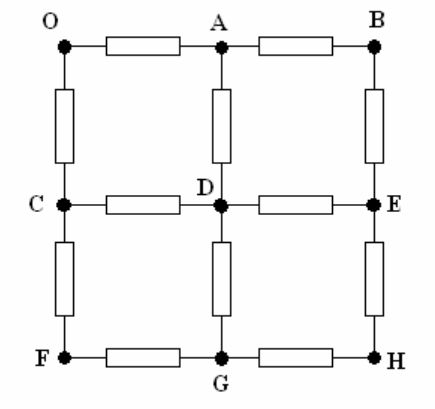
ENGINEERING SCIENCE C103
EXAM SOLUTIONS 2005

Q 7 Twelve 10 kΩ resistors are connected as shown.

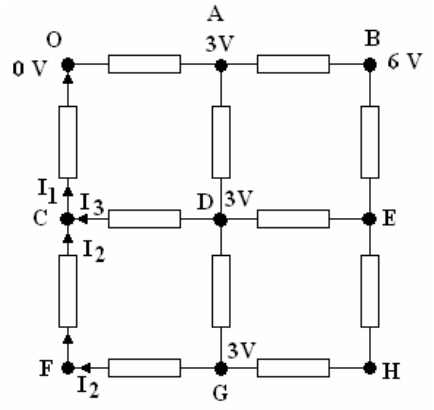


Determine the voltage at each node if:-

a) a 6 V battery is connected between O and B
b) a 6 V battery is connected between O and H

a) Because of symmetry the voltage at A D and G must be 3 V

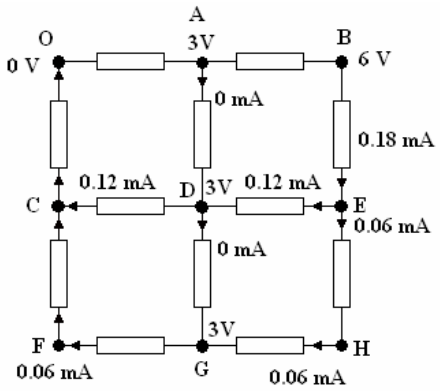
Examining node C we may deduce the current flow is as shown since V_C must be less than 3 V
Working in mA, Ohms Law gives



$I_1 = V_C/10K = 0.1\ V_C$
$I_2 = (3 - V_C)/20k = \ 0.15 - 0.05\ V_C$
$I_3 = (3 - V_C)/10k = \ 0.3 - 0.1\ V_C$
Kirchoff's rule gives
$I_1 = I_2 + I_3$

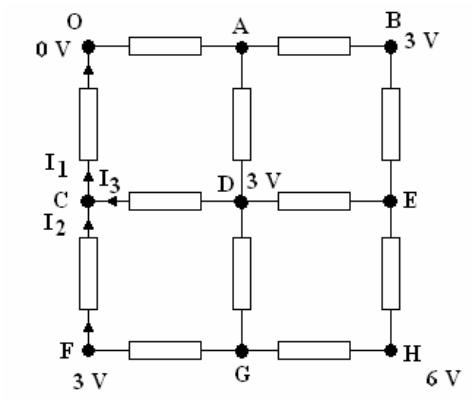
$0.1\ V_C = 0.15 - 0.05\ V_C + 0.3 - 0.1\ V_C$
$0.25\ V_C = 0.45$
$V_C = 1.8$ V

$I_1 = 0.18$ mA
$I_2 = \ 0.06$ mA
$I_3 = 0.12$ mA
We can easily deduce the other currents as shown
Now use Ohms Law to find voltages.



$V_F = 3 - 0.06 \times 10 = 2.4$ V
$V_E = 6 - 0.18 \times 10 = 4.2$ V
$V_H = 3 + 0.06 \times 10 = 3.6$ V

b) Again by symmetry we can deduce that V_G, V_D and V_A are 3V



Again examining node C we deduce the voltage is between 3 and 0 so the currents flow as shown.

$I_1 = V_C/10K = 0.1\ V_C$
$I_2 = (3 - V_C)/10k = \ 0.3 - 0.1\ V_C$
$I_3 = (3 - V_C)/10k = \ 0.3 - 0.1\ V_C$
Kirchoff's rule gives
$I_1 = I_2 + I_3$

$0.1\ V_C = 0.3 - 0.1\ V_C + 0.3 - 0.1\ V_C$
$0.3\ V_C = 0.6 \quad V_C = 2$ V
By symmetry $V_A = \ 2$ V

$I_1 = 0.2$ mA $\quad I_2 = \ 0.1$ mA $\quad I_3 = 0.1$ mA

Now use Ohms Law to find voltages.

$V_G = 3 + 0.1 \times 10 = 4$ V
By symmetry $V_E = \ 4$ V