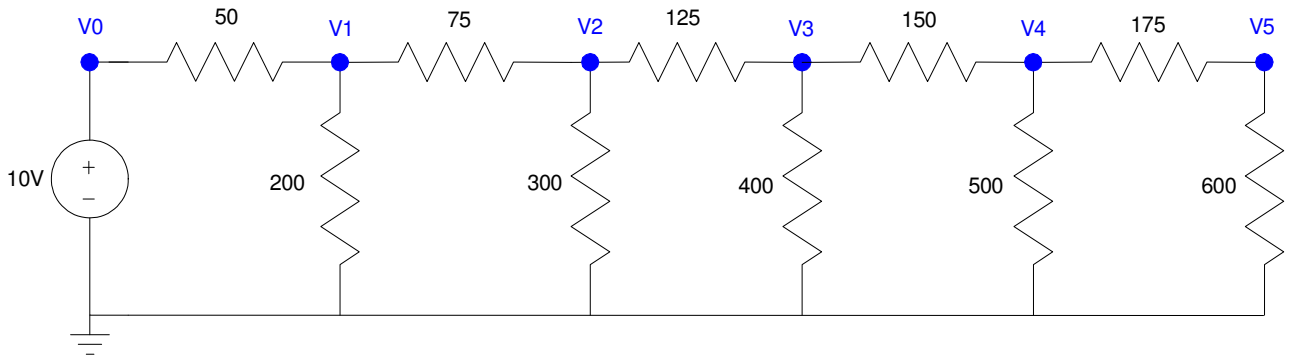
ECE 111 - Homework #9

EE 206 Circuts I

Voltage Nodes

1) Use Voltage Nodes write N equations for N unknowns for the following circuit.



$$V_0 = 10$$

$$\left(\frac{V_1 - V_0}{50}\right) + \left(\frac{V_1 - V_2}{75}\right) + \left(\frac{V_1}{200}\right) = 0$$

$$\left(\frac{V_2 - V_1}{75}\right) + \left(\frac{V_2 - V_3}{125}\right) + \left(\frac{V_2}{300}\right) = 0$$

$$\left(\frac{V_3 - V_2}{125}\right) + \left(\frac{V_3 - V_4}{150}\right) + \left(\frac{V_3}{400}\right) = 0$$

$$\left(\frac{V_4 - V_3}{150}\right) + \left(\frac{V_4 - V_5}{175}\right) + \left(\frac{V_4}{500}\right) = 0$$

$$\left(\frac{V_5 - V_4}{175}\right) + \left(\frac{V_5}{600}\right) = 0$$

2) Solve for the node voltages in Matlab. Group terms

$$V_0 = 10$$

$$-\left(\frac{1}{50}\right)V_0 + \left(\frac{1}{50}+\frac{1}{75}+\frac{1}{200}\right)V_1 - \left(\frac{1}{75}\right)V_2 = 0$$

$$-\left(\frac{1}{75}\right)V_1 + \left(\frac{1}{75}+\frac{1}{125}+\frac{1}{300}\right)V_2 - \left(\frac{1}{125}\right)V_3 = 0$$

$$-\left(\frac{1}{125}\right)V_2 + \left(\frac{1}{125}+\frac{1}{150}+\frac{1}{400}\right)V_3 - \left(\frac{1}{150}\right)V_3 = 0$$

$$-\left(\frac{1}{150}\right)V_3 + \left(\frac{1}{150}+\frac{1}{175}+\frac{1}{500}\right)V_4 - \left(\frac{1}{175}\right)V_4 = 0$$

$$-\left(\frac{1}{175}\right)V_4 + \left(\frac{1}{175}+\frac{1}{600}\right)V_5 = 0$$

Place in matrix form

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ \left(\frac{-1}{50}\right) & \left(\frac{1}{50}+\frac{1}{75}+\frac{1}{200}\right) & \left(\frac{-1}{75}\right) & 0 & 0 & 0 \\ 0 & \left(\frac{-1}{75}\right) & \left(\frac{1}{75}+\frac{1}{125}+\frac{1}{300}\right) & \left(\frac{-1}{125}\right) & 0 & 0 \\ 0 & 0 & \left(\frac{-1}{125}\right) & \left(\frac{1}{125}+\frac{1}{150}+\frac{1}{400}\right) & \left(\frac{-1}{150}\right) & 0 \\ 0 & 0 & 0 & \left(\frac{-1}{150}\right) & \left(\frac{1}{150}+\frac{1}{175}+\frac{1}{500}\right) & \left(\frac{-1}{175}\right) \\ 0 & 0 & 0 & 0 & \left(\frac{-1}{175}\right) & \left(\frac{1}{175}+\frac{1}{600}\right) \end{bmatrix} \begin{bmatrix} V_0 \\ V_1 \\ V_2 \\ V_3 \\ V_4 \\ V_5 \end{bmatrix} = \begin{bmatrix} 10 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

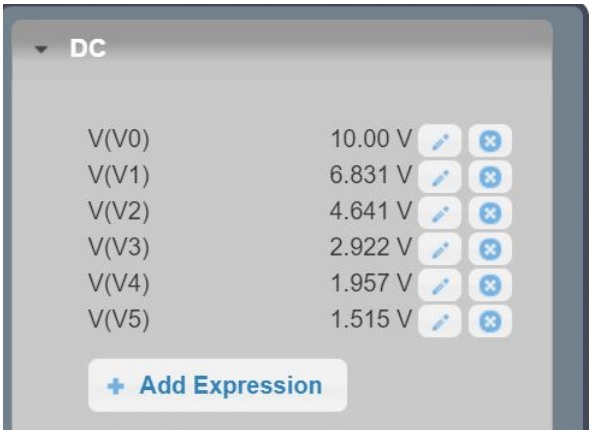
Solve in Matlab

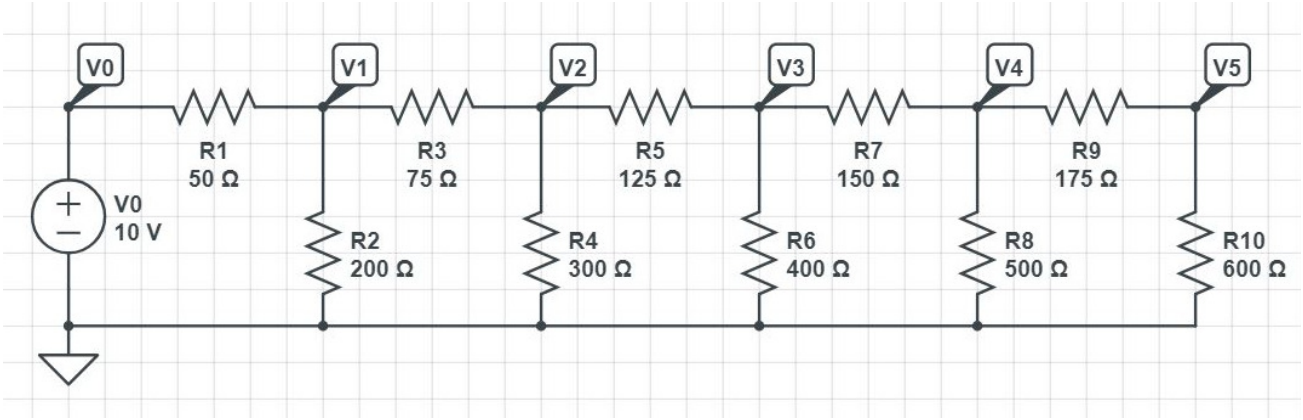
```
>> b1 = [1,0,0,0,0,0];
>> b2 = [-1/50,1/50+1/75+1/200,-1/75,0,0,0];
>> b3 = [0,-1/75,1/75+1/125+1/300,-1/125,0,0];
>> b4 = [0,0,-1/125,1/125+1/150+1/400,-1/150,0];
>> b5 = [0,0,0,-1/150,1/150+1/175+1/500,-1/175];
>> b6 = [0,0,0,0,-1/175,1/175+1/600];
>> B = [b1;b2;b3;b4;b5;b6]

    1.0000         0         0         0         0         0
   -0.0200    0.0383   -0.0133         0         0         0
         0   -0.0133    0.0247   -0.0080         0         0
         0         0   -0.0080    0.0172   -0.0067         0
         0         0         0   -0.0067    0.0144   -0.0057
         0         0         0         0   -0.0057    0.0074

>> A = [10;0;0;0;0;0]


    10
     0
     0
     0
     0
     0
```

```
>> V = inv(B)*A

V0   10.0000
V1    6.8315
V2    4.6405
V3    2.9225
V4    1.9567
V5    1.5149

>>
```

3) Check your answers in CircuitLab

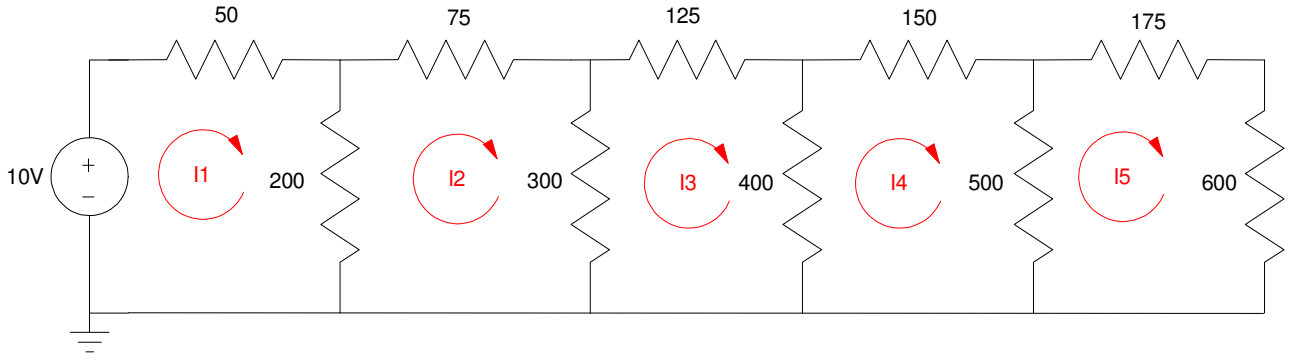
answers match calculations





Current Loops

4) Use Current Loops to write N equations for N unknowns for the following circuit.



$$-10 + 50(I_1) + 200(I_1 - I_2) = 0$$

$$200(I_2 - I_1) + 75(I_2) + 300(I_2 - I_3) = 0$$

$$300(I_3 - I_2) + 125(I_3) + 400(I_3 - I_4) = 0$$

$$400(I_4 - I_3) + 150(I_4) + 500(I_4 - I_5) = 0$$

$$500(I_5 - I_4) + 175(I_5) + 600(I_5) = 0$$

5) Solve for the currents in Matlab: Group terms

$$250I_1 - 200I_2 = 10$$

$$-200I_1 + 575I_2 - 300I_3 = 0$$

$$-300I_2 + 825I_3 - 400I_4 = 0$$

$$-400I_3 + 1050I_4 - 500I_5 = 0$$

$$-500I_4 + 1275I_5 = 0$$

Place in matrix form

$$\begin{bmatrix} 250 & -200 & 0 & 0 & 0 \\ -200 & 575 & -300 & 0 & 0 \\ 0 & -300 & 825 & -400 & 0 \\ 0 & 0 & -400 & 1050 & -500 \\ 0 & 0 & 0 & -500 & 1275 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \\ I_4 \\ I_5 \end{bmatrix} = \begin{bmatrix} 10 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

Solve using Matlab

```
>> B = [250,-200,0,0,0 ; -200,575,-300,0,0 ; 0,-300,825,-400,0];
>> B = [B ; 0,0,-400,1050,-500 ; 0,0,0,-500,1275]

B =

         250        -200           0           0           0
        -200         575        -300           0           0
           0        -300         825        -400           0
           0           0        -400        1050        -500
           0           0           0        -500        1275

>> A = [10;0;0;0;0]

A =

    10
     0
     0
     0
     0

>> I = inv(B)*A;
>> I*1000

I1   63.3703  mA
I2   29.2128  mA
I3   13.7444  mA
I4    6.4383  mA
I5    2.5248  mA
```

6) Check your answers in CircuitLab.

Answers match calculations

```
I1    63.3703  mA
I2    29.2128  mA
I3    13.7444  mA
I4     6.4383  mA
I5     2.5248  mA
```