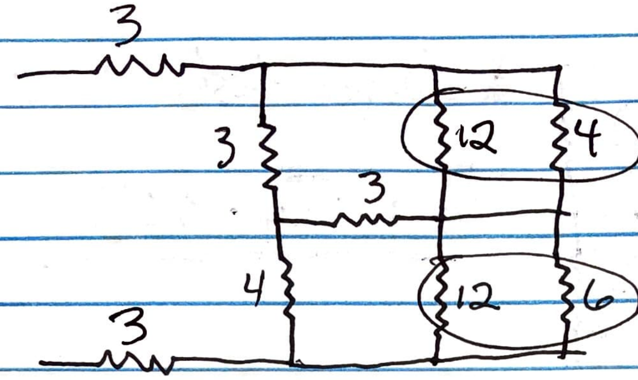
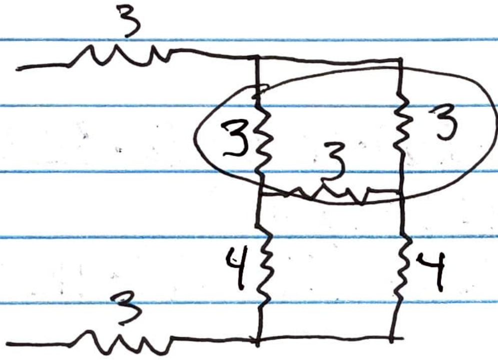
Final Exam

1.)



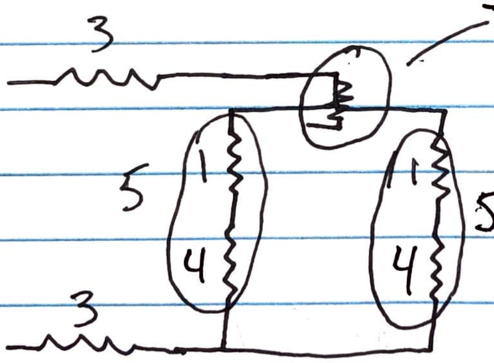
$12 \| 4 = 3\Omega$

$12 \| 6 = 4\Omega$



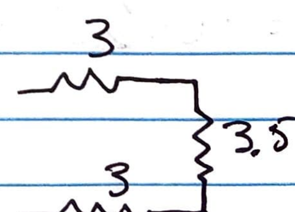
* Delta-wye

$R_1 = R_2 = R_3 = \frac{3 \cdot 3}{3+3+3}$



$\rightarrow R_1 = 1$
$R_2 = 1$
$R_3 = 1$

$5 \| 5 = 2.5\Omega$



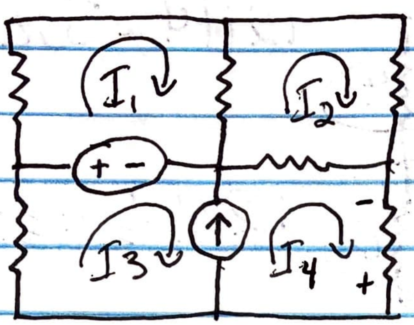
$2.5 + R_1 = 3.5\Omega$

$\Rightarrow 3 + 3.5 + 3 = 9.5\Omega$

$R_{eq} = 9.5\Omega$

$P_{sup} = I^2 \cdot R_{eq} = 5^2 \cdot 9.5 = 237.5\,W$

2.)



* Super Mesh.

$V_0 = -I_4 \cdot 3K\Omega$

$I_4 - I_3 = 4mA$

$I_3 \cdot 6K\Omega + 18 + (I_4 - I_2) \cdot 1K\Omega + I_4 \cdot 3K\Omega = 0$

$I_1 \cdot 3K\Omega + (I_1 - I_2) \cdot 1K\Omega - 18 = 0$

$(I_2 - I_1) \cdot 1K\Omega + I_2 \cdot 6K\Omega + (I_2 - I_4) \cdot 1K\Omega = 0$

$I_1 = 4.667 mA$

$I_2 = 0.667 mA$

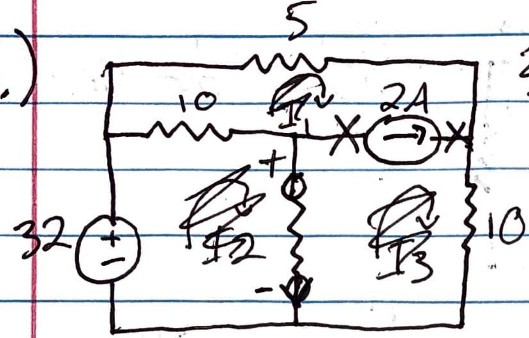
$I_3 = -3.33 mA$

$I_4 = 0.667 mA$

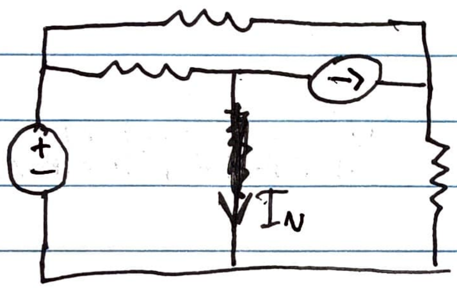
$V_0 = -0.667 \cdot 3K\Omega = -2V$

Final Exam.

3.)



~~$32\cdot\frac{5+10}{5+10+10} = 19.2A$~~



Solve for I_N

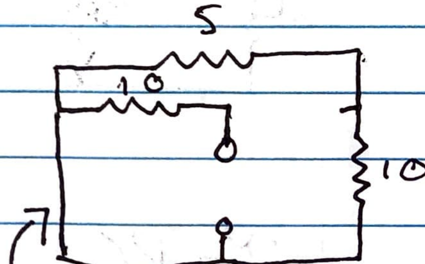
$I_1 = 0.8$

$I_2 = 4$

$I_3 = 2.8$

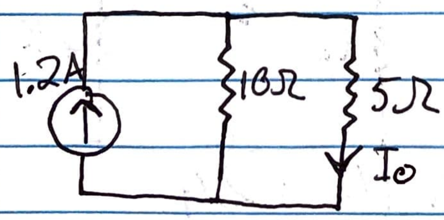
$I_N = I_2 - I_3 = 4 - 2.8 = \underline{1.2A}$

$R_{th} = 10\Omega$



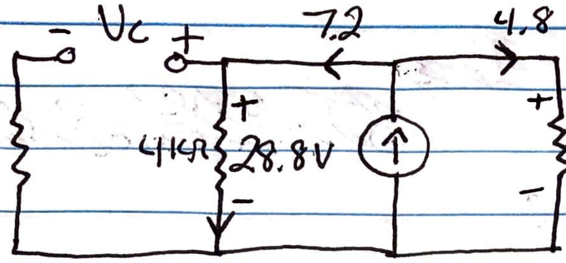
The 5 & 10Ω Are shorted by

Norton Circuit.



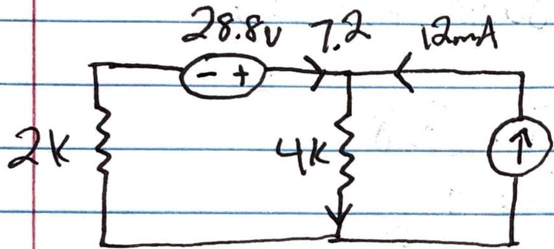
$I_o = 1.2 \cdot \frac{10}{5+10} = 0.8A$

4.) Solve for Vc.

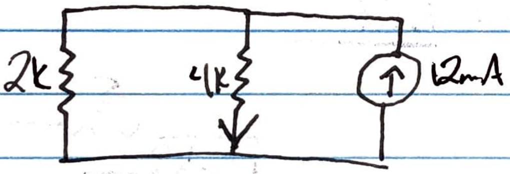


$12mA \cdot \frac{6}{4+6} = 7.2$

$V_c = 28.8v$



$K_1 + K_2 = 19.2mA$



$K_1 = 12 \cdot \frac{2}{4+2} = 4mA$

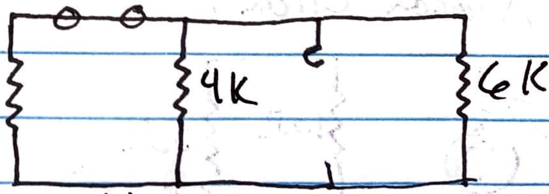
$K_2 = 19.2 - 4 = 15.2$

$\tau = RC$

$C = 1.667\mu F$

$R = 4.4K\Omega$

$\Rightarrow \tau = 7.3348$



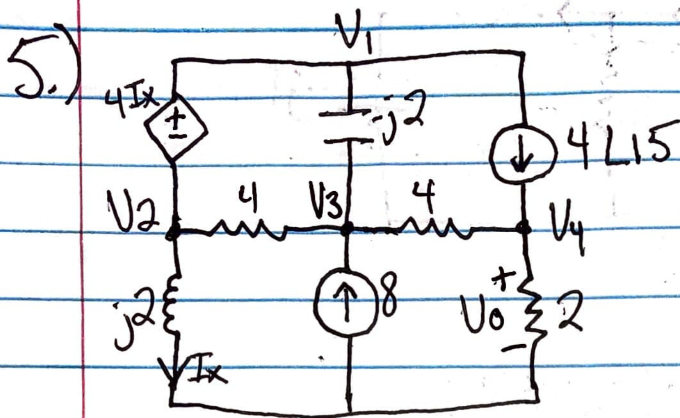
$4 \| 6 = 2.4$

$2.4 + 2 = 4.4K = R$

$\Rightarrow 4 + 15.2e^{-t/7.3348}\ mA$

Final Exam

5.)



$V_o = V_4$

$\cancel{V_1 = 4I_x}$ Equations

1 $V_1 - V_2 = 4I_x$

2 $\frac{V_1 - V_3}{-j2} + 4\angle 15 + \frac{V_2 - V_3}{4} + \frac{V_2}{j2} = 0$

3 $\frac{V_3 - V_1}{-j2} + \frac{V_3 - V_2}{4} + \frac{V_3 - V_4}{4} - 8 = 0$

4 $-4\angle 15 + \frac{V_4 - V_3}{4} + \frac{V_4}{2} = 0$

5 $I_x = \frac{V_2}{j2}$

$V_1 =$

$V_2 =$

$V_3 =$

$V_4 =$

$I_x =$

$V_o = V_4 =$

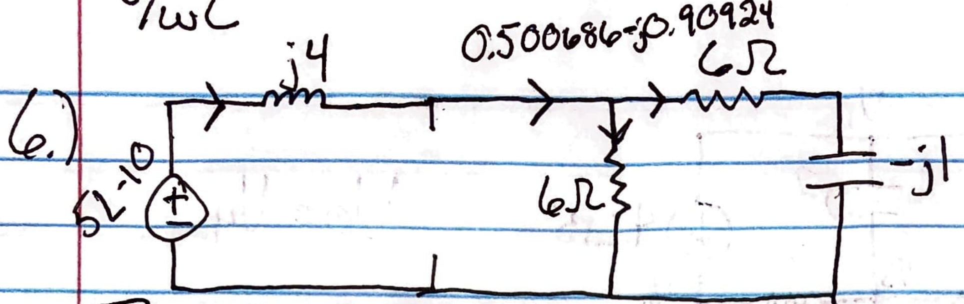
* Honestly, I put these equations in my TI-NSpire and a "Calculating" symbol came up for 10 minutes I think I broke it! LOL.

$j\omega L$

$-j/\omega C$

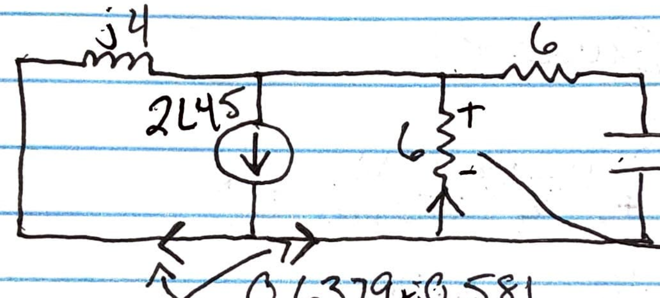
$V_o = V_o' + V_o''$

6.)



$Z_{eq} = 3.021 + j3.752$

$V_o' = 3.14599\angle -65.8587$



Voltage Divider

→ This will need to be negative

$\underline{\underline{0.1782 + j1.177}} \cdot \frac{6 - j1}{6 - j1 + 6} =$

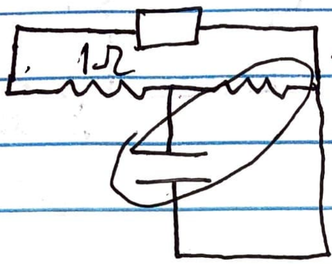
$V_o'' = 3.51416\angle 87.7421$

$V_o = V_o' + V_o'' = \underline{\underline{1.56247\angle 24.2039\ V}}$

Final Exam

7.) Z_L = Complex Conjugate of Z_{th}

Z_{th} =



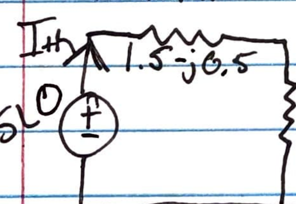
parallel = 0.5 + j0.5

$Z_{th} = 1 + (0.5 - j0.5) \Rightarrow \underline{1.5 - j0.5}$

$Z_L = \underline{1.5 + j0.5}$

$V_{th} = 5\angle 0\ V$

Thevenin Circuit



* This makes the reactive part = 0.

Z_{eq} of Thevenin's = 1.5 + 1.5 = 3Ω

$I_{th} = 5/3 = 1.667A$

$I_{th} \cdot 1.5 + j0.5 = V_L$

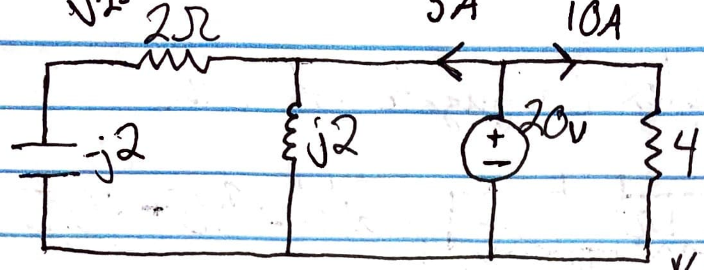
$I_{th} \cdot V_L = P_{L,max} = $ 4.1675+j1.38917

or

$4.3929 \angle 18.4349.$

8.)

$V_{2\Omega} = 2 \cdot 5 = 10$



$V_{4\Omega} = 10 \cdot 4 = 40$

* Caps and inductors absorb NO real power.

$Z_{eq} = 4/3$ or 1.33

$I_S = \frac{20}{1.33} = 15A$

$S_{vs} = 20 \cdot 15A = -300W$ * Since it says absorbed.

$S_{4\Omega} = 400W$

$S_{j2\Omega} = 0$

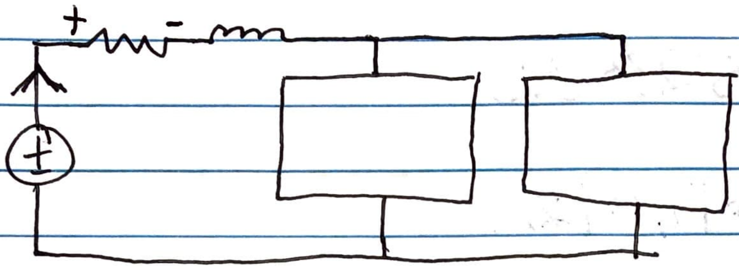
$S_{2\Omega} = 50W$

$S_{-j2\Omega} = 0$

$S_{vs} = -300W$

Final Exam.

9.) $P_{Load} = V_{Load} \cdot I_{Load} \cdot pf$



$100kW = 480 \cdot I \cdot pf$

$I = 231.481$

$150k = 480 \cdot I \cdot pf$

$I = 325.521$

$V = 325.521 \cdot 0.4\Omega$

$V_s = 130.208V$

* 60Hz 377t

10.) $Q_{old} = P\tan(\cos^{-1}(pf))$

$Q_{old} = 52350.3$

$Q_{new} = 17,092.7$

$Q_{old} - Q_{new} = \omega \cdot V_{rms}^2 \cdot C$

$35257.6 = 377 \cdot 220^2 \cdot C$

$C = 0.001932$

or

1.932 mF

Bonus: Larger, since the component of capacitors are negative j, we need pf to be negative (since leading is negative) we need a higher capacitor value.