EEGN307: Modeling DC Motors[1]

Lecture 20

Elenya Grant, Kathryn Johnson, and Hisham Sager[2]

Department of Electrical Engineering
Colorado School of Mines

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[2] Developed and edited by Tyrone Vincent and Kathryn Johnson, Colorado School of Mines, with contributions from Salman Mohagheghi, Chris Coulston, Kevin Moore, CSM and Matt Kupilik, University of Alaska, Anchorage

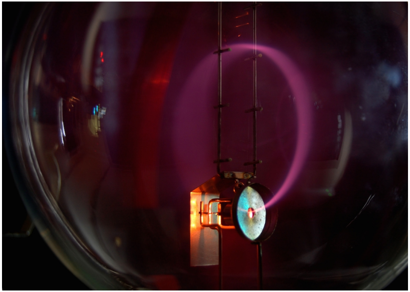
Electric Motors

- Motors are *transducers* which convert electrical energy to mechanical energy.
- We will look at models for brushed DC motors.

Key Idea 1: Lorentz Force

- An electron moving in a magnetic field experiences a force perpendicular to its motion and the magnetic field.

$$F = q(v \times B)$$



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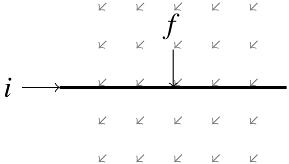
- Electrons move in a circle when exposed to a constant magnetic field.

Key Idea 1: Lorentz Force

- Electrons in a wire are constrained to move in a straight line. When a wire is placed in a magnetic field, and a current is set up through the wire, the Lorentz force creates a force perpendicular to the current and the magnetic field.

$$f = Ki$$



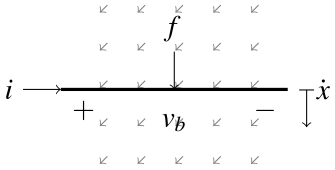
- This is the basis for a motor - the force on the wire can drive a mechanical load.

Key Idea 2: Conservation of Energy

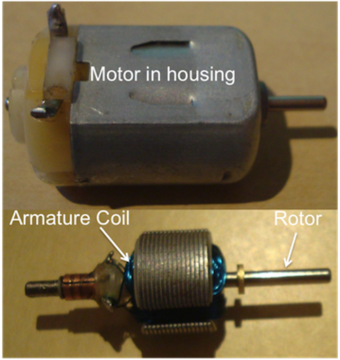
- A force on a wire will cause it to accelerate.
- Work done
  - on the wire: $\dot{x}f = \dot{x}Ki$.
  - to create the current: iv_b.
- Conservation of energy suggests these are equal

$$iv_b = \dot{x}Ki,$$
$$v_b = \dot{x}K.$$

- voltage (back electro-motive force) v_b is proportional to the wire's velocity



DC motor components



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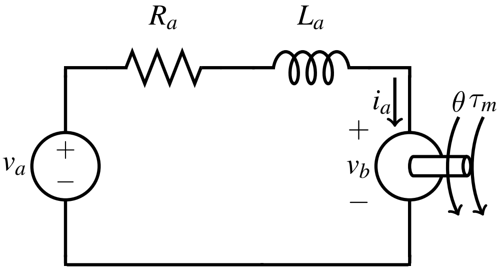
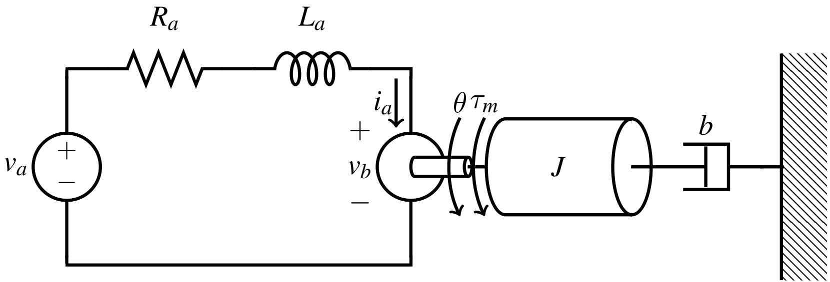


Motor Constants: K_t, K_e

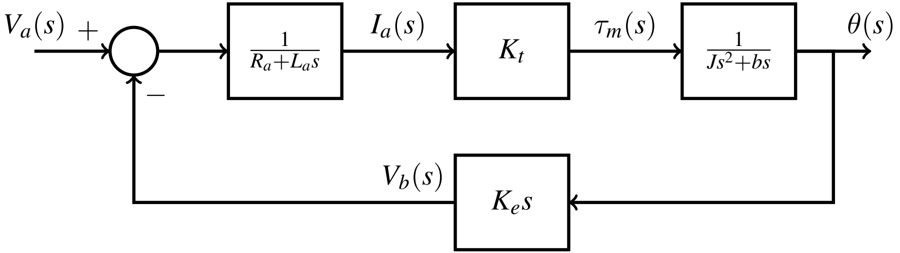
Transducer Relations: $\boxed{v_b = K_e\dot{\theta}}$

$\boxed{\tau_m = K_t i_a}$

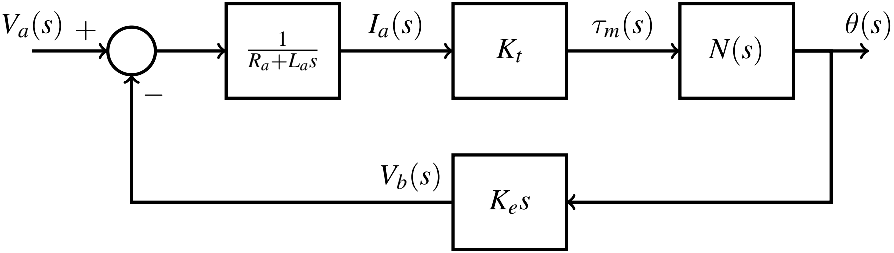
DC motor diagram



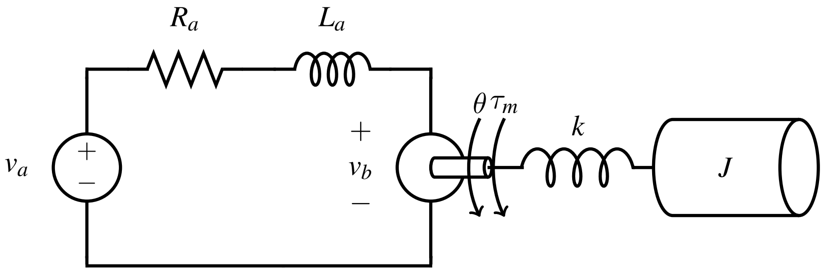
DC motor block diagram

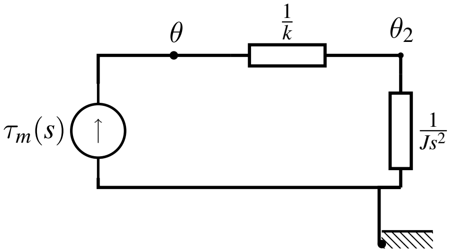


DC motor block diagram with arbitrary load



DC motor with different load




θ
$\frac{1}{k}$
θ_2
$\tau_m(s)$
$\frac{1}{Js^2}$