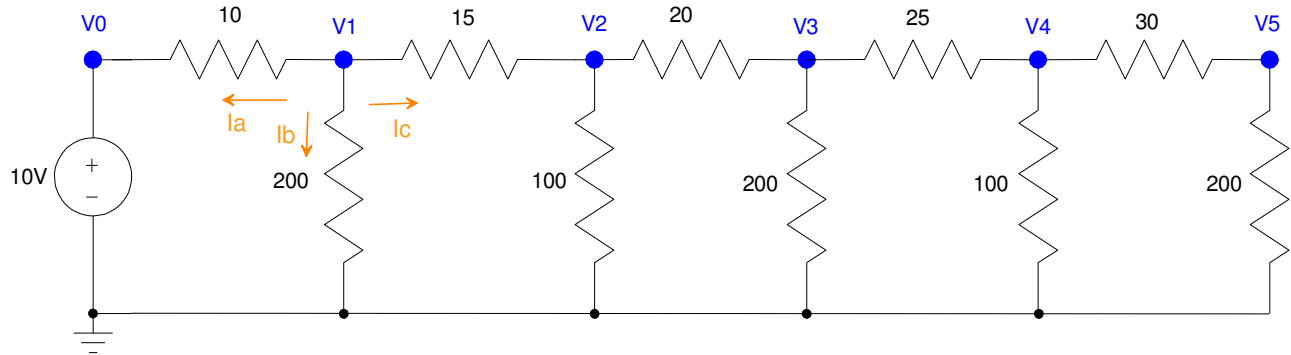


ECE 111 - Homework #9

ECE 211 Circuits I

Voltage Nodes



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

There are six voltage nodes. Write 6 equations for 6 unknowns

V0: $V_0 = 10$

V1: $I_a + I_b + I_c = 0$

$$\left(\frac{V_1 - V_0}{10} \right) + \left(\frac{V_1}{200} \right) + \left(\frac{V_1 - V_2}{15} \right) = 0$$

V2: $\left(\frac{V_2 - V_1}{15} \right) + \left(\frac{V_2}{100} \right) + \left(\frac{V_2 - V_3}{20} \right) = 0$

V3: $\left(\frac{V_3 - V_2}{20} \right) + \left(\frac{V_3}{200} \right) + \left(\frac{V_3 - V_4}{25} \right) = 0$

V4: $\left(\frac{V_4 - V_3}{25} \right) + \left(\frac{V_4}{100} \right) + \left(\frac{V_4 - V_5}{30} \right) = 0$

V5: $\left(\frac{V_5 - V_4}{30} \right) + \left(\frac{V_5}{200} \right) = 0$

2) Solve for the node voltages in Matlab.

Group terms

$$V_0 = 10$$

$$-\left(\frac{1}{10}\right)V_0 + \left(\frac{1}{10} + \frac{1}{200} + \frac{1}{15}\right)V_1 - \left(\frac{1}{15}\right)V_2 = 0$$

$$-\left(\frac{1}{15}\right)V_1 + \left(\frac{1}{15} + \frac{1}{100} + \frac{1}{20}\right)V_2 - \left(\frac{1}{20}\right)V_3 = 0$$

$$-\left(\frac{1}{20}\right)V_2 + \left(\frac{1}{20} + \frac{1}{200} + \frac{1}{25}\right)V_3 - \left(\frac{1}{25}\right)V_4 = 0$$

$$-\left(\frac{1}{25}\right)V_3 + \left(\frac{1}{25} + \frac{1}{100} + \frac{1}{30}\right)V_4 - \left(\frac{1}{30}\right)V_5 = 0$$

$$-\left(\frac{1}{30}\right)V_4 + \left(\frac{1}{30} + \frac{1}{200}\right)V_5 = 0$$

Express in matrix form

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ \left(\frac{-1}{10}\right) & \left(\frac{1}{10} + \frac{1}{200} + \frac{1}{15}\right) & \left(\frac{-1}{15}\right) & 0 & 0 & 0 \\ 0 & \left(\frac{-1}{15}\right) & \left(\frac{1}{15} + \frac{1}{100} + \frac{1}{20}\right) & \left(\frac{-1}{20}\right) & 0 & 0 \\ 0 & 0 & \left(\frac{-1}{20}\right) & \left(\frac{1}{20} + \frac{1}{200} + \frac{1}{25}\right) & \left(\frac{-1}{25}\right) & 0 \\ 0 & 0 & 0 & \left(\frac{-1}{25}\right) & \left(\frac{1}{25} + \frac{1}{100} + \frac{1}{30}\right) & \left(\frac{-1}{30}\right) \\ 0 & 0 & 0 & 0 & \left(\frac{-1}{30}\right) & \left(\frac{1}{30} + \frac{1}{200}\right) \end{bmatrix} \begin{bmatrix} V_0 \\ V_1 \\ V_2 \\ V_3 \\ V_4 \\ V_5 \end{bmatrix} = \begin{bmatrix} 10 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

Solve using Matlab

```
>> a1 = [1 0 0 0 0 0];
>> a2 = [-1/10, 1/10+1/200+1/15, -1/15, 0,0,0];
>> a3 = [0, -1/15, 1/15+1/100+1/20, -1/20, 0 0];
>> a4 = [0, 0, -1/20, 1/20+1/200+1/25, -1/25,0];
>> a5 = [0, 0, 0, -1/25, 1/25+1/100+1/30, -1/30];
>> a6 = [0, 0, 0, 0, -1/30, 1/30+1/200];
```

```
>> A = [a1;a2;a3;a4;a5;a6]
```

```
1.0000    0    0    0    0    0
-0.1000    0.1717   -0.0667    0    0    0
    0   -0.0667    0.1267   -0.0500    0    0
    0    0   -0.0500    0.0950   -0.0400    0
    0    0    0   -0.0400    0.0833   -0.0333
    0    0    0    0   -0.0333    0.0383
```

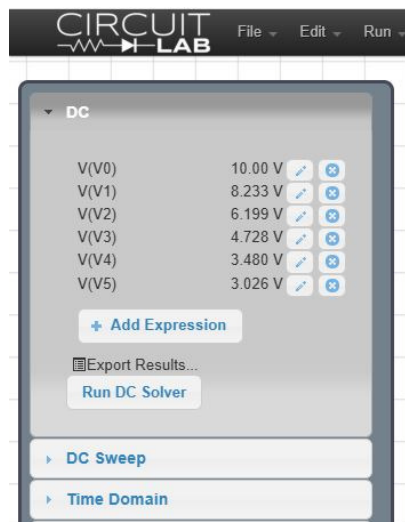
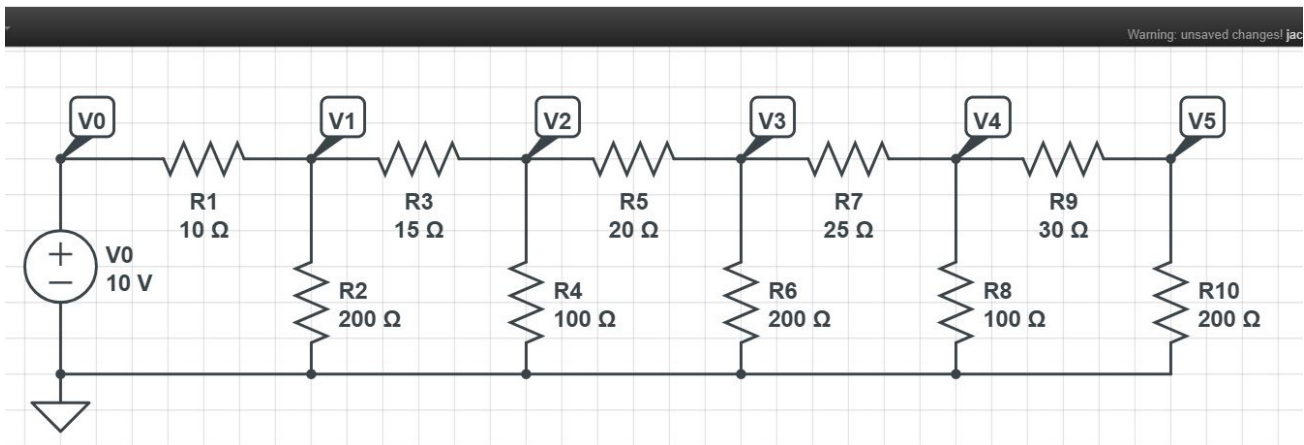
```
>> B = [10;0;0;0;0;0]
```

```
10  
0  
0  
0  
0  
0
```

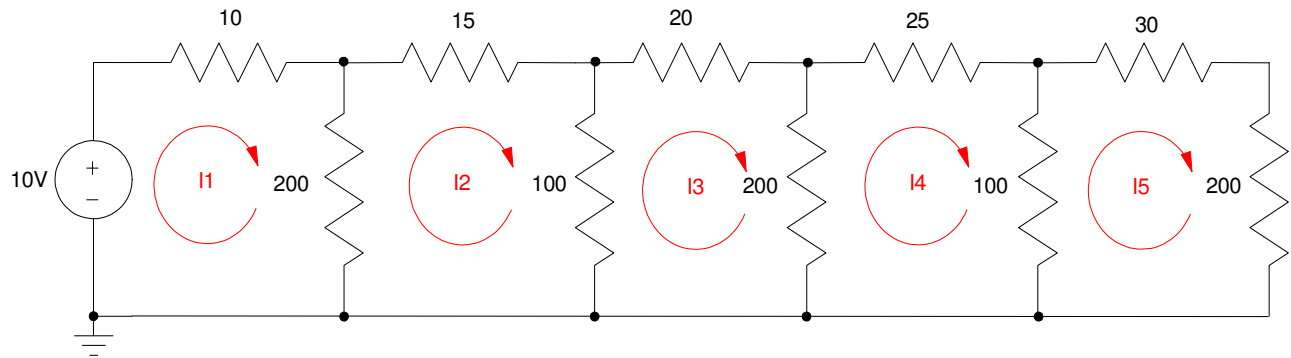
```
>> V = inv(A)*B
```

```
10.0000  
8.2328  
6.1993  
4.7280  
3.4798  
3.0259
```

3) Check your answers in CircuitLab (results match)



Current Loops



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

$$I1: -10 + 10I_1 + 200(I_1 - I_2) = 0$$

$$I2: 200(I_2 - I_1) + 15I_2 + 100(I_2 - I_3) = 0$$

$$I3: 100(I_3 - I_2) + 20I_3 + 200(I_3 - I_4) = 0$$

$$I4: 200(I_4 - I_3) + 25I_4 + 100(I_4 - I_5) = 0$$

$$I5: 100(I_5 - I_4) + 30I_5 + 200I_5 = 0$$

5) Solve for the currents in Matlab

Group terms

$$210I_1 - 200I_2 = 10$$

$$-200I_1 + 315I_2 - 100I_3 = 0$$

$$-100I_2 + 320I_3 - 200I_4 = 0$$

$$-200I_3 + 325I_4 - 100I_5 = 0$$

$$-100I_4 + 330I_5 = 0$$

Place in matrix form

$$\begin{bmatrix} 210 & -200 & 0 & 0 & 0 \\ -200 & 315 & -100 & 0 & 0 \\ 0 & -100 & 320 & -200 & 0 \\ 0 & 0 & -200 & 325 & -100 \\ 0 & 0 & 0 & -100 & 330 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \\ I_4 \\ I_5 \end{bmatrix} = \begin{bmatrix} 10 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

Solve using Matlab

```
>> B = [210,-200,0,0,0 ; -200,315,-100,0,0 ; 0,-100,320,-200,0 ; 0,0,-200,325,-100  
; 0,0,0,-100,330]
```

```
    210    -200         0         0         0  
   -200     315    -100         0         0  
        0    -100     320    -200         0  
        0         0    -200     325    -100  
        0         0         0    -100     330
```

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

```
    10  
     0  
     0  
     0  
     0
```

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

```
I1    0.1767  
I2    0.1356  
I3    0.0736  
I4    0.0499  
I5    0.0151
```

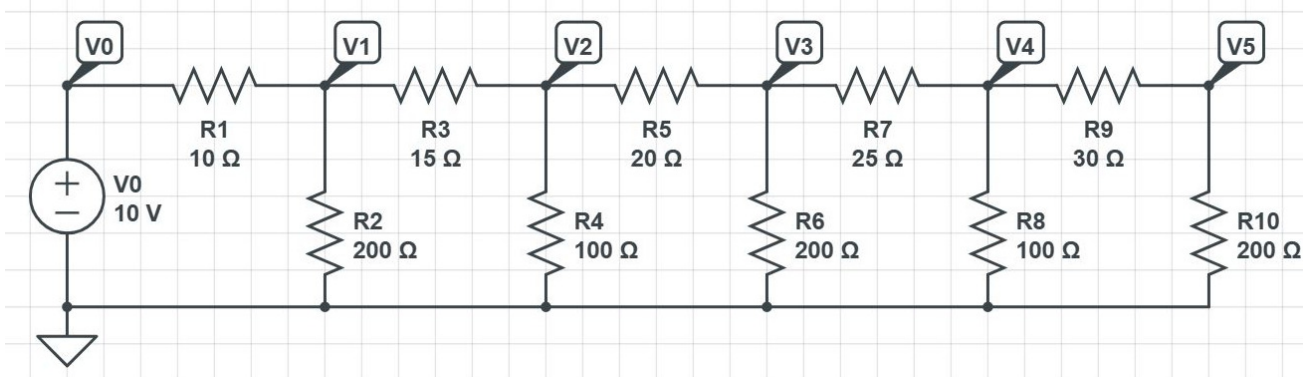
```
>> mA = I*1000
```

```
I1    176.7247  
I2    135.5609  
I3     73.5675  
I4     49.9276  
I5     15.1296
```

```
>>
```

6) Check your answers in CircuitLab.

- Answers match



DC		
V(V0)	10.00 V	✖
V(V1)	8.233 V	✖
V(V2)	6.199 V	✖
V(V3)	4.728 V	✖
V(V4)	3.480 V	✖
V(V5)	3.026 V	✖
I(R1.nB)	176.7 mA	✖
I(R3.nB)	135.6 mA	✖
I(R5.nB)	73.57 mA	✖
I(R7.nB)	49.93 mA	✖
I(R9.nB)	15.13 mA	✖
+ Add Expression		
Export Results...		
Run DC Solver		