國立臺灣科技大學答案卷

National Taiwan University of Science and Technology Answer Sheet

評分 Score	教師簽章 Signature of Lecturer
91	

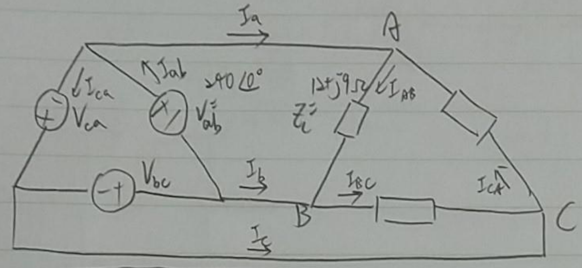
姓名/Name ______ 學號/Student ID ______ 班級/Class ______

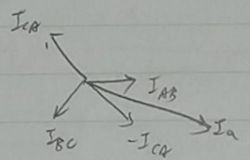
科目/Course title 電路學　　日期/Date 112.5.12

記分欄　從此處開始寫起。試卷用紙務須節用，非經主試認可不得續用其他紙張作答。/Please write from here.

1.

20





I_p

$I_{ab} = I_{AB} = \frac{240\angle 0^\circ}{12+j9} = \boxed{16\angle -36.87^\circ \text{ A}}$

$I_{bc} = I_{BC} = I_{AB}\angle -120^\circ = \boxed{16\angle -156.87^\circ \text{ A}}$

$I_{ca} = I_{CA} = I_{AB}\angle +120^\circ = \boxed{16\angle 83.13^\circ \text{ A}}$

#1(b)

$I_a + I_{CA} = I_{AB}$

I_L

$\Rightarrow I_a = I_{AB} - I_{CA} = \sqrt{3}\, I_{AB}\angle -30^\circ = 16\sqrt{3}\angle -66.87^\circ = \boxed{27.71\angle -66.87^\circ \text{ A}}$

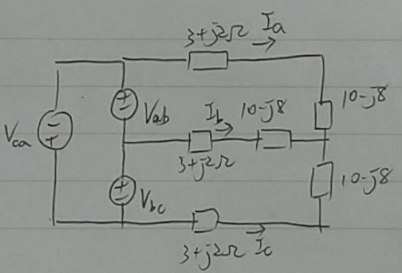
$I_b = I_a\angle -120^\circ = 27.71\angle -186.87^\circ = \boxed{27.71\angle 173.13^\circ \text{ A}}$

$I_c = I_a\angle +120^\circ = \boxed{27.71\angle 53.13^\circ \text{ A}}$

#1(a)

2.

20



$V_{ab} = 440\angle 10^\circ$

$V_{bc} = 440\angle -110^\circ$

$V_{ca} = 440\angle 130^\circ$

$\Rightarrow$

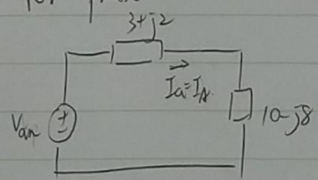
$V_{an} = \frac{V_{ab}}{\sqrt{3}}\angle -30^\circ = 254.0\angle -20^\circ$

$V_{bn} = 254.0\angle -140^\circ$

$V_{cn} = 254.0\angle 100^\circ$

⇓

Per phase:



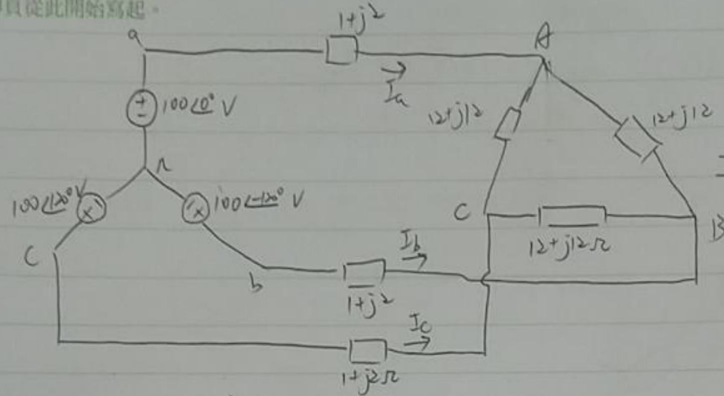
$I_a = \frac{V_{an}}{3+j2+10-j8} = \boxed{17.74\angle 4.775^\circ \text{ A}}$

$I_b = I_a\angle -120^\circ = \boxed{17.74\angle -115.225^\circ \text{ A}}$

$I_c = I_a\angle +120^\circ = \boxed{17.74\angle 124.775^\circ \text{ A}}$

#2

3



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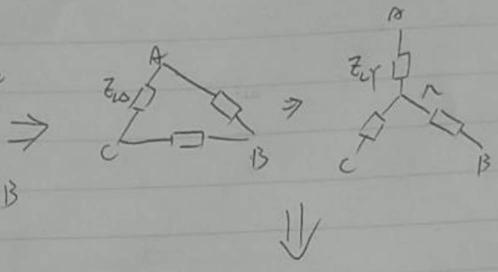
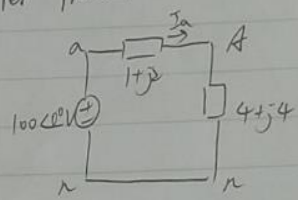


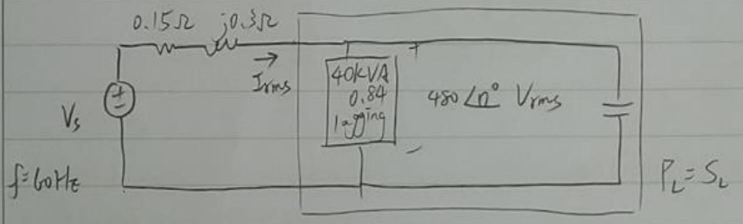
Per Phase:



$$Z_{LY} = \frac{(12+j12)^2}{\cancel{(12+j12)}\cdot 3} = 4+j4$$

$$I_L \quad \begin{aligned} \boxed{I_a} &= \frac{100\angle 0°}{1+j2+4+j4} = \boxed{12.80\angle -50.19°\ A} \\ \boxed{I_b} &= I_a\angle -120° = \boxed{12.80\angle -170.19°\ A} \\ \boxed{I_c} &= I_a\angle 120° = \boxed{12.80\angle 69.81°\ A} \end{aligned}$$ #3

4



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$\theta = \cos^{-1}(0.84) = 32.86°$

$Q = S\cdot\sin\theta = 40k\cdot\sin(32.86°) = 21.70\,k\text{var} \Rightarrow Q_C = \frac{V_{rms}^2}{Z_c^*} = \frac{V_{rms}^2}{\left(\frac{1}{j\omega C}\right)^*} = \frac{V_{rms}^2}{\frac{1}{j\omega C}} = -j\omega C\, V_{rms}^2$

$P = S\cos\theta = 33.6\,kW$

$\Rightarrow \cancel{(-j)}(21.70k) = \cancel{(-j)}\,2\pi\cdot 60\cdot C\cdot 480^2$

$\Rightarrow \boxed{C} = \frac{21.70k}{2\pi\cdot 60\cdot 480^2} = \boxed{249.8\,\mu F}$ #4

After the p.f. correction, $\theta = 0°$

$S_L = P_L = 33.6\,kVA = V_{rms}\cdot I_{rms} \Rightarrow I_{rms} = 70\angle 0°\ A_{rms}$

$\Rightarrow V_s = V_L + (0.15+j0.3)(70\angle 0°) = 490.5 + j21\ V_{rms}$

So the complex power supplied by the source is:

$$\boxed{S_{supplied}} = V_s\cdot I_s^* = (490.5+j21)(70) = \boxed{\begin{aligned}&34.37\angle 2.452°\ kVA \\ &= 34.335 + j1.47\ kVA\end{aligned}}$$ #4

5.

5. **(20 pts)** A certain store contains three balanced three-phase loads. The three loads are:

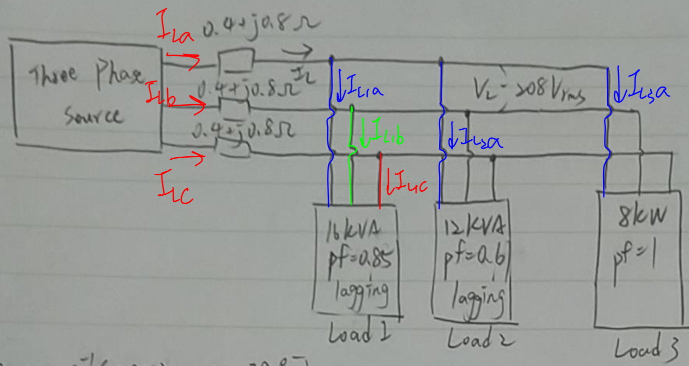
Load 1: 16 kVA at 0.85 pf lagging

Load 2: 12 kVA at 0.6 pf lagging

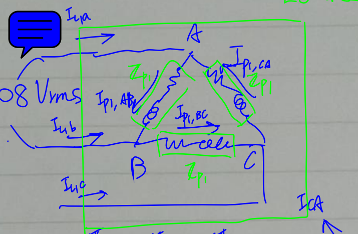
Load 3: 8 kW at unity pf

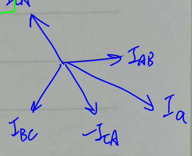
The line voltage at the load is 208 Vrms at 60 Hz, and the line impedance is $0.4 + j0.8\ \Omega$.

Please find (a) the complex power delivered to the loads (8 pts), and (b) the line currents (12 pts).



Load 1





$I_a = I_{AB} - I_{CA}$

$= \sqrt{3}\, I_{AB} \angle{-30^\circ}$

$\theta_{L1} = \cos^{-1}(0.85) = 31.79^\circ$

$S_{L1} = 16\angle 31.79^\circ$ kVA

$\theta_2 = \cos^{-1}(0.6) = 53.13^\circ$

$S_{L2} = 12\angle 53.13^\circ$ kVA

$\theta_{L3} = 0^\circ$

$S_{L3} = 8\angle 0^\circ$ kVA

$\Rightarrow \boxed{S_{Loads}} = S_{L1} + S_{L2} + S_{L3} = \boxed{\begin{matrix} 28.80 + j18.03 \text{ KVA} \\ \doteq 33.98\angle 32.05^\circ \text{ KVA}\end{matrix}}$ #5(a)

Assume Load 1, Load 2, and Load 3 are Delta connection ($V_L = V_p$)

P = Per phase

$S_{L1p} = \dfrac{V_{rms}^2}{Z_{p1}^*} = \dfrac{16000\angle 31.79^\circ}{3} \Rightarrow Z_{p1}^* = \dfrac{V_{rms}^2}{S_{L1p}} \Rightarrow Z_{p1} = 6.895 + j4.273\ \Omega \Rightarrow I_{L1a} = \sqrt{3}\, I_{p1,AB}\angle{-30^\circ} = \sqrt{3}\,\dfrac{V_{p,AB}}{Z_{p1}}\angle{-30^\circ} \doteq 20.99 - j39.14$ ($V_{p,AB} = 208\angle 0^\circ$)

$S_{L2p} = \dfrac{V_{rms}^2}{Z_{p2}^*} = \dfrac{12000\angle 53.13^\circ}{3} \Rightarrow Z_{p2}^* = \dfrac{V_{rms}^2}{S_{L2p}} \Rightarrow Z_{p2} = 6.490 + j8.653\ \Omega \Rightarrow I_{L2a} = \sqrt{3}\, I_{p2,AB}\angle{-30^\circ} = \sqrt{3}\,\dfrac{V_{p,AB}}{Z_{p2}}\angle{-30^\circ} \doteq 3.984 - j33.09$ ($208\angle 0^\circ$)

$S_{L3p} = \dfrac{V_{rms}^2}{Z_{p3}^*} = \dfrac{8000}{3}\angle 0^\circ \Rightarrow Z_{p3}^* = Z_{L3} = \dfrac{V_{rms}^2}{S_{L3p}} \Rightarrow Z_{p3} = 16.224\ \Omega \Rightarrow I_{L3a} = \sqrt{3}\, I_{p3,AB}\angle{-30^\circ} = \sqrt{3}\,\dfrac{V_{p,AB}}{Z_{p3}}\angle{-30^\circ} \doteq 19.23 - j11.10$ ($208\angle 0^\circ$)

$\Rightarrow \boxed{I_L} = \dfrac{V_L}{Z_{L1} /\!/ Z_{L2} /\!/ Z_{L3}}$ ~~$= 46.15 - j28.89$ Arms~~

~~$= 54.45\angle{-32.05^\circ}$ Arms~~ X #5(b)

$\Rightarrow \boxed{I_{La}} = I_{L1a} + I_{L2a} + I_{L3a} \doteq \boxed{94.32\angle{-62.05^\circ} \text{ Arms}}$ #5(b)

$\boxed{I_{Lb}} = I_{La}\angle 120^\circ = \boxed{94.32\angle 177.95^\circ \text{ Arms}}$ #5(b)

$\boxed{I_{Lc}} = I_{La}\angle{-120^\circ} = \boxed{94.32\angle 57.95^\circ \text{ Arms}}$ #5(b)

Check: $S_{Loads} = 3V_p I_p^* = 3V_L\left(\dfrac{I_L}{\sqrt{3}}\angle{+30^\circ}\right)^*$

$= 3\cdot 208\angle 0^\circ \left(\dfrac{94.32\angle(-62.05^\circ+30^\circ)}{\sqrt{3}}\right)^*$

$= 3\cdot 208\angle 0^\circ \cdot (46.16 + j28.90)$

$\doteq 33.98\angle 32.04^\circ$ KVA

ok (the same as #5(a))

$S_{L1p} = V_p I_p^*$

$= V_p I_p \angle \theta_v - \theta_i$

$Z_p = \dfrac{V_p}{I_p} = \dfrac{V_p}{I_p}\angle \theta_v - \theta_i$

$= \dfrac{V_p^2}{\frac{V_p}{I_p}\angle \theta_i - \theta_v} = \dfrac{V_p^2}{Z_p^*}$

$= I_p^2 \cdot \dfrac{V_p}{I_p}\angle \theta_v - \theta_i = I_p^2 Z_p$