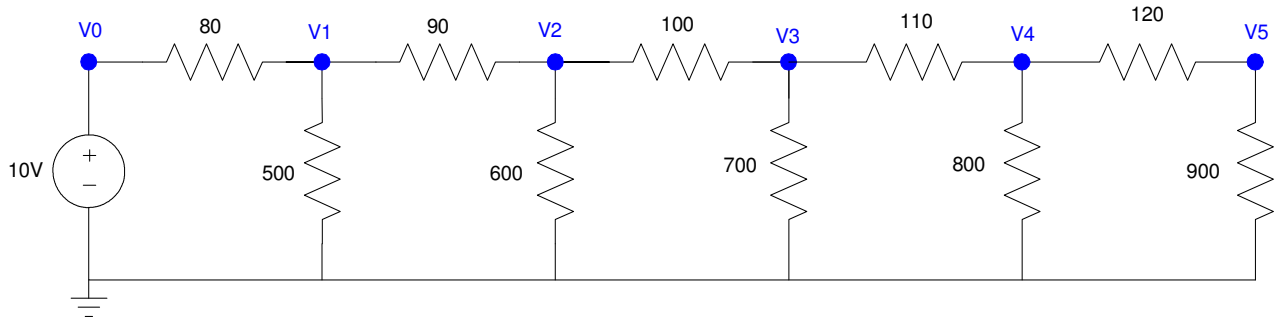
ECE 111 - Homework #6

Week #6: EE 206 Circuts I

1) Use Voltage Nodes write N equations for N unknowns for the following circuit. Solve for the node voltages in Matlab.



$$\left(\frac{V_1-V_0}{80}\right)+\left(\frac{V_1-V_2}{90}\right)+\left(\frac{V_1}{500}\right)=0$$

$$\left(\frac{V_2-V_1}{90}\right)+\left(\frac{V_2-V_3}{100}\right)+\left(\frac{V_2}{600}\right)=0$$

$$\left(\frac{V_3-V_2}{100}\right)+\left(\frac{V_3-V_4}{110}\right)+\left(\frac{V_3}{700}\right)=0$$

$$\left(\frac{V_4-V_3}{110}\right)+\left(\frac{V_4-V_5}{120}\right)+\left(\frac{V_4}{800}\right)=0$$

$$\left(\frac{V_5-V_4}{120}\right)+\left(\frac{V_5}{900}\right)=0$$

Group terms

$$V_0=10$$

$$-\left(\frac{1}{80}\right)V_0+\left(\frac{1}{80}+\frac{1}{90}+\frac{1}{500}\right)V_1-\left(\frac{1}{90}\right)V_2=0$$

$$-\left(\frac{1}{90}\right)V_1+\left(\frac{1}{90}+\frac{1}{100}+\frac{1}{600}\right)V_2-\left(\frac{1}{100}\right)V_3=0$$

$$-\left(\frac{1}{100}\right)V_2+\left(\frac{1}{100}+\frac{1}{110}+\frac{1}{700}\right)V_3-\left(\frac{1}{110}\right)V_4=0$$

$$-\left(\frac{1}{110}\right)V_3+\left(\frac{1}{110}+\frac{1}{120}+\frac{1}{800}\right)V_4-\left(\frac{1}{120}\right)V_5=0$$

$$-\left(\frac{1}{120}\right)V_4+\left(\frac{1}{120}+\frac{1}{900}\right)V_5=0$$

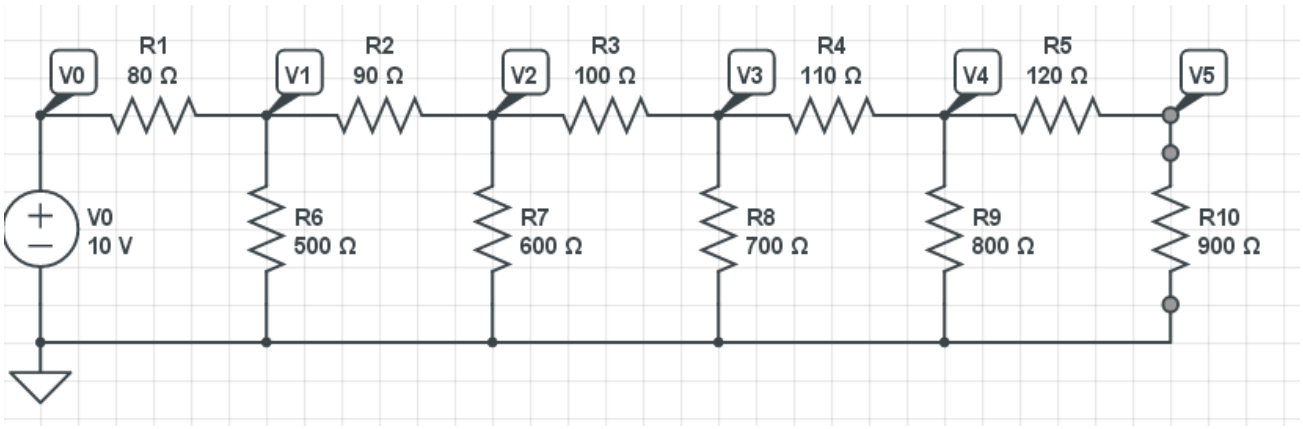
Place in matrix form

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ -\left(\frac{1}{80}\right) & \left(\frac{1}{80}+\frac{1}{90}+\frac{1}{500}\right) & -\left(\frac{1}{90}\right) & 0 & 0 & 0 \\ 0 & -\left(\frac{1}{90}\right) & \left(\frac{1}{90}+\frac{1}{100}+\frac{1}{600}\right) & -\left(\frac{1}{100}\right) & 0 & 0 \\ 0 & 0 & -\left(\frac{1}{100}\right) & \left(\frac{1}{100}+\frac{1}{110}+\frac{1}{700}\right) & -\left(\frac{1}{110}\right) & 0 \\ 0 & 0 & 0 & -\left(\frac{1}{110}\right) & \left(\frac{1}{110}+\frac{1}{120}+\frac{1}{800}\right) & -\left(\frac{1}{120}\right) \\ 0 & 0 & 0 & 0 & -\left(\frac{1}{120}\right) & \left(\frac{1}{120}+\frac{1}{900}\right) \end{bmatrix} \begin{bmatrix} V_0 \\ V_1 \\ V_2 \\ V_3 \\ V_4 \\ V_5 \end{bmatrix} = \begin{bmatrix} 10 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

Solve using Matlab

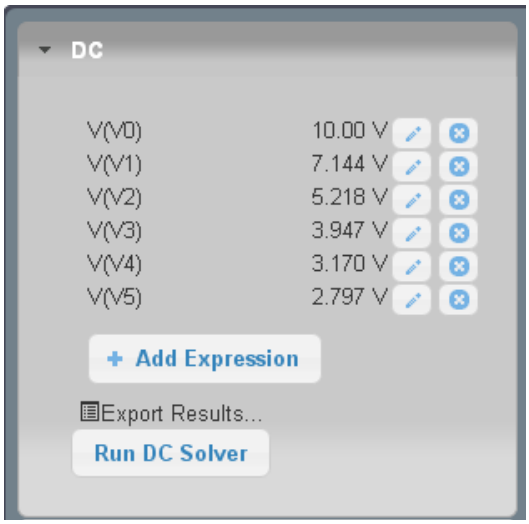
```
>> A = [1,0,0,0,0,0 ;
-1/80, 1/80+1/90+1/500, -1/90, 0, 0, 0;
0, -1/90, 1/90+1/100+1/600, -1/100, 0, 0;
0, 0, -1/100, 1/100+1/110+1/700, -1/110, 0;
0, 0, 0, -1/110, 1/110+1/120+1/800, -1/120;
0, 0, 0, 0, -1/120, 1/120+1/900]

B = [10 ; 0 ; 0 ; 0 ; 0 ; 0]

V = inv(A)*B

A =

    1.0000         0         0         0         0         0
   -0.0125    0.0256   -0.0111         0         0         0
         0   -0.0111    0.0228   -0.0100         0         0
         0         0   -0.0100    0.0205   -0.0091         0
         0         0         0   -0.0091    0.0187   -0.0083
         0         0         0         0   -0.0083    0.0094


B =

    10
     0
     0
     0
     0
     0


V =

 V0  10.0000
 V1   7.1445
 V2   5.2180
 V3   3.9472
 V4   3.1696
 V5   2.7967
```

2) Check your answers in CircuitLab

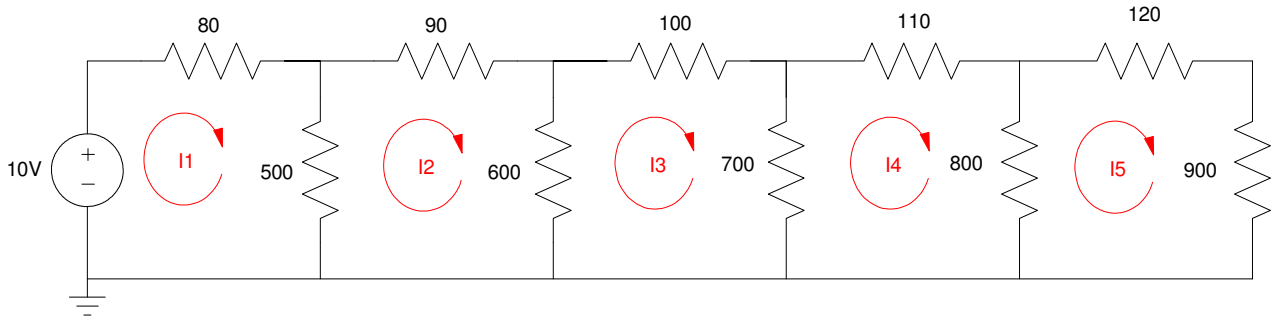


Matlab Results:

```
V0   10.0000
V1    7.1445
V2    5.2180
V3    3.9472
V4    3.1696
V5    2.7967
```



3) Use Current Loops to write N equations for N unknowns for the following circuit. Solve for the currents in Matlab



$$-10 + 80I_1 + 500(I_1 - I_2) = 0$$

$$500(I_2 - I_1) + 90I_2 + 600(I_2 - I_3) = 0$$

$$600(I_3 - I_2) + 100I_3 + 700(I_3 - I_4) = 0$$

$$700(I_4 - I_3) + 110I_4 + 800(I_4 - I_5) = 0$$

$$800(I_5 - I_4) + 120I_5 + 900I_5 = 0$$

Group terms

$$580I_1 - 500I_2 = 10$$

$$-500I_1 + 1190I_2 - 600I_3 = 0$$

$$-600I_2 + 1400I_3 - 700I_4 = 0$$

$$-700I_3 + 1610I_4 - 800I_5 = 0$$

$$-800I_4 + 1820I_5 = 0$$

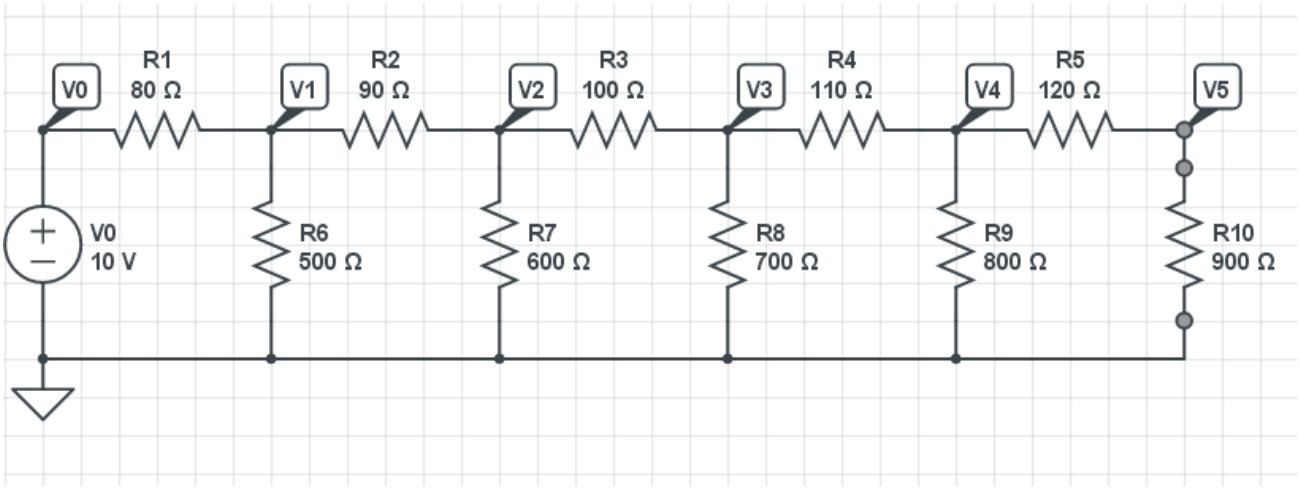
Place in matrix form

$$\begin{bmatrix} 580 & -500 & 0 & 0 & 0 \\ -500 & 1190 & -600 & 0 & 0 \\ 0 & -600 & 1400 & -700 & 0 \\ 0 & 0 & -700 & 1610 & -800 \\ 0 & 0 & 0 & -800 & 1820 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \\ I_4 \\ I_5 \end{bmatrix} = \begin{bmatrix} 10 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

Solve using Matlab

```
>> A = [580, -500, 0, 0, 0 ;
-500, 1190, -600, 0, 0 ;
0, -600, 1400, -700, 0 ;
0, 0, -700, 1610, -800 ;
0, 0, 0, -800, 1820]

B = [10 ; 0 ; 0 ; 0 ; 0]

I = inv(A)*B

A =

         580        -500           0           0           0
        -500        1190        -600           0           0
           0        -600        1400        -700           0
           0           0        -700        1610        -800
           0           0           0        -800        1820


B =

    10
     0
     0
     0
     0


I =

I1    0.0357
I2    0.0214
I3    0.0127
I4    0.0071
I5    0.0031

>>
```

4) Check your answers in CircuitLab.



Matlab Results

```
I1     0.0357
I2     0.0214
I3     0.0127
I4     0.0071
I5     0.0031
```