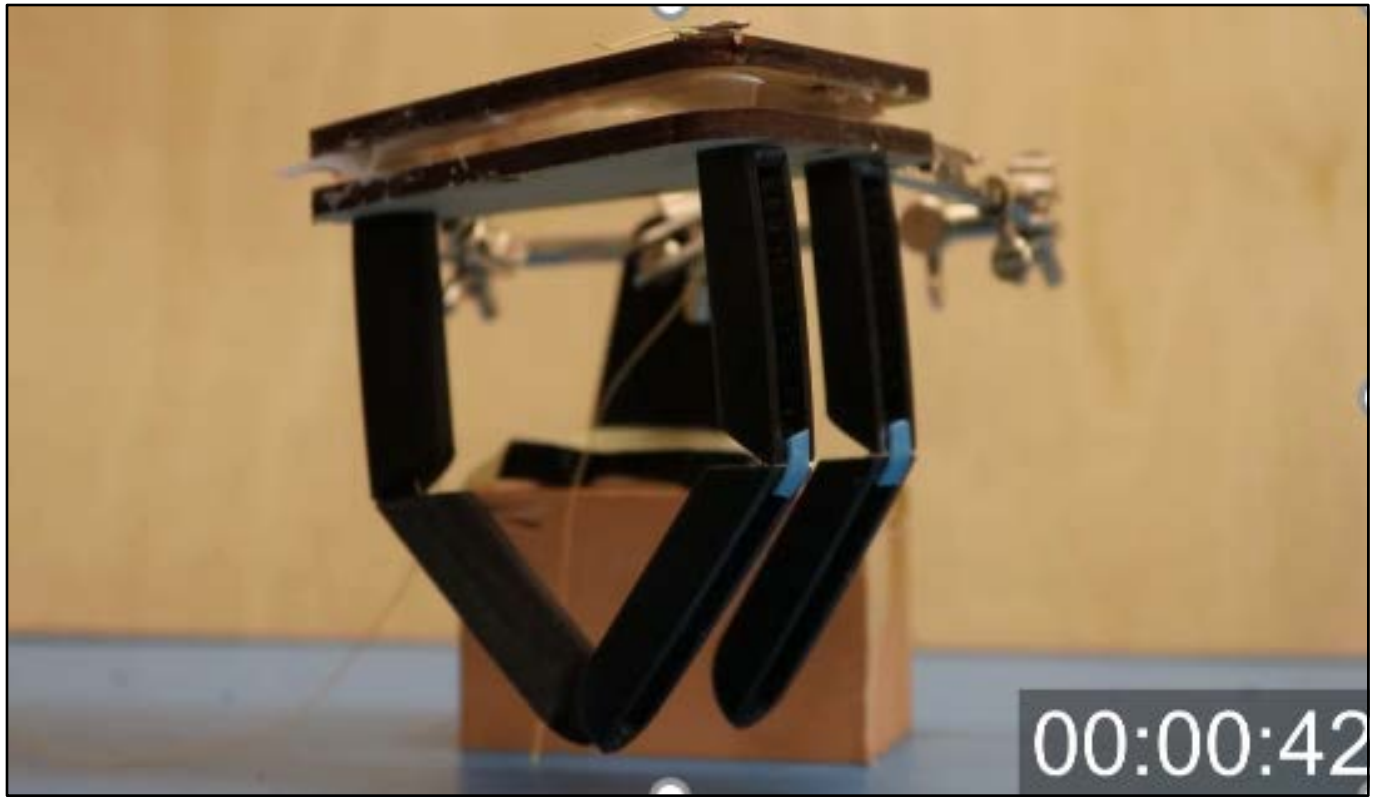
Actuators

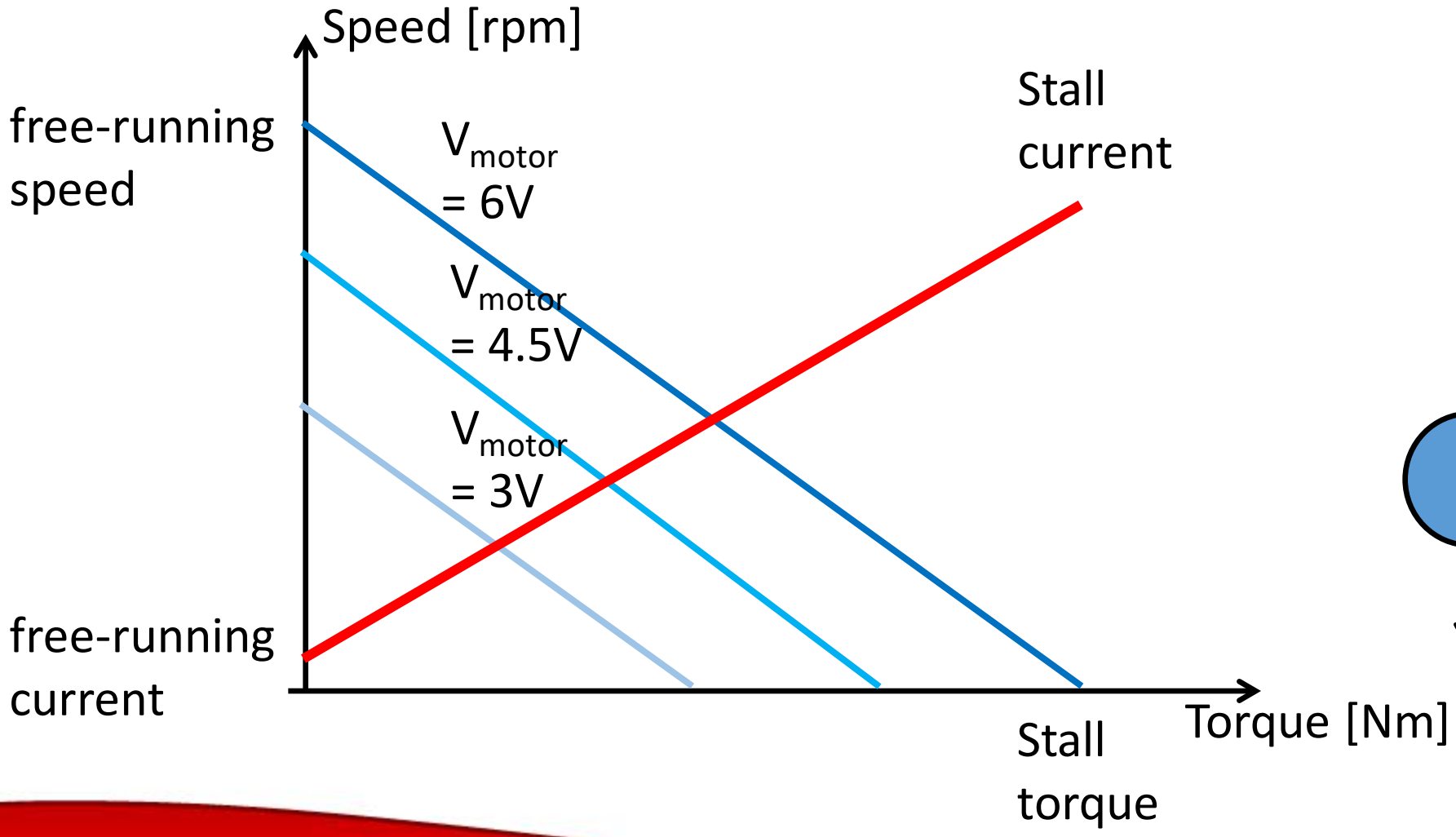
- A mechanism that converts energy into mechanical motion
  - Hydraulic
  - Pneumatic
  - Electric
  - Magnetic
  - Mechanical
  - Bio-hybrid
  - Light-driven
  - Thermal

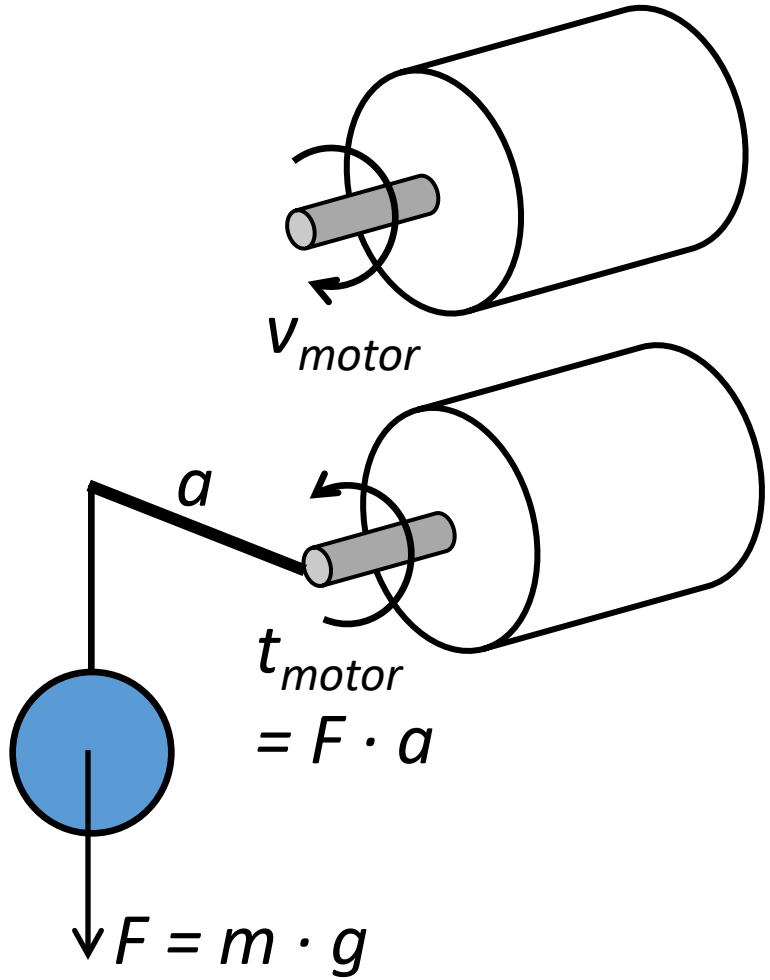


Actuators

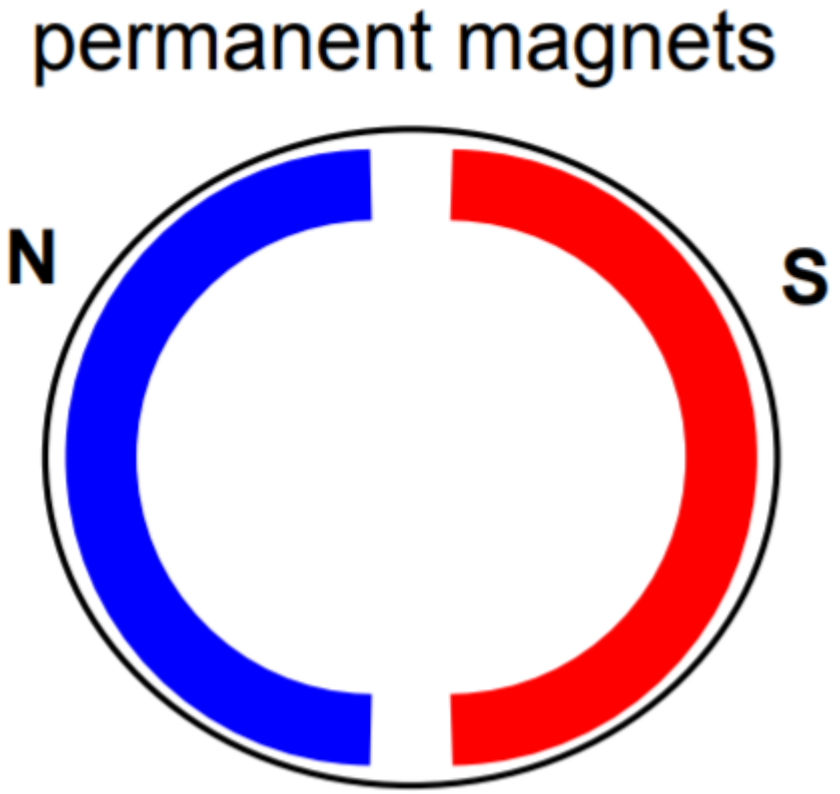
- A mechanism that converts energy into mechanical motion

Brushed DC motor

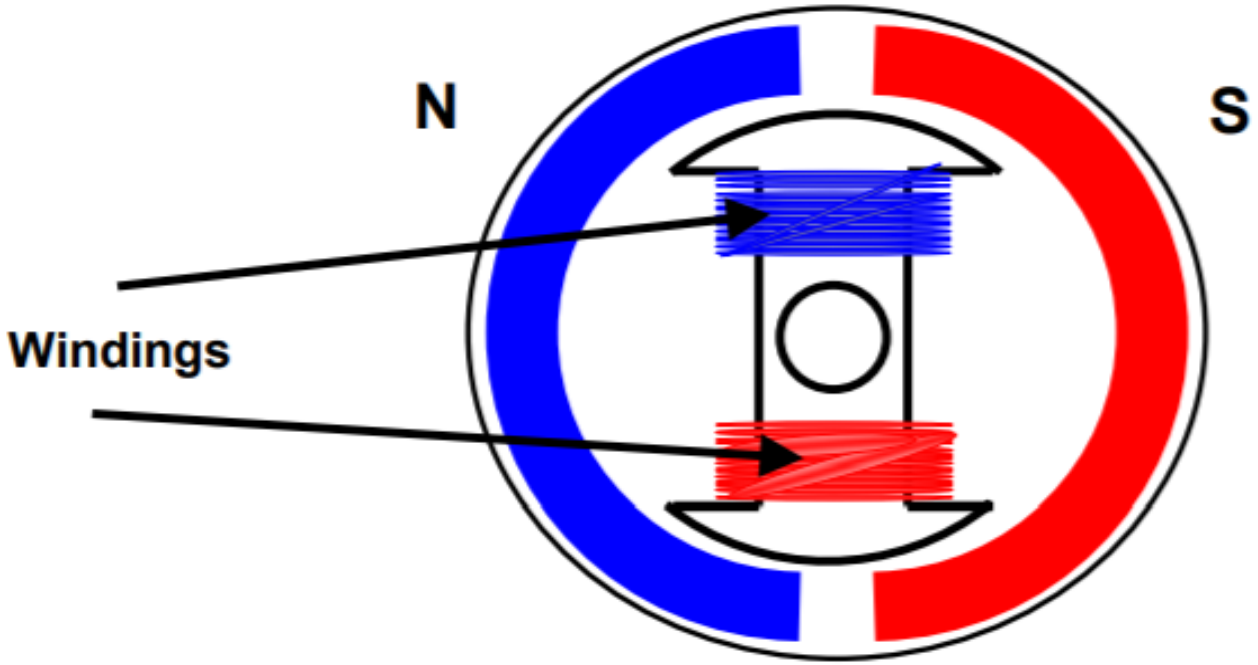




Brushed DC motor

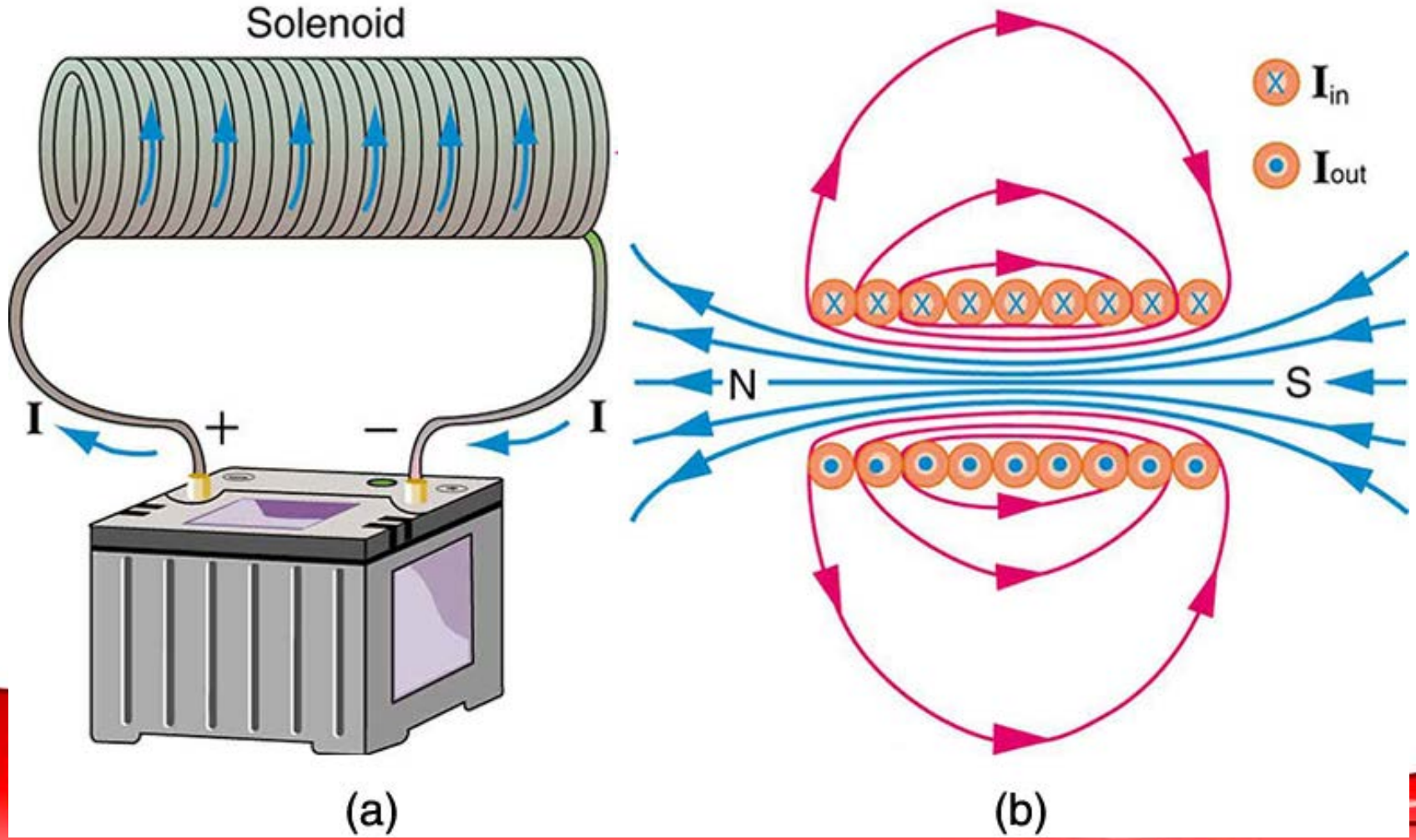


Brushed DC motor

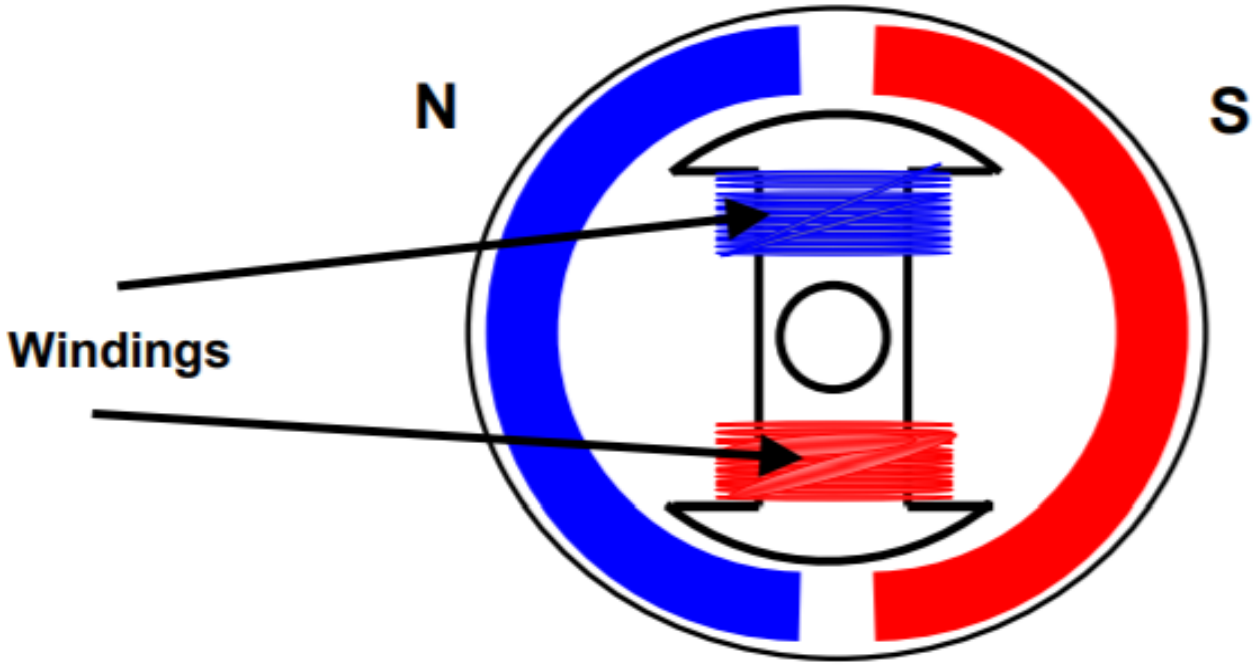


Brushed DC motor

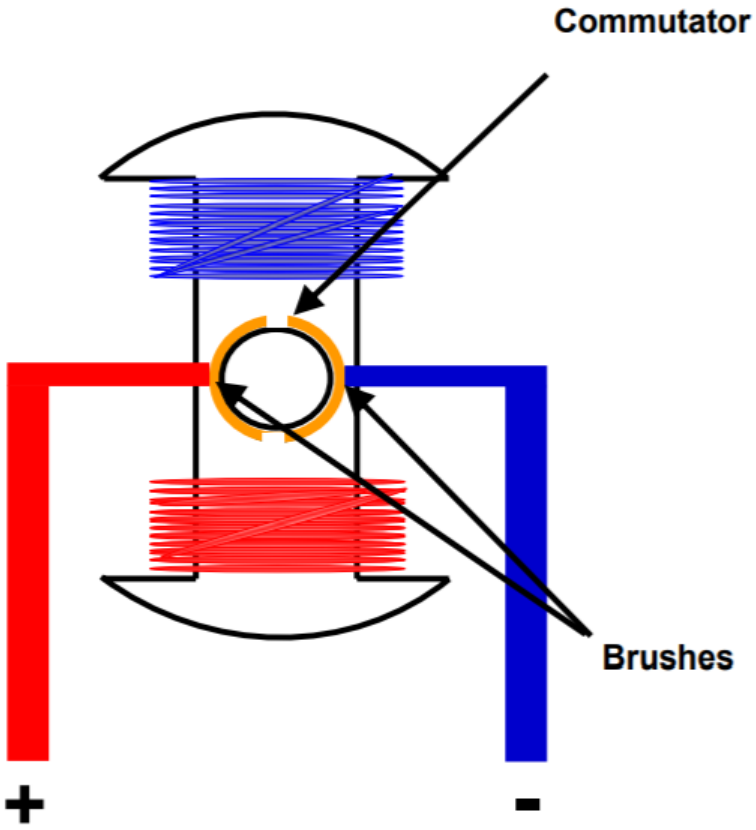
- Ampere's Right Hand Rule

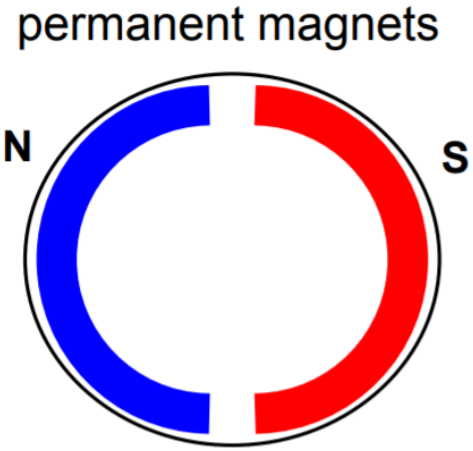


Brushed DC motor

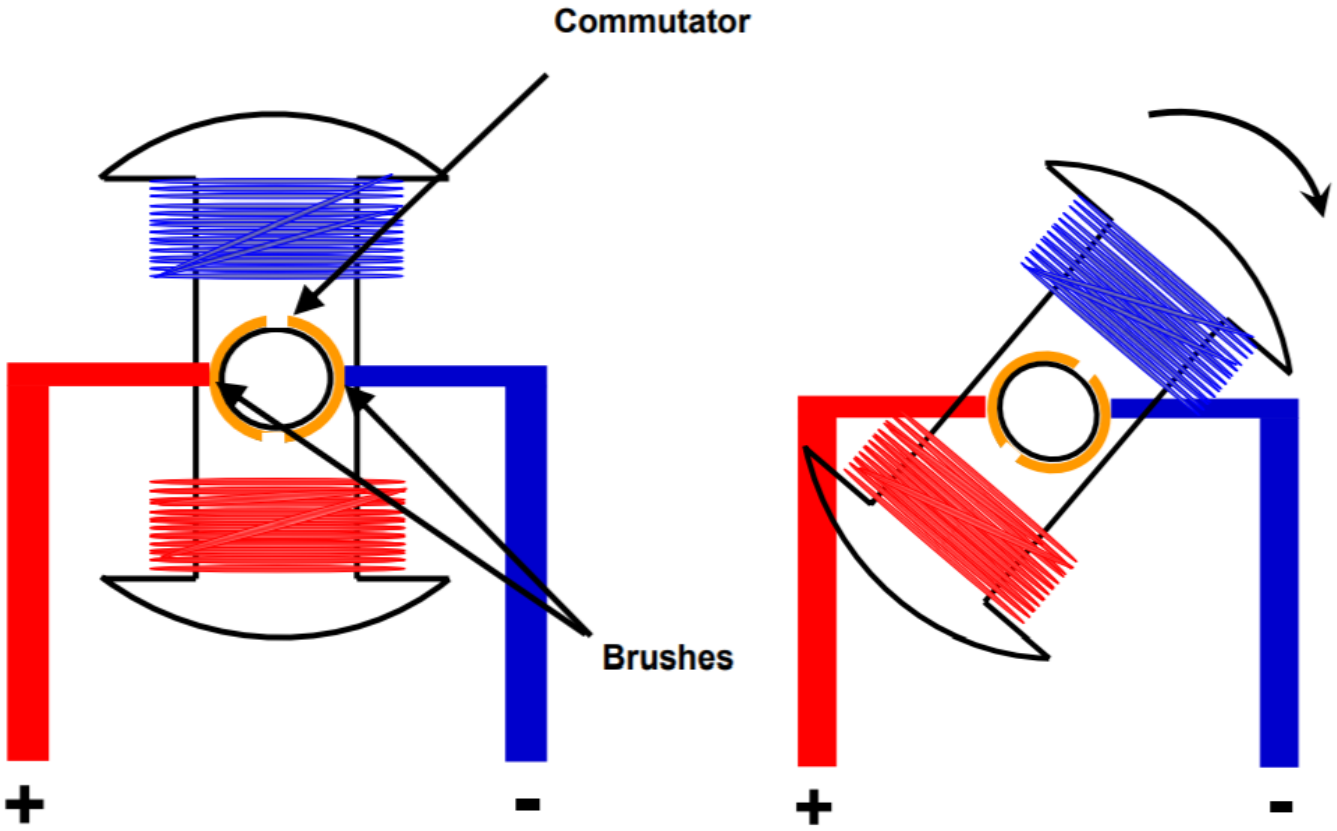


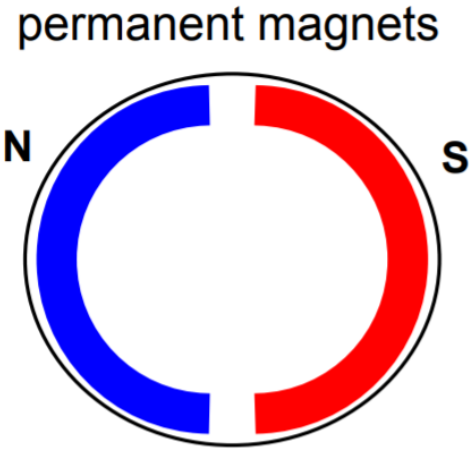
Brushed DC motor



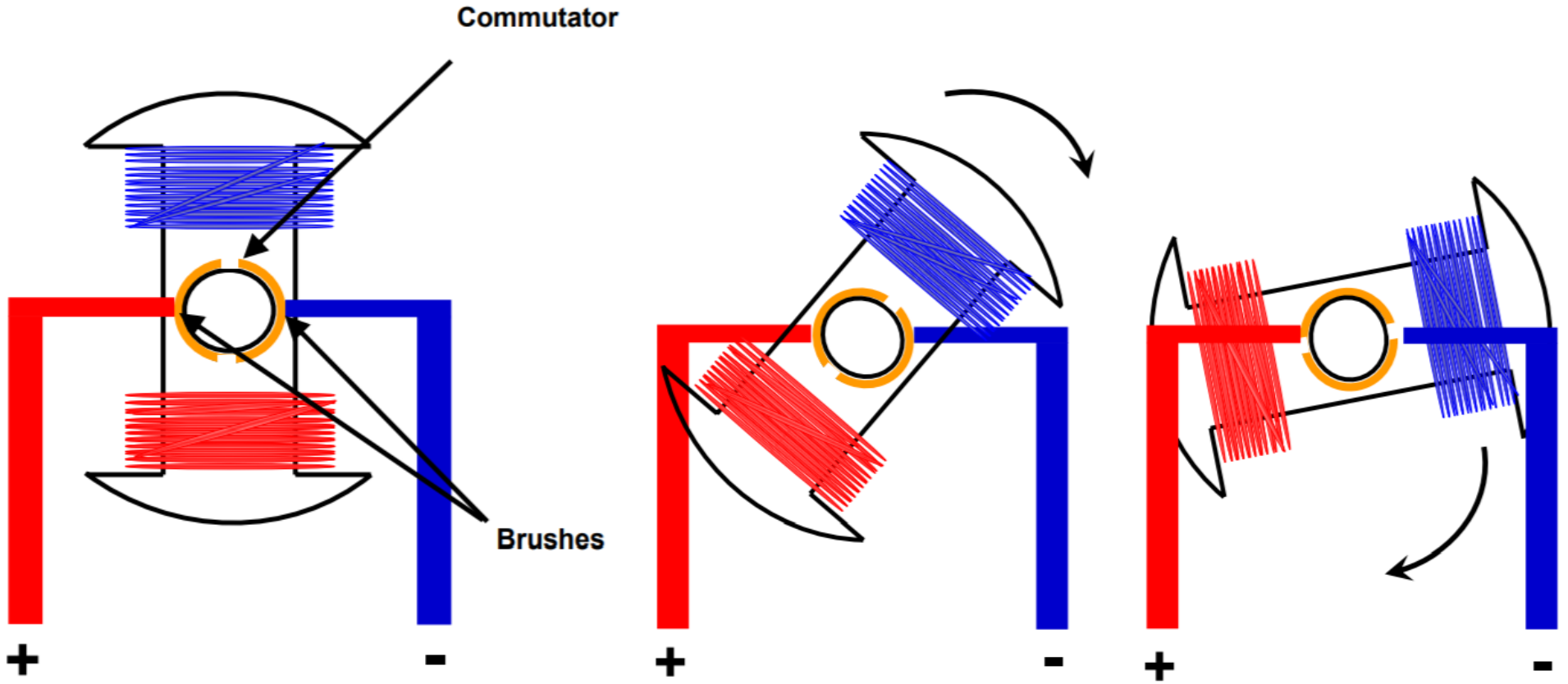


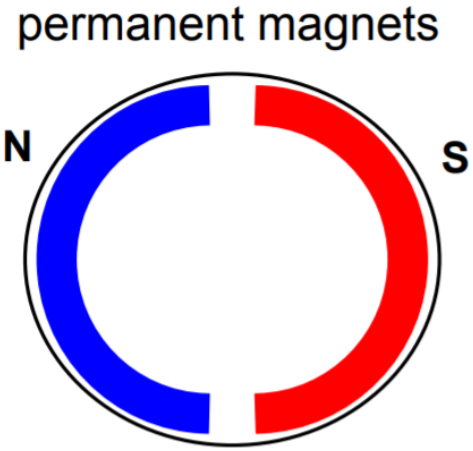
Brushed DC motor



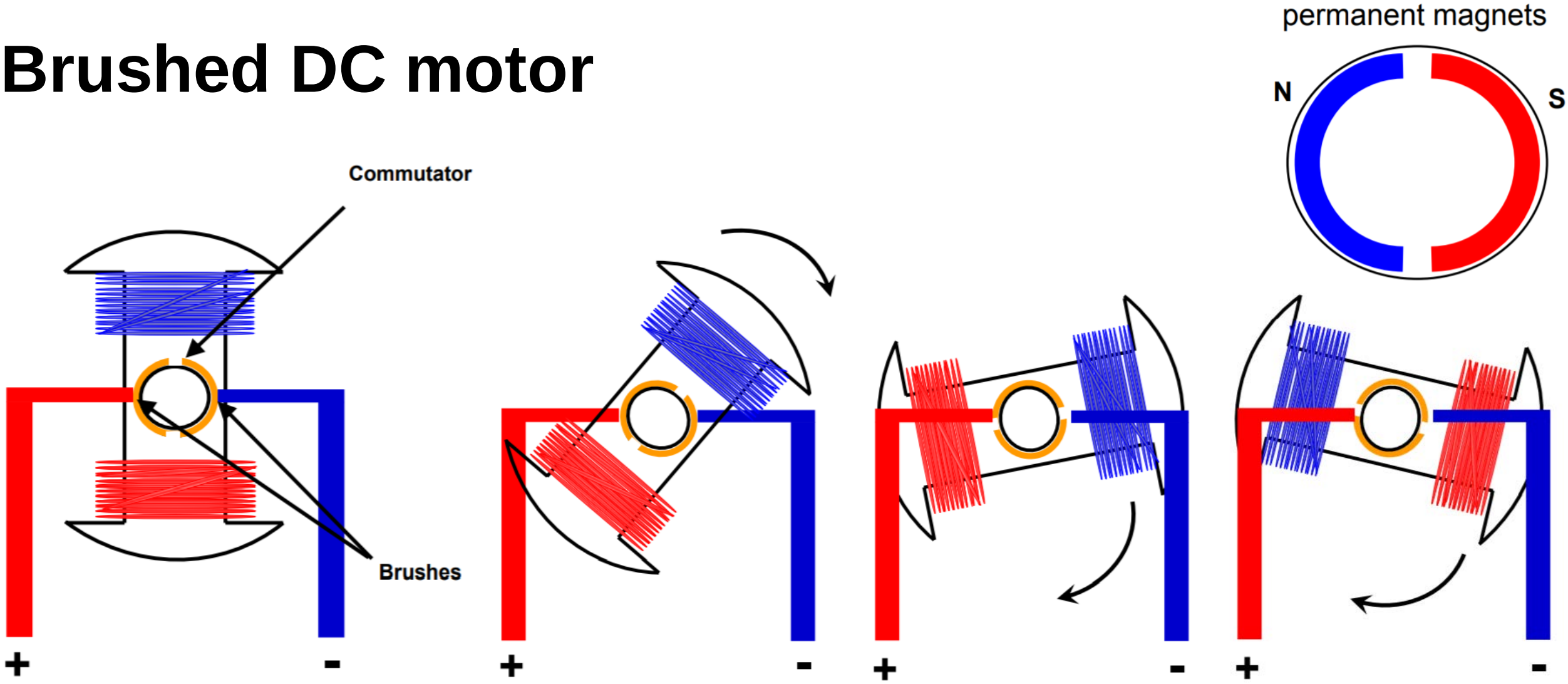


Brushed DC motor



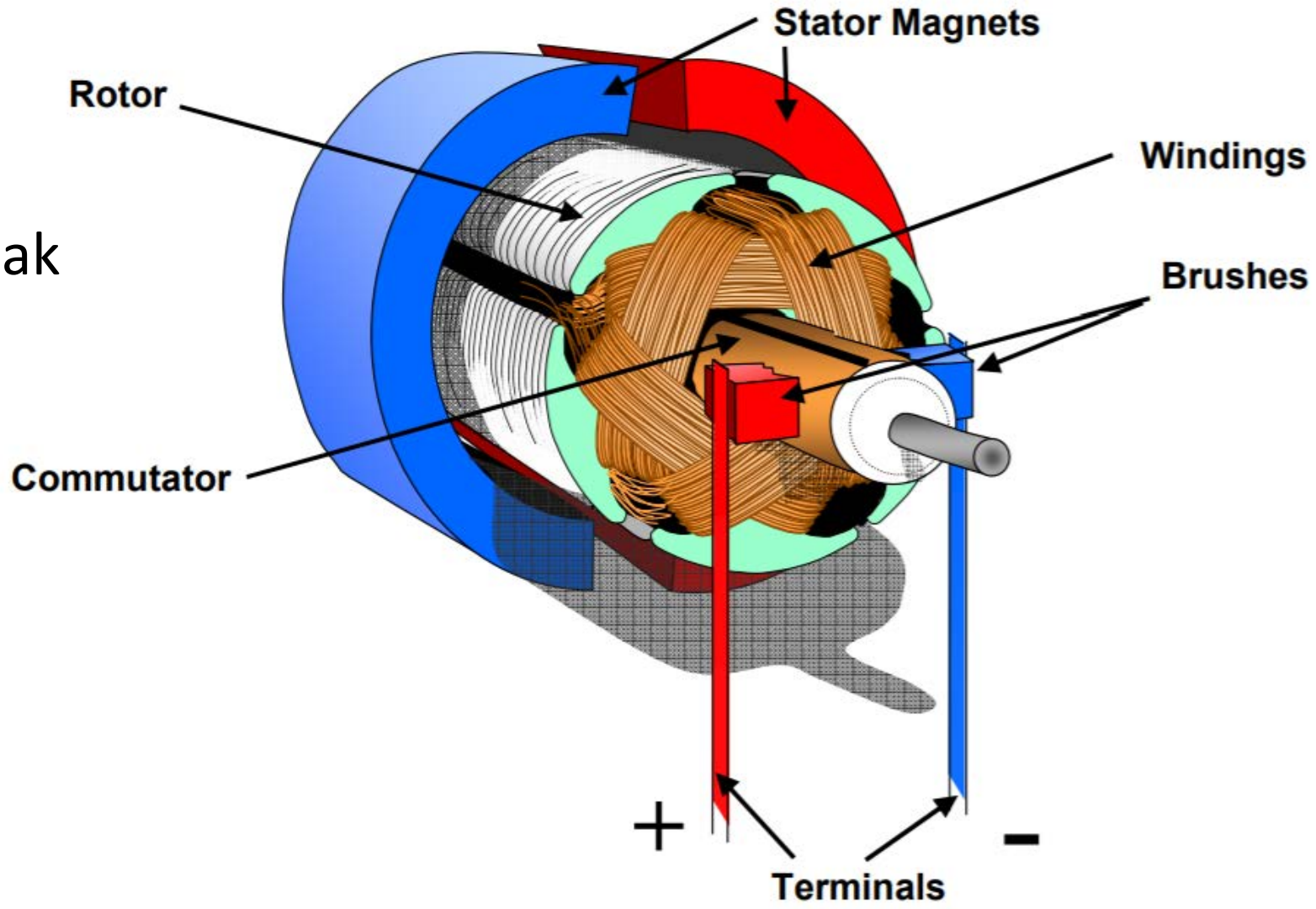


Brushed DC motor

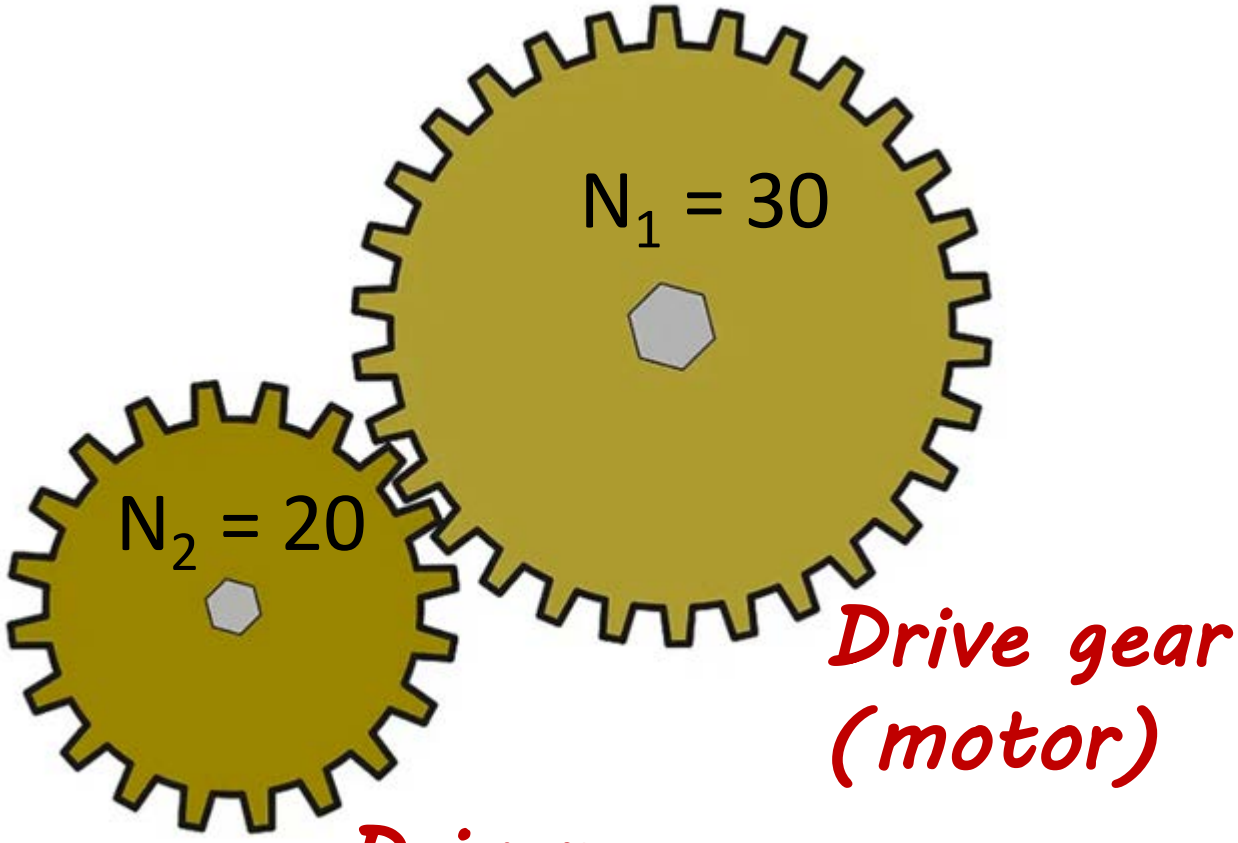


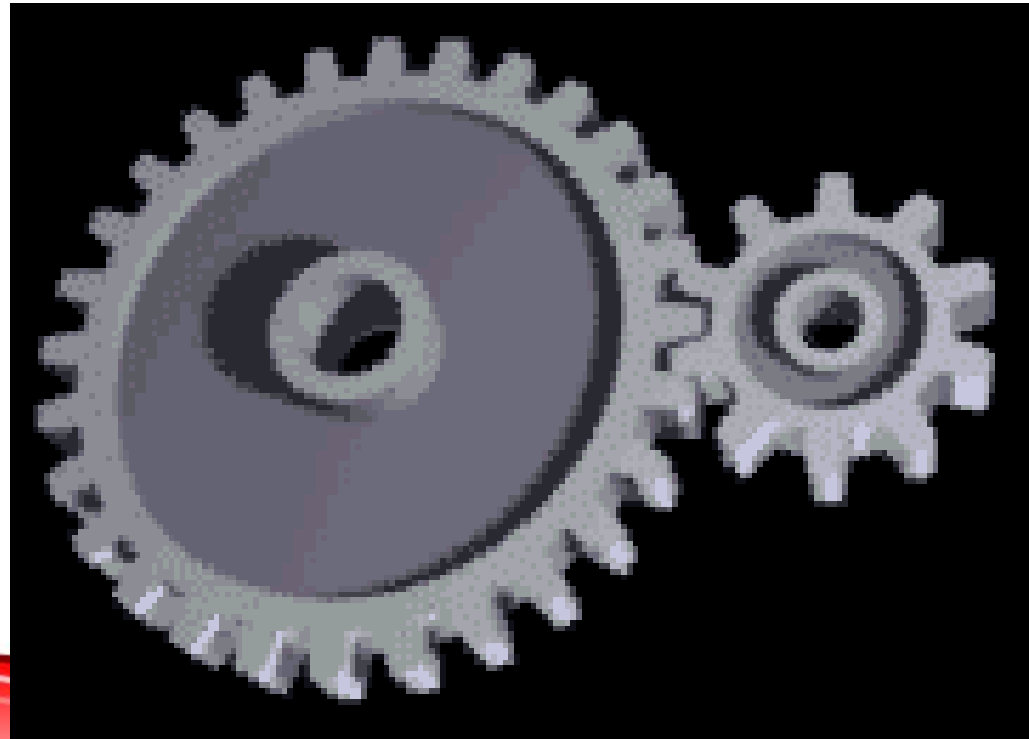
Brushed DC motor

- Standard motors are very fast and very weak
- Gear trains!



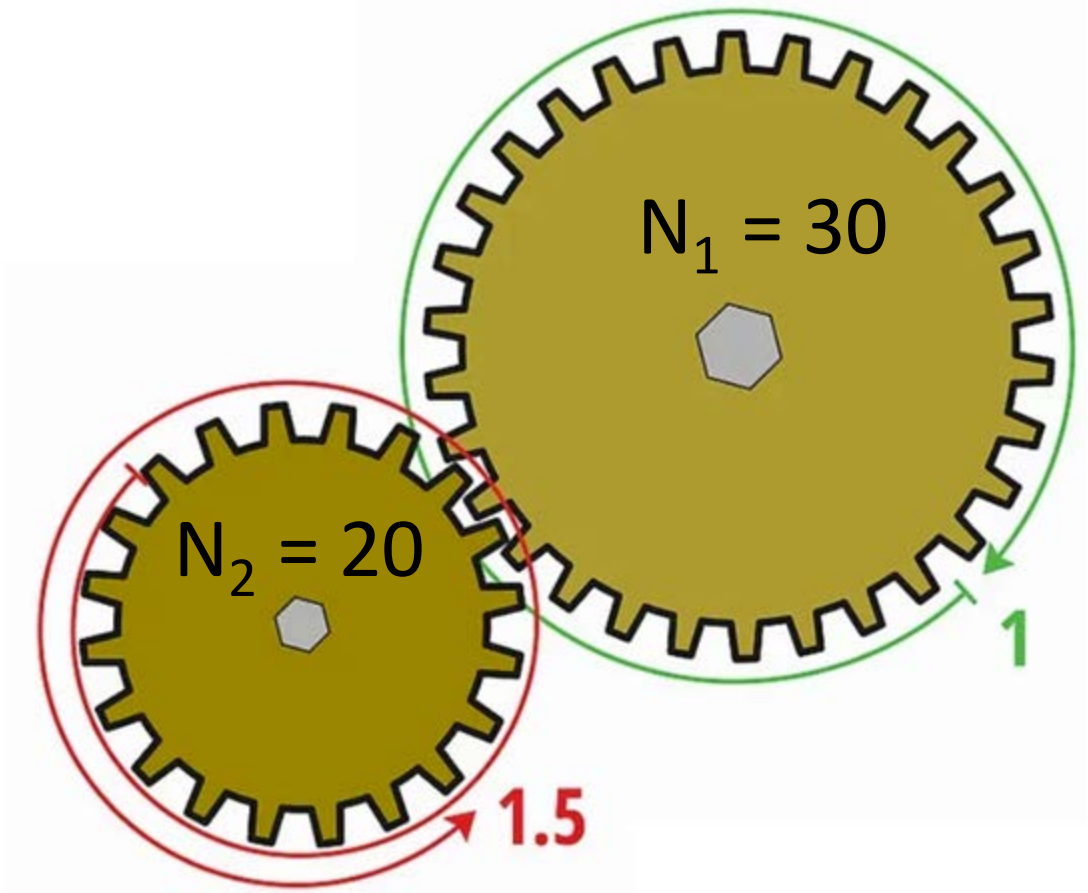
Gear Trains

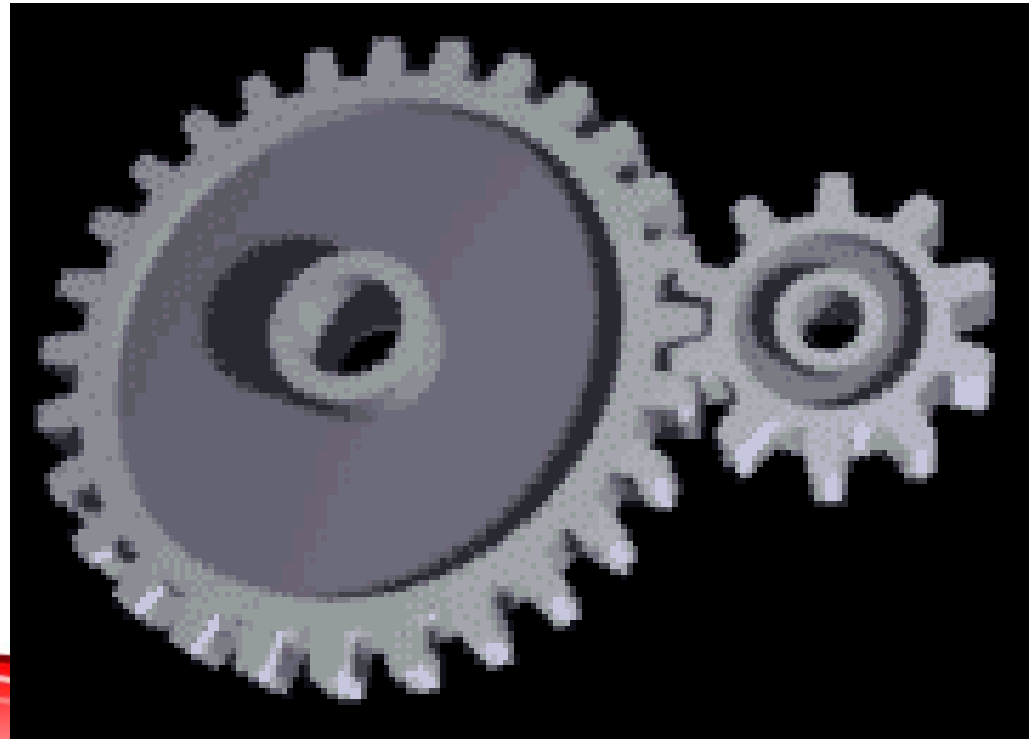




Gear Trains

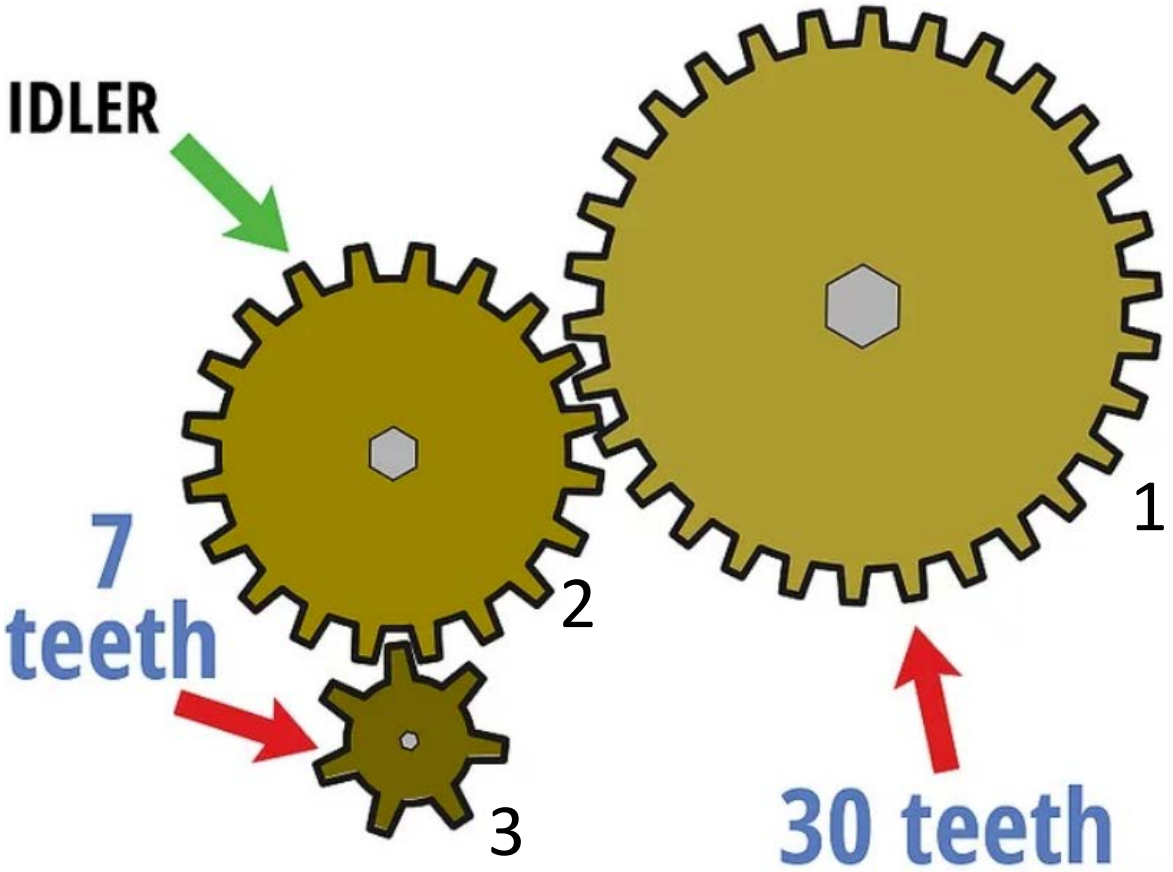
$$v_2 = v_1 \cdot \frac{N_1}{N_2}$$



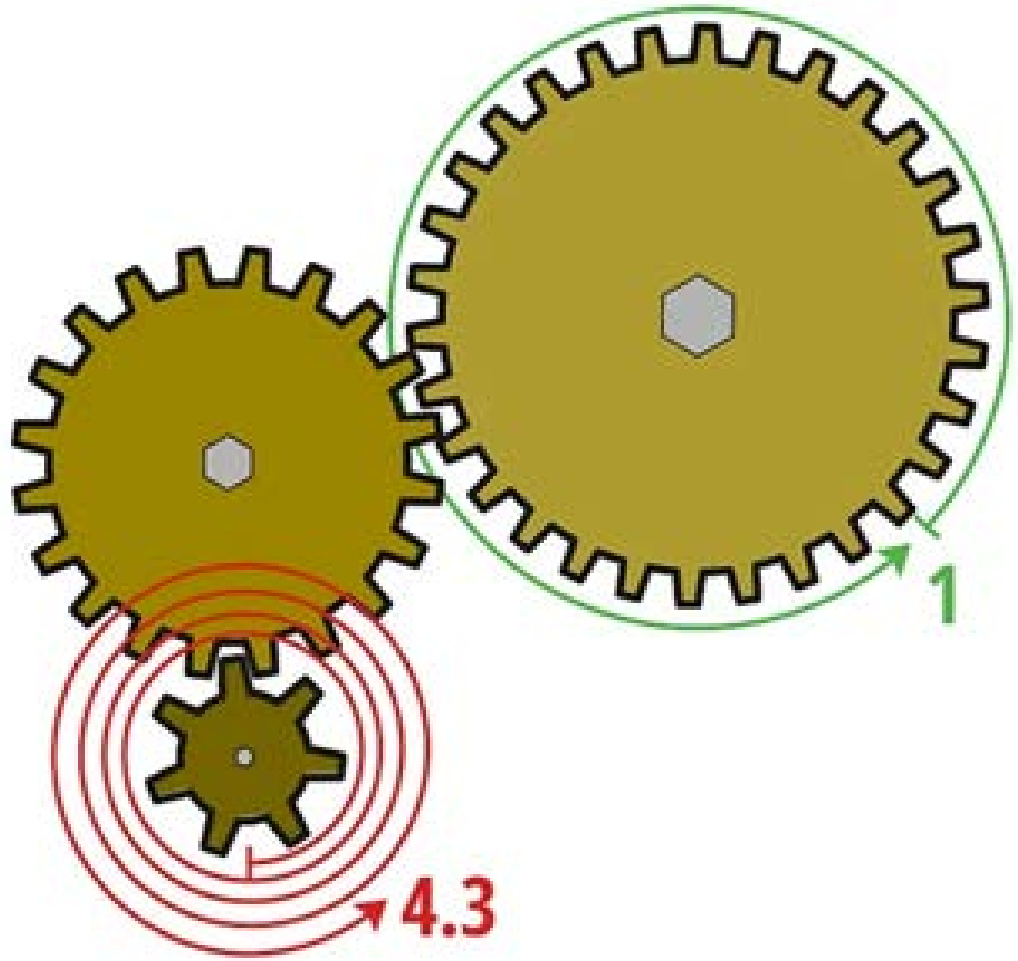


Gear Trains

$$v_3 = v_1 \cdot \frac{N_1}{N_3}$$



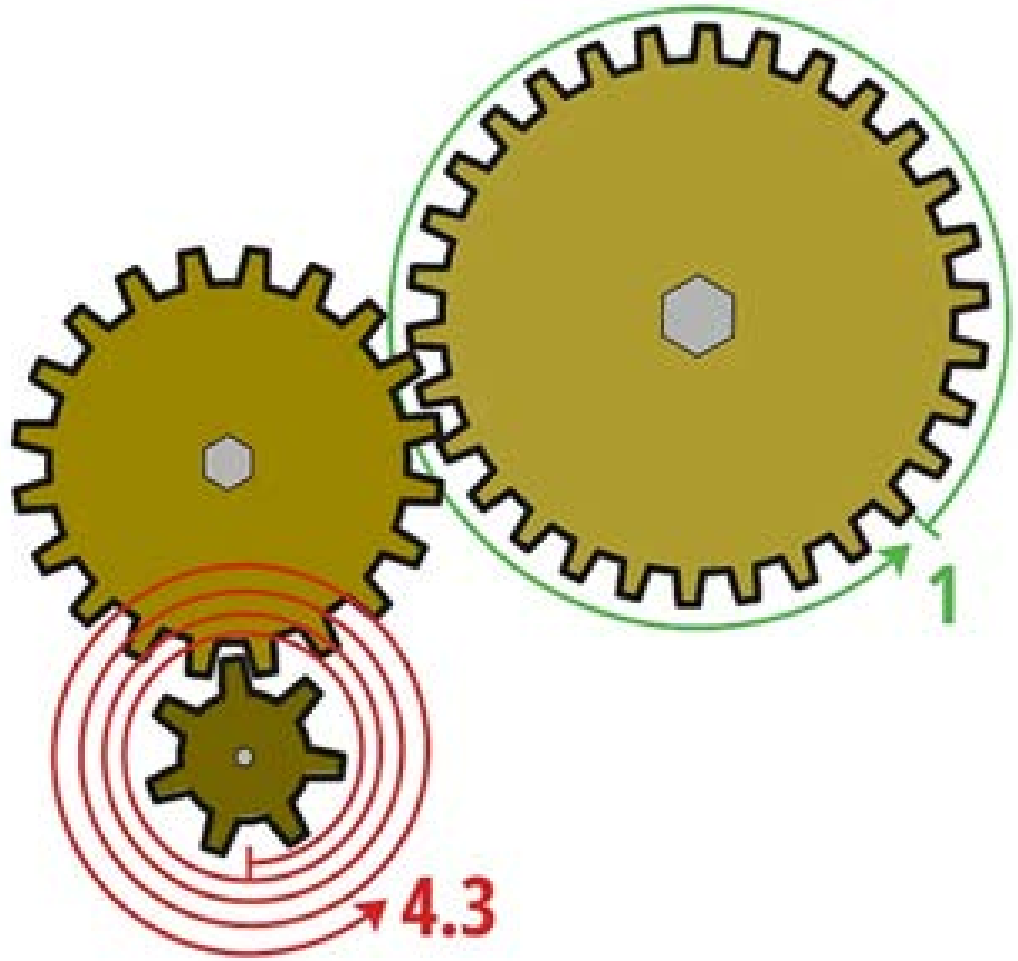
Gear Trains



$$v_3 = v_1 \cdot \frac{N_1}{N_3}$$

$$v_3 = v_1 \cdot \frac{N_1}{N_2} \cdot \frac{N_2}{N_3}$$

Gear Trains

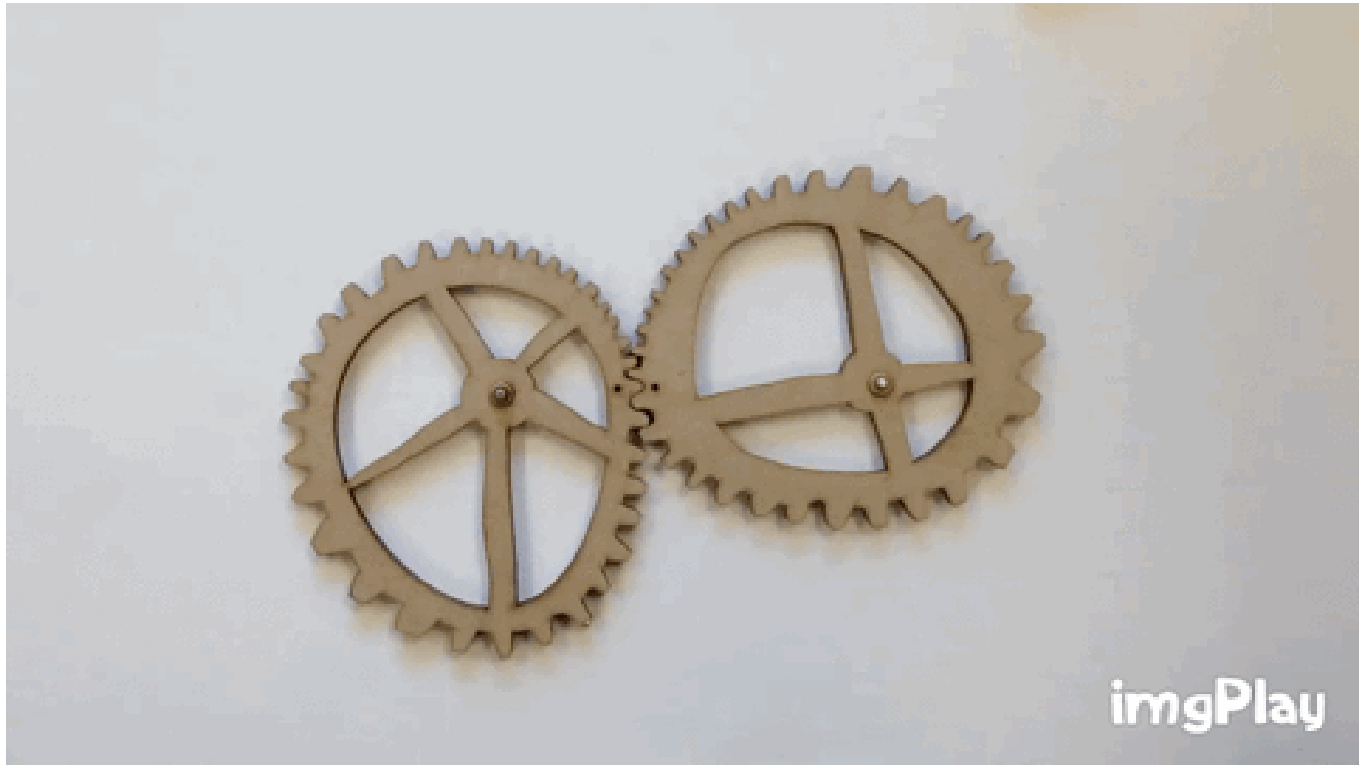


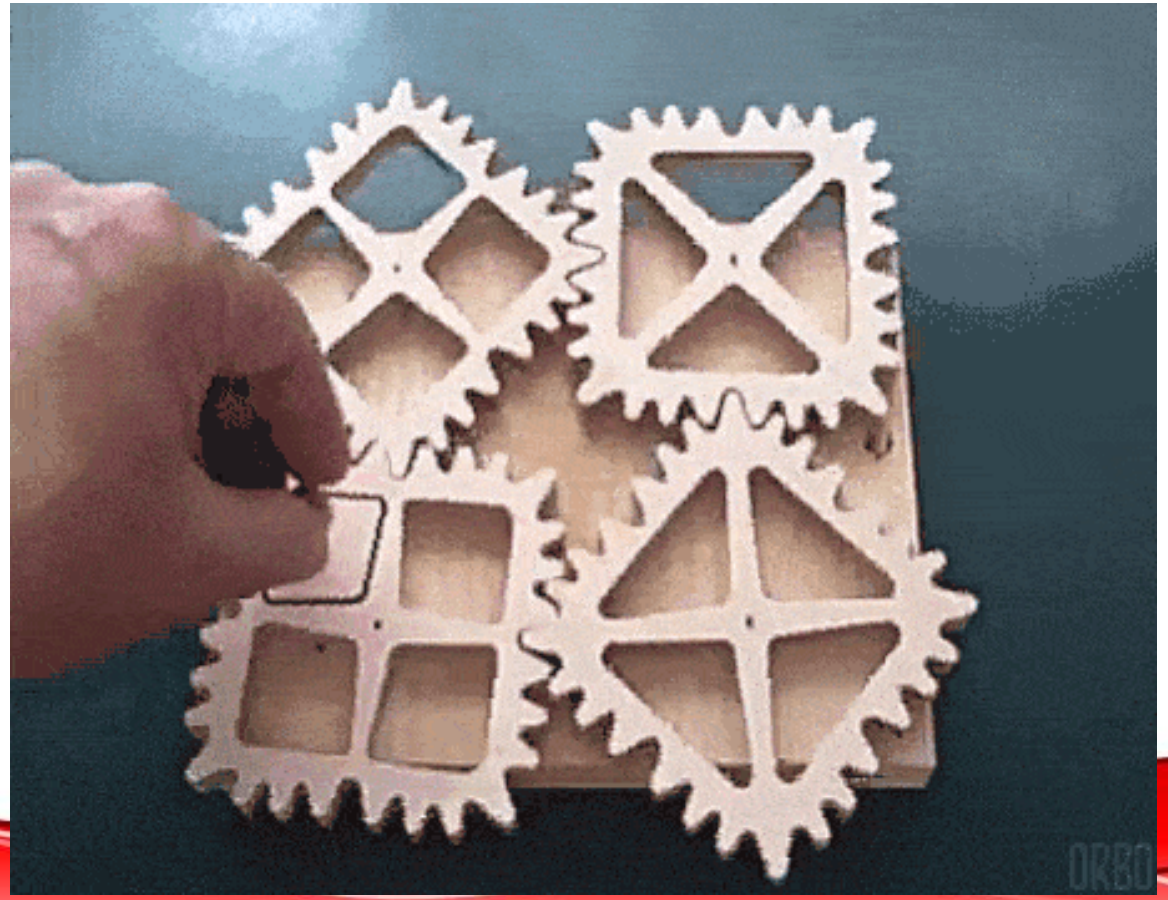
$$v_3 = v_1 \cdot \frac{N_1}{N_3}$$

$$\tau_3 = \tau_1 \cdot \frac{N_3}{N_1}$$

(real gears have loss - rule of thumb: loose ~10% per contact point)

Gear Trains

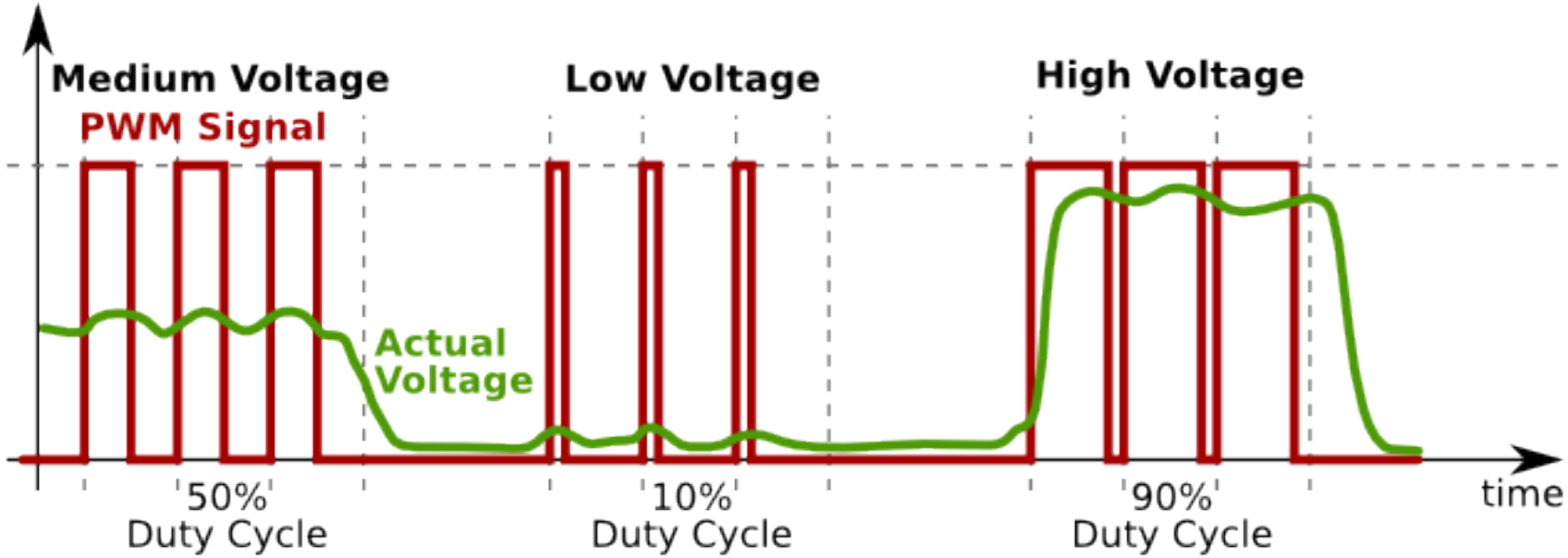


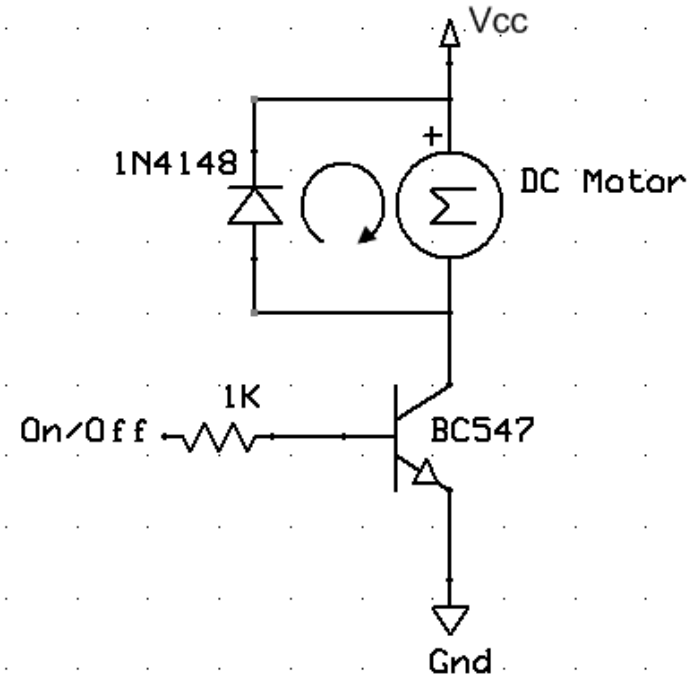


Driving a DC motor

Driving a DC motor

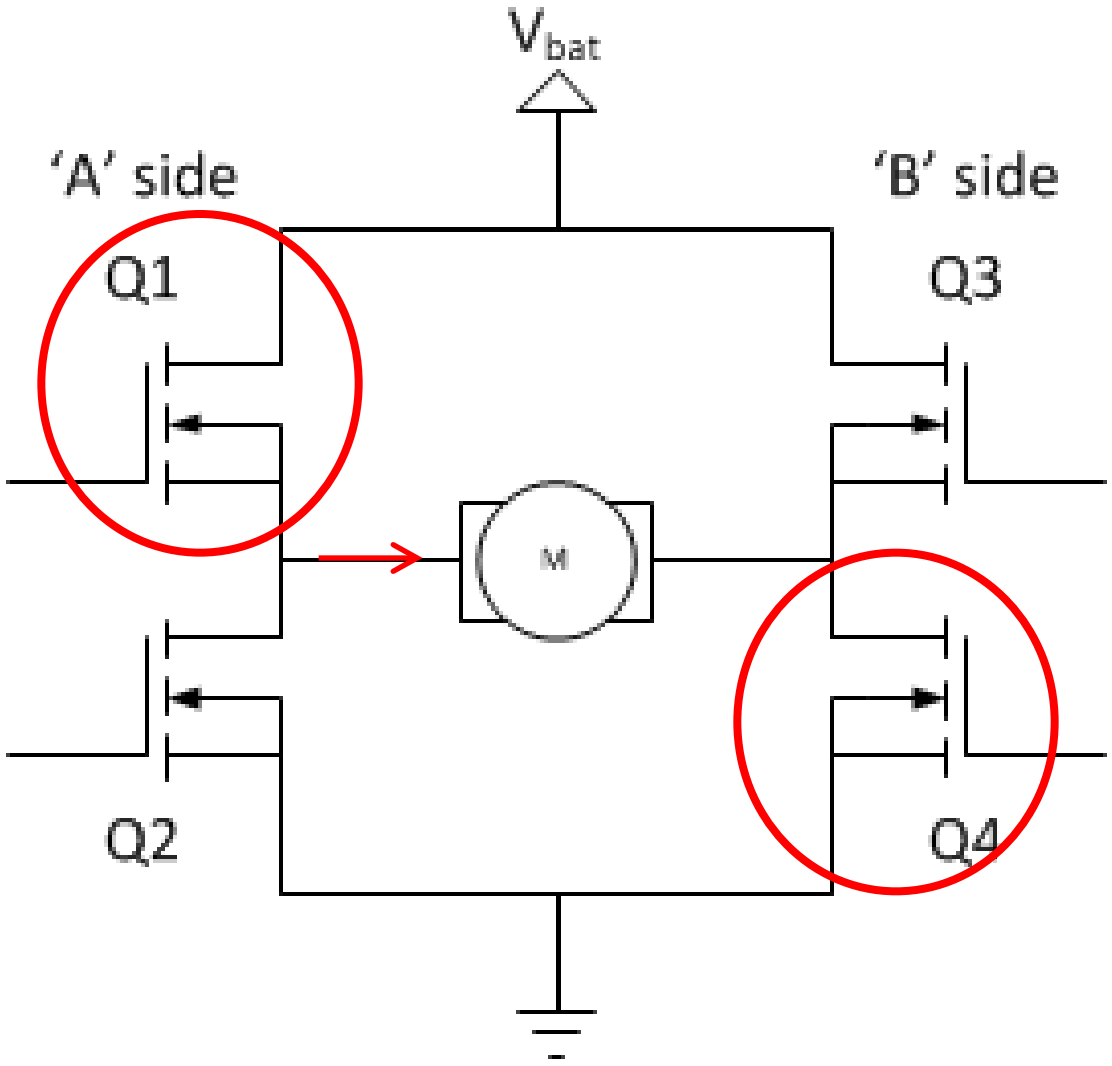
- Analog voltage





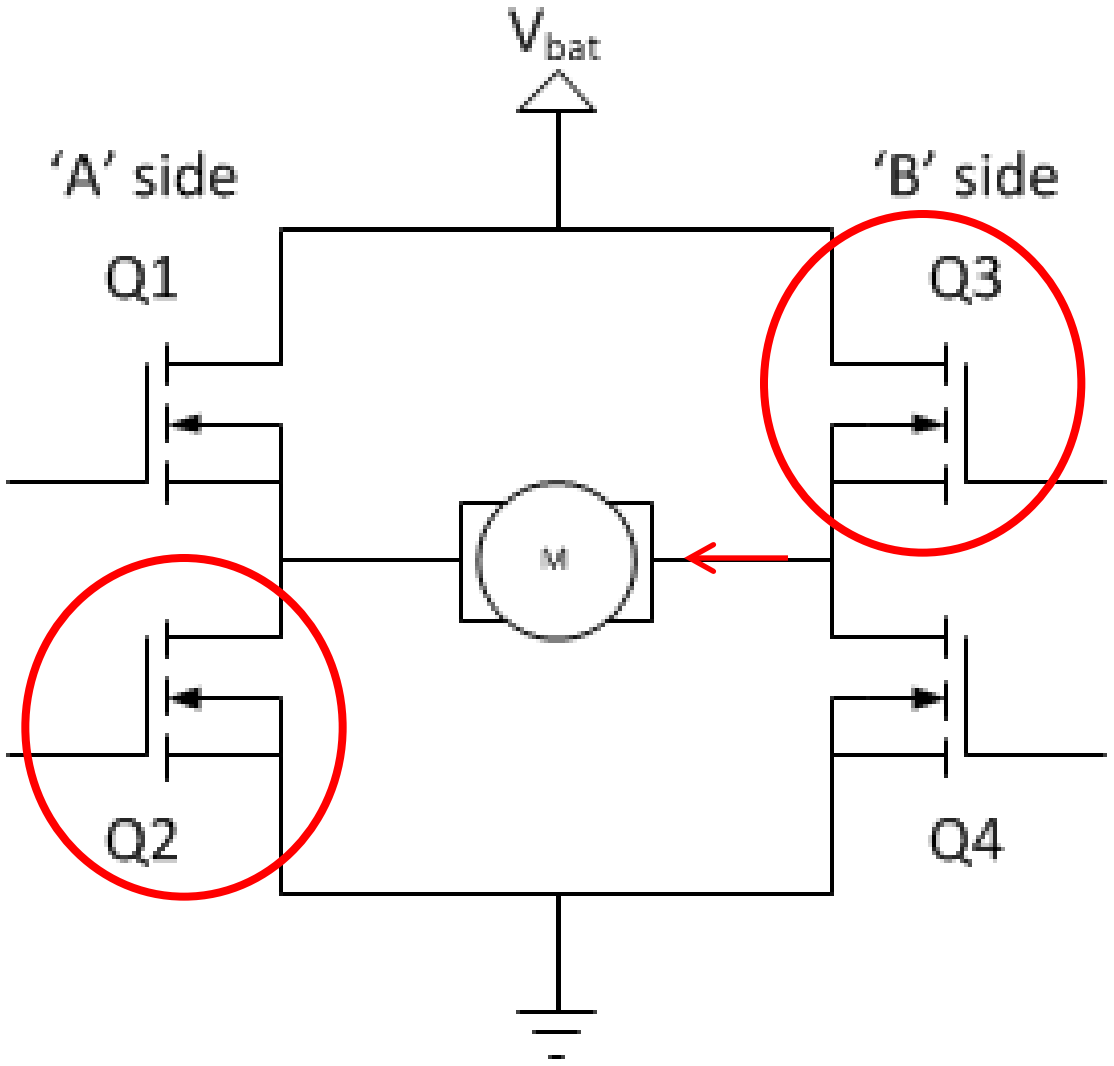
Driving a DC motor

- Analog voltage
- H-Bridge



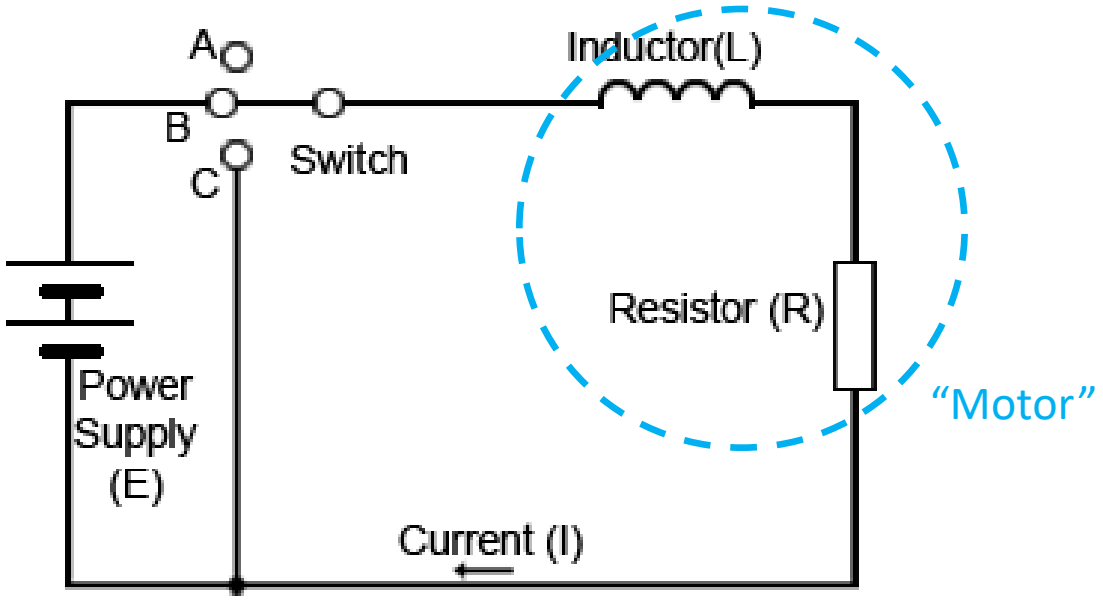
Driving a DC motor

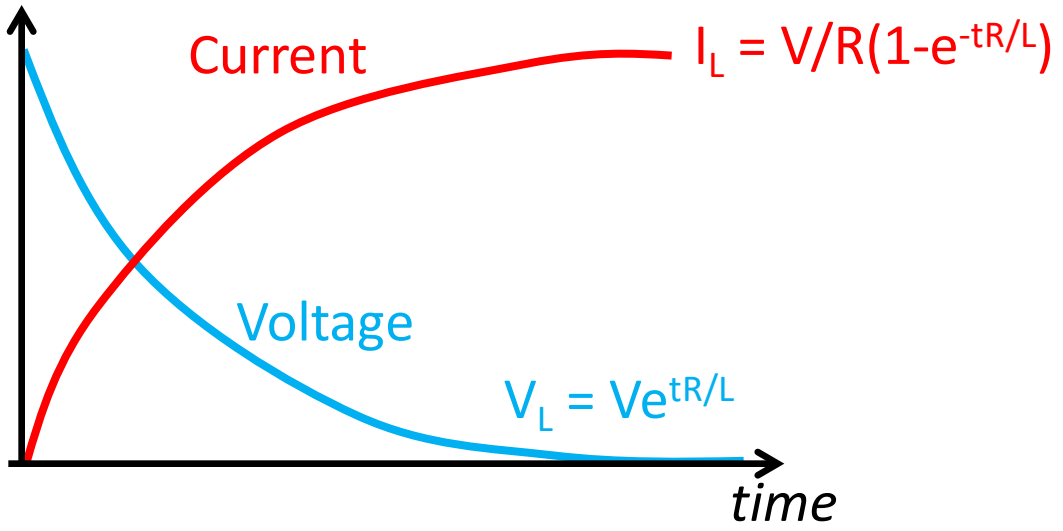
- Analog voltage
- H-Bridge



Driving a DC motor

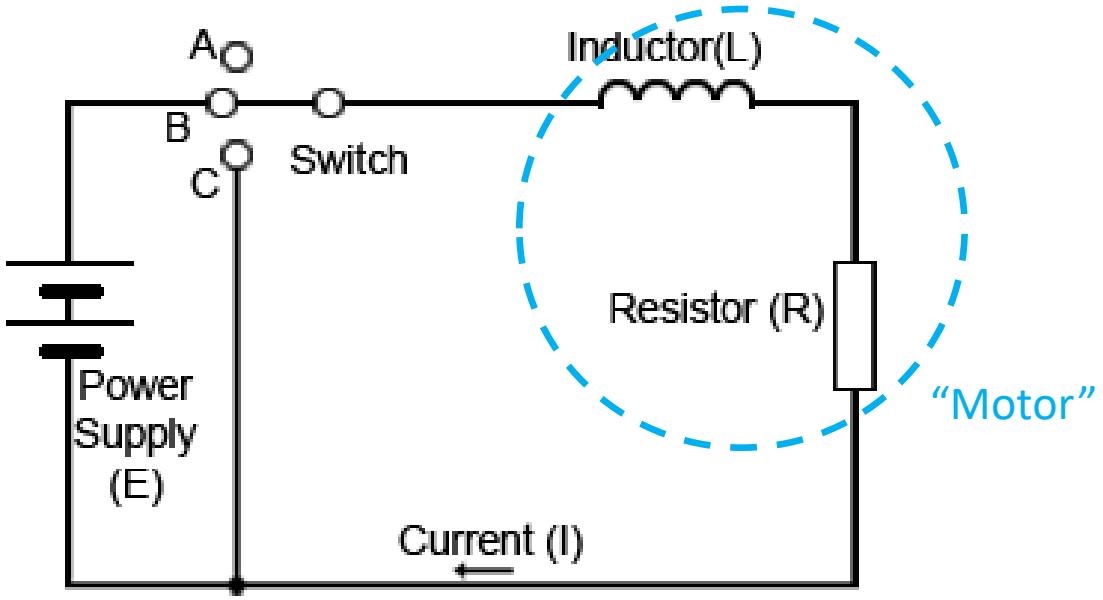
- Analog voltage
- H-Bridge
- Electromotive Force (EMF)

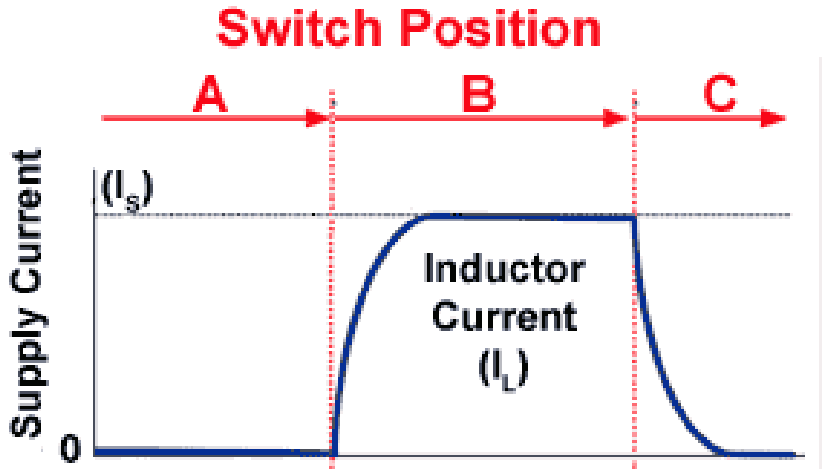


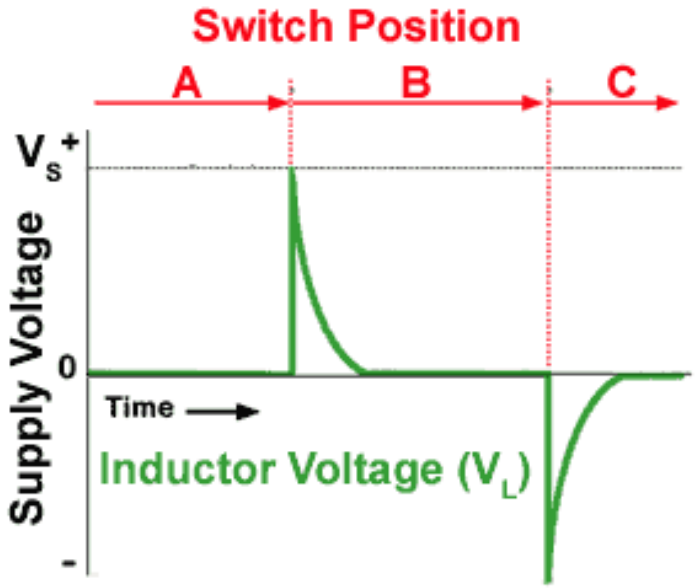


Driving a DC motor

- Analog voltage
- H-Bridge
- Electromotive Force (EMF)

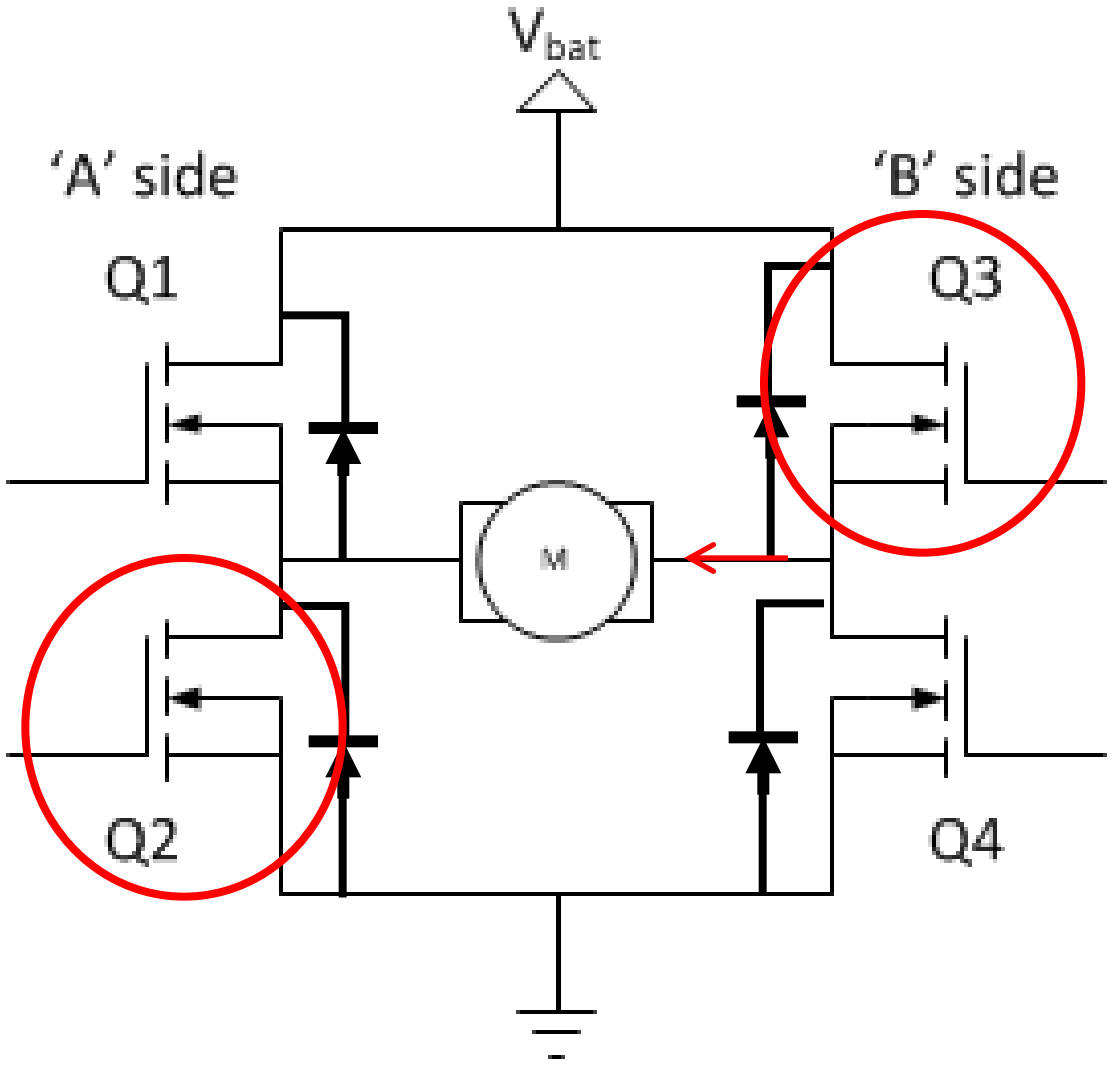






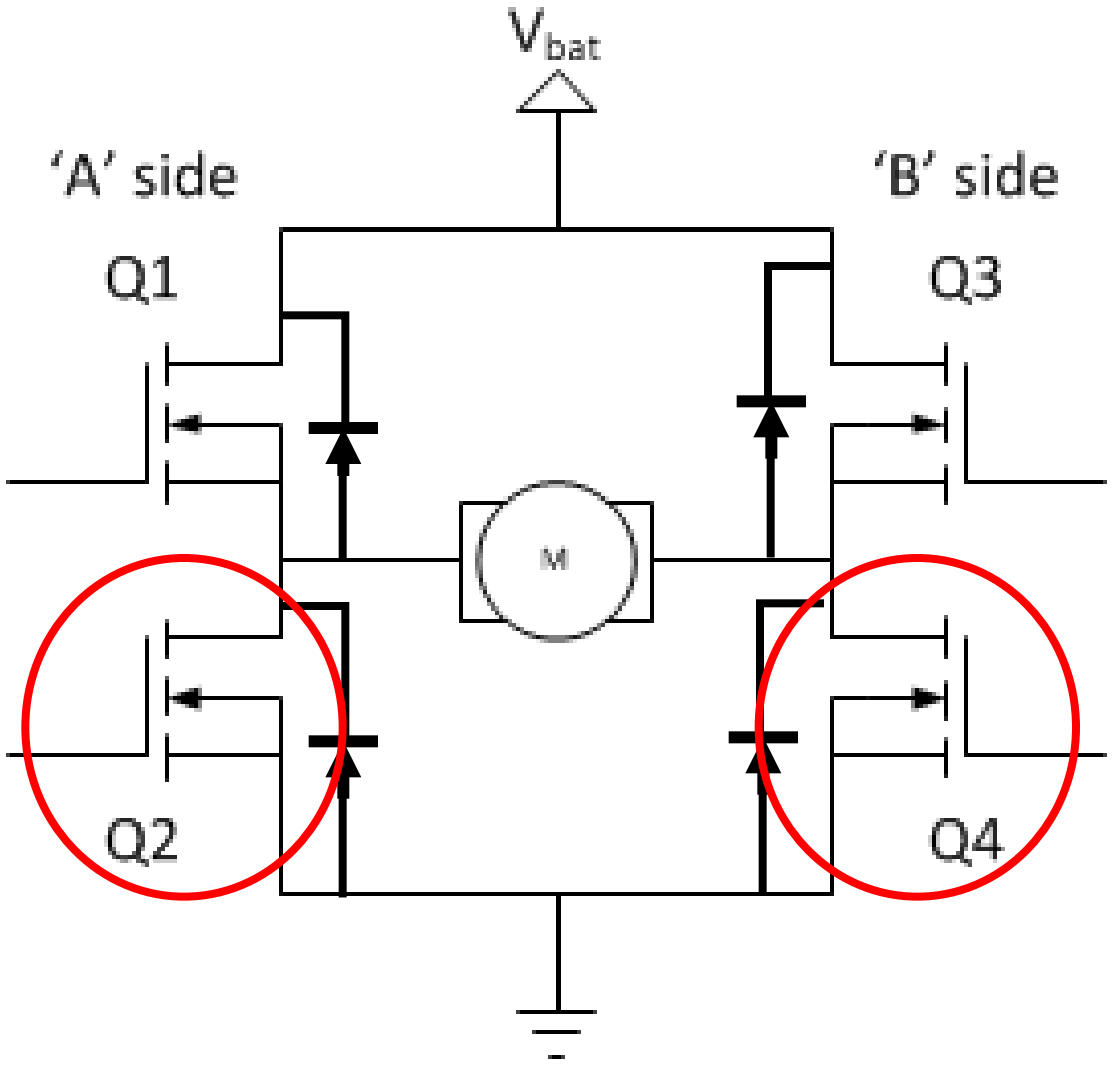
Driving a DC motor

- Analog voltage
- H-Bridge
- Electromotive Force (EMF)



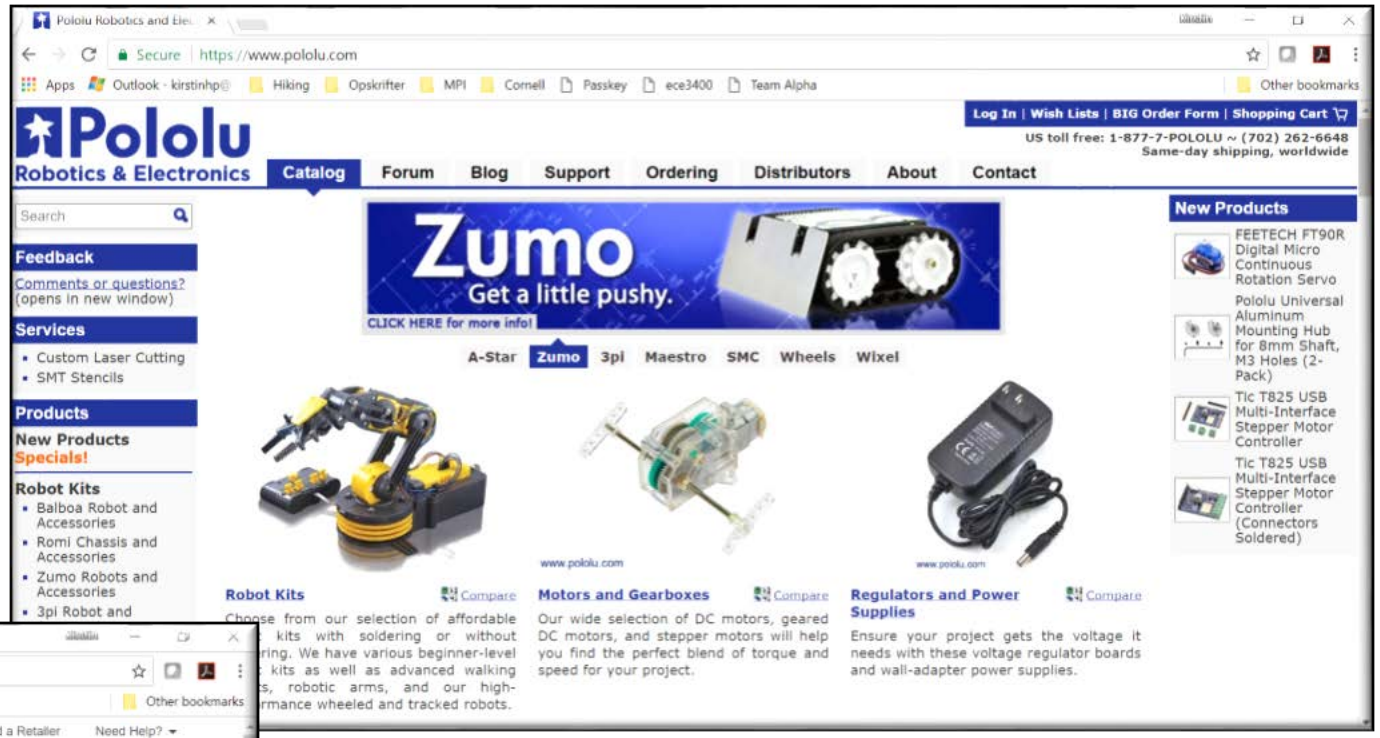
Driving a DC motor

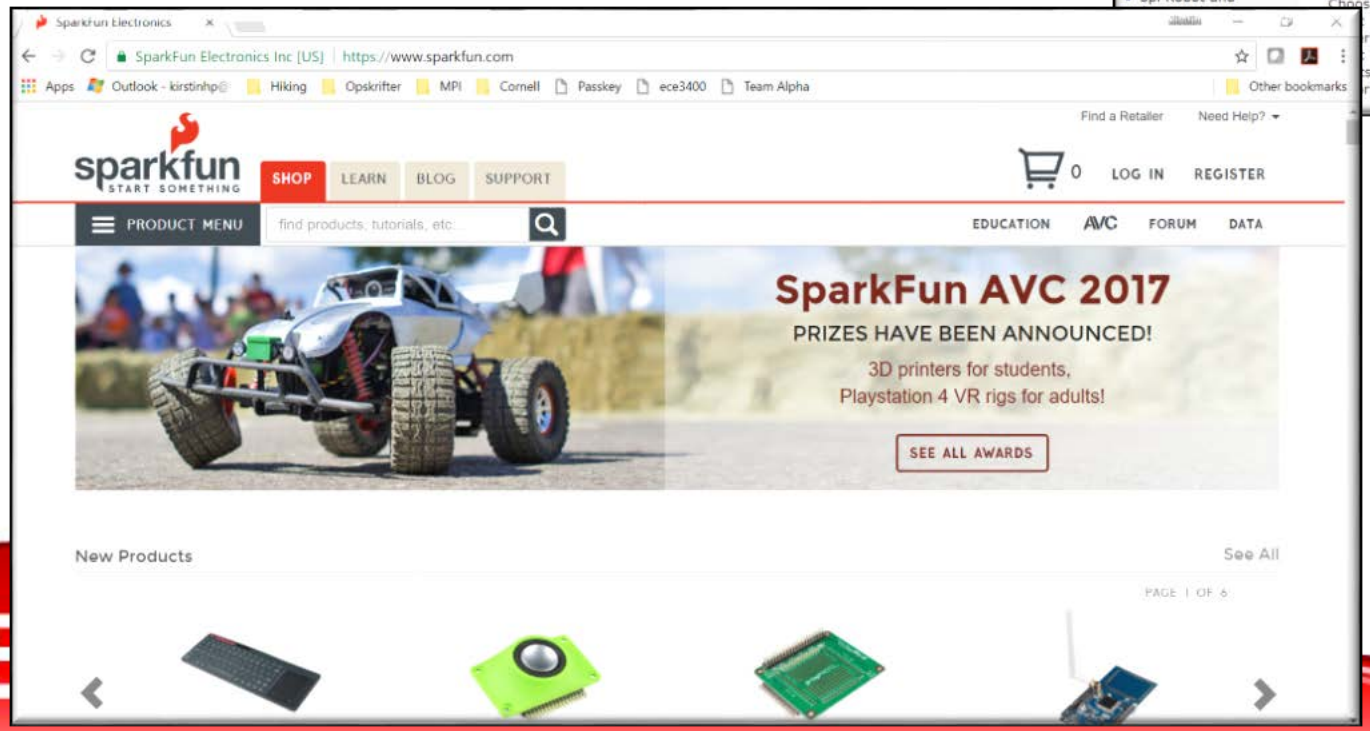
- H-Bridge
- PWM

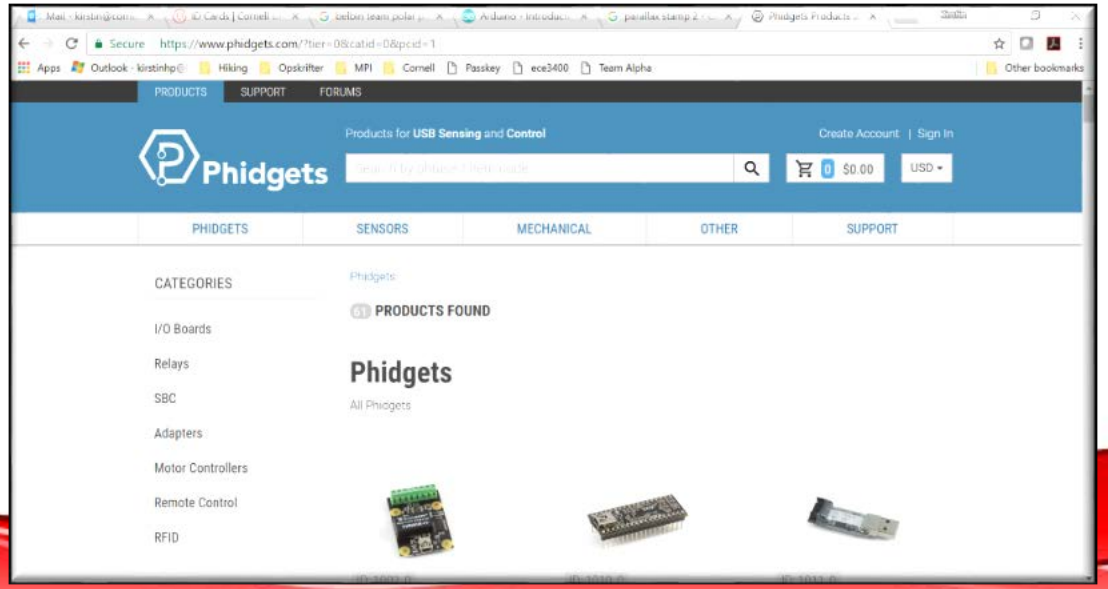


Commercial Vendors

- **Components:** Digikey, Allied, Mouser, Newark, Circuit Specialists
- **Robotics:** Parallax, Lynxmotion, Tower Hobbies, Hobbyking, Sparkfun, Polulu, Jameco, Phidgets
- **Mechanics:** McMaster, Stock Drive Products







Go Build Robots!