5 “units” insensitivity
- cause: “dry friction”
- compensation: “inverse function”

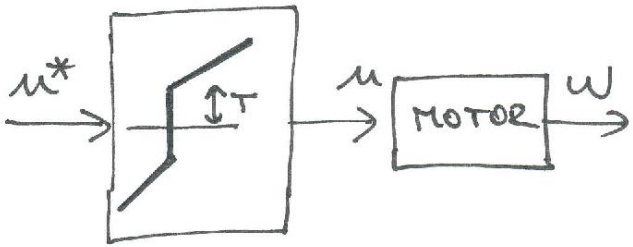










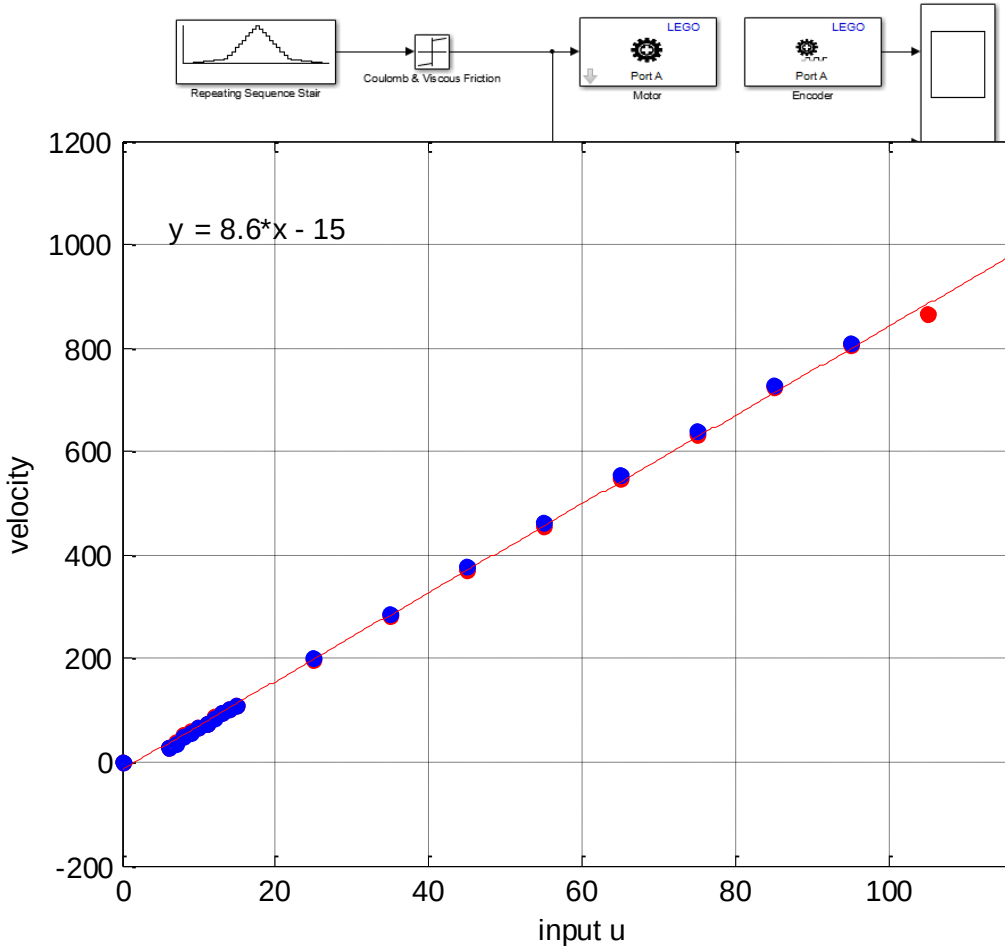


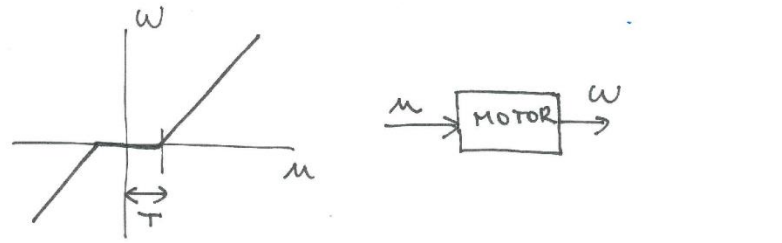
Friction compensation: how-to ...?

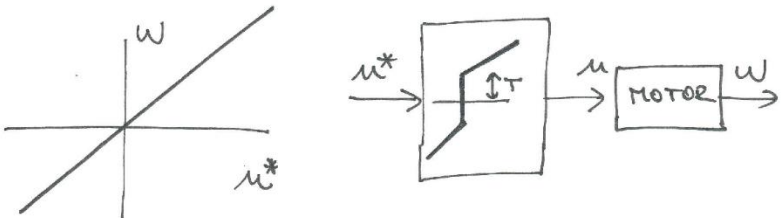
Resulting static characteristics?

(partial) Conclusion:

- The static characteristics is almost linear.
- Estimated gain of the system is 8,6.
- The simplest tf of the system is: G(s) = 8,6







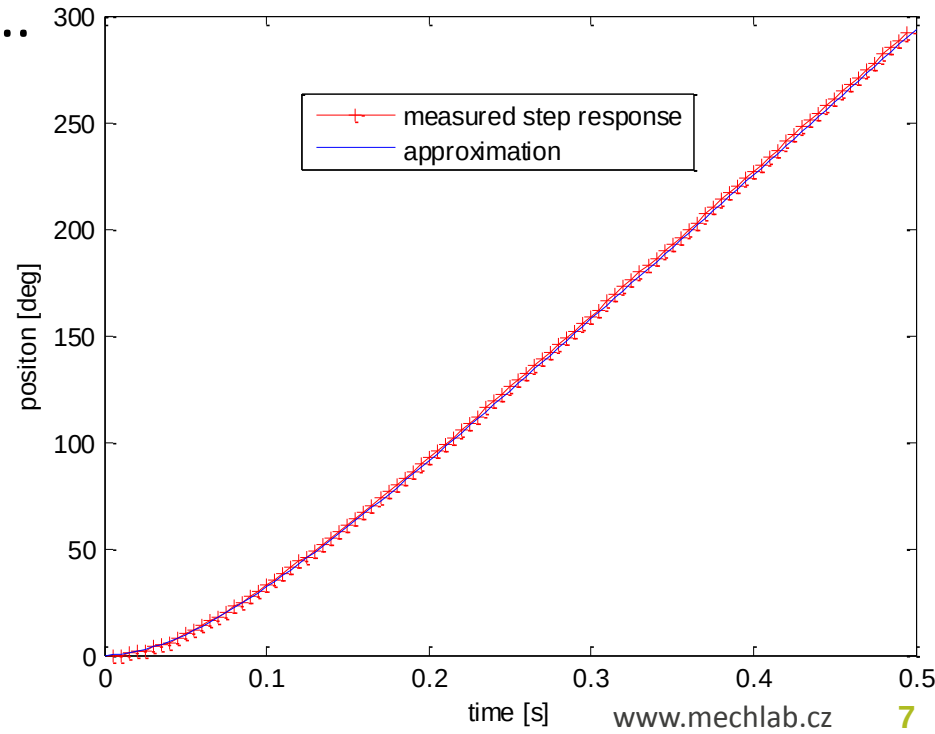
Estimate of tf

- tf input/speed: $G_{speed}(s) = \frac{gain}{\tau s + 1}$ (first order system)
- tf input/position: $G_{position}(s) = G_{speed}(s)\frac{1}{s} = \frac{gain}{(\tau s + 1)s}$
- Estimation: trial-error approach... (ini estimate of gain is 8,6)

Conclusion:

- The approximated tf of the system is:

$$G_{position}(s) = \frac{9.1}{(0.07s + 1)s}$$



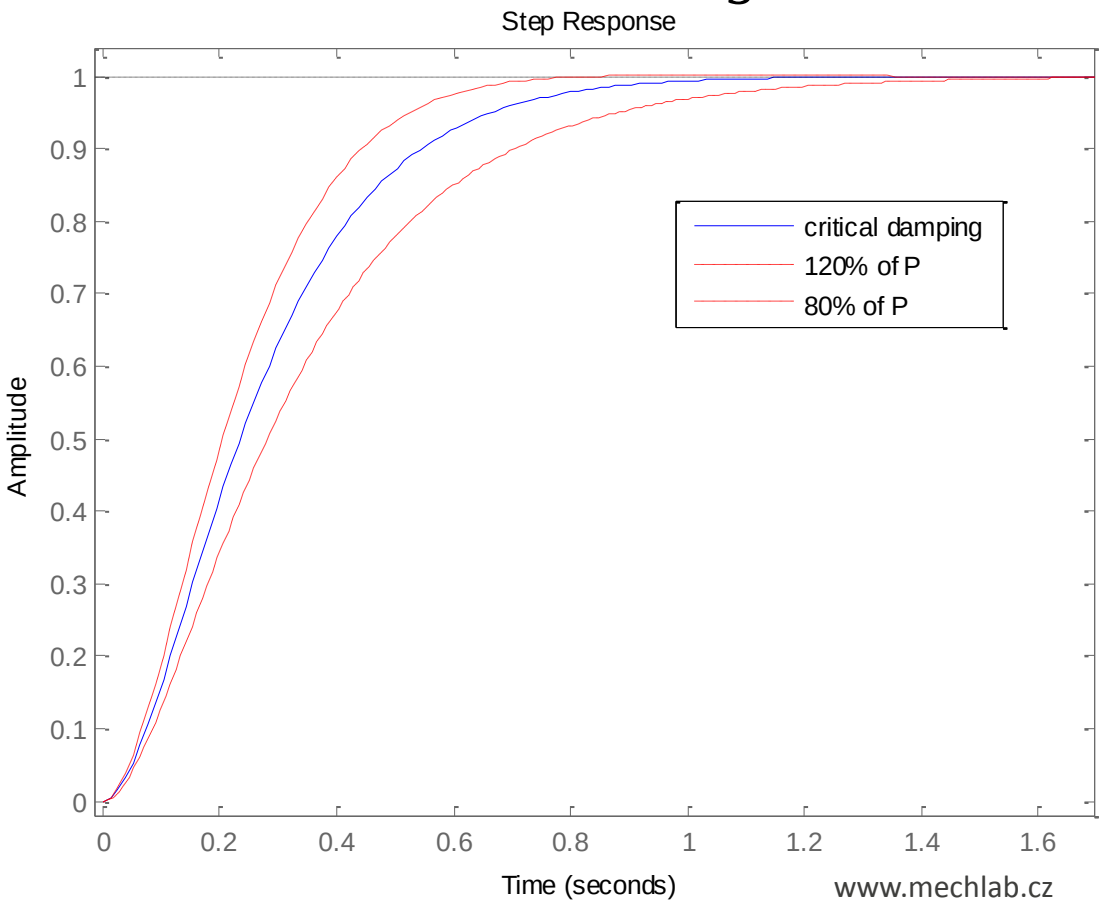
Control design - simulation

- P controller
- tf of closed loop systém

$$G_w = \frac{G_0}{1+G_0}$$

$$G_0 = PG_{position}$$

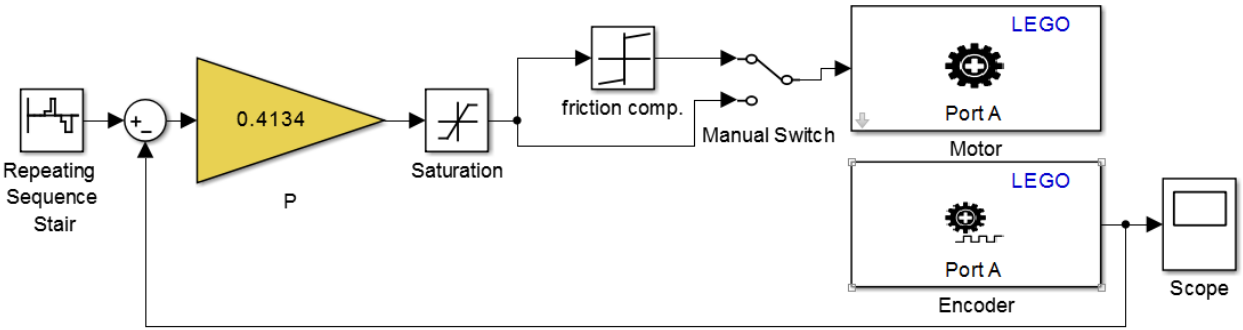
- ...
- Result: $P = \frac{1}{4\tau \ \ gain}$

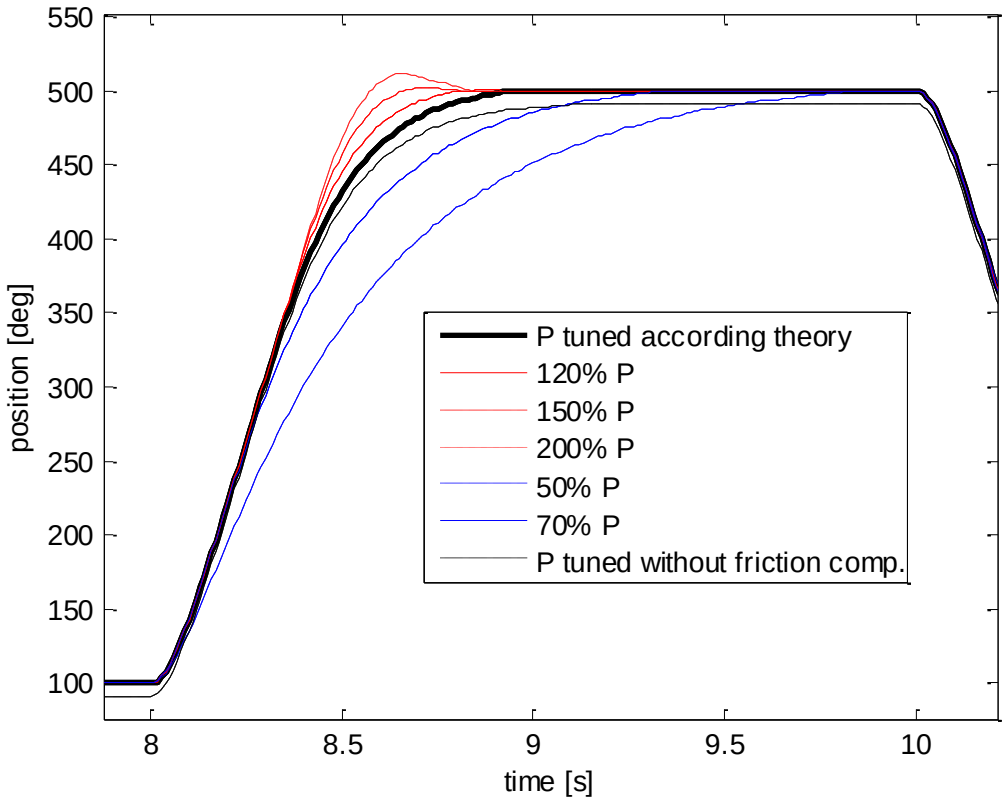


Control design – measured data

- P controller

$$P = \frac{1}{4\tau \ \ gain}$$





Robert Grepl, Ph.D.
grepl@fme.vutbr.cz

www.mechlab.cz
Institute of Solid Mechanics, Mechatronics and Biomechanics
Faculty of Mechanical Engineering
Brno University of Technology

mechatronics laboratory