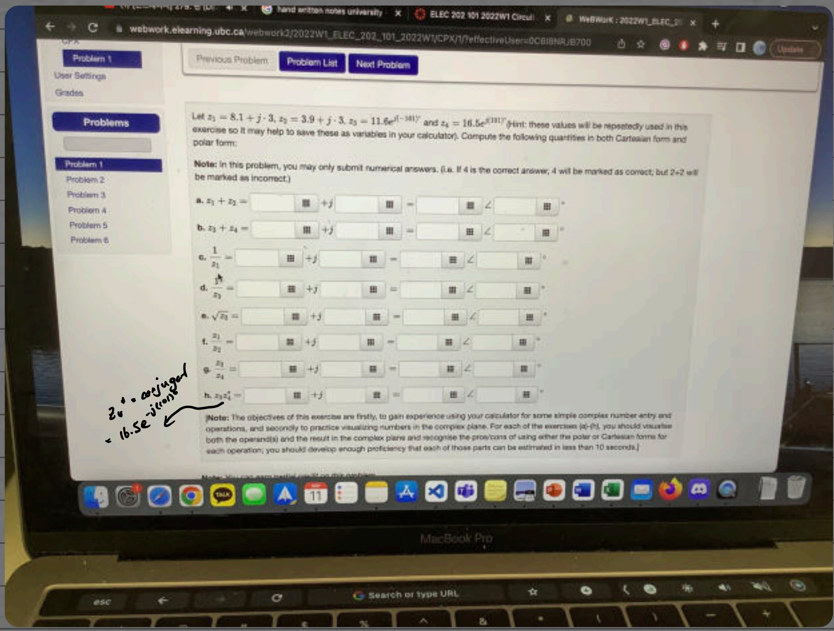
1



calc.

Let $z_1 = 1 + j\cdot 1.2$, $z_2 = 10 + j\cdot 6.2$, $z_3 = 10.3e^{j(-123)°}$ and $z_4 = 14.1e^{j(145)°}$ (Hint: these values will be repeatedly used in this exercise so it may help to save these as variables in your calculator). Compute the following quantities in the form indicated (Cartesian or polar):

calc.

Note: In this problem, you may only submit numerical answers. (i.e. If 4 is the correct answer, 4 will be marked as correct, but 2+2 will be marked as incorrect.)

a. $(\sqrt{3}\angle 30°)z_2 - \frac{z_1^*}{z_4} e^{j(\frac{1}{3})\pi} = \square \angle \square\,°$

b. $(\frac{1}{z_1} + \frac{1}{z_2} + \frac{1}{z_3})^{-1} = \square + j\,\square$

c. $\frac{z_1^* + z_3}{z_4 z_3} + z_2 = \square + j\,\square$

d. $\sqrt{z_3} - \frac{z_1^* z_2}{z_4 - \frac{j}{1 - z_3}} = \square \angle \square\,°$

[**Note:** For each of the exercises (a) to (d), you are primarily gaining practice using the calculator.]

Note: In this problem, you may only submit numerical answers. (i.e. If 4 is the correct answer, 4 will be marked as correct, but 2+2 w
be marked as incorrect.)

a. $\begin{Bmatrix} z_1 + z_2 = 10.8e^{j(-10)°} \\ 2z_1 + 3z_2 = 9.6e^{j(11)°} \end{Bmatrix}$

$e1 := z_1 + z_2 = 10.8e^{j}(-10)°$ solve $(\{e1, e2\}, \{a, b\})$

$e2 :=$ ...

$z_1 = \square + j\,\square$

$z_2 = \square + j\,\square$

b. $\begin{bmatrix} \frac{1}{3} + \frac{1}{j10} + \frac{1}{-j2} & \frac{-1}{j10} & 0 \\ \frac{-1}{j10} & \frac{1}{j10} + \frac{1}{11} & 8 \\ \frac{1}{j2} & 0 & 1 \end{bmatrix} \begin{bmatrix} z_1 \\ z_2 \\ z_3 \end{bmatrix} = \begin{bmatrix} -9 + \frac{16}{3} \\ 9 \\ 0 \end{bmatrix}$

$z_1 = \square + j\,\square$

$z_2 = \square + j\,\square$

$z_3 = \square + j\,\square$

c. $\begin{Bmatrix} \frac{z_1 - z_3}{6} + \frac{z_1}{-j8} + z_3 = 0 \\ \frac{z_2}{12} + \frac{z_2 - 12}{j4} - z_3 = 0 \\ z_3 = 0.2(12 - z_1) \end{Bmatrix}$

$z_1 = \square + j\,\square$

$z_2 = \square + j\,\square$

$z_3 = \square + j\,\square$

For any pair of numbers (A, B) ($A \in \mathbb{R}$ and $B \in \mathbb{R}$), one can find another pair of numbers (C, θ) ($C \in \mathbb{R}_+$ and $-180^\circ < \theta \leq 180^\circ$), such that $A\cos(\omega t) + B\sin(\omega t) = C\cos(\omega t + \theta)$. Find the relationship between the two pairs of numbers (i.e., find the functions $A(C,\theta)$,$B(C,\theta)$,$C(A,B)$, and $\theta(A,B)$ and use this to fill in the blanks in the following equations.)

Note: In this problem, you may only submit numerical answers. (i.e. If 4 is the correct answer, 4 will be marked as correct, but 2+2 will be marked as incorrect.)

a. $8.9\cos(\omega t) + 0.8\sin(\omega t) =$ ___ $\cos(\omega t +$ ___ $^\circ)$

b. $12.4\cos(\omega t + 44^\circ) =$ ___ $\cos(\omega t)+$ ___ $\sin(\omega t)$

$A\cos(\omega t) + B\sin(\omega t) = C\cos(\omega t - \gamma)$

$C = (A^2+B^2)^{1/2}$ $\quad \gamma = \operatorname{atan}\left(\frac{b}{a}\right)$

$\tan(-244) = \frac{b}{a}$

calc.

$8.9\cos(\omega t) + 0.8\sin(\omega t)$

$\underset{A}{}$ $\quad \underset{B}{}$

A B

Use triangle congruence theorems to solve the following problems:

Note: In this problem, you may only submit numerical answers. (i.e. If 4 is the correct answer, 4 will be marked as correct, but 2+2 will be marked as incorrect.)

a. Given $z_1 = 7.9\angle 0^\circ$, $|z_2| = 6$, $angle(z_1 + z_2) = -41^\circ$, determine the two possible values for z_2. (**Hint:** This is an SSA problem.)

$z_2 =$ ___ $+j$ ___ or

$z_2 =$ ___ $+j$ ___

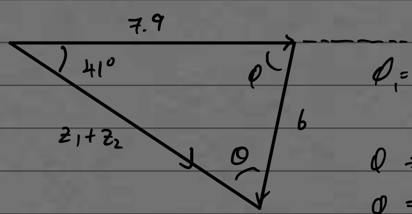
b. Given $z_1 = 3.1\angle 0^\circ$, $|z_2| = 8.6$, $|z_3| = 8.5$, and $z_3 = z_1 + z_2$ determine the two possible values for z_2. (**Hint:** This is an SSS problem.)

$z_2 =$ ___ $+j$ ___ or

$z_2 =$ ___ $+j$ ___

a) $z_1 = 7.9\angle 0^\circ$ $\quad |z_2| = 6$ $\quad \measuredangle(z_1+z_2) = -41^\circ$

$\measuredangle z_1 = 0^\circ$



$\phi_1 = 79.252780$

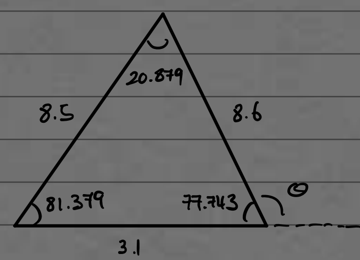
$\phi \rightarrow 180 - \theta$

$\phi = 18.747$

$6\measuredangle -(180 - 79.252) = -5.681 - 1.928i$

$6\measuredangle -(180 - 18.747) = -1.1188 - 5.8947i$

b)



$8.6\measuredangle(180 - 77.743) = -1.8257 + 8.404i$

or $\quad -1.8257 - 8.404i$

as triangle has a set shape due to length being pre-defined.

For each expression, find the positive real value of ω that would cause R_{eq} to be purely real, as well as the resulting R_{eq}. Note that $//$ is the binary operator that finds the equivalent resistance of two resistors in parallel (i.e., $a//b = \frac{ab}{(a+b)}$).

[**Hint:** For (a), try setting the imaginary coordinate to be zero. For (b), try equating the numerator and denominator angles].

Note: In this problem, you may only submit numerical answers. (i.e. If 4 is the correct answer, 4 will be marked as correct, but 2+2 will be marked as incorrect.)

a. $R_{eq} = \frac{1}{j \cdot 18.9\omega} + (j \cdot 158.876\omega)//8.7$

$\omega =$ and $R_{eq} =$

b. $R_{eq} = (2.2 + \frac{1}{j \cdot 18.9\omega})//(j \cdot 158.876\omega)$

$\omega =$ and $R_{eq} =$

a) $R_{eq} = \frac{1}{j \cdot 18.9w} + (j \cdot 158.876w) // 8.7$

$= \frac{1}{18.9wj} + \frac{158.876wj\,(8.7)}{158.876wj + 8.7}$

$\downarrow$

$\frac{1382wj}{158.876wj + 8.7}$

$\downarrow$

$\frac{1382wj\,(-158.876wj + 8.7)}{(158.876wj + 8.7)(-158.876wj + 8.7)}$

$\downarrow$

$\frac{219566.632w^2 + 12023.4wj}{-25241.58w^2 + 75.69}$

$\Rightarrow Im = \frac{1}{18.9wj} + \frac{12023.4wj}{-25241.58w^2 + 75.69}$

$\frac{-j}{18.9w} + \frac{12023.4wj}{-25241.58w^2 + 75.69}$

$j\left(\frac{-1}{18.9w} + \frac{12023.4wj}{-25241.58w^2 + 75.69}\right)$

$\downarrow$

$\frac{1}{i} = -i$

$\frac{-1}{18.9w} + \frac{12023.4wj}{-25241.58w^2 + 75.69} = 0$

$w = \pm\, 0.019357$

$R_{eq} = Re(\,''\,)$

$= \frac{219566.632w}{\sim} \Big|_{w=0.019357}$

$= 0.9657\,\Omega$

b) $\frac{[2.2 + (\frac{1}{18.9wj})][158.876wj]}{[2.2 + (\frac{1}{18.9wj})] + [158.876wj]}$

$\downarrow$

$\frac{(349.5272wj + 8.406)}{2.2 + j(158.876w - \frac{1}{18.9w})} \cdot \frac{(2.2 - j(158.876w - \frac{1}{18.9w}))}{(2.2 - j(158.876w - \frac{1}{18.9w}))}$

$\downarrow$

$\frac{1}{18.9wj} = -\frac{j}{18.9w}$

$\frac{349.5272wj \cdot 2.2 - 349.5272w\,(158.876w - \frac{1}{18.9w}) + 8.406(2.2) - 8.406j\,(158. \ldots)}{2.2^2 - (158.876w - \frac{1}{18.9w})^2}$

$\hookrightarrow Im(\,''\,) = \frac{349.5272(2.2)w - 8.406(158.876w -}{2.2^2 + (158.876w - \frac{1}{18.9w})^2}$

$0 =$

$\therefore w = \pm\, 0.028$

$= 0.028$

$R_{eq} = Re(\,''\,)\,|_{w=0.028}$

$= \frac{349.5272w\,(158.8\ldots) + 8.406(2.2)}{2.2^2 + (158.\ldots)}$

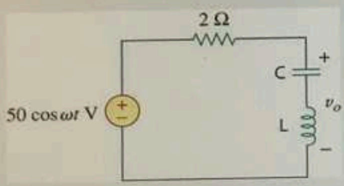
$= 3.823\,\Omega$

PHP

1.

In the circuit shown C = 10 millifarads and L = 18 millihenrys. If the steady state voltage Vo across the two reactive elemenets in series is zero, what is the frequency of the source in rad/s?

Note: In this problem, you may only submit numerical answers. (i.e. If 4 is the correct answer, 4 will be marked as correct, but 2+2 will be marked as incorrect.)



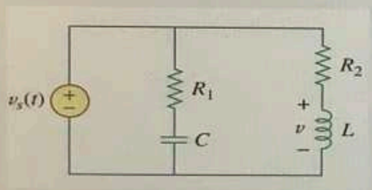
ω = [ ] rad/s

$Z = \frac{V_s}{Z_c + Z_L}$, but $I = 0$ as $V_o = 0$

$\therefore \; Z_c + Z_L = 0 \Rightarrow Z_c = -Z_L \Rightarrow \frac{1}{j\omega C} = -j\omega L \Rightarrow \omega = 74.53559 \text{ rad/s}$

The voltage in the inductor is known from an oscillogram as $v(t) = 7cos(25t + 40^o)$ volts. If the complex power in any element is the product of the voltage phasor by the conjugate of the current phasor DIVIDED BY TWO, What is the real part of the power delivered by the voltage source on the left of the circuit, if L = 330 millihenrys and C = 2 millifarads, R1 = 65 ohms and R2 = 80 ohms.

Note: In this problem, you may only submit numerical answers. (i.e. If 4 is the correct answer, 4 will be marked as correct, but 2+2 will be marked as incorrect.)



$V(t) = 7\cos(25t + 40°) \rightarrow 7\angle 40°$ cmplx power $\rightarrow \frac{V_p \cdot I_p}{2}$

$P = IV$

P_{ave} = [ ] watts

$V(t) = 7\cos(25t + 40°) = 7\angle 40°$, $\omega = 25$ rad/s

$X_C = \frac{1}{j\omega L} = -j\frac{1}{\omega L} = -j\frac{1}{25(2\times10^{-3})} = -20j \rightarrow 65 - 20j$

$X_L = j\omega L = j(25)(330\times10^{-3}) = 8.25j \rightarrow 80 + 8.25j$

$\rightarrow Z_{eq} = \frac{(65-20j)(80+8.25j)}{(65-20j)+(80+8.25j)}$

$= 37.3492 - 4.3096i \; \Omega$

$V(t) = \frac{X_L}{R_2 + X_L} \cdot V_s \Rightarrow V_s = \frac{V(t)}{\left(\frac{X_L}{R_2 + X_L}\right)} = \frac{7\angle 40}{\frac{8.25j}{80 + 8.25j}}$

$= 68.238 \angle -44.11218° \, V$

$i(t) = \frac{V_s}{Z_{eq}} = 1.815 \angle -37.530° \text{ A}$

$P = \frac{V I^*}{2} = \frac{(68.238 \angle -44.11218° V)(1.815 \angle 37.530°)}{2}$

$= 61.92680 \angle -6.5821$

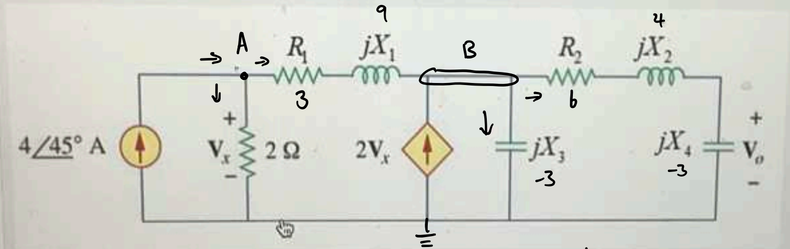
$= 61.5186 - 7.0984i$

$P_{ave} = 61.5186 \text{ W}$

The current source on the left is $i_s(t) = 4\cos(377t + 45^o)$ volts. We know the impedance of every element in the network. N.B. The X is a real number and is called the "reactance" in ohms. So, jX is the impedance, X is the reactance, a real number, in ohms. The reactance of the inductor is ωL and the reactance of the capacitor is a negative real number $-1/(\omega C)$ ohms. Find the value of $v_o(t)$ in volts at t = 0, at t = 4 ms, and at t = 12 ms. If the complex power in any element is the product of the voltage phasor by the conjugate of the current phasor DIVIDED BY TWO, compute also the real part of the complex power delivered by the source on the left.

$$R_1 = 3\ \Omega,\ R_2 = 6\ \Omega,\ X_1 = 9\ \Omega,\ X_2 = 4\ \Omega,\ X_3 = -3\ \Omega,\ X_4 = -3\ \Omega.$$

Note: In this problem, you may only submit numerical answers. (i.e. If 4 is the correct answer, 4 will be marked as correct, but 2+2 will be marked as incorrect.)



$V_o(0) =$ volts

$V_o(0.004) =$ volts

$V_o(0.012) =$ volts

$P_{ave} = =$ watts

$\omega = 377$ rad/s

$V_x := A$

$4\angle 45^\circ = \frac{A}{2} + \frac{A-B}{3+9j}$ $\frac{A-B}{3+9j} + 2A = \frac{B}{-3j} + \frac{B}{6+4j-3j}$

$A = 3.61682 + 0.919i$ $B = 21.8733 - 15.3657i$

$V_o = B \cdot \frac{jX_4}{R_2 + jX_2 + jX_4}$

$= 13.18368 \angle -134.5499 \rightarrow 13.18368\cos(377t - 134.5499)$

rad

$V_o(0) = -9.2487$ V

$V_o(0.004) = 13.18368\cos(377t - 2.3483\ (0.004)) = 8.7962$

$V_o(0.012) = -7.4969$

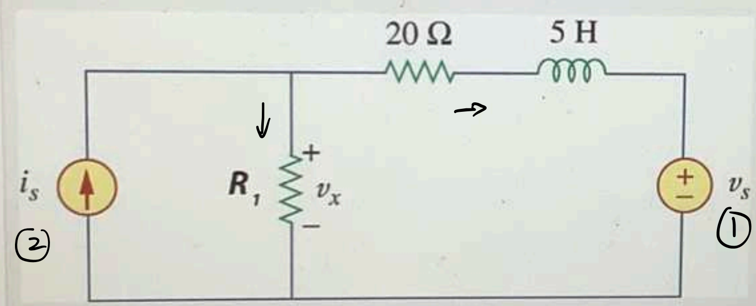
$P_{av} = \frac{V_m I_m^*}{2} = \frac{V_x(4\angle 45)}{2} = \frac{(3.61682 + 0.919i)(4\angle -45)}{2}$ $= 7.4639\angle -44.75$ W

$= 6.4146 - 3.815i$

$P_{ave} = 6.414$ W

We have insisted on the fact that phasor analysis is predicated on all the sources having the same frequency. If they don't, we can use superposition. Solve the circuit for all the sources with the same frequency ω_1, then for all the sources with frequency ω_2, etc., and then we superimpose the responses. Here is your opportunity. Use superposition to find the voltage $v_x(t)$ at t = 0, and at t = 0.8 seconds. $R_1 = 20$ ohms. $v_s(t) = 42sin(2t)$ volts, $i_s(t) = 12cos(6t + 10^o)$ amps.

Note: In this problem, you may only submit numerical answers. (i.e. If 4 is the correct answer, 4 will be marked as correct, but 2+2 will be marked as incorrect.)



$V_x(0) =$ volts

$V_x(0.8) =$ volts

short is $\Rightarrow$ $V_x = \dfrac{R_1}{R_1 + 20 + X_L} \cdot V_s$

$= \dfrac{20}{20 + 20 + 2(5)j} \cdot 42 \angle 0^\circ$

$= 19.7647 - 4.9411i$

$V_{x_1} = 20.372 \angle -14.036$

$\dfrac{V_x - 42}{20 + 10j} = \dfrac{-V_x}{20}$ // same ans.

$V_x \left(\dfrac{1}{20+10j} + \dfrac{1}{20} \right) = \dfrac{42}{20+10j}$

short Vs $\Rightarrow$ $i_s = \dfrac{V_x}{R_1} + \dfrac{V_x}{20 + j\omega L}$

$12\cos(6t + 10) = \dfrac{V_x}{20} + \dfrac{V_x}{20 + 30j}$

$12 \angle 10^\circ = V_x \left(\dfrac{1}{20} + \dfrac{1}{20+30j} \right)$

$V_{x_2} = 173.066 \angle 29.44^\circ$

$V_x = 20.372 \sin(2t - 14.0362) + 173.066 \cos(6t + 29.44^\circ)$

$V_x(0) = 20.372 \sin(-14.0362) + 173.066 \cos(29.44^\circ) = 150.631$

$V_x(0.8) = 20.372 \sin\left(2(0.8) - \dfrac{14.0362\pi}{180}\right) + 173.066 \cos\left(6(0.8) + \dfrac{29.44\pi}{180}\right) = 118.292$

Find the absolute value of the current in each inductor at t = 0, and the absolute value of the voltage in the capacitor at t = 0.

Note: In this problem, you may only submit numerical answers. (i.e. If 4 is the correct answer, 4 will be marked as correct, but 2+2 will be marked as incorrect.)

$v_s(t) = 10\cos(100t - 45^\circ)u(-t)$ V

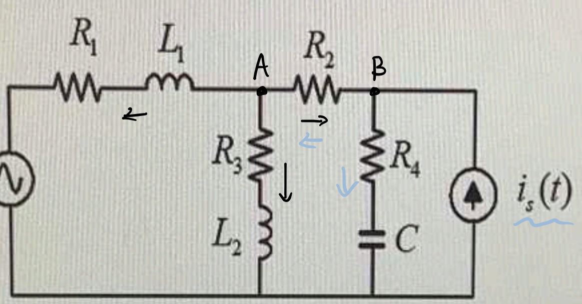
$i_s(t) = 3\cos(100t - 30^\circ)u(-t)$ A

$R_1 = 50\,\Omega \quad L_1 = 2H$

$R_2 = 20\,\Omega \quad R_3 = 70\,\Omega$

$R_4 = 100\,\Omega \quad L_2 = 2H$

$C = 50\,\mu F$



$|I_{L1}(0)|$ = -0.875 amps

$|I_{L2}(0)|$ = 0.9867 amps

$|V_c(0)|$ = 342.407 volts

$$\frac{A - V_s}{R_1 + X_{L1}} + \frac{A - B}{R_2} + \frac{A}{R_3 + X_{L2}} = 0 \qquad i_s = \frac{B}{R_4 + X_C} + \frac{B - A}{R_2}$$

$V_s = 10 \angle -45^\circ$

$X_{L1} = 100(2)j$

$X_{L2} = 100(2)j$

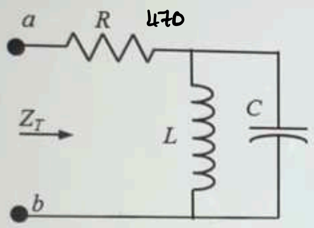
$i_s = 3 \angle -30$

$X_C = -(100)(50\times10^{-6})j$

$A = 173.981 \angle 8.4968 \qquad B = 186.72839 \angle -1.09839$

Il1 is 0.8737. not the answer there.

Let $R = 470\Omega, C = 1.7\mu F$ and $L = 45mH$. Determine the impedance, Z_T seen at terminals $a - b$, for the different operating frequencies:



$Z_L = (1\times10^3)(45\times10^{-3})j$

$Z_C = \dfrac{1}{j(1\times10^3)(1.7\times10^{-6})}$

$\dfrac{1}{j\omega C}$ $\quad j\omega L$

$(Z_L \parallel Z_C) + R$

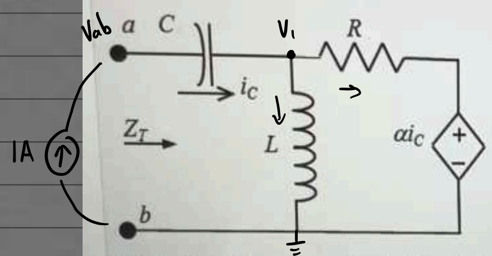
Note: In this problem, you may only submit numerical answers. (i.e. If 4 is the correct answer, 4 will be marked as correct, but 2+2 will be marked as incorrect.)

a. $\omega = 1krad/s : Z_T =$ ___ $\angle$ ___ $° \ \Omega$

b. $\omega = 10krad/s : Z_T =$ ___ $\angle$ ___ $° \ \Omega$

c. $f = 1kHz : Z_T =$ ___ $\angle$ ___ $° \ \Omega$

Let $R = 7\Omega$, $C = \frac{1}{3}F$, $L = 9H$ and $\alpha = 4V/A$. Determine the requested quantities seen at terminals $a - b$ for an operating frequency of $2rad/s$:
The overall impedance of this circuit seen at the port on the left can be represented either as a resistor Rs in series with a reactor Xs, or by a (different) resistor Rp in parallel with a (different) reactor Xp.



$Z_C = \dfrac{1}{j\omega C}$ $\quad Z_L = j\omega L$ $\quad \omega = 2$

Note: In this problem, you may only submit numerical answers. (i.e. If 4 is the correct answer, 4 will be marked as correct, but 2+2 will be marked as incorrect.)

a. Impedance: $Z_T =$ ___ $\angle$ ___ $°\Omega$

b. Series-Resistance: $R_s =$ ___ Ω

c. Series-Reactance: $X_s =$ ___ Ω

d. Parallel-Resistance: $R_p =$ ___ Ω

e. Parallel-Reactance: $X_p =$ ___ Ω

$Z_C = \dfrac{1}{j(2)(\frac{1}{3})}$ $\quad Z_L = j(2)(9)$ $\quad \alpha = 4$

$i_C = 1 \Rightarrow \quad 1 = \dfrac{V_1}{Z_L} + \dfrac{V_1 - \alpha}{R}$

$V_1 = 10.25 \angle 21.25$

$\dfrac{V_{ab} - V_1}{-j\frac{1}{2(1/3)}} = 1$

$V_{ab} = 9.8 \angle 13.05$

or $9.5549 + 2.2158i$

R_p & X_p $\Rightarrow$

or

$= 9.8 \angle 13.05$

$Z_p = \dfrac{R\alpha j}{R + \alpha j}$ $\quad$ where $Z_p = 9.8 \angle 13.05° \ \Omega$

$= \dfrac{R \cdot \alpha j}{R + \alpha j} \cdot \dfrac{R - \alpha j}{R - \alpha j}$

$= \dfrac{R^2 \alpha j - R\alpha^2(-1)}{R^2 - \alpha^2(-1)}$

$= \dfrac{R^2\alpha j + R\alpha^2}{R^2 + \alpha^2}$

$= \underbrace{\dfrac{R\alpha^2}{R^2+\alpha^2}}_{a} + \underbrace{\dfrac{R^2\alpha}{R^2+\alpha^2}}_{b} j$

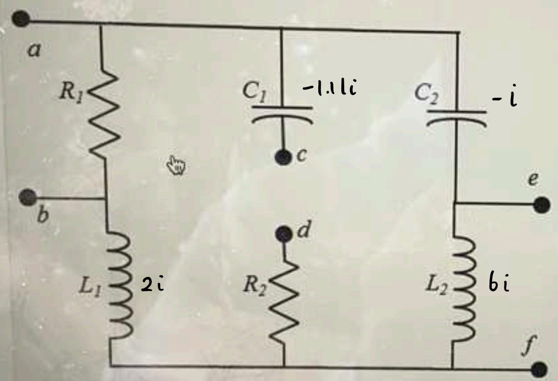
$Z = a + bj$
$= 9.5549 + 2.2158i$

$9.5549 = \dfrac{R\alpha^2}{R^2+\alpha^2}$ $\quad 2.2158 = \dfrac{R^2\alpha}{R^2+\alpha^2}$ $\quad \Rightarrow R = 10.059 \ \Omega$

$\alpha = 43.401 \ \Omega$

Let $R_1 = 9\Omega$, $R_2 = 4\Omega$, $C_1 = 0.9F$, $C_2 = 1F$, $L_1 = 2H$ and $L_2 = 6H$. Determine the impedance that would be seen at the requested terminals for an operating frequency of $1 rad/s$:

1.12842 1.73077 3.65385 1.73077+3.65385i



Note: In this problem, you may only submit numerical answers. (i.e. If 4 is the correct answer, 4 will be marked as correct, but 2+2 will be marked as incorrect.)

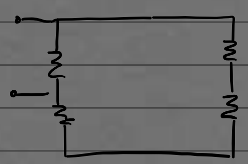
a. $a - b : Z_T =$ ∠ °Ω

b. $c - d : Z_T =$ ∠ °Ω

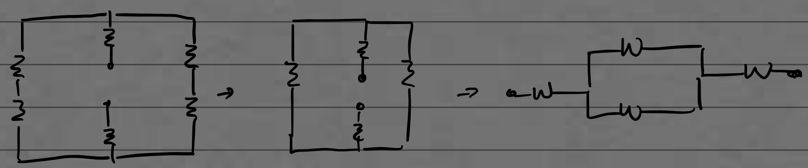
c. $e - f : Z_T =$ ∠ °Ω

d. $a - c : Z_T =$ ∠ °Ω

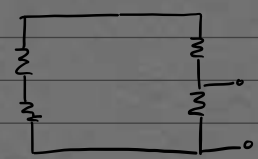
a)



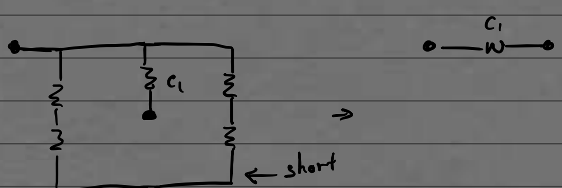
b)



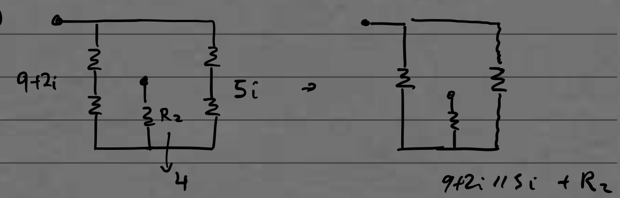
c)



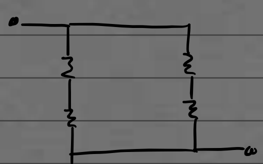
d)

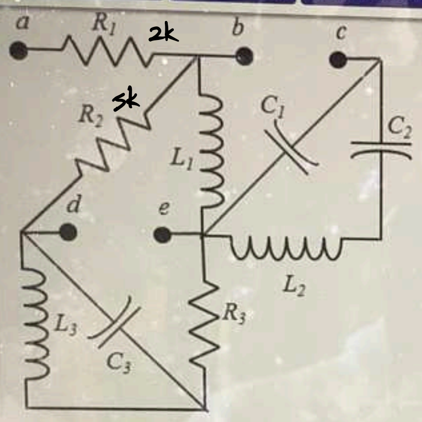


e)



f)





$r1 = 2k \quad r2 = 5k$

$Z_{L_1} = j(2\pi \cdot 50\times10^{3})(27\times10^{-3}) =$

$Z_{L_2} = j(\;''\;)(29\times10^{-3}) =$

$Z_{L_3} = j(\;''\;)(18\times10^{-3}) =$

$Z_{C_1} = -j\,\frac{1}{(\;''\;)(550\times10^{-12})}$

$Z_{C_2} = -j\,\frac{1}{(\;''\;)(850\times10^{-12})}$

$Z_{C_3} = -j\,\frac{1}{(\;''\;)(500\times10^{-12})}$

Note: In this problem, you may only submit numerical answers. (i.e. If 4 is the correct answer, 4 will be marked as correct, but 2+2 will be marked as incorrect.)

a. $a - b: Z_T =$ ____ $\angle$ ____ °kΩ

b. $a - c: Z_T =$ ____ $\angle$ ____ °kΩ

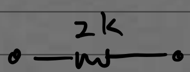
c. $a - e: Z_T =$ ____ $\angle$ ____ °kΩ

d. $b - d: Z_T =$ ____ $\angle$ ____ °kΩ

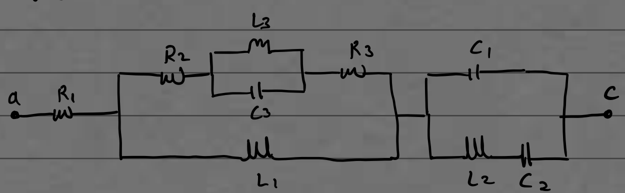
e. $c - d: Z_T =$ ____ $\angle$ ____ °kΩ

f. $d - e: Z_T =$ ____ $\angle$ ____ °kΩ

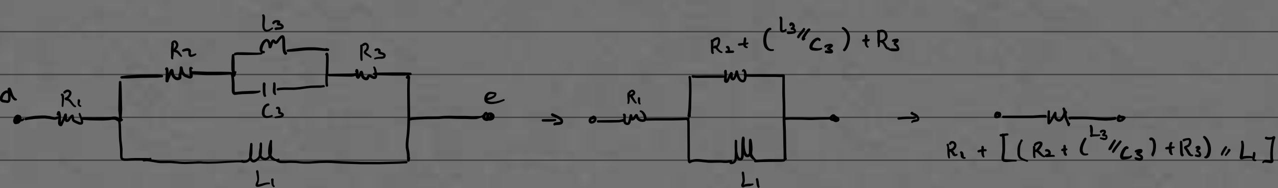
a)



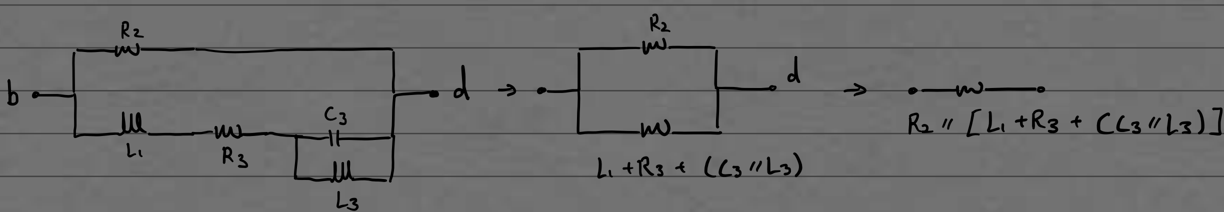
b)



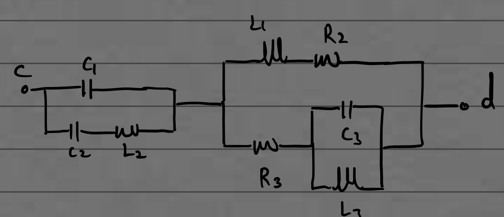
c)



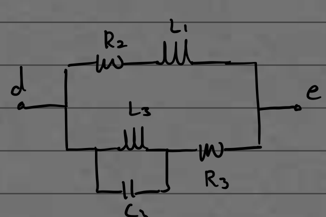
d)



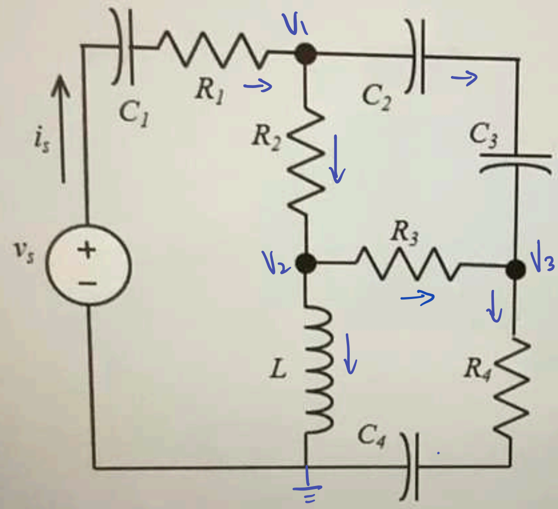
e)



f)



In the circuit shown, $R_1 = 6k\Omega$, $R_2 = 9k\Omega$, $R_3 = 10k\Omega$, $R_4 = 4k\Omega$, $C_1 = 450nF$, $C_2 = 200nF$, $C_3 = 750nF$, $C_4 = 200nF$, and $L_1 = 23H$.
Determine $i_s(t)$ under different values of $v_s(t)$:



Note: In this problem, you may only submit numerical answers. (i.e. If 4 is the correct answer, 4 will be marked as correct, but 2+2 will be marked as incorrect.)

a. $v_s(t) = 12cos(377t)V : i_s(t) =$ ____ $cos(377t+$ ____ $°)A$

b. $v_s(t) = 60cos(377t + 100°)V : i_s(t) =$ ____ $cos(377t+$ ____ $°)A$

$Z_{C1} = -j \frac{1}{377(450\times10^{-9})}$

$Z_{C2} = -j \frac{1}{377(200\times10^{-9})}$

$Z_{C3} = -j \frac{1}{377(750\times10^{-9})}$

$Z_{C4} = -j \frac{1}{377(200\times10^{-9})}$

$Z_L = j(377)(23)$

$R_1 = 6k$ $R_2 = 9k$ $R_3 = 10k$

A: $\frac{V_s - V_1}{C_1 + R_1} = \frac{V_1 - V_2}{R_2} + \frac{V_1 - V_3}{C_2 + C_3}$

B: $\frac{V_1 - V_2}{R_2} = \frac{V_2 - V_3}{R_3} + \frac{V_2}{L}$

C: $\frac{V_1 - V_3}{C_2 + C_3} + \frac{V_2 - V_3}{R_3} = \frac{V_3}{R_4 + C_4}$

$i_s = \frac{V_s - V_1}{C_1 + R_1}$

$V_s = 12cos(377t)$

$V_s = 12 \angle 0°$

$\therefore i_s = 5.365\times10^{-4} \angle -4.30187$

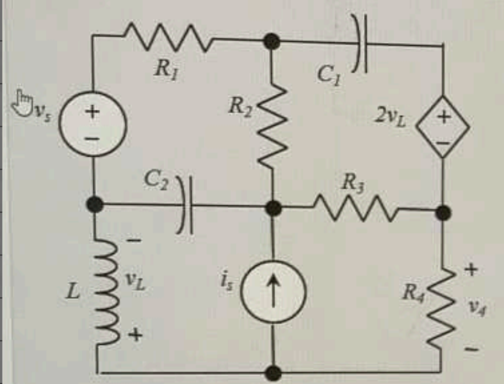
$V_s = 60cos(377t + 100°)$

$= 60 \angle 100°$

$\therefore i_s = \frac{(60\angle100) - V_1}{''}$

$= 2.682\times10^{-3} \angle 95.698$

In the circuit shown, $R_1 = 9k\Omega$, $R_2 = 8k\Omega$, $R_3 = 9k\Omega$, $R_4 = 6k\Omega$, $C_1 = 400nF$, $C_2 = 250nF$ and $L = 3H$. Given that $v_s(t) = 2\cos(500t)V$ and $i_s(t) = 8\sin(500t)mA$, determine the Thevenin equivalent seen by resistor R_4 (assume the lower node as the reference) and use this to determine the signal $v_4(t)$.



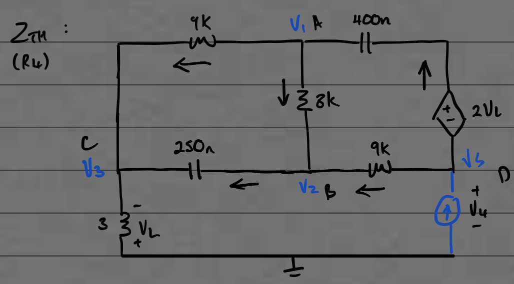
Note: In this problem, you may only submit numerical answers. (i.e. If 4 is the correct answer, 4 will be marked as correct, but 2+2 will be marked as incorrect.)

a. $Z_{Th} =$ ∠ °kΩ

b. $V_{Th} =$ ∠ °V

c. $v_4(t) =$ $\cos(500t +$ $)V$

Z_{TH} :
(R_4)



short VS
open CS
leave dependant sources.

$V_L = -V_3$

A: $\frac{V_s - 2V_3 - V_1}{\frac{1}{j500(400n)}} = \frac{V_1 - V_3}{9k} + \frac{V_1 - V_2}{8k}$

B: $\frac{V_s - V_2}{9k} + \frac{V_1 - V_2}{8k} = \frac{V_2 - V_3}{\frac{1}{j500(250n)}}$

C: $\frac{V_1 - V_3}{9k} + \frac{V_2 - V_3}{\frac{1}{j500(250n)}} = \frac{V_3}{j500(3)}$

where $V = RI$

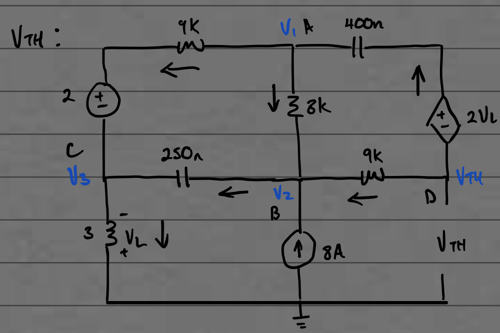
$V_s = Z_{TH} I$

$V_s = Z_{TH}(1)$

$= 4.509 \angle -24.4264$

D: $1 = \frac{V_s - 2V_3 - V_1}{\frac{1}{j500(400n)}} + \frac{V_s - V_2}{9k}$

V_{TH} :



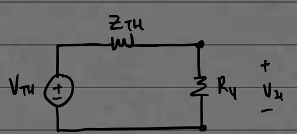
A: $\frac{V_{TH} - 2V_3 - V_1}{\frac{1}{j500(400n)}} = \frac{V_1 - V_2}{8k} + \frac{V_1 - 2 - V_3}{9k}$

B: $\frac{V_1 - V_2}{8k} + \frac{V_{TH} - V_2}{9k} + \overset{-8mi}{8m\angle -90°} = \frac{V_2 - V_3}{\frac{1}{j500(250n)}}$

C: $\frac{V_1 - 2 - V_3}{9k} + \frac{V_2 - V_3}{\frac{1}{j500(250n)}} = \frac{V_3}{j500(3)}$

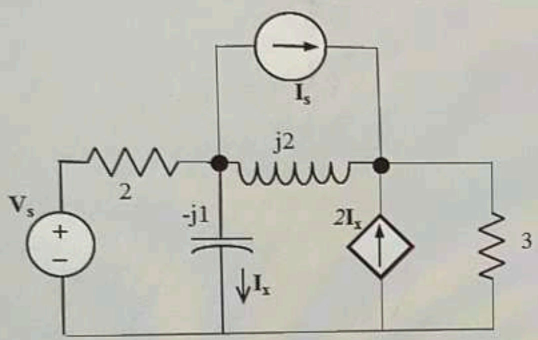
$V_{TH} = 13.56033 \angle -118.8989°$

D: $\frac{V_{TH} - 2V_3 - V_1}{\frac{1}{j500(400n)}} + \frac{V_{TH} - V_2}{9k} = 0$



$V_4(t) = V_{TH} \cdot \frac{R_4}{R_4 + Z_{TH}}$

For the circuit shown, the voltage and current sources have respective phasors $V_s = 4\angle 70° V$ and $I_s = 8\angle 85° A$. Compute the phasor I_x flowing through the capacitor as well as the complex power (S_c) *received* by the capacitor. Compute also the complex power (S_{DS}) *supplied* by the dependent source. Note: All phasors in this question, as is common in the Electric Power Industry, are RMS/IEEE Phasors.

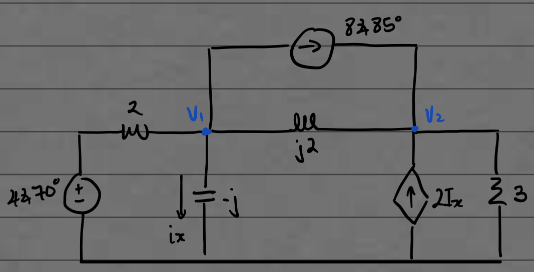


Note: In this problem, you may only submit numerical answers. (i.e. If 4 is the correct answer, 4 will be marked as correct, but 2+2 will be marked as incorrect.)

a. $I_x =$ ____ $\angle$ ____ $°A$

b. $S_c =$ ____ $\angle$ ____ $°VA$

c. $S_{DS} =$ ____ $\angle$ ____ $°VA$



$\frac{I_{peak}}{\sqrt{2}} = I_{rms}$

a) $\frac{4\angle 70 - V_1}{2} = \frac{V_1 - V_2}{j2} + I_x + 8\angle 85°$

$\frac{V_1 - V_2}{j2} + 8\angle 85° + 2(I_x) = \frac{V_2}{3}$

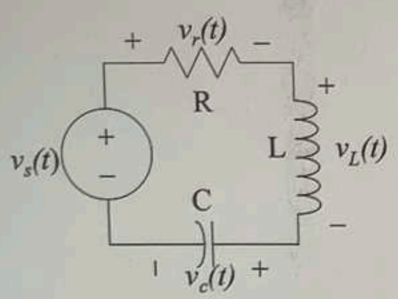
$I_x = \frac{V_1}{-j}$

b) $S_c = I_{rms}^* V_1$

$= I_x^* V_1$

c) $S_{DC} = I_x^* (2) \cdot V_2$

Consider the RLC series circuit shown with $v_s(t) = 17cos(\omega t)V$, $R = 2\Omega$, $L = 13mH$ and $C = 5\mu F$. Determine the resonant frequency by $\omega_r = (L \cdot C)^{-1/2}$. Compute the complex power received by each circuit component (the subscripts "R", "L", "C" and "S" respectively refer to the resistor, inductor, capacitor, and source) under the following source frequencies:



$17\cos(\omega t) \rightarrow \frac{17}{\sqrt{2}} \angle 0°$

why?

Note: Use "j" when submitting complex and imaginary numbers (e.g. submit 4+j3 for a complex number with real component 4 and imaginary component 3)

a. $\omega = 0.1\omega_r$

$S_R =$ ___ VA

$S_L =$ ___ VA

$S_C =$ ___ VA

$S_S =$ ___ VA

b. $\omega = \omega_r$

$S_R =$ ___ VA

$S_L =$ ___ VA

$S_C =$ ___ VA

$S_S =$ ___ VA

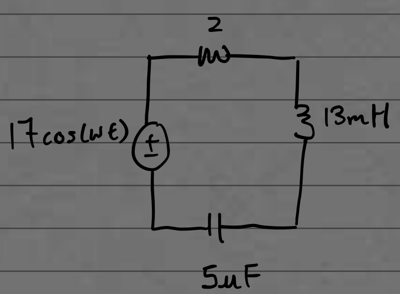
c. $\omega = 10\omega_r$

$S_R =$ ___ VA

$S_L =$ ___ VA

$S_C =$ ___ VA

$S_S =$ ___ VA



$w_r = (L \cdot C)^{-1/2}$ $\quad V = \frac{17}{\sqrt{2}}$ $\quad I = \dfrac{\frac{17}{\sqrt{2}}}{2 + jw(13m) + \frac{1}{jw(5u)}}$

$W = 0.1W_r$

$= 392.23227$: $\bar{I} = 9.434 \times 10^{-5} + 0.023i$

$V_R = \bar{I} \cdot R$

$= 2.668 \times 10^{-4} + 6.73519 \times 10^{-2} i$

$V_c = \bar{I} \cdot \bar{Z}_c$

$17.17 - 6.8 \times 10^{-2} i$

$V_L = \bar{I} \cdot \bar{Z}_L$

$= -0.1717 + 6.8 \times 10^{-4} i$

$S = \bar{I}^* V$

$S_R = \bar{I}^* V_R = 1.134 \times 10^{-3}$

$S_L = \bar{I}^* V_L = 0.00289j$

$S_c = \bar{I}^* V_c = -0.2891j$

$S_s = \bar{I}_{rms} V_s =$

$w = w_r$: $i = 6.010407 + 2.9245 \times 10^{-10} i \rightarrow$

$S_R = 72.25$ ✓

$S_L = 1842.0207i$ ✓

$S_c = -1842.0207i$ ✓

$S_s = \bar{I}_{rms} V_s$

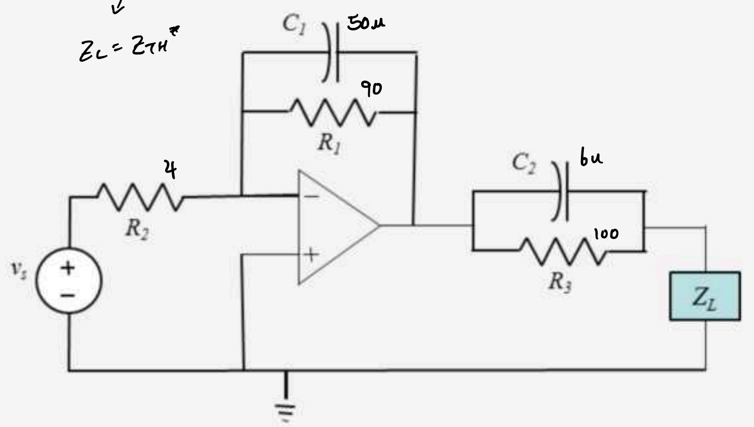
$= (6.010407 \times 2.9245 \times 10^{-10} i)(\frac{17}{\sqrt{2}})$

$= 72.25$ ✗

$w = 10w_r$: $S_R = 1.134 \times 10^{-3}$ $\quad S_L = 0.289i$ $\quad S_c = -2.891 \times 10^{-3} i$ $\quad S_s = 1.134 \times 10^{-3} + 0.286i$

Let $v_s(t) = 1cos(377t)V$, $R_1 = 90\Omega$, $R_2 = 4\Omega$, $R_3 = 100\Omega$, $C_1 = 50\mu F$ and $C_2 = 6\mu F$. Determine the complex load Z_L to maximize the average power it receives and compute the resulting values for the load: When writing the power as a function of time, write the phase as an angle between -180 and 180 degrees.

$Z_L = Z_{TH}^*$



Note: Use "j" when submitting complex and imaginary numbers (e.g. submit 4+j3 for a complex number with real component 4 and imaginary component 3)

a. Impedance, $Z_L =$ ____ Ω

b. Apparent power received, $S =$ ____ ?

c. Average power received, $P =$ ____ ?

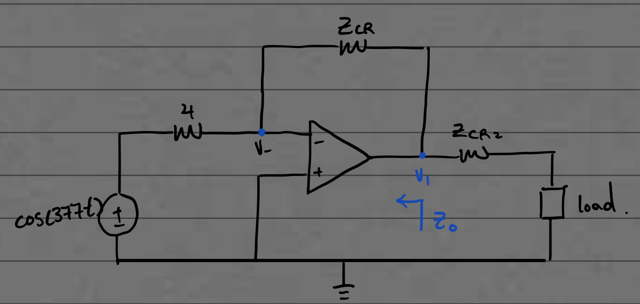
d. Reactive power received, $Q =$ ____ ?

e. Complex power received, $\mathbf{S} =$ ____ ?

f. Instantaneous power received $p(t) =$ ____ + ____ $cos(754t+$ ____ $°)$?

$Z_{C_1} = \dfrac{1}{j(377)(50\times10^{-6})}$ // $R_1 = 90$ $\downarrow$ Z_{CR}

$Z_{C_2} = \dfrac{1}{j(377)(6\times10^{-6})}$ // $R_3 = 100$ $\downarrow$ Z_{CR_2}



$V_- = V_+$

$0 = V_-$

Output Impedance of ideal op-amp is 0.

a) $Z_{TH} = Z_o + (Z_{CR_2})$

$= 0 + 95.132 - 21.5189$

$Z_L = Z_{TH}^*$

b) $V_o = -\dfrac{R_f}{R_i} V_s$

$= -\dfrac{(R_1 // C_1)\cdot 1\angle 0°}{R_2}$

$= -5.80179 + 9.8427i$

$I = \dfrac{V_o}{Z_{CR_2} + Z_L}$

$= -3.04932\times10^{-2} + 0.0517i$

$= 6.005\times10^{-2} \angle 120.517°$

$V_L = I_L Z_L$

$= -4.014109 + 4.265i$

$= 5.85703 \angle 133.2629°$

$S = V_{L rms} I_{rms}$

$= \dfrac{6\times10^{-2}}{\sqrt{2}} \cdot \dfrac{5.857}{\sqrt{2}}$

c) $P = V_{rms} I_{rms} \cos(\theta_v - \theta_i)$

$= 0.17138$ W

d) $Q = V_{rms} I_{rms} \sin(\theta_v - \theta_i)$

$= 3.87\times10^{-2}$ VAr

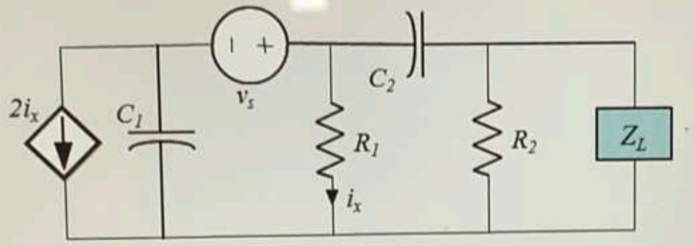
e) $\bar{S} = P + Qj = 0.17138 + 0.0387j$

f) $p_{inst}(t) = V_r I_r \cos(\theta) + V_r I_r \cos(2\omega t + \theta_v + \theta_i)$

$= P +$

$360 - (\theta_v + \theta_i)$ as per question.

Let $v_s(t) = 8cos(2t)V$, $R_1 = 8\Omega$, $R_2 = 7\Omega$, $C_1 = 100mF$ and $C_2 = 650mF$.



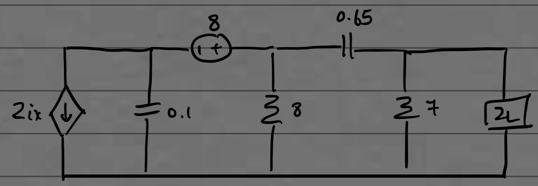
Note: In this problem, you may only submit numerical answers. (i.e. If 4 is the correct answer, 4 will be marked as correct, but 2+2 will be marked as incorrect.)

a. If Z_L is a purely resistive load chosen to maximize the average power it receives, the resistor value is $Z_L =$ ____ Ω

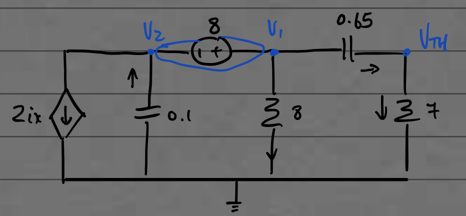
and the resulting average power is $P =$ ____ W.

b. If Z_L is a complex load chosen to maximize the average power it receives, the load value is $Z_L =$ ____ $+j$ ____ Ω

and the resulting average power is $P =$ ____ W.



$\omega = 2$

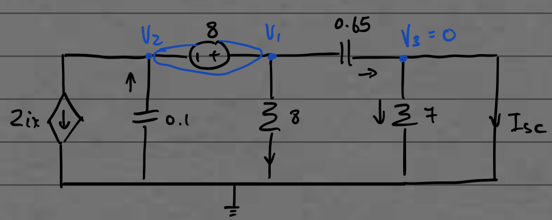


$$\frac{V_1 - V_{TH}}{Z_{C2}} = \frac{V_{TH}}{7}$$

$$\frac{-V_2}{Z_{C1}} = 2i_x + \frac{V_1}{8} + \frac{V_1 - V_{TH}}{Z_{C2}}, \quad i_x = \frac{V_1}{8}$$

$$V_2 = V_1 - 8$$

$$V_{TH} = 0.7023 + 2.727i$$



$$\frac{V_1 - V_3}{Z_{C2}} = \frac{V_3}{7} + I_{sc}$$

$$\frac{V_1 - V_3}{Z_{C2}} + 2i_x + \frac{V_1}{8} = \frac{-V_2}{Z_{C1}}, \quad i_x = \frac{V_1}{8}$$

$$V_2 = V_1 - 8$$

$$V_3 = 0$$

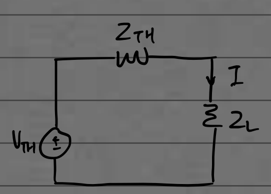
$$i_{sc} = -0.32627 + 1.305i$$

$$Z_{TH} = \frac{V_{TH}}{i_{sc}} = 1.82264 - 1.0705i$$

Purely R:

$$Z_L = |Z_{TH}| = \sqrt{1.82264^2 + 1.0705^2}$$

$$= 2.1129$$



$$I_{rms} = \frac{V_{TH}}{Z_{TH} + Z_L}$$

$$P_L = |I_{rms}^2| Z_L$$

$$= \left[\frac{(0.014^2 + 0.69^2)^{1/2}}{\sqrt{2}}\right]^2 (2.1129)$$

$$= 0.5132$$

$$I = 1.4323 \times 10^{-2} + 0.69687i$$

$$I_{rms} = \frac{I}{\sqrt{2}}$$

Cmplx R:

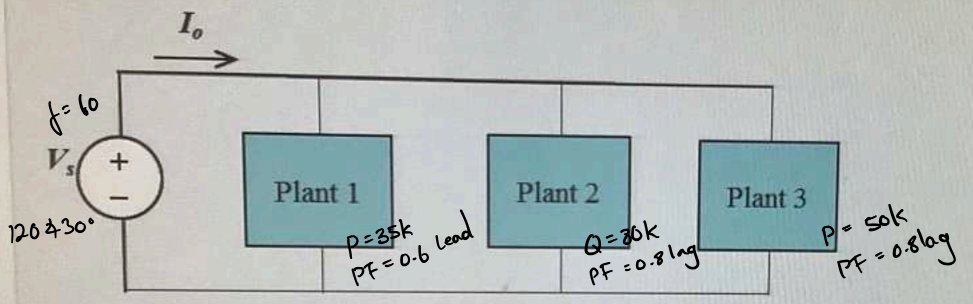
$$Z_L = Z_{TH}^* = 1.82264 + 1.0705i$$

$$P = \frac{|V_{TH}|^2}{8 R_{TH}}$$

$$P_L = \frac{|V_{TH}|^2}{8 R_L} \quad \text{where } R_L = 1.82264$$

$$= 0.5544$$

In the diagram below, the source voltage phasor is $V_s = 120\angle 30^{o} V$ (rms) and measurements show that Plant 1 receives $35kW$ with PF 0.6 leading, plant 2 receives $80kVA$ with PF 0.8 lagging and Plant 3 receives $50kW$ with PF 0.8 lagging. Compute the current phasor I_o and the overall power factor. If the source frequency is $60Hz$, what single passive (time domain) component value should be added in parallel to bring the power factor to unity?



$S = P \cdot pf$

$S_1 + S_2 + S_3 = S_{total}$

$= V_{rms} I_{rms}^*$

$= 120\angle 30^\circ \; (I_o^*)$

Note: In this problem, you may only submit numerical answers. (i.e. If 4 is the correct answer, 4 will be marked as correct, but 2+2 will be marked as incorrect.)

$I_o =$ [ ] $\angle$ [ ] $^\circ A$ (rms)

Overall PF: [ ] ?

Component: [ ] ?

$S = VI \quad P = VI\cos(\theta)$ $\quad\quad P_1 + P_2 + P_3$

$VI = \dfrac{P}{\cos(\theta)} = \dfrac{P}{pf}$

$S = \dfrac{P}{\cos\theta}$ $\quad pf = \cos(\theta)$

$\theta = \cos^{-1}(pf)$ $\quad\quad 0.00715338$

leading

$S_1 = 58.333.33 \angle -53.13$ $\quad S_2 = 80k \angle 36.869$ $\quad S_3 = 62.5k \angle 36.869$

$S_{total} = S_1 + S_2 + S_3$

$I_o^* = \dfrac{S_{total}}{V_s} = \dfrac{153977.36 \angle 14.6078}{120 \angle 30}$

$I_o^* = 1283.144 \angle -15.392$

$I_o = 1283.144 \angle 15.392$

b) $\cos(30 - 14.607) = 0.964$ since $pf > 0$ its lagging

c) $S_{Total} = 149000 + 38833.3i$ → to make unity, we need leading (−) ∴ Capacitor

$\quad\quad P + Qj$

$Q = \dfrac{|V_s|^2}{X_c} = \dfrac{|V_s|^2}{\frac{1}{wC}}$ $\quad\quad Im(S_T) = abs\left(\dfrac{abs(V_s)^2}{\frac{1}{-j wC}}\right)$

$C = \dfrac{Q}{|V_s|^2 w} = \dfrac{38833.\dot{3}}{120^2 \cdot 2\pi 60} = 7.1533 \times 10^{-3}$

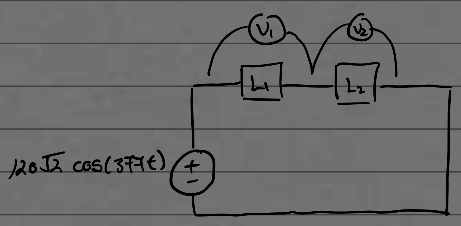
Consider a voltage source, $v_s(t) = 120\sqrt{2}cos(377t)V$, connected across two loads in series $(v_s = v_1 + v_2)$. If the load voltmeter RMS readings measure $100V$ and $46V$, respectively, with the voltage of the first load leading that of the second (by an angle between 0 and 180 degrees), determine the phases for v_1 and v_2. If you also know that load 1 has PF 0.9 lagging, compute the PF of load 2.

Note: In this problem, you may only submit numerical answers. (i.e. If 4 is the correct answer, 4 will be marked as correct, but 2+2 will be marked as incorrect.)

a. Phase of $v_1(t)$: ____ °

b. Phase of $v_2(t)$: ____ °

c. Load 2 PF: ____ ?



$V_1 = 100V \quad V_2 = 46V$

$120\sqrt{2}\cos(377t) = 100\cos(377t + \alpha) + 46\cos(377t + \beta)$

$120\angle 0 = 100\angle\alpha + 46\angle\beta$

$100\angle\alpha \rightarrow (a^2+b^2)^{1/2} = 100$ $\qquad 46\angle\beta \Rightarrow (c^2+d^2)^{1/2} = 46$

$\tan^{-1}\left(\frac{b}{a}\right) = \alpha$ no need $\qquad \tan^{-1}\left(\frac{d}{c}\right) = \beta$ no need

$a + c = 120$ & $b + d = 0$

$a = 92.85$ $\qquad c = 27.15$

$b = 37.13323$ $\qquad d = -37.13323$

$\rightarrow 100\angle 21.797$ $\qquad \rightarrow 46\angle -53.827$

$pf_1 = 0.9$ lag $\qquad pf_2 = \cos(\beta - \theta_i)$

$0.9 = \cos(\alpha - \theta_i)$ $\qquad = \cos(-53.827 - (-4.044))$

$pf_1\theta = 25.8419$ $\qquad = 0.645$ since

$\alpha - \theta_i =$ $\qquad$ pf angle < 0 $\therefore$ leading

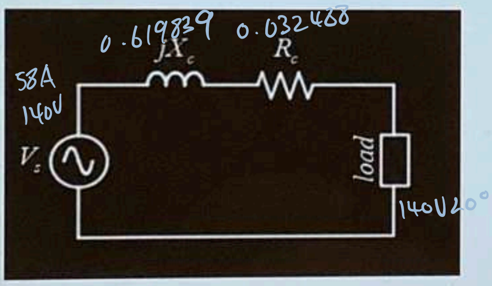
$\theta_i = \alpha - 25.8419$

$= -4.044$

In the quitessential electric power system in the figure, a voltmeter reads the same at the source and at the load, 140 volts. At the source, an ammeter reads 58 amps. The source sees a inductive circuit. The cable (feeder) has a resistance of 0.0324844 ohms and a reactance of 0.619839 ohms. (a) What is the power factor angle, in degrees, at the source; (b) What is the active power delivered by the source; (c) What is the reactive power delivered by the source; (d) What is the power factor angle at the load, in degrees; (e) What is the active power absorbed by the load; (f) What is the reactive power absorbed by the load.

Note: In this problem, you may only submit numerical answers. (i.e. If 4 is the correct answer, 4 will be marked as correct, but 2+2 will be marked as incorrect.)

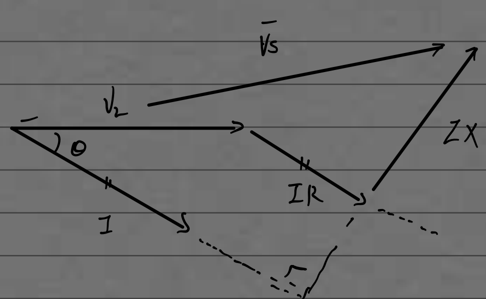
Simple Power System



(a) θ_s = 3 deg

(b) P_s = W

(c) Q_s = VAr



$\cos\theta = \frac{I}{V_S}$ $\quad \sin\theta \cdot \frac{IX}{V_S}$

$P_L = I_L V_L \cos\theta$

$=$

$V_S^2 = (\cos\theta\, V_L + IR)^2 + (\sin\theta\, V_L + IX)^2$

$140^2 = (140\cos\theta + 58(0.0324844))^2 + (140\sin\theta + 58(0.619839))^2$

$19600 = (140\cos\theta + 1.8840952)^2 + (140\sin\theta + 35.950)^2$

$= 19600\cos^2\theta + 2\cdot 263.77\cos\theta + 3.54981 + 19600\sin^2\theta + 2\cdot 5033.09\sin\theta + 1292.45$

$= 19600\cos^2\theta + 19600\sin\theta + 527.5466\cos(x) + 10066.2\sin(x) + 1296$

$\theta = -175.612^\circ$ or -10.387°

$I = 58 \angle 10.387$

$V_S = 140\angle 0^\circ + (0.0324844 + 0.619839j)(58\angle 10.387)$

$= 140 \angle 14.77$

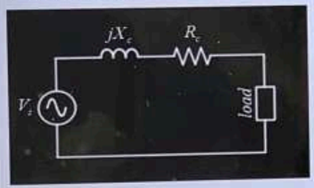
a) $\theta_s = \theta_v - \theta_i$

$= 14.77 - 10.387$

In the quitessential electric power system in the figure, a voltmeter reads the same at the source and at the load, 146 volts. At the source, an ammeter reads 52 amps. The source sees a capacitive circuit. The cable (feeder) has a resistance of 0.550543 ohms and a reactance of 0.704663 ohms. (a) What is the power factor angle, in degrees, at the source; (b) What is the active power delivered by the source; (c) What is the reactive power delivered by the source; (d) What is the power factor angle at the load, in degrees; (e) What is the active power absorbed by the load; (f) What is the reactive power absorbed by the load.

Note: In this problem, you may only submit numerical answers. (i.e. If 4 is the correct answer, 4 will be marked as correct, but 2+2 will be marked as incorrect.)

Simple Power System



$Z = 52 \angle 47.1681$

$V_s = 146 \angle 0^\circ + (52 \angle -47.038^\circ)(0.550543 + 0.7\ldots j)$

$= 146 \angle 18.3263$

$\theta_s = \theta_v - \theta_i$

$= 18.3263 - 47.038$

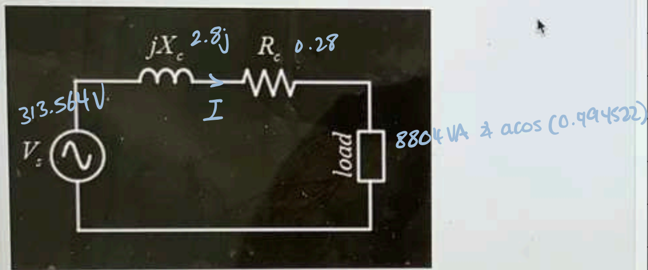
$= -28.837$

lag

In the figure, the load absorbs 8.804 kVA at a power factor 0.994522 inductive. For the feeder (cable) R = 0.28 ohms, and X = 10R. The voltage at the source is 313.564 volts. What is the voltage at the load, in volts?

Note: In this problem, you may only submit numerical answers. (i.e. If 4 is the correct answer, 4 will be marked as correct, but 2+2 will be marked as incorrect.)

Simple Power System



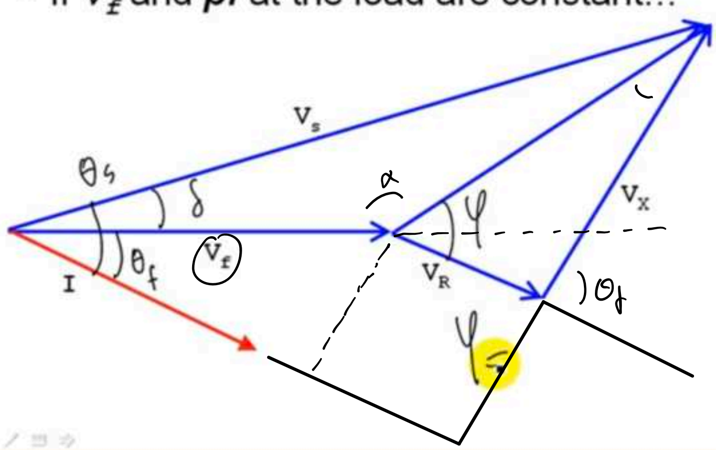
V_{load} = V

$S_L = 8804$ $pf = 0.994522$ → $S_L = 8804 \angle \cos^{-1}(pf)$

$\frac{V_s - V_L}{jX_c + R_c} = \left(\frac{\bar{S}}{\bar{V}_L}\right)^*$ $\bar{S} = \bar{V}\bar{I}^*$

If only I(rms) changes

- If v_f and *pf* at the load are constant…



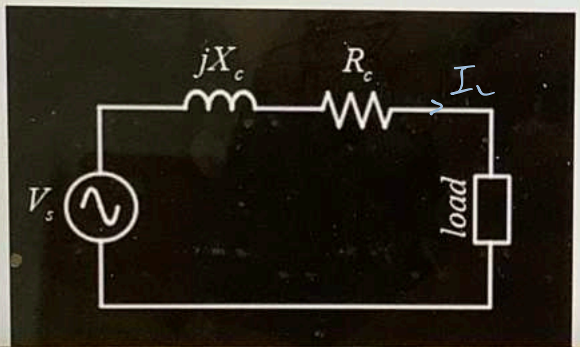
$\cancel{\cos}$ sin $\theta_s = \frac{V_x + \cos\theta_f V_L}{V_s}$

$\cos\theta_s = \frac{I + \sin\theta_f V_L}{V_s}$

In the figure, a 247.574 volts source delivers 3.96118 kVA at a power factor 0.972502 inductive through a cable with R = 0.07 ohms and X = 6R to a load. Compute: (a) the voltage at the load; (b) the active power of the load; (c) the reactive power of the load and (d) the power factor angle of the load.

Note: In this problem, you may only submit numerical answers. (i.e. If 4 is the correct answer, 4 will be marked as correct, but 2+2 will be marked as incorrect.)

Simple Power System



245.012

12°

$I_L = \frac{S}{V_S}$ $\theta = \cos^{-1}(pf)$

$Z_{TH} = \frac{V_S}{I_L \angle(-\theta)}$ lag

$Z_{TH} - Z_R - Z_C = Z_L$

$V_L = I_L Z_L$

b) $P = 2V\cos(\theta_L)$ $\theta_L = (\theta_V - \theta_L)$

$=$ $= 12$

$\bar{S} = S\angle\theta = \bar{V}\bar{I}^*$

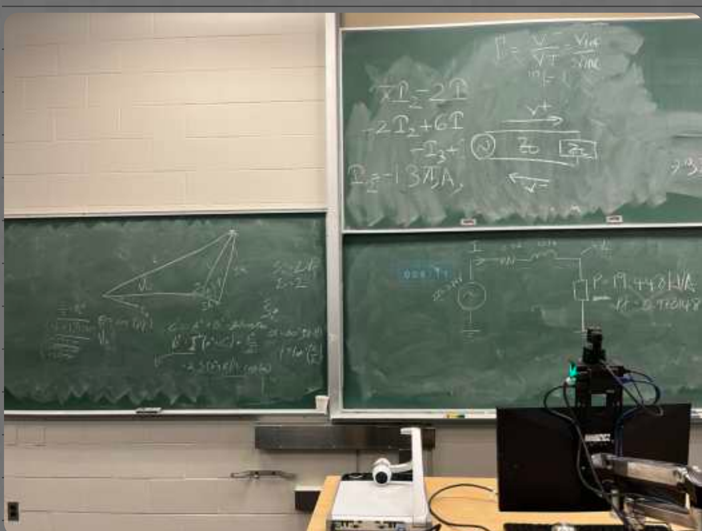
$\bar{I} = \left(\frac{S\angle\theta}{\bar{V}}\right)^*$

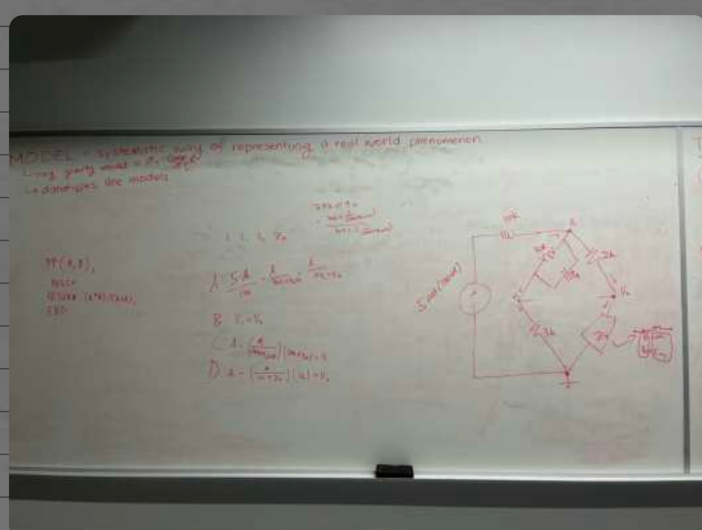
$= 15.56 - 3.72i$

$V_L = V_S - V_Z$

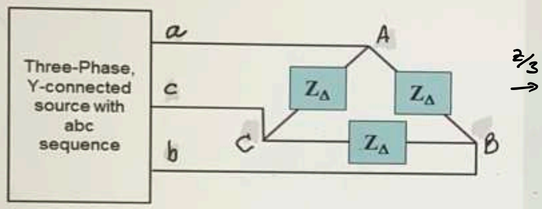
$= V_S - \bar{I}(Z_L + R)$

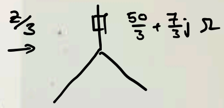
$= 253.65 - 44.611i$





For the balanced three phase circuit below, take $V_{an} = 165\angle 0°V$, $V_{bn} = 165\angle -120°V$, $V_{cn} = 165\angle 120°V$ and $Z_\Delta = 50 + j7\Omega$. Compute the requested line voltage, line current, phase current and total complex power supplied to the load. Compute the load PF (specify leading or lagging) and determine the value of a component that can be added in parallel to each branch of the delta load (i.e., three identical components) to raise the PF to unity; to do the latter, assume the frequency of operation is $60Hz$.





Note: In this problem, you may only submit numerical answers. (i.e. If 4 is the correct answer, 4 will be marked as correct, but 2+2 will be marked as incorrect.)

$V_{ab} =$ ∠ °V

$I_a =$ ∠ °A

$I_{AB} =$ ∠ °A

$S_L =$ ∠ °VA

PF = ?

$V_{an} = 165\angle 0°V$, $V_{bn} = 165\angle -120°V$, $V_{cn} = 165\angle 120°V$ and $Z_\Delta = 50 + j7\Omega$.

$V_{an} = 165 \angle 0°\ V \rightarrow V_{ab} = 165\sqrt{3} \angle 30° = V_L$

$I_a = \dfrac{V_{an}}{\left(\frac{Z_\Delta}{3}\right)} = \dfrac{165}{\left(\frac{50}{3} + \frac{7}{3}j\right)} = 9.804 \angle -7.969°$

$I_{AB} = \dfrac{V_{ab}}{Z_\Delta} = \dfrac{165\sqrt{3} \angle 30°}{50 + 7j} = 5.66 \angle 22.03°$

$S_L = 3 V_\phi I_\phi$ with $\angle V_\phi° - I_\phi°$ or $\sqrt{3}\, V_{an} I_a$

$= 3 V_{AB} I_{AB} \angle 30 - 22.03$

$pf = \cos(30 - 22.03)$

$= 0.9903$

$\text{Im}(Z_\Delta \,//\, Z_x) = 0$

$\text{Im}\left((50 + 7i) \,//\, \dfrac{1}{j\omega C}\right) = 0$

$\text{Im}\left(50 + 7j \,//\, \dfrac{1}{2\pi f \cdot C \cdot j}\right) = 0$

$C = 7.2844E{-6}\ F$