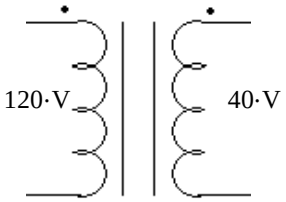
ECE 3600 Exam 1 Fall 2013 (The space between problems has been removed.)

(31 pts) Questions This part of the exam is Closed book, Closed notes, No Calculator.

Write Legibly! If I can't read what you've written or your answer is ambiguous, I'll assume you don't know.

1. What is the most energy-efficient type of common power plant? Hint: It's also one of the oldest.
2. Name 3 sources of electrical power for the grid which do not produce greenhouse gasses by normal operation.
3. Describe how a combined-cycle, natural gas, power plant works and achieves its high efficiency?
4. Express power lost using the following: P_{in} and η
5. Why do transformers have a maximum voltage rating?
   That is, what bad thing are you trying to limit by limiting the voltage?
6. Why do transformers have a maximum current rating?
7. When accounting for the non-ideal characteristics of a power transformer, which of the following is the most important (least often neglected)?

   magnetization reactance core losses winding losses leakage reactance
8. You have a 120/40-V, 480-VA transformer. Can you use this transformer to transform 120 V to 80 V? If yes, show the connections and compute the new VA rating.



9. a) How many single-phase transformers are required to transform 3-phase power. Give the minimum number.

   b) Show how these single-phase transformers might be connected between the source (shown at left below) and a load (shown at right). Do not create an unbalanced load for the source.

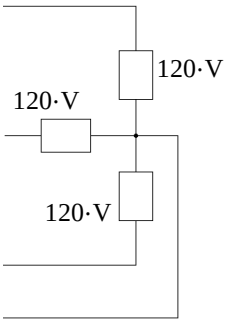
480V, 3-phase

A _____

B _____

C _____

N _____



   c) What is the required turns ratio of the transformers you showed above. Since you don't have a calculator, you may show a mathematical expression instead of a number.

10. a) When analyzing a power system using the per-unit system, which, if any, of the bases should be constant throughout the system?

    b) For those bases that change from place to place throughout the system, which is the primary one that changes and what type of part causes the changes?

The following problems were handed out to the student after finishing the closed-book part.

This part of the exam is **open book**, **open notes**. You MUST show work to get credit. Show the correct units for each value. Assume voltage and current values are RMS and $f := 60 \cdot Hz$. Assume normal abc sequence and balanced conditions for all 3ϕ.

1. (20 pts) A single-phase, 240-V source is connected to two loads. The source provides 2400W and 12A. Load 1 consumes 1500W at a power factor of 0.6.

   In order to find the following, you may have to make some assumptions. If you do, be sure to clearly state your assumption in such a way that I can tell that you know what the other assumption might be.

   a) Find the complex power (both P and Q) consumed by load 2.

   b) Load 2 can be modeled as 2 parts. Draw a model and find the values of the parts.

2. (24 pts) A 3-phase generator produces 320-V , 60-Hz 3-phase power. It is connected through 3 lines to a single 3-phase load which consumes 1.8kW with a 90% lagging power factor. **Each** line has a resistance of R_{line} and a reactance of X_{line} and consumes 40 + 100j VA.

   Source end: 320-V Lines: $R_{line} + X_{line}$ Load end: 1.8 kW, 90% pf, lagging

   Each line: 40 + 100j VA.

   a) Find the complex power (both P and Q) provided by the source.

   b) Find the line current that would be measured by an ammeter.

   c) Find the line resistance and reactance. R_{line} = ? X_{line} = ?

   d) What is the efficiency of this system?

3. (25 pts) The parameters of a 4:1 step-down transformer are shown below. The primary voltage is $V_S := 120 \cdot V$

   The transformer is loaded with $\mathbf{Z_L} = R_L + jX_L$ and the secondary current is $I_2 := 3.2 \cdot A$

   $R_m := 1.5 \cdot k\Omega$ $R_s := 5 \cdot \Omega$ $X_m := 1 \cdot k\Omega$ $X_s := 7 \cdot \Omega$

   a) The primary, source voltage provides 40 VARs $Q_S := 40 \cdot VAR$ Find X_L

   Hint: draw the model with the load.

   If you can't find X_L, mark here ___ , use $X_L = 2\Omega$ and move on.

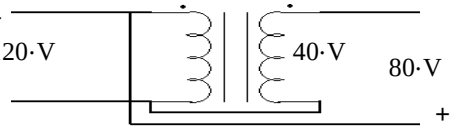
   b) Find R_L

   If you can't find R_L, mark here ___ , use $R_L = 9\Omega$ and move on.

   c) Find the efficiency of this transformer.

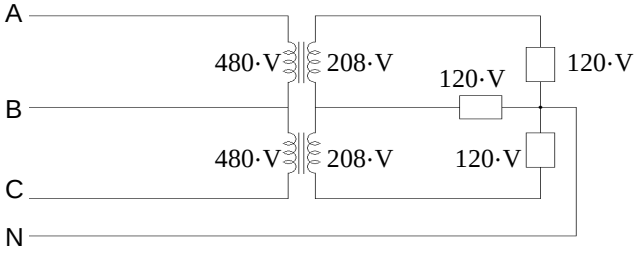
Answers

Closed-book part

1. Hydroelectric 2. 3 of these: Hydroelectric wind solar (steam or solar-cells) nuclear geothermal
3. The "waste" heat of a gas turbine is then used to run a steam cycle generator. 4. $P_{losses} = P_{in} - \eta \cdot P_{in}$
5. Core saturation Insulation breakdown would happen at quite a bit higher voltage
6. Winding resistance & I^2R heating 7. leakage reactance
8. 

9. a) 2 b) 480V, 3-phase

   c) $\frac{480 \cdot V}{208 \cdot V}$



10. a) S_{base} b) V_{base} Transformers

1. a) $(900 - 408.\cdot j)\cdot VA$ b) Parallel: $64\cdot\Omega$ & $18.8\cdot\mu F$ OR Series: $53.1\cdot\Omega$ & $110\cdot\mu F$
2. a) $(1.92 + 1.17\cdot j)\cdot kVA$ b) $4.06\cdot A$ c) $2.43\cdot\Omega$ $6.07\cdot\Omega$ d) $93.75\cdot\%$
3. a) $2.06\cdot\Omega$ b) $8.72\cdot\Omega$ c) $87.5\cdot\%$