EE 206 Test #3 - Name _____

AC Analysis of Circuits. April 27, 2020

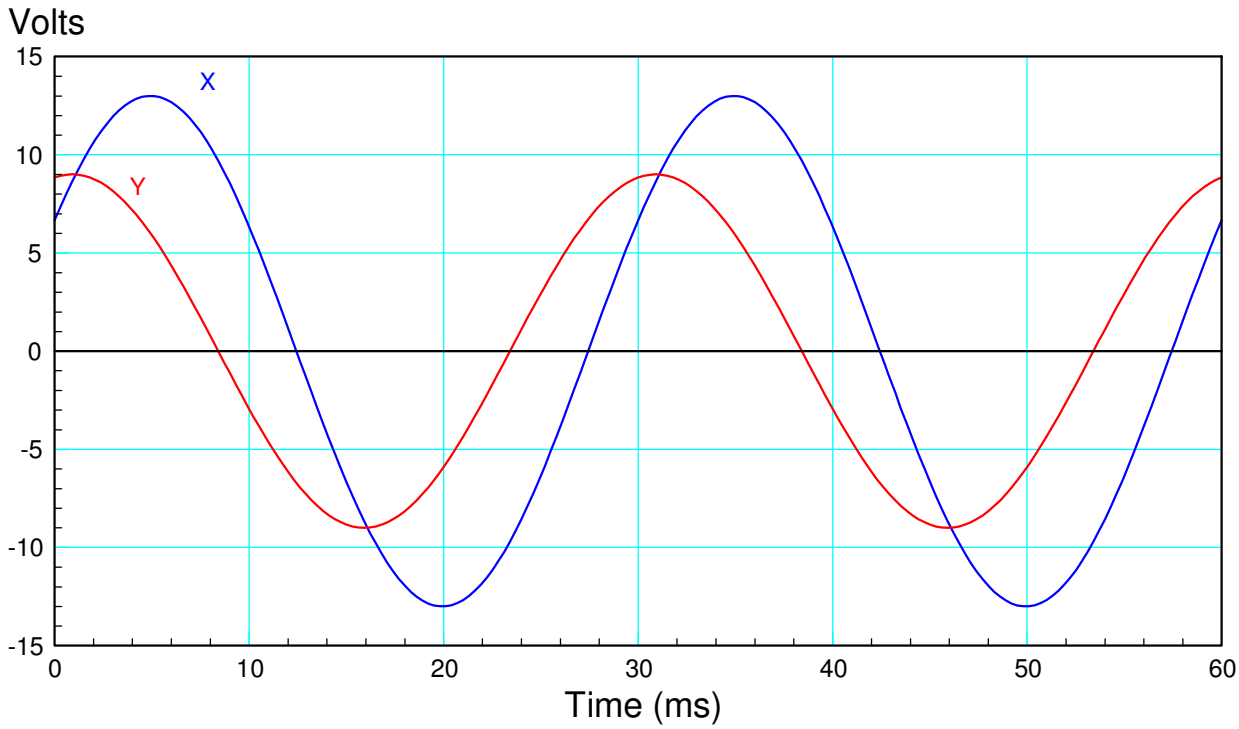
Due Tuesday, April 28th at midnight (solutions posted on Wednesday)

Open book, open notes, internet, calculators, matlab permitted. Individual effort only.

No aid given, received, or observed: (signature) _____

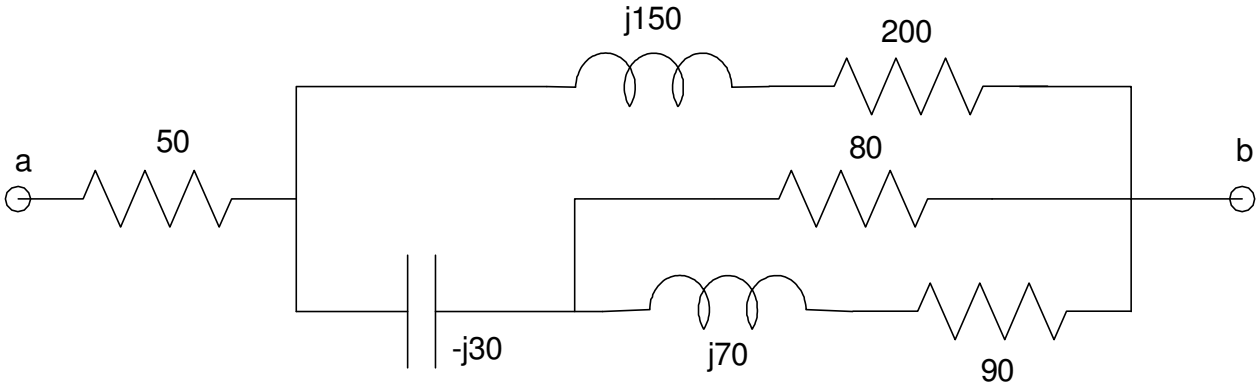
1) Determine the frequency and the phasor represetation for X and Y.

Frequency (Hz)	X		Y	
	Amplitude	Phase	Amplitude	Phase
33.33 Hz	**13V**	**-60 deg**	**9V**	**-24 deg**



2) Determine the resistace Rab (it will be a complex number)

Rab = 94.228 - j8.358



$90 + j70 \parallel 80 = 47.811 + j13.254$

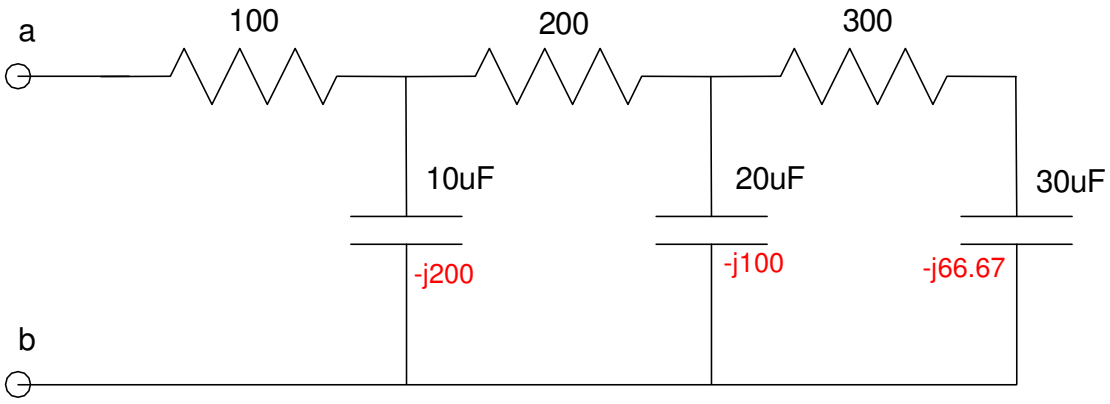
$47.811 + j13.254 + (-j30) = 47.811 - j16.746$

$(47.811 - j16.746) \parallel (200 + j150) = 44.228 - j8.358$

$(44.228 - j8.358) + 50 = 94.228 - j8.358$

3) Determine the impedance from a to b. Assume w = 500 rad/sec (79.58Hz)

Zab = 168.043 - j113.737



(300 - j66.67) || (-j100) = 25.472 - j85.849

(25.472 - j85.849) + 200 = 225.472 - j85.849

(225.472 - j85.849) || (-j200) = 68.043 - j113.737

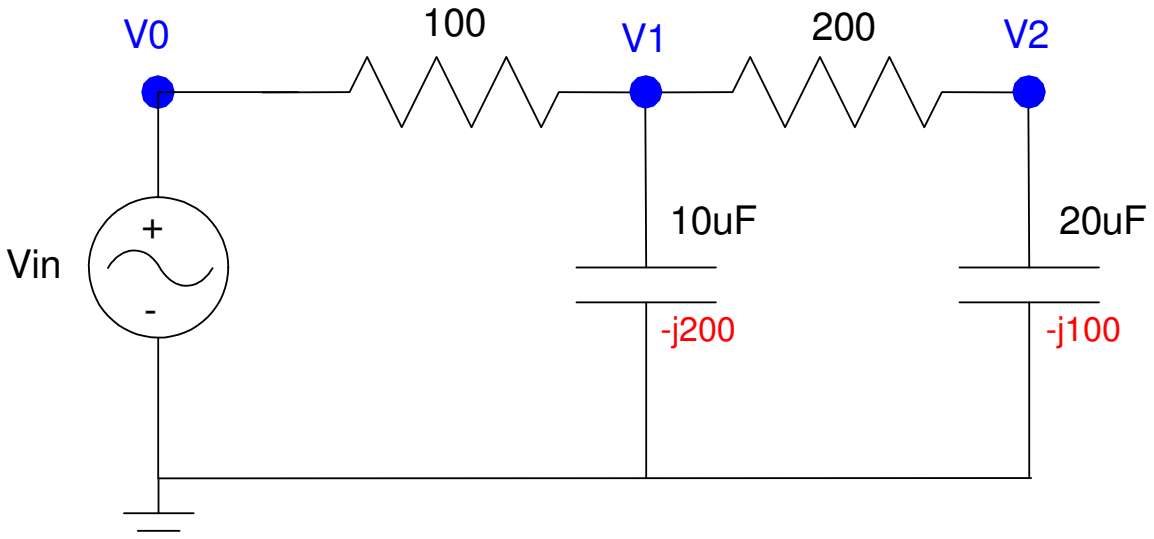
(68.043 - j113.737) + 100 = 168.043 - j113.737

4) Assume

$$V_{in} = 10\cos(500t) + 20\sin(500t)$$

Determine the voltages v1(t) and v2(t)

v1(t) = 0 cos(500t) + 14.2857 sin(500t)
v2(t) = 5.7143 cos(500t) + 2.8571 sin(500t)



Several approaches. Since I have access to Matlab, use voltage nodes:

$$V_0 = 10 - j20$$

$$\left(\frac{V_1 - V_0}{100}\right) + \left(\frac{V_1}{-j200}\right) + \left(\frac{V_1 - V_2}{200}\right) = 0$$

$$\left(\frac{V_2 - V_1}{200}\right) + \left(\frac{V_2}{-j100}\right) = 0$$

Place in matrix form

$$\begin{bmatrix} 1 & 0 & 0 \\ \left(\frac{-1}{100}\right) & \left(\frac{1}{100} + \frac{1}{-j200} + \frac{1}{200}\right) & \left(\frac{-1}{200}\right) \\ 0 & \left(\frac{-1}{200}\right) & \left(\frac{1}{200} + \frac{1}{-j100}\right) \end{bmatrix} \begin{bmatrix} V_0 \\ V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 10 - j20 \\ 0 \\ 0 \end{bmatrix}$$

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>> A = [1,0,0;-1/100,1/100+1/(-j*200)+1/200,-1/200 ; 0,-1/200,1/200+1/(-j*100)]

A =

   1.0000                  0                  0
  -0.0100            0.0150 + 0.0050i  -0.0050
        0           -0.0050             0.0050 + 0.0100i

>> B = [10-j*20;0;0];
>> V = inv(A)*B

V =

  10.0000 -20.0000i
        0 -14.2857i
  -5.7143 - 2.8571i

>>
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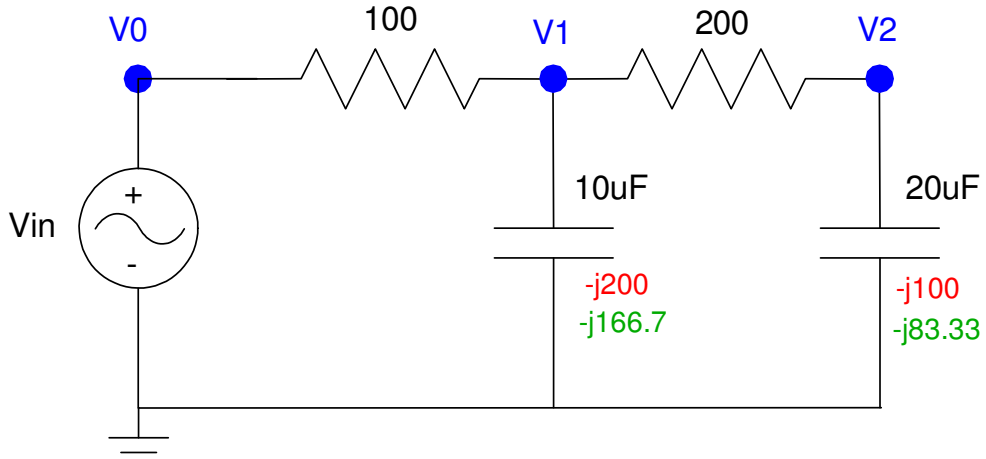
5) Assume

$$V_{in} = 10\cos(500t) + 11\sin(600t)$$

Determine the voltages v1(t) and v2(t)

V1(t) = 5.7143 cos(500t) + 2.8571 sin(500t) - 3.2419 cos(600t) + 5.9461 sin(600t)
V2(t) = 2.8571 sin(600t) - 2.5905 cos(600t) - 0.2714 sin(600t)



At w = 500 (red)

$$V_0 = 10 + j0$$

$$\left(\frac{V_1 - V_0}{100}\right) + \left(\frac{V_1}{-j200}\right) + \left(\frac{V_1 - V_2}{200}\right) = 0$$

$$\left(\frac{V_2 - V_1}{200}\right) + \left(\frac{V_2}{-j100}\right) = 0$$

Place in matrix form

$$\begin{bmatrix} 1 & 0 & 0 \\ \left(\frac{-1}{100}\right) & \left(\frac{1}{100} + \frac{1}{-j200} + \frac{1}{200}\right) & \left(\frac{-1}{200}\right) \\ 0 & \left(\frac{-1}{200}\right) & \left(\frac{1}{200} + \frac{1}{-j100}\right) \end{bmatrix} \begin{bmatrix} V_0 \\ V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 10 + j0 \\ 0 \\ 0 \end{bmatrix}$$

Solve

```
A = [1,0,0;-1/100,1/100+1/(-j*200)+1/200,-1/200 ; 0,-1/200,1/200+1/(-j*100)];
B = [10;0;0];
V = inv(A)*B

  10.0000
   5.7143 - 2.8571i
  -0.0000 - 2.8571i
```

At w = 600 (green)

$$V_0 = 11 + j0$$

$$\left(\frac{V_1 - V_0}{100}\right) + \left(\frac{V_1}{-j166.67}\right) + \left(\frac{V_1 - V_2}{200}\right) = 0$$

$$\left(\frac{V_2 - V_1}{200}\right) + \left(\frac{V_2}{-j83.33}\right) = 0$$

Place in matrix form

$$\begin{bmatrix} 1 & 0 & 0 \\ \left(\frac{-1}{100}\right) & \left(\frac{1}{100} + \frac{1}{-j166.67} + \frac{1}{200}\right) & \left(\frac{-1}{200}\right) \\ 0 & \left(\frac{-1}{200}\right) & \left(\frac{1}{200} + \frac{1}{-j83.33}\right) \end{bmatrix} \begin{bmatrix} V_0 \\ V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 0 - j11 \\ 0 \\ 0 \end{bmatrix}$$

```
A = [1,0,0;-1/100,1/100+1/(-j*166.67)+1/200,-1/200 ; 0, -1/200,
1/200+1/(-j*83.33)];
B = [0-j*11;0;0];
V = inv(A)*B

        0 -11.0000i
  -3.2419 - 5.9461i
  -2.5905 + 0.2714i
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6) Determine the first 5 terms of the Fourier series approximation to x(t)

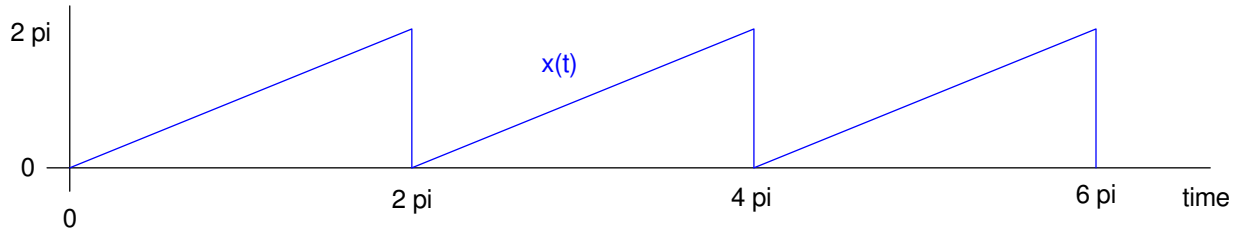
$$T = 2\pi$$

$$x(t) = x(t+T)$$

$$x(t) = t \qquad 0 < t < T$$

$$x(t) \approx a_0 + a_1\cos(t) + b_1\sin(t) + a_2\cos(2t) + b_2\sin(2t)$$

a0	a1	b1	a2	b2
3.1415	**0**	**-1.9997**	**0**	**-0.9999**

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t = [0:0.001:2*pi]';
x = t;
a0 = mean(x)

a0 =   3.1415

a1 = 2*mean(x .* cos(t))
a1 =  6.2928e-004

b1 = 2*mean(x .* sin(t))
b1 =   -1.9997

a2 = 2*mean(x .* cos(2*t))
a2 =  6.2928e-004

b2 = 2*mean(x .* sin(2*t))
b2 =   -0.9999

a3 = 2*mean(x .* cos(3*t))
a3 =  6.2928e-004

b3 = 2*mean(x .* sin(3*t))
b3 =   -0.6666

a4 = 2*mean(x .* cos(4*t))
a4 =  6.2928e-004

b4 = 2*mean(x .* sin(4*t))
b4 =  -0.4999

a5 = 2*mean(x .* cos(5*t))
a5 = 6.2928e-004

b5 = 2*mean(x .* sin(5*t))
b5 =  -0.3999
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