Name _____ **ECE 3600 Exam 1 Fall 2016**

(27 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. Decribe how a combined-cycle, natural gas, power plant works and achieves its high efficiency?

4. Give the approximate efficiency of a Rankin-cycle steam turbine power plant, regardless of the source of heat.

5. What two things can be controlled to maximize the coefficient of performance of a wind turbine?

6. 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".

7. Give three expressions for efficiency, η .

8. In a 3-phase system where the 3 voltages are equal, the 3 currents are equal and the 3 loads are equal is often called a _____ system.

9. A single-phase transformer is rated at $2400\ \text{VA}, 1200/240\ \text{V}$. The primary is hooked to a 1000V source
   a) The primary is hooked to a 1000-V source, is the secondary voltage?

   b) At this voltage (1000-V primary), what is the maximum power that transformer should be allowed to transform? (Assuming the right type and value of load.)

   c) In order to actually transform this much power, what should the load impedance value be?

   d) In order to actually transform this much power, what type load impedance should be used?

   e) What is the turns ratio of this transformer?

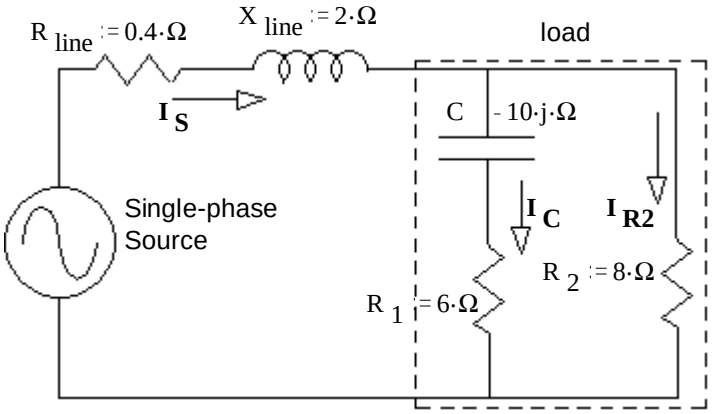
   f) A resistor, R_L, hooked to the secondary of this transformer would appear how big from the primary side?

Problems. You MUST show work to get credit. Show the correct units for each value. Assume voltage and current values are RMS and $f := 60\cdot\text{Hz}$. Assume normal abc sequence and balanced conditions for all 3ϕ.

1. (30 pts) C, R_1, & R_2 together are the load (in dotted box). The reactive power used by the load is

   $Q_{load} := -600\cdot\text{VAR}$ Find:

   a) The real power used by the load.
   P_{load} = ?



   If you can't find this P, try parts e) and f) first and then come back to part a).

   b) The apparent power of the load. |**S**| = S = ?

d) This power factor is: i) leading ii) lagging
(circle one)

e) The voltage at the load (magnitude). V_{load} = ?

f) The magnitudes of the three currents. $|\mathbf{I_C}|$ = ? $|\mathbf{I_{R2}}|$ = ? $|\mathbf{I_S}|$ = ?

g) The source voltage (magnitude). V_S = ?

h) Is there something weird about this voltage? If so, what?
Why? (extra credit)

2. (25 pts) A 3-phase generator produces 400-V , 60-Hz 3-phase power. It is connected through 3 lines to a single 3-phase load which consumes 4.5 kW with a 82% lagging power factor. Each line has a resistance of R_{line} and no reactance. The system efficiency is 90%.

Source end:400-V Lines: R_{line} Efficiency: 90% Load end: 4.5 kW, 82% 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. (18 pts) The parameters of a 5:1 step-down transformer are shown below. The primary voltage is $V_S := 220 \cdot V$

The transformer is loaded with $\mathbf{Z_L} = R_L + jX_L$ and the secondary current is $I_2 := 4 \cdot A$

$R_m := 1.2 \cdot k\Omega$ $R_s := 10 \cdot \Omega$ $X_m := 1 \cdot k\Omega$ $X_s := 12 \cdot \Omega$

a) The primary, source voltage provides 180 Watts $P_S := 180 \cdot W$ Find R_L

Hint: draw the model with the load.

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

b) Find X_L

Answers

Questions 1. Hydroelectric

2. Hydroelectric wind solar (steam or solar-cells) nuclear geothermal 3 of these

3. The "waste" heat of a gas turbine is then used to run a steam cycle generator.

4. 35 - 40% 5. Blade pitch angle and rotational speed

6. a) What is a "base load". The electrical load which nearly constant.
b) What is a "peak load". The electrical load above the base load which fluctuates from hour to hour.

7. $\eta = \frac{P_{out}}{P_{in}} = \frac{P_{out}}{P_{out} + P_{loss}} = \frac{P_{in} - P_{loss}}{P_{in}}$ 8. balanced

9. a) $200 \cdot V$ b) $2 \cdot kW$ c) $20 \cdot \Omega$ d) Purely resistive, power factor of 1 e) 5 : 1 f) $25 \cdot R_L$

Problems 1. a) $1.38 \cdot kW$ b) $1.505 \cdot kVA$ c) 0.917 d) i) e) $90.3 \cdot V$ f) $7.75 \cdot A$ $11.3 \cdot A$ $16.7 \cdot A$ g) $89.5 \cdot V$
h) V_S is less than V_{Load} Partial resonance between the inductance in the line and the capacitance of the load.
OR Because the Q of the line partially cancels the Q of the load

2. a) $5 + 3.14 \cdot j$ kVA b) $8.52 \cdot A$ c) $2.29 \cdot \Omega$ d) $372 \cdot V$

3. a) $8.33 \cdot \Omega$ b) $6.21 \cdot \Omega$