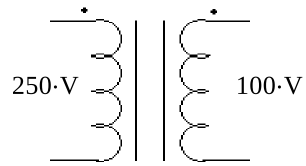
ECE 3600 Exam 2 given: Fall 18

(The space between problems has been removed.)

1. To Bring a Synchronous Generator "On Line" you must do several things. Name at least 3. Be as specific as you can.
   1.
   2.
   3.
   4.
   5.

2. a) You have a 250/100-V, 500-VA transformer. Show the necessary connections to use this transformer to transform 350 V to 250 V.



   b) Connected this way, determine the maximum power that could be converted from 350 V to 250 V without overloading the transformer.

   c) Show the 350-V source and the load.

3. Is it desirable for at least one side of a 3-phase transformer to be wired in a certain way? yes no circle one
   If yes, which way and why? Questions ______/ 18

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

1. (28 pts) A 60 Hz, 4-pole, 3-phase, Δ-connected, synchronous generator supplies 150 kW of power to a 3.6 kV bus. The synchronous reactance is 50 Ω/phase. The generator emf is 3.8 kV. Find the following.
   a) The power angle, δ.

   b) The total reactive power generated.

   c) Draw the phasor diagram for this generator and label the phasors. Label with numbers if you have them.

   d) Find a new magnitude of the generator emf so that $Q := 24 \cdot kVAR$

   e) Find the new power angle, δ.

2. (30 pts) A 3-phase induction motor is Y-connected to a 340-V bus.
It has the following equivalent circuit components:

$R_1 := 0.5\cdot\Omega$ $R_2 := 0.8\cdot\Omega$ $R_C := \infty$ $X_1 := 2\cdot\Omega$ $X_2 := 1\cdot\Omega$ $X_M := 20\cdot\Omega$

currently running at $n_m := 1710\cdot rpm$ mechanical, rotational losses: $P_{mech} := 400\cdot W$

DON'T FORGET: Your powers are for the whole motor and your model is only for ONE phase.

a) Draw the circuit model of one phase, and label the known parts and values.

b) Find the slip. Make a reasonable assumption as necessary.

c) The line current (magnitude) Note: a number that may be helpful:
$$\frac{1}{\frac{1}{j\cdot X_M}+\frac{1}{\frac{R_2}{s}+j\cdot X_2}} = 9.182+7.948\cdot j\ \Omega = 12.145\ \Omega\ \underline{/\ 40.88^o}$$

d) The stator copper losses

e) The air-gap P_{AG}

f) The power converted from electrical to mechanical.

g) The rotor copper losses.

h) The overall machine efficiency.

3. (23 pts) The parameters of a 4:1 step-down transformer are shown below.
The transformer is loaded with $\mathbf{Z}_L := (2.5+1\cdot j)\cdot\Omega$ and the secondary voltage is $V_2 := 32\cdot V$

$R_m := 800\cdot\Omega$ $R_s := 3\cdot\Omega$ $X_m := 700\cdot\Omega$ $X_s := 5\cdot\Omega$

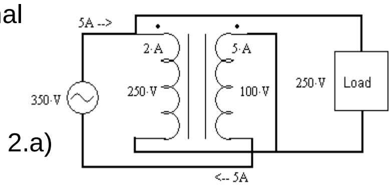
a) Find the primary, source voltage. Magnitude only. $|\mathbf{V}_S| = ?$ As part of your answer, make a useful drawing or schematic.

b) If this load were considered "full load", find the voltage regulation as defined in your notes. $\%VR = ?$

c) Find the efficiency of the transformer. $\eta = ?$

<u>Answers</u> **Questions**

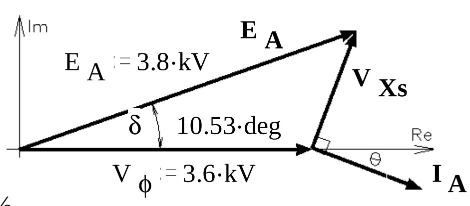
1. 1. Bring speed to the correct rpm so that the generator frequency matches the line frequency.
   2. Adjust the field current, I_f so that the generator voltage matches the line voltage.
   3. Readjust speed if necessary, check that the phases are in the correct sequence if necessary.
   4. Wait until the phases align (0 volts difference between generator terminal and the line phase). Connect to the line at just the right moment.
   5. Increase input torque to produce real electrical power and and field current to produce reactive power.
3. yes, Δ, to reduce third-harmonic currents.

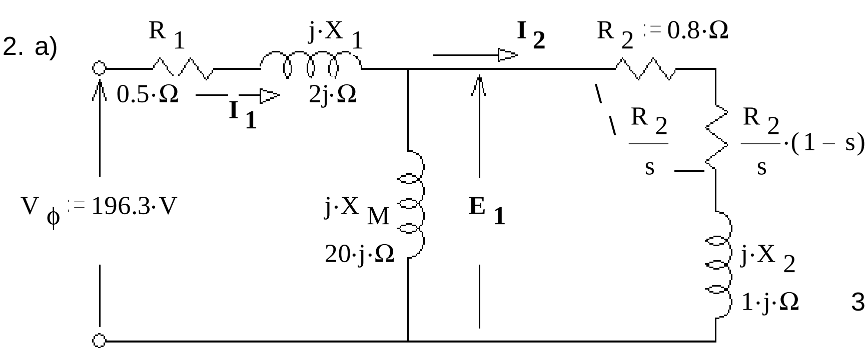
2.a)


b) $1.75\cdot kW$

<u>Problems</u>

1. a) $10.53\cdot deg$ b) $29.4\cdot kVAR$ c) --> d) $3776\cdot V$ e) $10.6\cdot deg$

c)


2. a)


b) $5\cdot\%$ c) $14.14\cdot A$ d) $300\cdot W$
e) $5.51\cdot kW$ f) $5.23\cdot kW$ g) $275.4\cdot W$
h) $83.2\cdot\%$

3. a) $142.2\cdot V$ b) $11.1\cdot\%$ c) $87.2\cdot\%$