COLORADO SCHOOL OF MINES DEPARTMENT OF ELECTRICAL ENGINEERING

EENG 577

M1-A2 Assignment KEY

Question 1. A load absorbs 1 kW of average power at a power factor of 0.91 lagging. Determine the complex power delivered to the load.

a) 1000 ∠0° VA

b) 1099 ∠24.5° VA

c) 1099 ∠–24.5° VA

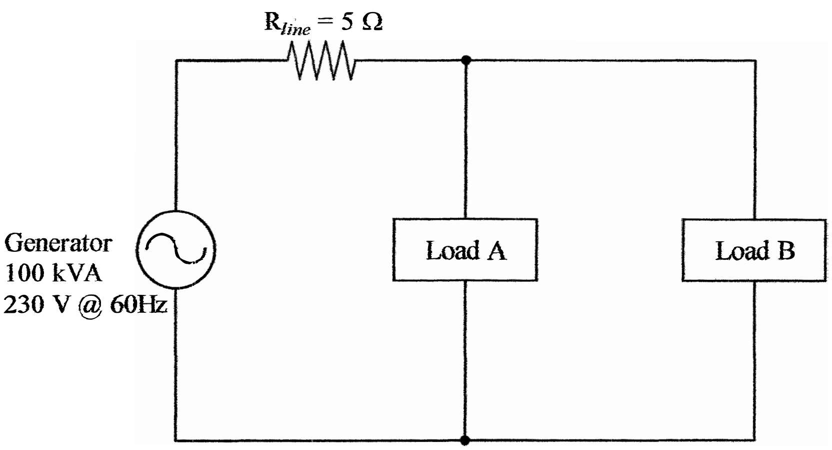
d) 910 ∠–24.5° VA

e) 1000 ∠32° VA

$\theta = \cos^{-1}(0.91) = 24.5°$

$S = \frac{P}{pf} = \frac{1kW}{0.91} = 1099\ VA$

Question 2. The generator supplies power to the two induction motors as shown in the circuit below. Determine the total reactive power supplied by the generator.



Load A: 50 kW
PF = 0.8 lagging

Load B: 5 kW
PF = 0.7 lagging

a) 37.5 kVAR

b) 42.6 kVAR

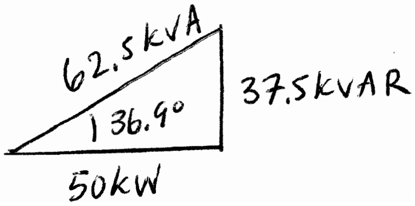
c) 5.10 kVAR

d) 0 kVAR

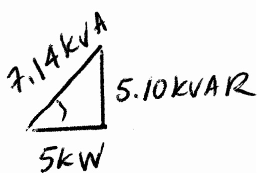
e) 69.64 kVAR

Using Power Triangles

Load A



Load B



$Q_{TOTAL} = (37.5 + 5.10)\ kVAR$

$= 42.6\ kVAR$

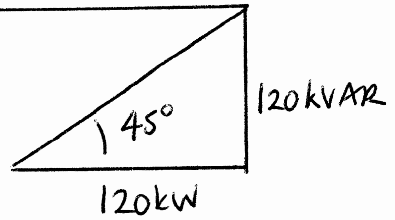
Question 3. An industrial load consumes 120 kW at a power factor of 0.707 lagging and is connected to a 480 ∠0° Vrms, 60 Hz line. Determine the value of the capacitor that, when connected in parallel with the load, will improve the power factor to 0.95 lagging.

a) 624 µF   b) 763 µF   c) 928 µF

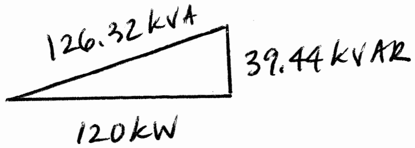
d) 471 µF   e) none of the above

$Q_C = -\omega C V^2$

Before correction



After correction



$Q_C = 39.44\ \text{kVAR} - 120\ \text{kVAR} = -80.59\ \text{kVAR}$

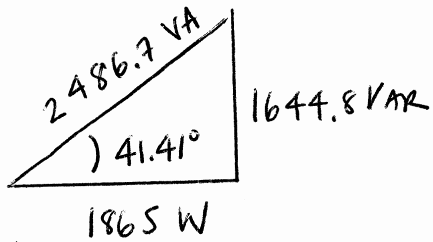
$C = \dfrac{80.59\ \text{kVAR}}{377\,(480\text{V})^2} = 928\ \mu\text{F}$

Question 4. A 2½ hp, 220∠0° Vrms, 60 Hz, single-phase induction motor operates at a power factor of 0.75 lagging. Assuming that the motor is 100% efficient, the rms motor current is most nearly. (1 hp = 746 W)

a) 8.5∠−41.4° Arms   b) 8.5∠41.4° Arms   c) 11.3∠−41.4° Arms

d) 11.3∠41.4° Arms   e) None of the above

$2.5\text{hp}\,(746\ \text{W/hp}) = 1865\text{W}$



$\underline{S} = \underline{V}\,\underline{I}^*$

$2486.7\angle 41.41°\ \text{VA} = 220\angle 0\ \underline{I}^*$

$\underline{I}^* = 11.3\angle 41.41°\ \text{A}$

$\underline{I} = 11.3\angle -41.4°\ \text{A}$

Question 5. If a 120-V, 60-Hz sinusoidal source is applied to an ideal capacitor, determine the average power (P).

a) a positive quantity

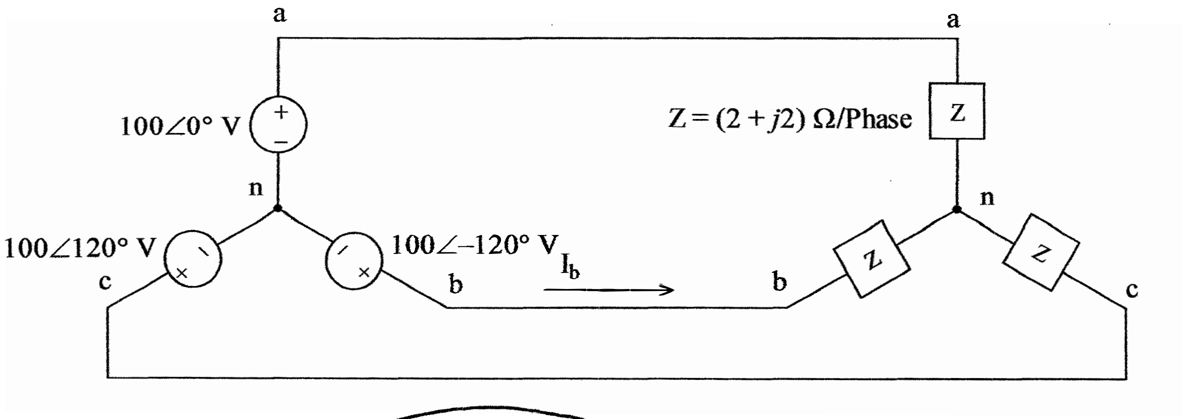
b) a negative quantity

c) 120 VAR

d) −120 VAR

e) zero

Question 6. Determine the line current I_b in the balanced Y-connected system shown below.



a) 20.6 ∠−90° A

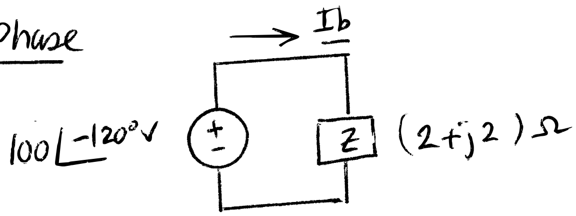
b) 35.3 ∠−165° A

c) 35.3 ∠−75° A

d) 15.1 ∠−150° A

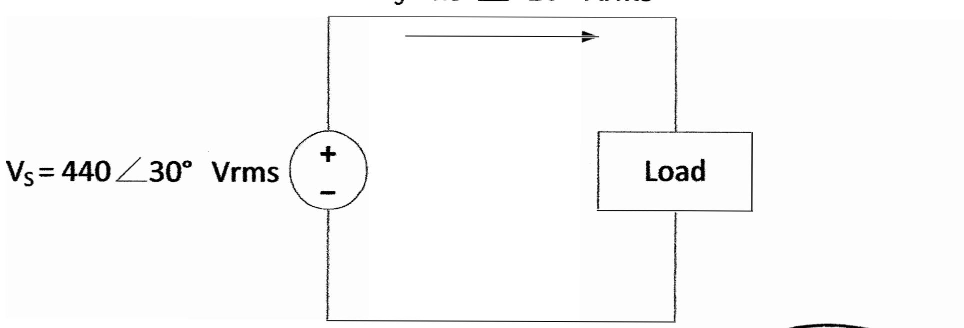
e) 15.1 ∠−90° A

Per Phase



$$I_b = \frac{100\angle -120^\circ \text{ V}}{(2+j2)\,\Omega} = 35.36\angle -165^\circ \text{ A}$$

Question 8. Determine the complex power delivered by the source in the circuit shown below.



a) 11∠20° kVA

b) 11∠−40° kVA

c) 11∠40° kVA

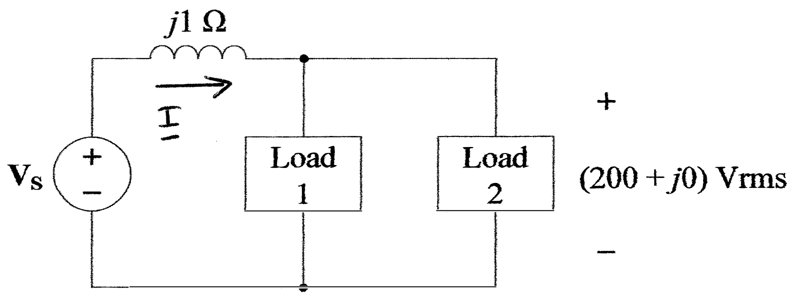
d) (20.7 + j7.52) kVA

e) None of the above

$$S = V I^* = 440\angle 30^\circ \text{ V } (25\angle 10^\circ \text{ A})$$

$$= 11\angle 40^\circ \text{ kVA}$$

Question 7. Find the phasor voltage V_S (rms) in the circuit shown below if loads L_1 and L_2 are absorbing 15 kVA at 0.6 pf lagging and 6 kVA at 0.8 pf leading, respectively.



Load 1

$\underline{S_1} = 15\angle 53.13°\ kVA$

Load 2

$\underline{S_2} = 6\angle -36.87°\ kVA$

Total Load

$\underline{S_T} = \underline{S_1} + \underline{S_2} = 16.16\angle 31.33°\ kVA$

$\underline{S_T} = \underline{V}\,\underline{I}^*$

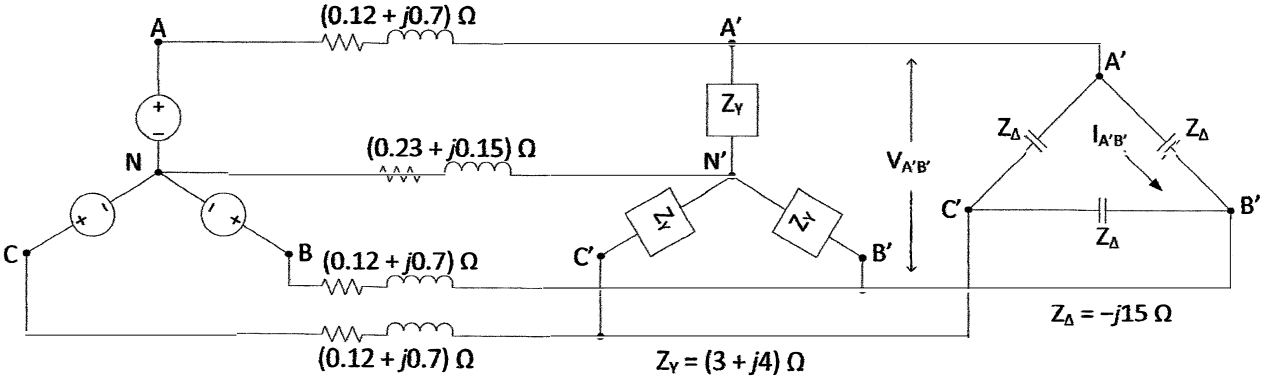
$$\underline{I}^* = \frac{16.16\angle 31.33°\ kVA}{200\angle 0°\ V} = 80.8\angle 31.33°\ A$$

$\underline{I} = 80.8\angle -31.33°\ A$

$\underline{V_S} = 200\angle 0°\ V + j1\Omega(80.8\angle -31.33°\ A)$

$= \underline{251.65\angle 15.91°\ V}$

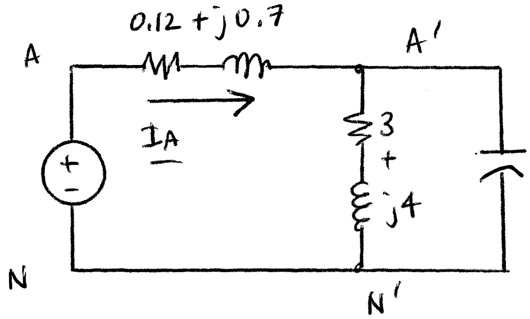
Question 8. Consider the balanced three-phase system shown below. The magnitude of the generator line-to-line voltage is 480 Volts. Using the generator phase voltage (V_{AN}) as the reference, determine the phasor value of the line voltage across the parallel loads ($V_{A'B'}$). Assume a positive phase sequence.



Per Phase Equivalent

$\frac{480\angle 30}{\sqrt{3}\angle 30^\circ}$

$277\angle 0^\circ$ V



$Z_Y = \frac{Z_\Delta}{3}$

$\frac{-j15}{3} = -j5\ \Omega$

$Z_{eq} = (3+j4) \,//\, -j5$

$= 7.5 - j2.5$

Voltage Division

$Z_T = Z_{eq} + Z_{line} = (7.62 - j1.80)\ \Omega$

$V_{A'N'} - \frac{277\angle 0^\circ \text{V}\ (7.5 - j2.5)}{7.62 - j1.8} = 279.7\angle -5.14^\circ$ V

$V_{A'B'} = 279.7\angle -5.14^\circ \text{V}\ (\sqrt{3}\angle 30^\circ)$

$= 484.4\angle 24.86^\circ$ V