Name_____ ECE 3600 Homework 5 3 Phase   Due: Sat, 1/25/25   a
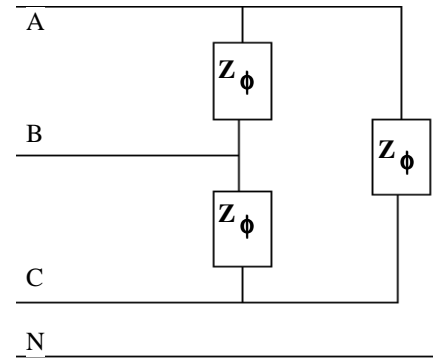
1. A 3-phase circuit is connected as shown. Find the following:

  a) The load power factor, assume lagging.

3φ source

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

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

$V_S := 520 \cdot V$

Always assumed to be V_{LL}

  b) The line current.

  c) The value of Y-connected impedances that would result in exactly the same line currents and same pf. $\mathbf{Z_Y}$
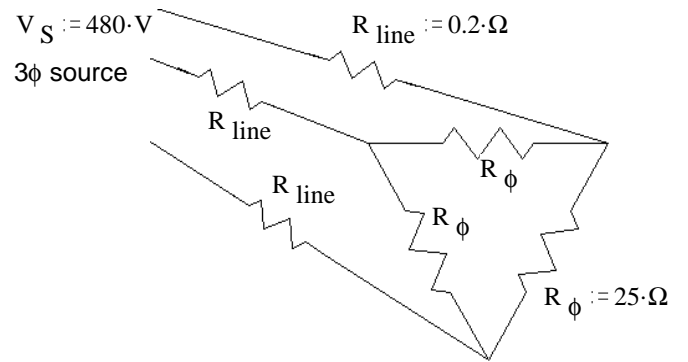
  d) The phase impedance, $\mathbf{Z_\phi}$

  e) The reactive power of each $\mathbf{Z_\phi}$

  f) Correct the power factor with capacitors connected in a wye configuration.

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2. For the three-phase circuit shown, the R_{line} resistors
represent the resistance of the distribution system.
Find the following:
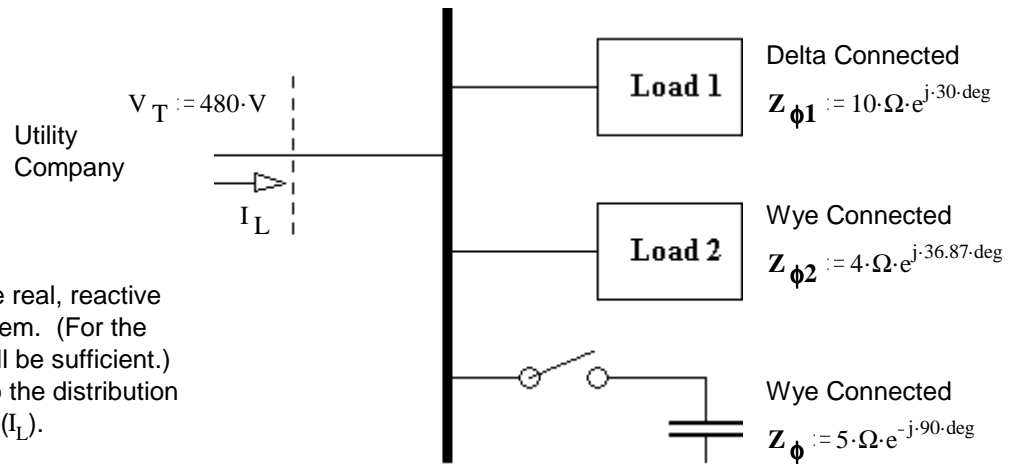a) Total power out of the source, including line and load.

$V_S := 480 \cdot V$

3ϕ source

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

R_{line}

R_{line}

R_ϕ

R_ϕ

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

b) Line losses.

c) Distribution system efficiency. η =

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3. Textbook 2-6, modified.
The figure 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).

$V_T := 480 \cdot V$

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

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

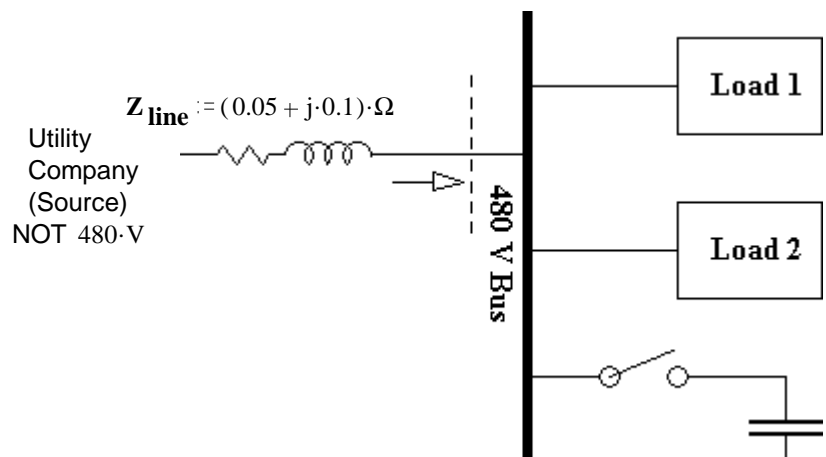b) Repeat a) with the switch closed.

c) What happened to the total current supplied by the utility when the switch closed? Why?

   Current is less by more than $20A$ because caps supply most of the VARs to loads 1 & 2.

d) and e) New configuration.
For the parts d) and e) below, the lines
from the utility each have an impedance
of $\mathbf{Z_{line}}$. Assume the source voltage is
adjusted so that the bus voltage at the
plant remains $480V$. (This makes it
possible to use most of the numbers
you've already calculated.)

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

Utility
Company
(Source)
NOT $480 \cdot V$

Load 1

480 V Bus

Load 2

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.

Answers

1. a) 0.857
   b) 23.3·A
   c) 12.9·Ω $\underline{/\,}$ 31·deg
   d) 38.6·Ω $\underline{/\,}$ 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·%