ECE 3600 Exam 2 given: Fall 11

(The space between problems has been removed.)

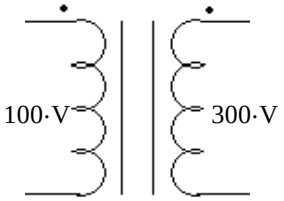
Write Legibly! This part of the exam is Closed book, Closed notes, No Calculator.

(22 pts) Questions If I can't read what you've written or you answer is ambiguous, I'll assume you don't know.

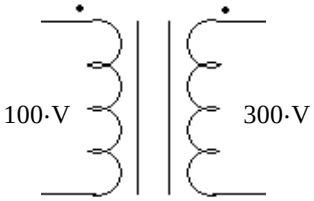
1. The voltage regulation of a transformer is often specified as %VR. Of the four values given below, circle the best %VR that could be a specification for a transformer.

   a) 2% b) 50% c) 98% d) 120%

2. You have a 100/300-V, 600-VA transformer. Can you use this transformer to transform 200 V to 300 V? If yes, show the connections and compute the new VA rating.



3. You have a 100/300-V, 600-VA transformer.
   a) Can you use this transformer to transform 320 V to 240 V? If yes, show the connections and compute the maximum power that can be transformed at these voltages.



4. 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?

5. The B-H curve causes a number of problems. Name at least 3.

6. a) List the bases of a per-unit system.

   b) When analyzing a power system, which, if any, of these bases should be constant throughout the system?

   c) For those bases that change from place to place throughout the system, which is the primary one that changes and what type of part causes the changes?

   d) Show how to find the remaining bases from those listed in parts b) and c).

7. The power angle of a synchronous generator is limited to what range of values?

8. a) List at least 3 different synchronous motor speeds in the US, in rpm.

ECE 3600 Exam #2 Fall 2011
Arn Stolp
Scores:
Questions _____ / 22 pts
Prob 1 _____ / 20 pts
Prob 2 _____ / 20 pts
Prob 3 _____ / 18 pts
Prob 4 _____ / 20 pts
Total _____ / 100 pts

The following problems were handed out to the student after finishing the closed-book part.

1. (20 pts) A transformer is rated at $240V / 60V, 360VA$.

   The following measurements are taken in a standard short-circuit test: $V = 20 \cdot V$ $P = 12 \cdot W$

   The following measurements are taken in a standard open-circuit test: $I = 500 \cdot mA$ $P = 24 \cdot W$

   Draw the standard non-ideal transformer model and find the values or reactances of all the components. You may neglect R_m and X_m when finding the other two components.

2. (20 pts) The parameters of a 4:1 step-down transformer are shown below.
   The transformer is loaded with $\mathbf{Z_L} := (5 + 3 \cdot j) \cdot \Omega$ and the secondary current is $I_2 := 4.8 \cdot A$

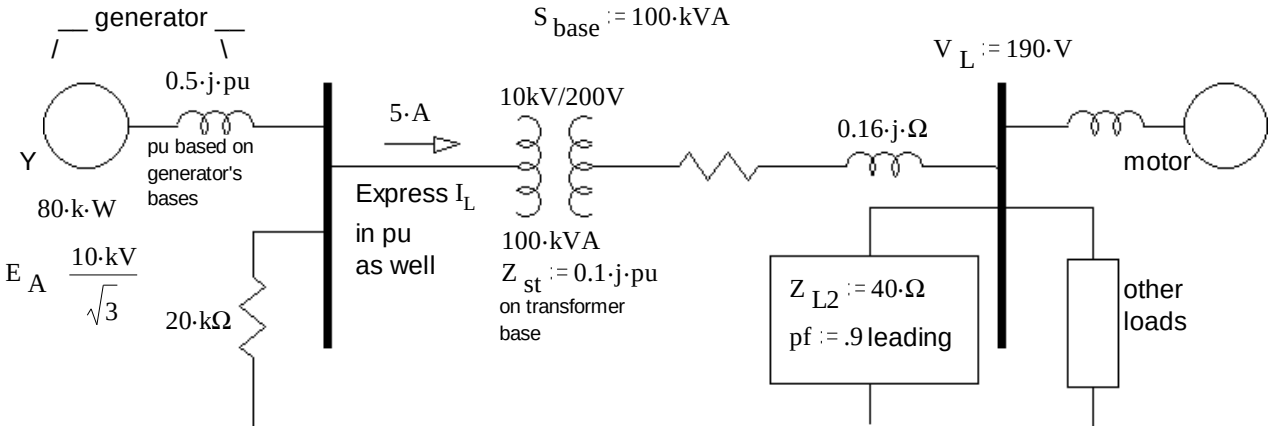
   $R_m := 2 \cdot k\Omega$ $R_s := 4 \cdot \Omega$ $X_m = ?$ $X_s := 8 \cdot \Omega$

   a) draw the model with the load connected. Label parts, voltages and currents as needed for the rest of the problem.

   b) Find the primary, source voltage. Magnitude only. $|\mathbf{V_S}| = ?$

   c) The primary, source voltage provides VARs $Q_S := 140 \cdot VAR$ Find X_m

3. (18 pts) A one-line, per-phase diagram is shown below. Using the S_{base} given, draw a per-phase, per-unit diagram. Include pu values for **all** the values given in the drawing below. E_A voltages are line-to-neutral.



Give phase angle for Z_{L2}

4. (20 pts) You have a 3-phase, Y-connected, synchronous generator with synchronous reactances of 2Ω/phase. The magnitude of the back EMF is $380V$, the magnitude of the line current is $80A$ and it lags the phase voltage by 30^o.

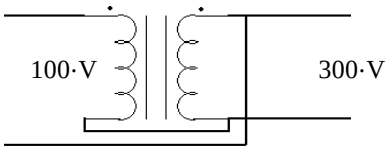
   $X_s := 2 \cdot \Omega$ $E_A := 380 \cdot V$ $I_L := 80 \cdot A$ $\theta := 30 \cdot deg$ with I_L lagging V_ϕ

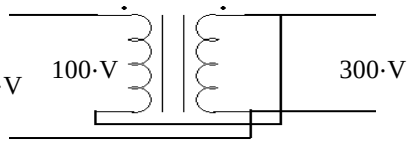
   a) Draw a phasor diagram of this situation.

   b) Find the line voltage this generator is connected to, magnitude only. Hint: It's a geometry problem.

   c) Find the power angle, δ.

Closed-book part

1. a) 2. 

1.2·kVA 3. 

1.92·kW

4. yes Δ, to reduce third-harmonic currents.

5. Core losses Nonlinearities, esp. in the currents Requires more windings so that the core flux can be less

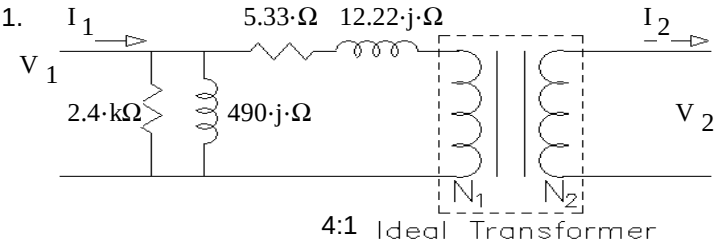
Sets voltage limits 3rd harmonic currents Requires larger, heavier cores 3 of these

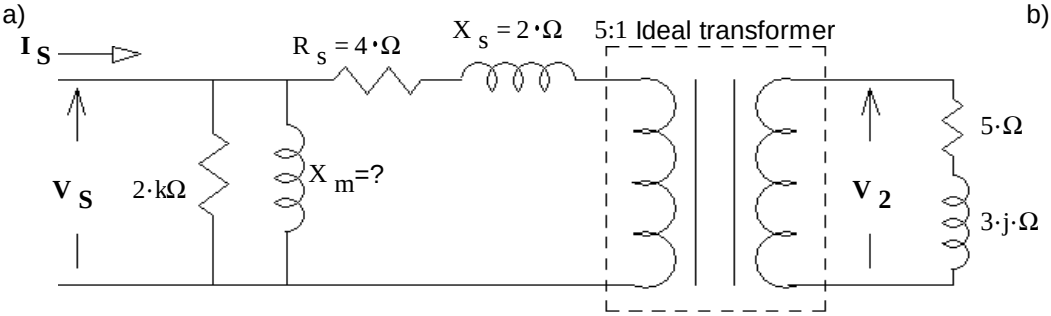
6. a) S_{base} V_{base} I_{base} Z_{base} b) S_{base} c) V_{base} Transformers

d) $I_{base} = \frac{S_{base}}{\sqrt{3}\cdot V_{base}}$ $Z_{base} = \frac{V_{base}^2}{S_{base}}$

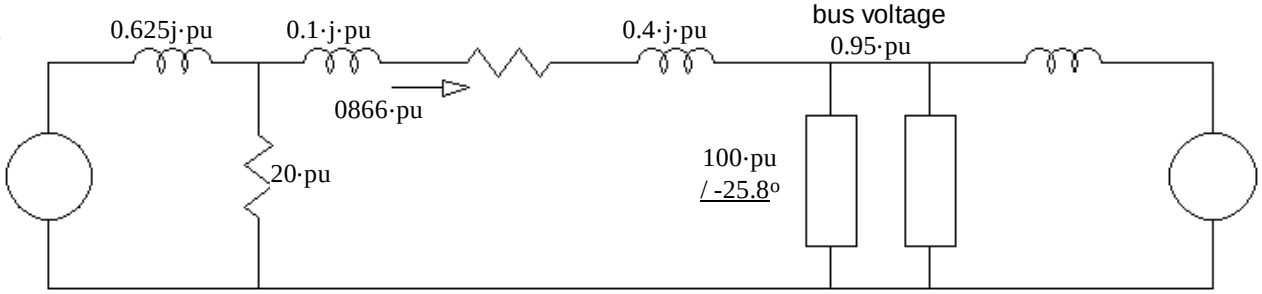
7. $0^o < \delta < 90^o$ 8. $\frac{3600\cdot rpm}{any\_integer}$ 3600·rpm 1800·rpm 1200·rpm 900·rpm 720·rpm etc..

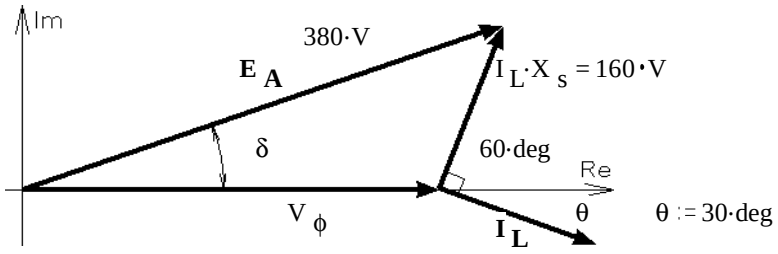
Open-book part

1. 

2. a) 

b) 121.1·V c) 247·Ω

3. 

4. a) 

b) 474.3·V c) 21.39·deg

θ := 30·deg