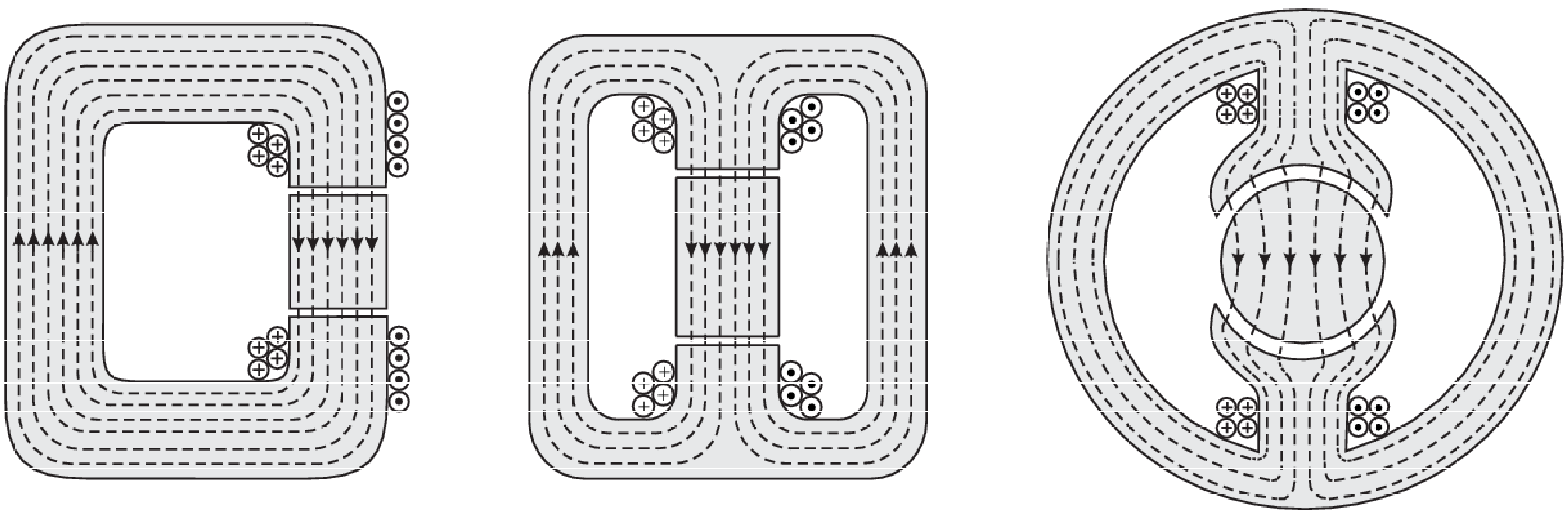
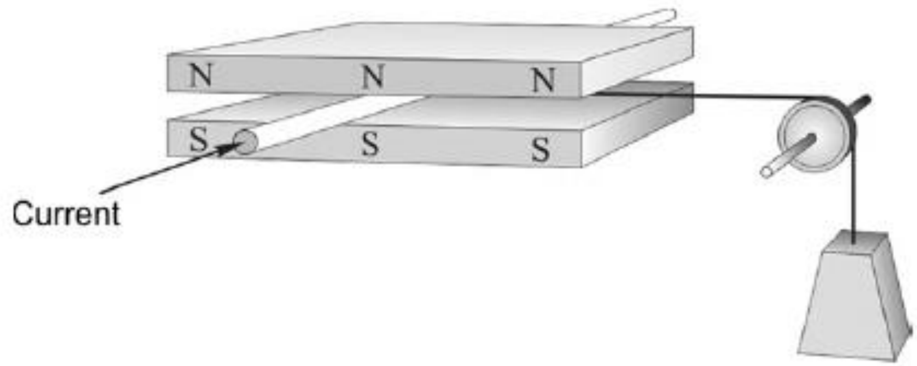
Mechatronic Actuators

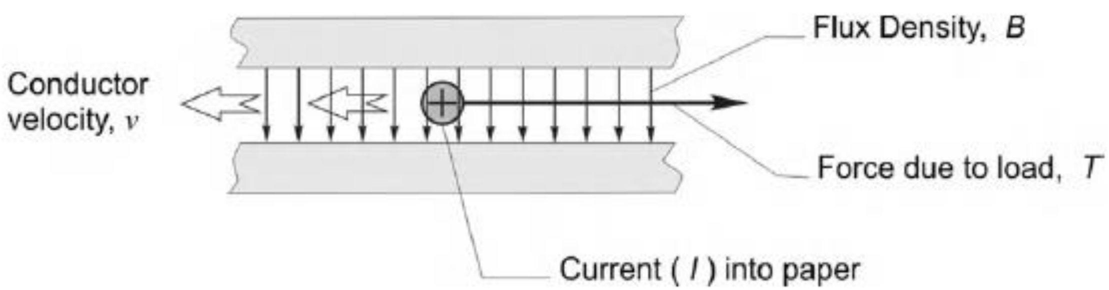
Lecture 4a

Magnetic flux in an electric motor

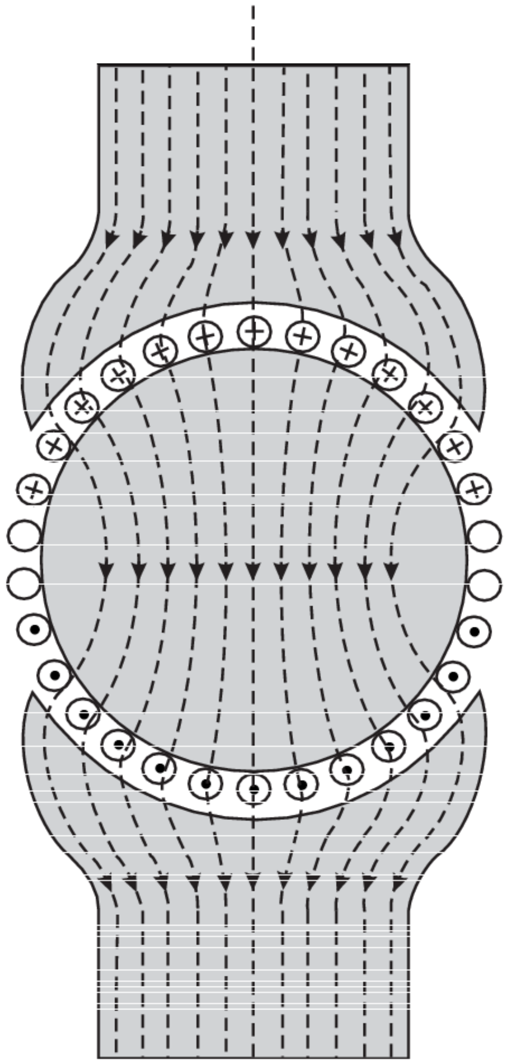


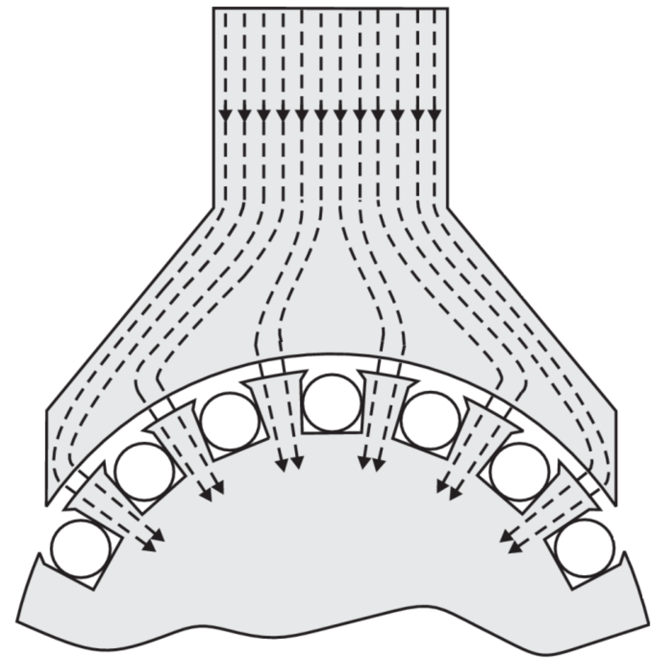
Principle of operation of a linear DC motor



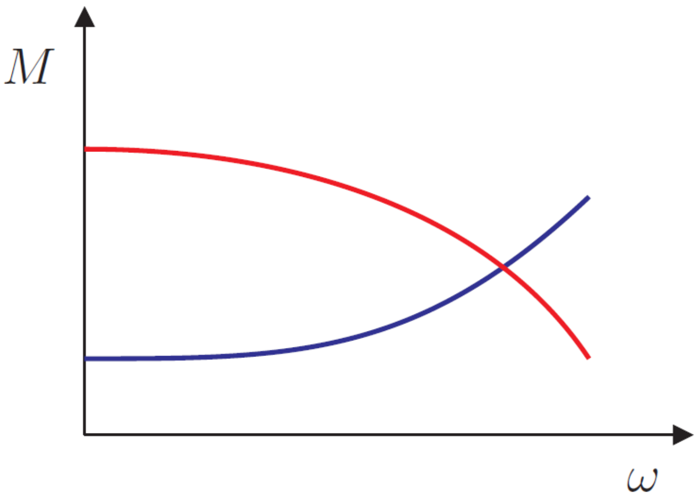


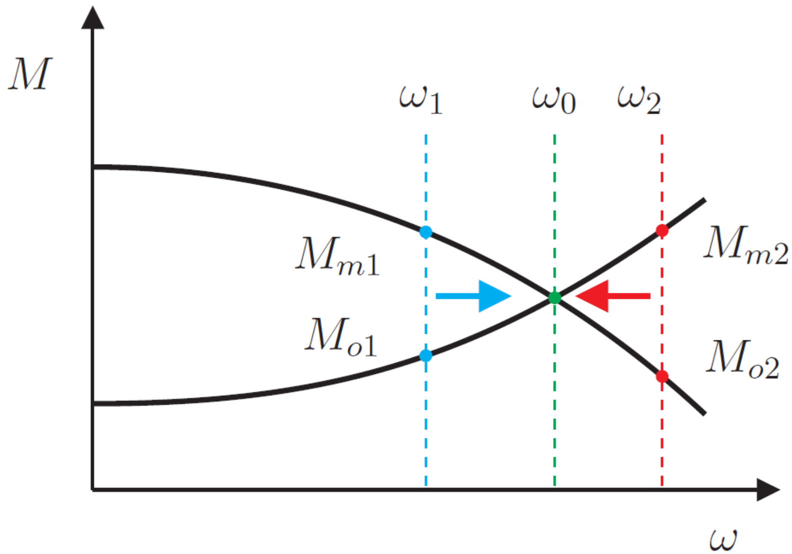
Rotor formation





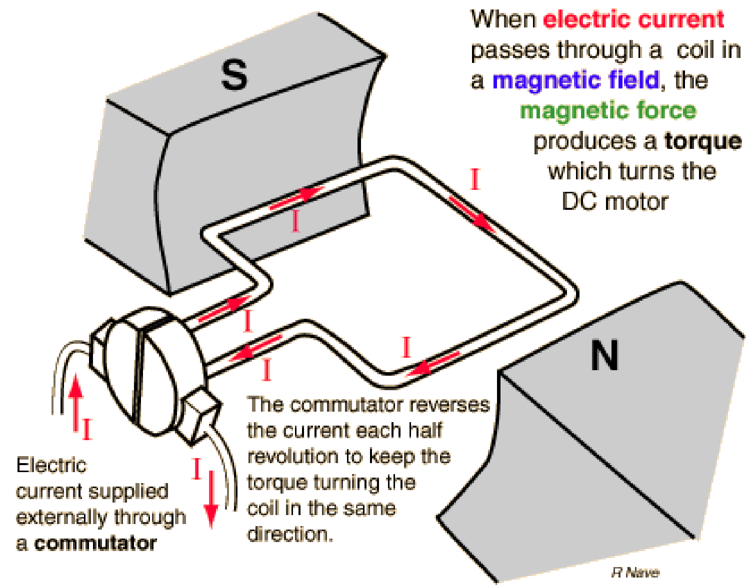
Moment characteristic

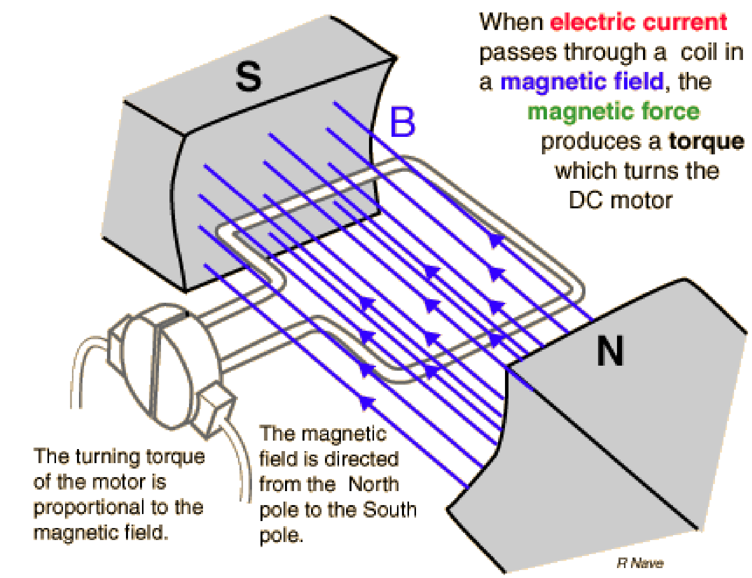


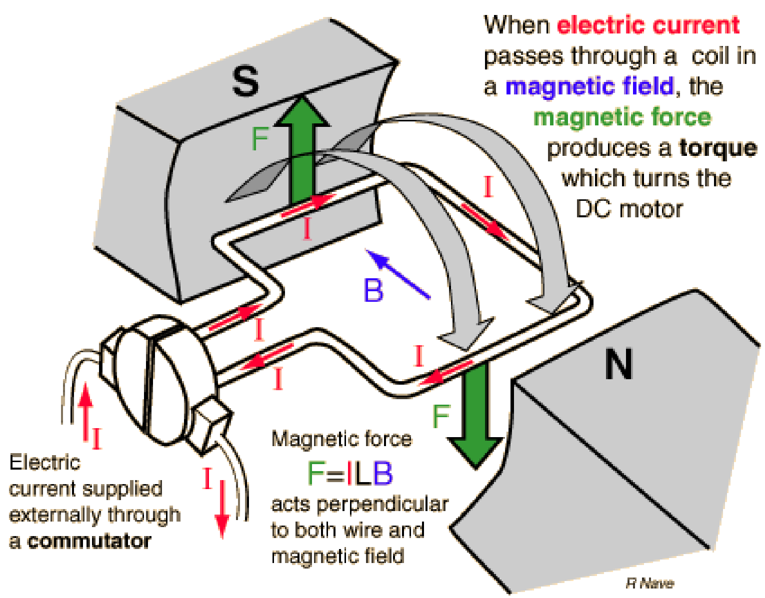


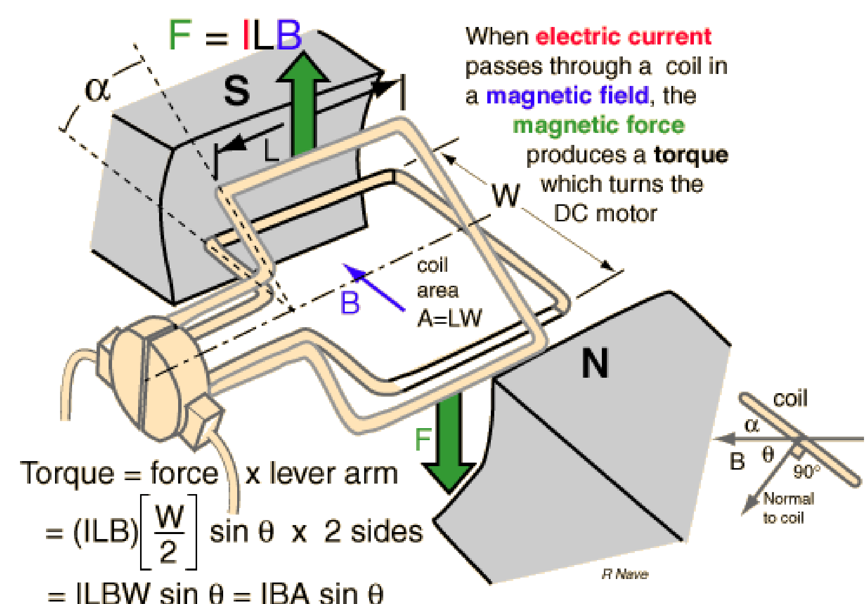
$$M_m - M_o = J\frac{d\omega}{dt}$$

DC electric motor



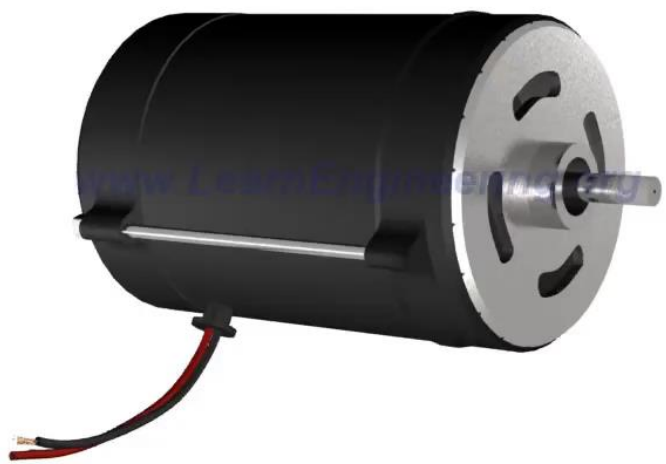




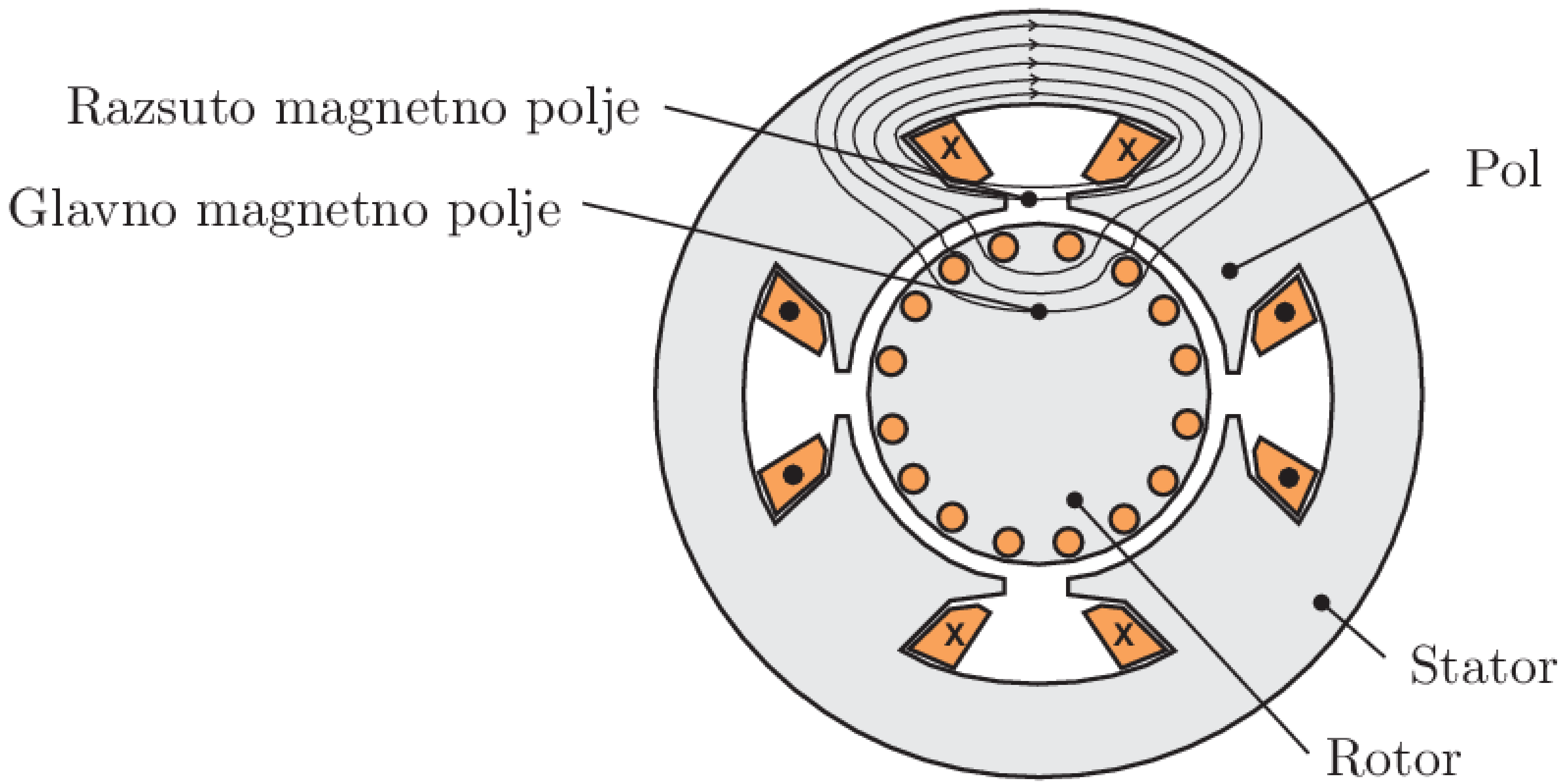


Animation

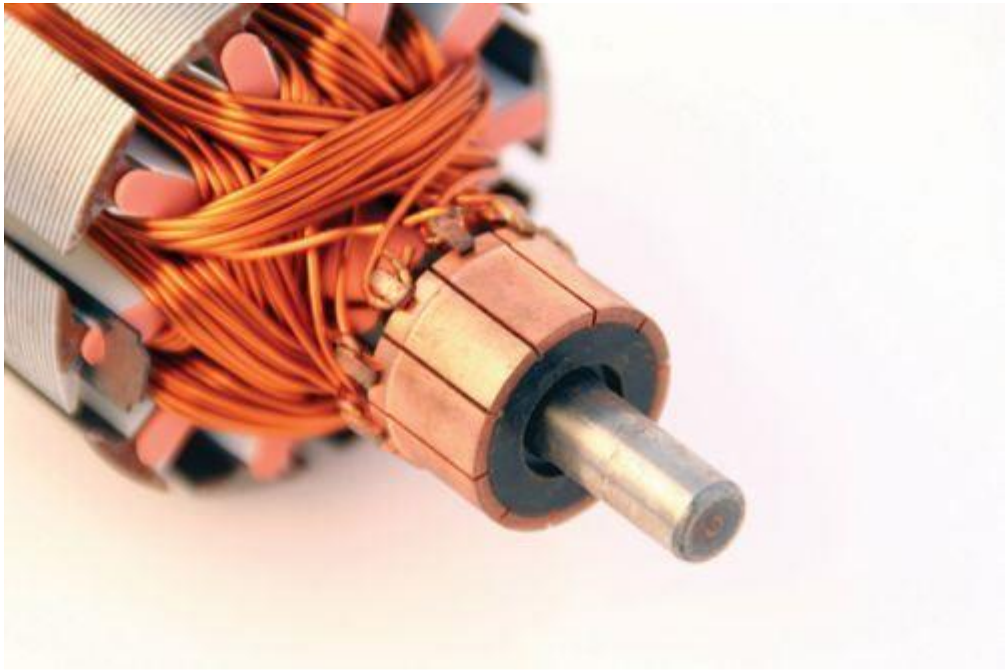
Direct Current Electric Motor.mp4



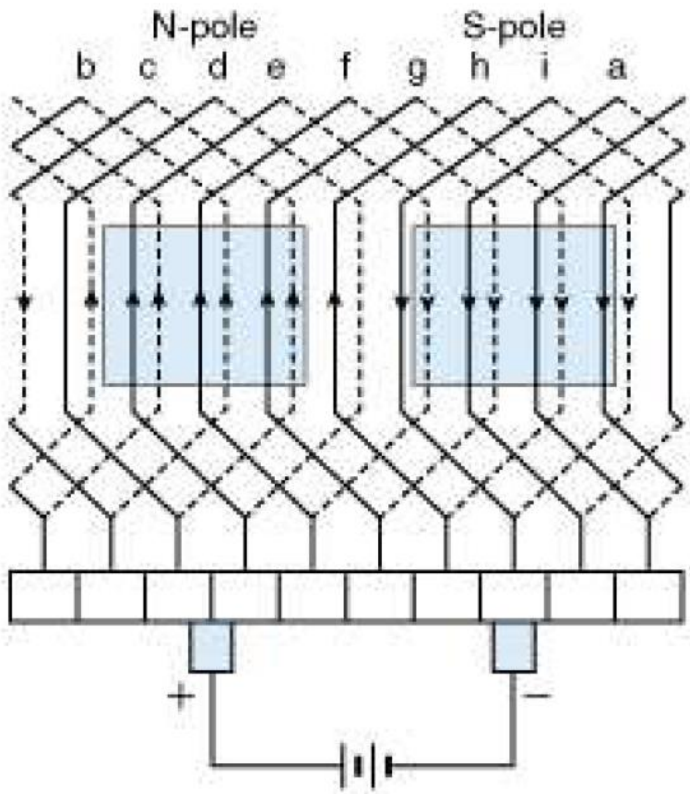
The actual electric motor



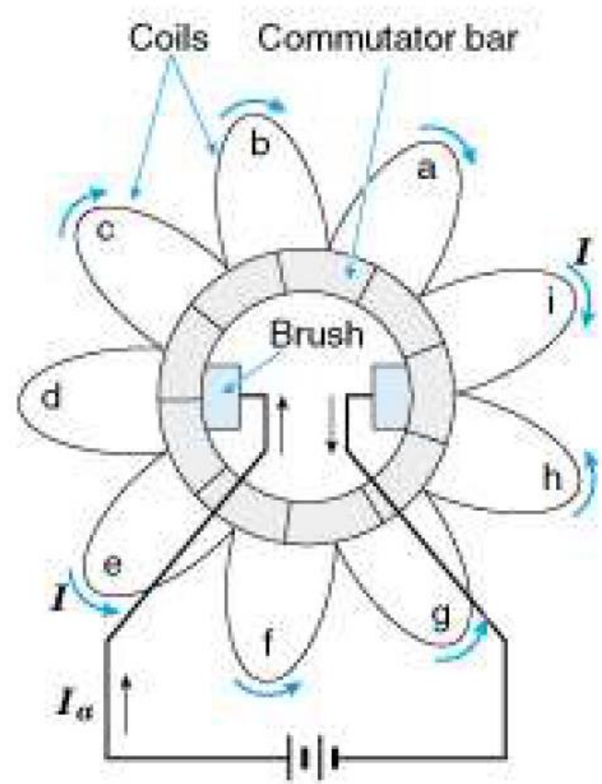
The actual commutator



Connection

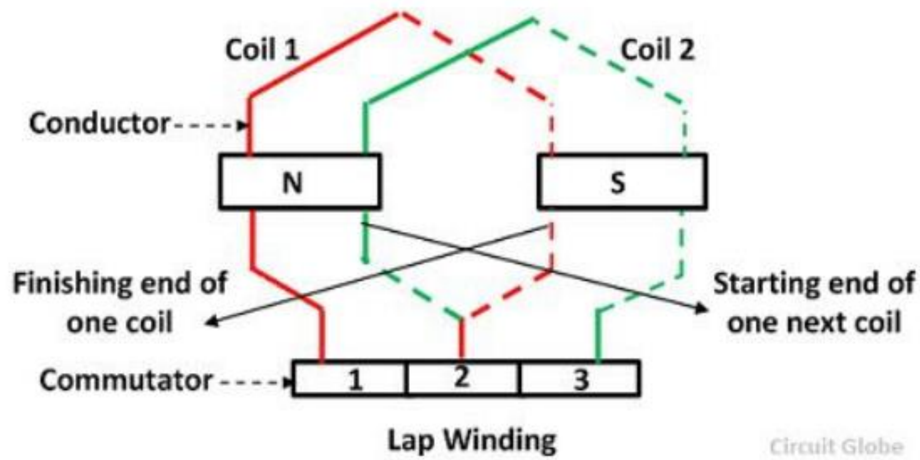


(a) Development diagram of lap winding

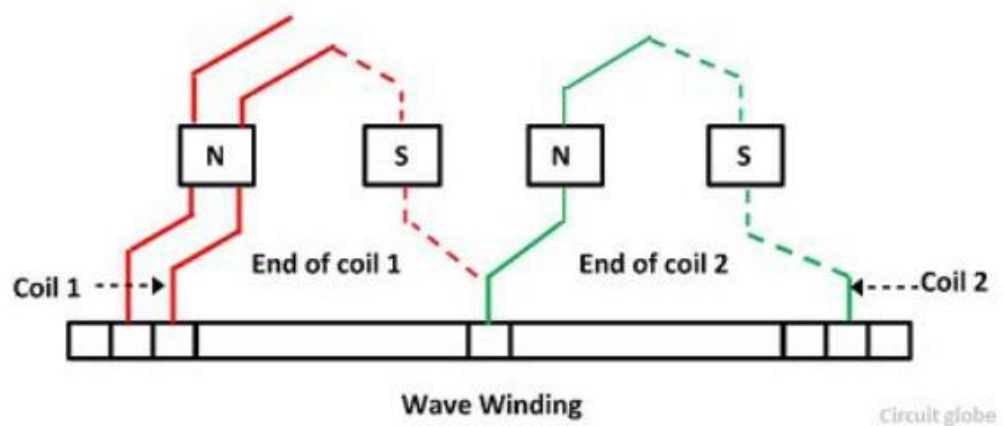


(b) Connection of coil

Two types

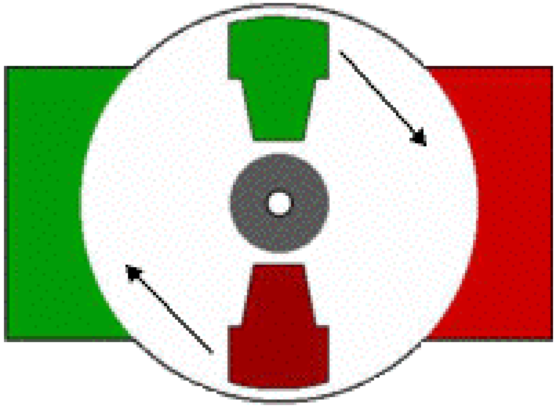


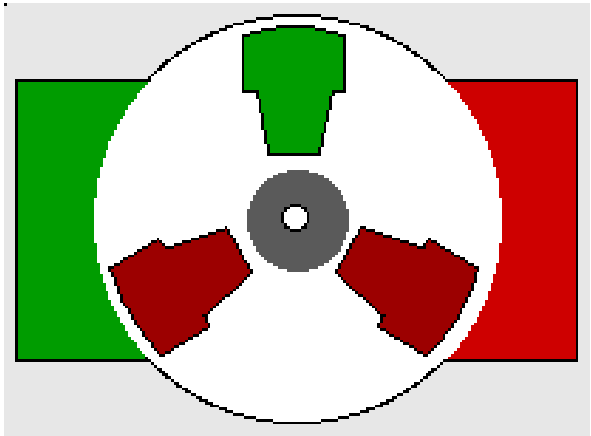
Coil 1
Coil 2
Conductor
N
S
Finishing end of one coil
Starting end of one next coil
Commutator
1
2
3
Lap Winding
Circuit Globe

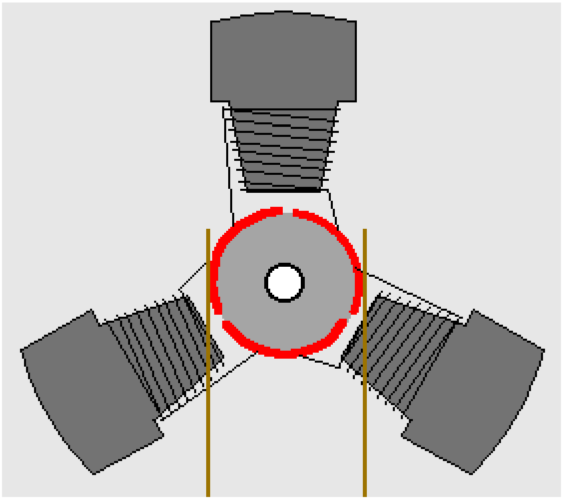


N
S
N
S
End of coil 1
End of coil 2
Coil 1
Coil 2
Wave Winding
Circuit globe

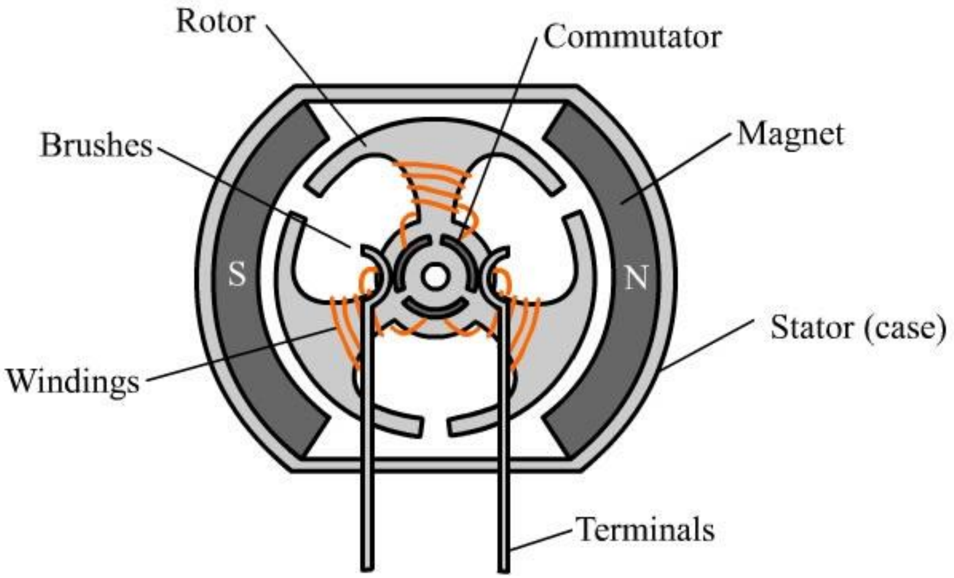
The problem of the moment



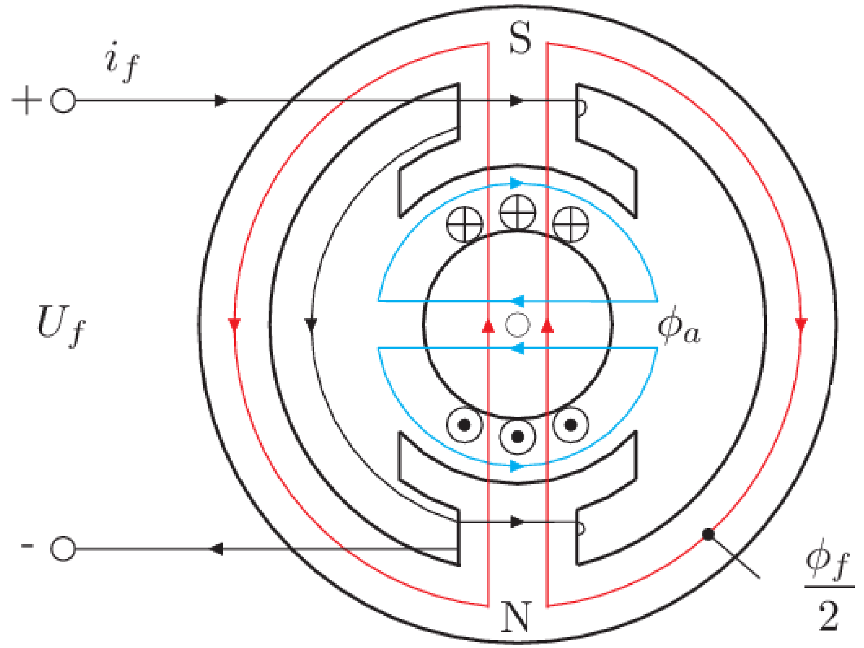




Typical Brushed Motor in Cross-section



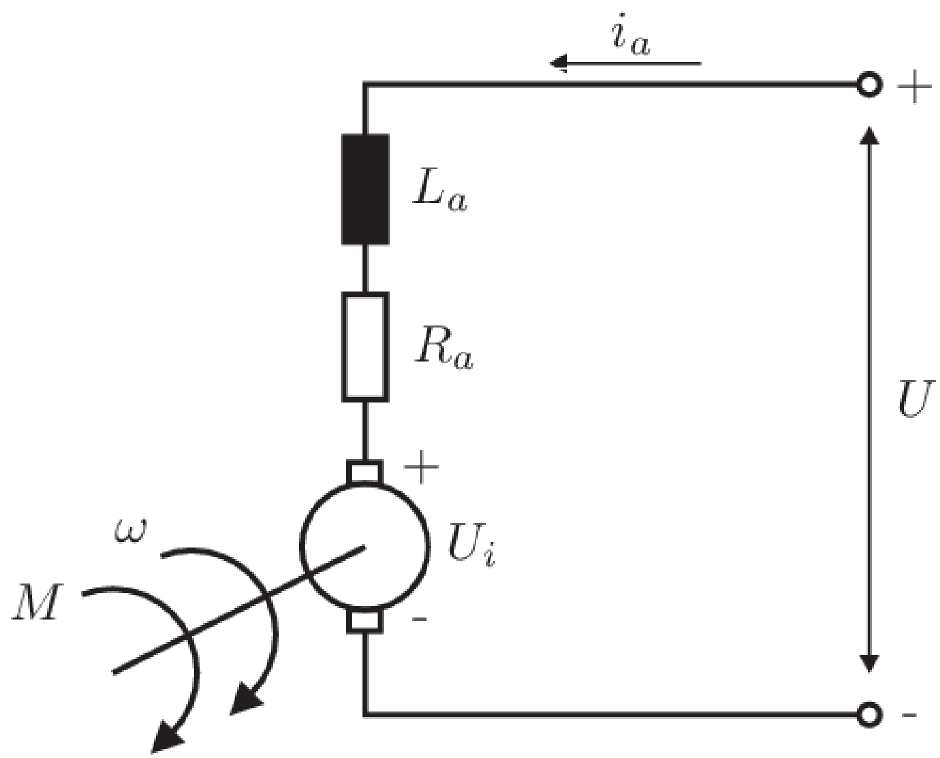
Mathematical starting point (induced voltage)



$$U_i = K\,\phi_f\,\omega$$

$$U_i = K_b\,\omega$$

Electric circuit



$$U = U_i + R_a\, i_a + L_a\, \frac{d\, i_a}{d\, t}$$

Equations

$$U = U_i + R_a\, i_a + L_a\, \frac{d\, i_a}{d\, t}$$

$$U = U_i + R_a\, i_a$$

$$U\, i_a = U_i\, i_a + R_a\, i_a^2$$

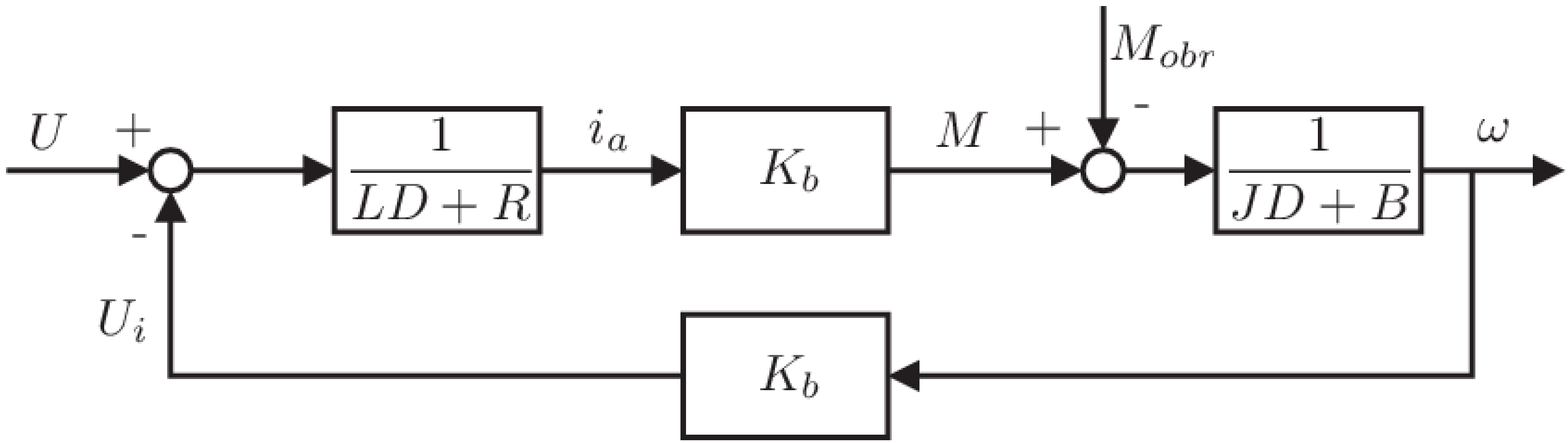
$$P = M\, \omega = U_i\, i_a$$

$$M = \frac{U_i\, i_a}{\omega_m}$$

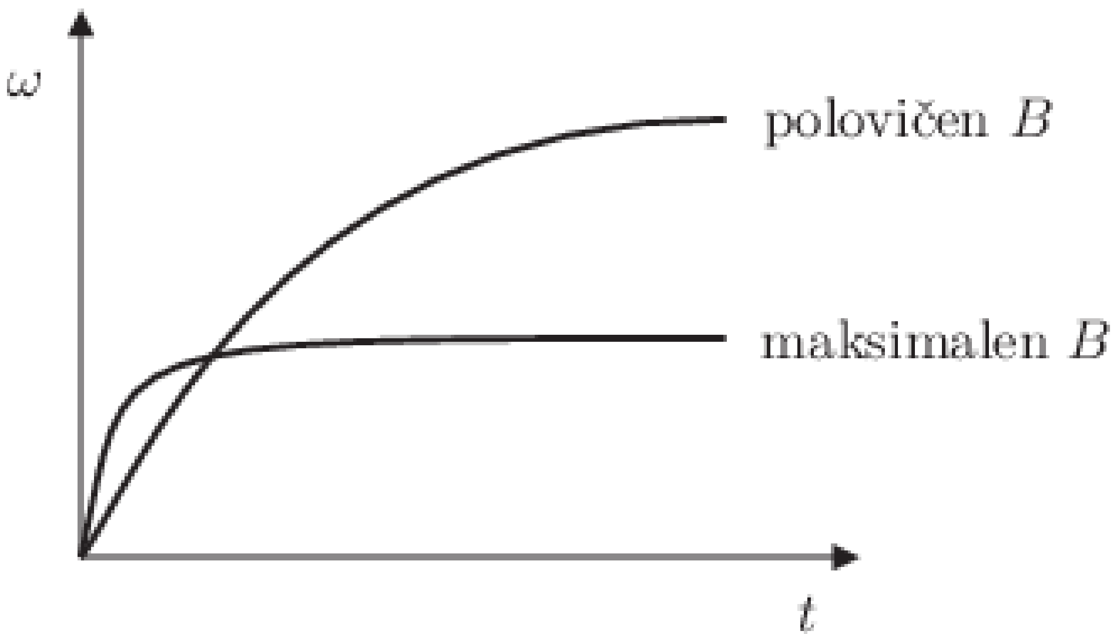
$$M = K_b\, i_a$$

$$J\, \frac{d\, \omega_m}{d\, t} + B\, \omega_m = M_e - M_{obr}$$

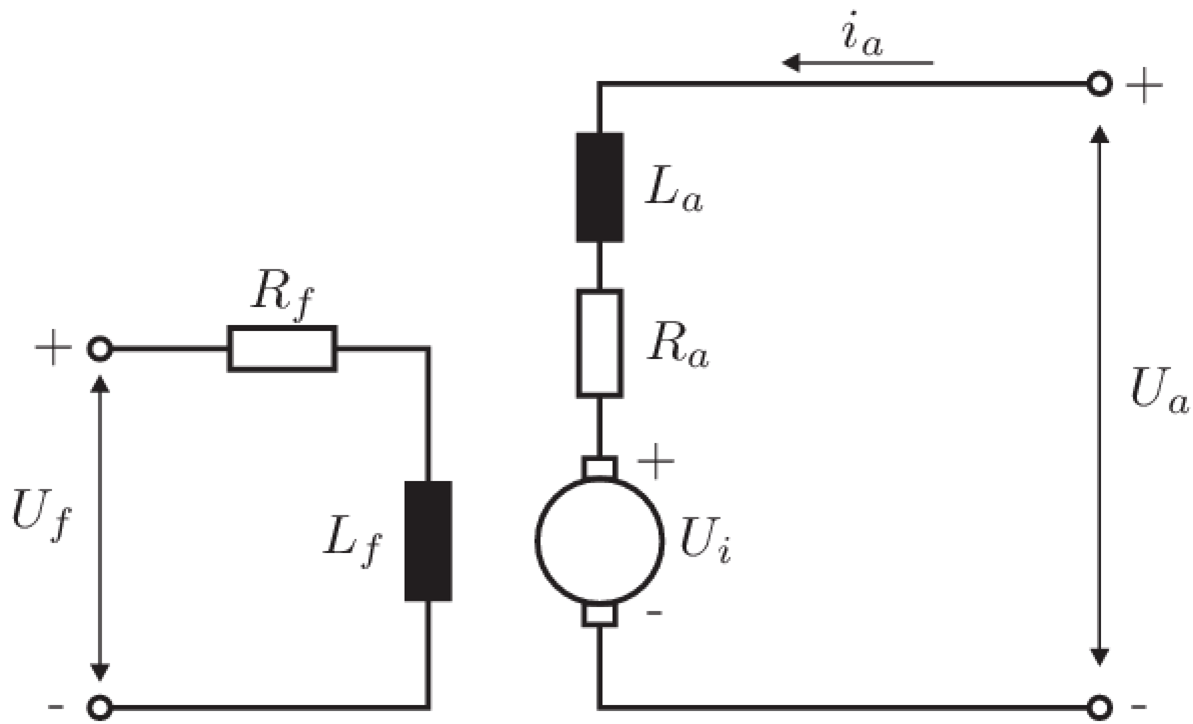
Block diagram



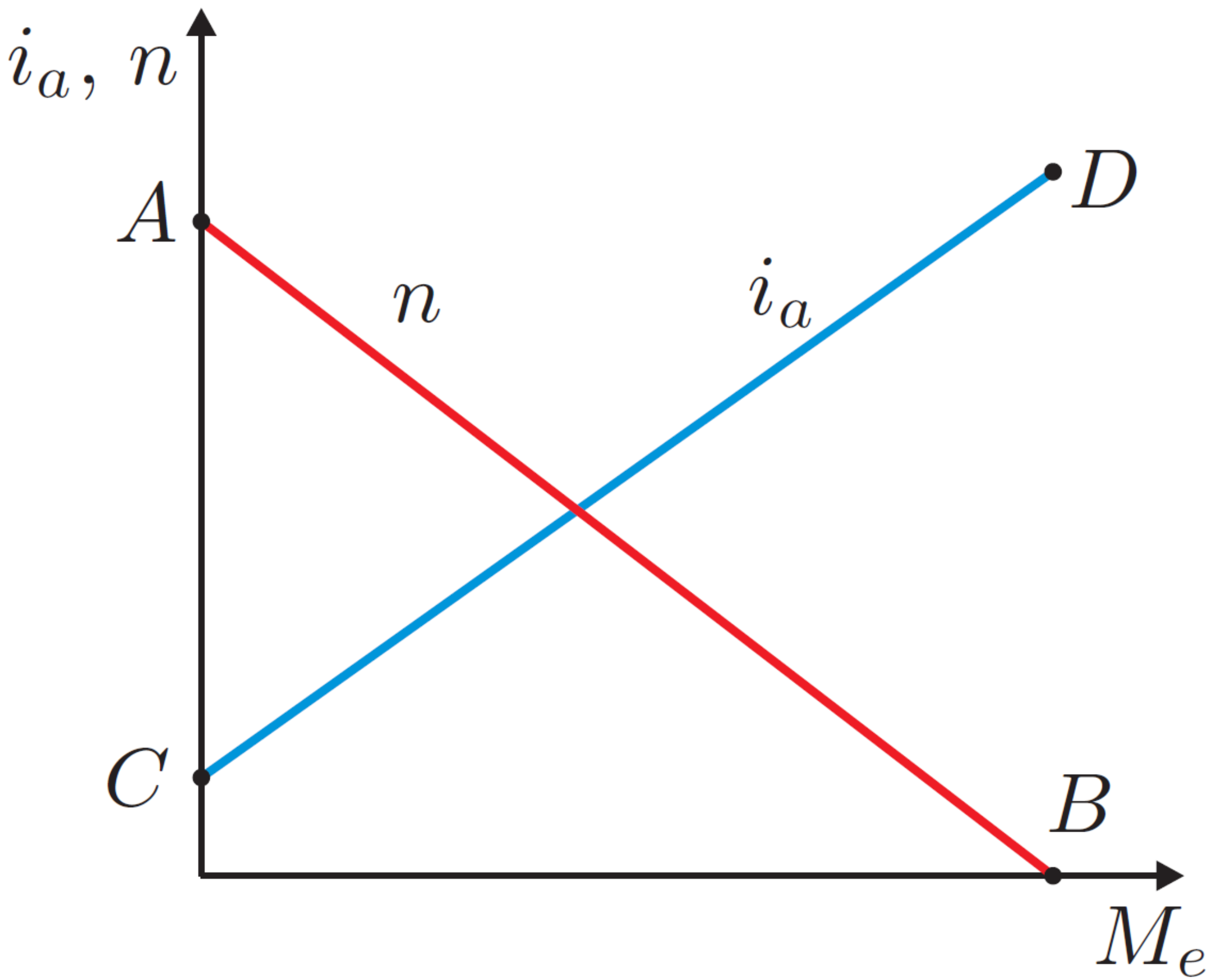
Effect of magnetic field density on motor speed



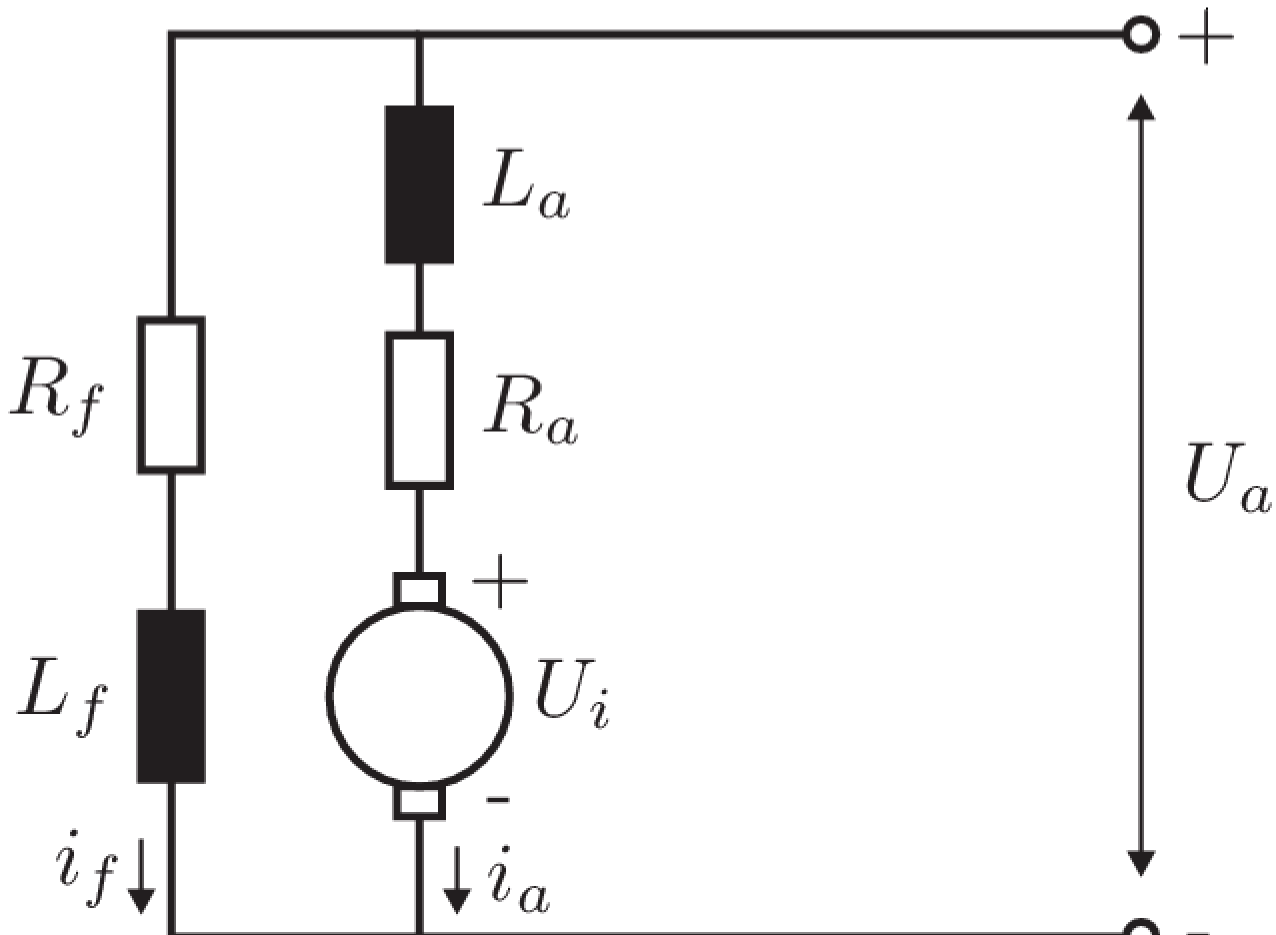
DC electric motor with separate excitation



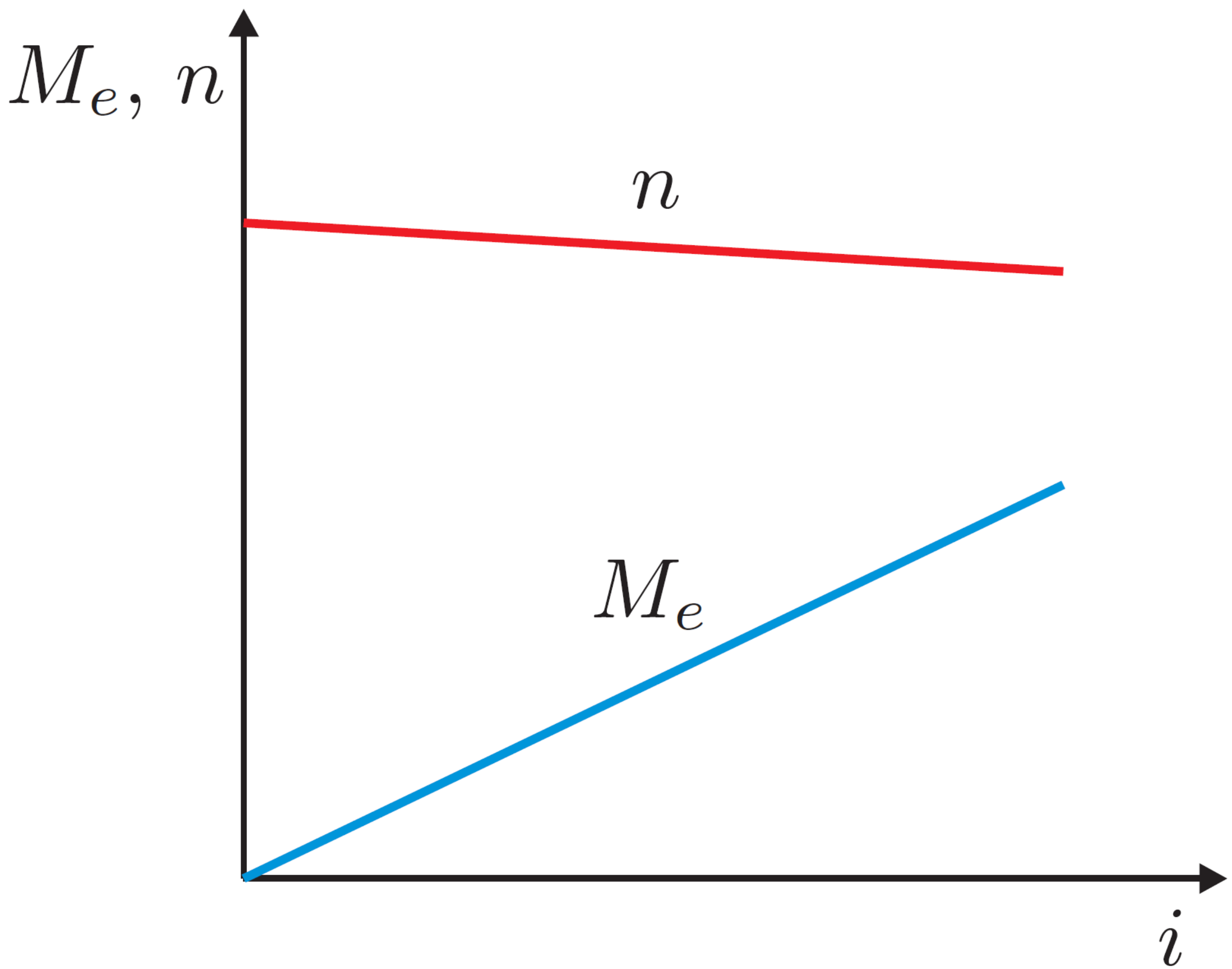
Characteristic



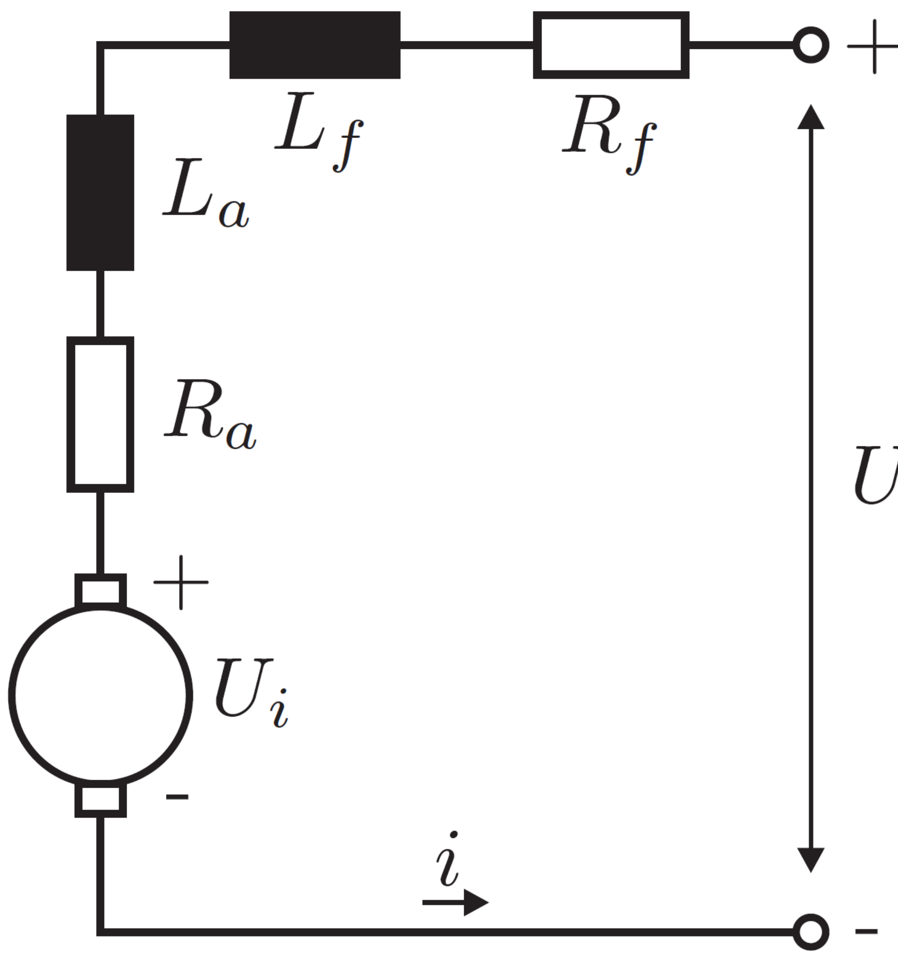
DC-shunt electric motor (with parallel excitation)



Characteristic



DC-series electric motor (with series excitation)



Characteristic