Name KEY

E-mail ______________________

EE 4221

Hour Exam 1

October 5, 2017

Directions:

1. DO NOT START until told to do so.

2. There are 4 problems in this examination. All problems are equal valued.

3. The correct answer is a necessary but not sufficient condition to receive full credit for a problem. You MUST show you work! Disorderly or illegible work cannot and thus will not be graded.

4. The exam is "closed notes/closed book". You are however allowed use of an 8.5" x 11.0" formula sheet of your own design as a reference during the exam.

5. The exam duration is 70 (seventy) minutes.

1. A single phase load is supplied by a sinusoidal voltage $v(t) = 200\cos(377t)$V. The resulting instantaneous power is $p(t) = 800 + 1000\cos(754t - 36.87°)$W. Determine:

a) The average real power consumed by the load.

$P = 800\,W$

b) The reactive power associated with the load.

$Q = -600\,VAR$

c) A **time domain** expression for the current flowing through the load

$$I = \left(\frac{S}{V_{RMS}}\right)^* \left(\frac{1000\angle 36.87}{\frac{200}{\sqrt{2}}\angle 0°}\right)^* = \sqrt{25}\angle 36.87\ A_{RMS}$$

$$10\cos(754t + 36.87°)\ A$$

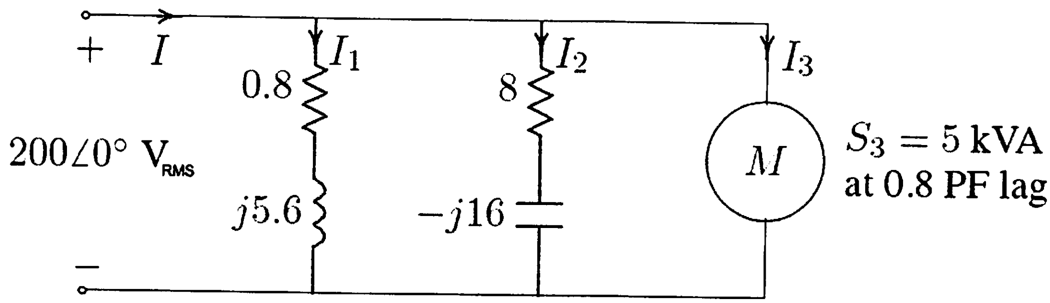
d) The value of the load impedance

$$\frac{200\angle 0°}{10\angle 36.87} = 20\angle -36.87° = 16 - j12\ \Omega$$

doe $|I_{RMS}|^2 \cdot R = P$ $\quad (\sqrt{25})^2 \cdot 16 = 800\,W$ $\quad$ YES!

$|I_{RMS}|^2 \cdot X_L = Q$ $\quad (\sqrt{25})^2 \cdot -12 = -600\,VAR$

2. Two impedances, Z1 = 0.8 + j5.6Ω and Z2 = 8.0 - j16.0Ω and a single phase motor are connected in parallel with a 200VRMS, 60 Hz supply as shown below. The motor draws 5kVA at a p.f. of 0.8 lagging. Determine:



a) The composite power triangle that represents the total combined load.

$1000 + j\,7000$

$I_1 = \dfrac{200}{.8 + j5.6} = 35.36\angle -81.87$

$S_1 = 200 \times 35.36\angle +81.87 = 7071.07\angle 81.87$

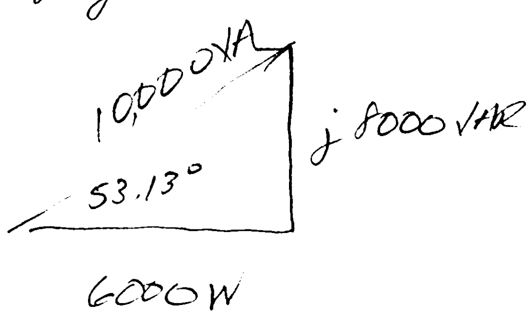
$I_2 = \dfrac{200}{8 - j16} = 11.18\angle 63.43°$

$= 2236.07\angle -63.43$

$1000 - j2000$

$S_3 = 5000\angle 37.87$

$4000 + j3000$



b) the value of a single paralleled capacitor (in Farads) that when added to the system would improve the overall power factor to unity.

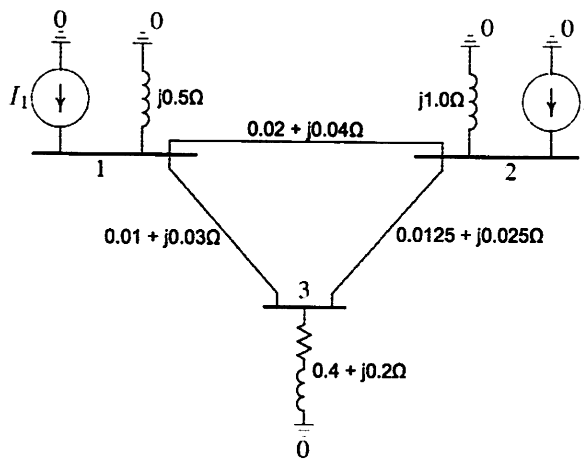
$Q_{cap} = -8000\text{VAR}$ for unity pf $= \dfrac{V_{rms}^2}{X_C}$

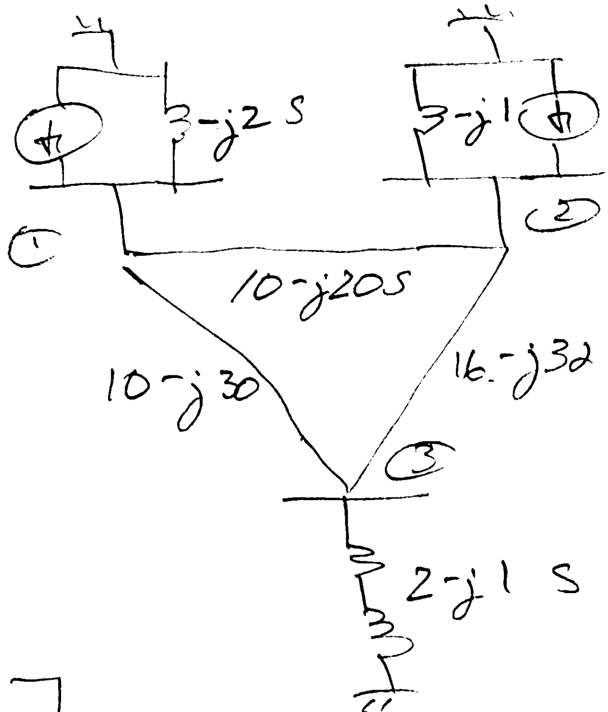
$X_C = \dfrac{200^2}{8000} = 5 = \dfrac{1}{\omega C}$; $C = \dfrac{1}{2\pi(60)\times 5}$

$= 530.5\,\mu F$

3. The **impedance diagram** for a three bus power system is shown below. The impedance of the transmission lines that interconnect the busses is also noted.

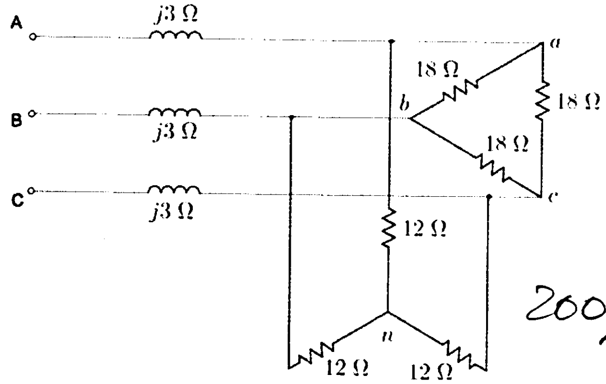
Construct the **admittance diagram** for the circuit and determine the Ybus matrix that could be used to solve for the bus voltages in the system.



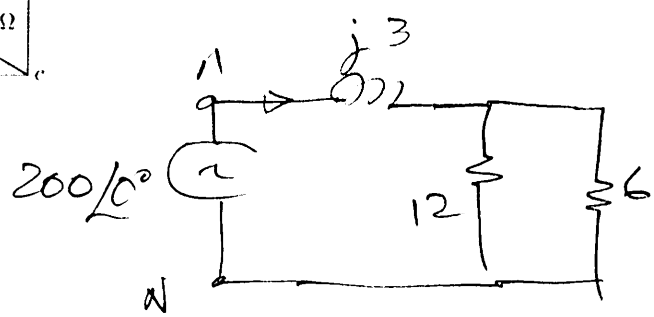


$$\begin{bmatrix} 20-j52 & -10+j20 & -10+j30 \\ -10+j20 & 26-j53 & -16+j32 \\ -10+j30 & -16+j32 & 28-j63 \end{bmatrix} = Y_{BUS}$$

4. An A-B-C positive phase sequence 60Hz three phase generator feeds a paralleled wye / delta load through a transmission line with impedance (z line = j3.0 Ω). Given the voltage between the A and B lines at the generator, $V_{AB} = 346.41\angle 30^\circ$ V $_{RMS}$ determine:



$Z_{eq} = \frac{Z_\Delta}{3} = 6\Omega$



a). The total apparent power supplied by the three phase source.

$$\bar{I}_S = \frac{200\angle 0^\circ}{4+j3} = 40\angle -36.87^\circ$$

$$S_{a\phi} = \bar{V}_{AN}\,\bar{I}_S^* = 200\angle 0 \times 40\angle 36.87 = 8000\angle 36.87^\circ$$

$$S_T = 3S_\phi = 24{,}000\angle 36.87^\circ \text{ VA}$$

b). The load side line voltage Vab

$$\bar{V}_{an} = \bar{V}_{AN} - j3\bar{I}_S = 200\angle 0^\circ - (j3)(40\angle -36.87^\circ)$$

$$= 160\angle -36.87$$

$$V_{ab} = \sqrt{3}\,160\angle -36.87 + 30^\circ = 277.13\angle -6.87^\circ$$