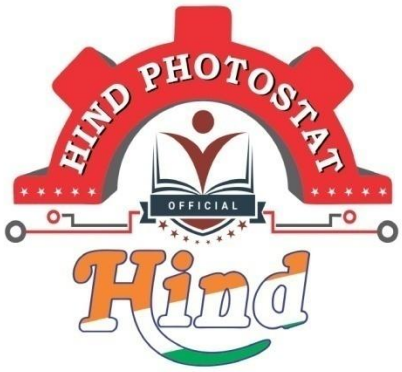

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Network Theory

By- Kiran Sir

- Theory
- Explanation
- Derivation
- Example
- Shortcuts
- Previous Years Question With Solution

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*Content:-

**1) Basics
2) Steady state AC circuits (Resonance)
3) Network Theorems
**4) Transient Analysis ← Very important
**5) Two Port Network
6) Filters
7) Magnetic coupled circuits } only memory Based Questions are asked. Don't waste much time on Revision.
8) Graph Theory

*Books:-

1) Fundamentals of Electric circuits - Alexander & Sadiku.
2) Engg. ckt Analysis - Hayt & Kemmerly
3) Network Analysis - Van Valkenburg
(Transients & Two Port)
↳ In Conventional.

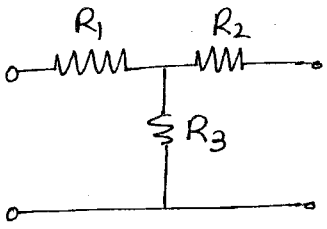
*Horne work
*Work Book
*Previous Papers (Gate) → EC. → EE. → IN.

IES → EC, EE
↓ ↓
Memory, Problems (Num + Theory)

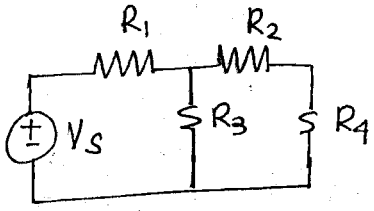
*CAS → obj (Made Easy book), Conventional

*Previous PSU papers.
*Test Series → old, new.

*Network & circuit:



T Network
↳ Comb^n of element
↳ may or may not be closed



N/w or circuit
↳ Comb^n of element
↳ necessary cond^n is closed path.

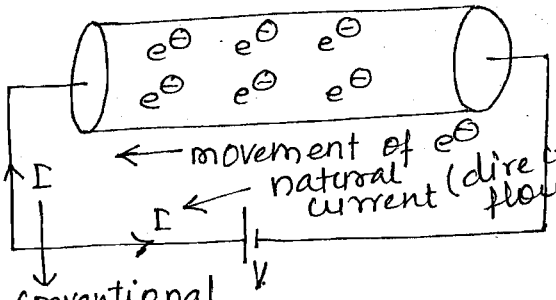
*All circuits are considered as networks but all networks cannot be considered as circuits.

*Network is a comb^n of elements, it may or may not consists of closed path.

*circuit is also a comb^n of elements and it should consist of closed path.

*Charge (Q), I, V, P, W:

$$q = -1.602 \times 10^{-19} C$$



$$I = \frac{da}{dt}$$ → unit is coulomb/sec or Ampere.

Mag. of conventional current = Mag. of Natural current

$$I = \frac{dQ}{dt}$$

$$Q = \int_{-\infty}^{t} I\,dt$$

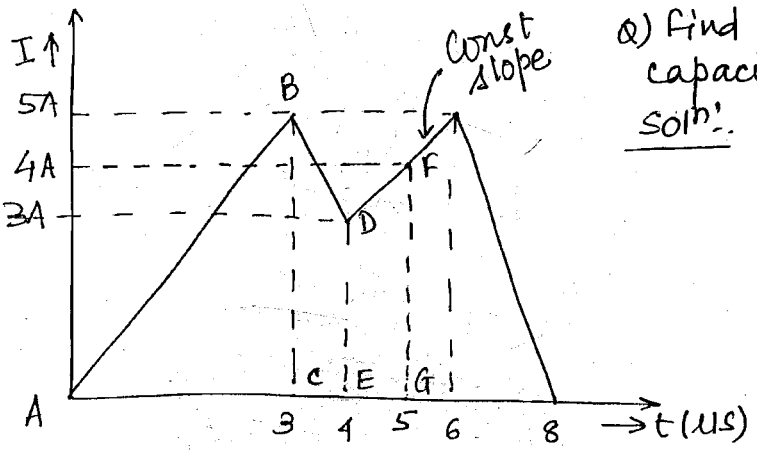
$$Q = \int_{-\infty}^{t} I\,dt = \int_{-\infty}^{0} I\,dt + \int_{0}^{t} I\,dt$$

$$Q = Q_0 + \int_{0}^{t} I\,dt$$

Q_0 → Initial charge

Note:
*In circuit Theory we only consider the "conventional current" and not the "Natural current"

*KCL and KVL are based on the "CONVENTIONAL CURRENT"



Q) Find charge aquired by the capacitor in 5μs

Soln:- 0-3μs (Region ABC)

$Q = \int I\,dt$ = Area under current time curve

$= \frac{1}{2} \times 3 \times 5 = 7.5$

(3μs-4μs) (Region BCDE)

⇒ Trapezoidal shape

$= \frac{1}{2}$ (sum of two heights) × (distance b/w two heights)

$= \frac{1}{2} \times (5+3) \times 1 = 4$

(4μs-5μs) (Region DFGE)

⇒ Trapezoidal shape

$= \frac{1}{2} \times (3+4) \times 1 = 3.5$

So total Area = 7.5+4+3.5

= 15μC

* To move an $e^{\ominus}$ from one place to another we require an external force called as EMF. So, mathematically ↳ "Electromotive force"

$$V = \frac{dW}{dQ} \text{ (Joules/C) or Volts}$$

* Time Rate of change of work is called Power.

Mathematically,

$$P = \frac{dW}{dt} \text{ (Joules/sec) or Watt}$$

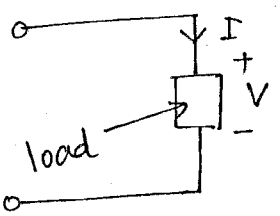
$$\Rightarrow P = \frac{dW}{dQ} \times \frac{dQ}{dt}$$

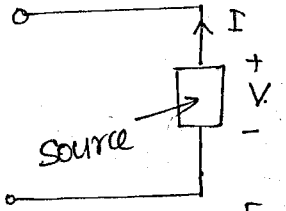
$$P = VI = I^2R = \frac{V^2}{R}$$

Also, $G = \frac{1}{R}$ = Conductance

Hence, $P = I^2/G = V^2G$

*Note :-





of element

* Current entering at the +ve terminal of the element
* Absorbing Power
* Acts as load.

or current leaving from the +ve terminal of the element

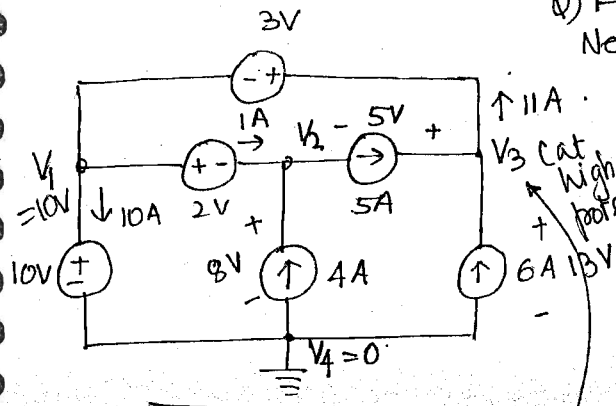
* Current entering at the −ve terminal of the element
* Delivering Power
* Acts as source

} of element

* When the current is Entering at the "+ve terminal", the element is "Absorbing Power"

* When the current is leaving from the "+ve terminal" the element is "Delivering Power".

Q) Find Power of each element of the Network shown:-



Soln:-

$P_{10} = 10V \times 10A = 100$ watts (Absor)

$P_4 = (-2+10) \times 4 = 32$ watts (delivering)

$P_5 = (-2-3) \times 5A = -25$ watts. (delivering)

$P_6 = (+3+10) \times 6A = 78$ watts (delivering)

$P_2 = 2V \times 1A = 2W$ (absorbing)

$P_3 = 11A \times 3V = 33$ watts (absorbing)

$V_1 - V_2 = 2$

$\Rightarrow V_2 = V_1 - 2 = 8V$

$V_3 - V_1 = 3V$

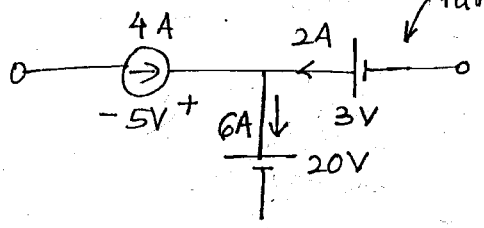
$V_3 = 3 + V_1 = 13V$

$P_4 = 4A \times 8V = 32$ Watts.
$P_6 = 13V \times 6A = 78$ watts.
$P_5 = 5A \times 5V = 25$ watts.
} Delivering Power

$P_{10} = 10V \times 10A = 100$ Watts
$P_2 = 2V \times 1A = 2$ watts
$P_3 = 11A \times 3V = 33$ watts
} Absorbing Power.

*Note :-

$(P_T)_{absorb} = (P_T)_{delivered}$ ← Satisfies for all networks.



Part of Network given.

Q) Find total power absorbed of fig. shown:.

soln:. $P_{20} = 20V \times 6A$
$= 120$ watts (A)

$P_4 = 5V \times 4A = 20$ watts (D)

$P_3 = 3V \times 2A = 6$ watts. (D)

also, $P_4 = -20$ watts (Absorbing)

$P_3 = -6$ watts (Absorbing).

so, total power absorbing $= 120 - 20 - 6 = 94$ watts (Absorbing)

* Note:-

* when only any part of Network is given we have to follow above steps to calculate total Absorbing or Delivering power.

* Power is always positive, in real time power is never considered to be as -ve and the same is valid for voltage also. For eg

Bulb → 40W (we donot say -40watt Bulb since it is absorbing Power)

Battery → +12°V (we donot say -12 V Battery which is source and it delivers power)

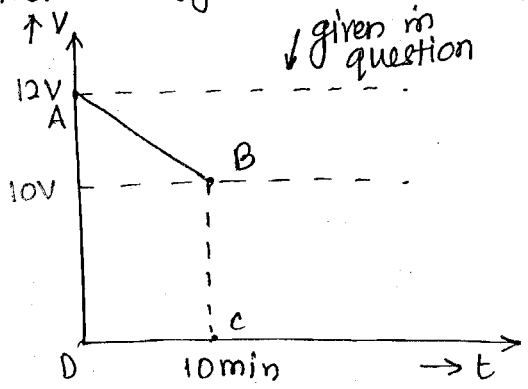
* Energy:-

* capacity to do any work is called as Energy

$$W = \int_0^t P\,dt$$

→ unit watt-sec or Joules.

Q) A fully charged mobile phone is good for 10 min talk time. During talk time battery delivers a const. current of 2A. Find Energy of the Battery during talk time?



↓ given in question

Soln:- * calculations for energy, time should always be in seconds.

Area of ABCD = $\frac{1}{2}$ × (Sum of 2 heights × dist. b/w 2 heights)

$= \frac{1}{2} \times (12+10) \times 600$

$\boxed{VxI = 6600}$

So, $\boxed{W = VIt} \Rightarrow \boxed{W = Pxt}$

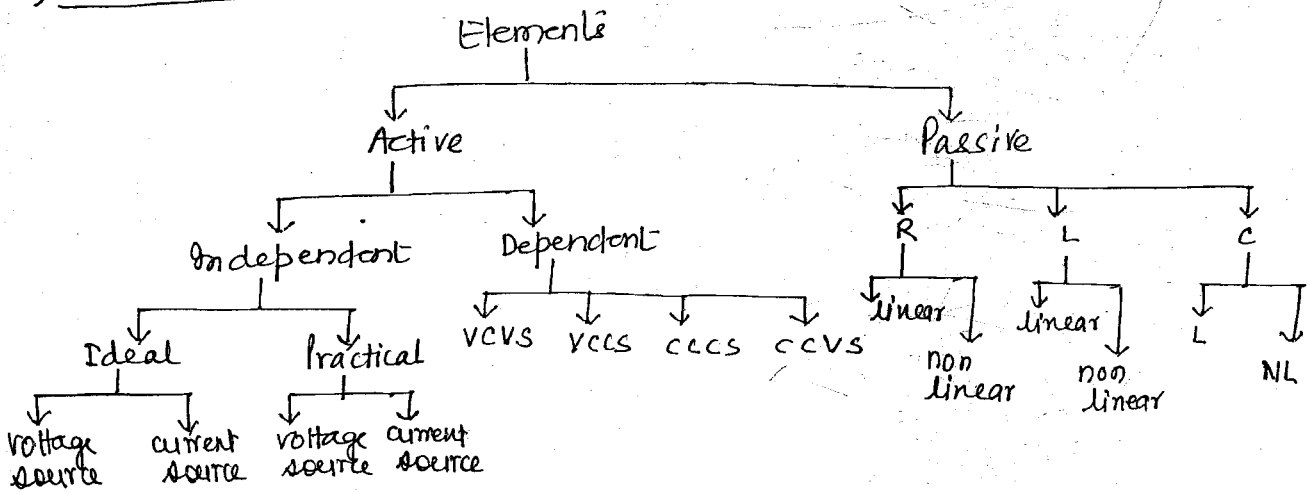
$W = 6600 \times 2A$

$\boxed{W = 13.2\ KJ}$

* CLASSIFICATION OF ELEMENTS:-

1) Active & Passive elements
2) Linear & Non linear elements
3) Unidirectional & Bi directional elements
4) Time variant & Invariant elements
5) Lumped & Distributed elements.

1) Active & Passive Elements:-



*ACTIVE ELEMENT:

*When the Element is capable of Delivering Energy Independently for long time (approx infinite time), then "ACTIVE ELEMENT"

OR

When the Element is having properly of Internal amplification then it is called as "ACTIVE ELEMENT"

*Examples:

1) Voltage source. } Independent sources.
2) current source. }
3) Transistor, & } Dependent sources.
4) OP-AMP

Note:

*when the 'c' is connected to DC, the capacitor is charging and while discharging it delivers energy independently, and that energy delivered to the ckt depends on the time Constant of the ckt, whereas the ACTIVE ELEMENT delivers energy independently.

* During discharging capacitor can deliver energy independently for short time (depends on its time const) and capacitor is not having the properly of Internal Amplification. Hence capacitor is not an "ACTIVE ELEMENT".

*PASSIVE ELEMENT:

*when the Element is not capable of delivering energy Independently then it is called as "PASSIVE ELEMENT"

*Examples:

1) Resistor
2) Bulb
3) Transformer *** $(V_1 I_1 = V_2 I_2)$ → *** Internal power = External power.
   ↳ step up or step down the voltage, but no power is stepped up or stepped down Hence no Internal amplification