Massachusetts Institute of Technology - Physics Department

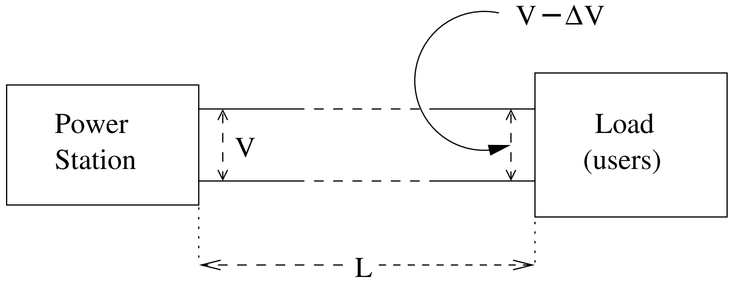
Physics - 8.02 **Assignment #5** March 15, 2002.

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

***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 $5\,\text{cm}^2$ 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 $\Delta V$ along the two lines, thus the voltage delivered to the user is $V - \Delta V$ (see diagram). Express this voltage loss $\Delta V$ in terms of $R$ and the current $I$, and also in terms of the power $P$, and the voltage $V$.

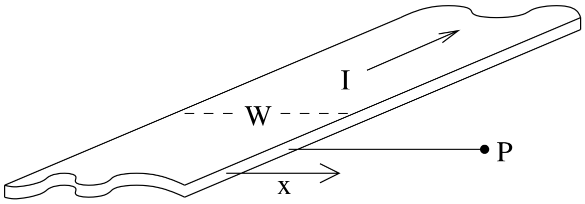
(c) It is desirable that ΔV be at most 2% of $V$. Since $P$ and $R$ are a given, this imposes a condition on the voltage $V$. What is the minimum voltage $V$ needed to keep $\Delta V$ down to 2% of $V$ at $+40^o$ C, and $-40^o$ C?

(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!!**