ECE 320 & ECE 329

# ENERGY SYSTEMS I

## BACKGROUND STUDY IN ENERGY SYSTEMS

SESSION no. 22

ECE 320 / ECE 329
Mid-Course Critique

Normally, student critiques of classes come at the end of the semester. The responses benefit next year's class at best. Here's your chance to do something this semester at its midpoint.

These questions are intended to provide a framework for your discussion. You need not answer them all, but do answer those that you consider most important. Feel free to add your comments on anything appropriate that is not listed here, but you consider important.

1. What good features of this course have been most helpful to you?

2. The goals of this course, as stated on the first day, include developing a more solid foundation of first principles solutions methods, improve communications and problem solving skills, understand basic ideas about energy systems, and use mathematical methods to solve problems. How well is this being done? How can we do better?

3. This course has an unusual format of recitation by guest experts. Is this worthwhile? Does it help you learn the material? If so, how much detail is appropriate? Should there be critiques of the guest experts? Should the guest experts be graded?

4. No professor is perfect. How can the professor help you better? What new methods, ideas, and resources should he try? What should he abandon or modify?

5. Have the homework, quizzes, and exams been a reasonable test of what you should learn in the course? How can they be improved? (besides being eliminated, wherein we all concur)

6. This semester, I am collecting homework and grading it. It requires a significant effort. Is the homework worthwhile? Should I continue grading it? Or should I forget about it?

7. Grading is an unfortunate, but necessary evil of our system. How can it be done better?

8. What should be addressed in more detail? What should be covered in less detail? What should be added? What should be deleted?

9. What office hours would better serve you? Morning or afternoon? Other, perhaps unconventional, times?

10. Is the website posted in a manner that is thorough, convenient, and timely for your use? If not, what should be the standard?

11. The professor uses videos from youtube occasionally. Are these appropriate? Are they helpful? Should he use them more? Or less?

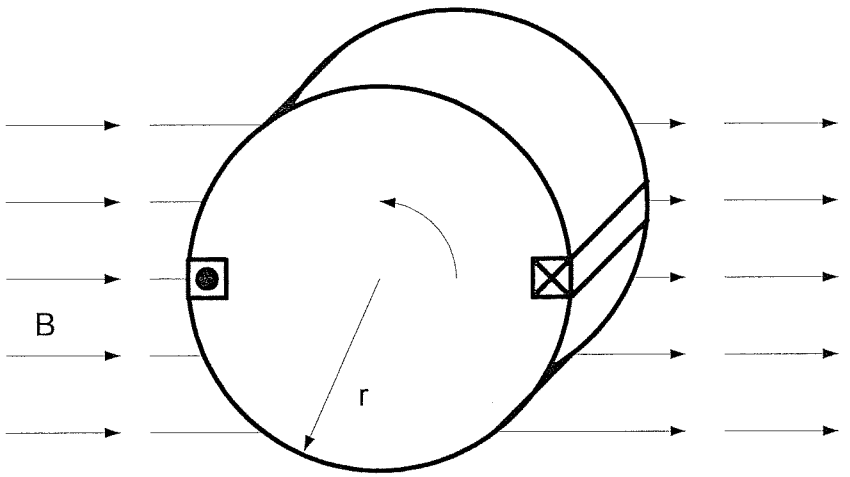
12. Are you planning to take ECE 420? _____ (yes/no)

ECE 320 / ECE 329 NAME _____

Quiz 6 2 March 2012

Introduction to DC Machines

1. (6 points) A 0.2 meter long conductor inside a rotor with a 0.1 meter radius rotates counterclockwise at an angular velocity of 200 radians/second in a uniform, constant magnetic field of 0.25 Wb/m$^2$ directed ~~into the page~~ out of the page. The conductor returns on the other side of the rotor.
   a. (3 points) Determine the magnitude of the induced voltage.




$B := 0.25 \cdot \frac{Wb}{m^2}$ $\omega := 200.0 \cdot \frac{rad}{sec}$ $ll := 0.2 \cdot m$ $r := 0.1 \cdot m$ $sides := 2$

$voltage := sides \cdot (\omega \cdot r \cdot B) \cdot ll = 2\,V$

b. (3 points) The conductor is connected to a 0.05 Ohm resistor. For the voltage that you found in part a and the current direction as shown, determine the magnitude and direction of the induced torque. If you didn't find a voltage in part a, make one up.

$R_X := 0.05 \cdot \Omega$ $voltage = 2\,V$ $I := \frac{voltage}{R_X} = 40\,A$

$force := B \cdot ll \cdot I = 2\,N$

$torque := sides \cdot r \cdot force = 0.4\,N \cdot m$ Clockwise

2. (4 points) For the electric motor shown on the video monitor, identify the parts of the machine indicated.

   A. _____Commutator_____

   B. _____Armature windings_____

   C. _____Field magnets_____

   D. _____Rotor slots_____

ECE 320 / ECE 329
Homework
DC Machines

Recitation
Monday 26 March 2012
LSW 28

Do the following problems from the textbook:

1. Questions 8.2, 8.3, 8.4, 8.5, and 8.6 on page 552.

2. Problems 8.1, 8.2, and 8.3 on page 553.

3. Problems 8.4 and 8.6 on page 553.

4. Problem 8.7 on page 554. Using software may make this one quicker.

5. Problem 8.8 on page 554.

6. Problem 8.20 on page 559.

7. Problem 8.14a on page 556.

# BASIC EQUATIONS

$$T_e = K_a \phi_f I_a$$

$$E_a = K_a \phi_f \omega$$

$$E_a = V_A - I_a R_a$$

$$P_m = T_e \omega = E_a I_a$$

EXAMPLE ...

- DC MOTOR

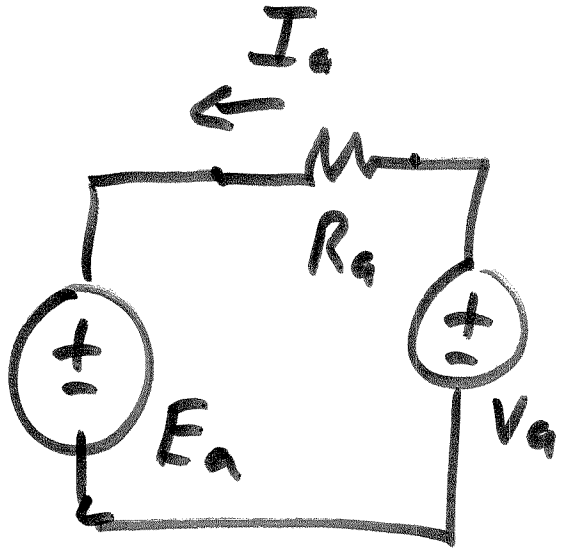
$K_a = 100$

$\phi_d = 23.0$ mWb

$\omega = 94$ $\frac{rad}{sec}$

$R_a = 400$ mΩ

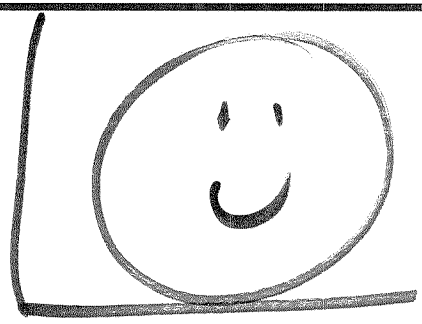
$V_a = 230$ V




$E_a = K_a \phi_d \omega$

- SEPARATELY EXCITED

FIND $I_a$, $T_e$,



ENERGY EFFICIENCY

$$E_a = K_a \, \phi \, \omega$$

$$E_a = (100)(23.0 \text{ mWb})\left(94 \frac{\text{rad}}{\text{sec}}\right)$$

$$E_a = 216.2 \text{ V}$$

Wb = V·sec

$$I_a = \frac{V_a - E_a}{R_a}$$

$$I_a = \frac{\cancel{230V} \; 230V - 211.2V}{0.400\,\Omega}$$

$$I_a = 34.5\,A$$

$$T_e = K_a \phi_d I_a$$

$$T_e = (100)\left(0.023 \frac{N \cdot m}{A}\right)(34.5A)$$

$$T_e = 79.4 \, N \cdot m$$

$$T_e \omega = E_a I_a$$

$$K_a \phi_d I_a \omega = K_a \phi_d \omega I_a$$

$$\frac{T_e}{I_a} = K_a \phi_d$$

$$\frac{N \cdot m}{A} = K_a \phi_d$$

$$P_{in} = (230v)(34.5A)$$

$$P_{in} = 7931\ w$$

$$P_{out} = \tau(79.4Nm)(94\ \tfrac{rad}{sec})$$

$$P_{out} = 7464\ w$$

$$\eta = \frac{P_{out}}{P_{in}} = \frac{7464w}{7931w} = 0.94$$

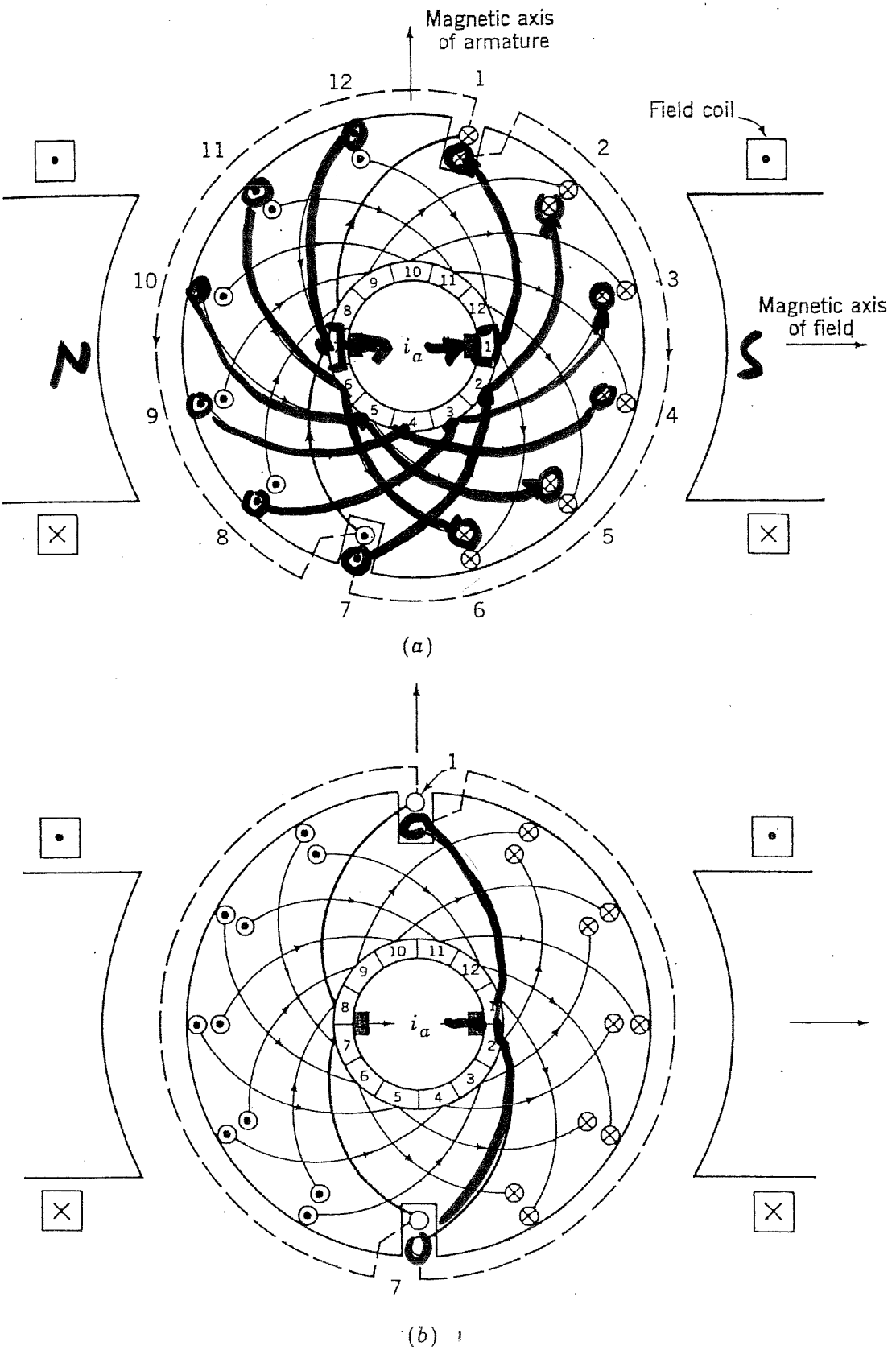



Fig. 9-7. Dc machine armature winding with commutator and brushes. (*a*), (*b*) Current directions for two positions of the armature.

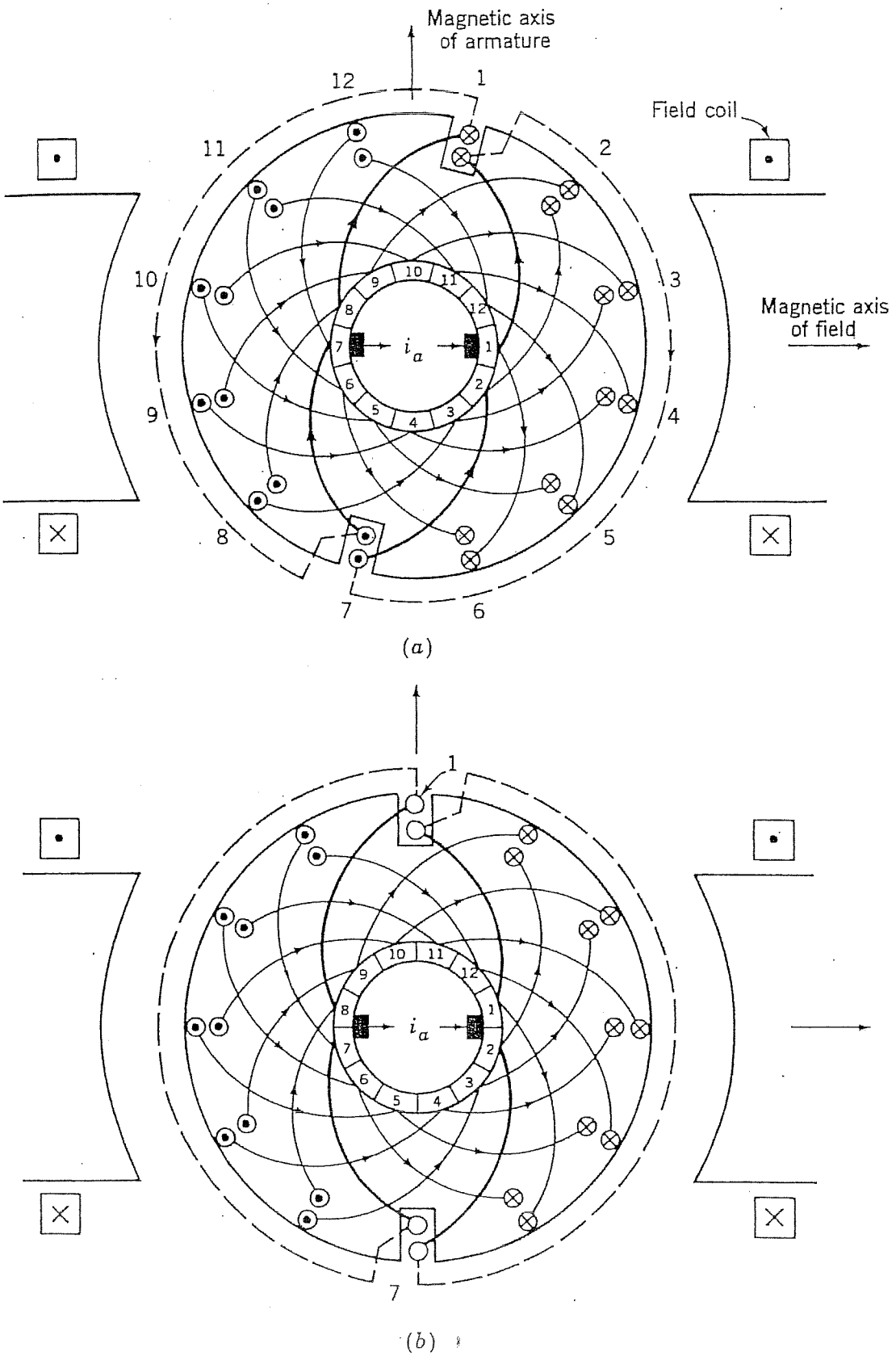



Fig. 9-7. Dc machine armature winding with commutator and brushes. (*a*), (*b*) Current directions for two positions of the armature.

# ECE 320 / ECE 329

# Energy Systems I

# Lesson 22

# DC Machines

# Example

# Commutator behavior