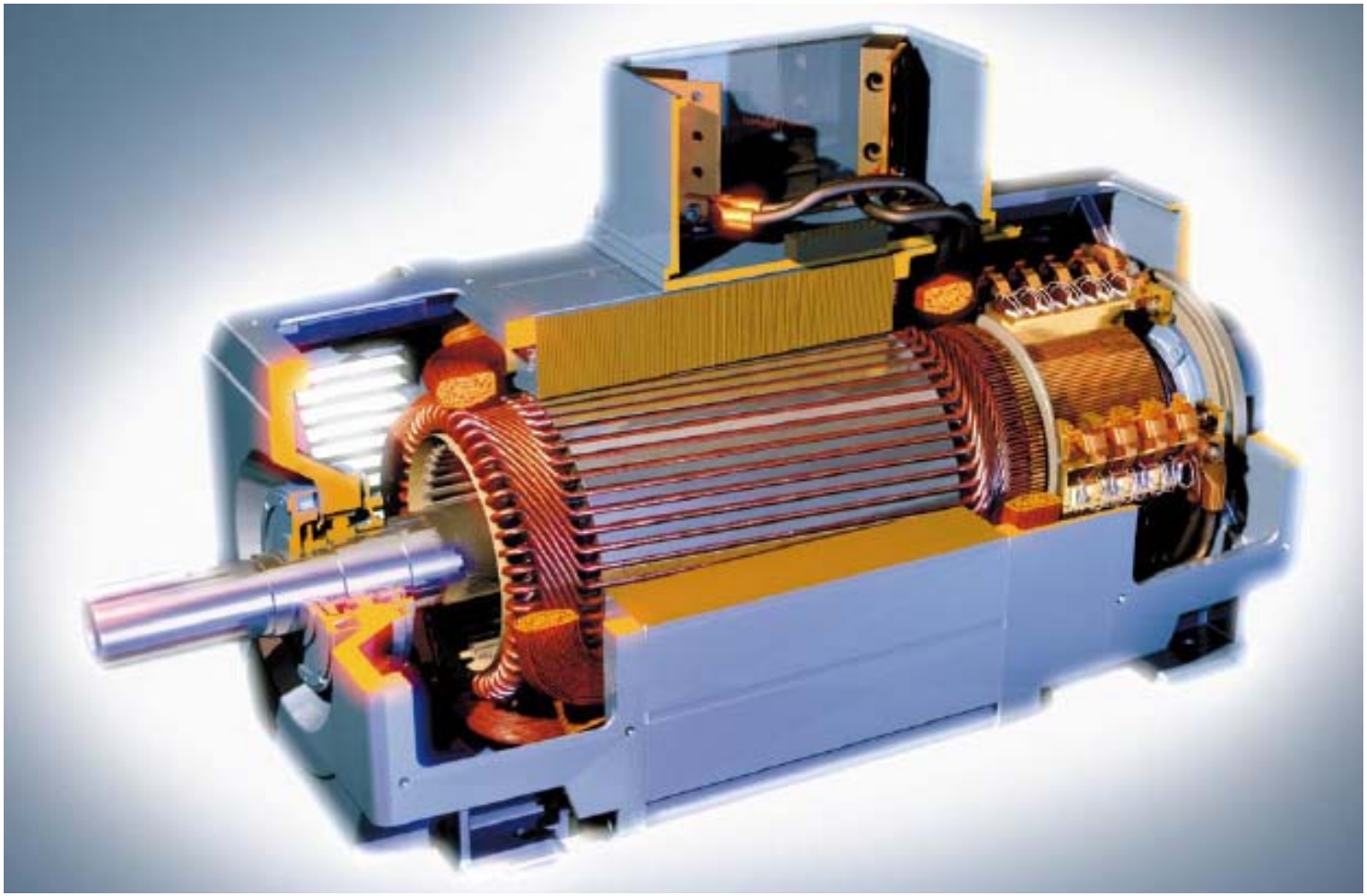
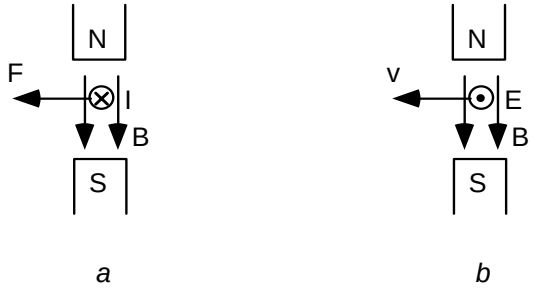
DC motor

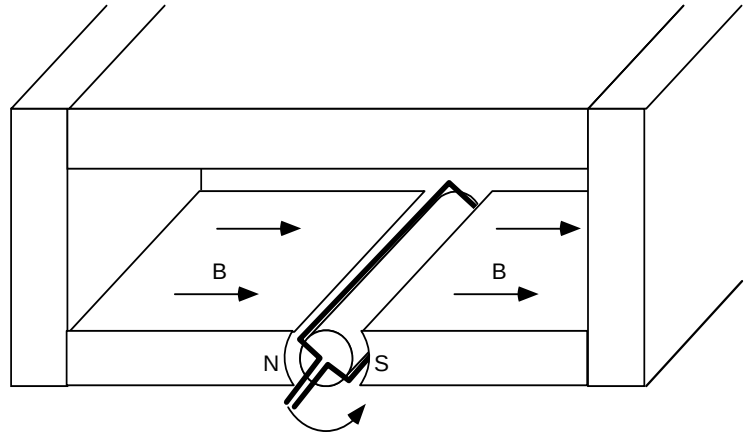


A basic dc-machine



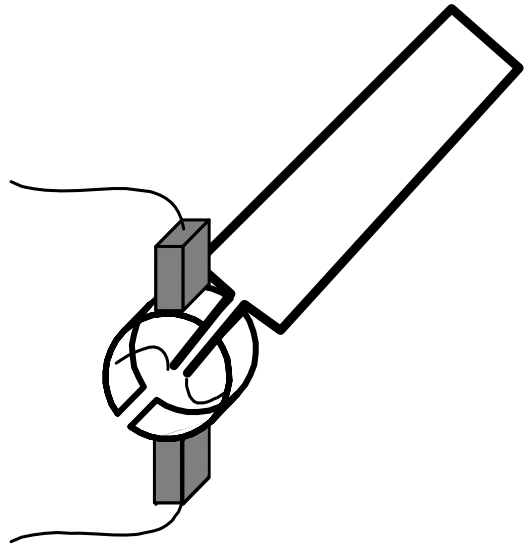
a) Force F = BIL

b) EMF E = BvL



Rotating turn

The commutator



DC-Motor Equivalent Circuit

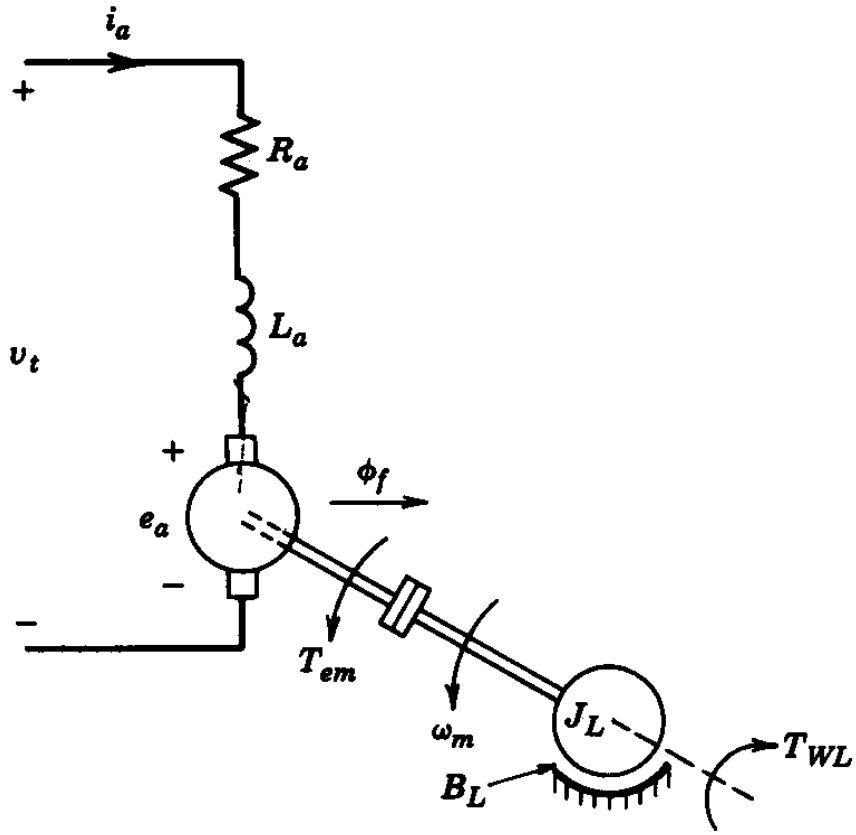


Figure 13-2 A dc motor equivalent circuit.

- The mechanical system can also be represented as an electrical circuit

Four-Quadrant Operation of DC-Motor Drives

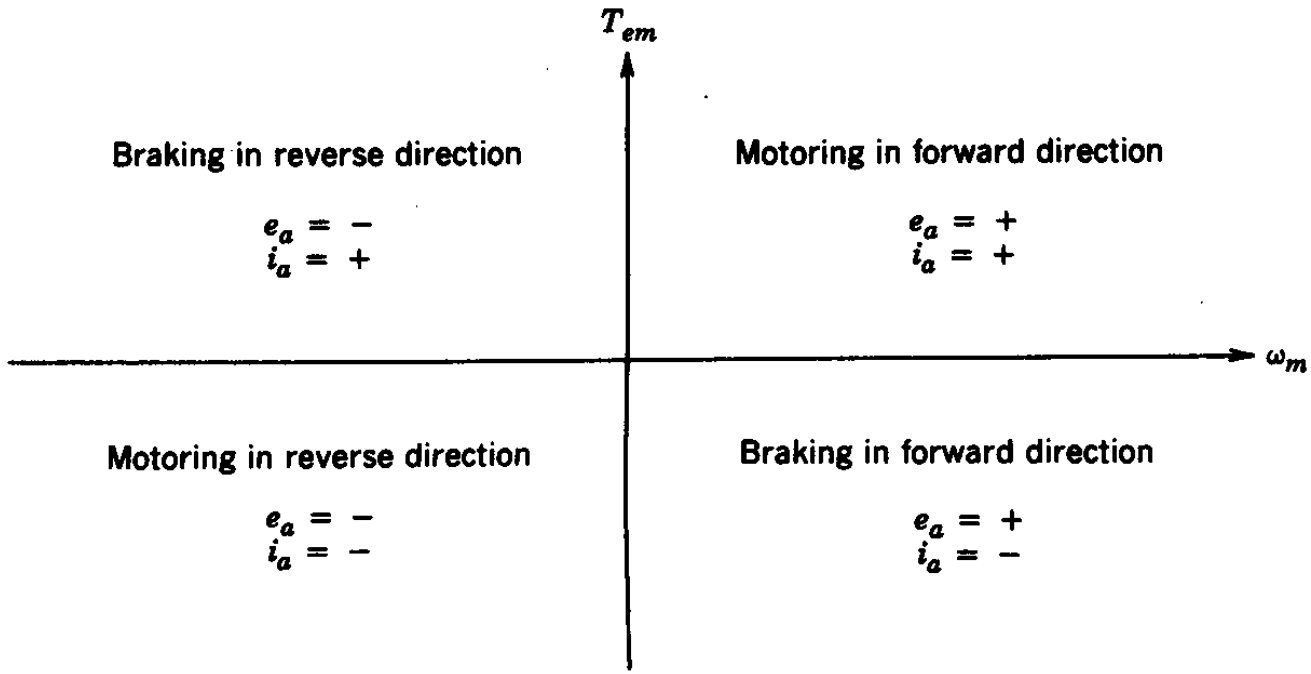


Figure 13-3 Four-quadrant operation of a dc motor.

- High performance drives may operate in all four quadrants

Converter for DC-Motor Drives

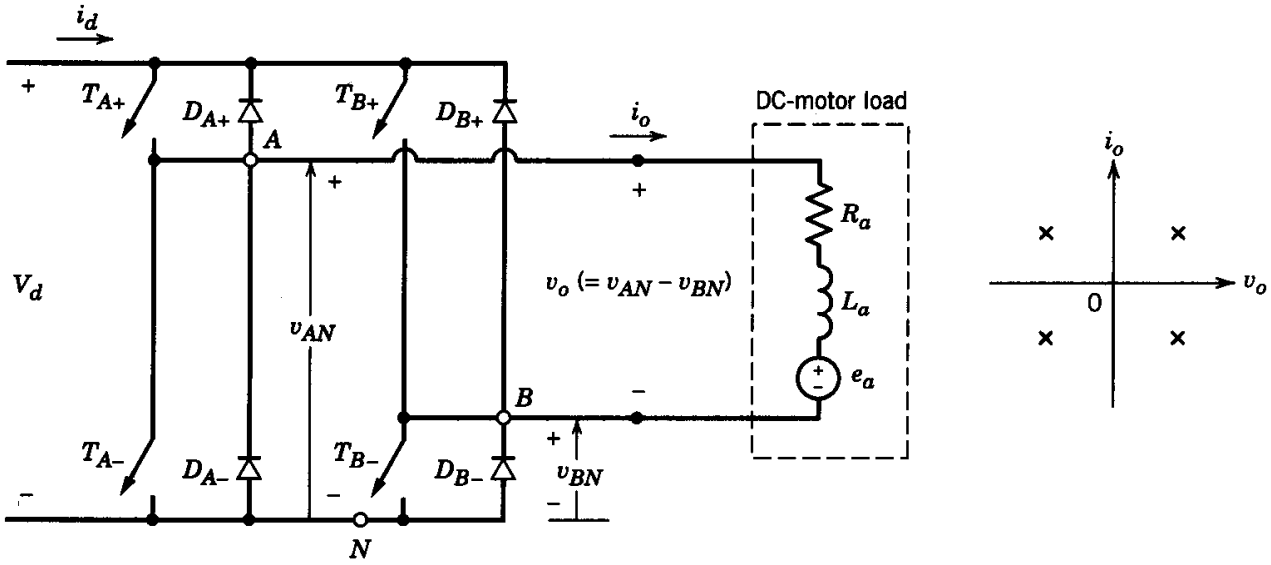


Figure 7-27 Full-bridge dc–dc converter.

- Four quadrant operation is possible

DC-Motor Drive Torque-Speed Characteristics and Capabilities

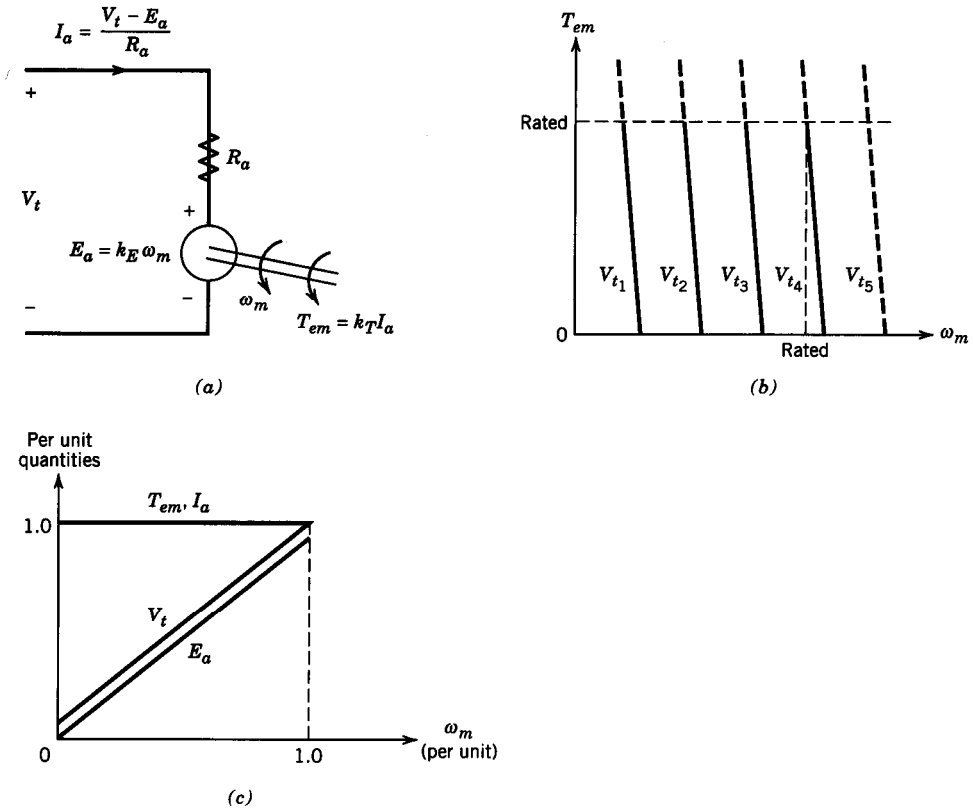


Figure 13-4 Permanent-magnet dc motor: (*a*) equivalent circuit; (*b*) torque-speed characteristics: $V_{t5} > V_{t4} > V_{t3} > V_{t2} > V_{t1}$, where V_{t4} is the rated voltage; (*c*) continuous torque–speed capability.

- With permanent magnets

DC-Motor Drive Capabilities

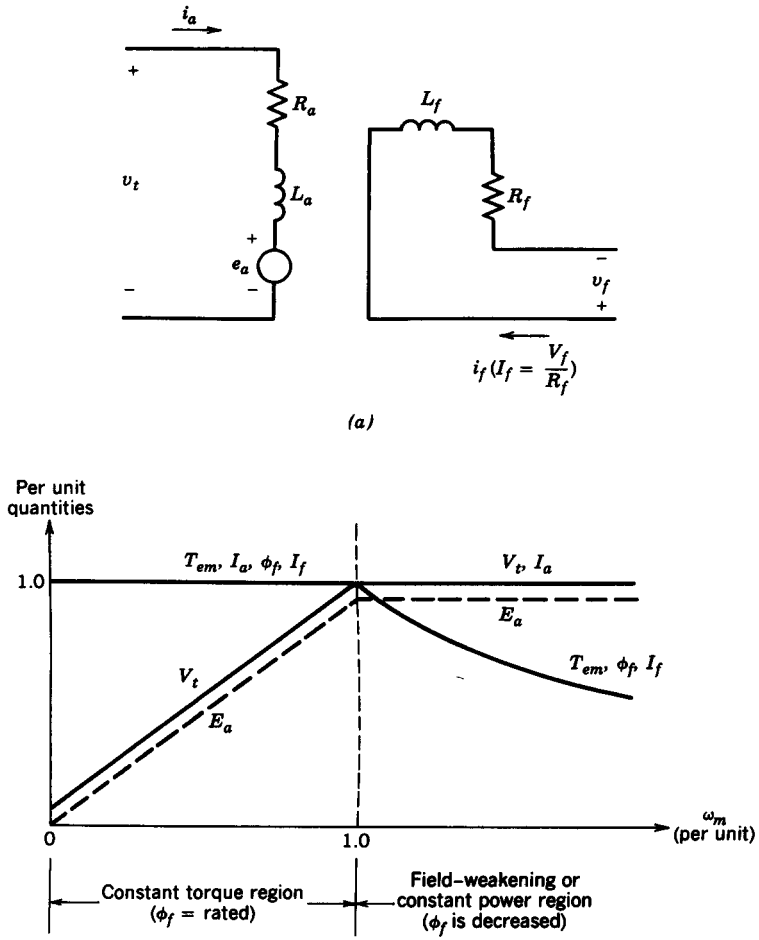


Figure 13-5 Separately excited dc motor: (*a*) equivalent circuit; (*b*) continuous torque–speed capability.

- Separately-Excited field

Controlling Torque, Speed and Position

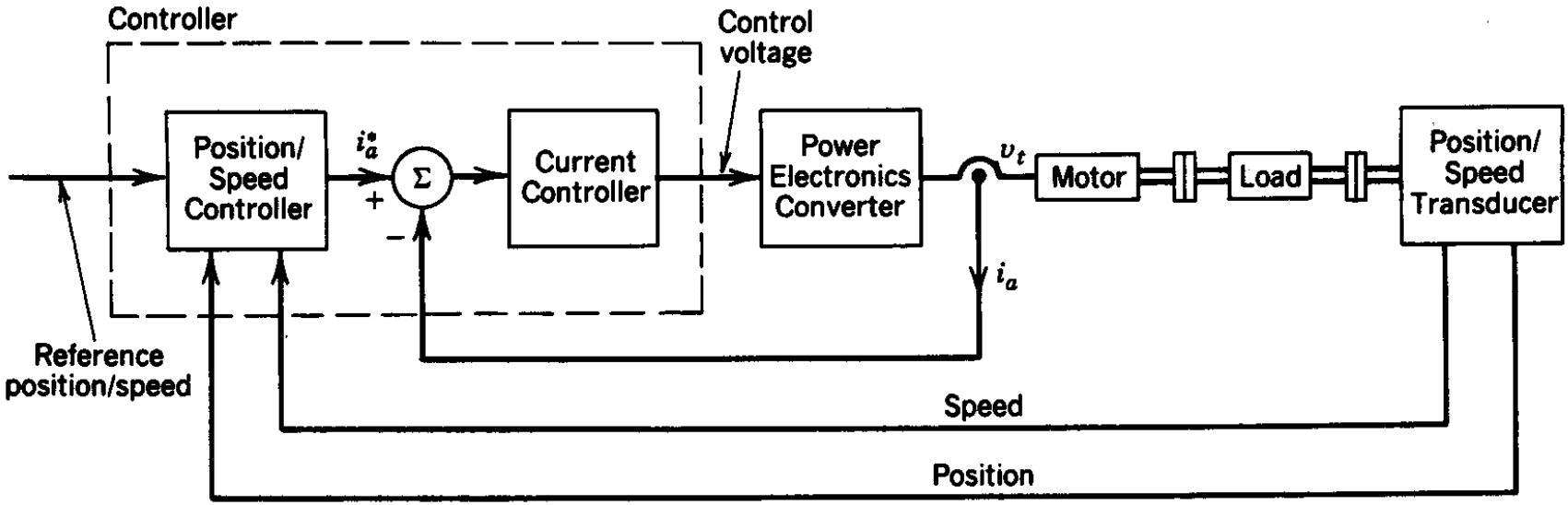


Figure 13-6 Closed-loop position/speed dc servo drive.

- Cascaded control is commonly used

Small-Signal Representation of DC Machines

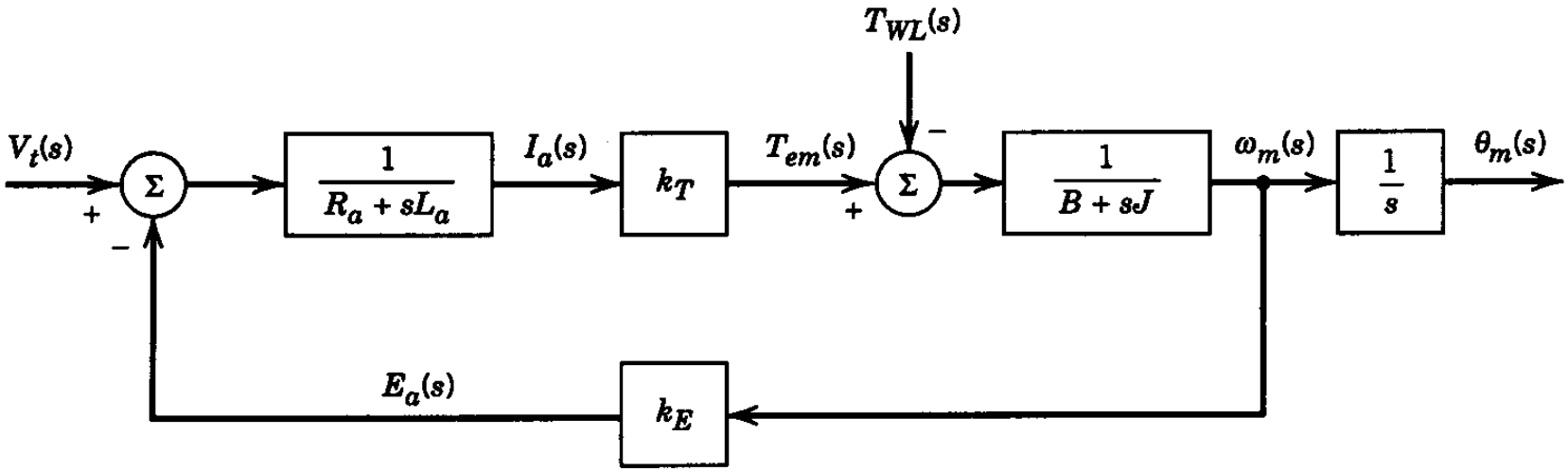


Figure 13-7 Block diagram representation of the motor and load (without any feedback).

- Around a steady state operating point

Electrical Time-Constant of the DC Machine

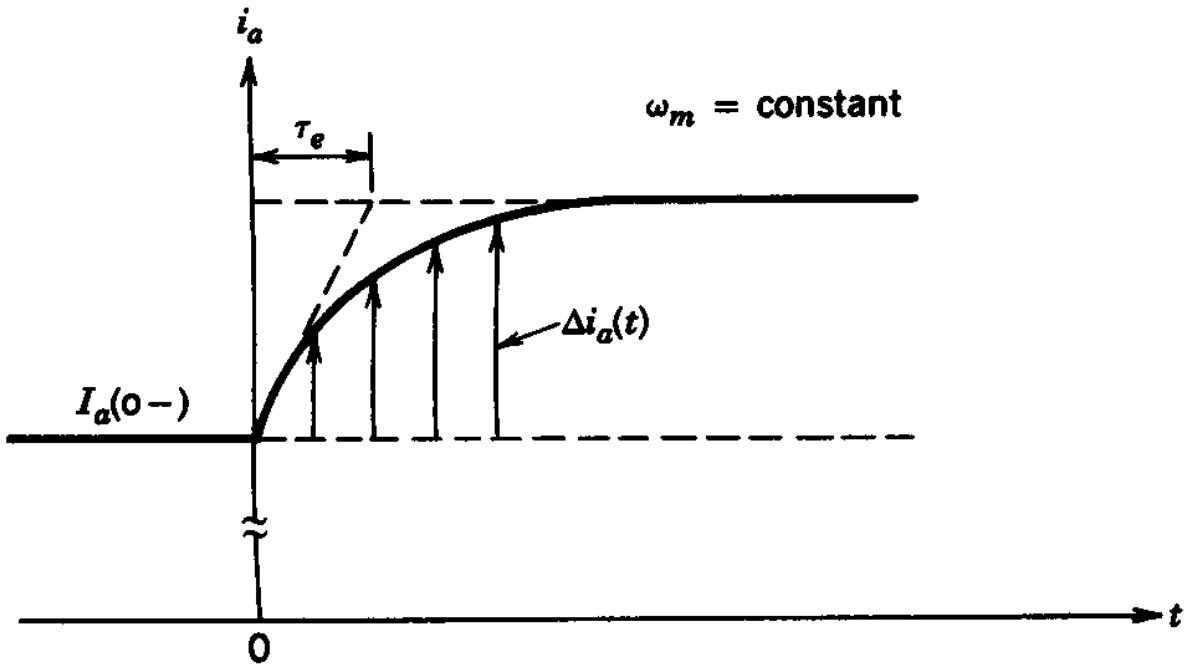


Figure 13-8 Electrical time constant τ_e; speed ω_m is assumed to be constant.

- The speed is assumed constant

Mechanical Time-Constant of the DC Machine

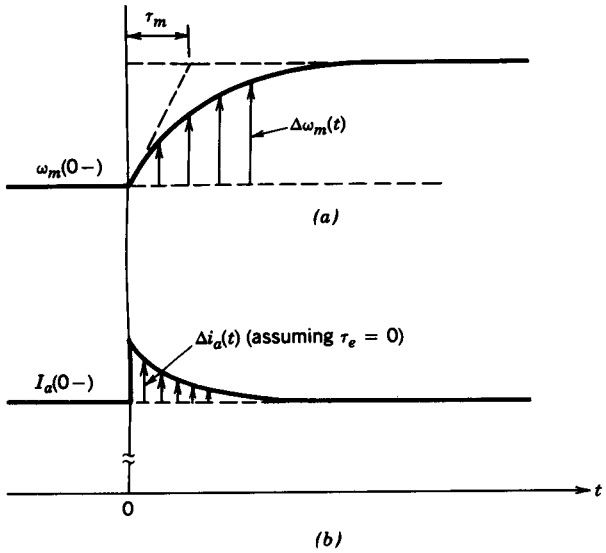
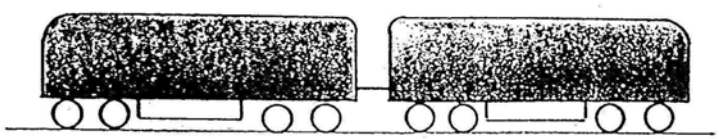


Figure 13-9
Mechanical time constant τ_m; load torque is assumed to be constant.

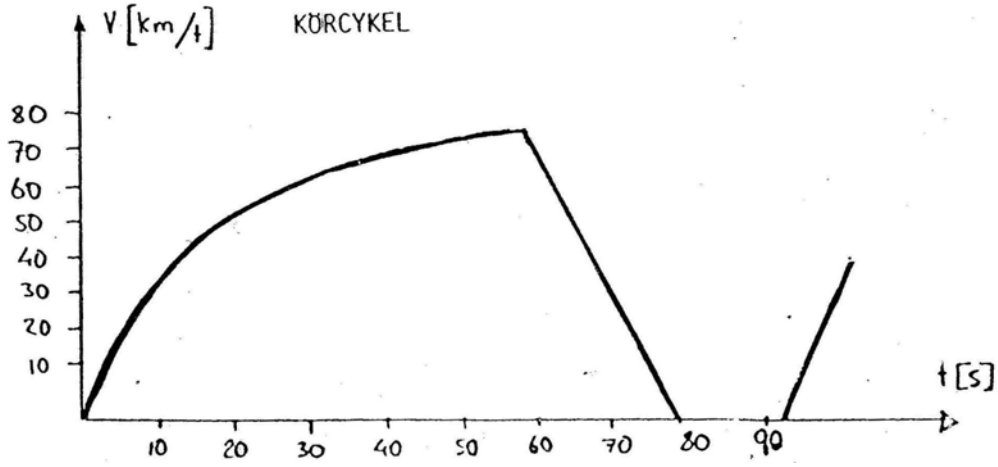
- The load-torque is assumed constant

Underground trainset, C15



Main data

Line voltage:	500 – 770 V dc
Nom. speed:	80 km/h
Acceleration:	1,1 m/s^2 (6 sec to 25 km/h)
Weight:	2 x 36 tons (full load)
Nom. power:	4 x 2 x 80 kW
Track width:	1435 mm



Main circuit, C15