ECE 3600 Exam 2 given: Spring 25

DO NOT use erasable ink

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

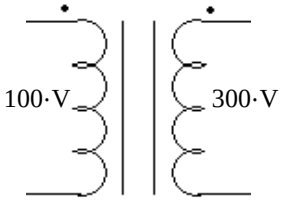
If I can't read what you've written or you answer is ambiguous, I'll assume you don't know.

(14 pts) Questions

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%

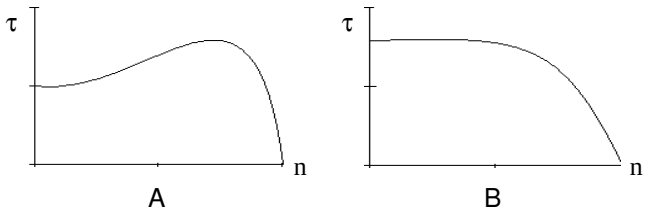
2. You have a 100/300-V, 600-VA transformer. Can you use this transformer to transform 200 V to 300 V? If yes, show the connections and compute the new VA rating.



3. 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?

4. a) The torque-speed curves of 2 induction motors (A and B) are shown at right. Only one equivalent circuit parameter is different between the two. What is it?



   b) This parameter is bigger in which motor?

   c) The starting current is bigger in which motor?

1. (36 pts) A $60\ \text{Hz}$, 6-pole, 3-phase Y-connected synchronous generator supplies $96\ \text{kW}$ to a $3\ \text{kV}$ bus. The line current generated is $19\ \text{A}$ and lags the generator phase voltage (V_ϕ) by 13.5^o. The synchronous reactance is $24\ \Omega$/phase. The field current is $10\ \text{A}$, DC, and the field flux is directly proportional to this current. **Exam 2 Sp 25 p2**

   a) Draw a phasor diagram and find the induced armature voltage (E_A) and the power angle, δ. $E_A = ?$ $\delta = ?$

   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?

1. continued d) The power angle, δ, is changed to 25^{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. **Exam 2 Sp 25 p3**

e) Find the power generated now with: $\delta := 25 \cdot \text{deg}$

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) Find the power angle.

2. (30 pts) A 3-phase, Δ-connected, induction motor has the following equivalent circuit components:

$R_1 := 0.2\cdot\Omega$ $R_2 := 0.5\cdot\Omega$ $R_C := \infty$

$X_1 := 0.4\cdot\Omega$ $X_2 := 0.6\cdot\Omega$ $X_M := 15\cdot\Omega$

currently running at $n := 1720\cdot rpm$

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 output shaft torque is $\tau_{load} := 60\cdot N\cdot m$ Find the output power

d) The mechanical power losses (all lumped together) is $P_{mech\_loss} := 400\cdot W$ Find P_{conv}

e) Find $|\mathbf{I}_2|$

2. continued f) Find the line current. $|\mathbf{I_L}|$ = ? Note: Don't try any shortcuts here. You need to do your math with full complex numbers. I advise you to assume the phase angle of $\mathbf{I_2}$ is 0°.

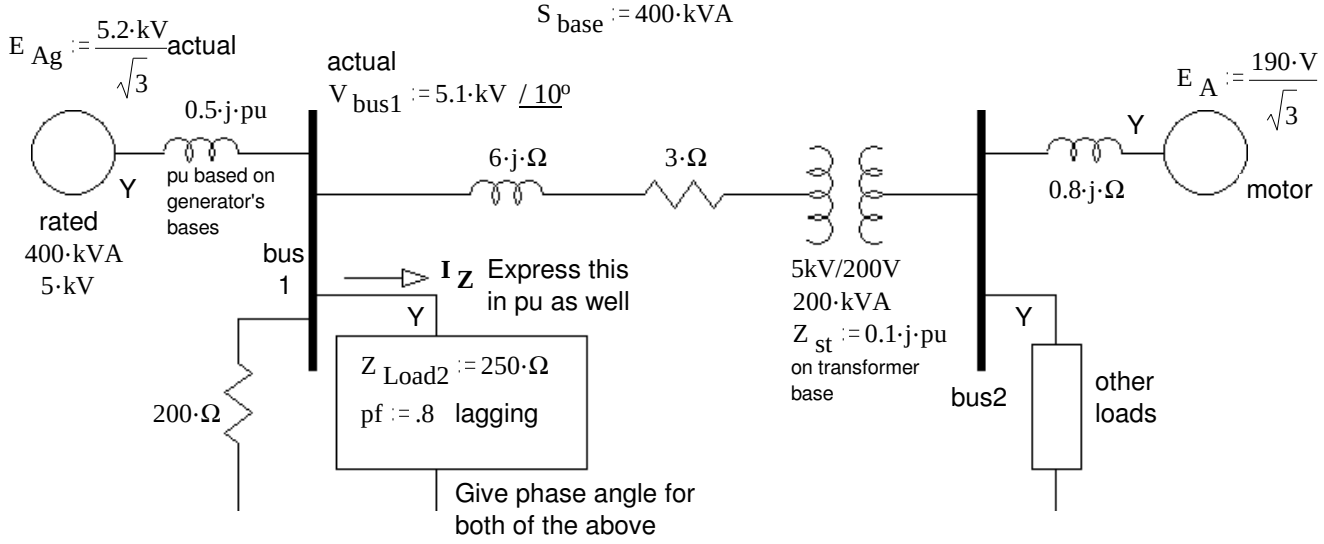
g) Find P_{RCL}

h) The stator copper losses P_{SCL}

i) The overall machine efficiency η

3. (20 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.

Exam 2 Sp 25 p6



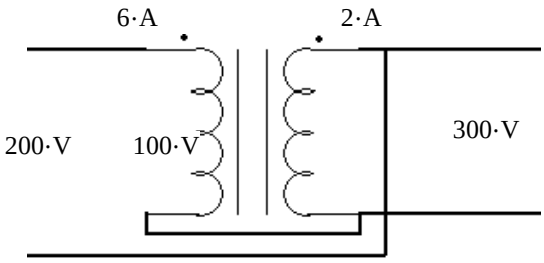
b) Find the actual $\mathbf{I_Z}$ in amps.

Prob 3 _____/ 20

Questions _____ / 14 Total _____/ 100

Answers

1. a) 2.



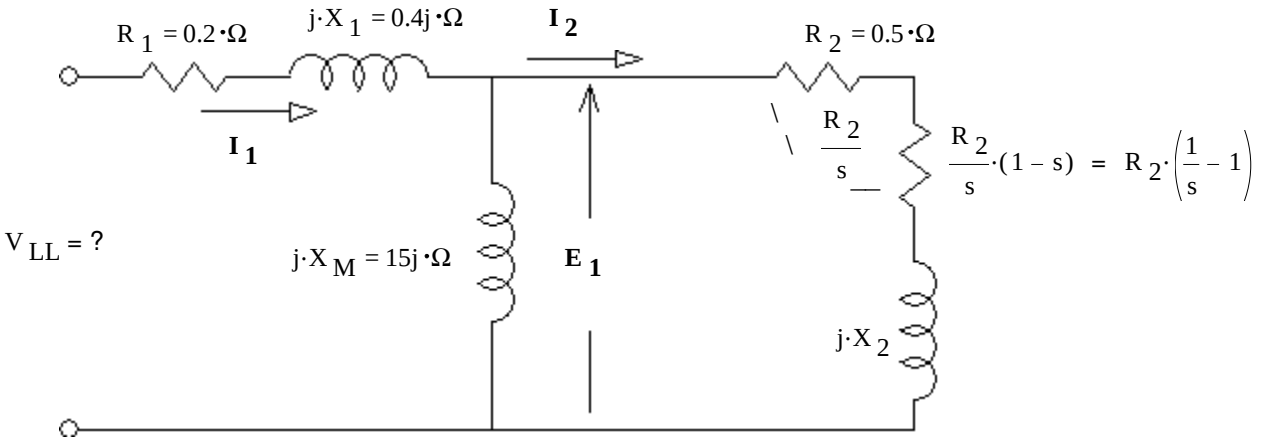
3. Yes, Δ, to reduce third-harmonic currents.

4. a) R_2 or rotor resistance b) B c) A

Problems. open note sheets

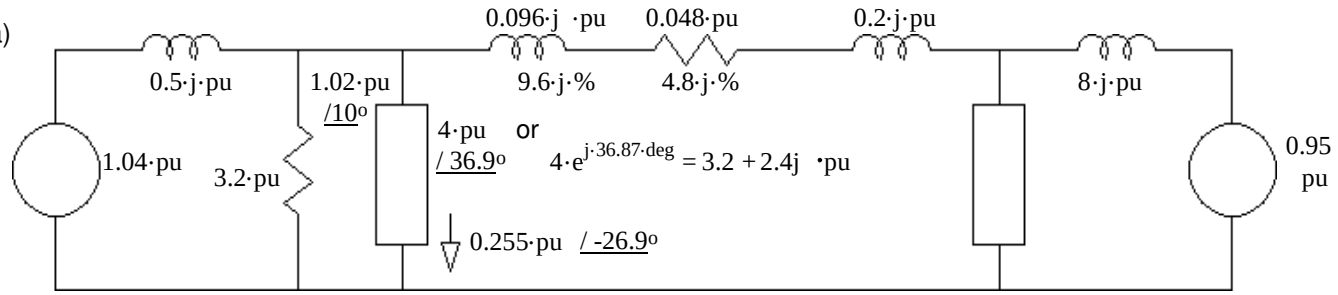
1. a) 13.56·deg b) 23.04·kVAR c) 803.7·N·m d) Increased the input torque to the generator. e) 173.·kW
   f) decreased g) 10.6·A h) 23.5·deg

2. a)



b) 0.04444 c) 10.81·kW d) 11.21·kW e) 18.64·A f) 41.40·A g) 521.3·W h) 342.8·W i) 89.53·%

3. a)



b) 11.78·A /-26.9°