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 me 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 available 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 on the voltage across winding

\[ N1 := VL \]
\[ N2 := Vh - VL \]
\[ \frac{N1}{N2} = 10.5 \]

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

\[ \text{Power}_{\text{Advantage}} := \frac{N1 + N2}{N2} \]
\[ \text{Power}_{\text{Advantage}} = 11.5 \]

\[ Sw := \frac{2000\text{kVA}}{\text{Power}_{\text{Advantage}}} \]
\[ Sw = 173.91\text{kVA} \]

So a 2000kVA transformer is effectively implemented using a 174kVA transformer
Alternate way:

Let's say that the autotransformer is supplying a rated, unity power factor load.

\[ I_h := \frac{2000 \text{kVA}}{V_h} \quad I_h = 144.93 \text{ A} \quad I_2 := I_h \]

\[ I_1 := \frac{N_2}{N_1} \cdot I_2 \quad I_1 = 13.8 \text{ A} \]

\[ I_L := I_1 + I_2 \quad I_L = 158.73 \text{ A} \]

\[ V_L \cdot I_L = 2000 \text{kVA} \quad V_1 := V_L \]

However, for the individual windings:

\[ S_1 := V_1 \cdot I_1 \quad S_1 = 173.91 \text{kVA} \]

- 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.
This simplifies to:

\[ F = i \cdot \text{len} \cdot B \cdot \sin(\theta) \]

where \( \theta \) 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).

\[ e_{\text{ind}} = (\text{vel} \times B) \cdot \text{len} \]

- 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...