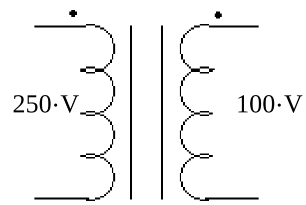
ECE 3600 Exam 1 Fall 2014 (The space between problems has been removed.)

(16 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 name of the organization which ensures the reliability of power in North America? (Initials will be fine)
2. a) What is the most important characteristic of a power plant which provides base power?

   b) What is the most important characteristic of a power plant which provides peak power?
3. a) You have a 250/100-V, 500-VA transformer.
   Show the necessary connections to use
   this transformer to transform 350 V to 250 V.
   Also show the 350-V source and the load.



   b) Compute the new VA rating.
4. Why do transformers have a maximum voltage rating?
   That is, what bad thing are you trying to limit by limiting the voltage?
5. A transformer rated at 300/120 V, 600VA , 60Hz is used at 50Hz .

   a) Do any of the other ratings (voltage, current or VA) have to change? If yes, which one(s) and by how much?

   b) Do any ratings stay the same? If yes, which one(s)?

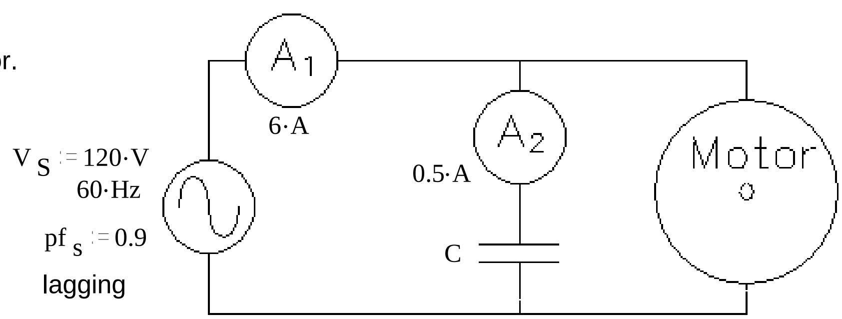
The following problems were handed out to the student after finishing the closed-book part.

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. (24 pts) A capacitor (C) is used to partially correct the power factor of a motor to 0.9. That is, the power factor as seen by the source is 0.9. Two ammeters (A_1 and A_2) read the currents shown.

   Find the following:

   a) The original power factor of the motor.
   As part of your solution, find
   the P and Q of the motor.



   If you can't find this power factor, mark an x here _____ and assume $pf_m = 0.85$ for the rest of the problem.
   You may salvage some points from a) if you find the motor Q from this pf_m , otherwise skip to b)

   b) How much current flows through the motor (magnitude).

   c) Add an additional component to the drawing above in order to completely correct the power factor.
   Find the value of the component.

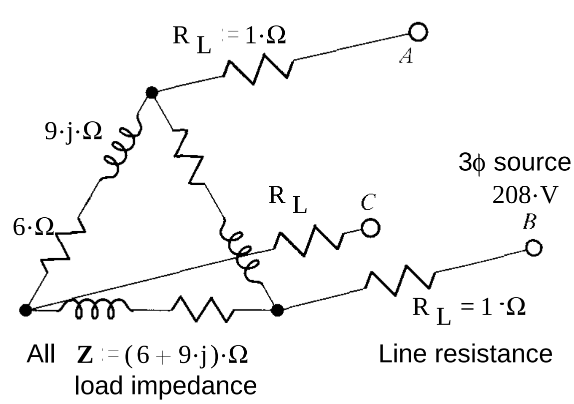
2. (32 pts) Find the following:

   a) The line current that would be measured by an ammeter.

   b) The power factor of the load. Don't include the lines.

   c) The power consumed by the three-phase load.
   Don't include power lost in the lines.

   d) What is the efficiency of this system?

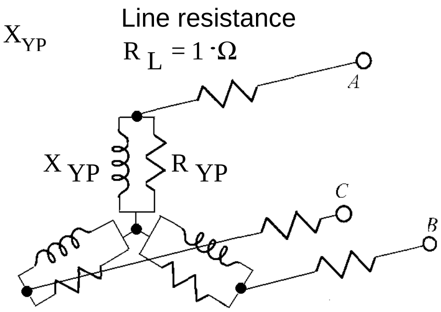


e) What is the line voltage at the load? Just magnitude.

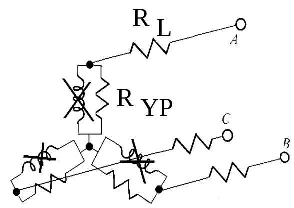
f) The same load could also be represented by Y-connected, parallel R_{YP} and X_{YP}

Find the value of R_{YP} .

R_{YP} can be found from the load voltage and power, both found on the last page.



g) The load power factor is corrected at the load.
(Now the load looks like R_{YP} alone with no X_{YP} .)
What is the new load power of this system?



h) What is the new efficiency of this system?

3. (28 pts) A 500/100-V, 2.5-kVA transformer is subjected to an OC test and a SC test with the results below.

a) Draw a model of this transformer and find the values of all the elements of the model, including the turns ratio.

During the open-circuit test: $I_{OC} := 0.5 \cdot A$ $P_{OC} := 150 \cdot W$

During the short-circuit test: $V_{SC} := 22 \cdot V$ $P_{SC} := 70 \cdot W$

Make sure you added all the elements of the model, including the turns ratio.

b) The transformer is connected to a primary source voltage of 360V and loaded with $\mathbf{Z_L} := (2 + 1 \cdot j) \cdot \Omega$.
(you may add these parts to your drawing if you wish.)
Find the secondary voltage. Magnitude only. $|\mathbf{V_2}| = ?$

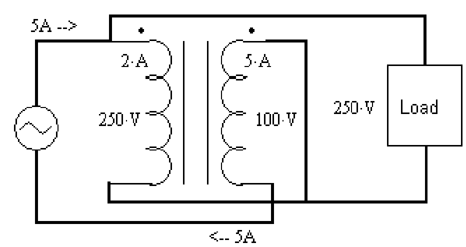
c) Is this transformer operating within its ratings? Show all evidence and calculate needed to to determine this.

Answers

Closed-book part

1. NERC, the National Electrical Reliability Council
2. a) Low cost per kWH
   b) Output can be changed quickly

3. a)



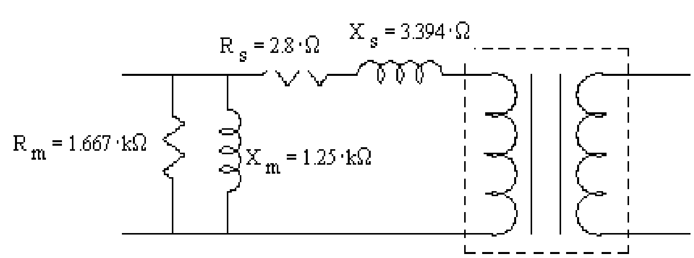
b) 1.75·kW

4. Core saturation (Insulation breakdown would happen at quite a bit higher voltage)
5. a) Voltage and VA ratings are 5/6th of what they were, OR: $300 \cdot V \cdot \frac{50}{60} = 250 \cdot V$ $120 \cdot V \cdot \frac{50}{60} = 100 \cdot V$ $600 \cdot VA \cdot \frac{50}{60} = 500 \cdot VA$
   b) Current ratings stay the same.

Open-book part 1. a) $648 \cdot W$ $373.8 \cdot VAR$ 0.866
b) $6.23 \cdot A$ c) $57.8 \cdot \mu F$

2. a) $28.3 \cdot A$ b) 0.555 c) $4.81 \cdot kW$
d) 66.7% e) $176.8 \cdot V$ f) $6.5 \cdot \Omega$
g) $5 \cdot kW$ h) 86.7%

3. a)



b) $67.1 \cdot V$ c) NO, $6 \cdot A > 5 \cdot A$