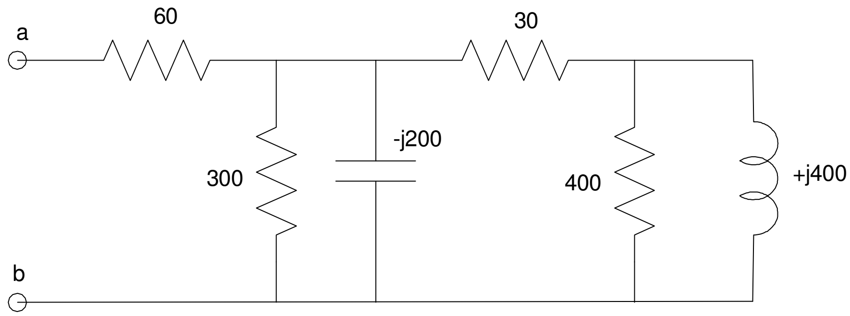
EE 206 Review, Phasors. Due Wednesday, Janyary 18th

1) Determine the impedance: Zab



400 || j400 = 200 + j200

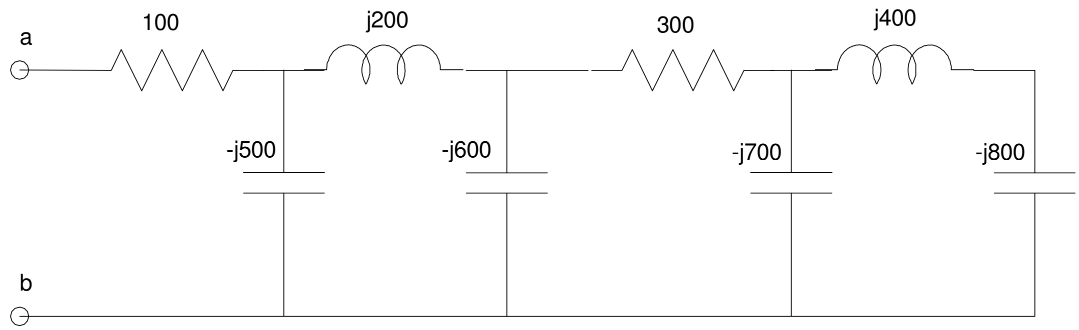
(200 + j200) + (30) = 230 + j200

(230 + j200) || (-j200) || (300) = 138.801 - j68.029

(138.801 - j68.029) + (60) = 198.801 - j68.029

ans: Zab = 198.801 - j68.029

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



(j400) + (-j800) = -j400

(-j400) || (-j700) = -j254.545

(-j254.545) + (300) = 300 - j254.545

(300 - j254.545) || (-j600) = 131.668 - j224.947

(131.668 - j224.947) + (j200) = 131.668 - j24.947

(131.668 - j24.947) || (-j500) = 112.380 - j51.949

(112.380 - j51.949) + (100) = 212.380 - j51.949

ans: Zab = 212.380 - j51.949

3) (Voltage Nodes): For the following circuit

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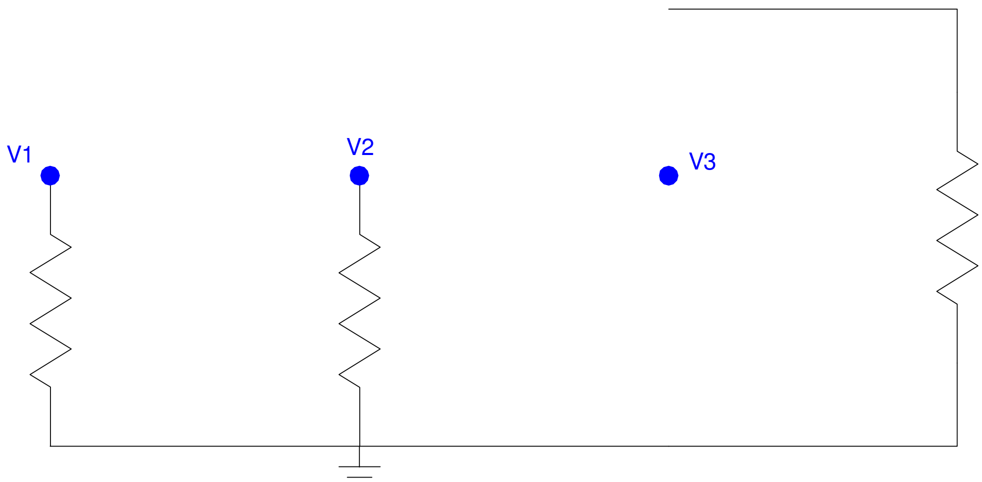

Group terms

$$I_1 - I_2 = 40\text{mA}$$

$$-300I_2 + 700I_3 - 400I_4 = 5$$

$$-400I_3 + 900I_4 = 0$$

$$100I_1 + 200I_2 + 500I_4 = 0$$

Place in matrix form

$$\begin{bmatrix} 1 & -1 & 0 & 0 \\ 0 & -300 & 700 & -400 \\ 0 & 0 & -400 & 900 \\ 100 & 200 & 0 & 500 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \\ I_4 \end{bmatrix} = \begin{bmatrix} 0.04 \\ 5 \\ 0 \\ 0 \end{bmatrix}$$

Solve using Matlab

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>> A = [1,-1,0,0 ; 0,-300,700,-400 ; 0,0,-400,900 ; 100,200,0,500]

     1    -1      0      0
     0  -300    700   -400
     0     0   -400    900
   100   200      0    500

>> B = [0.04;5;0;0]

    0.0400
    5.0000
         0
         0

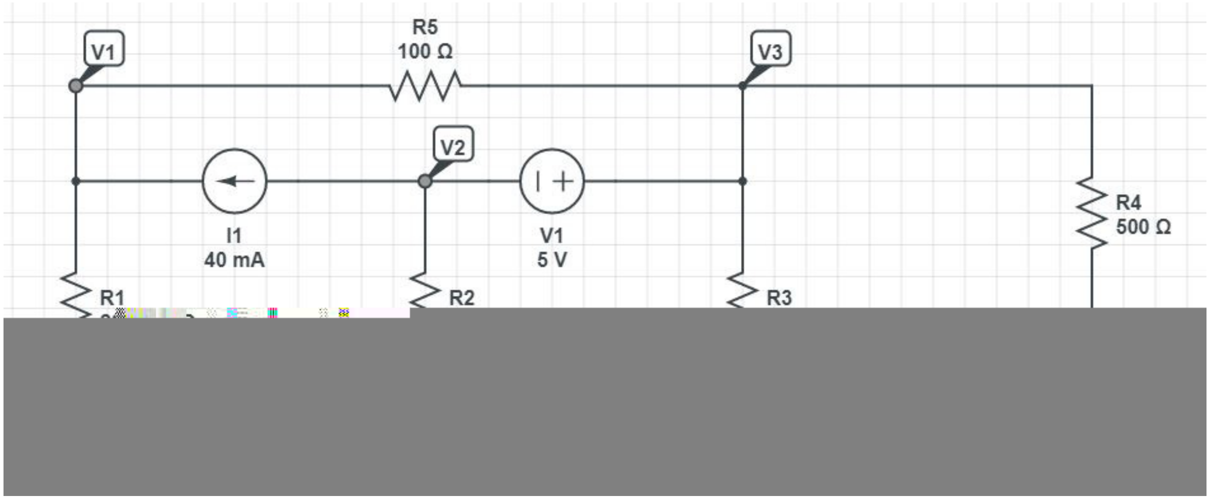
>> I = inv(A)*B

    0.0257
   -0.0143
    0.0013
    0.0006

>> mA = I * 1000

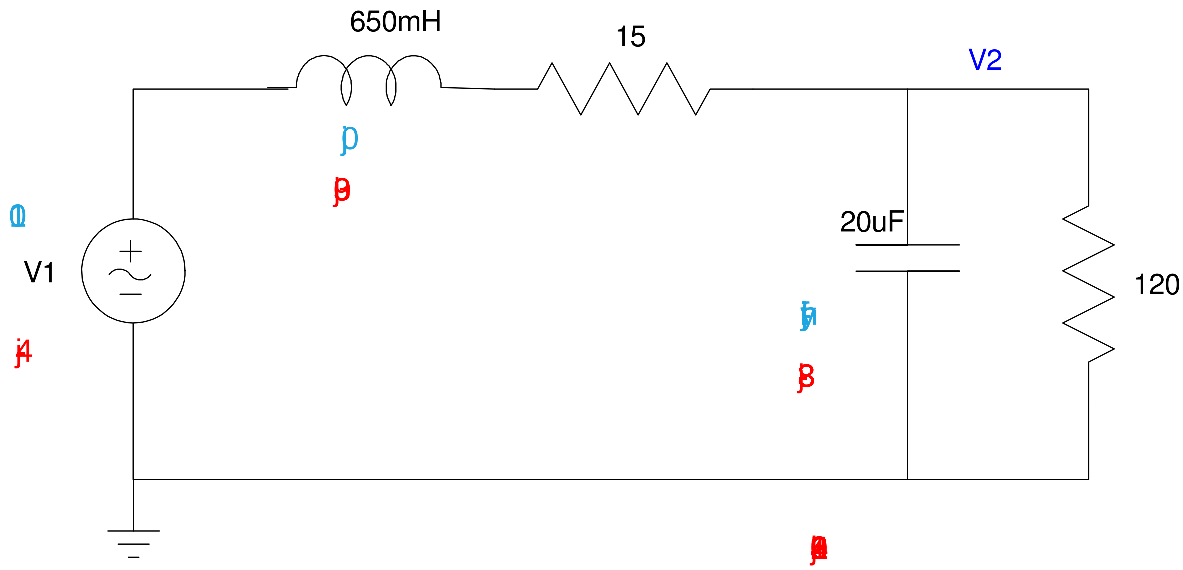
   25.6716
  -14.3284
    1.3433
    0.5970
```

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



5) Assume Vin contains a DC and AC signal:

$$V_1 = 10 + 4\sin(600t)$$



DC (blue) & AC (red) circuit

a) Determine the voltage, V2, using phasor analysis

DC: V1 = 10

$$V_2 = \left(\frac{120}{120+15}\right)10$$

$$V_2 = 8.889V$$

AC: V1 = 4 sin(600t)

$$V_1 = 0 - j4$$

$$C \rightarrow \frac{1}{j\omega C} = -j83.333\Omega$$

$$L \rightarrow j\omega L = j390\Omega$$

$$120\Omega \,||\, -j83.333\Omega = 39.042 - j56.221$$

$$V_2 = \left(\frac{39.042-j56.221}{(39.042-j56.221)+(15+j390)}\right)(0-j4)$$

$$V_2 = -0.562 + j0.583$$

meaning

$$v_2(t) = -0.562\cos(600t) - 0.582\sin(600t)$$

The total answer is DC + AC

$$v_2(t) = 8.889 - 0.562\cos(600t) - 0.582\sin(600t)$$

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

Note: polar form is easier to see in lab. The AC term is

$$V_2 = -0.562 + j0.583 = 0.810\angle 133.975^0$$

which has a peak-to-peak voltage of twice this

$$V_{2pp} = 1.619V_{pp}$$

From CircutLab:

V2 (orange line)

- max = 9.693V
- min = 8.085V

DC = average(max, min)

DC = 8.889V   vs. 8.889V calculated

AC = max - min

AC = 1.608Vpp   vs. 1.619Vpp calculated

The time delay to V2 gives the phase shift (should be +134 degrees or -226 degrees)