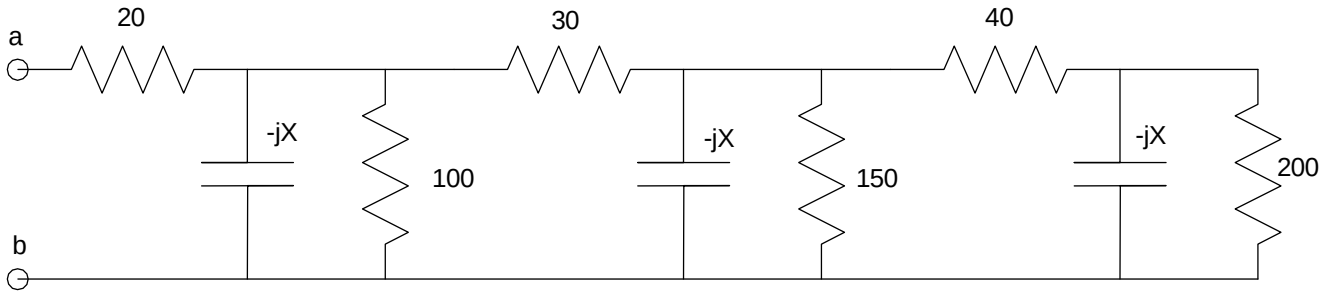
ECE 320 - Homework #1

EE 206 Review, Phasors. Due Monday, August 30th

Please submit as a Word or pdf file if submitting to Blackboard or emailing to Jacob_Glower@yahoo.com with subject ECE 320 HW#1

Resistors in series and parallel

1) Assume X = infinity (DC analysis). Determine the resistance Rab



200 + 40 = 240

240 || 150 = 92.3077

92.3077 + 30 = 122.3077

122.3077 || 100 = 55.0173

55.0173 + 20 = 75.0173

ans: Rab = 75.0173 Ohms

2) Assume -jX = -j250. Determine the resistance Rab (it will be a complex number)

200 || -j250 = 121.951 - j97.561

(121.951 - j97.561) + (40) = 161.951 - j97.561

(161.951 - j97.561) || (150) || (-j250) = 65.611 - j39.431

(65.611 - j39.431) + (30) = 95.611 - j39.431

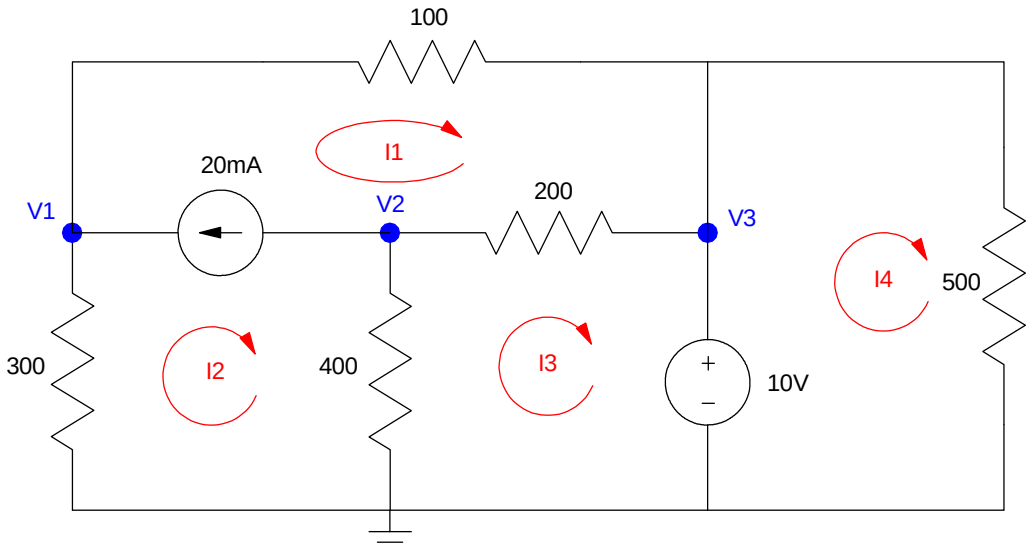
(95.611 - j 39.431) || (100) || (-j250) = 45.334 - j18.399

(45.334 - j18.399) + (20) = 65.334 - j18.339

ans: Rab = 65.334 - j18.339 Ohms

Voltage Nodes & Current Loops

3) (Voltage Nodes): For the following circuit



a) Write the voltage node equations

$$V_3 = 10$$

$$\frac{V_1 - V_3}{100} - 0.02 + \frac{V_1}{300} = 0$$

$$0.02 + \frac{V_2}{400} + \frac{V_2 - V_3}{200} = 0$$

b) Solve using Matlab (or similar program)

group terms

$$V_3 = 10$$

$$\frac{1}{100} + \frac{1}{300} V_1 - \frac{1}{100} V_3 = 0.02$$

$$\frac{1}{400} + \frac{1}{200} V_2 - \frac{1}{200} V_3 = -0.02$$

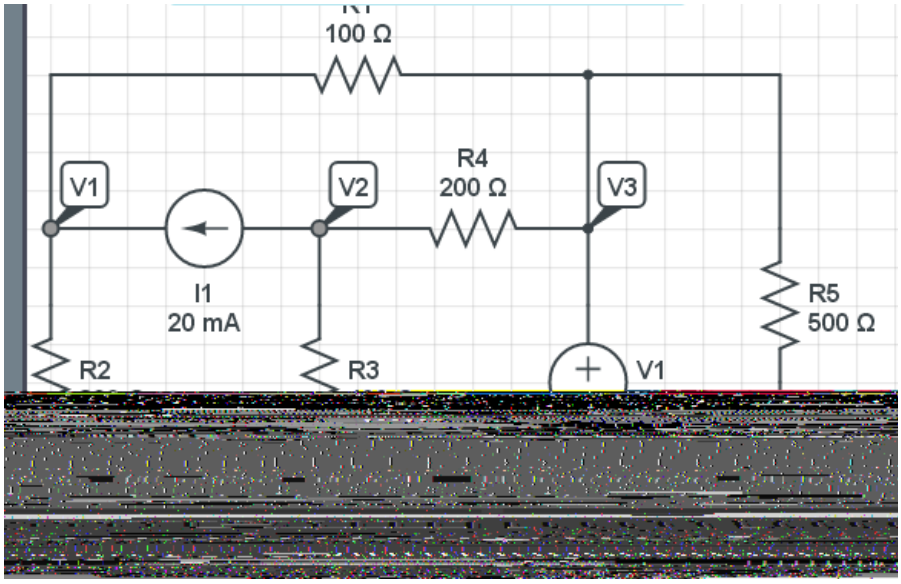
Put in matrix form

$$\begin{bmatrix} 0 & 0 & 1 \\ \frac{1}{100} + \frac{1}{300} & 0 & \frac{-1}{100} \\ 0 & \frac{1}{400} + \frac{1}{200} & \frac{-1}{200} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} 10 \\ 0.02 \\ -0.02 \end{bmatrix}$$

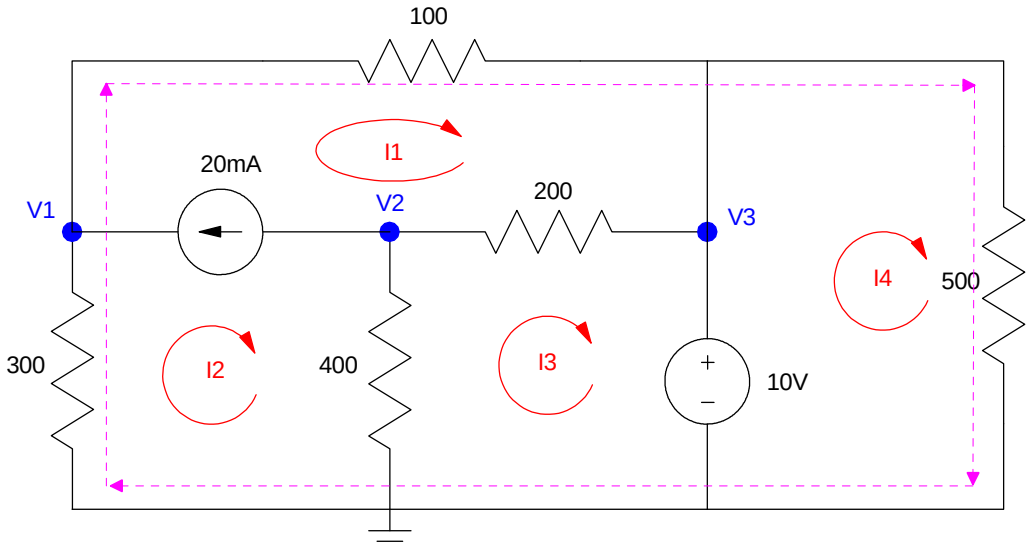
Solve using Matlab

```
>> A = [0,0,1 ; 1/100+1/300,0,-1/100 ; 0,1/400+1/200,-1/200]

A =

         0         0    1.0000
    0.0133         0   -0.0100
         0    0.0075   -0.0050

>> B = [10;0.02;-0.02]

B =

   10.0000
    0.0200
   -0.0200

>> V = inv(A)*B

V =

 V1   9.0000
 V2   4.0000
 V3  10.0000
```

c) Check your answers in CircuitLab (or similar circuit simulator)



4) (Current Loops) For the following circuit



a) Write the current loop equations

$$I_1 - I_2 = 20mA$$

$$400(I_3 - I_2) + 200(I_3 - I_1) + 10 = 0$$

$$-10 + 500I_4 = 0$$

$$300I_2 + 100I_1 + 500I_4 = 0$$ superloop

b) Solve using Matlab (or similar program)

group terms

$$I_1 - I_2 = 20mA$$

$$-200I_1 - 400I_2 + 600I_3 = -10$$

$$500I_4 = 10$$

$$300I_2 + 100I_1 + 500I_4 = 0$$

Place in matrix form

$$\begin{matrix} 1 & -1 & 0 & 0 \\ -200 & -400 & 600 & 0 \\ 0 & 0 & 0 & 500 \\ 100 & 300 & 0 & 500 \end{matrix} \begin{matrix} I_1 \\ I_2 \\ I_3 \\ I_4 \end{matrix} = \begin{matrix} 0.02 \\ -10 \\ 10 \\ 0 \end{matrix}$$

Solve in Matlab

```
>> A = [1,-1,0,0 ; -200,-400,600,0 ; 0,0,0,500 ; 100,300,0,500]

     1    -1     0     0
  -200  -400   600     0
     0     0     0   500
   100   300     0   500

>> B = [0.02 ; -10 ; 10 ; 0]

    0.0200
  -10.0000
   10.0000
         0

>> I = inv(A)*B

I1   -0.0100
I2   -0.0300
I3   -0.0400
I4    0.0200
```

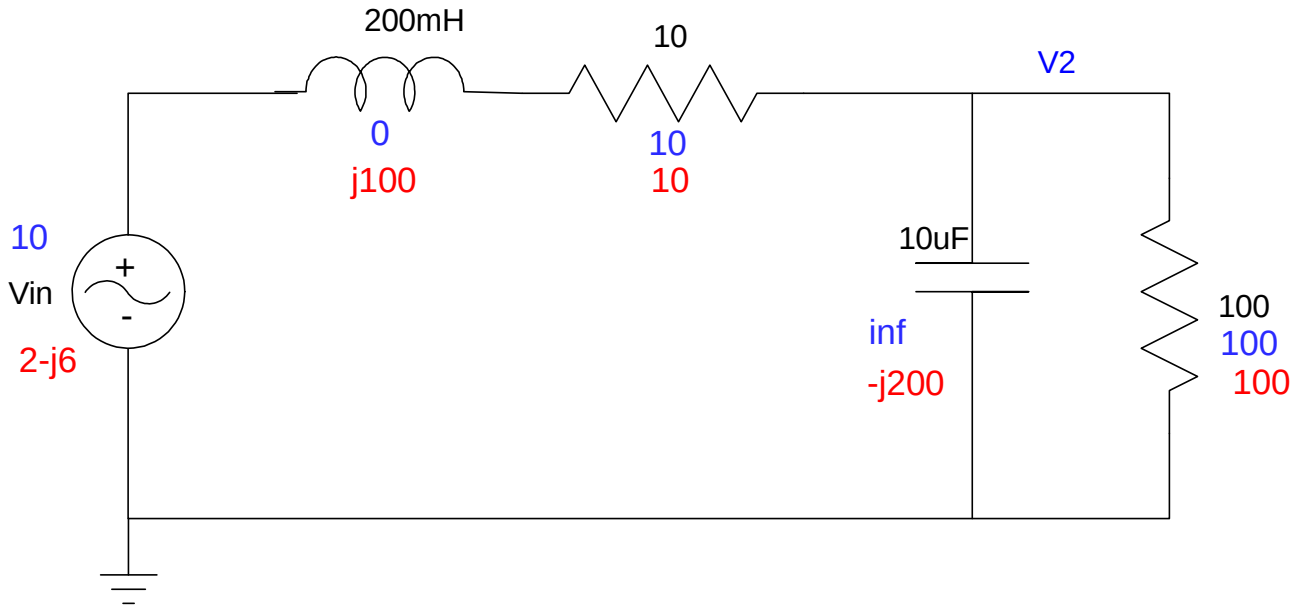
c) Check your answers in CircuitLab (or similar circuit simulator)

note: I(R3) = I3 - I2 = -10mA

5) Assume Vin contains a DC and 500 rad/sec signal

$$V_{in} = 10 + 2\cos(500t) + 6\sin(500t)$$

a) Determine the voltage, V2, using phasor analysis



DC Analysis (blue)

Vin = 10

$$V_2 = \frac{100}{100+10}\ 10 = 9.091V$$

meaning V2(t) = 9.091

AC Analysis (red)

Vin = 2 - j6

$$L \rightarrow jwL = j100$$

$$C \rightarrow \frac{1}{jwC} = -j200$$

100 || -j200 = 80 - j40

$$\frac{(80-j40)}{(80-j40)+(10+j100)}\ (2-j6) = -3.487 - j3.897$$

meaning V2(t) = -3.487 cos(500t) + 3.897 sin(500t)

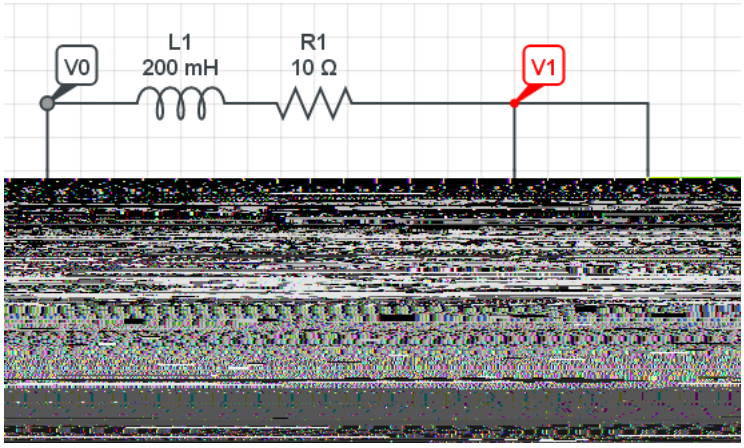
The total answer is DC + AC

ans V2(t) = 9.091 - 3.487 cos(500t) + 3.897 sin(500t)

b) Check your answer using CircuitLab (or similar program)

500 rad/sec = 79.58Hz

$$w = 2pf$$



Running a time domain simulation for 3 cycles

- The output (orange) has a peak-to-peak voltage of 10V (vs. 10.46Vpp calculated)
  2 * | -3.487 - j 3.897 | = Vpp = 10.46Vpp
- The output (orange) has an average voltage of 9.2V (vs. 9.091V)