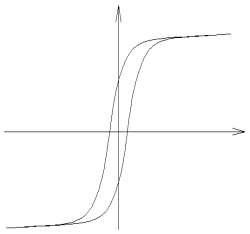
ECE 3600 Exam 1 Given Fall 2018 (The space between problems has been removed.)

Closed Book, Closed notes, Calculators OK, Show all work to receive credit

Circle answers, show units, and round off reasonably

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

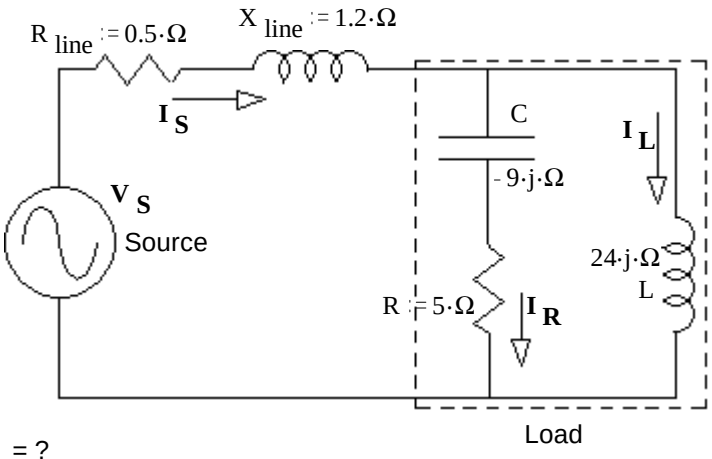
1. What is the name of the organization which ensures the reliability of power in North America? (Initials will be fine)
2. Some power sources are used to supply base loads and some are used to supply peak loads.
   a) What is a "base load". b) What is a "peak load".
3. Decribe how a combined-cycle, natural gas, power plant works and achieves its high efficiency?
4. Express the VARs of a leading-pf load in terms of pf and P.
5. a) Name the common curve shown at right.



   b) Label the vertical and horizontal axes with the correct letters. Alternatively, you may indicate which axis is related to voltage and which is related to current by labeling with: $N \cdot I$ and $V = N \cdot \frac{d}{dt}\phi$
   c) Many electrical devices we study contain a something which is characterized by this curve. What is that?
   d) Name at least 2 issues caused by this part having this characteristic curve.
6. What does it mean when a 3-phase system is "balanced"?
7. Why do transformers have a maximum voltage rating?
   That is, what bad thing are you trying to limit by limiting the voltage?
8. Why do transformers have a maximum current rating?

Problems

1. (37 pts) R, L, & C together are the load (in dotted box). The power used by the load is $P_{Load} := 720 \cdot W$ Find:



   a) The magnitude of the resistor current. $|\mathbf{I_R}| = ?$
   b) The voltage at the load (magnitude). $V_{Load} = ?$
   c) The reactive power used by the load. $Q_{Load} = ?$
   d) The apparent power of the load. $|\mathbf{S}_{Load}| = S_{Load} = ?$
   e) The power factor of the load. $pf_{Load} = ?$
   f) This power factor is: i) leading ii) lagging (circle one)
   g) The magnitudes of the other currents. $|\mathbf{I_L}| = ?$ $|\mathbf{I_S}| = ?$
   h) The source voltage (magnitude). $V_S = ?$

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2. (38 pts) a) A 3-phase system consists of a generator, 3 lines and a load. At the generator the line voltage is 380-V, the total power is $14.4\ \text{kW}$, and the power factor is 0.80. The overall efficiency of the system is 85%. Each line has the same resistance (R_{line}) and no reactance.

a) Find the magnitude of the line current. I_L = ?

b) Find the line resistance. R_{line} = ?

c) What is the line voltage at the load? **Do not** ignore the phase difference between the voltage and the current. Hint: remember that the line has no reactance and therefore no Q.

d) Assume that the load is Y-connected and each branch is a resistor (R_{load}) in **parallel** with a reactance (X_{load}). Find the value of load resistance. R_{load} = ?

e) The power factor is corrected to 1 at the load. The generator line voltage remains 380-V. What is the new efficiency?
Hint: You may interpret the power factor correction as though X_{load} has been eliminated.
Beware! The power given above and the I_L calculated above are no longer valid.

Answers

Questions 1. NERC, the National Electrical Reliability Council

2. a) The electrical load which nearly constant.
b) The electrical load above the base load which fluctuates from hour to hour.

3. The "waste" heat of a gas turbine is then used to run a steam cycle generator. 4. $-\sqrt{\left(\frac{P}{pf}\right)^2 - P^2}$

5. a) B-H curve or Hysteresis curve
b) Vertical axis: B or $V = N\cdot\frac{d}{dt}\phi$ Horizontal axis: H or $N\cdot I$ c) The core
d) Core losses Nonlinearities, esp. in the currents 3rd harmonic currents Sets voltage limits Requires more windings so that the core flux can be less Requires larger, heavier cores 2 of these

6. The 3 voltages are equal, the 3 currents are equal and the 3 loads are equal.

7. Core saturation Insulation breakdown would happen at quite a bit higher voltage 8. Winding resistance & I^2R heating

Problems 1. a) $12\cdot\text{A}$ b) $123.55\cdot\text{V}$ c) $-660\cdot\text{VAR}$ d) $976.73\cdot\text{VA}$ e) 0.737
f) Leading, capacitor dominates g) $5.15\cdot\text{A}$ $7.91\cdot\text{A}$ h) $120\cdot 44\cdot\text{V}$

2. a) $27.35\cdot\text{A}$ b) $0.963\cdot\Omega$ c) $344.6\cdot\text{V}$ d) $9.70\cdot\Omega$ e) $90.97\cdot\%$