ECE 3600 homework # 5

c

1. A 3-phase circuit is connected as shown.
   Find the following:

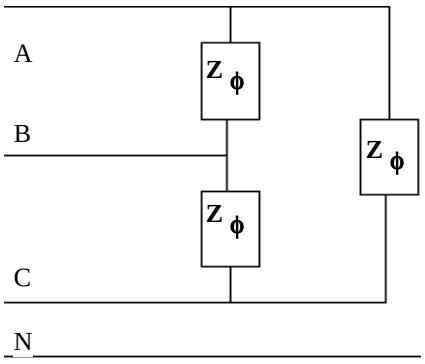
   a) The load power factor, assume lagging.
   b) The line current.
   c) The phase impedance, $\mathbf{Z}_{\phi}$
   d) The value of Y-connected impedances that would result in exactly the same line currents and same pf.
   e) The reactive power of each $\mathbf{Z}_{\phi}$
   f) Correct the power factor with capacitors connected in a wye configuration. $\omega := 377 \cdot \frac{rad}{sec}$

3ϕ source

$P_{3\phi} := 18 \cdot kW$

$S_{3\phi} := 21 \cdot kVA$

$V_S := 520 \cdot V$



2. For the three-phase circuit shown, the R_{line} resistors represent the resistance of the distribution system. Find the following:

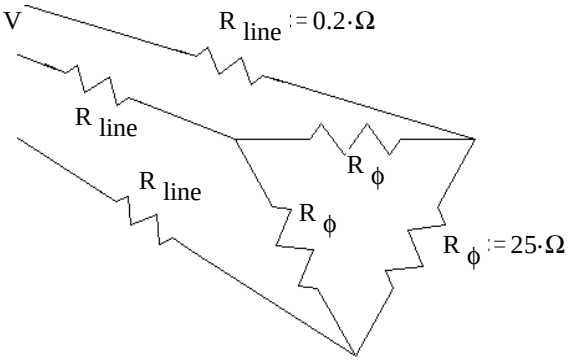
   a) Total power out of the source, including line and load.
   b) Line losses.
   c) Distribution system efficiency.

$V_S := 480 \cdot V$

3ϕ source

$R_{line} := 0.2 \cdot \Omega$

$R_{\phi} := 25 \cdot \Omega$



3. Textbook 2-6, modified
   The figure below shows a one-line diagram of a small 480-V distribution system in an industrial plant. For parts a) and b), assume all the lines have zero impedance.

   a) With the switch open, find all the real, reactive and apparent powers in the system. (For the apparent power, just the total will be sufficient.) Find the total current supplied to the distribution system from the utility company (I_L).
   b) Repeat a) with the switch closed.
   c) What happened to the total current supplied by the utility when the switch closed? Why?

$V_T := 480 \cdot V$

Utility Company I_L

Load 1

Delta Connected

$Z_{\phi 1} := 10 \cdot \Omega \cdot e^{j \cdot 30 \cdot deg}$

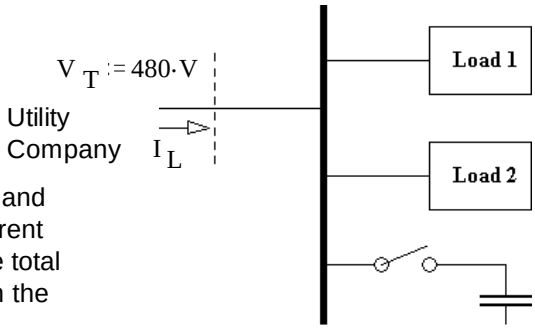
Load 2

Wye Connected

$Z_{\phi 2} := 4 \cdot \Omega \cdot e^{j \cdot 36.87 \cdot deg}$

Wye Connected

$Z_{\phi} := 5 \cdot \Omega \cdot e^{-j \cdot 90 \cdot deg}$



   For the two parts below, assume the source voltage is adjusted so that the bus voltage at the plant remains 480V and the lines from the utility each have an impedance of $\mathbf{Z_{line}}$.

   d) With the switch open, find the magnitude of the source voltage and the efficiency of the system.
   e) With the switch closed, find the magnitude of the source voltage and the efficiency of the system.

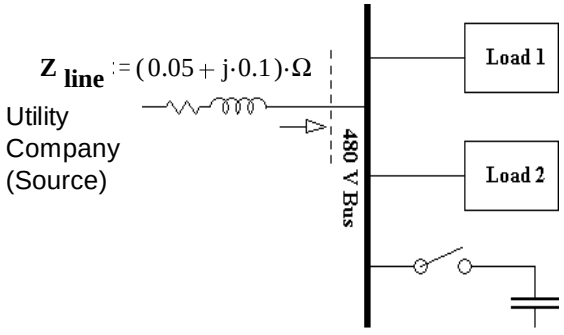
$Z_{line} := (0.05 + j \cdot 0.1) \cdot \Omega$

Utility Company (Source)

480 V Bus

Load 1

Load 2



Answers

1. a) 0.857
   b) 23.3·A
   c) 38.6·Ω ∠ 31·deg
   d) 12.9·Ω ∠ 31·deg
   e) 3.61·kVAR
   f) 106·μF

2. a) 27·kW
   b) 632.8·W
   c) 97.7%

3. a) 59.86·kW
   34.56·kVAR
   46.04·kW
   34.53·kVAR
   input:
   105.9·kW
   69.09·kVAR
   126.4·kVA
   152·A

   b) Loads 1 & 2 are the same
   Caps
   0·W -46.06·kVAR
   input:
   105.9·kW
   23.03·kVAR
   108.4·kVA
   130.4·A

   c) Current is less by more than 20A because caps supply most of the VARs to loads 1 & 2.
   d) 505.4·V 96.8·%
   e) 496.0·V 97.6·%

ECE 3600 homework # 5