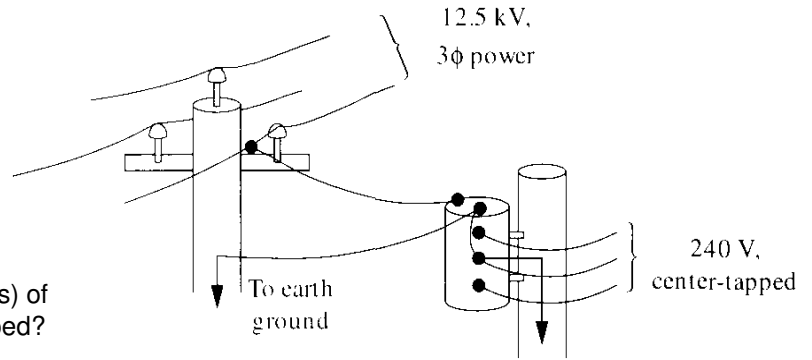# ECE 3600   homework # 8

Ideal Transformers WILL be on exam 1

1. The city of Murray, Utah. distributes power to neighborhoods with a 12.47-kV three-phase system. (12.47 kV is the line voltage.) Each group of houses is served from one phase and ground, and transformed to 240/120 V by a pole transformer, as shown.

12.5 kV, 3φ power

To earth ground

240 V, center-tapped

   a) What is the turns ratio (primary/secondary turns) of the pole transformer to give 240 V, center-tapped?

   b) When a 1500-W toaster-oven is turned on, how much does the current increase in the high-voltage wire? Assume the power factor is unity and the transformer is 100% efficient.

   c) Repeat b) for a clothes drier that draws 15 A.

2. A single-phase transformer is designed to operate at 60 Hz. Its voltage ratings are: primary, 500 V; secondary, 200 V. The maximum permissible load is 30 kVA.

   a) What will be the magnitudes of primary and secondary currents when the device is full-loaded?

   b) Loading is accomplished by an impedance connected across the 200-V terminals. How many ohms will correspond to full-load of the transformer? (Use IT model.)

3. 5.3 The 30-kVA transformer of the problem above is made subject to a SC test. One winding is short-circuited and the other winding is fed from a 60-Hz voltage source. The voltage is raised until rated current is circulated in the windings. This occurs when the applied voltage equals 5.11% of rated winding voltage. The transformer consumes 290 W during the test.

   a) Compute the series impedance $\mathbf{Z_s} = R_s + jX_s$ of the transformer referred to primary and secondary sides.

   b) Compute the core flux during the SC test. (Express its magnitude in percent of normal operating flux.)

   c) Why is it permissible to assume that all of the 290 W constitute ohmic losses in R, and no part of it is core loss?

4. 5.5 The transformer in Exercise 5.3 is fed from a 500-V source. A load impedance of $Z_L := (1.03 + j \cdot 0.72) \cdot \Omega$ is connected across the secondary.

   a) Find the currents in both windings and the secondary voltage by use of the IT model.

   b) Same as in part a) but now include the transformer impedance in your analysis. Take note of the change in your answers.

5. 5.6 The same 30-kVA transformer is made subject to an OC test. It is fed from a 500-V source with the secondary open. The transformer consumes 230 W and draws 0.8 A.

   a) Find R_m and X_m .

   b) Based upon the SC and OC test data compute the efficiency of the transformer when loaded with the $\mathbf{Z_L}$ impedance above.

Answers

1. a) 30   b) 208·mA

2. a) 60·A   150·A   b) 1.333·Ω

3. a) $0.0806 + 0.418 \cdot j \cdot \Omega$ $0.0129 + 0.0669 \cdot j \cdot \Omega$ b) 5.11% of normal rated value.

   c) Because the core flux is 5.11% of normal rated value, the core losses (which are approximately proportional to the square of the flux) are negligible.

4. a) 63.66·A   159.2·A   b) 61.23·A   153.1·A   c) Yes, a little

5. a) 1.09·kΩ   0.76·kΩ   b) 97.8·%   **ECE 3600   homework # 8**