Voltage Nodes with Phasors
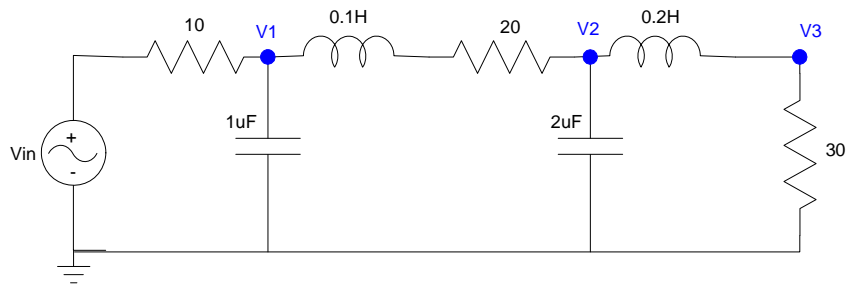
EE 206 Practice Problems

1) Write the votlage node equations for the following circuit. Assume

$$V_{in} = 20\cos(500t) + 5\sin(500t)$$

2) Write the votlage node equations for the following circuit. Assume
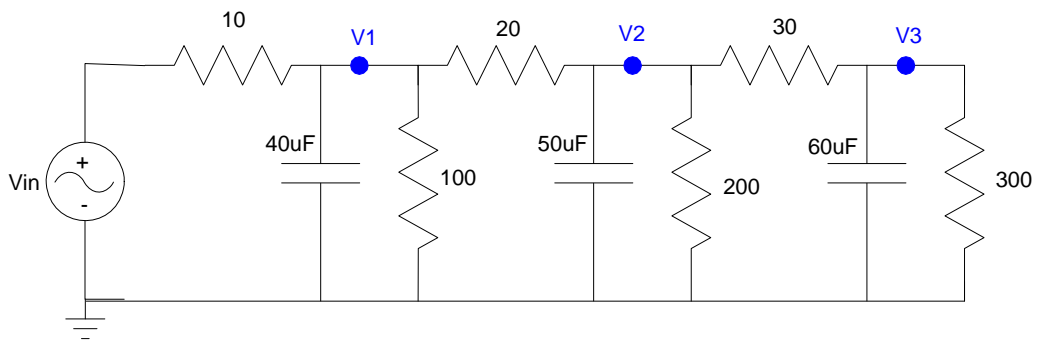
$$V_{in} = 30\cos(2000t - 50^0)$$

Problem 1 & 2

3) Write the votlage node equations for the following circuit. Assume

$$V_{in} = 20\cos(500t) + 5\sin(500t)$$

4) Write the voltage node equations for the following circuit. Assume
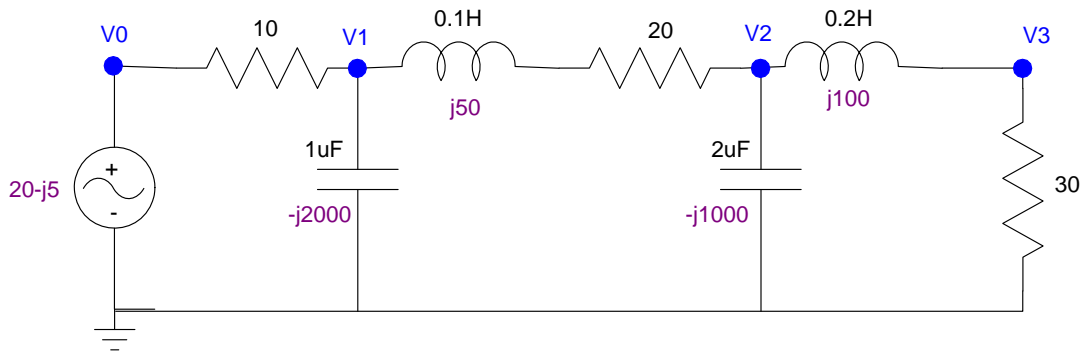
$$V_{in} = 30\cos(2000t - 50^0)$$

Solutions

1) Write the votlage node equations for the following circuit. Assume

$$V_{in} = 20 \cos{(500t)} + 5 \sin(500t)$$

Step 1) Convert to phasors (shown in figure below)

Now write the voltage node equations

$$V_0 = 20 - j5$$

$$\left(\frac{V_1 - V_0}{10}\right) + \left(\frac{V_1}{-j2000}\right) + \left(\frac{V_1 - V_2}{20 + j50}\right) = 0$$

$$\left(\frac{V_2 - V_1}{20 + j50}\right) + \left(\frac{V_2}{-j1000}\right) + \left(\frac{V_2 - V_3}{j100}\right) = 0$$

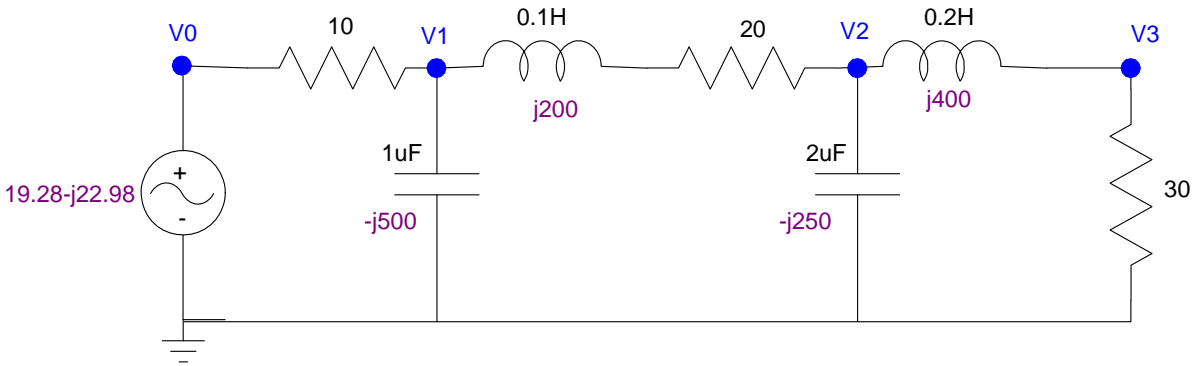$$\left(\frac{V_3 - V_2}{j100}\right) + \left(\frac{V_3}{30}\right) = 0$$

Note that it's the same as we did at DC, only now with complex numbers

2) Write the votlage node equations for the following circuit. Assume

$$V_{in} = 30\cos{(2000t - 50^0)}$$

First, convert to phasor notation.   My circuit diagram software doesn't do greek letters well so Vin is expressed in rectangular form

$$V_{in} = 19.28\cos(2000t) + 22.98\sin(2000t)$$

Now write the voltage node equations

$$V_0 = 30\angle - 50^0$$

$$\left(\frac{V_1-V_0}{10}\right) + \left(\frac{V_1}{-j500}\right) + \left(\frac{V_1-V_2}{20+j200}\right) = 0$$

$$\left(\frac{V_2-V_1}{20+j200}\right) + \left(\frac{V_2}{-j250}\right) + \left(\frac{V_2-V_3}{j400}\right) = 0$$

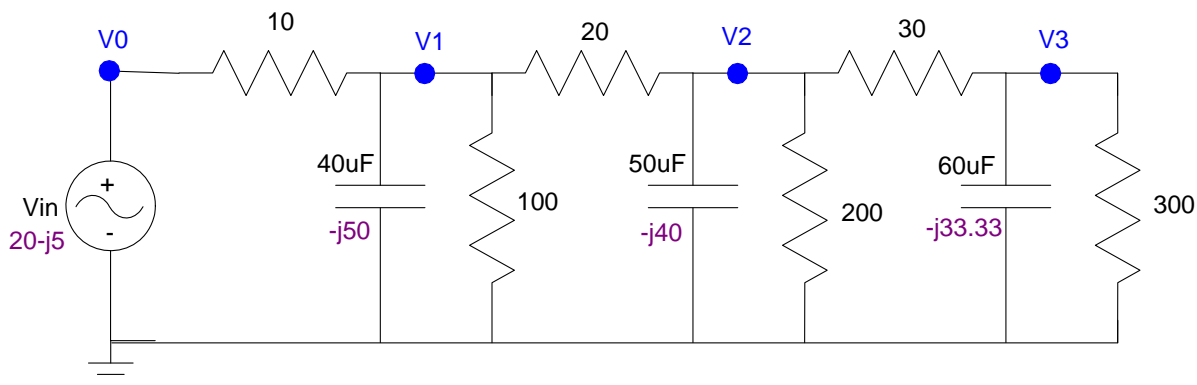$$\left(\frac{V_3-V_2}{j400}\right) + \left(\frac{V_3}{30}\right) = 0$$

Problem 3) Write the votlage node equations for the following circuit. Assume

$$V_{in} = 20\cos(500t) + 5\sin(500t)$$

Start by converting to phasors

$$\omega = 500$$

$$V_{in} = 20 - j5$$

Now write the voltage node equations

$$V_0 = 20 - j5$$

$$\left(\frac{V_1 - V_0}{10}\right) + \left(\frac{V_1}{-j50}\right) + \left(\frac{V_1}{100}\right) + \left(\frac{V_1 - V_2}{20}\right) = 0$$

$$\left(\frac{V_2 - V_1}{20}\right) + \left(\frac{V_2}{-j40}\right) + \left(\frac{V_2}{200}\right) + \left(\frac{V_2 - V_3}{30}\right) = 0$$
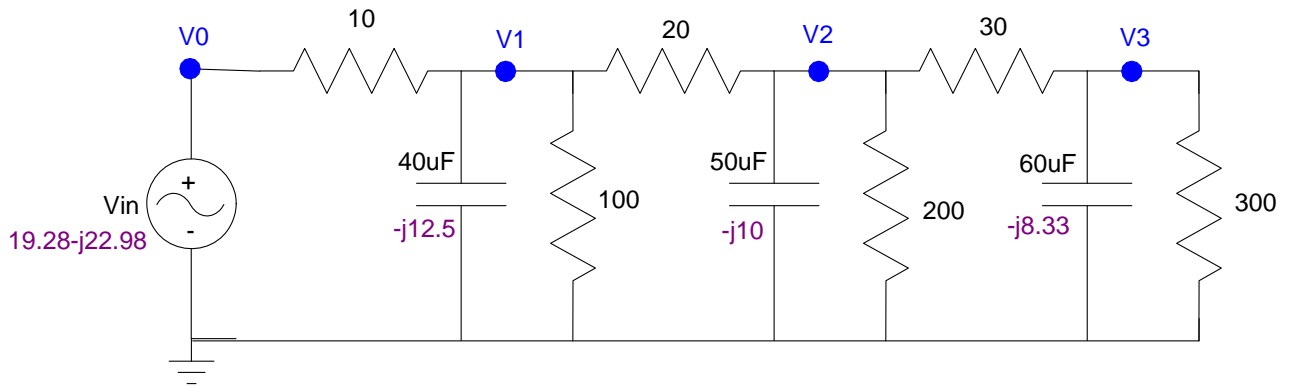
$$\left(\frac{V_3 - V_2}{30}\right) + \left(\frac{V_3}{-j33.33}\right) + \left(\frac{V_3}{300}\right) = 0$$

Problem 4) Write the votlage node equations for the following circuit. Assume

$$V_{in} = 30\cos(2000t - 50^0)$$

Start by converting to phasors

$$V_{in} = 30\angle - 50^0 = 19.28 - j22.98$$

Now write the votlage node equations

$$V_0 = 30\angle - 50^0$$

$$\left(\frac{V_1 - V_0}{10}\right) + \left(\frac{V_1}{-j12.5}\right) + \left(\frac{V_1}{100}\right) + \left(\frac{V_1 - V_2}{20}\right) = 0$$

$$\left(\frac{V_2 - V_1}{20}\right) + \left(\frac{V_2}{-j10}\right) + \left(\frac{V_2}{200}\right) + \left(\frac{V_2 - V_3}{30}\right) = 0$$

$$\left(\frac{V_3 - V_2}{30}\right) + \left(\frac{V_3}{-j8.33}\right) + \left(\frac{V_3}{300}\right) = 0$$