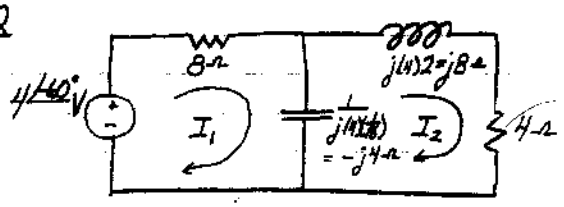
EE 212 HW4 SOLN.

PR 9.2, 9.3, 9.4

9.2



I_1 mesh: $-4\angle 40^\circ + 8I_1 + (-j4)(I_1 - I_2) = 0$

$\Rightarrow I_1(8 - j4) + I_2(j4) = 4\angle 40^\circ$

I_2 mesh: $(-j4)(I_2 - I_1) + j8I_2 + 4I_2 = 0$

$\Rightarrow I_1(j4) + I_2(-j4 + j8 + 4) = 0$

$\Rightarrow I_1(j4) + I_2(4 + j4) = 0$

$\Rightarrow I_1 = \frac{I_2(4+j4)}{-j4}$

$= \frac{I_2(4+j4)\,j4}{(-j4)(j4)}$

$= \frac{I_2(16j - 16)}{16}$

$= I_2(-1 + j)$

$I_2(-1+j)(8-j4) + I_2 j4 = 4\angle 40^\circ$

$\Rightarrow I_2(-8 + j4 + j8 + 4 + j4) = 4\angle 40^\circ$

$\Rightarrow I_2(-4 + j16) = 4\angle 40^\circ$

$\Rightarrow I_2 = \frac{4\angle 40^\circ}{16.49\angle 104^\circ}$

$= 0.243\angle -164^\circ$ A

$\Rightarrow I_1 = (\sqrt{2}\angle 135^\circ)(0.243\angle -164^\circ)$

$= 0.343\angle -29^\circ$ A

$\Rightarrow P_{8\Omega} = \frac{1}{2}(0.343)^2 8 = 0.471\,W = 471\,mW$

$P_{4\Omega} = \frac{1}{2}(0.243)^2 4 = 0.118\,W = 118\,mW$

$P_{2H} = 0\,W$

$P_{1/16F} = 0\,W$

$P_{source} = -\frac{1}{2}(4)(0.343)\cos(-60^\circ - (-29^\circ))$ (due to passive sign convention)

$= -0.588 = -588\,mW$

P_{source}	$-588\,mW$
$P_{8\Omega}$	$471\,mW$
P_C	$0\,W$
P_L	$0\,W$
$P_{4\Omega}$	$118\,mW$

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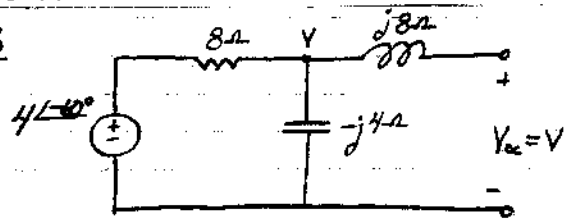
9.3



→ find Thevenin equivalent circuit

node eqn @ $V = V_{oc}$: $\frac{V-4\angle -60^\circ}{8\Omega} + \frac{V-0}{-j4} = 0$

$\times j8$ ⇒ $jV - j4\angle -60^\circ - 2V = 0$

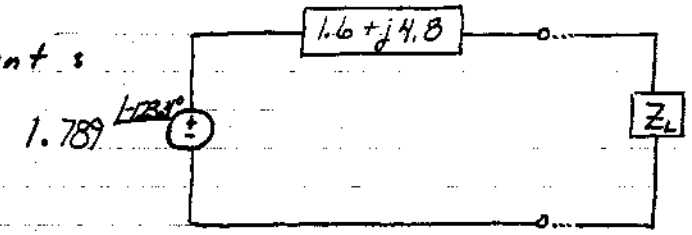
⇒ $V(-2+j) = 4\angle 30^\circ$

⇒ $V = \frac{4\angle 30^\circ}{\sqrt{2^2+1^2}\,\angle \tan^{-1}(1/-2)} = 1.789\angle -123.4^\circ$

$Z_o = \frac{8(-j4)}{8-j4} + j8 = \frac{-j32}{8-j4} + j8 = \frac{-j32(8+j4)}{8^2+4^2} + j8$

$= \frac{128(-j2+1)}{80} + j8 = 1.6 + j4.8\,\Omega$

⇒ Thevenin equivalent:



a) for max. power transfer $Z_L = 1.6 - j4.8\,\Omega$

$P_{Lmax} = \frac{|V_{oc}|^2}{8R_o} = \frac{1.789^2}{8 \cdot 1.6} = 0.25\,W$

$Z_L = 1.6 - j4.8\,\Omega$

$P_{Lmax} = 0.25\,W$

b) $R_L = \sqrt{1.6^2 + 4.8^2} = 5.06\,\Omega$

$P_{Lmax} = \frac{\frac{1}{2}(1.789)^2(5.06)}{(1.6+5.06)^2 + 4.8^2} = 0.12\,W$

$R_L = 5.06\,\Omega$

$P_{Lmax} = 0.12\,W$

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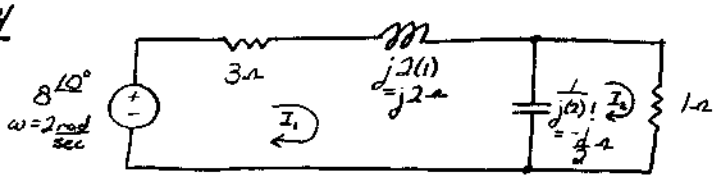
9.4



mesh I_1: $-8 + 3I_1 + j2I_1 + \left(\frac{-j}{2}\right)(I_1 - I_2) = 0$

$\Rightarrow \left(3 + j2 - \frac{j}{2}\right)I_1 + \frac{j}{2}I_2 = 8$

$\rightarrow (16 + j4 - j)I_1 + jI_2 = 16$

$\Rightarrow (6 + 3j)I_1 + jI_2 = 16$

mesh I_2: $\left(\frac{-j}{2}\right)(I_2 - I_1) + I_2 = 0$

$\rightarrow \frac{j}{2}I_1 + \left(1 - \frac{j}{2}\right)I_2 = 0$

$\Rightarrow jI_1 + (2 - j)I_2 = 0$

$\Rightarrow I_1 = \frac{1}{j}(j - 2)I_2$

$= (1 + j2)I_2$

$(6 + j3)(1 + j2)I_2 + jI_2 = 16$

$\Rightarrow (6 + j12 + j3 - 6 + j)I_2 = 16$

$\Rightarrow j16I_2 = 16$

$\Rightarrow I_2 = \frac{1}{j} = -j = 1\angle -90°$ $\Rightarrow I_1 = (1 + j2)(-j) = -j + 2 = \sqrt{5}\angle -26.6°$

$P_{source} = -\frac{1}{2}(8)(\sqrt{5})\cos(0° - (-26.6°)) = \underline{-8W}$

$P_{3\Omega} = \frac{1}{2}(\sqrt{5})^2(3) = \underline{7.5W}$

$P_{1H} = \underline{0W}$

$P_{1F} = \underline{0W}$

$P_{1\Omega} = \frac{1}{2}(1)^2(1) = \frac{1}{2} = \underline{0.5W}$