ECE 320: Lecture 8

Notes

Household wiring examples:

- A load draws a large current for a short period of time (say a few 60Hz cycles). For example, many laser printers normally draw very little current most of the time, even when they aren't printing. But every few seconds they may draw a large current (in excess of 30 A peak) for a few cycles to keep the fuser element within its temperature range.

  The voltage drop from this current passing through the impedance of the wire, and then returning through the impedance of the neutral wire causes the voltage across the load tc drop. This is visible as flickering lights, or even computers rebooting.

- The neutral wire is grounded at the distribution transformer, and, for modern installations at the service entrance. If this ground reference is lost, then if the load on one side of the neutr: is almost a short circuit (for example, when your refrigerator compressor starts), the voltage on the other side could reach 240V.

Transformers

Transformers allow AC voltage to be stepped up or down (and current to go down or up respectively).

Two or more coupled coils on a magnetic core. I will draw the core as a square, with the coils o the two vertical limbs, but in reality, the two coils are often wound one on top of the other.

One winding will be called the primary (1) and the other the secondary (2). Sometimes, windin are labelled with "X" for the low voltage winding, and "H" for the higher voltage winding. Ther are N1 turns on the primary, and N2 turns on the secondary.

Each winding has a polarity mark. The voltage will have its positive referred to this mark, and current will flow into the polarity mark. In many power systems applications, the secondary current is treated as flowing out of the secondary winding polarity mark.

Ideal Transformer Relations

We say transformer is ideal is there is no winding resistance, the core is a perfect magnetic material.

$$\frac{V1}{V2} = \frac{N1}{N2} \quad \text{or} \quad \frac{V1}{N1} = \frac{V2}{N2}$$

and

$$N1 \cdot I1 = -N2 \cdot I2 \qquad \text{or} \qquad N1 \cdot I2 + N2 \cdot I2 = 0 \qquad \text{or} \qquad \frac{I1}{I2} = \frac{-N2}{N1}$$

If we treat I2 as flowing out of the polarity mark, then the negative sign goes away.

Combining these:

$$S1 = V1 \cdot \overline{I1}$$

$$S2 = V2 \cdot \overline{I2} = \left[\left(\frac{N2}{N1}\right) \cdot V1\right] \cdot \overline{\left[\left(\frac{-N1}{N2}\right) I1\right]} = -V1 \cdot \overline{I1}$$

These relationships can be extended to a case with three windings as well:

$$\frac{V1}{N1} = \frac{V2}{N2} = \frac{V3}{N3} \qquad N1 \cdot I1 + N2 \cdot I2 + N3 \cdot I3 = 0$$

These can be further extended to cases with additional windings.