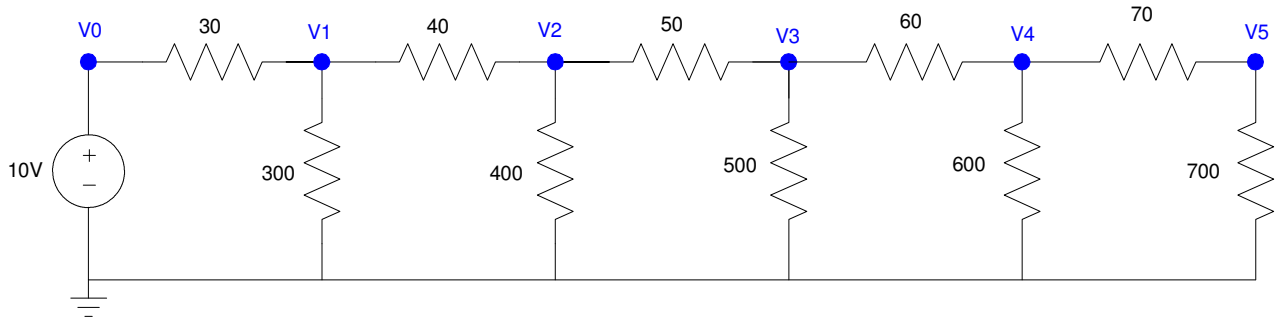
ECE 111 - Homework #6

Week #6: EE 206 Circuts 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

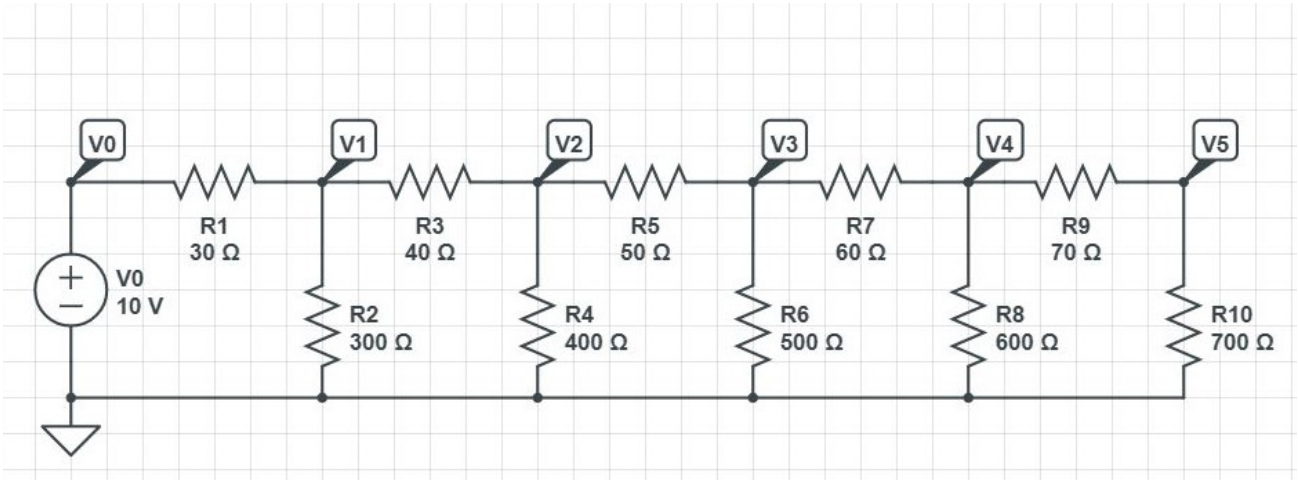
$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ \left(\frac{-1}{30}\right) & \left(\frac{1}{30}+\frac{1}{300}+\frac{1}{40}\right) & \left(\frac{-1}{40}\right) & 0 & 0 & 0 \\ 0 & \left(\frac{-1}{40}\right) & \left(\frac{1}{40}+\frac{1}{400}+\frac{1}{50}\right) & \left(\frac{-1}{50}\right) & 0 & 0 \\ 0 & 0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

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

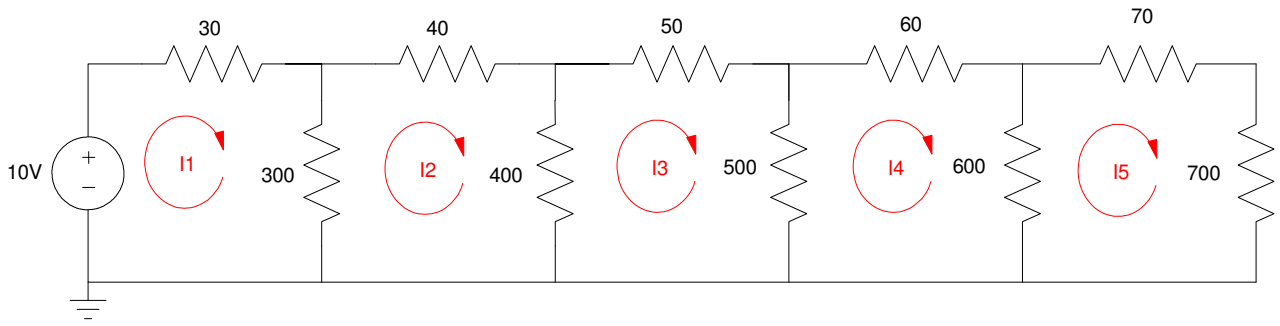


From Matlab

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

The answers match

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.