

ECE 431

First Exam - Spring 2006 - Closed book, (standard class sheet allowed), 55 min.

Problem points (out of 100) are indicated. Work all problems in exam booklets.

Problem #1 (20 points)

A balanced 3-phase, 208 Volt (line-line) source serves a balanced, 3-phase load. A variable 3-phase capacitor bank is connected across the load in a Delta configuration. Measurements of the source line current for various values of capacitor Vars (3-phase) give:

Capacitor Vars (3-phase):	0	200	400	600	800	1,000	1,200	1,400
Source line current:	3.75	3.43	3.17	3.00	2.92	2.95	3.07	3.29

- (a) Approximately how many Vars (3-phase) does the load consume by itself?
 - (b) Approximately how many Watts (3-phase) does the load consume?
 - (c) Do you think your answer of (a) is too high, exactly right, or too low? Explain why.
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Problem #2 (20 points)

- (a) Suppose you would like to observe the magnetic saturation curve of a transformer. Describe in as much detail as you can how you might do that. Explain how it would work.
 - (b) If 3 transformers (each rated for 250KVA) are connected in a delta-delta configuration, what would be the rating of the open-delta transformer bank created by removing one of the transformers?
 - (c) If a transformer nameplate indicates ratings of 2400Volts/240Volts, 60Hz, 25KVA, 5% Impedance, what would be the value of the short circuit current on the 240 Volt side if the 240 Volt side was shorted while rated voltage was applied to the 2400 Volt side?
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(OVER)

Problem #3 (15 points)

Determine the number of steps, frequency, and speed (in rpm) for the given movements of a stepper motor. Assume that only full steps can be taken. The stepper motor has 5 phases and 24 rotor teeth.

- (a) Turn 81° clockwise (CW) within 0.1 s.
 - (b) Turn 135° counter-clockwise (CCW) within 0.3 s.
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Problem #4 (20 points)

A balanced, symmetrical, 3-phase, Y-connected, 60 Hz, 6-pole, 230 Volt (line-line) induction motor has negligible stator resistance, negligible stator and rotor leakage reactance. The magnetizing reactance referred to the stator is 40 Ohm per phase. You may ignore core losses plus windage and friction losses.

- (a) What is the magnitude of the line current if it delivers a load torque of 13 NM at a speed of 1080 RPM?
 - (b) What is the power factor of the machine at this load?
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Problem #5 (25 points)

A balanced, symmetrical, 2 HP, 3-phase, Y-connected, 60 Hz, 6-pole, 208 Volt (line-line) induction motor has a no-load line current of 3 Amps and a full-load line current of 5 Amps. The full-load speed is 1080 RPM. (full-load means the output power is 2 HP)

- (a) What is the frequency of the rotor currents at full load?
 - (b) Find an estimate of the rotor resistance referred to the stator.
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