Electrical Machines 1

Hour 6

DC Motors

$P_{electrical}$ DC motor $P_{mechanical}$

e, i   T, n

I_f
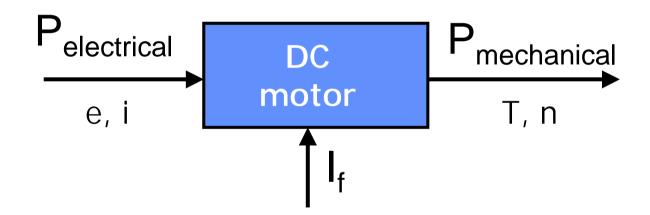
Torque Equation (Sect. 4.2.5)

- Equation 4.17a: $E_a I_a = T\omega_m$

- Equation 4.17: $T = K_a \Phi I_a$

  (where $K_a = Np/\pi a$
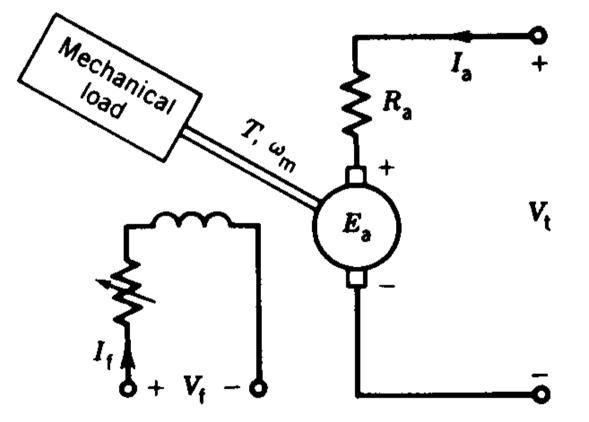
  or $K_a = Zp/2\pi a$)

- Example 4.1 (P.139)

Speed Equation

Since $E_a = K_a \Phi \omega_m = V_t - I_a R_a$,

then re-arrange:

$$\omega_m = \frac{V_t - I_a R_a}{K_a \Phi}$$

Separately Excited Motor (P.173)

Separately Excited Motor (P.173)

- From the circuit (Fig. 4.50)
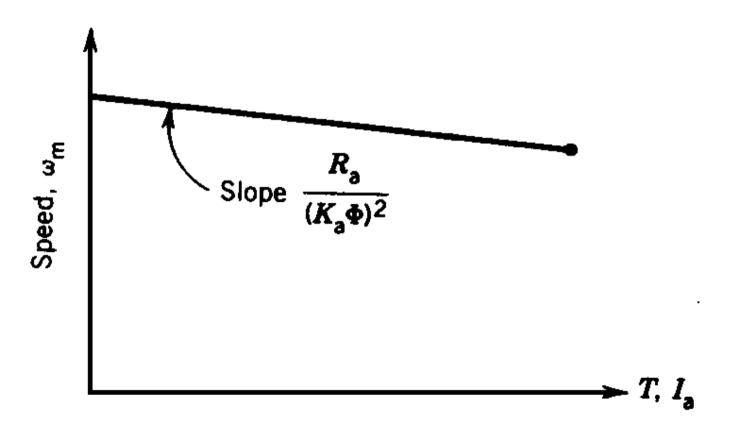
$$V_t = E_a + I_a R_a$$

$$E_a = V_t - I_a R_a$$

$$= K_a \Phi \omega_m$$

- I_a and ω_m depend on the mechanical load connected to the motor shaft

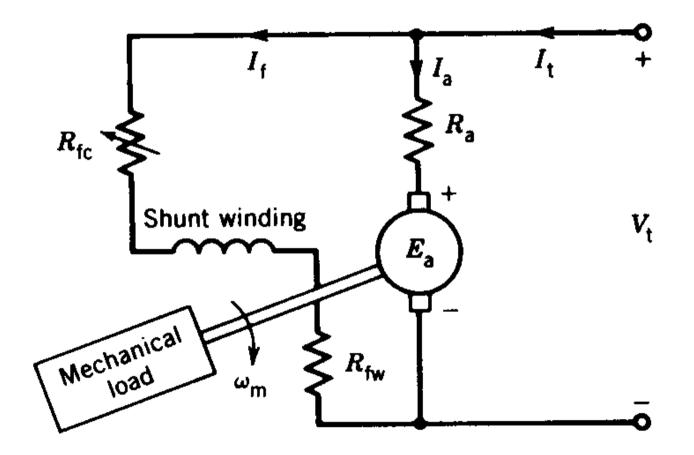# Torque-speed Characteristic of Separately Excited Motor (Fig.4.51)

Slope $\dfrac{R_a}{(K_a\Phi)^2}$

Speed, ω_m T, I_a

Shunt Motor (P.168)

Shunt Motor (P.168)

- From the circuit (Fig. 4.48)

$$V_a = E_a + I_aR_a$$

$$I_t = I_a + I_f$$

$$E_a = V_t - I_aR_a$$

$$= K_a\Phi\omega_m$$

- I_a and ω_m depend on the mechanical load connected to the motor shaft

- Example 4.6 (P.170)

Torque-speed Characteristic of Shunt Motor

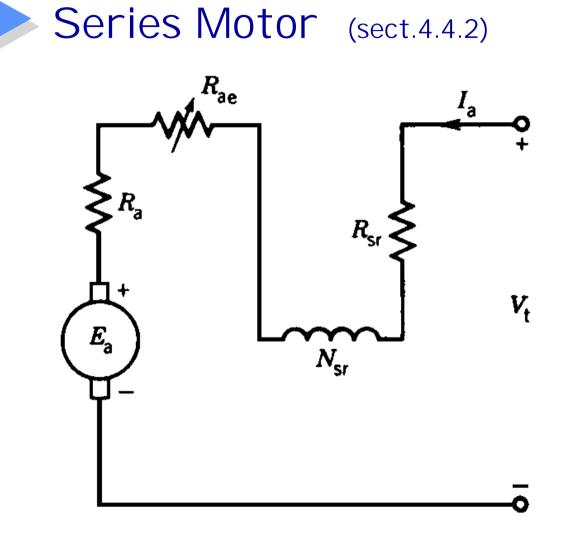- Torque-speed Characteristic of a Shunt Motor is very similar to a Separately Excited Motor

Series Motor (sect.4.4.2)
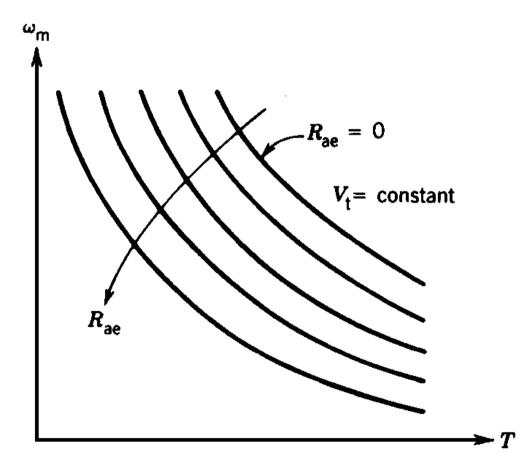
Reading: sect. 4.4.2

- Circuit (Fig. 4.55)

- Torque-speed Characteristic

  (Figure 4.55b)

- Example 4.9

▶ Series Motor (sect.4.4.2)

▶ Torque-speed Characteristic of Series Motor (Fig.4.55b)

Torque-speed Characteristics of Different DC Motors (Fig. 4.56)