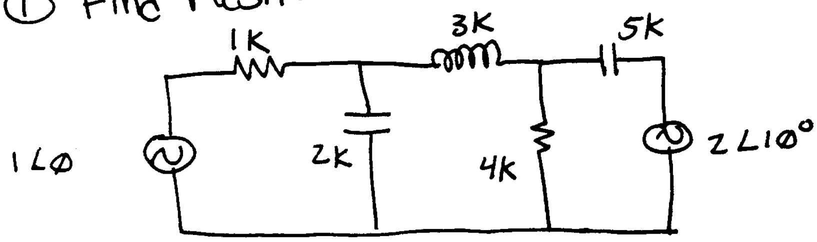
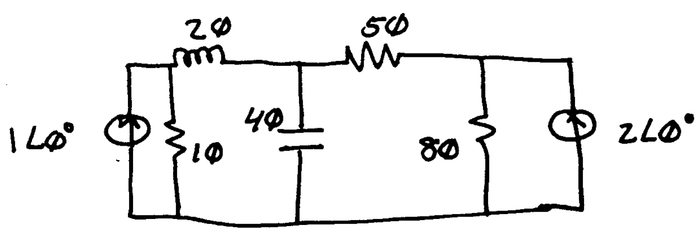
AC Circuits worksheet

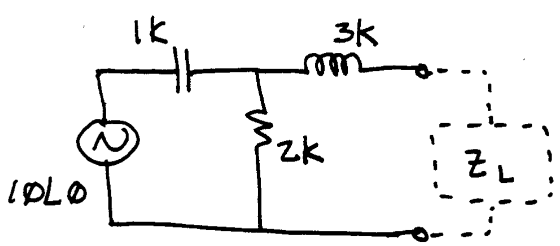
① Find Mesh:



② Find Nodal:



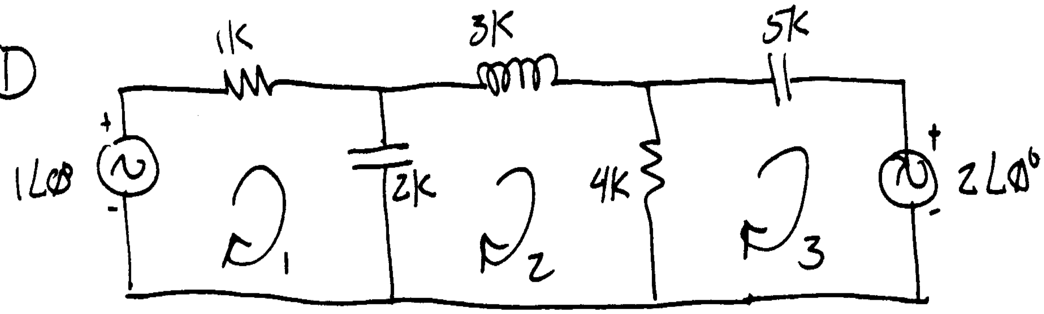
③ Find Thevenin + Norton Equivalents, find Z_L for max power transfer and P_L for that case.



④ A 120V system has 3 loads in parallel: A resistive 800W, A resistive 1200W, and a 2HP motor with $\eta = .85$ and a .7 lagging power factor. Draw the power triangle and determine a parallel load for a total $F_p = 1$.

AC circuits (Answers)

①



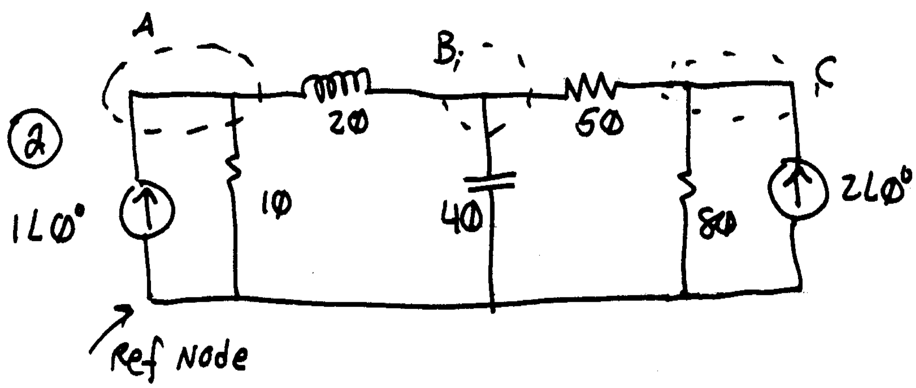
$$\#1: \quad 1\angle 0^\circ = i_1(1K - j2K) - i_2(-j2K)$$

$$\#2: \quad 0 = -i_1(-j2K) + i_2(4K + j3K - j2K) - i_3(4K)$$

$$\#3: \quad -2\angle 0^\circ = -i_2(4K) + i_3(4K - j5K)$$

-combine, simplify, & solve-

②



$$A: \quad 1\angle 0^\circ = V_A\left(\frac{1}{10} + \frac{1}{j20}\right) - V_B\left(\frac{1}{j20}\right)$$

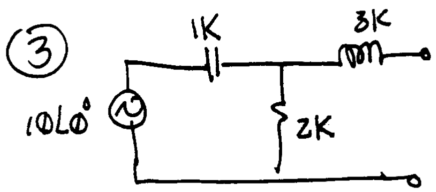
$$B: \quad 0 = -V_A\left(\frac{1}{j20}\right) + V_B\left(\frac{1}{50} + \frac{1}{j20} - \frac{1}{j40}\right) - V_C\left(\frac{1}{50}\right)$$

$$C: \quad 2\angle 0^\circ = -V_B\left(\frac{1}{50}\right) + V_C\left(\frac{1}{50} + \frac{1}{80}\right)$$

-combine, simplify, & solve-

AC circuits (answers, 2)

(3)



$Z_{Th} = Z_N = (2K \| -j1K) + j3K$

$Z_{Th} = Z_N = 2.24K \angle 79.7°$

$E_{Th} = 10\angle 0 \cdot \dfrac{2K}{2K - j1K} = 8.94 \angle 26.6°$

For I_N, either find the short circuit output current, or do a source conversion from the thevenin form.

$I_N = E_{Th}/Z_{TH} = 8.94\angle 26.6° / 2.24K \angle 79.7° = 3.99mA \angle -53.1°$

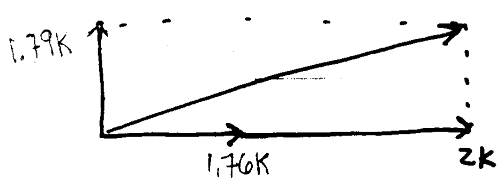
$Z_L = 2.24K \angle -79.7°$ $\quad (400.5 - j2.2K)$

$P = \dfrac{E_{Th}^2}{4R} = \dfrac{8.94^2}{4 \cdot 400.5} = 49.9\ mW$

(4) Resistive = 2000W; Inductive ⇒ $2HP \cdot 746W/HP \cdot \dfrac{1}{.85} = 1.76\ kW$

$F_p = \cos\theta$, $\theta = \cos^{-1} F_p = 45.6°$ $\quad S = 1.76KW/.7 = 2.51KVA$

This is equivalent to: 1.76 KW resistive + 1.79K Inductive.



(3.76 K TOTAL)

Result: $4.16K \angle 25.5°$ — Apparent power, in VA

To get back to $F_p = 1$, we need Q = 1.79 KVAR capacitive.

$Q = \dfrac{V^2}{X_C}$, $\quad X_C = \dfrac{V^2}{Q} = \dfrac{120\ VAC^2}{1.79\ KVAR} = 8.04\ \Omega$

$X_C = \dfrac{1}{2\pi f C}$ $\quad C = \dfrac{1}{2\pi f X_C} = \dfrac{1}{2\pi 60Hz \cdot 8.04\Omega} = 330\ uF$