HW1 SOLUTIONS MAE140

AMIT PANDEY
APPANDEY@UCSD.EDU

1-10/

- $V = 9.6V$
- 50mA fuse
- 1.5W charger.

Need to determine current flowing through the fuse. If it exceeds 50mA then the fuse will blow.

$P = VI$

$\Rightarrow I = \frac{P}{V} = \frac{1.5}{9.6} = 0.15625$ Amps $= \underline{156.25\ mA}$.

$156.25 > 50$, HENCE THE FUSE WILL BLOW

OR:

$P = VI$
$= 9.6 \times 50 \times 10^{-3}$
$= 0.48W < 1.5W$

so the fuse will blow.

1-16/

- 5 A fuse
- 25 bulbs per string
- Each bulb rated at 7W

Need to determine the MAXIMUM number of strings that can be connected without blowing the fuse.

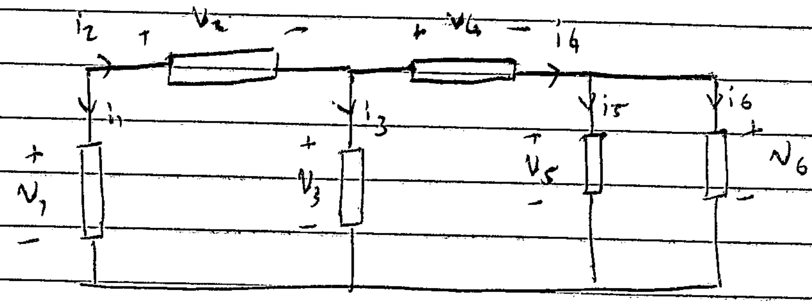
How much power consumed per string? $7 \times 25 = \underline{175W}$

Maximum power able to be delivered before fuse blows? $120 \times 5 = 600W$.

So, maximum number of strings is $\frac{600}{175} = \underline{3.43}$

We need to round down to $\underline{3\ strings}$, 4 strings will blow the fuse.

1-22



DEVICE	V	I	P	Absorb/Deliver?
#1	15	-1	-15	DELIVER
#2	5	1	5 W	ABSORB
#3	10	2	20 W	ABSORB
#4	-10	-1	10 W	ABSORB
#5	20	-3	-60W	DELIVER
#6	20	2	40	ABSORB

Check balance:

Σ absorbing + Σ delivering

$= -15 + 5 + 20 + 10 - 60 + 40$

$= 0$

2-5

$V = 15V$,

$P_x = 25mV$

Find the resistance.

$P = VI$, $V = IR$,

$I = \frac{V}{R}$

$\Rightarrow P = \frac{V^2}{R} \Rightarrow R = \frac{V^2}{P}$

$= \frac{15^2}{(25 \times 10^{-3})} = \underline{\underline{9000 \Omega}} , \underline{9 k\Omega}$

2-10

Maximum power rating of resistors : 500V, 0.25W.

Let us first compute case for $\underline{R > 1 M\Omega}$

$P = \frac{V^2}{R}$,

Given $V = 500V$, we see the power absorbed by the resistor is maximum when the resistance takes its lowest possible value.

Therefore

$P = \frac{500^2}{1 \times 10^6} = \underline{\underline{0.25W}}$.

Increasing the resistance above $1 M\Omega$ with a constant voltage will reduce the absorbed power below 0.25W, 10

∴ Voltage is the controlling limit.

Now for $R < 1M\Omega$

We have $V = \sqrt{PR}$

Given $P = 6.25W$, we see that the voltage across the resistor is 500V when $R = 1 \times 10^6 \Omega$ and decreases with the resistance. Therefore for $R < 1M\Omega$, the power rating of the resistor is the controlling limit.

2-12

Resistance of $5k\Omega$ at $25°C$

Resistance of 340Ω at $100°C$

Formulate two linear equations:

$$5000 = m(25) + c \quad (1)$$
$$340 = m(100) + c \quad (2)$$

Rearrange equation 2,

$$c = 340 - 100m$$

sub into (1)

$$5000 = 25m + (340 - 100m)$$
$$4660 = -75m$$
$$m = -62.13$$

$$c = 340 - 100m$$
$$= 6553.3$$

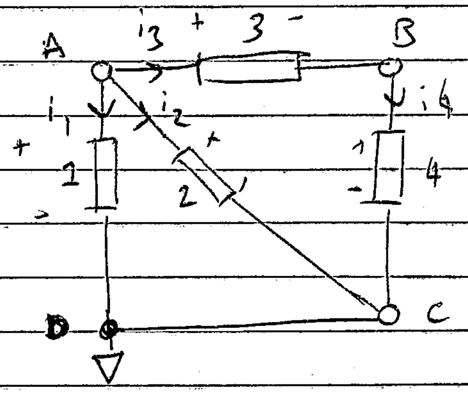
So, we have a relationship

$$R = -62.13T + 6553.3$$

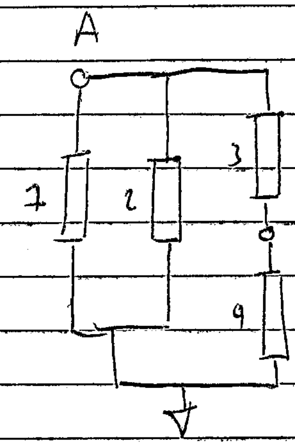
The

$$1000 = -62.13T + 6553.3$$
$$\Rightarrow T \simeq 89.38°C$$

2-15



$\Rightarrow$



(a) Nodes : A, B, C.

We note that the connection labelled D is not a node as it is connected by short circuit to node C.

Loops : D - A - C

A - B - C

A - B - C - D

(b)
- 1 & 2 are connected in parallel
- 3 & 4 are connected in series
- ~~The series resistance R of 3 and 4~~ The sum of 3 & 4 are in parallel with 1 & 2.

(c) KCL

@ NODE

A | $i_1 + i_2 + i_3 = 0$

B | $i_3 = i_4$

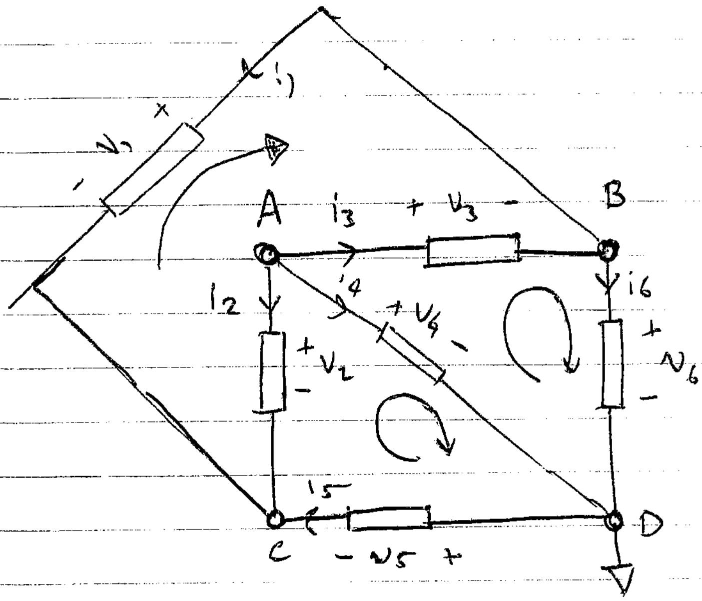
C | $i_1 + i_2 + i_4 = 0$

KVL

$V_1 - V_2 = 0$

$V_2 - V_3 - V_4 = 0$

2-17



(a) CURRENT NODES: A, B, C, D

VOLTAGE LOOPS: A-D-C, A-B-D, B-D-C, A-B-C

(b) No elements in series or parallel

(c) CURRENT NODES

NODE A: $i_2 + i_3 + i_4 = 0$

NODE B: $i_3 = i_1 + i_6$

NODE C: $i_1 + i_2 + i_5 = 0$

NODE D: $i_4 + i_6 = i_5$

VOLTAGE LOOPS

$v_5 - v_2 + v_4 = 0$

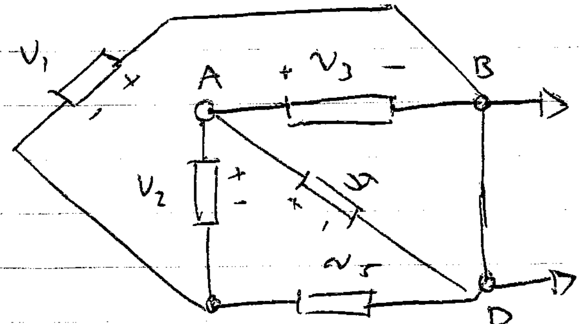
$v_6 - v_4 + v_3 = 0$

$v_2 - v_1 - v_3 = 0$

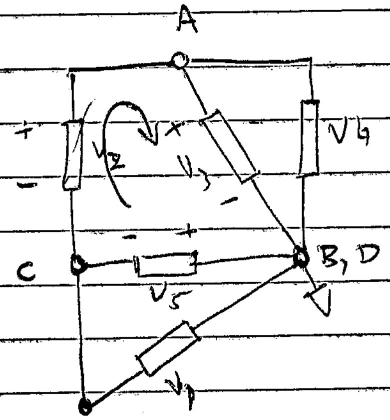
2-19

FOR THIS QUESTION, ACTUAL VOLTAGES DO NOT NEED TO BE COMPUTED.

Let us redraw the circuit when node B touches ground



This is the same as:



We see that:

$v_3 = v_4$

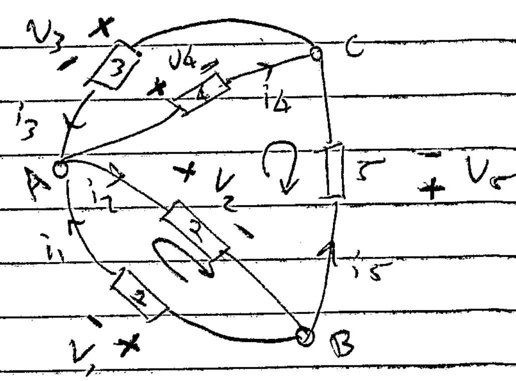
$v_5 = v_1$

$v_5 - v_2 + v_3 = 0$

$v_6 = 0$

2-23

(a) With the passive sign convention, the reference direction of current points toward positive terminal, so:



We get the following voltage loops (others may be possible):

$v_1 + v_2 = 0$

$v_5 + v_2 - v_4 = 0$

$v_3 + v_4 = 0$

(b) $v_3 = 0$

$v_5 = -v_2$

$v_1 = -v_2$

$v_5 = v_1$