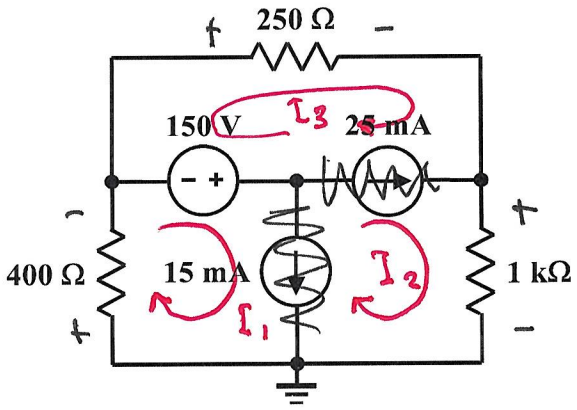
EE 2240

Homework Problem #028

Define mesh currents and express the mesh equations in the matrix form discussed in class.



Do not attempt to solve the equations.

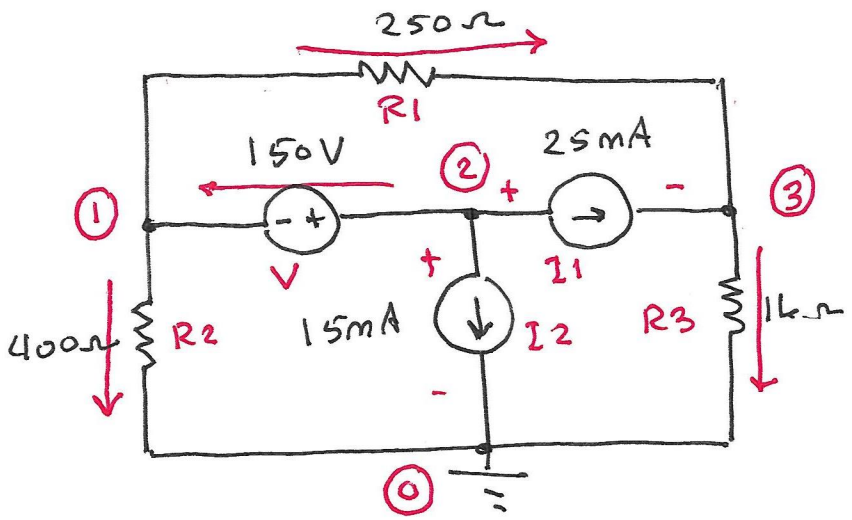
$$I_2 - I_3 = 25\,mA$$

$$I_1 - I_2 = 15\,mA$$

$$250\,I_3 + 1000\,I_2 + 400\,I_1 = 0$$

In matrix form:

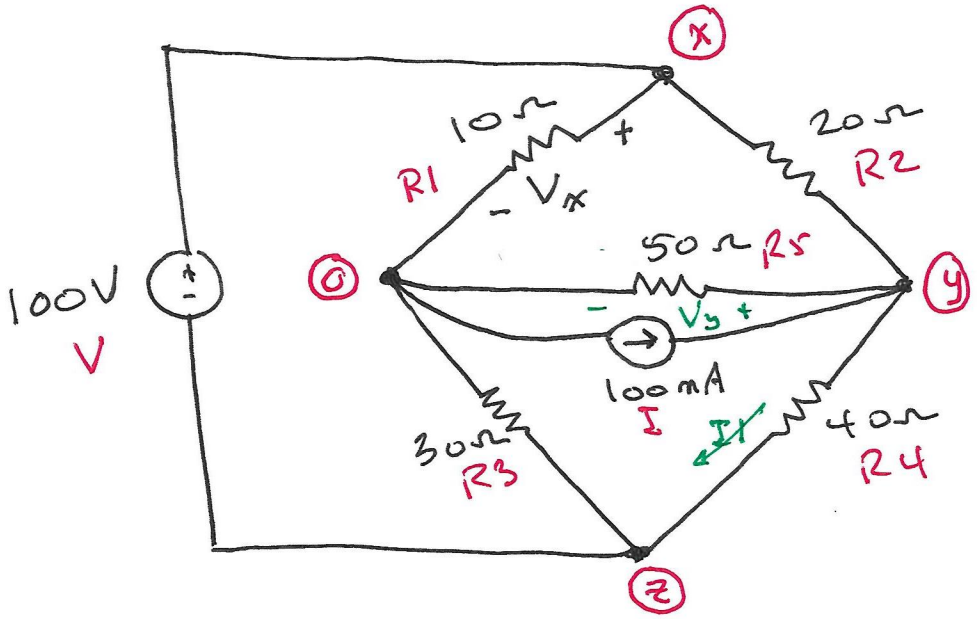
$$\begin{bmatrix} 0 & 1 & -1 \\ 1 & -1 & 0 \\ 400 & 1E3 & 250 \end{bmatrix} \begin{Bmatrix} I_1 \\ I_2 \\ I_3 \end{Bmatrix} = \begin{bmatrix} 25\times10^{-3} \\ 15\times10^{-3} \\ 0 \end{bmatrix}$$



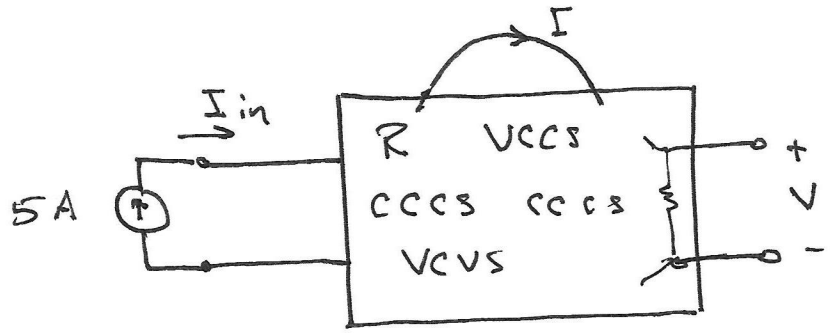
Netlist

```
Title
R1      1    3    250
V       2    1    DC    150
I1      2    3    DC    25m
R2      1    0    400
I2      2    0    DC    15m
R3      3    0    1k
.op
.end
```

← LTspice puts this in automatically

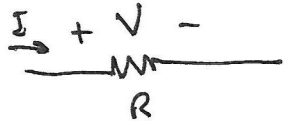

X
10Ω
R1
+
V_x
-
20Ω
R2
50Ω Rs
100V
V
G
Y
-
V_y +
100mA
I
30Ω
R3
I1
40Ω
R4
Z

Linearity and Proportionality

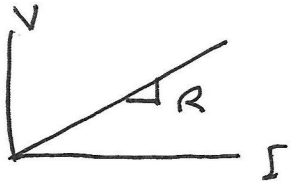


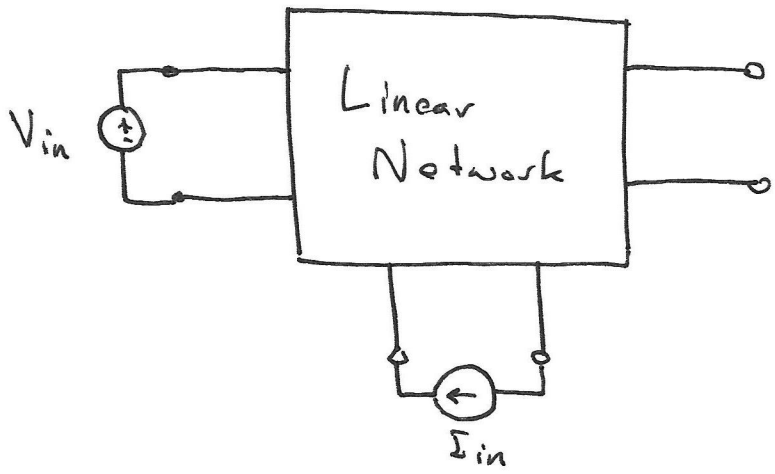
With $I_{in} = 5A$, $I = 4mA$ and $V = 6V$.

What would I and V be if I_{in} is changed to 10A?



$V = RI$





$$V_{out} = \alpha V_{in} + \beta I_{in}$$

When $V_{in} = 10\,V$ and $I_{in} = 5\,mA$, $V_{out} = 7\,V$
When $V_{in} = 20\,V$ and $I_{in} = 3\,mA$, $V_{out} = 5\,V$
} experimental data

Determine α and β, and then calculate V_{out} when $V_{in} = 15\,V$ and $I_{in} = 4\,mA$.

$$10\alpha + 5\times10^{-3}\beta = 7$$

$$20\alpha + 3\times10^{-3}\beta = 5$$

In matrix form:

$$\begin{bmatrix} 10 & 5\times10^{-3} \\ 20 & 3\times10^{-3} \end{bmatrix} \begin{bmatrix} \alpha \\ \beta \end{bmatrix} = \begin{bmatrix} 7 \\ 5 \end{bmatrix}$$

$\alpha = ?$ $\beta = ?$

Superposition next.