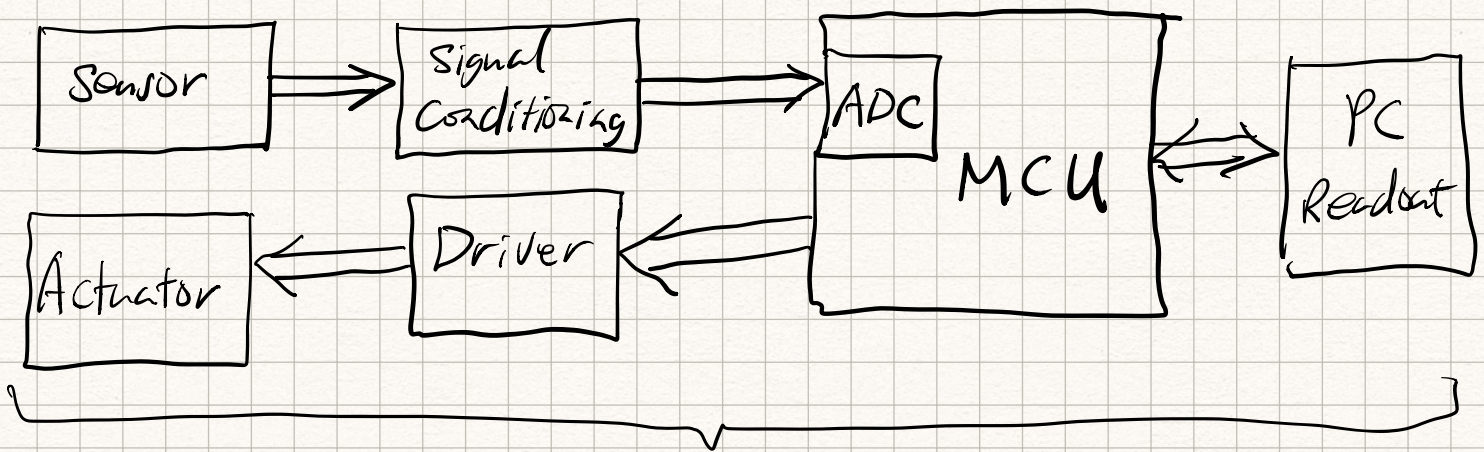
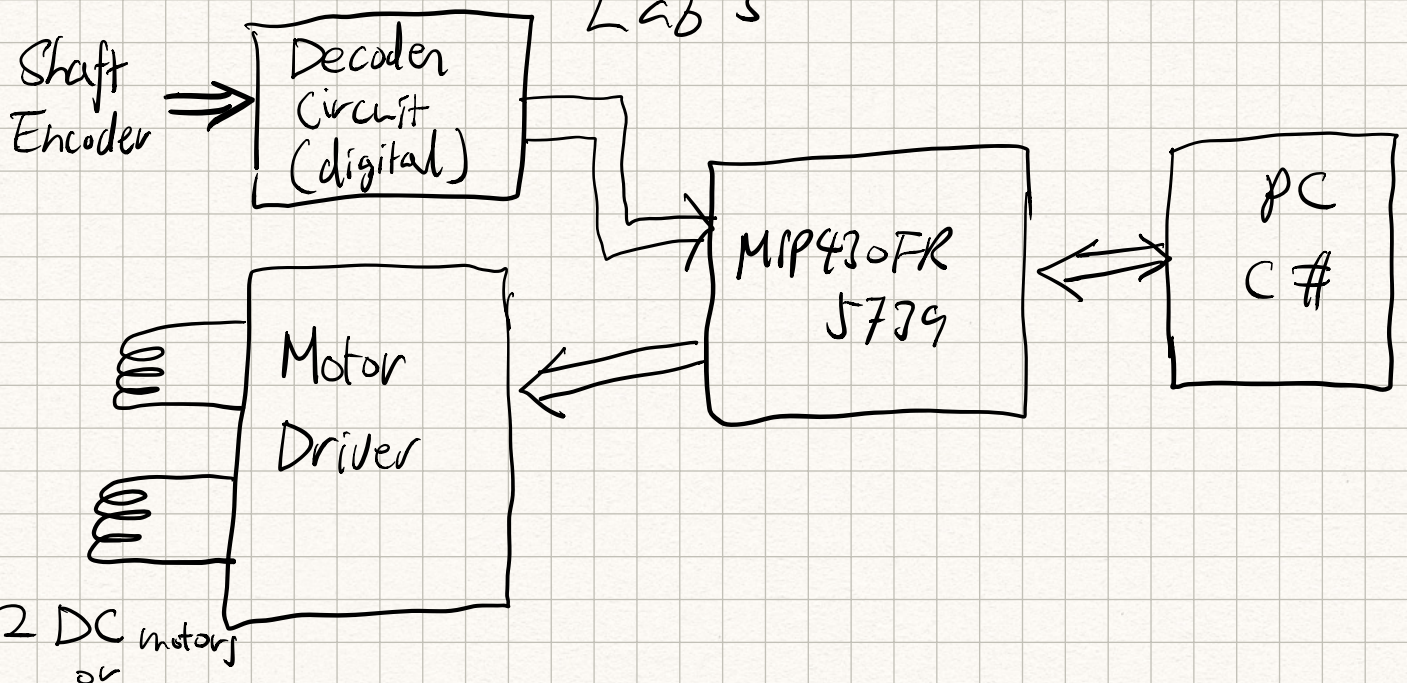
MECH 423 Lecture 12



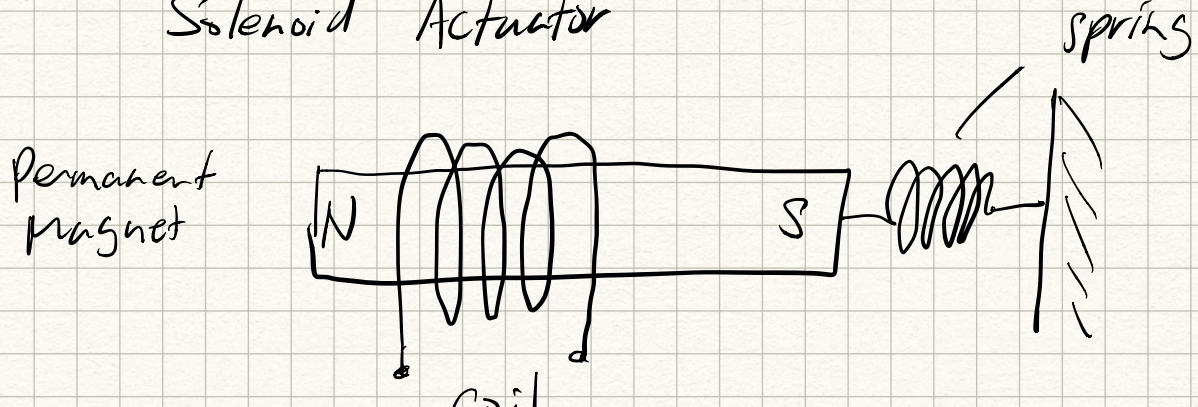
Lab 3



2 DC motors
or
1 stepper motor

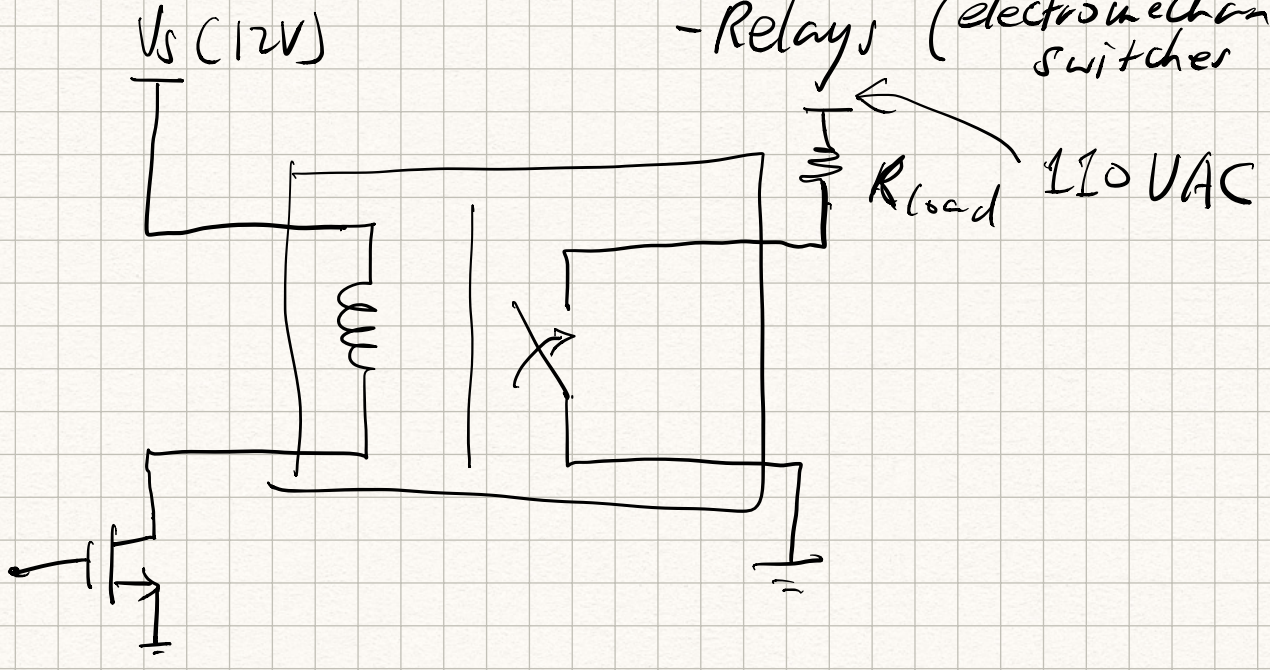
Inductive Actuators & How to drive them.

Solenoid Actuator



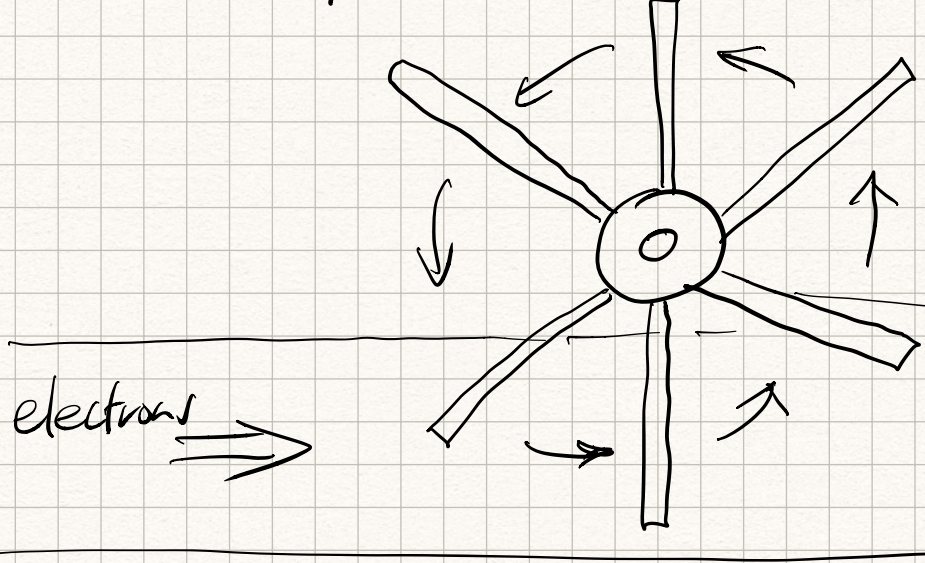
- Bistable linear motion.
- Speed ~ 100ms

Application Examples:
- Door lock
- Flow control valves
- Relays (electromechanical switches)



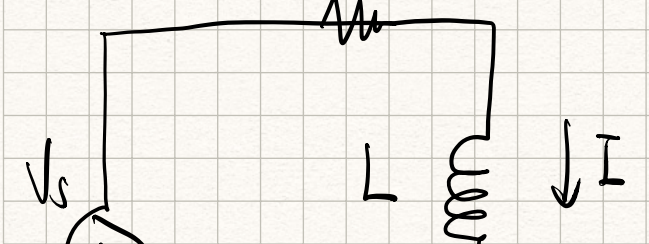
* An inductor is an energy storage device

⇒ Inductor stores energy in the momentum of electrons.

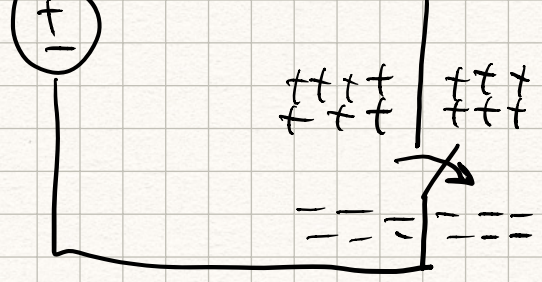


Law of induction

$$V = -L\frac{dI}{dt}$$



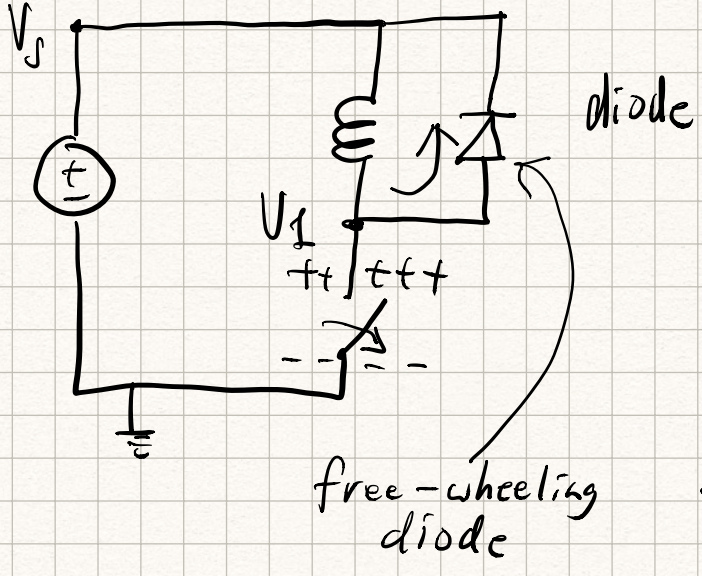
* Initially, switch is closed
  - current I through the inductor
* Open the circuit

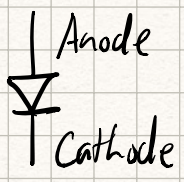


* The inductor pushes charges on to either side of the switch
* Kaboom! Electrical breakdown

$$V = -L\frac{dI}{dt} \qquad \frac{dI}{dt} \to \infty \quad V \to -\infty$$

How to fix this problem:





* When the switch is closed
  - diode has no effect
* When the switch is opened

$V_1 \uparrow$ but the diode clamps V_1

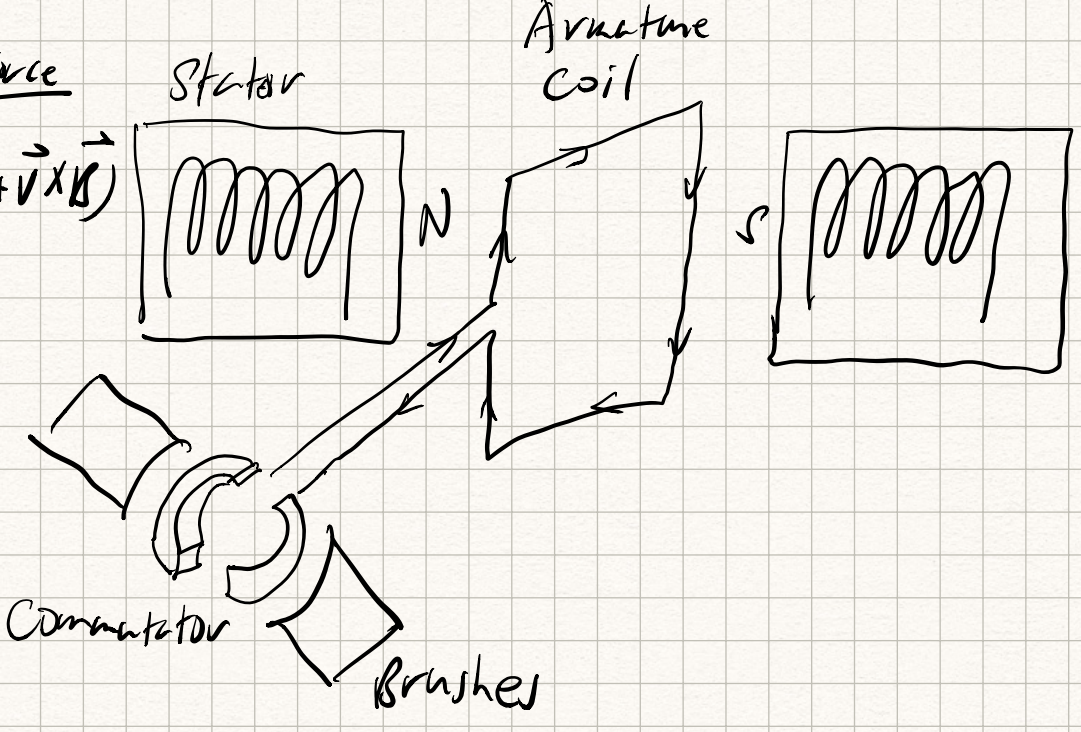
$$V_1 \leq V_s + V_D$$

$$V_D \sim 0.7V$$

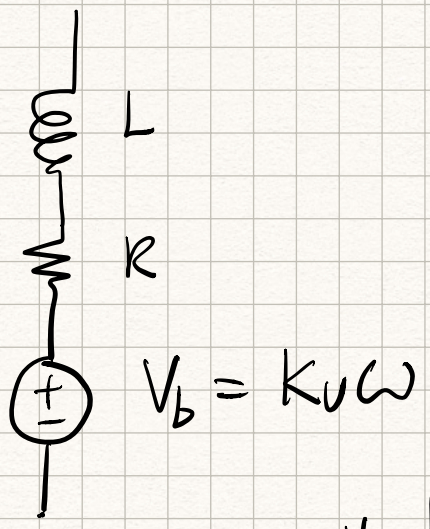
Brushed DC Motors

Lorentz Force

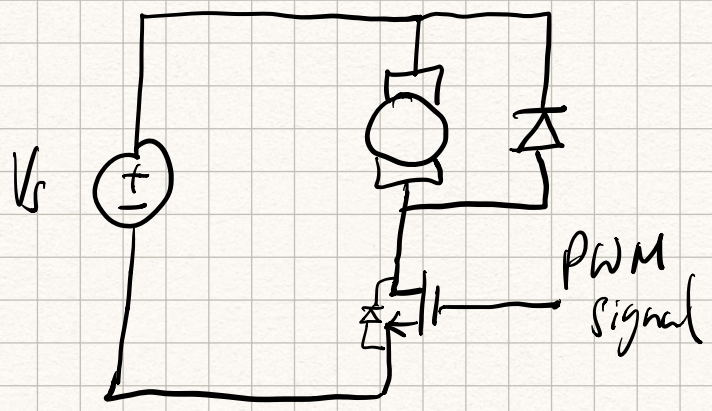
$$F = q(E + \vec{v} \times \vec{B})$$



Electrical Model

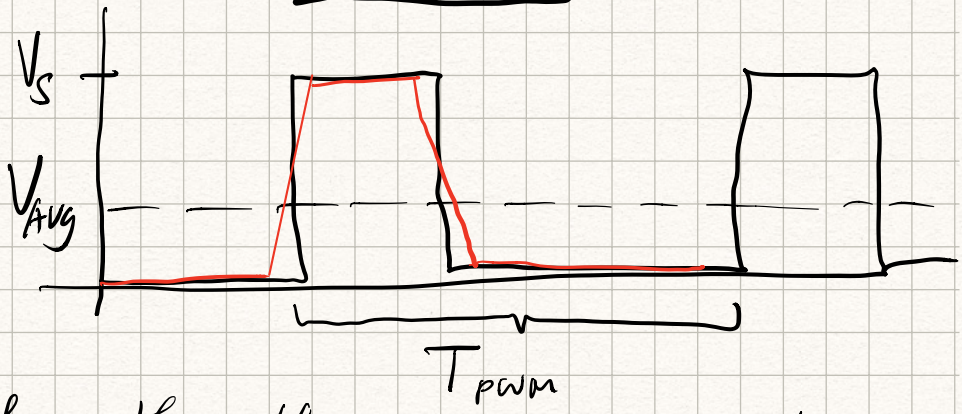


How to drive (in one direction)



How to select the PWM freq?

$$f_{pwm} = \frac{1}{T_{pwm}}$$



* T_{pwm} should be less than the mech. response time.
* T_{pwm} should be greater than the elec. response time.
  - Prevent energy loss in the switch

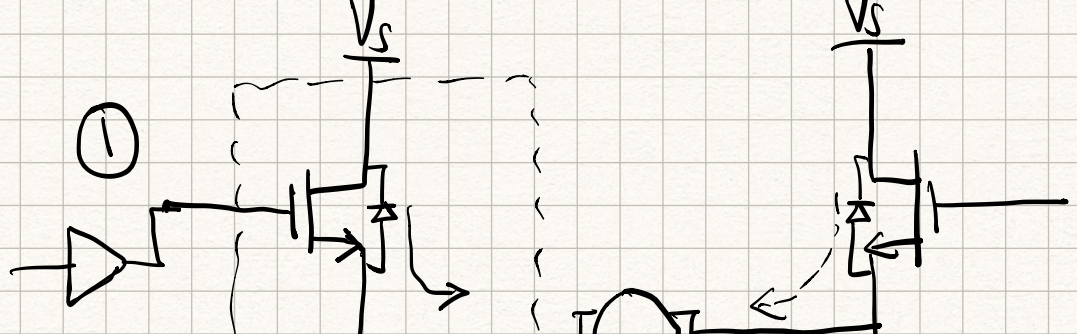
$$\tau_{elec} < T_{pwm} < \tau_{mech}$$

$$10kHz > f_{pwm} > 100Hz$$

PWM Noise

Bidirectional Drive

- Need an H-bridge

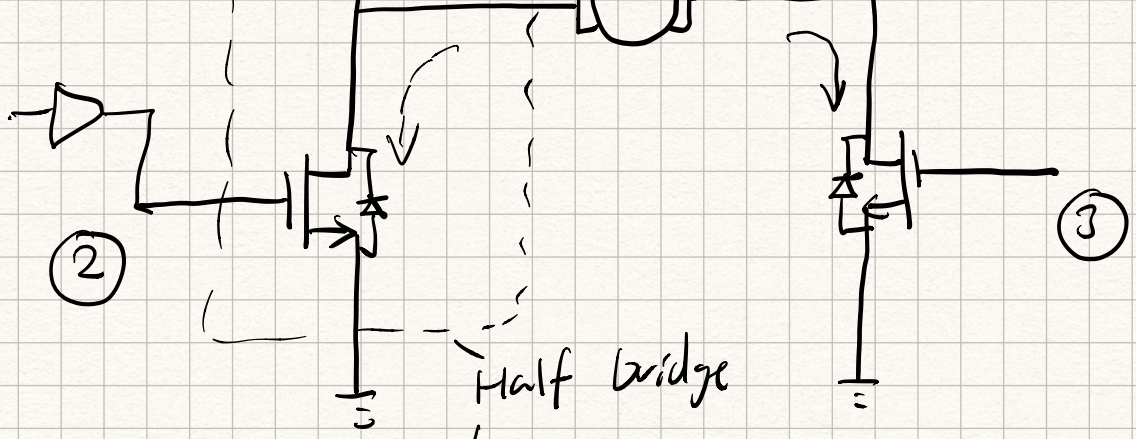


Forward

① & ③ ON

④ ② & ④ OFF

Reverse



① & ③ OFF

Break

① & ④ OFF

② & ③ ON

Half bridge

4 in lab 3 driver.