ECE 3600 Exam 2 given: Fall 23   First part, Closed EVERYTHING
Closed book, Closed notes, No reference sheets, Calculator OK.

Write Legibly!   If I can't read what you've written or your answer is ambiguous, I'll assume you don't know.

(30 pts) Questions

1. Why do transformers have a maximum voltage rating?
   That is, what primary bad thing are you trying to limit in the transformer by limiting the voltage?
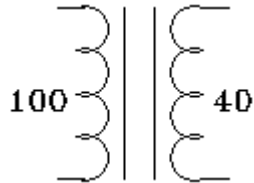   Not some secondary effect.

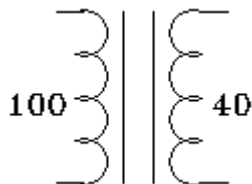2. Why do transformers have a maximum current rating? Again, what non-ideal characteristic is the issue?

3. Show connections to the following 100/40-V, 200-VA transformers to get the voltage ratios desired.
   Clearly show the source and load. Compute the new VA rating of each connection. Show your work.

   a) 140/40 V

   c) 60/40 V

More on other side ===>

4. This problem is about 3-phase transformers.

   If wired Y - Y, what is the likely phase-angle difference between primary and secondary?

   If wired Y - Δ, what is the likely phase-angle difference between primary and secondary?

   If wired Δ - Y, what is the likely phase-angle difference between primary and secondary?

   If wired Δ - Δ, what is the likely phase-angle difference between primary and secondary?

   Is it desirable for at least one winding of a 3-phase transformer to be wired in a certain way?   yes   no

   If yes, which way and why?   circle one

5. 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?

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

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

Hand this part in to get the second part.   _____/ 30

1. (22 pts) A step-down transformer is rated at 300/100 V, 1.2 kVA, 60 Hz   **ECE 3600 Exam 2 Fall 23 p3**

The parameters below were obtained from testing the transformer in the usual ways, making the normal simplifications.

$R_m := 1.8 \cdot k\Omega$ $R_S := 4 \cdot \Omega$ $X_m := 1.2 \cdot k\Omega$ $X_S := 8 \cdot \Omega$ actual $N := 2.81$
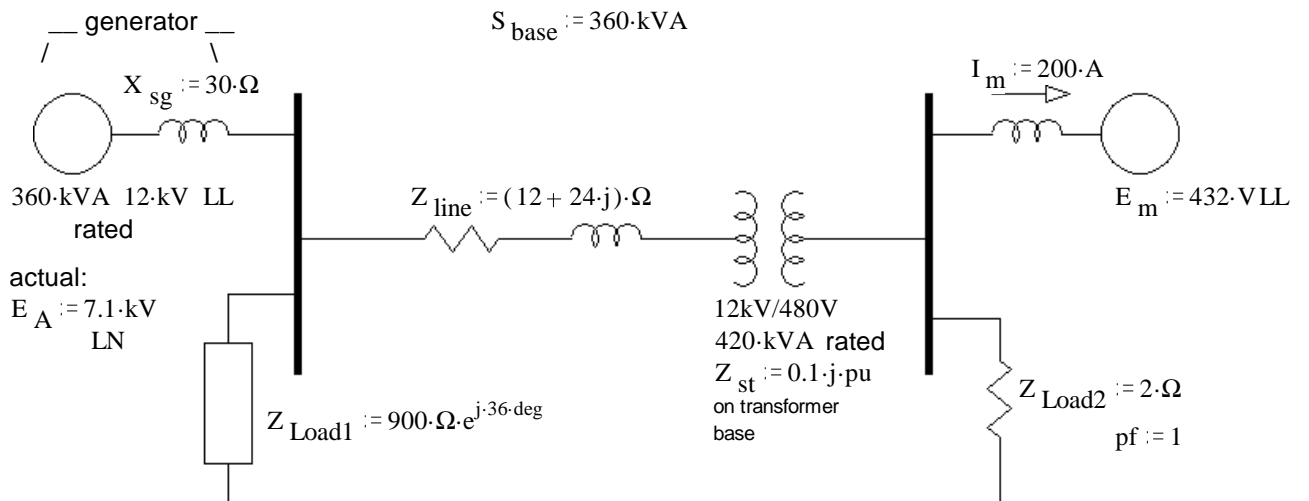
a) What was measured during the short-circuit test on this transformer? Give me values.

b) What was measured during the open-circuit test on this transformer? Give me values.
   Don't forget the measurement needed to find the actual turns ratio.

c) The actual turns ratio was designed so that the secondary voltage would be $100V$ when the transformer is fully loaded. Use this information along with one of the measurements you found in part b) to find the voltage regulation as defined in your notes.

$\%VR = ?$

2. (18 pts) A one-line, per-phase diagram is shown below. Using the S_{base} given, draw a per-phase, per-unit **E2 F23 p4** diagram. Show how you find the bases and include pu values for **all** the values given in the drawing below. E_A voltage is line-to-neutral, E_m voltage is line-to-line.

generator

$X_{sg} := 30 \cdot \Omega$

$S_{base} := 360 \cdot kVA$

$I_m := 200 \cdot A$

360·kVA 12·kV LL
rated

$Z_{line} := (12 + 24 \cdot j) \cdot \Omega$

$E_m := 432 \cdot V LL$

actual:
$E_A := 7.1 \cdot kV$
LN

12kV/480V
420·kVA rated
$Z_{st} := 0.1 \cdot j \cdot pu$
on transformer
base

$Z_{Load1} := 900 \cdot \Omega \cdot e^{j \cdot 36 \cdot deg}$

$Z_{Load2} := 2 \cdot \Omega$

pf := 1

3. (30 pts) A 60 Hz, 4-pole, 3-phase, Δ-connected, synchronous generator supplies 240 kW of power to a 3.6 kV bus. The synchronous reactance is $50\text{ }\Omega$/phase. The generator emf is 3.8 kV.and the DC field current is 19 A. 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.

e) What does the operator change to get this new E_A, and to what new value.
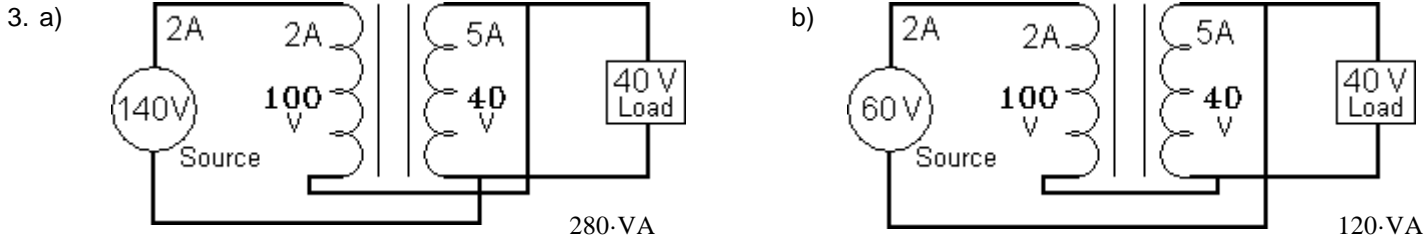   Hint: reread the initial problem statement.

f) Find the new power angle, δ.

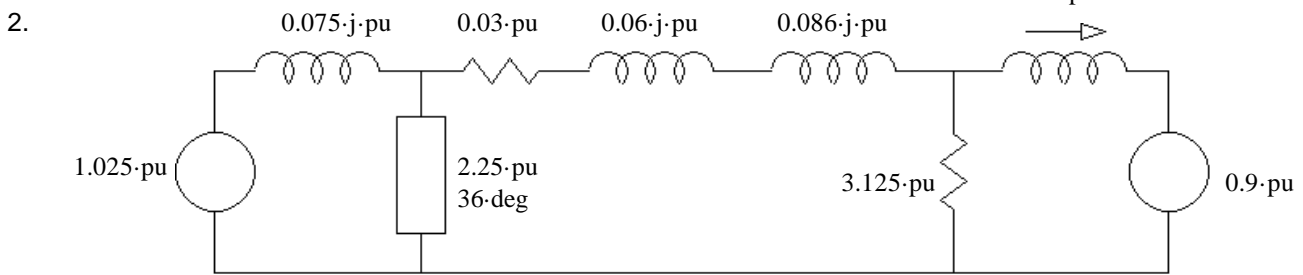g) Find the line current supplied by this generator. $I_L = ?$

_____/ 30

1. Core saturation   2. Winding resistance & I^2R heating

3. a)

280·VA

b)

120·VA

4. $0°$ $\pm 30°$ $\pm 30°$ $0°$ Yes, Δ , to provide a path for the third-harmonic currents.

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

6. $0° < \delta < 90°$ 7. $\dfrac{3600 \cdot rpm}{any\_integer}$

1. a) $4 \cdot A$ $35.78 \cdot V$ $64 \cdot W$ b) $300 \cdot V$ $0.3 \cdot A$ $50 \cdot W$ c) $6.762 \cdot \%$

2.

3. a) $17 \cdot deg$ b) $7.33 \cdot kVAR$ c)

   d) $3.9 \cdot kV$

   e) The operator changes the
      field current to $19.5A$ DC.

   f) $16.55 \cdot deg$

   g) $38.8 \cdot A$