ECE 320: Lecture 18

Notes

- Reminder: Exam 1 will be next Friday, October 10.
  * Anyone who is interested in an early exam needs to notify fee today and give me the times they are available after 5:00pm on Wednesday
- Lab 2, part 2, and the division of lab sections in A and B weeks was discussed. Handouts availalbe in the lab and on the lab web page.
- WSU Career Fair, Tuesday Oct 7, 9:00-3:30pm

Example: An autotransformer is used to connect a 12.6-kV distribution system line to a 13.8kV distribution line. It must be capable of handling 2000 kVA.

$kVA := kW$

(a) What must the N1:N2 turns ratio be to accomplish this connection?

$Vh := 13.8kV$

$VL := 12.6kV$

Determine the number of turns based the voltage across winding

$N1 := VL$

$N2 := Vh - VL \qquad \frac{N1}{N2} = 10.5$

(b) How much apparent power must the windings of each autotransformer handle?

$Power\_Advantage := \frac{N1 + N2}{N2} \qquad Power\_Advantage = 11.5$

$Sw := \frac{2000kVA}{Power\_Advantage} \qquad Sw = 173.91\,kVA$

So a 2000kVA transformer is effectively implemented using a 174kVA transformer

Alternate way:

Lets say that the autotransformer is supplying a rated, unity power factor load.

$Ih := \frac{2000kVA}{Vh}$ $Ih = 144.93\,A$ $I2 := Ih$

$I1 := \frac{N2}{N1} \cdot I2$ $I1 = 13.8\,A$

$IL := I1 + I2$ $IL = 158.73\,A$

$VL \cdot IL = 2000\,kVA$ $V1 := VL$

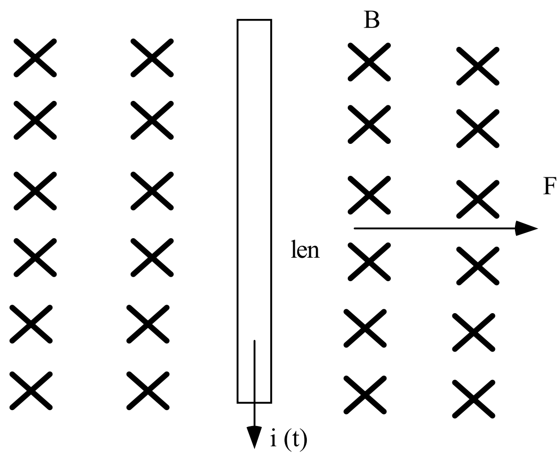
However, for the individual windings:

$S1 := V1 \cdot I1$ $S1 = 173.91\,kVA$

- Autotransformers are used in many of the transmission level substations in this region.

Electromechanical Energy Conversion

- Our next topic is dc machines.
- Before we do rotating machines, lets see how current flowing through a magnetic field can produce force.



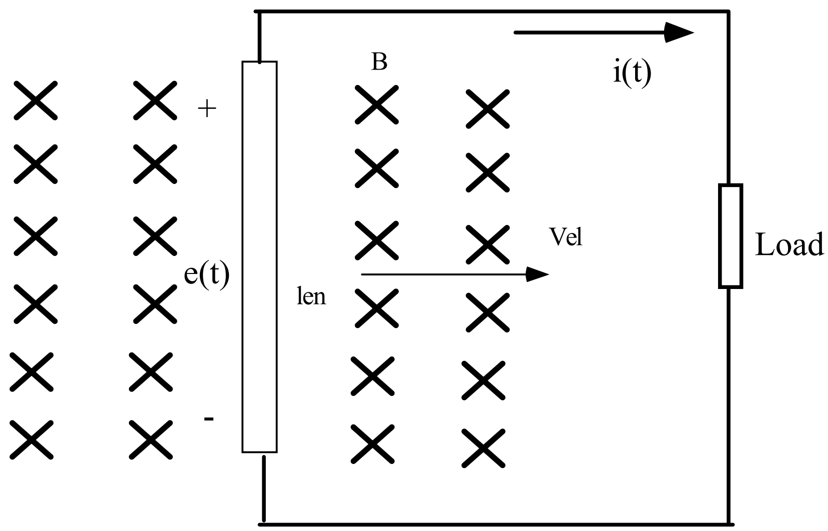
F = i (len x B) i = Magnitude of the current in the wire
len = length of the wire
B = magnetic flux density vector

This simplifies to:

$F = i \cdot len \cdot B \cdot \sin(\theta)$ where θ is the angle between wire (think of as a vector in the direction of current flow) and magnetic flux vector

Right hand rule determine direction of force.

Also, if a conductor moves through a magnetic field, a voltage will be induced on it in a manner similar to the voltage induced by a changing flux (in this case the flux is changing due to motion the wire).



$e_{ind} = (vel \times B) \bullet len$

- Note that if the wire is connected to a load, then a current will flow.
- Also notice that the current will in the opposite direction from the current that was used to calculate force above, so the current will serve to slow down the piece of wire. However, if induced current produced a force to accelerate the wire, we would have a perpetual motion machine...