ECE 3600 Homework 4 Due: Sat, 1/27/24 c

Note: All voltages and currents are always assumed to be RMS unless said to be otherwise.

1. The following are questions from p 78 of the textbook. These could be good closed-book exam questions.

   a) 2.1. What types of connections are possible for three-phase generators and loads?

   b) 2.2. What is meant by the term “balanced” in a balanced three-phase system?

   c) 2.3. What is the relationship between phase and line voltages and currents for a wye (Y) connection?

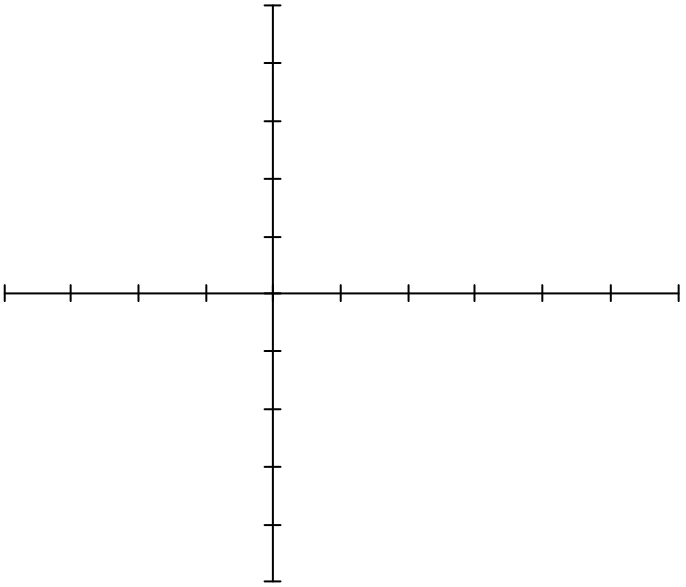
   d) 2.4. What is the relationship between phase and line voltages and currents for a delta (Δ) connection?

   e) 2.5. What are the two phase sequences?

   f) 2.7. What is a Y-Δ transform?

2. Textbook 2-1. Three impedances of $4 + j3\ \Omega$ are Δ-connected and tied to a three-phase 208-V power line. Find I_ϕ, I_L, P, Q, S (|S|), and the power factor of this load.

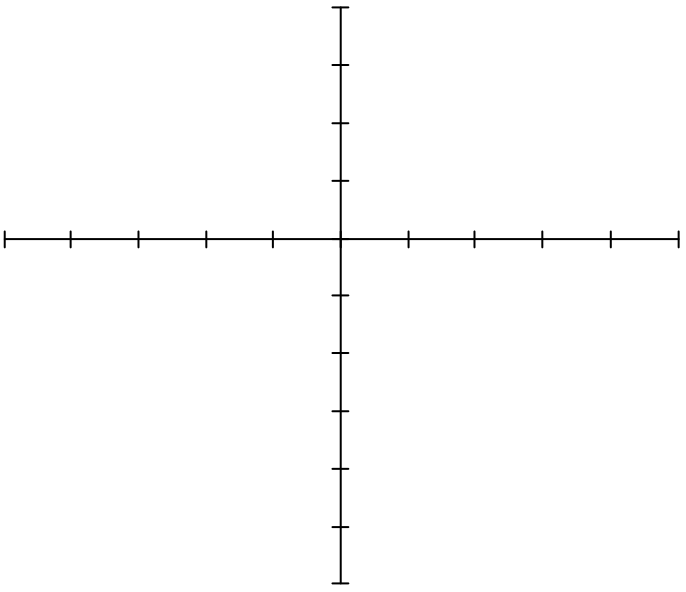
3. a) A balanced three-phase 480-V source (three line-to-neutral voltages of $277\ \text{V}$) supplies a balanced three-phase inductive load. The load draws a total of $9\ \text{kW}$ at a power factor of 0.9. Calculate the phase currents and the magnitude of the per-phase load impedances, assuming a Y-connected load. Draw a phasor diagram showing all three voltages and currents, assume V_a is 0^0.



b) In order to correct the power factor, three capacitors are connected in parallel with the load impedances. $\omega := 377 \cdot \frac{\text{rad}}{\text{sec}}$ Find the value of the capacitors.

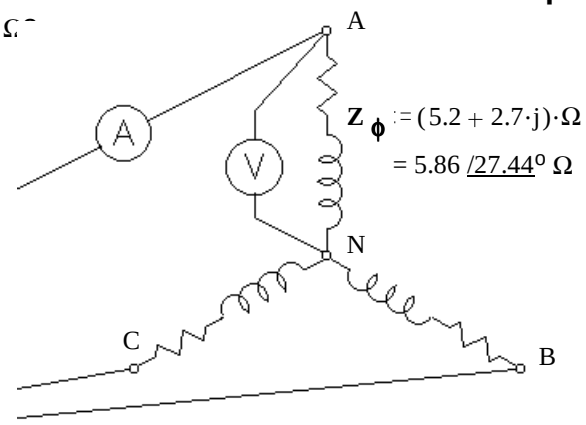
4. Repeat problem 3, assuming a delta-connected load. Make sure you are clear about the phase angle of $\mathbf{I_{ab}}$.

a)



b)

5. The voltmeter shown measures 120 V. Let this voltage be the phase reference (0^o). The phase impedance is $\mathbf{Z}_\phi = 5.2 + j2.7 = 5.86 \angle 27.44^o\ \Omega$



$\mathbf{Z}_\phi := (5.2 + 2.7 \cdot j) \cdot \Omega$

$= 5.86 \angle 27.44^o\ \Omega$

a) What is $\mathbf{V}_{AB}$ as a phasor?

b) What would the ammeter measure?

c) What is the apparent power?

d) What is the real power?

e) Correct the power factor with capacitors connected in a delta configuration, that is, find the value of the capacitors.

$\omega := 377 \cdot \frac{rad}{sec}$

6. Three 230-V generators are connected in a wye configuration to generate three-phase power. The load consists of three balanced delta-connected impedances of $\mathbf{Z_L} = 3.8 + j1.5\ \Omega$.

a) An ammeter is placed in one line, what would it measure?

b) Find the total apparent power.

c) Find the total real power consumed by the load.

d) What is the phase angle between $\mathbf{I_A}$ and $\mathbf{V_{AB}}$, assuming ABC rotation?

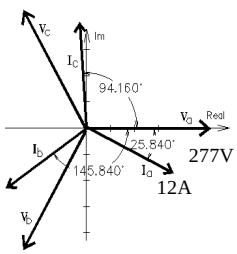
Answers

1. a) 2.1. Y & Δ b) 2.2. The 3 voltages are equal, the 3 currents are equal and the 3 loads are equal.

c) 2.3. $V_\phi = \frac{V_{LL}}{\sqrt{3}} = \frac{V_L}{\sqrt{3}}$ $I_\phi = I_L$ d) 2.4. $V_\phi = V_{LL} = V_L$ $I_\phi = \frac{I_L}{\sqrt{3}}$

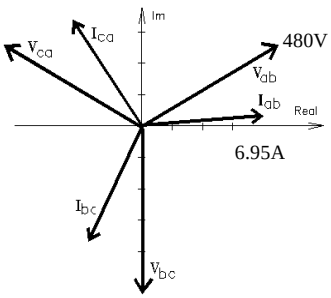
e) 2.5. abc or acb f) 2.7. $\mathbf{Z_Y} = \frac{\mathbf{Z_\Delta}}{3}$ 2. 41.6A·A 72.1·A 20.8·kW 15.6·kVAR 26.0·kVA

3. 12·A lagging by 25.8° 23·Ω



b) 50.2·μF

4. 6.95A /4.16° 69.1·Ω



b) 16.7·μF

5. a) $208 \cdot V \cdot e^{j \cdot 30 \cdot deg}$ b) 20.5·A c) 7.37·kVA d) 6.54·kW e) 69.5·μF

6. 168·A 117·kVA 108·kW - 51.541 °