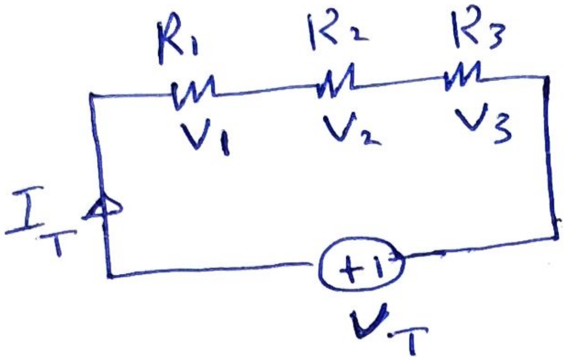
Resistance Combinations

1- series

We have shown the equivalent resistance in series for "N" resistor:-



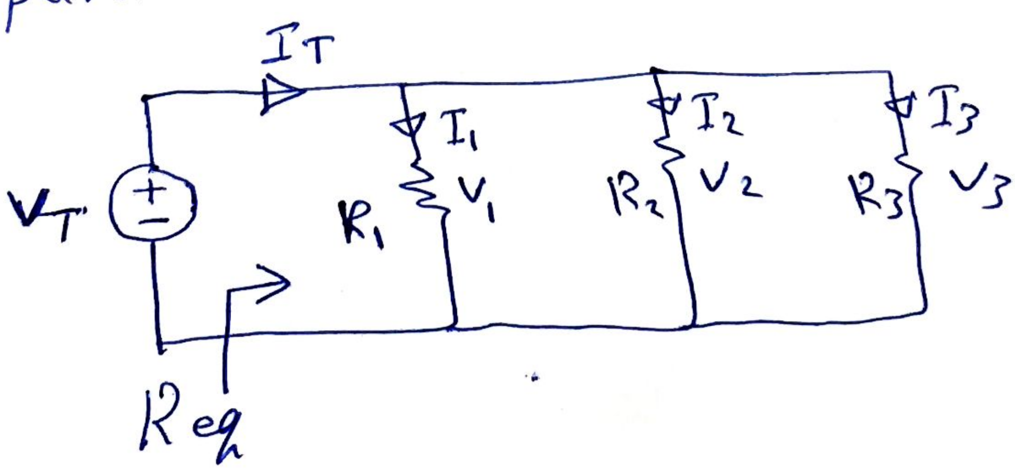
$$R_{eq} = R_1 + R_2 + R_3$$

$$V_T = V_1 + V_2 + V_3$$

$$I_T = I_1 = I_2 = I_3$$

$$R_{eq} = \frac{V_T}{I_T}$$

2- Parallel :- The equivalent resistance for "N" parallel resistor.

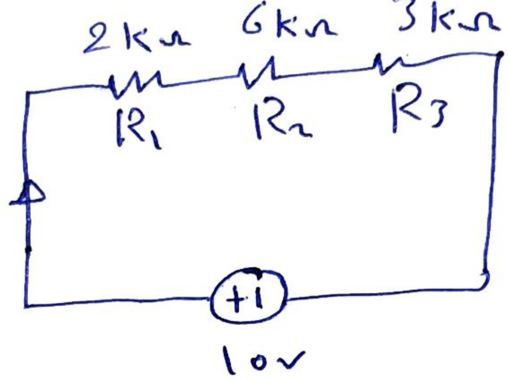


$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$V_T = V_1 = V_2 = V_3$$

$$I_T = I_1 + I_2 + I_3$$

Ex1 For the circuit as shown fig.1, find the R_{eq}. and the current in circuit.



Sol:-

$$R_{eq} = R_1 + R_2 + R_3$$

$$R_{eq} = 2k + 6k + 3k$$

$$R_{eq} = 11k\Omega$$

∴ series Resistance

$$V_T = V_1 + V_2 + V_3$$

$$I_T = I_1 = I_2 = I_3$$

$$R_{eq} = \frac{V_T}{I_T} \Rightarrow I_T = \frac{V_T}{R_{eq}} = \frac{10v}{11k\Omega} = 0.9mA$$

Find the voltage in circuit.

$V_1 = R_1 I_1 \Rightarrow V_1 = 2k * 0.9m = 1.8V$

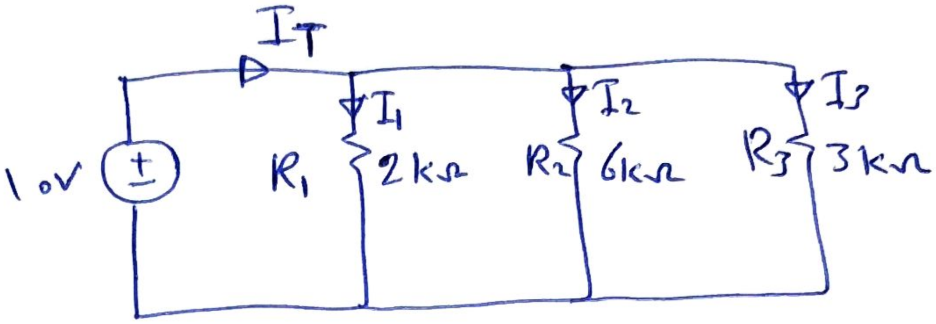
$V_2 = R_2 I_2 \Rightarrow V_2 = 6 \times 10^3 * 0.9 \times 10^{-3} = 5.4V$

$V_3 = R_3 I_3 \Rightarrow V_3 = 3 \times 10^3 * 0.9 \times 10^{-3} = 2.7V$

$V_T = V_1 + V_2 + V_3$

$V_T = 9.9 \simeq 10V$ ✓

EX2 For the circuit as shown in fig 2. find the R_{eq} and the current in each resistor.



Sol the parallel resistance

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R_{eq}} = \frac{1}{2k} + \frac{1}{6k} + \frac{1}{3k}$$

$$\frac{1}{R_{eq}} = \frac{6k \times 3k + 2k \times 3k + 2k \times 6k}{2k \times 6k \times 3k} = \frac{18M + 6M + 12M}{36G}$$

or

$$\frac{1}{R_{eq}} = \frac{18 \times 10^6 + 6 \times 10^6 + 12 \times 10^6}{36 \times 10^9}$$

$$\frac{1}{R_{eq}} = \frac{36 \times 10^6}{36 \times 10^9}$$

$$R_{eq} = \frac{36 \times 10^9}{36 \times 10^6} = 1 \times 10^3 \ \Omega$$

$R_{eq} = 1 k\Omega$.

$$I_T = \frac{V_T}{R_{eq}} = \frac{10}{1\times10^{3}} = 10\times10^{-3}\ A$$

$$I_T = 10mA \qquad \therefore V_T = V_1 = V_2 = V_3$$

$$I_1 = \frac{V_1}{R_1} = \frac{10V}{2k\Omega} = 5\times10^{-3}\ A$$

$$I_2 = \frac{V_2}{R_2} = \frac{10V}{6k\Omega} = \frac{10}{6k} = 1.667\times10^{-3}\ A$$

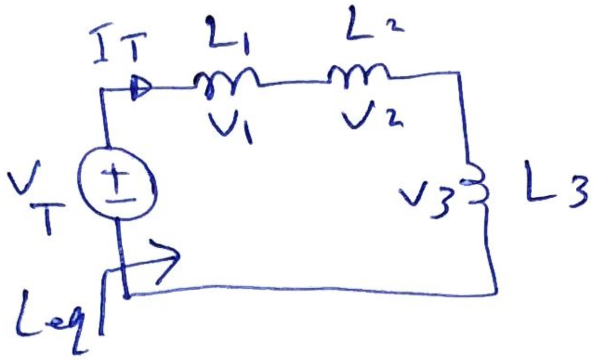
$$I_3 = \frac{V_3}{R_3} = \frac{10}{3k} = 3.333\times10^{-3}\ A$$

$$I_T = I_1 + I_2 + I_3 = 10\times10^{-3}\ A \checkmark$$ للتأكد من صحة الحل

Inductance Combinations

1- Series

we have shown the equivalent Inductance in series for 'N' Inductance :-

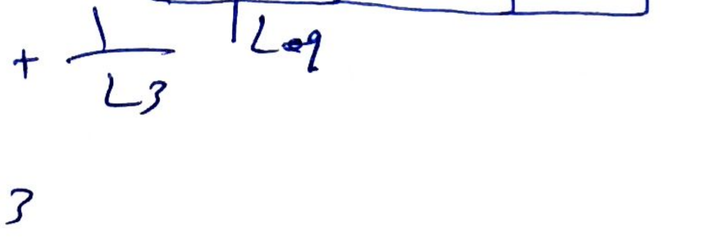


$$L_{eq} = L_1 + L_2 + L_3$$

$$V_T = V_1 + V_2 + V_3$$

$$I_T = I_1 = I_2 = I_3$$

2- parallel



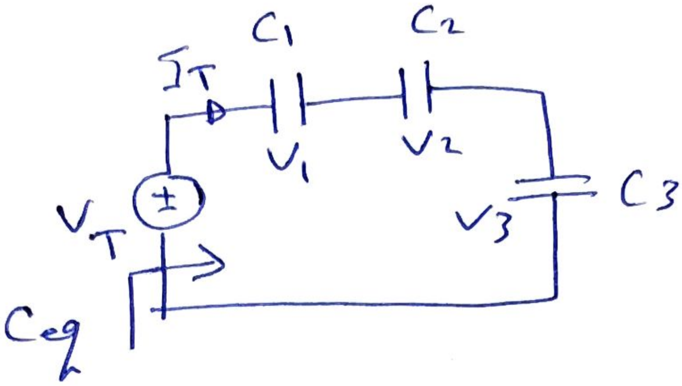
$$\frac{1}{L_{eq}} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3}$$

$$V_T = V_1 = V_2 = V_3$$

$$I_T = I_1 + I_2 + I_3$$

Capacitor combinations

1- Series

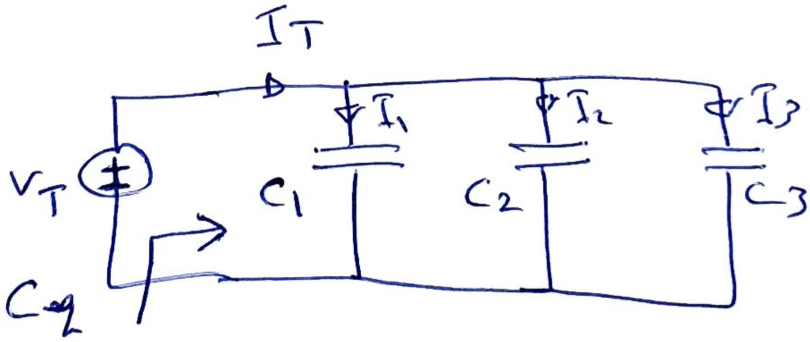


$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

$$I_T = I_1 = I_2 = I_3$$

$$V_T = V_1 + V_2 + V_3$$

2- Parallel

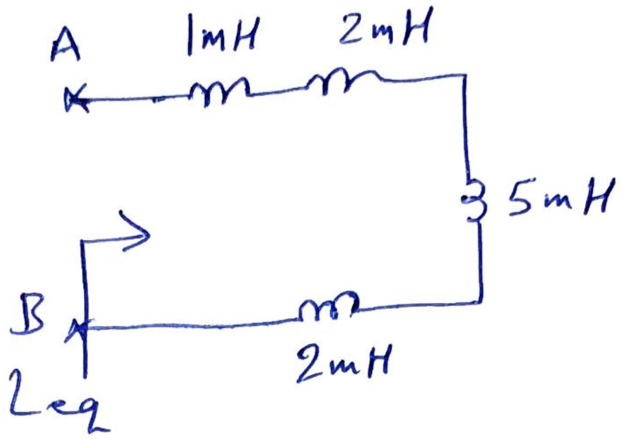


$$C_{eq} = C_1 + C_2 + C_3$$

$$V_T = V_1 = V_2 = V_3$$

$$I_T = I_1 + I_2 + I_3$$

EX3) Find the Leq. in fig below.



Sol)

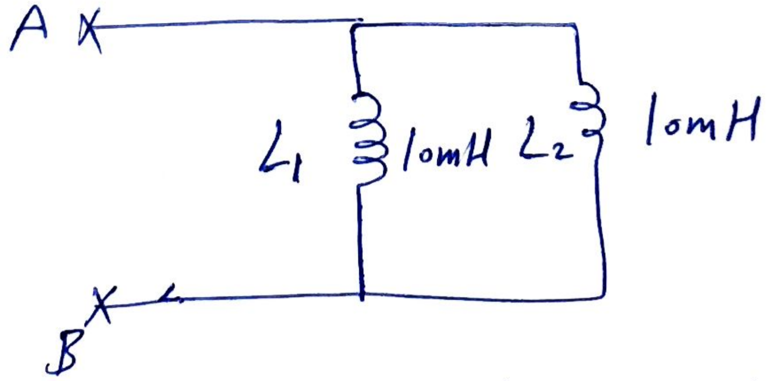
∴ series

$$L_{eq} = L_1 + L_2 + L_3 + L_4$$

$$L_{eq} = 1\times10^{-3} + 2\times10^{-3} + 5\times10^{-3} + 2\times10^{-3} = 10\times10^{-3}\,H$$

$$L_{eq} = 10\,mH$$

EX4) Find the Leq at points A and B. in circuit.



Sol)

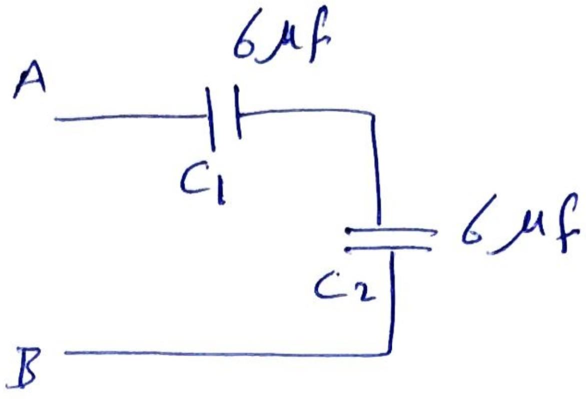
∴ Parallel

$$\frac{1}{L_{eq}} = \frac{1}{L_1} + \frac{1}{L_2}$$

$$\frac{1}{L_{eq}} = \frac{1}{10\times10^{-3}} + \frac{1}{10\times10^{-3}} \Rightarrow$$

$$L_{eq} = 5\times10^{-3}\,H$$

EX5) find C_{eq} in the circuit below



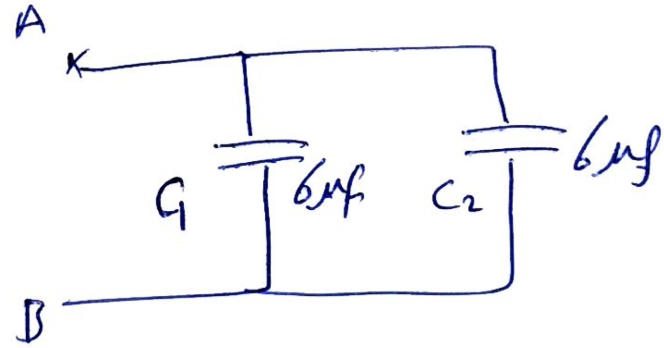
Sol)

∴ Series

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$$

$$\frac{1}{C_{eq}} = \frac{1}{6\times10^{-6}} + \frac{1}{6\times10^{-6}} = 3\,\mu f$$

EX6) find the C_{eq} in the circuit below



Sol)

Parallel

$$C_{eq} = C_1 + C_2 = 6\times10^{-6} + 6\times10^{-6}$$

$$C_{eq} = 12\times10^{-6}\,F \Rightarrow \boxed{C_{eq} = 12\,\mu f}$$

Basics of electrical eng.

Course1 contents

1. Basis of electrical engineering.
2. Ohm's Law.
3. Combination of sources.
4. Kirchhoff's Laws.
5. Resistance combinations.
6. wye - Delta transformation.
7. maxwell currents (mesh or Loop analysis).
8. Nodal analysis.
9. Source transformation.
10. Superposition theorem.
11. Thevenin theorem.
12. Norton theorem.
13. Maximum power transfer theorem.

Reference :-

Engineering circuit analysis, 7th edition, william H Hayt.

Electrical units

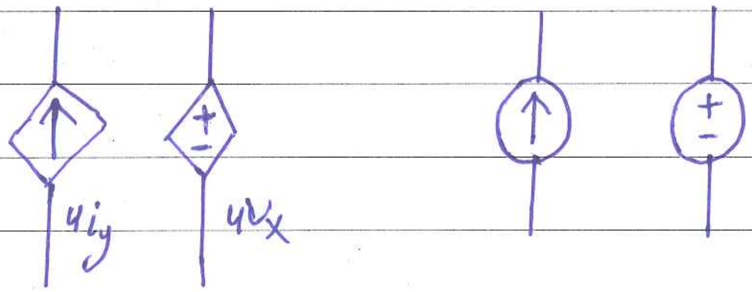
Quantity	Symbol	unit	Symbol
current	I	ampere	A
voltage	V	Volt	V
Resistance	R	ohm	Ω
capacitance	C	farad	F
Inductance	I	Henry	H
power	p	watt	w
frequency	f	Hertz	HZ
conductance	G	Siemens	S
Electric charge	Q	coulomb	C
Energy	E	Joule	J

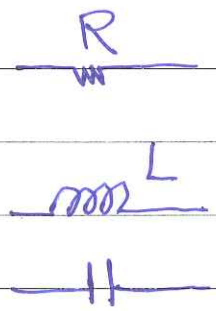
Multiples and submultiples

prefix	symbol	Exponential format	Multiplier
Milli	M	10^{-3}	0.001
Micro	μ	10^{-6}	0.000 001
nano	n	10^{-9}	0.000 000 001
pico	P	10^{-12}	0.000 000 000 001
Kilo	k	10^{3}	1000
mega	M	10^{6}	1000 000
giga	G	10^{9}	1000 000 000
tera	T	10^{12}	1000 000 000 000

Electrical circuits

- Active elements
  - sources
    - Dependent sources
    - un-dependent sources
- passive elements
  - Loads (R, L, C)
    - linear Loads
    - non-linear Loads





linear Loads

electric current : the number of charged particles that passing a point in a conductor every second. expressed in amperes

1 Amp. = 1 coulomb/second

voltage : the difference in electrical charge between two points in a circuit expressed in volts

1 volt = 1 Joule / collomb

قدرة

electrical power : is the rate at which electrical energy is converted to another form, such as motion, heat, light or an electromagnetic field.

$$P = U \times I \qquad \frac{J}{C} \times \frac{C}{s} = \frac{J}{s} = \text{watt}$$

one watt is the power resulting from an energy dissipation, conversion, or storage process equivalent to one joule per second

in the resistance the energy absorbed is dissipated by the resistor in the form of heat.

$P = V * I$ power supplied by the sources.

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

or

$P = I^2 * R$

} power dissipated by the resistor.

"Ohm's Law" "قانون أوام"

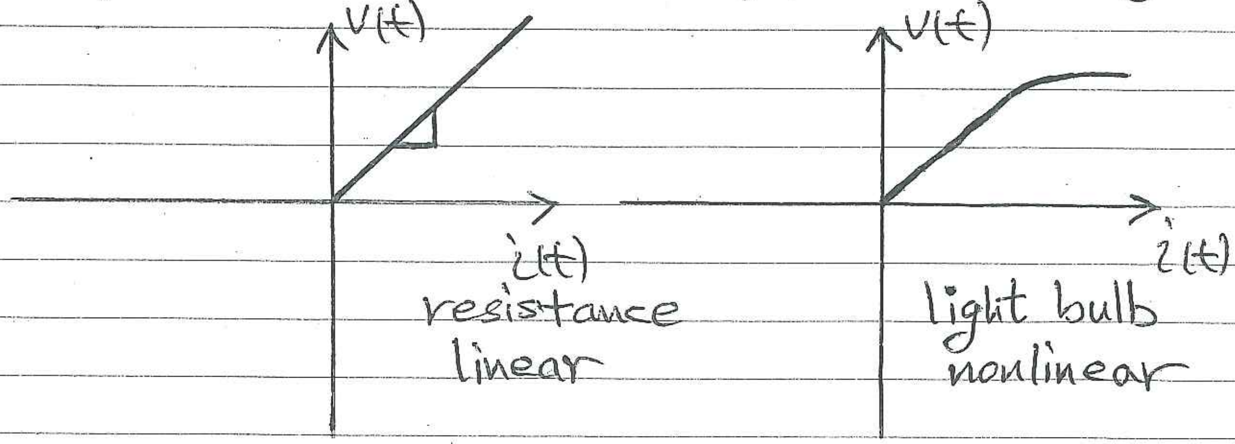
Ohm's law is named for the German physicist Georg Simon ohm, who is credited with establishing the voltage - current relationship for resistance. As a result of his pioneering work, the unit of resistance bears his name.

Ohm's law states that the voltage across a resistance is directly proportional to the current flowing through it.

The resistance, measured in ohms, is the constant of proportionality between the voltage and current.

$$R = \frac{V}{I} \quad (\Omega)$$

In our analysis we will always assume that the resistor are linear and are thus described by a straight line characteristic that passes through the origin, it is important that readers realize that some very useful and practical elements do exist that exhibit a nonlinear resistance characteristic; that is, the voltage - current relationship is not a straight line.



Since a resistor is passive element, the proper current Voltage relationship is illustrated in above Fig.

The power supply to the terminals is absorbed by the resistor. Note that the charges move from higher to the lower potential as is passes through the resistor and the energy absorbed is dissipated by the resistor in the form of heat.

The instantaneous power

$$P(t) = V(t) * i(t) \quad \text{Watt}$$

and can be written as

$$P(t) = R * i^2(t) = \frac{V^2(t)}{R}$$

Conductance, represented by the symbol G, is another quantity with wide application in circuit analysis.

G التوصيلية
Conductance

$$G = \frac{1}{R} \quad ((\text{Siemens}))$$

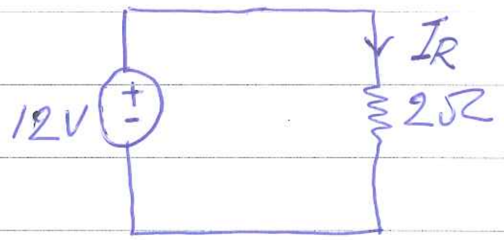
$$G = \frac{I}{V} \quad ((\text{Siemens}))$$

$$P(t) = \frac{i^2(t)}{G} = G V^2(t)$$

EX:- For the circuit as shown in fig., find the
(1) current in the resistance (2Ω).

Sol/

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



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

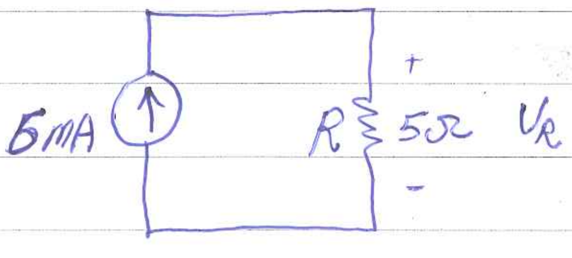
single Loop circuit

$$I_R = \frac{12}{2} = 6A$$

EX: for the circuit as shown in fig. find the
(2) Voltage across the resistance (5Ω)

Sol/

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

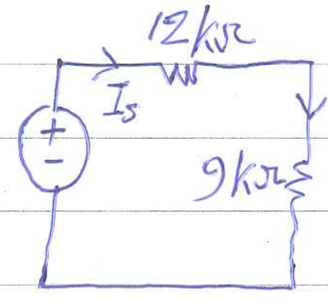


$$V_R = 6 \times 10^{-3} \times 5 = 30\,mV$$

EX: if V_o = 3 Volt in the circuit in fig. find
(3) V_s.

Sol/

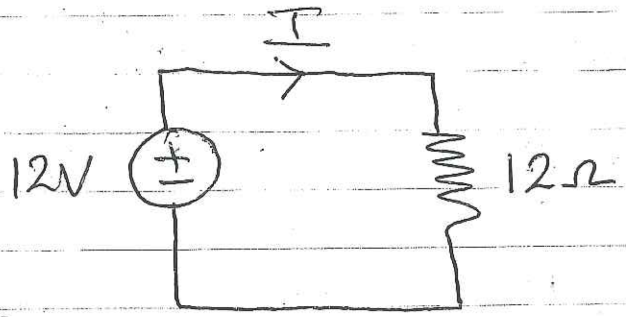
$$I = \frac{V}{R} \Rightarrow I = \frac{3}{9K\Omega} = \frac{1}{3}mA$$



$$V_s = I \times (12K + 9K)$$

$$V_s = \frac{1}{3} \times 10^{-3} \times 21 \times 10^{3} = 7\ Volt$$

Ex: For the circuit as shown in Fig., find the power absorbed in the resistance.



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

$I = \frac{V}{R} = \frac{12}{12} = 1\,(A)$

$P = V * I = 12 * 1 = 12$ watt

OR

$P = I^2 * R = (1)^2 * 12 = 12$ watt

OR

$P = \frac{V^2}{R} = \frac{(12)^2}{12} = 12$ watt

$P = V * I = (I * R) * I = I^2 R$

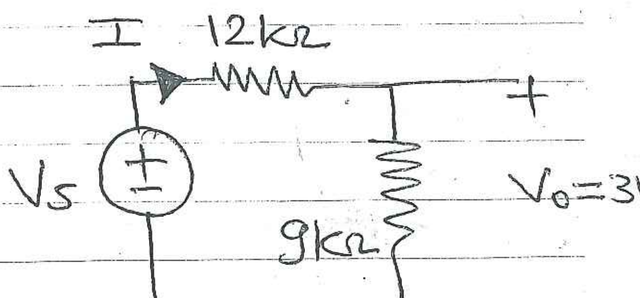
$P = V * \frac{V}{R} = \frac{V^2}{R}$

Ex:- if $V_o = 3$ Volt in the circuit in Fig., find V_s

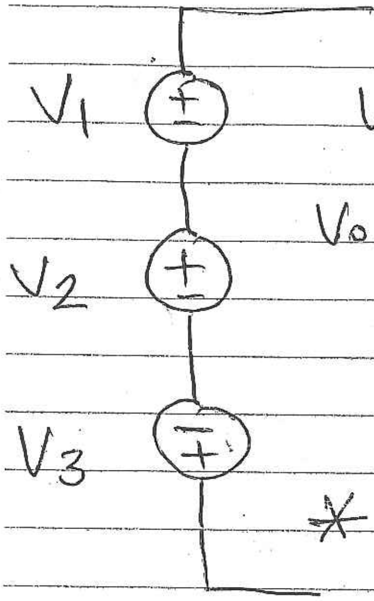
$I = \frac{3}{9k\Omega} = \frac{1}{3}$ mA

$I = \frac{V_s}{12k\Omega + 9k\Omega} = \frac{1}{3}$ mA

$V_s = \frac{21\,k\Omega}{3}$ mA $= 7$ Volt

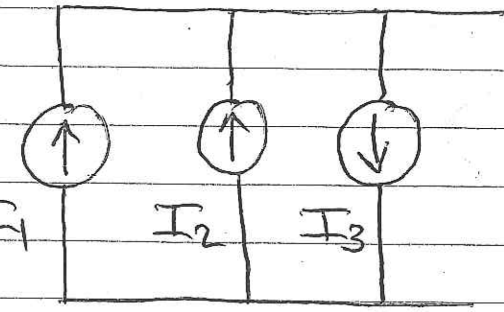


"Combination of Sources"



$V_1 + V_2 - V_3$

Voltage Sources



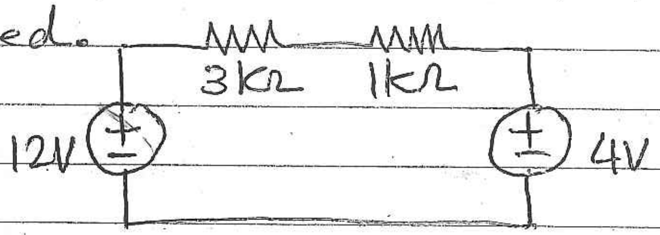
$I_1 + I_2 - I_3$

Current Sources

* at the same method, we can be applied the combination to the dependent sources.

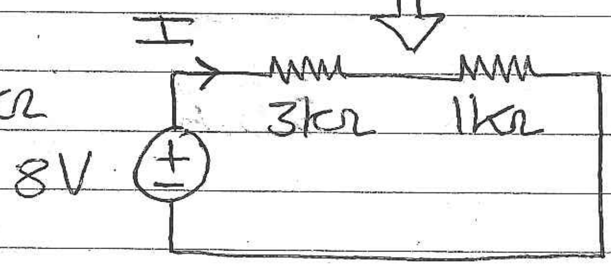
((Voltage Source))

Ex:- Find the current in the network in Fig., and the power supplied.



$V = 12 - 4$

$V = 8$ Volt



$R_{eq} = 3k\Omega + 1k\Omega$

$= 4k\Omega$

$$I = \frac{8}{4k\Omega} = 2\,mA$$

$$P = V * I = 2*10^{-3} * 8 = 16\ mwatt$$