EELE 250: Circuits, Devices, and Motors

Electric Motors

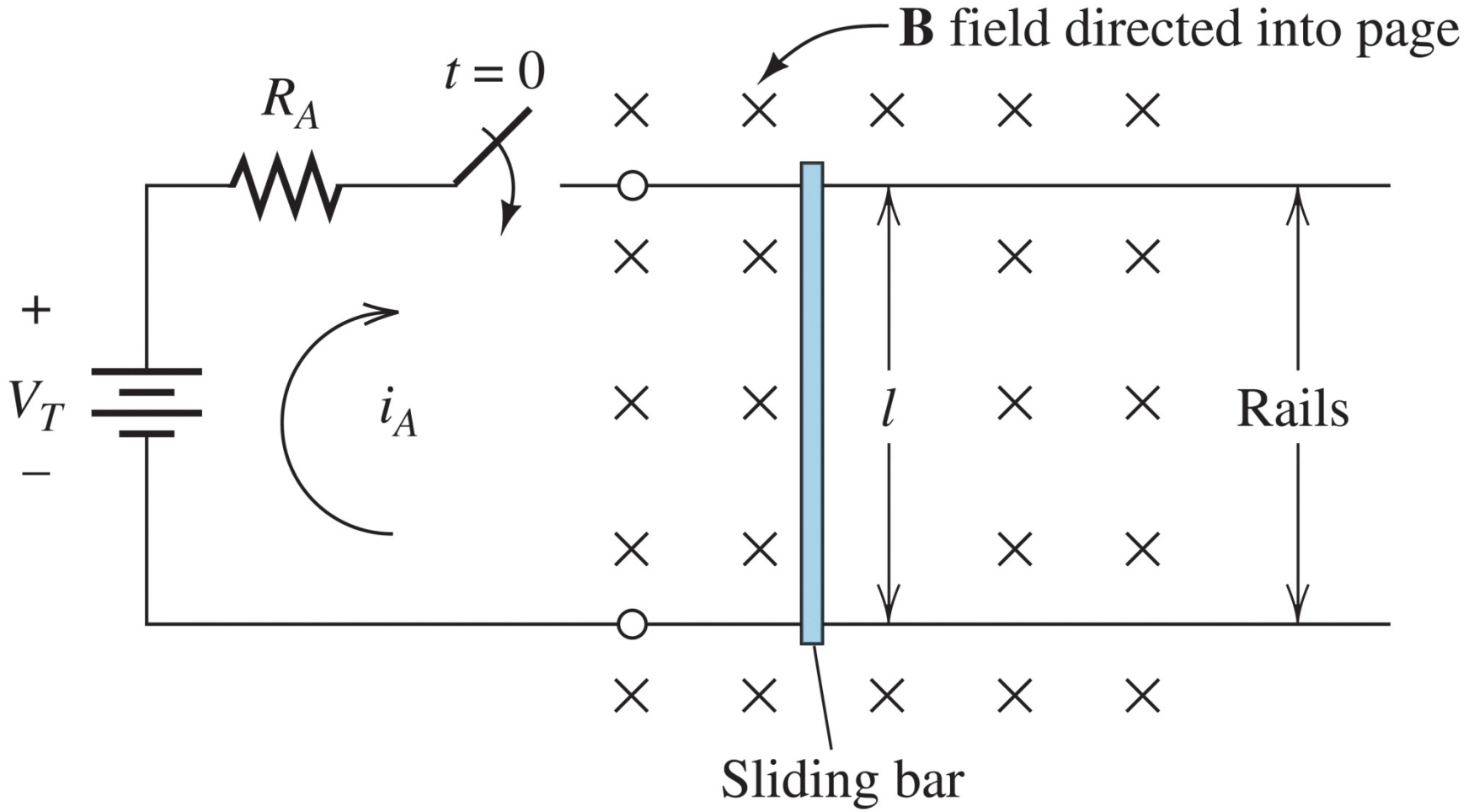
Assignment Reminder

- Read 16.1 - 16.3
- Exam #3 is on Friday in class. Closed book, but you may bring a single handwritten sheet of notes, a pen/pencil, and a calculator. Coverage is the Op Amp material.
- No quiz this week.
- Lab #8 this week. No labs the week of 11/18 or the week of 11/25. Lab #9 (last) will be week of 12/2.

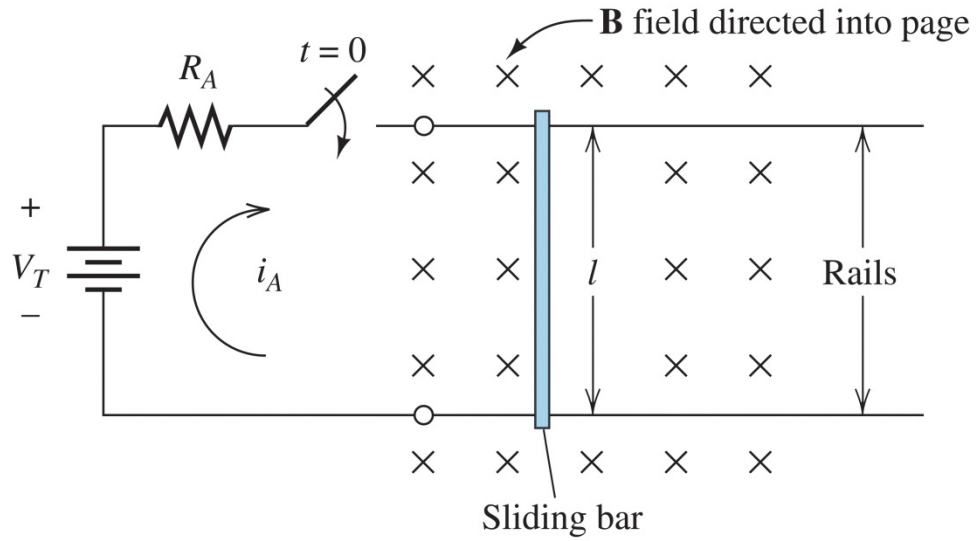
DC Motor Principles

- Electric current in a magnetic field produces a force on the conductor
- Need to arrange for the force to create a useful motion

DC Rail Machine



DC Rail Machine (cont.)

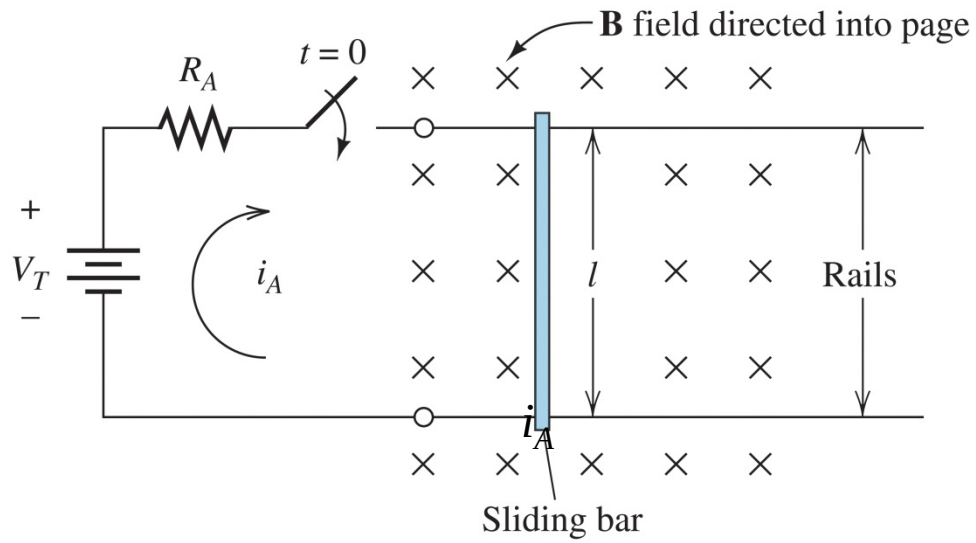


Force on sliding bar due to current = i_A **l** x **B**

Voltage produced by bar moving in magnetic field:

$e_A = B\ l\ u$

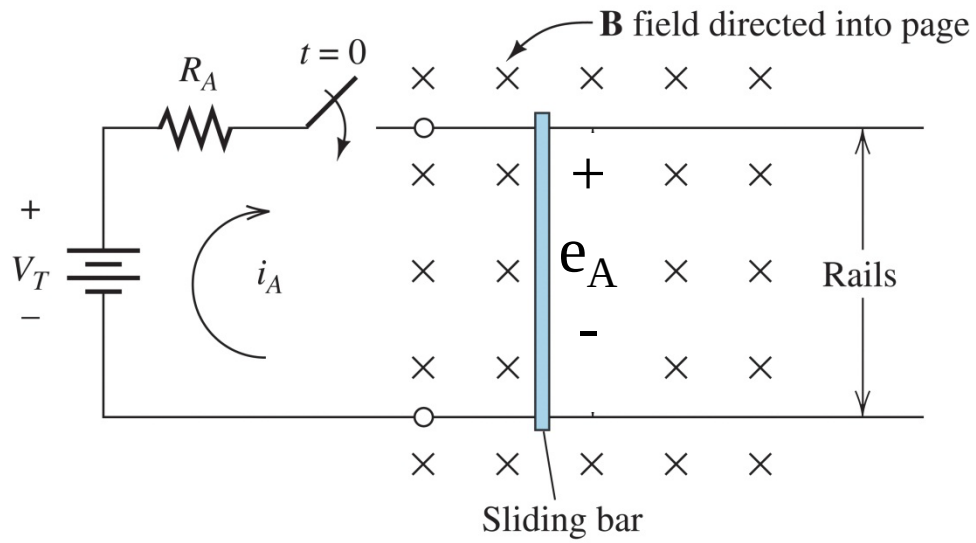
DC Rail Machine (cont.)



At $t = 0$, bar is at rest, and initial current $i_{A0} = V_T/R_A$

At $t = 0$, initial force on bar is $i_{A0}\, l\, B$ to the right

DC Rail Machine (cont.)



As bar accelerates due to force, the voltage e_A across the bar increases as its velocity *u* increases: B *l u*

Current in bar becomes $(V_T - e_A)/R_A$

At steady-state, $e_A = V_T$, $i_A = 0$, and bar moves at constant velocity

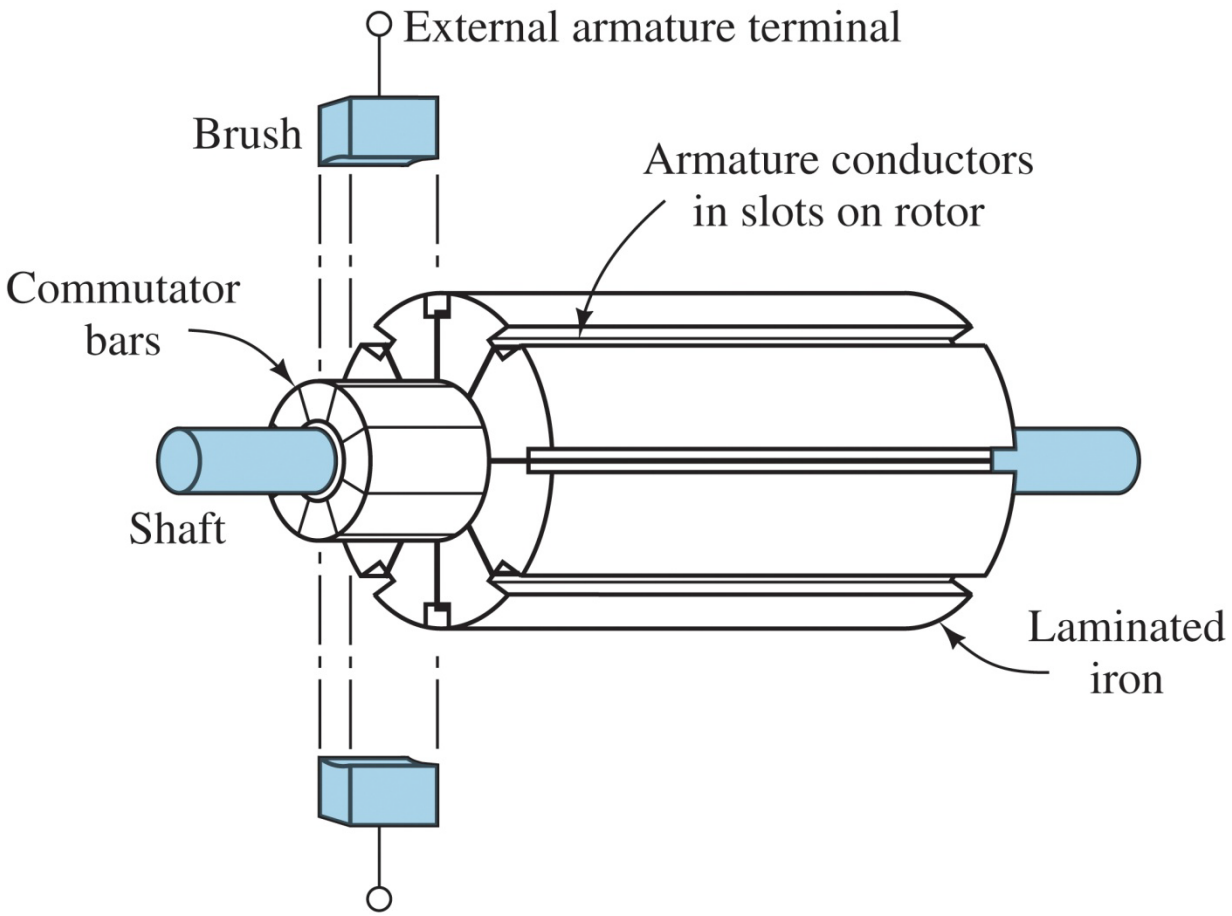
Rotating DC machine

- In most applications, the rail machine model is replaced by a fixed magnet with a rotating conductor
- Force is increased by using many turns of the conductor rather than a single sliding bar
- One issue: as the rotation occurs, the direction of the magnetic field with respect to the conductor alternates, and this causes the force on the conductor to reverse direction

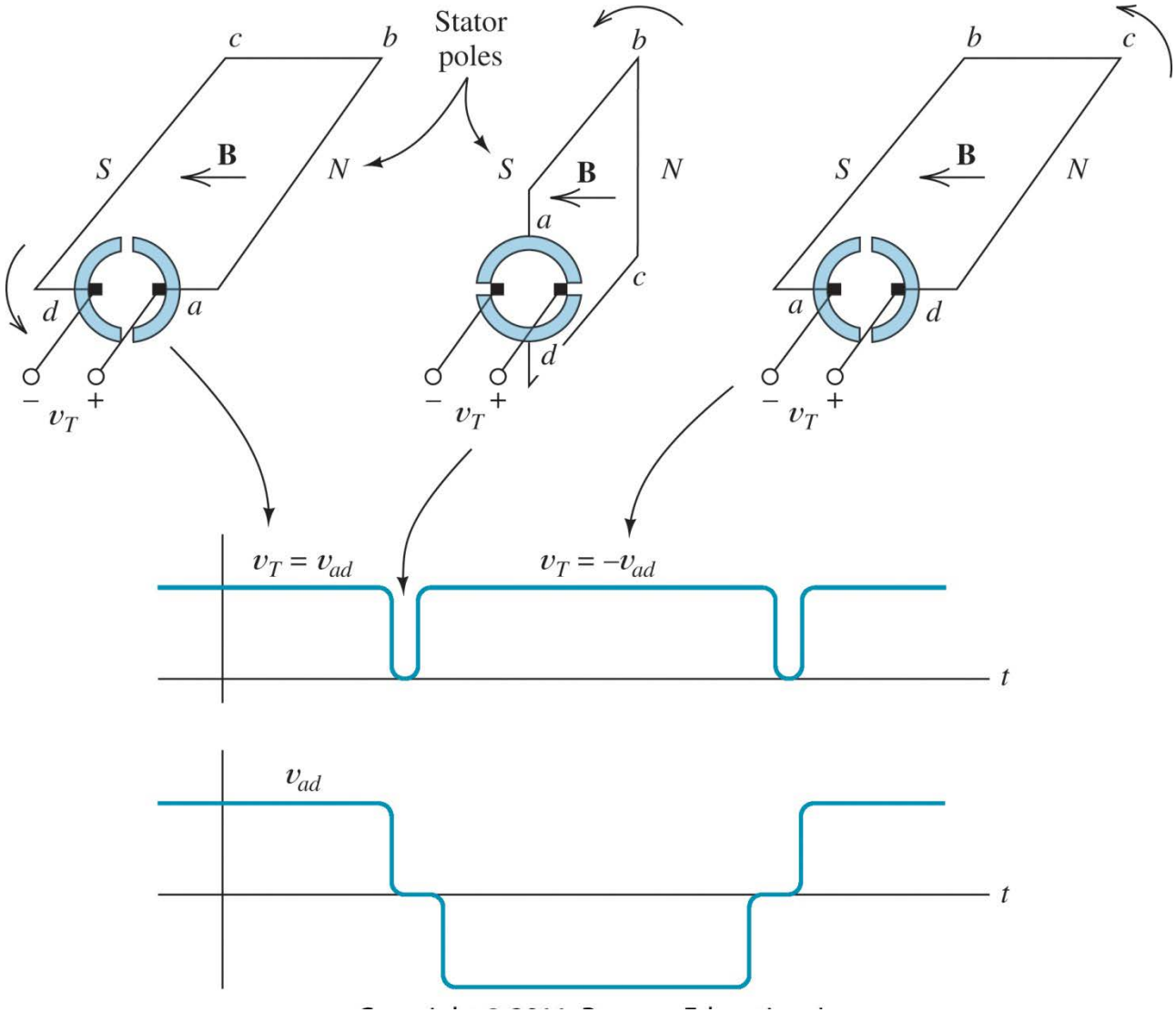
Rotating DC machine (cont.)

- To eliminate the alternating force direction, we can either “turn off” the current for half of the rotation, or we can reverse the current direction for half of the rotation
- Reversing the current is known as *commutation*

Commutation Concept



Commutation (cont.)



Simple DC motor kit

- Permanent magnet
- Insulated wire formed into a loop on an axle
- Simple on-off commutator by stripping insulation on one side of the axle
- 9V battery connected to axle contacts