ECE 3600 Exam 1 given: Fall 12

(The space between problems has been removed.)

Write Legibly! This part of the exam is Closed book, Closed notes, No Calculator.

(22 pts) Questions If I can't read what you've written or you answer is ambiguous, I'll assume you don't know.

1. a) The Gadsby power plant (the subject of the first field trip) is used to supply: base load or peak load (circle one)

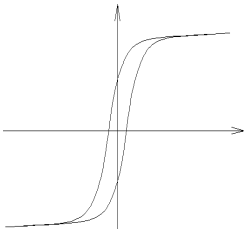
   b) The Intermountain Power Plant (A large coal-fired power plant near Delta, Utah) is used to supply: base load or peak load

2. What is cogeneration?

3. How does a combined-cycle, natural gas, power plant achieve its high efficiency?

4. a) Name the common curve shown at right.

   b) What part of a transformer characterized by this curve?



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. The voltage regulation of a transformer is often specified as %VR. Of the four values given below, circle the best %VR that could be a specification for a transformer.

   a) 2% b) 50% c) 98% d) 120%

8. What does it mean when a 3-phase system is "balanced"?

9. Express the VARs of a leading-pf load in terms of pf and P.

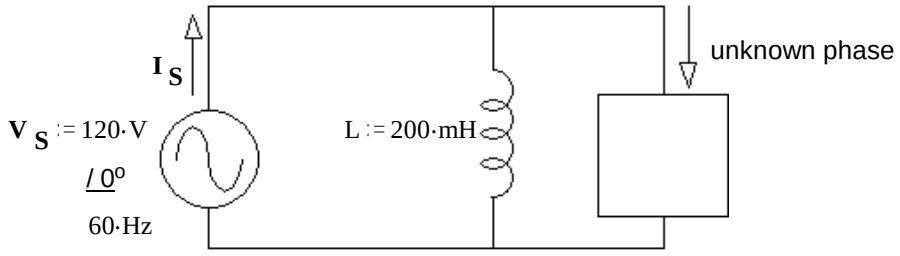
The following problems were handed out to the student after finishing the closed-book part.

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. (23 pts) An inductor is used to completely correct the power factor of a load. $|\mathbf{I}_{Load}| = 4 \cdot A$

   Find the following:

   a) The power consumed by the load. P_L = ?



   If you can't find this power, mark an x here _____ and assume $P_{Load} = 450W$ for the rest of the problem.

   b) The power supplied by the source.

   c) The inductor current (magnitude).

   d) The source current (magnitude and phase). $\mathbf{I}_S$ = ?

   e) The load can be modeled as 2 parts in series. Draw the model and find the values of the parts.

   f) The inductor, L, is replaced with a $50\ mH$ inductor.

   circle one

   i) The **new** source current $|\mathbf{I}_S|$ is **greater** than that calculated in part d).

   ii) The **new** source current $|\mathbf{I}_S|$ is **the same** as that calculated in part d).

   iii) The **new** source current $|\mathbf{I}_S|$ is **less** than that calculated in part d).

2. (25 pts) A 3-phase generator produces 300-V , 60-Hz 3-phase power. It is connected through 3 lines to a single 3-phase load which consumes 3.6 kW with a 80% lagging power factor. Each line has a resistance of R_{line} and no reactance. The system efficiency is 90%.

   Source end: 300-V Lines: R_{line} Efficiency: 90% Load end: 3.6 kW, 80% pf, lagging

   a) Find the complex power provided by the source.

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

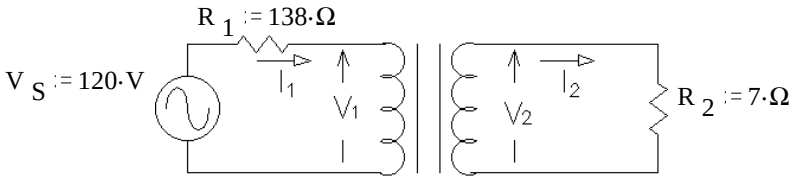
   c) What is the value of the line resistance? R_{line} = ?

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

3. (12 pts) The transformer shown in the circuit below is ideal. It is rated at 220/55 V, 100 VA, 60 Hz
   Find the following:

   a) V_2 = ?

   b) Is this transformer operating within its ratings? Show your evidence.



4. (18 pts) A transformer is rated at 210V / 70V, 420VA.

   The following values were found by making the standard OC and SC tests. R_m and X_m were neglected when finding the other two components.

   $R_m := 2 \cdot k\Omega$ $X_m := 747 \cdot \Omega$

   $R_s := 4 \cdot \Omega$ $X_s := 8.2 \cdot \Omega$

   a) Draw the standard non-ideal transformer model and label the parts.

   b) What were the measurements that were taken in the standard open-circuit test? (Give me numbers)

   c) What were the measurements that were taken in the standard short-circuit test? (Give me numbers)

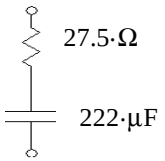
Answers

Closed-book part

1. a) peak load b) base load
2. The "waste" heat of a some electrical generator is then used in another way, say water or air heating.
3. The "waste" heat of a gas turbine is then used to run a steam-cycle generator.
4. a) B-H curve or Hystereses curve b) The core
5. Core saturation Insulation breakdown would happen at quite a bit higher voltage, so it's NOT the limiting factor
6. Winding resistance & I^2R heating 7. a)
8. The 3 voltages are equal, the 3 currents are equal and the 3 loads are equal. 9. $Q = -\sqrt{\left(\frac{P}{pf}\right)^2 - P^2}$

Open-book part

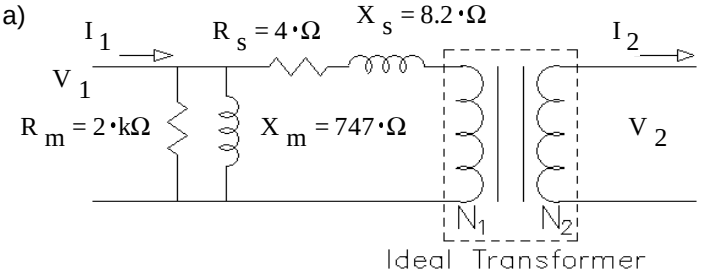
1. a) 440.4·W b) 440.4·W c) 1.59·A d) 3.67·A $\angle 0^o$ e)



   f) i)

2. a) $4 + 2.7 \cdot j$ kVA b) 9.29·A c) 1.546·Ω d) 279.7·V

3. a) 13.44·V b) no 4. a)



   b) 22·W 0.30·A

   c) 16·W 18.25·V