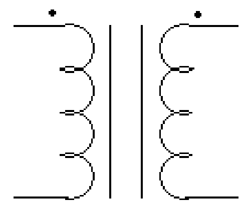
ECE 3600 Exam 2 given: Fall 19

(Some space between problems has been removed.)

Closed Book, Closed notes (Except for the colored sheets handed out in class), Calculators OK. Show all work to receive credit.

Circle answers, show units, and round off reasonably

1. a) (12 pts) You have a 400/100-V, 1.2-kVA transformer.
   Can you use this transformer to transform 400 V to 300 V?
   If yes, show the connections (include source and load) and compute the new VA rating.



   b) Show the 400-V source and the load.

   c) Could this transformer also be used to transform 240 V to 180 V ? If yes, what is the maximum real power that could be transformed at these voltages?

2. (31 pts) The parameters of a transformer are shown below.
   Ratings: 360/120-V, 840-VA   Model values: $R_m := 500\cdot\Omega$ $R_s := 6\cdot\Omega$ $X_m := 400\cdot\Omega$ $X_s := 8\cdot\Omega$

   The secondary voltage is measured as $V_2 := 93.6\cdot V$ The secondary current is measured as $I_2 := 7.2\cdot A$
   The transformer is loaded with a resistor, R_L, in series with a capacitive reactance, $X_C := -5\cdot\Omega$
   a) Find the value of the load resistor. $R_L = ?$

If you can't find R_L, use a value between 10Ω and 15Ω , Write that value here R_L=__________ and proceed.

   b) Find the primary, source voltage. Magnitude only. $|\mathbf{V_S}| = ?$ As part of your answer, make a useful drawing or schematic and label it with known numbers.

c) Find the efficiency of the transformer.

NOTE: This efficiency is unrealistically low.

d) Is this transformer operating within its ratings? Show all evidence and calculations needed to to determine this.

3. (26 pts) A 60 Hz, 2-pole, 3-phase, Y-connected synchronous generator supplies 90 kW of power to a 4 kV bus. The synchronous reactance (X_S) is 50 Ω/phase. The power angle (δ) is 12.5^o. Find the following.

a) The magnitude of the generator emf (E_A)

b) The total reactive power generated.

NOTE: This number is unrealistically big.

c) The operators are told to double the generated power, what do they do?

Use this new power for the rest of the problem.

d) The operators are told to generate the same reactive power as before (part b) what do they adjust?

e) After making the adjustment of the previous part, find the new magnitude of the generator emf

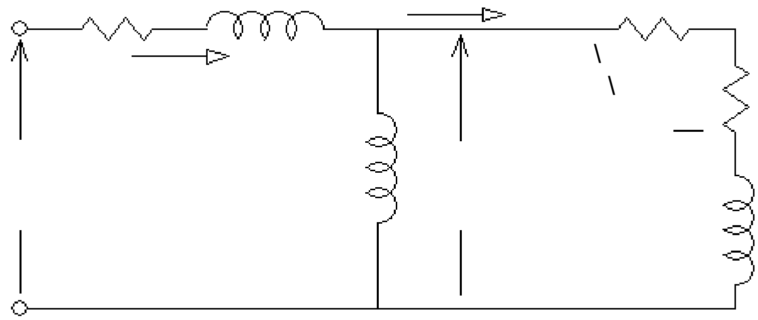
f) The power angle, δ.

4. (31 pts) The following information is for a 3-phase, Δ-connected, induction motor:

$X_M := 80 \cdot \Omega$ $R_C := \infty$ $n_m := 1128 \cdot \text{rpm}$ Shaft torque: $\tau_{shaft} := 52 \cdot \text{N} \cdot \text{m}$

$|\mathbf{E_1}| = E_1 := 200 \cdot \text{V}$ $|\mathbf{I_2}| = I_2 := 12 \cdot \text{A}$ $P_{RCL} := 420 \cdot \text{W}$

a) Below is a drawing of the circuit model of one phase. Label **all** the parts and arrows and add known values.



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

c) Find R_2

d) Find X_2

If you can't find X_2, or doubt your value, mark here ____ and use $X_2 = 4\ \Omega$ for the rest of the problem.

e) The magnitude of the line current.   I advise you to assume the phase angle of E_1 is 0^o.

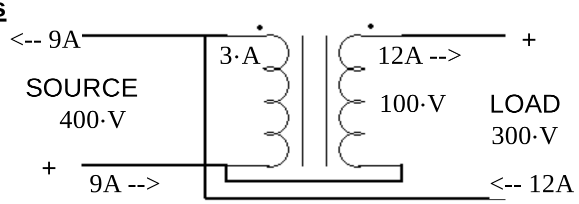
f) The air-gap power

g) The power converted from electrical to mechanical form.

h) Find the mechanical power losses (all lumped together).

Answers

1. a),b)



c) Same connections 2.16·kW

2. a) $12 \cdot \Omega$ b) $287.7 \cdot \text{V}$
   c) $75.7 \cdot \%$ d) no

3. a) $3001 \cdot \text{V}$ b) $85.96 \cdot \text{kVAR}$
   c) Increase the shaft torque from the prime mover
   d) The DC field current
   e) $3205 \cdot \text{V}$ f) 23.9^o

4. b) $6 \cdot \%$ c) $0.972 \cdot \Omega$ d) $3.90 \cdot \Omega$ e) $22.2 \cdot \text{A}$ f) $7 \cdot \text{kW}$ g) $6.58 \cdot \text{kW}$
   h) $437.6 \cdot \text{W}$