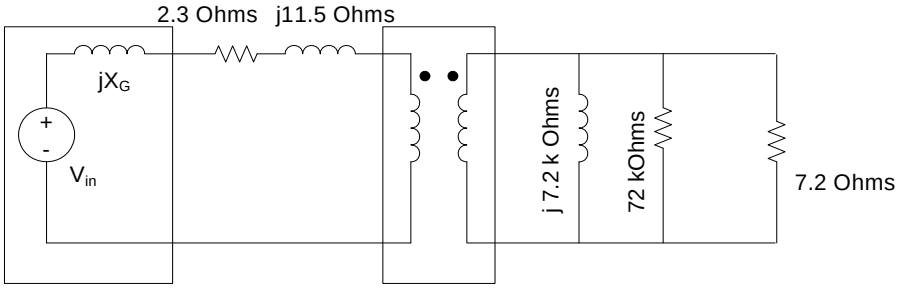
ECE 320 / ECE 329 NAME _____

Quiz 5 22 February 2012

Per Unit

1. (6 points) For the transformer circuit shown below:
   a. Specify the base for each region of the circuit.
   b. Convert all the impedances to per unit on the base that you specify.
   c. Draw the per unit circuit that your analysis creates.



Generator
480V, 2.5kVA
X_G=0.50pu

Ideal Transformer
480V: 120V
2.0kVA

Select a base of 480V : 120V, 2.0kVA

$$Z_{baseR} := \frac{(120\cdot V)^2}{2000\cdot V\cdot A} = 7.2\,\Omega \qquad Z_{baseL} := \frac{(480\cdot V)^2}{2000\cdot V\cdot A} = 115.2\,\Omega$$

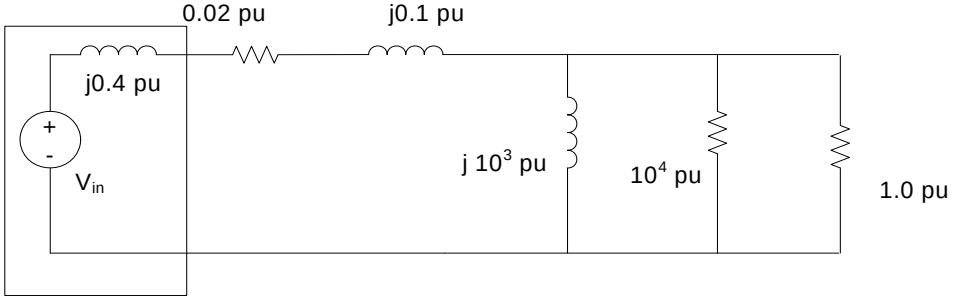
$$R_{Lpu} := \frac{7.2\cdot\Omega}{Z_{baseR}} = 1 \qquad X_p := \frac{11.5\cdot\Omega}{Z_{baseL}} = 0.1$$

$$R_{Cpu} := \frac{72\cdot k\Omega}{Z_{baseR}} = 1\times 10^4 \qquad R_P := \frac{2.3\cdot\Omega}{Z_{baseL}} = 0.02$$

$$X_{Mpu} := \frac{7.2\cdot k\Omega}{Z_{baseR}} = 1\times 10^3$$

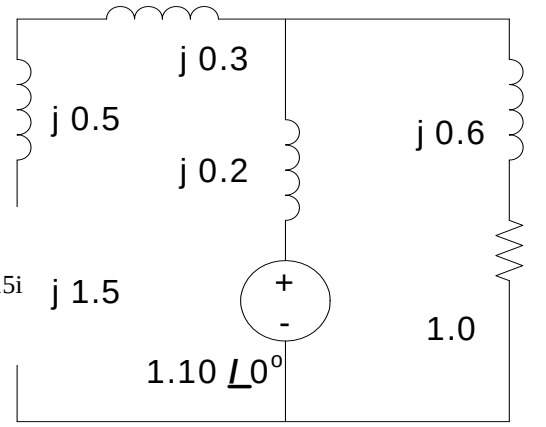
Convert the generator to per unit on the system base.

$$Z_{baseG} := \frac{(480\cdot V)^2}{2500\cdot V\cdot A} = 92.16\,\Omega \qquad X_G := \frac{0.50\cdot Z_{baseG}}{Z_{baseL}} = 0.4$$



2. (4 points) For the per unit circuit shown below, find the real power dissipated in the resistor.

$j := \sqrt{-1}$



A node method

$$\frac{V_x - 1.1}{j\cdot 0.2} + \frac{V_x}{j\cdot 2.3} + \frac{V_x}{1.0 + j\cdot 0.6} = 0$$

$$V_x := \frac{\frac{1.1}{j\cdot 0.2}}{\frac{1}{j\cdot 0.2} + \frac{1}{j\cdot 2.3} + \frac{1}{(1.0 + j\cdot 0.6)}} = 0.922 - 0.115i$$

Find the resistor current.

$$I_r := \frac{V_x}{1.0 + j\cdot 0.6} = 0.627 - 0.491i$$

Find the resistor power.

$$P_r := \left(\left|I_r\right|\right)^2 \cdot 1.0 = 0.634$$

Alternative method: use loop equations.

$$\begin{pmatrix} I_l \\ I_r \end{pmatrix} := \begin{pmatrix} j\cdot 2.5 & -j\cdot 0.2 \\ -j\cdot 0.2 & 1.0 + j\cdot 0.8 \end{pmatrix}^{-1} \cdot \begin{pmatrix} 1.1 \\ -1.1 \end{pmatrix} = \begin{pmatrix} -0.05 - 0.401i \\ -0.627 + 0.491i \end{pmatrix}$$

$$P_r := \left(\left|I_r\right|\right)^2 \cdot 1.0 = 0.634$$