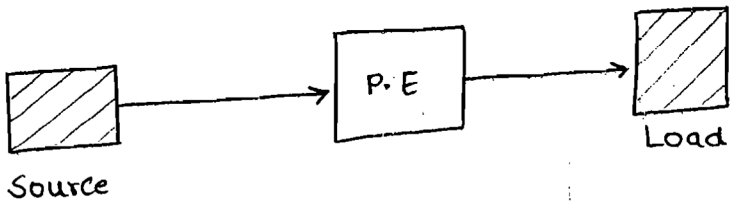
CHAPTER - 1 Power Semiconductor switching Devices

Lec-1

Introduction of Power Electronics

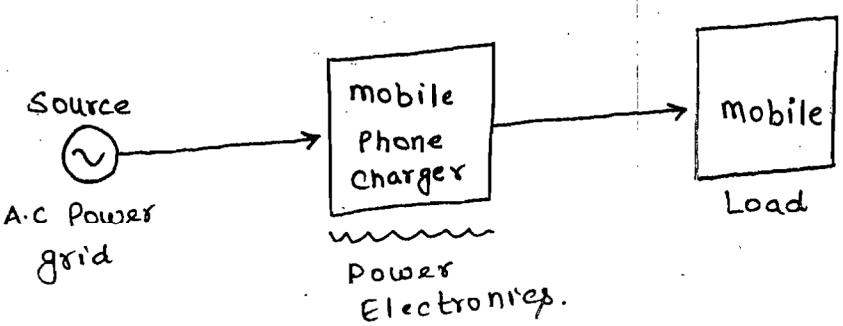


- Power Electronics is the circuitry that takes Power from Source & delivers Power to Load.
- P.E is the Application of Electronics & circuitry to control the electric Power conversion into one form to another form.

Power Electronics
↳ (solid state device)
e.g :- diode, SCR, Thyristor.

(control the Conversion of electric Power)

e.g :-



Classification :-

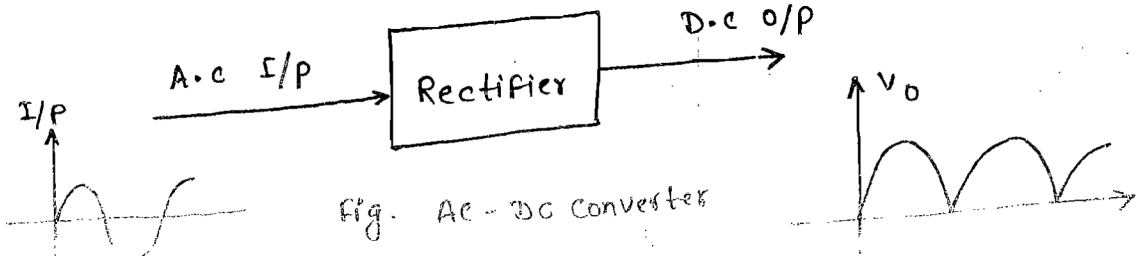


Fig. AC - DC Converter

(ii)

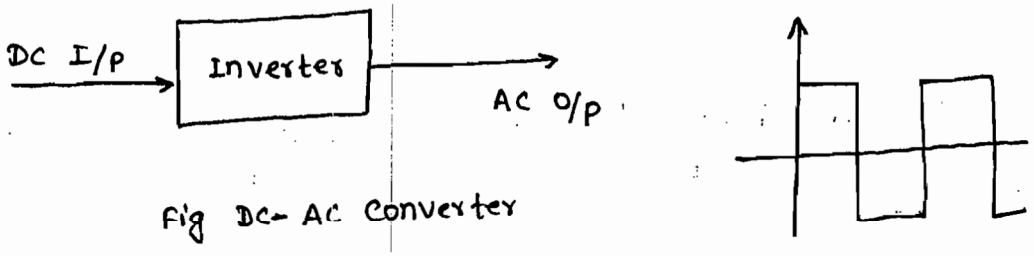


Fig DC- AC Converter

(iii)

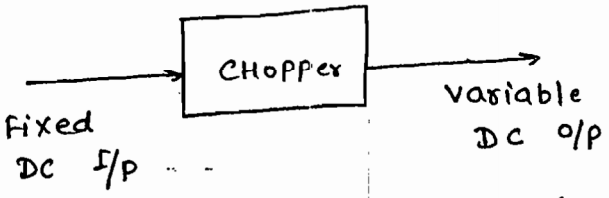
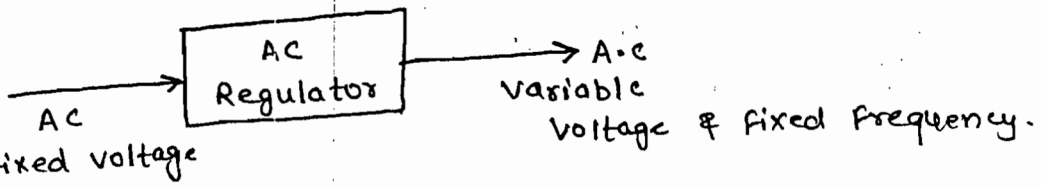


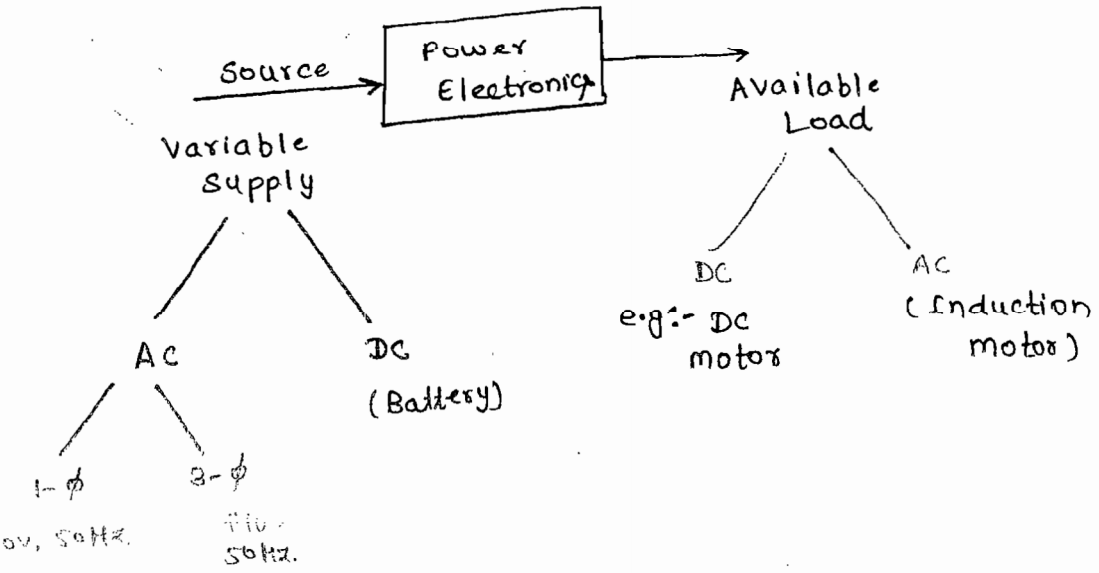
Fig. DC- DC converter

(iv)



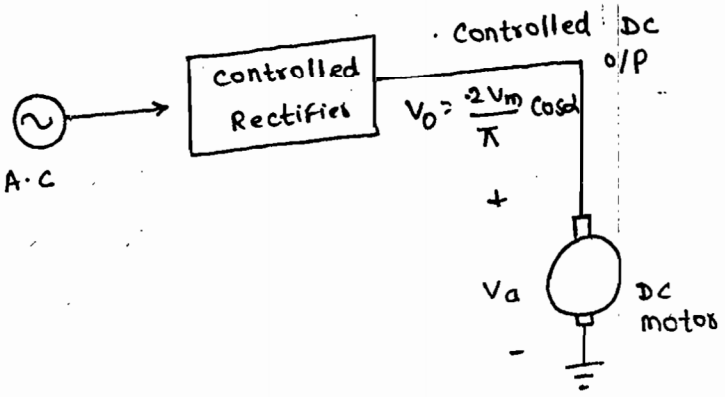
(v)

cyclo converter is also called frequency changer.



Example of Power Electronics :-

(i) Speed Control of DC motor



$V_0 = V_a = \frac{2V_m}{\pi}\cos\alpha$

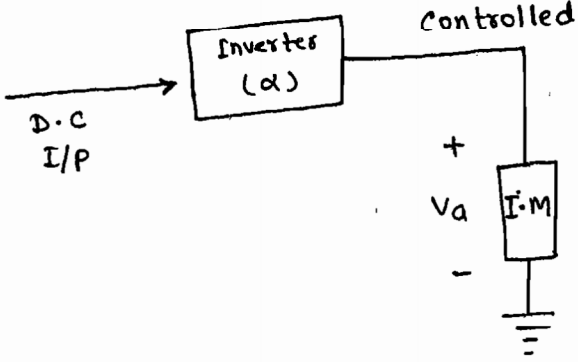
$V_a \propto N$

$V_a = F(\alpha)$

$V_a \propto \alpha$.

$N = f(\alpha)$

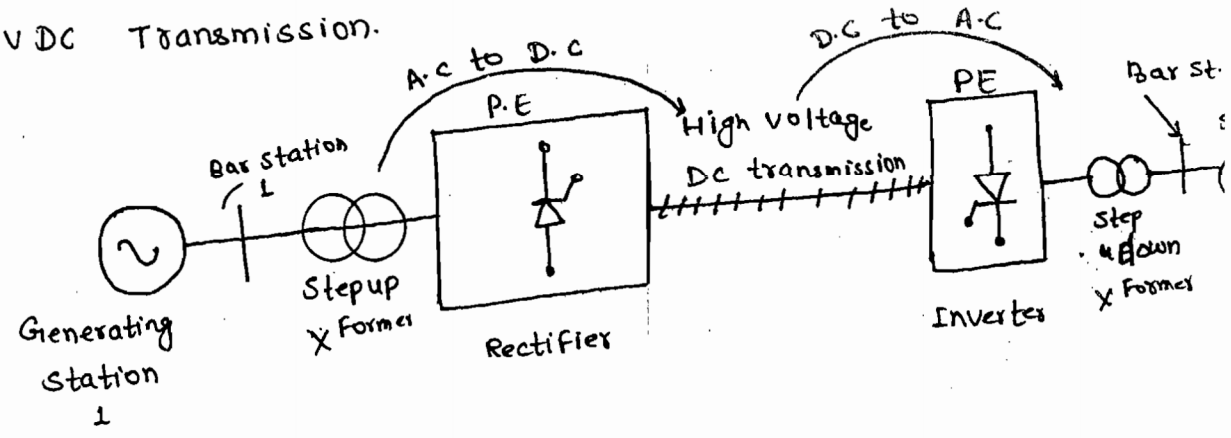
(ii) Speed Control of Induction motor.

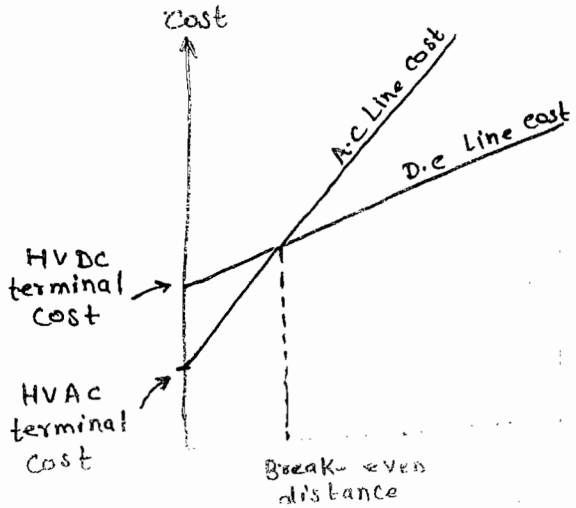


$N \propto V_a$

$N \propto$ Controlled AC O/P.

(iii) HV DC Transmission.





Lec-2 Basic Concept OF Semi Conductor

Semi conductor

- Intrinsic Semiconductor or Pure S-C or Natural S-C
- Extrinsic Semiconductor or Impure S-C or Artificial S-C

Conductivity [Extrinsic S-C] > conductivity [Intrinsic S-C]

→ Extrinsic S-C = Intrinsic S-C + Doping.

Doping

- Low Level doping
  - $1 : 10^8$
  - dopant
  - Pure S-C
  - e.g:- All electronic devices.
- High Level doping
  - $1 : 10^3$
  - dopant
  - Pure S-C
  - e.g (Tunnel diode)

- Doping increases the conductivity.

Extrinsic Semiconductor

- P-type
  - (Positive type)
  - Intrinsic SC + {trivalent impurity}
  - 3rd group element.
- N-type
  - (Negative type)
  - Intrinsic S-C + pentavalent impurity
  - 5th group element

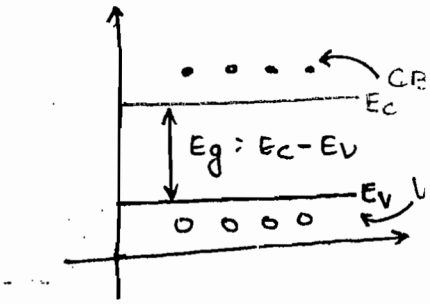
III group	IV Group Semiconductor.	V Group.
B_5 : 2, (3)	C_6 : 2 (4)	N_7 : 2, (5)
Al_{13} : 2, 8, (3)	Si_{14} : 2, 8, (4)	P_{15} : 2, 8, (5)
$Ga\ 31$: 2, 8, 18, (3)	Gl_{32} : 2, 8, 18 (4)	$As\ 33$: 2, 8, 18, (5)
$In\ 49$: 2, 8, 18, (3)	$Sn\ 50$: 2, 8, 18, (4)	$Sb\ 51$: ... (5)
	$Pb\ 82$: ... (4)	

- Sn (Tean), Pb (lead) are not easily available in earth crust so cost is high.
- easily available

$$C_6 : 2, 4$$

Energy gap : $[C_6]$: (5-6) ev.

$$\text{Energy gap} \propto \frac{1}{\text{conductivity } (\sigma)}$$



- Low conductivity so we not used.

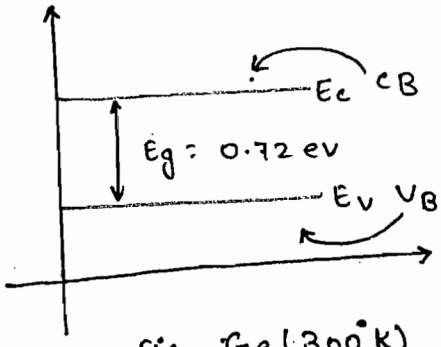


Fig Ge (300°K)

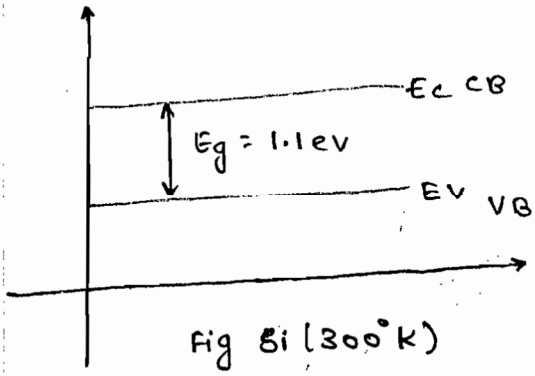


Fig Si (300°K)

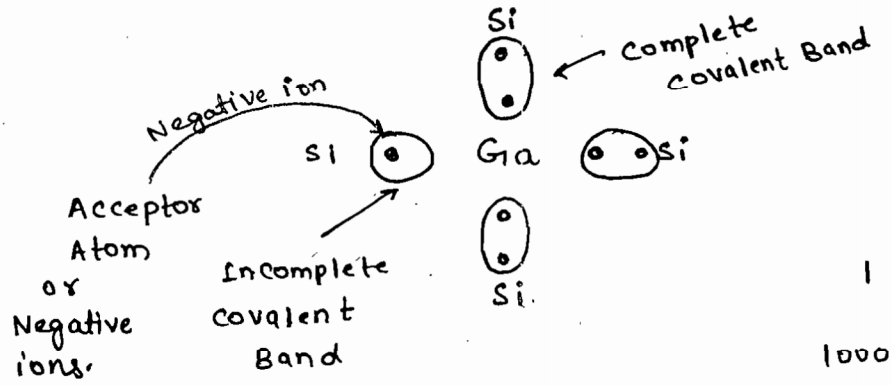
$$Eg\ [Si] > Eg\ [Ge]$$

$$\sigma\ [Ge] > \sigma\ [Si]$$

Parameters	Ge	Si
Thermal Limit	100°C	200°C
voltage rating	Low	High
current rating	Low	High
Power rating	Low	very high
	Medium	High

due to this region we used mostly these Si

P- type Semiconductor :-



$1\ Ga = 1\ Hole + 1\ N_A^{\ominus}$

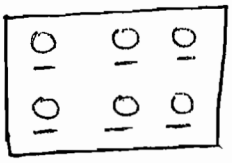
$1000\ Ga = 1000\ Hole + 1000\ N_A^{\ominus}$

$10^6\ Ga = 10^6\ Holes + 10^6\ N_A^{\ominus}$

Positive charge carrier (P-type) → Positive mobile Charge carrier.

$N_A^{\ominus}$ → Negative Inmobile ions.

P type → Electrically neutral



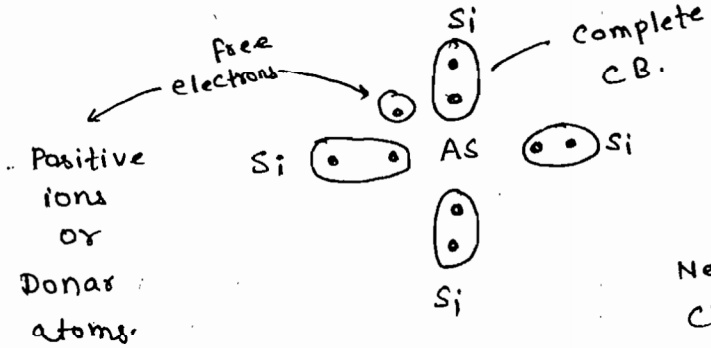
P- type S-C

n - type Semiconductor

Donar ions

$1\ As = 1\ \text{Free electron} + 1\ N_D^{\ominus}$

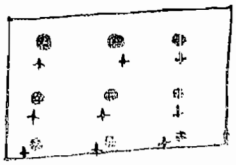
$1000\ As = 1000\ e^- + 1000\ N_D^{\ominus}$



Negative Charge carrier (n-type S-C) → Negative mobile Charge carrier

Positive Inmobile ions.

n- type → Electrically neutral



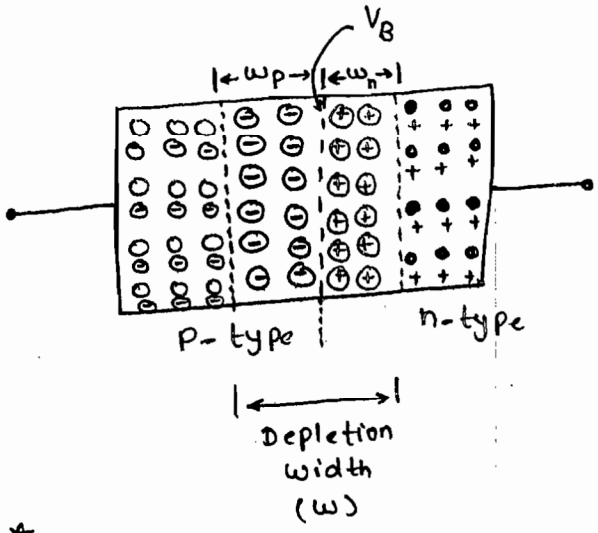
n- type S-C

key point :-

(i) In case of p-type semiconductor Holes support the flow of current that means Positive mobile carriers.

(ii) In case of n-type S-C $\xrightarrow{\text{free}}$ electrons suppor the flow of curren that means Negative mobile carriers.

(iii) Inmobile ions is responsible for formation of Depletion width Due to depletion width potential barrier exist due to Potential barrier oppases the flow of current p to n and n-p.



$w = w_p + w_n$.

$$N_A w_p = N_D w_n$$

Charge of neutrility equation

N_A - Acepter concentration in p-side.

N_D - Donar concentration in n-side

Case (i) $N_A = N_D$

$$w_p = w_n$$

Case-2 $N_A >> N_D$

$$w_p = \frac{N_D w_n}{N_A}$$

$$w_p << w_n$$

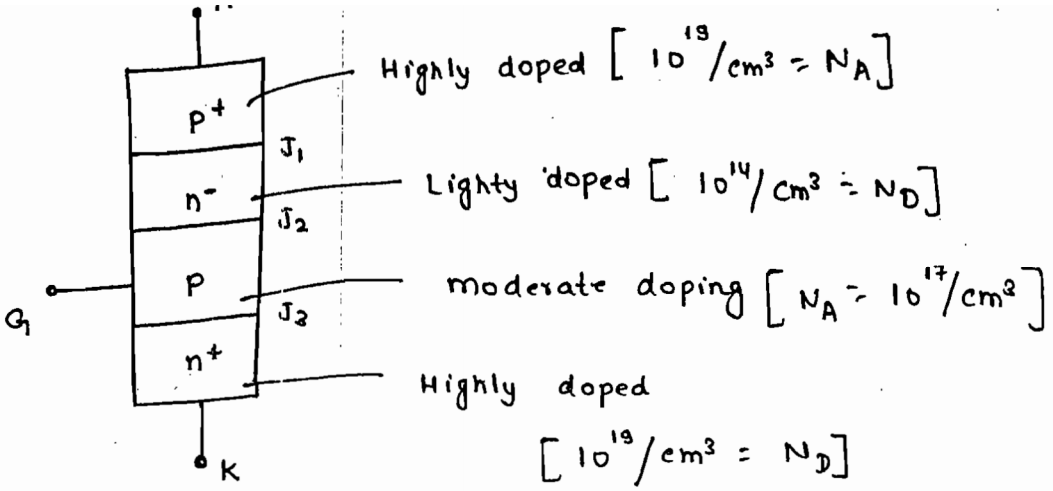
Doping $\propto$ $\frac{1}{\text{Depletion width}}$

Case-3 $N_D >> N_A$

$$w_n = \frac{N_A w_p}{N_D}$$

$w_n << w_p$

e.g :-



Basic Concept Of Power Electronics

By :- Ravi Sir

⇨ Basic need of Power Electronics :-

Introduction of Power electronics :-

- with the help of Power electronics devices, we can easily handled, Load components. for ex:- Load voltage, current, power, Flux torque, etc.
- in general, to design Power electronics. converters, we use diodes, SCR's, IGBT's, GTO's, mosfet, TRIAC, BJT's etc.

→ Passive devices

- All uncontrolled devices are called passive devices.
- ex:- Diodes.

Passive filter :-

- this Converter is designed only with diodes.

Active devices

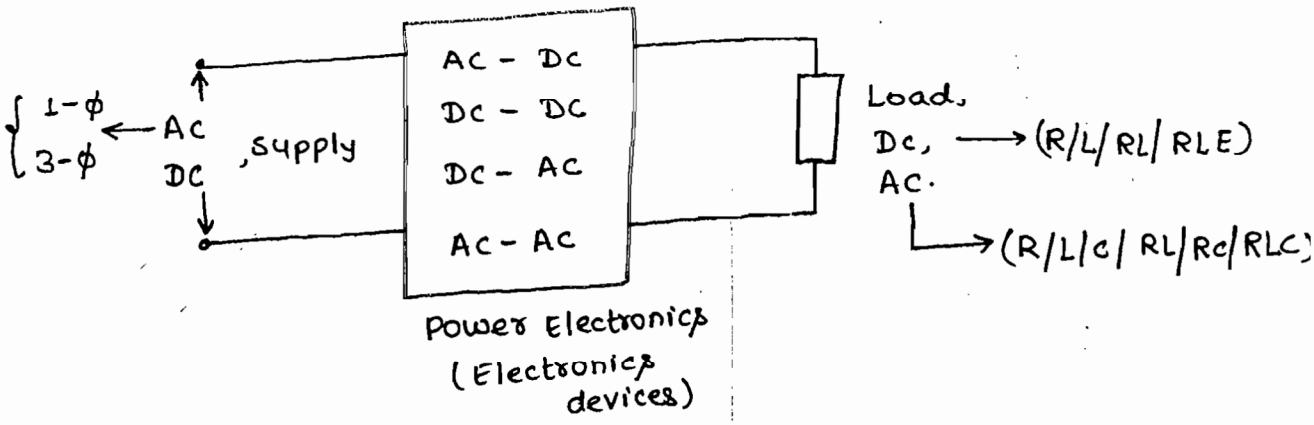
- All controlled devices are called Active devices.

ex :- SCR, GTO, MOSFET, IGBT, TRIC, BJT, etc.

Active filter :-

- this converter will have atleast one controlled devices.

Power Electronic converters :-



Basic of Circuit theory :-

(i) Active elements :-

- these element can delivers almost constant Power For Long duration.
- All independent and dependent sources will be examples of Active element.

ex :- gen(AC/DC), batteries etc.

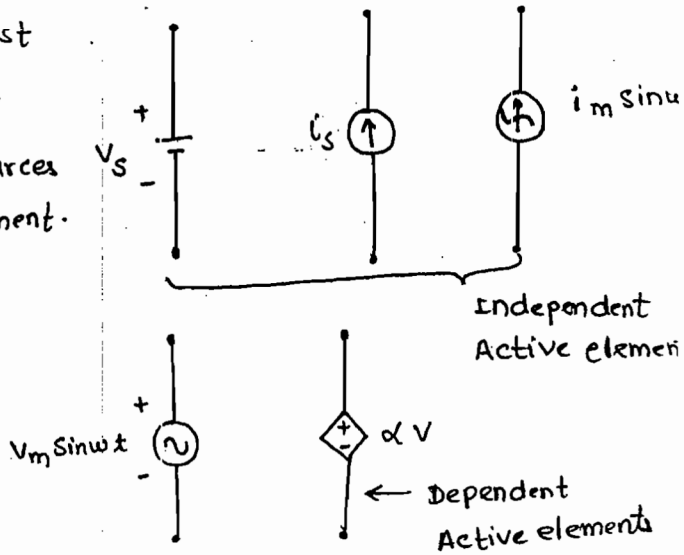
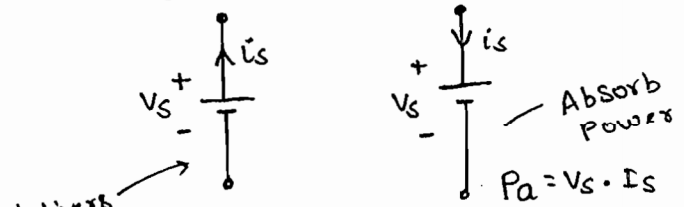


Fig. Active elements

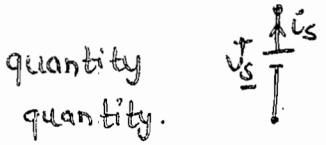
DC Independent voltage source :-



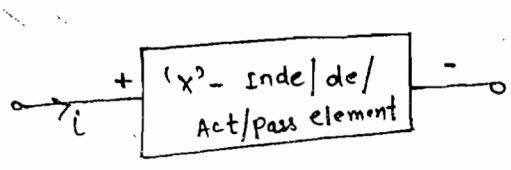
Ideal D.C voltage source.

V_S - independent quantity

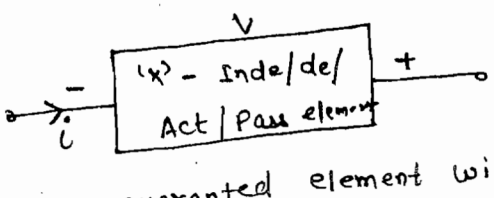
i_S - Dependent quantity.



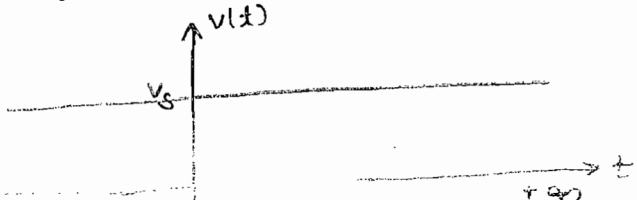
key point :-

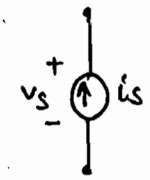


- guaranted element will absorb power.



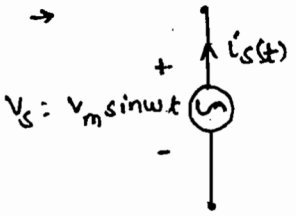
- guaranted element will delivers power.



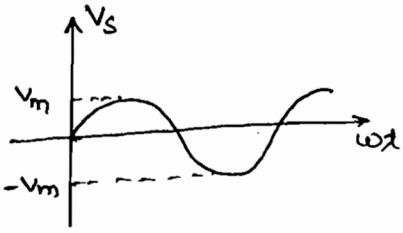


i_s - Independent constant

V_s - Dependent quantity

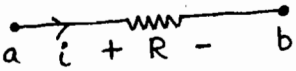


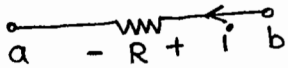
- V_s - Independent quantity
- i_s - Depend upon load (dependent quantity.



(ii) Passive element

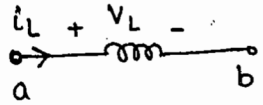
- These element are responsibble to absorb/deliver Power.
  - Resistance is responsible for absorb Power



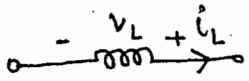


*** current is always flow Higher to Lower potential in Resistor.

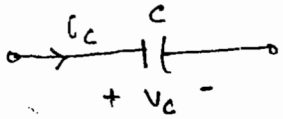
- Passive elements, for ex - Inductor and capacitor can absorb/deliver Power, but for a very short time interval.



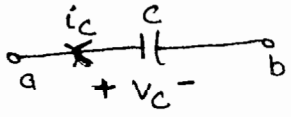
- Charging Inductor (absorb Power)



- discharging Inductor (delivers Power)



- charging capacitor (absorb Power)



- discharging capacitor (delivers Powa)

*** Key Point :-

- during discharging Inductor current polarity is same charging Inductor. voltage Polarity will change. due to Inductor does not allow sudden charge of current.
- during discharging capacitor voltage Polarity is same as charging capacitor & current polarity will change. due to capacitor does not allow sudden change in voltage