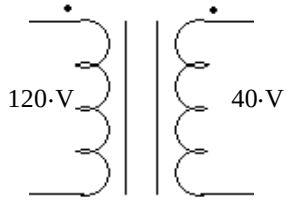
ECE 3600 Exam 2 given: Fall 22 First part, Closed EVERYTHING

Closed book, Closed notes, No colored reference sheets, Calculator OK.

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

1. You have a 120/40-V, 480-VA transformer. Can you use this transformer to transform 120 V to 80 V? If yes, show the connections and compute the new VA rating.



   b) Show the 120-V source and the load.
   c) Could this transformer also be used to transform 90 V to 30 V ? If yes, what is the maximum real power that could be transformed at these voltages?

2. 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%

3. a) When analyzing a power system using the per-unit system, which, if any, of the bases should be constant throughout the system?

   b) 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?

4. a) How many single-phase transformers are required to transform 3-phase power? Give the minimum number.

   b) Show how these single-phase transformers might be connected between the source (shown at left below) and a load (shown at right). Do not create an unbalanced load for the source.

   480V, 3-phase

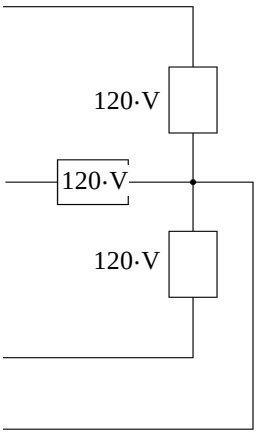
   A _____

   B _____

   Source

   C _____

   N _____



   c) What is the required turns ratio of the transformers you showed above. Since you don't have a calculator, you may show a mathematical expression instead of a number.

1. (25 pts) A 600/100-V, 3-kVA transformer is subjected to an OC test and a SC test with the results below. **E2 F22 p2**

a) Draw a model of this transformer and find the values of all the elements of the model, including the turns ratio.
During the open-circuit test: $I_{OC} := 0.4 \cdot A$ $P_{OC} := 140 \cdot W$ During the short-circuit test: $V_{SC} := 24 \cdot V$ $P_{SC} := 80 \cdot W$

b) The transformer is connected to a primary source voltage of 400V and loaded with $\mathbf{Z_L} := (1.5 + 1 \cdot j) \cdot \Omega$.
(you may add these parts to your drawing if you wish.)
Find the secondary voltage. Magnitude only. $|\mathbf{V_2}|$ = ?

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

2. (36 pts) A $60\ \text{Hz}$, 4-pole, 3-phase Y-connected synchronous generator supplies $90\ \text{kW}$ to a $2.4\ \text{kV}$ bus. The line current generated is $22\ \text{A}$ and lags the generator phase voltage (V_ϕ) by 10.23^o. The synchronous reactance is $30\ \Omega$/phase. The field current is $10\ \text{A}$, DC, and the field flux is directly proportional to this current.
   a) Draw a phasor diagram and find the induced armature voltage (E_A) and the power angle, δ. E_A = ? δ = ?

   b) Find the total reactive power generated.

   c) The mechanical, rotational losses (to overcome mechanical friction) in this generator are: $P_{rot} := 5 \cdot \text{kW}$
   What is the input shaft torque?

   d) The power angle, δ, is changed to 30^o. The field current is NOT changed. What did the operator do to change the power angle? Say what changed and whether it increased or decreased.

   e) Find the power generated now with: $\delta := 30 \cdot \text{deg}$

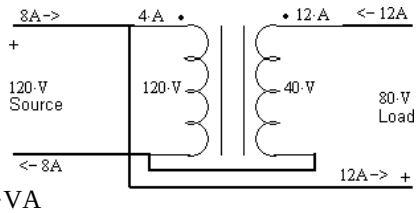
f) Did the reactive power also change? If yes, say whether it increased or decreased. No calculation is required.

g) Find a new DC field current so that the reactive power output returns to that found in part b).

h) Did the power angle change when the field current was changed?
If yes, say whether it increased or decreased. No calculation is required.

Answers

1.



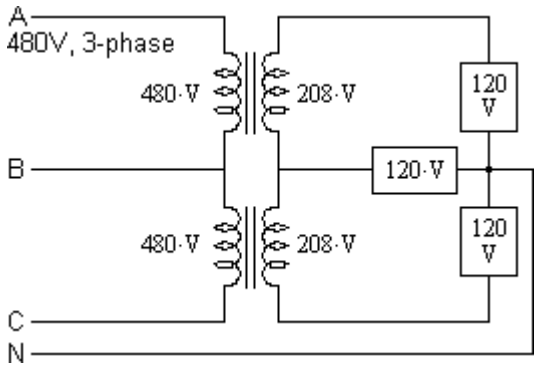
960·VA

c) Normal connections (no autotransformer connections) 360·W

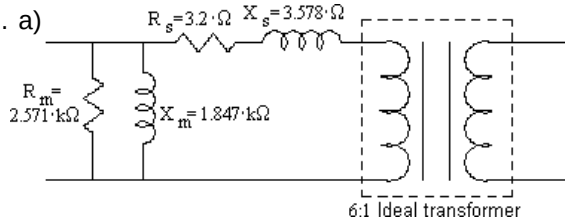
2. a) 3. a) S_{base} b) V_{base} Transformers

4. a) 2 b)

c) $\frac{480 \cdot V}{208 \cdot V}$

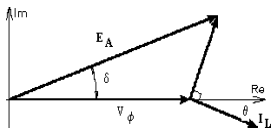


1. a)



b) 62.2·V c) NO, currents too big

2. a)

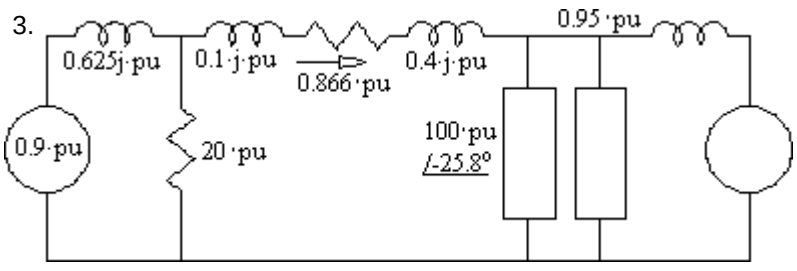


1637·V b) 16.24·kVAR c) 504·N·m
23.37·deg
d) Increased the input torque to the generator.

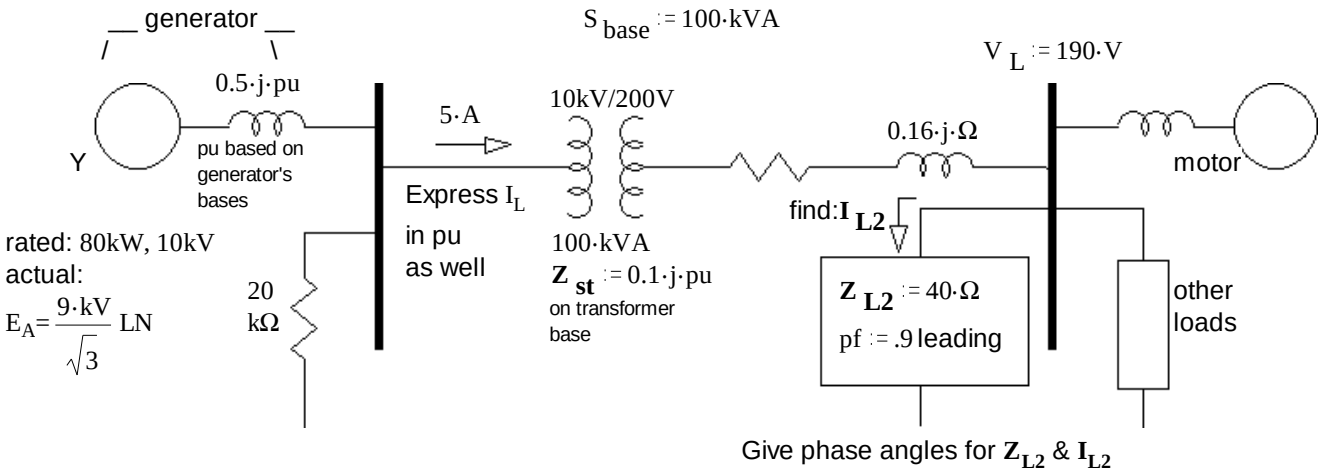
e) 113.4·kW f) decreased

g) 10·45·A h) decreased

3.



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 voltage is line-to-neutral. **ECE 3600 E2 F22 p5**



Answers are on the Bottom of p.4