Name: _____

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Circle Section: 9:30 12:30

ECE 333

Exam #1

Wednesday, October 3, 2012

Closed book, closed notes
One 8.5” by 11” note sheet allowed,

1. _____ / 14

2. _____ / 11

3. _____ / 11

4. _____ / 44

5._____ / 20

Total _____ / 100

1. (14 points total)

A 60 Hz, single phase motor with a power factor of 0.6 lagging draws 4.2 kW of power at 240 V from a 10 kVA transformer. Suppose a second motor is needed and it too draws 4.2 kW with the same power factor. With both motors on-line, the transformer will be overloaded.

a. What is the real power, reactive power, and apparent power being consumed with both motors online?

b. What is the minimum power factor needed to continue to use the 10 kVA transformer (without it being overloaded)?

c. How much kVAr of capacitance is needed to provide this level of power factor correction?

d. Now assume it is desired to correct the two motor load to a power factor of 0.95 lagging. How much total capacitance in kVAr is needed?)

e. In two or three sentences, explain why power factor correction is done.

2. (11 points total)

Assume a balanced, three-phase, 60 Hz power system supplies a load such that the line-to-line voltage at the load is 480 V. The load, which is wye-connected, is an impedance that draws 24 A line current and has a lagging power factor of 0.8. Assume the impedance of the wires from the source to the load is $0.5 + j1\ \Omega$ per phase.

a. Find the total (all three phases) real and reactive power consumed by the load impedance.

b. What is the line-to-line voltage magnitude at the source?

c. Assume a second impedance of equal magnitude is placed in parallel with the above impedance on each phase so the system is still balanced. How does the magnitude of the neutral current change?

3. (11 points total)

Assume you have a 75 kW microturbine that burns 850,000 Btu/hr when running at full output, and that when running the microturbine there are no other costs. You can assume the cost of natural gas for the turbine is $3 per million Btu (Mbtu).

a. What is the cost of electricity from this tubine in $/MWh?

b. If electricity from the local utility costs 10 cents per kWh, what would be the yearly savings from using this microturbine assuming the electric load is fixed at 75 kW for the entire year? Express your answer in $/year.

c. Calculate the simple payback period in years (i.e., assuming no interest costs) if the initial investment for the microturbine is $120,000 and there are no other costs or savings. The waste heat from the microturbine is not used.

4. Multiple Choice (4 points each, 11 problems, 44 points total)

Circle the choice closest to the correct answer. Unless indicated otherwise, you should show your work or provide justification for the selected answer.

1. As discussed in class, what is the current (mid 2012) installed wind energy capacity in the US? (No justification needed).			
a. 10 MW	b. 5 GW	c. 25GW	d. 50 GW

2. A balanced three-phase load draws a total of 300 kVA with a line-to-line voltage of 3 kV. What is the line current magnitude?			
a. 33 A	b. 58 A	c. 100 A	d. 173 A

3. If a current waveform has half-wave symmetry, what harmonic components can be present? (No justification required).			
a. 1^{st} only	b. 1^{st} and 3^{rd} only	c. Even only	d. Odd only

4. What is the THD in the following signal? $i(t) = 5\cos(\omega t) + 4\cos(3\omega t) + 3\cos(6\omega t)$			
a. 0%	b. 33%	c. 66%	d. 100%

5. If the magnitude of the current entering the high side of an ideal single-phase 200kV/50kV 15 MVA transformer is 50 A, what is the magnitude of the current leaving the low side of the transformer?			
a. 12.5A	b. 100 A	c. 200 A	d. 300 A

6. Approximately, how large is a common horizontal-axis wind turbine? (No justification needed).			
a. 1.5 W	b. 1.5 kW	c. 1.5 MW	d. 1.5 GW

Problem 4 continues on the next page

4. Multiple Choice, continued

7. If the a-phase line-to-neutral voltage (V_{AN}) is $\|V\|\angle\theta$, find the line-to-line voltages V_{AB} and $V_{BC,}$ and the line-to-neutral voltage $V_{BN.}$ (No justification needed).			
a. $V_{AB}=\frac{\|V\|}{\sqrt{3}}\angle(\theta+30°)$ $V_{BC}=\frac{\|V\|}{\sqrt{3}}\angle(\theta+90°)$ $V_{BN}=\|V\|\angle(\theta+120°)$	b. $V_{AB}=\|V\|\angle(\theta+120°)$ $V_{BC}=\frac{\|V\|}{\sqrt{3}}\angle(\theta+30°)$ $V_{BN}=\sqrt{3}\|V\|\angle\theta$	c. $V_{AB}=\sqrt{3}\|V\|\angle(\theta+30°)$ $V_{BC}=\sqrt{3}\|V\|\angle(\theta-90°)$ $V_{BN}=\|V\|\angle(\theta-120°)$	d. $V_{AB}=\sqrt{3}\|V\|\angle(\theta-30°)$ $V_{BC}=\sqrt{3}\|V\|\angle(\theta+90°)$ $V_{BN}=\|V\|\angle(\theta+120°)$

8. A 50 W speaker is designed to operate at 230 V. If the speaker is actually operated from a 240 V voltage source, what will the power output be?			
a. 45.9 W	b. 47.9 W	c. 52.2 W	d. 54.4 W

9. A Carnot heat engine with a thermal efficiency of 80 % is being designed. If the cold reservoir is to be held at 300 K (27 ^{o}C), what temperature must the high-temperature reservoir be held at?			
a. 375 K	b. 750 K	c. 1500 K	d. 3000 K

10. Wind turbine A has a rated power output of *x* W and blade diameter of *d* meters. If wind turbine B has a blade diameter of *2d* meters, what would you expect its rated power output to be?			
a. *x/8* W	b. *2x* W	c. *4x* W	d. *8x* W

11. A 58% efficient power plant with a fuel containing 40,000 kJ/kWh has an uncontrolled sulfur emission rate of 6.95 g/kWh. If the regulations state that sulfur emissions must be below 1.23 g/kWh, which of the following sulfur scrubber efficiencies is able to meet this standard? (Circle all that apply)			
a. 82%	b. 83 %	c. 84%	d. 85%

5. (20 points total).

True/False – Two points each. Circle T if statement is true, F if statement is False.

T F 1. In the US natural gas prices, which closely follow the price of petroleum, are near record high levels.

T F 2. When doing per phase analysis, one of the impedance angles may be set arbitrarily.

T F 3. The total real power losses in an ideal transformer are always zero.

T F 4. An important advantage of compact fluorescent lights over incandescent lights is that the compact fluorescent lights create far fewer harmonics.

T F 5. In the US many states are encouraging renewable generation through the use of renewable portfolio standards.

T F 6. A consequence of Kirchohoff's current law is that the net real and reactive power flowing into a high voltage transmission line must equal the net real and reactive power flowing out of the transmission line.

T F 7. In Illinois the capacity factor for solar is usually less than 25%.

T F 8. While the amount of wind capacity in Asia is growing, Europe still leads Asia in the amount of new wind capacity added in 2011.

T F 9. The power in the wind varies with the cube of the wind speed.

T F 10. As a direct consequence of Kirchoff's current law the locational marginal price (LMP) at a bus in the power grid can never be less than zero since this would require negative resistive losses.

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