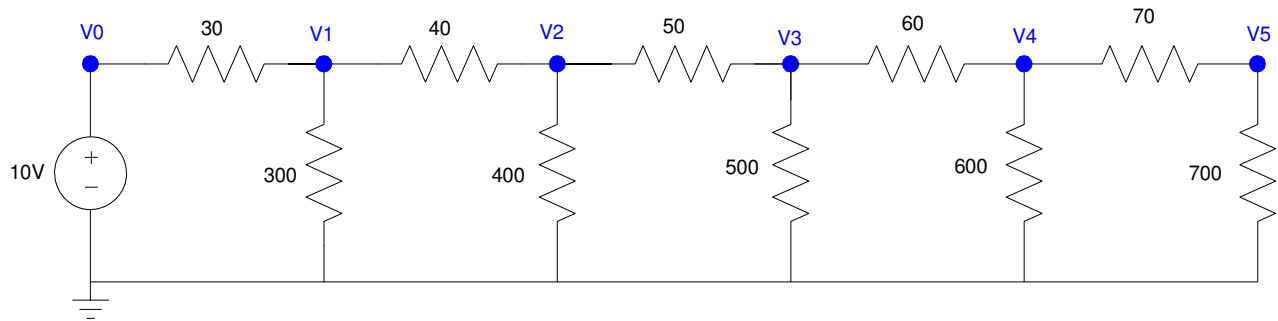


# ECE 111 - Homework #6

Week #6: EE 206 Circuits I - Due Tuesday, February 21st

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



$$V_0 = 10$$

$$\left(\frac{V_1 - V_0}{30}\right) + \left(\frac{V_1}{300}\right) + \left(\frac{V_1 - V_2}{40}\right) = 0$$

$$\left(\frac{V_2 - V_1}{40}\right) + \left(\frac{V_2}{400}\right) + \left(\frac{V_2 - V_3}{50}\right) = 0$$

$$\left(\frac{V_3 - V_2}{50}\right) + \left(\frac{V_3}{500}\right) + \left(\frac{V_3 - V_4}{60}\right) = 0$$

$$\left(\frac{V_4 - V_3}{60}\right) + \left(\frac{V_4}{600}\right) + \left(\frac{V_4 - V_5}{70}\right) = 0$$

$$\left(\frac{V_5 - V_4}{70}\right) + \left(\frac{V_5}{700}\right)$$

2) Solve for the node voltages in Matlab.

Group terms

$$V_0 = 10$$

$$-\left(\frac{1}{30}\right)V_0 + \left(\frac{1}{30} + \frac{1}{300} + \frac{1}{40}\right)V_1 - \left(\frac{1}{40}\right)V_2 = 0$$

$$-\left(\frac{1}{40}\right)V_1 + \left(\frac{1}{40} + \frac{1}{400} + \frac{1}{50}\right)V_2 - \left(\frac{1}{50}\right)V_3 = 0$$

$$-\left(\frac{1}{50}\right)V_2 + \left(\frac{1}{50} + \frac{1}{500} + \frac{1}{60}\right)V_3 - \left(\frac{1}{60}\right)V_4 = 0$$

$$-\left(\frac{1}{60}\right)V_3 + \left(\frac{1}{60} + \frac{1}{600} + \frac{1}{70}\right)V_4 - \left(\frac{1}{70}\right)V_5 = 0$$

$$-\left(\frac{1}{70}\right)V_4 + \left(\frac{1}{70} + \frac{1}{700}\right)V_5 = 0$$

Place in matrix form

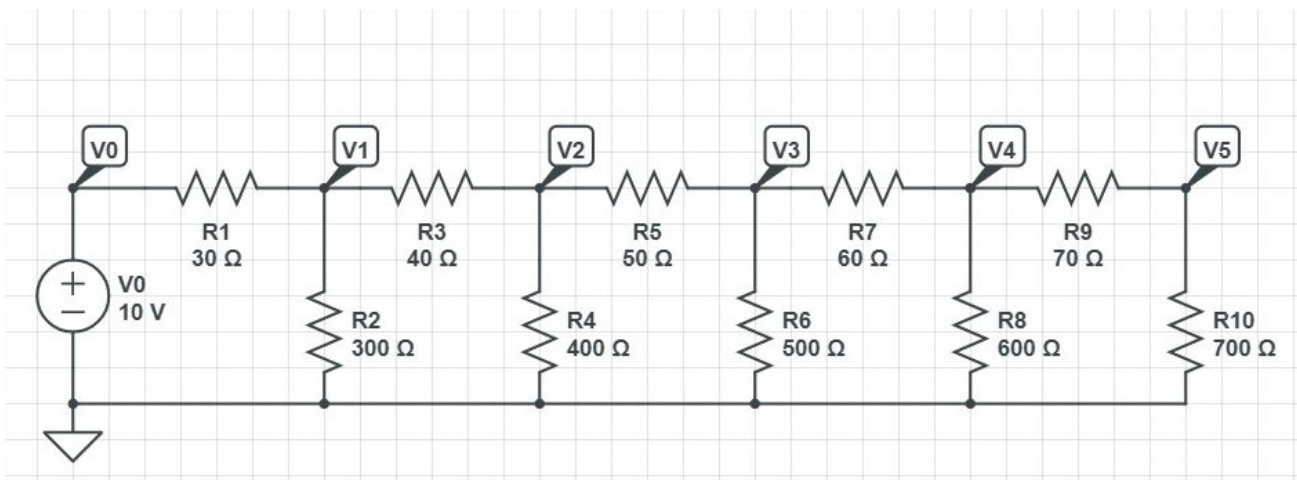
$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ \left(\frac{-1}{30}\right) & \left(\frac{1}{30} + \frac{1}{300} + \frac{1}{40}\right) & \left(\frac{-1}{40}\right) & 0 & 0 & 0 \\ 0 & \left(\frac{-1}{40}\right) & \left(\frac{1}{40} + \frac{1}{400} + \frac{1}{50}\right) & \left(\frac{-1}{50}\right) & 0 & 0 \\ 0 & 0 & \left(\frac{-1}{50}\right) & \left(\frac{1}{50} + \frac{1}{500} + \frac{1}{60}\right) & \left(\frac{-1}{60}\right) & 0 \\ 0 & 0 & 0 & \left(\frac{-1}{60}\right) & \left(\frac{1}{60} + \frac{1}{600} + \frac{1}{70}\right) & \left(\frac{-1}{70}\right) \\ 0 & 0 & 0 & 0 & \left(\frac{-1}{70}\right) & \left(\frac{1}{70} + \frac{1}{700}\right) \end{bmatrix} \begin{bmatrix} V_0 \\ V_1 \\ V_2 \\ V_3 \\ V_4 \\ V_5 \end{bmatrix} = \begin{bmatrix} 10 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

Solve using Matlab

```
a1 = [1,0,0,0,0,0];
a2 = [-1/30, 1/30+1/300+1/40, -1/40, 0,0,0];
a3 = [0, -1/40, 1/40+1/400+1/50, -1/50, 0,0];
a4 = [0,0, -1/50, 1/50+1/500+1/60, -1/60, 0];
a5 = [0,0,0, -1/60, 1/60+1/600+1/70, -1/70];
a6 = [0,0,0,0, -1/70, 1/70+1/700];
A = [a1;a2;a3;a4;a5;a6]
B = [10;0;0;0;0;0]
V = inv(A)*B
```

```
v0    10.0000
v1     8.0080
v2     6.4197
v3     5.2369
v4     4.4459
v5     4.0417
```

### 3) Check your answers in CircuitLab



From Matlab

V0	10.0000
V1	8.0080
V2	6.4197
V3	5.2369
V4	4.4459
V5	4.0417

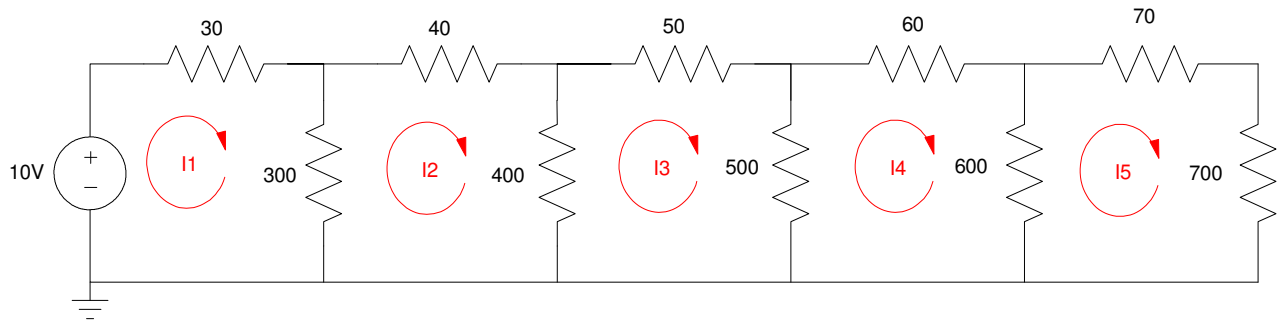
The answers match

The image shows a screenshot of the CircuitLab DC solver interface. The title is "DC". Below it, a list of voltage measurements is shown:

V(V0)	10.00 V	<input type="text"/>	<input type="text"/>
V(V1)	8.008 V	<input type="text"/>	<input type="text"/>
V(V2)	6.420 V	<input type="text"/>	<input type="text"/>
V(V3)	5.237 V	<input type="text"/>	<input type="text"/>
V(V4)	4.446 V	<input type="text"/>	<input type="text"/>
V(V5)	4.042 V	<input type="text"/>	<input type="text"/>

Below the table are buttons for "+ Add Expression", "Export Results...", and "Run DC Solver". At the bottom, there is a "DC Sweep" section with a right-pointing arrow.

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



$$-10 + 30I_1 + 300(I_1 - I_2) = 0$$

$$300(I_2 - I_1) + 40I_2 + 400(I_2 - I_3) = 0$$

$$400(I_3 - I_2) + 50I_3 + 500(I_3 - I_4) = 0$$

$$500(I_4 - I_3) + 60I_4 + 600(I_4 - I_5) = 0$$

$$600(I_5 - I_4) + 70I_5 + 700(I_5) = 0$$

5) Solve for the currents in Matlab

Group terms

$$330I_1 - 300I_2 = 10$$

$$-300I_1 + 740I_2 - 400I_3 = 0$$

$$-400I_2 + 950I_3 - 500I_4 = 0$$

$$-500I_3 + 1160I_4 - 600I_5 = 0$$

$$-600I_4 + 1370I_5 = 0$$

Place in matrix form

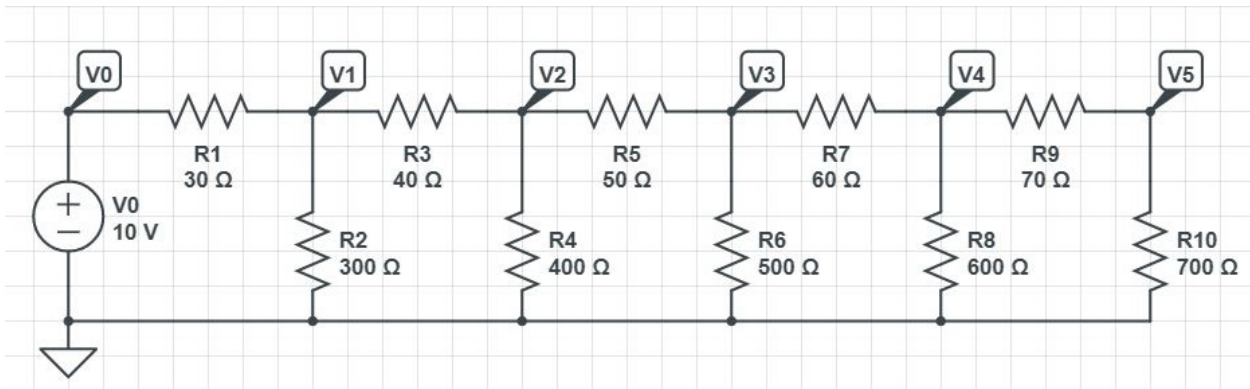
$$\begin{bmatrix} 330 & -300 & 0 & 0 & 0 \\ -300 & 740 & -400 & 0 & 0 \\ 0 & -400 & 950 & -500 & 0 \\ 0 & 0 & -500 & 1160 & -600 \\ 0 & 0 & 0 & -600 & 1370 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \\ I_4 \\ I_5 \end{bmatrix} = \begin{bmatrix} 10 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

## Solve using Matlab

```
a1 = [330,-300,0,0,0];  
a2 = [-300,740,-400,0,0];  
a3 = [0,-400,950,-500,0];  
a4 = [0,0,-500,1160,-600];  
a5 = [0,0,0,-600,1370];  
A = [a1;a2;a3;a4;a5]  
B = [10;0;0;0;0]  
I = inv(A)*B  
I * 1000
```

```
      mA  
I1    66.4000  
I2    39.7067  
I3    23.6573  
I4    13.1836  
I5     5.7738
```

6) Check your answers in CircuitLab.



I(R1.nB)	66.40 mA	<input type="text"/>	<input type="text"/>
I(R3.nB)	39.71 mA	<input type="text"/>	<input type="text"/>
I(R5.nB)	23.66 mA	<input type="text"/>	<input type="text"/>
I(R7.nB)	13.18 mA	<input type="text"/>	<input type="text"/>
I(R9.nB)	5.774 mA	<input type="text"/>	<input type="text"/>

[+ Add Expression](#)

Export Results...

[Run DC Solver](#)

**DC Sweep**

**Time Domain**