Massachusetts Institute of Technology - Physics Department

Physics - 8.02 **Assignment #5** March 15, 2002.

We strongly recommend that you read about a topic before it is covered in lectures.

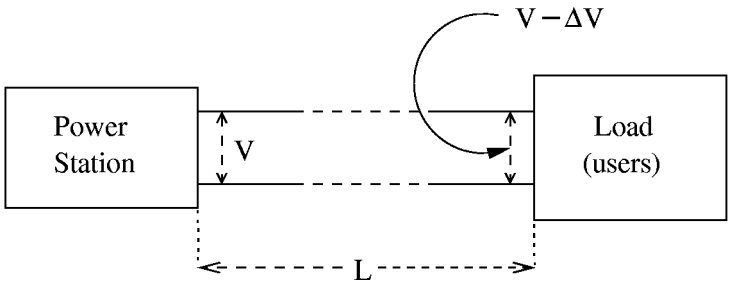
Lecture Date	Topics Covered	Reading from Giancoli
#17 Mon 3/18	Motional EMF - Dynamos - Eddy Currents Magnetic Braking	Sect. 29-3, 29-4, 29-5 & 29-8
#18 Wed 3/20	Displacement Current (*Difficult Concept*) Synchronous Motors - Induction Motors Secret Top, how does it work?	Sect. 32-1 Sect. 27-6 & 31-8
#19 Fri 3/22	**Vacation Special** * How do Magicians levitate women? (with demo) * Electric shock treatment (no demo) * Electrocardiogram - Pacemakers (with demo) * Superconductivity - Floating Bullet Trains * Aurora Borealis *Enjoy the "Special", and Take Notes!*	 Sect. 25-10 Page 606 Sect. 25-9 Page 694

Due before 4 PM, Friday, March 22 in 4-339B.

Problem 5.1

High Voltage Power Transmission.

A power station transmits 200 MW of electric power, at a voltage V over a distance L of 300 miles to the users. The transmission lines are made of 1 inch diameter (about 5 cm^2 cross sectional area) aluminum cables (see Table 25.1 in Giancoli).



(a) Find the ohmic resistance R of the transmission lines at $+40^o$ C, and at -40^o C (length $2L$).

(b) There is a total voltage drop ΔV along the two lines, thus the voltage delivered to the user is $V - \Delta V$ (see diagram). Express this voltage loss ΔV in terms of R and the current I, and also in terms of the power P, and the voltage V.

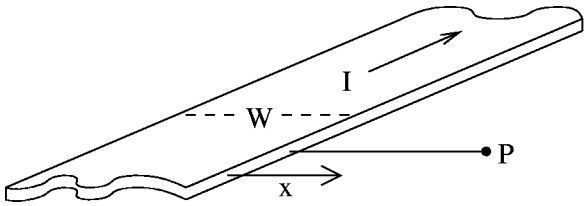
(c) It is desirable that ΔV be at most 2% of V. Since P and R are a given, this imposes a condition on the voltage V. What is the minimum voltage V needed to keep ΔV down to 2% of V at $+40^o$ C, and -40^o C?

(d) What is the power dissipated in the lines for these two temperatures?

(e) If the distance between the wires is 8 m (assume they run parallel), what then is the Lorentz force on a 25 m segment of one of these wires (calculate this for both temperatures)?

Problem 5.2
Ampere's law in action – Giancoli 28-27.

Problem 5.3
Magnetic Field of a Current Carrying Ribbon.
A thin, flat, "infinitely" long ribbon of width W carries a uniform current I. Determine the magnetic field at a point P that is in the plane of the ribbon at a distance x from one edge, as shown in the diagram. Test your result in the limit for $W \to 0$.



Problem 5.4
Force on loop – Giancoli 29-14.

Problem 5.5
Betatron – Giancoli 29-49.

Problem 5.6
Intuition Breaks Down – Do the problems marked "Test 1" and "Test 2" in the Lecture Supplement of March 15.

Problem 5.7
Fringe Fields – Giancoli 29-69.

Recitations.

There are 13 recitation instructors (see the 8.02 Website). If for any reason you are unhappy with your present recitation, see Maria Springer in 4-352 and CHANGE!!