Engr M20 HW #11

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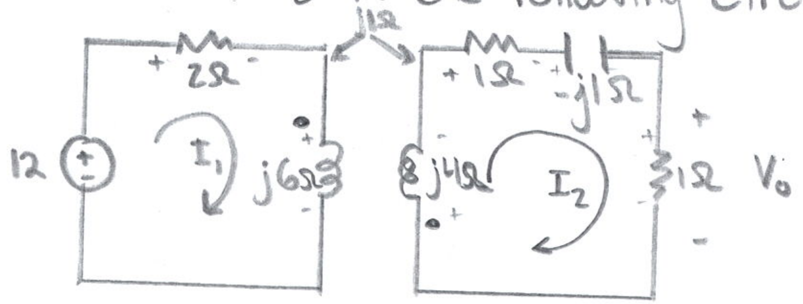
1) Determine V_o in the following circuit:



Note: Currents I_1 and I_2 are entering the "dotted" side which means that the mutual inductance is the same sign.

$M_1 = j1(I_2)$, $M_2 = j1(I_1)$

KVL loop 1: $-12 + 2I_1 + j6(I_1) + j1(I_2) = 0$ (Eq 1)

KVL loop 2: $I_2 - j1(I_2) + I_2 + j4(I_2) + j1(I_1) = 0$ (Eq 2)

(Eq 1) $\rightarrow$ $I_1(2+j6) = 12 - j1(I_2) \rightarrow I_1 = \dfrac{12 - jI_2}{2+j6}$

(Eq 2) $\rightarrow$ $2I_2 + j3I_2 + j\left(\dfrac{12 - jI_2}{2+j6}\right) = 0$

$\left(2I_2 + j3I_2 + \dfrac{j12 + I_2}{2+j6} = 0\right)(2+j6)$

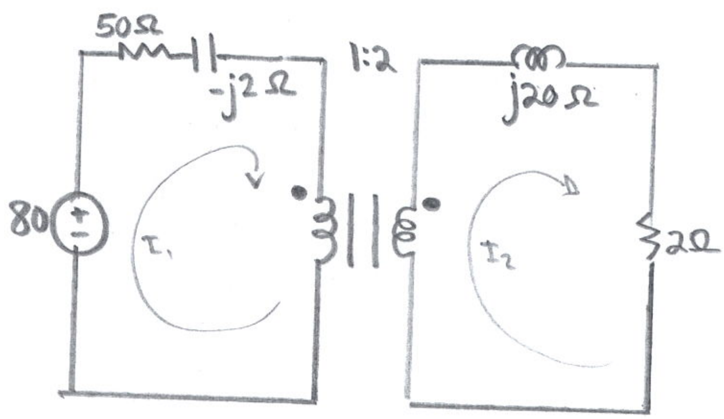
$\rightarrow 4I_2 + j12I_2 + j6I_2 - 18I_2 + j12 + I_2 = 0$

$\rightarrow -13I_2 + j18I_2 = -j12$

$I_2 = \dfrac{-j12}{-13+j18} = \dfrac{12\angle +90^\circ}{22.2\angle \cancel{+54.16}} = .54 \cancel{\angle +144.16^\circ}$

$\therefore V_o = I_2 R = (1)(.54\cancel{\angle -35.84^\circ}) = \boxed{540.5 \cancel{\angle 144.16^\circ} \text{ mV}}$

2) Find the power absorbed by the 2Ω resistor in the following ckt:



<u>Note:</u> $P = VI = I^2R$

$\rightarrow \quad P = (2)(I_2^2)$

So, find I_2.

<u>Note:</u> $n = \frac{2}{1} = 2$

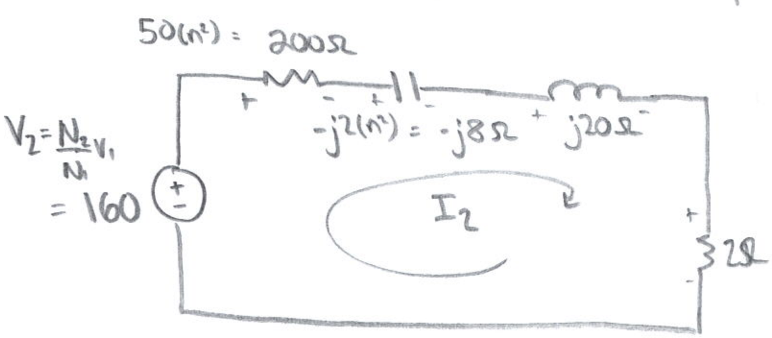
and $Z_{in} = \frac{Z_L}{n^2}$

$\rightarrow (Z_{in})n^2 = Z_L$

and $\frac{V_1}{V_2} = \frac{N_1}{N_2}$

$\rightarrow V_2 = \frac{N_2 V_1}{N_1}$

Reflect loop 1 onto loop 2.



KVL: $-160 + 200I_2 - j8I_2 + j20I_2 + 2I_2 = 0$

$$202I_2 + j12I_2 = 160$$

$$I_2 = \frac{160}{202+j12} = \frac{160\angle 0^\circ}{202.4\angle 3.4^\circ} = \underline{0.7907\angle -3.4^\circ} \text{ A}$$

$\therefore \; P = I^2R = (2)(0.7907\angle -3.4^\circ)^2 = 1.3\angle +6.8^\circ$ W

$\longrightarrow P = \underline{1.3\text{W}} - j0.15\text{VA}$

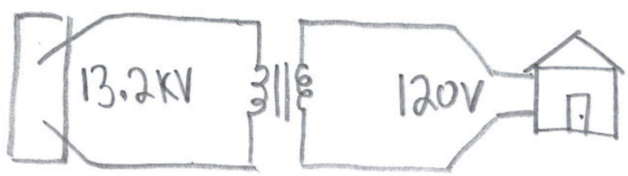
or,

$\longrightarrow \boxed{1.3\text{W}}$

3) The three-phase system of a town distributes power with a line voltage of 13.2 kV. A pole transformer connected to single wire and ground steps down the high voltage wire to 120 V_{rms} and serves the house as shown below.

a) Calculate the turns ratio of the pole transformer to get 120V.

b) Determine how much current a 100-W lamp connected to the 120-V hot line draws from the high voltage line.



a) Note: $n = \frac{V_2}{V_1} = \frac{N_2}{N_1} \Rightarrow \frac{120}{13200} = \boxed{\frac{1}{110}}$ ← secondary ← primary

b) Note: $\frac{I_1}{I_2} = \frac{N_2}{N_1}$

$P = VI \rightarrow I = \frac{P}{V} = \frac{100}{120} = 0.8333A$

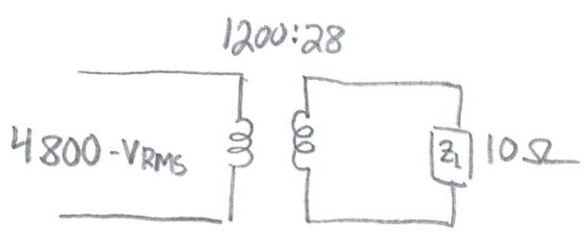
$\frac{I_1}{I_2} = \frac{N_2}{N_1} \rightarrow I_1 = I_2 \frac{N_2}{N_1} = (0.8333A)\left(\frac{1}{110}\right) = \boxed{7.58mA}$

4) A 4800-V_{rms} transmission line feeds a distribution transformer with 1200 turns on the primary and 28 turns on the secondary. When a 10-Ω load is connected across the secondary, find:

a) the secondary voltage

b) the primary and secondary currents

c) the power supplied to the load.



a) $\frac{V_2}{V_1} = \frac{N_2}{N_1} = \frac{28}{1200} \rightarrow V_2 = (4800)\left(\frac{28}{1200}\right) = \boxed{112\,V}$

b) $I_s = \frac{V}{R} = \frac{112}{10} = \boxed{11.2A}$

$\frac{I_1}{I_2} = \frac{N_2}{N_1} = \frac{28}{1200} \rightarrow I_1 = (11.2)\left(\frac{28}{1200}\right) = \boxed{261.33\,mA}$

c) $P = VI = (112)(11.2) = \boxed{1254.4\,W}$