Electrical and Electrunical Computer Science

Current → voltage → Resistance

$V = I/R$

Band Colours — Tolerence value

Black – 0, 10^0 — silver – ±10 % — NA

Brown – 1, 10^1 – 10 — ± 1

Red – 2, 10^2 – 100 — ± 2

Orange – 3, 10^3 – 1000 — NA

Yellow – 4, 10^4 – 10,000 — NA

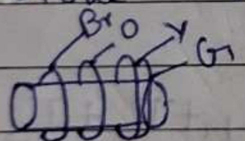
Green – 5, 10^5 ~~Blue~~ – 6 – 10,0000 — ± 0.5 %

Violet – 6 $10^{6,7}$ – 1,00000 — ± 0.25 %

Grey – 7 10^8 — 1,000,000 — ± 0.10 %

White – 8 10^{89} — 1,0000000 — ~~NA~~ ± 0.05 %

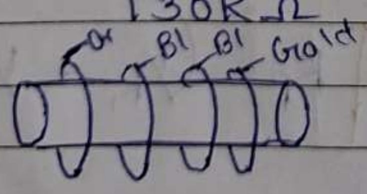
Gold – 9 10^{10} ± 5 % — 10000000 — NA



Brown – 1, Orange 3, Yellow – 10^4, Gold – ± 5

$13 \times 10^4 \pm 5$

$130 k\Omega$

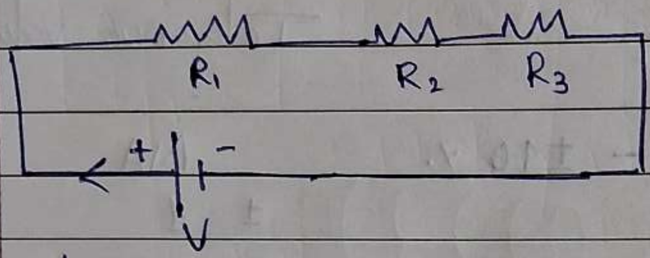


$30 \times 10^0 \pm 5$

$= 30 \Omega \pm 5$

Resistors in Series

Current - remains Same
Voltage - changes



$$V = V_1 + V_2 + V_3$$

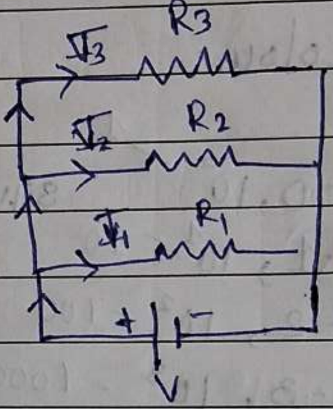
$$IR_s = IR_1 + IR_2 + IR_3$$

$$\cancel{I} R_s = \cancel{I}(R_1 + R_2 + R_3)$$

$$\Rightarrow \boxed{R_s = R_1 + R_2 + R_3}$$

Resistors in Parallel

Current - changes
voltage - Remains Same



$\cancel{I/=}$ $V = I/R$

$$I = V/R$$

$$V/R_1 = I_1$$

$$V/R_2 = I_2$$

$$V/R_3 = I_3$$

$$I = I_1 + I_2 + I_3$$

$$V/R_p = V/R_1 + V/R_2 + V/R_3$$

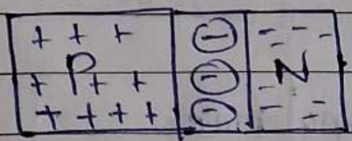
$$\cancel{V}/R_p = \cancel{V}(1/R_1 + 1/R_2 + 1/R_3)$$

$$\boxed{R_p = (1/R_1 + 1/R_2 + 1/R_3)}$$

Diodes

07/5/10

PN juntion diode



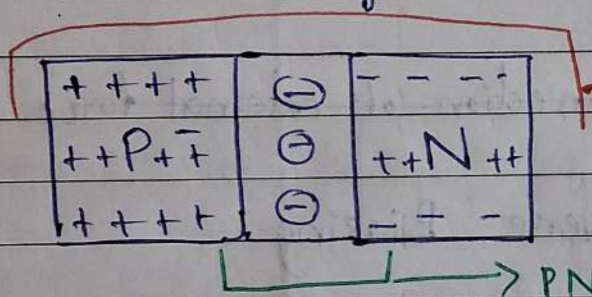
Pand N subscript

particles

P- Holes containg protons, relectrons and neutrons, whereas

N- ~~Al~~ Electron are negatively ~~h~~ charged

* Holes are heavy than electrons



Barrier potential (due to dis electrons + holes stop move

PN junction

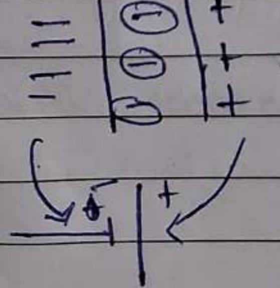
* opposite poles attract each other

pu^{rton}

* positive carriers are heavy compared to electrons

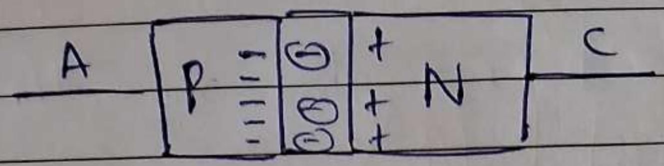
* Electrons move faster

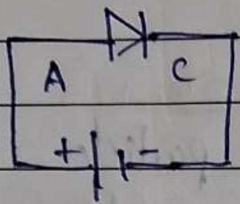
Re combination of electrons → $\boxed{\text{Biasing}}$



P type → Anode
N type → Cathode

electrostatic field

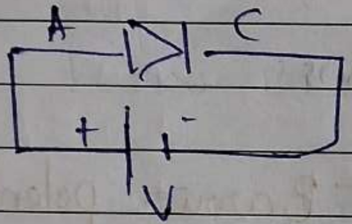




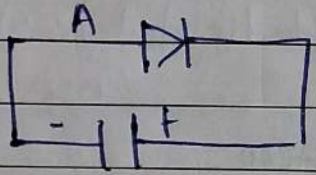
Connection of external force

Electron + holes is called Biasing

Forward Biasing



~~Connection of external force~~

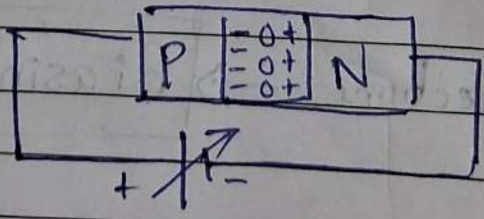


Reverse Biasing :

(−) P ⟶ A

(+) N ⟶ C

Forward Bias:



Silicon material (Si) $V_{Bp} \rightarrow 0.7v$

Germanium " " (Ge) $V_{Bp} \rightarrow 0.3v$

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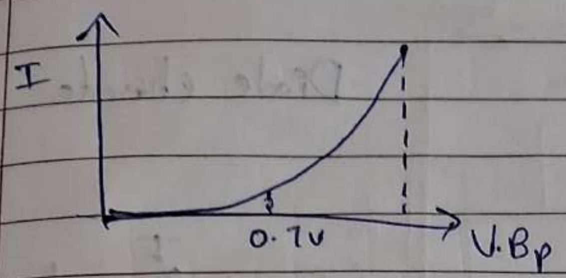


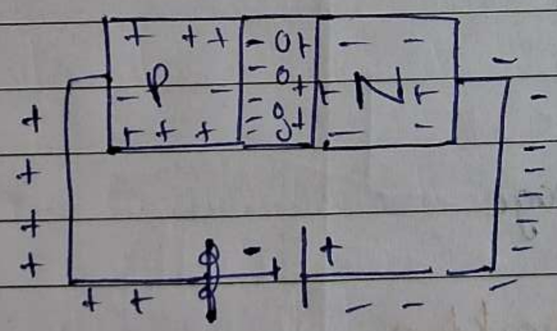
Diode is unidirectional

here I - movement of both carriers
so it is called as Bipolar device
∴ diode is bipolar device

The Direction of current (I)

Anode to cathode (so it is unidirectional)

Reverse Biasing

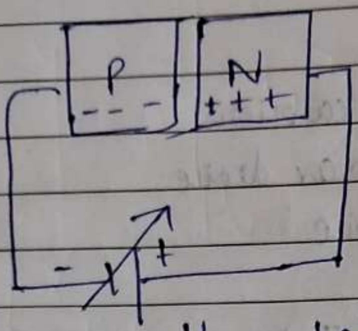


-ve plate → p layer majority → +ve attract

+ve plate → N layer majority → -ve attract

∴ No carriers crossing the junction
∴ I = 0

=> At one stage



V_{RB} – high voltage

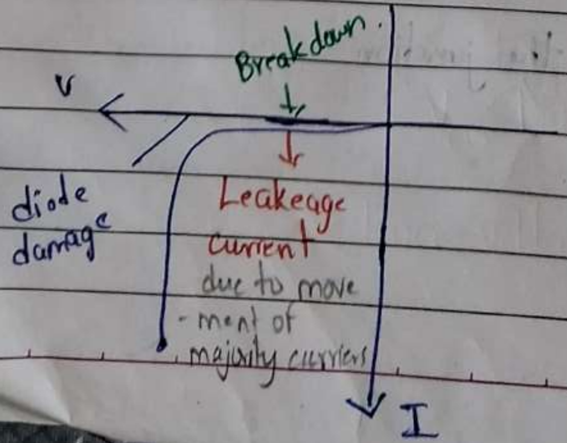
Reverse Biasing

due to high potential
→ high force moving the charges

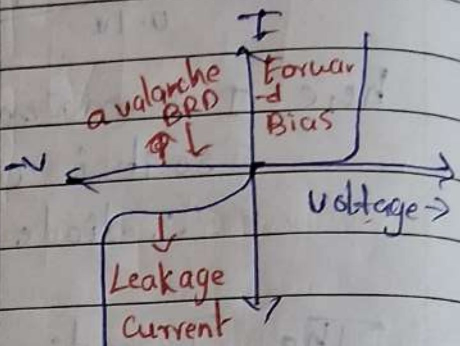
electrons (-) → N layer
protons (+) → P layer

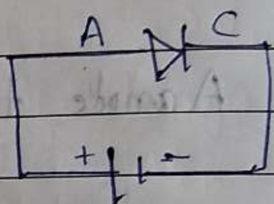
∴ due to this junction damage
This damage is called
~~Aval~~ Avalanche Breakdown

CHARECTERSTICS

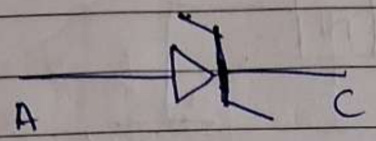


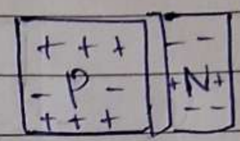
Diode charecter





Zener Diode





Zener Diode

→ Very thin PN Junction layer
→ Zener diode is Bi diouchional

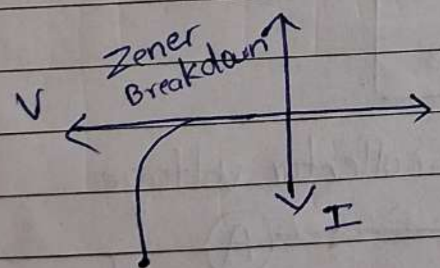
Uses

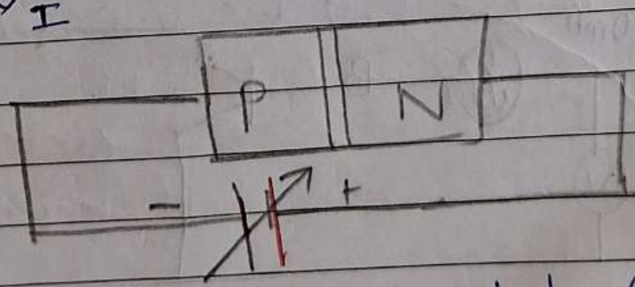
→ Mostly used in ~~B~~ Reverse Bias Condition

In R.B (Reverese Bias) condition current Increases ↑ voltage remains constant

Current ↑ es Voltage constant

{ Force with which the component get Reduced }





*Doping - Inserting non-semiconductor (P-type substrate

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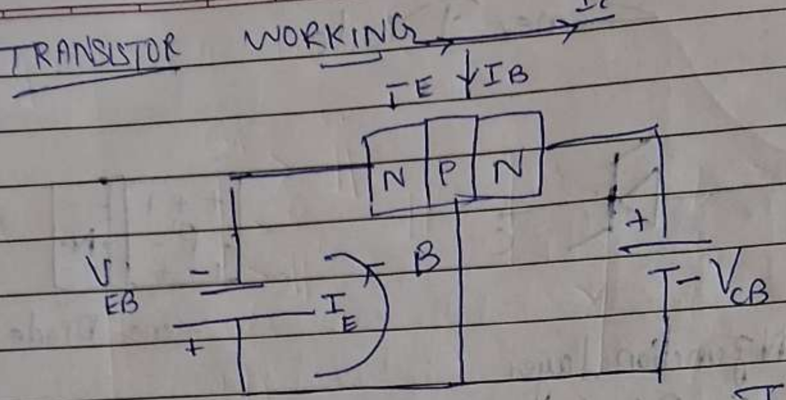
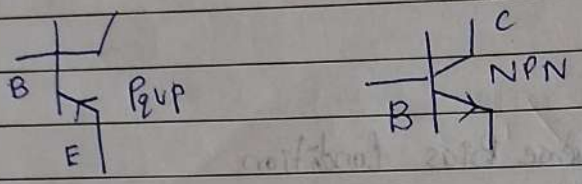
TRANSISTOR WORKING



$J_1 \rightarrow$ Emitter junction
(or)
Emitter Diode
$\rightarrow V_{EB} \rightarrow FB$



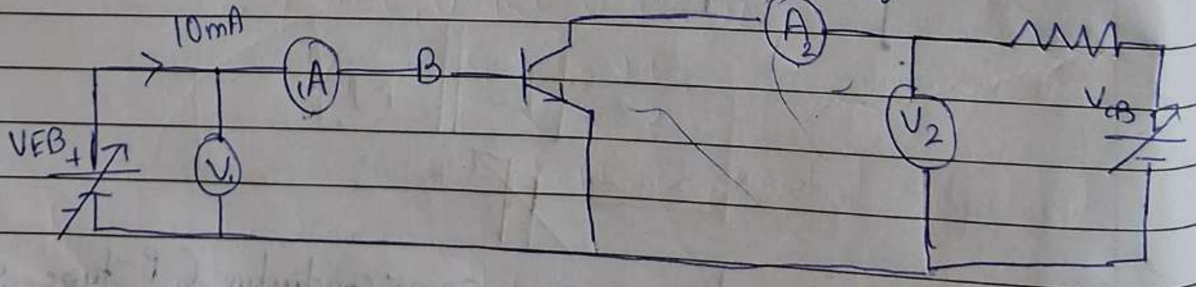
$J_2 \rightarrow$ Collution juntion
$\rightarrow V_{CB} \rightarrow RB$

→ $\boxed{I_E \simeq I_B + I_C}$ $\Rightarrow I_B \approx 0$

→ Base potential < collector potential

$$\boxed{V_{EB} < V_{CB}}$$

Emitter voltage < collector voltage



$V_{CB} \uparrow I_{es} \rightarrow I_{es}$

V_{EB} > knee voltage

Emitter junction starts conducting.

* Emitter layer is medium
* Base layer is thin layer
* Collector layer is bigger

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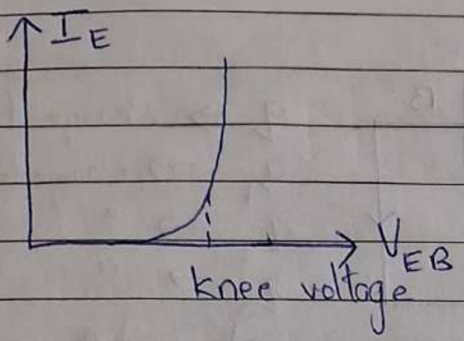
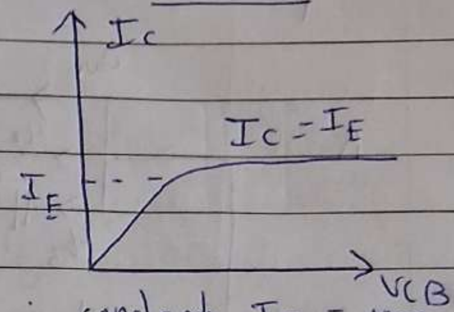
Emitter Base



Collector Base :



constant I_E = 10mA
I_C voltage can differ

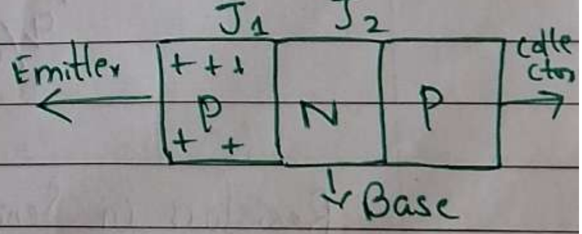
=> Capacitors - It is a two-terminal electrical devices that can store energy in the form of an electric charge

* In our everyday life we use (220-240V)

=> Stablizers :- Stabilizers Voltage aswell is an electrical device that delivers constant voltage to electrical appliances and electronics

=> Inductors :- A passive two-terminal electrical composed that stores energy in a magnetic field when electric current flows through it

TRANSISTOR

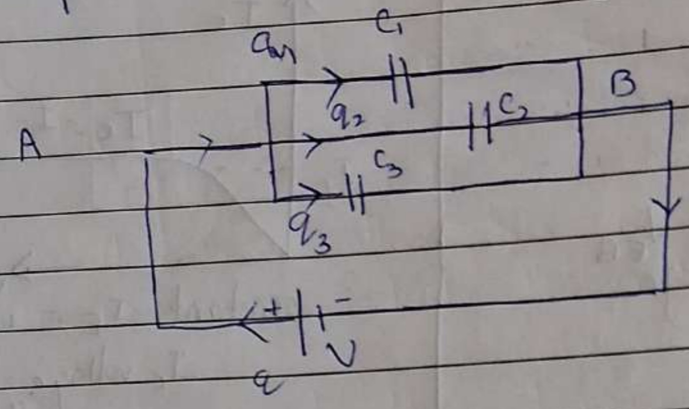


* Revolution of whole electric field
* LED - Light emitting diode

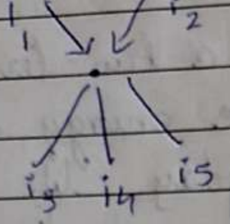
* Emitter heavily doped   E - Emitter
* Base medium doped   C - Collector
* Collector lightly doped   B - Base

* Emitter layer is bigger when compared to Base layer

Capacitors in Parallel:



$q \rightarrow$ charge from V
$q_1 \rightarrow$ charge from C_1
$q_2 \rightarrow$ " " C_2
$q_3 \rightarrow$ " " C_3
at point A apply KCL
$q = q_1 + q_2 + q_3$



KCL
algebric Sum of current meeting at a point is Zero

$\Rightarrow \quad q = q_1 + q_2 + q_3$

we know $\boxed{C = q/V}$

$\Rightarrow \quad q = CV$

$\therefore q_{v_1} = C_1 V$

$q_{v_2} = C_2 V$

$q_{v_3} = C_3 V$

$\therefore q = C_1 V + C_2 V + C_3 V$

$q/V = \underbrace{C_1 + C_2 + C_3}$

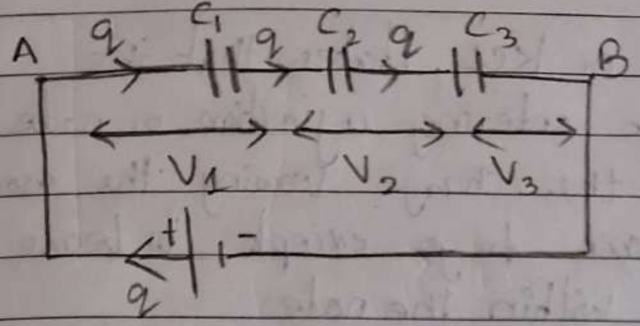
C_{eff} (equivalent capacitance)

Resistors in Series
= Capacitance in parallel

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

$\therefore C \uparrow es \; q \uparrow es \; V \downarrow es$

Capcitors in Series



$\Rightarrow C = q/V, \quad V = q/C$

$\Rightarrow V_1 = q/C_1, \quad V_2 = q/C_2$

$V_3 = q/C_3$

V_1 = voltage across C_1
V_2 = voltage across C_2
V_3 = voltage across C_3

=> Applying KVL Law

{ Sum of all voltage in a given closed circuit is equal to zero }

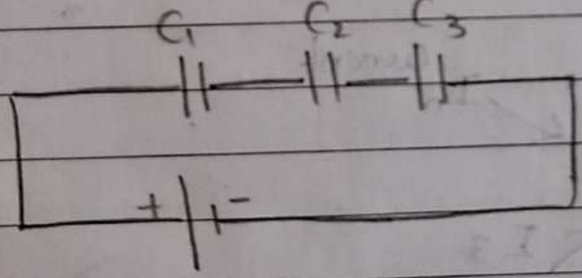
$V = V_1 + V_2 + V_3$

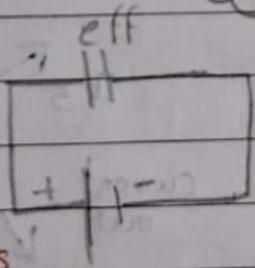
$V = q/C_1 + q/C_2 + q/C_3$

$V = q(1/C_1 + 1/C_2 + 1/C_3)$

$\therefore V/q = (1/C_1 + 1/C_2 + 1/C_3) = 1/eff$

effective (or) eff equivalent capacitance





C ↓es q ↓es V↑es

=> voltage ~~dri~~ divider circuit

* In series we can store more charges

KCL Law

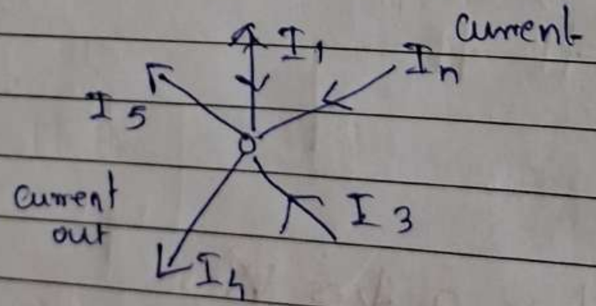
Kirchoffs Current law or KCL, states that the total current or change entering a junction or node is exactly equal to the change leaving the node as it has no other place to go except to leave as no change is lost within the node

In other words the algebraic sum of All the current entering and leaving a node must be equal to zero.

$$I_{(exiting)} + I_{(entering)} = 0$$

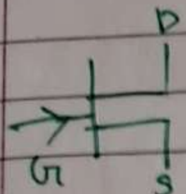
This idea by kirchoffs is commonly known as the conservation of change

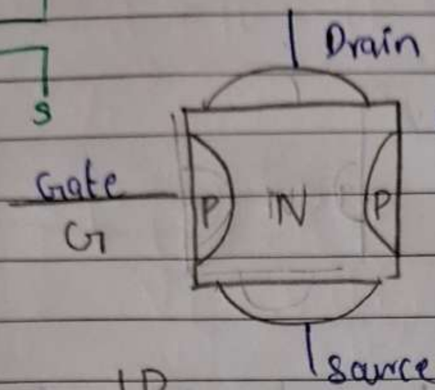
kirchoff's Current law.



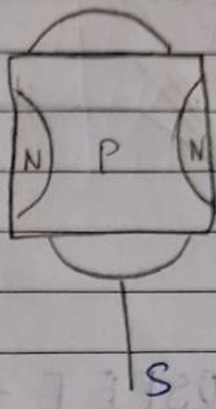
$$I_1 + I_2 + I_3 \; (-I_4 + -I_5) = 0$$

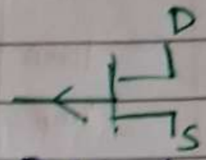
FET (Field Effect Transistors)



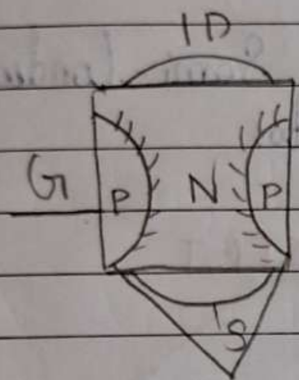


N channel
(FET)





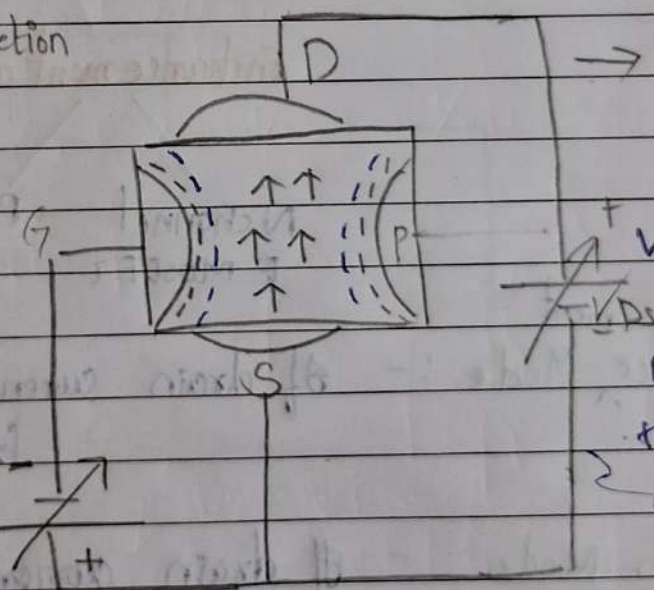
P channel
(FET)



→ In F. Biasing condition the deption layer width is not going to change

In R.B The Depletion Layer ↑es

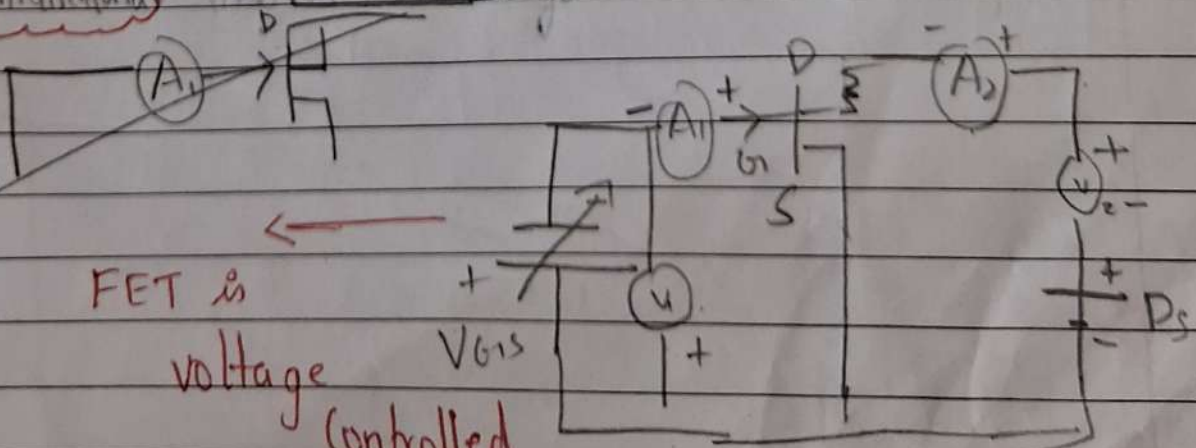
⇒ N channel Depletion
(FET)



→ work on R-Biasing
Based on V_{GS} voltage the current flow is determined

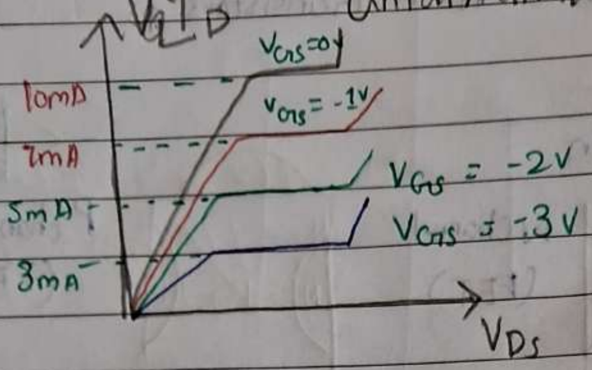
Votage Controlled Device

Not Bipolar But unidirectional



FET is voltage Controlled

Unidirectional



23/10/24 MOSFET - Metal Oxide Semi-Conductor Field Effect Transistor

Insulated Gate FET

MOSFET

Enchancement mode — Depletion Mode

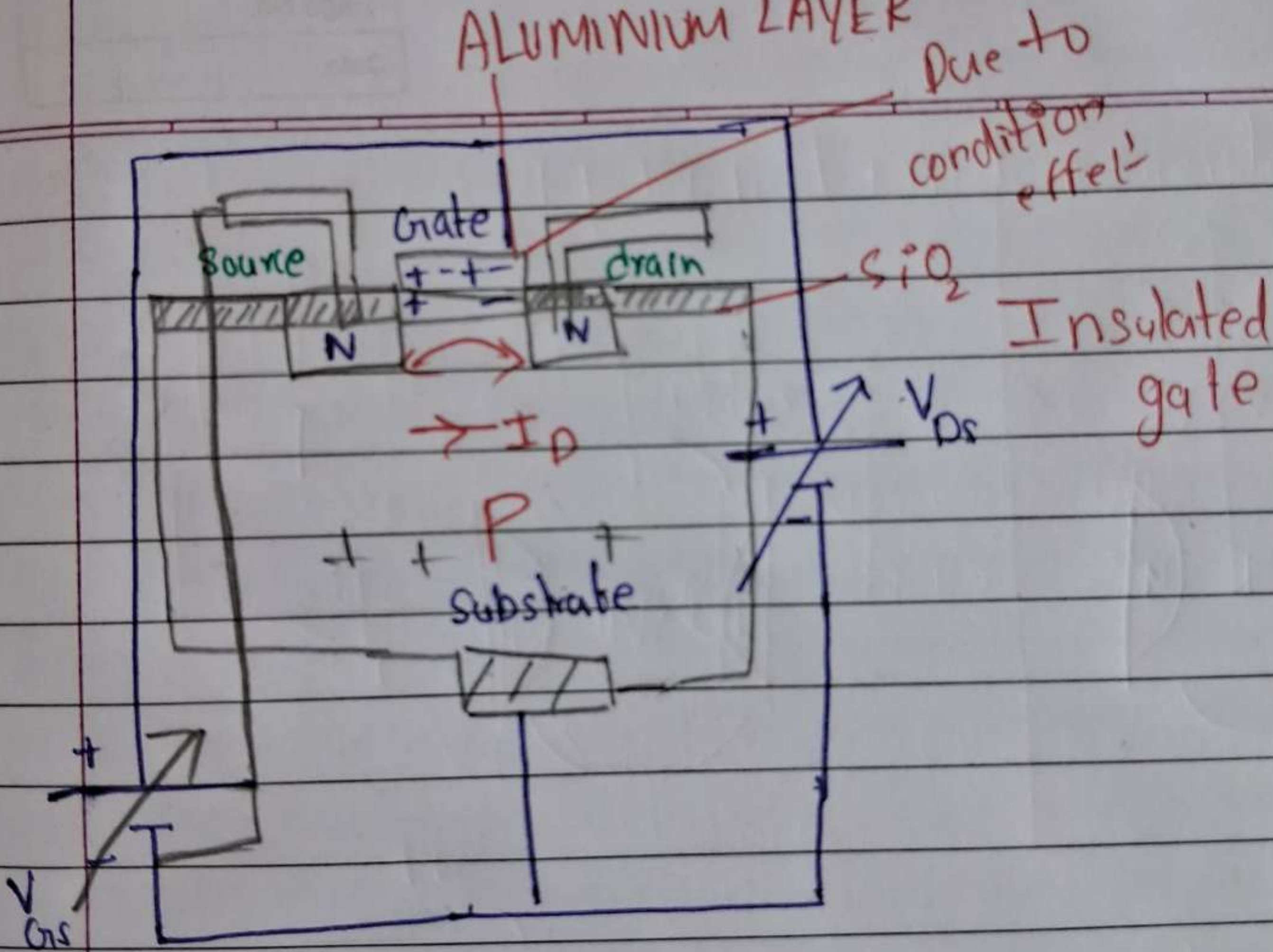
Enchancement mode: N channel E MOSFET, P channel E-MOSFET

Depletion Mode: N-ch D-MOSFET, P-ch E-MOSFET

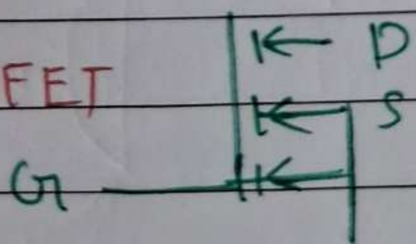
Enchancement Mode :- If drain curent ↑es based on Gate + Source voltage

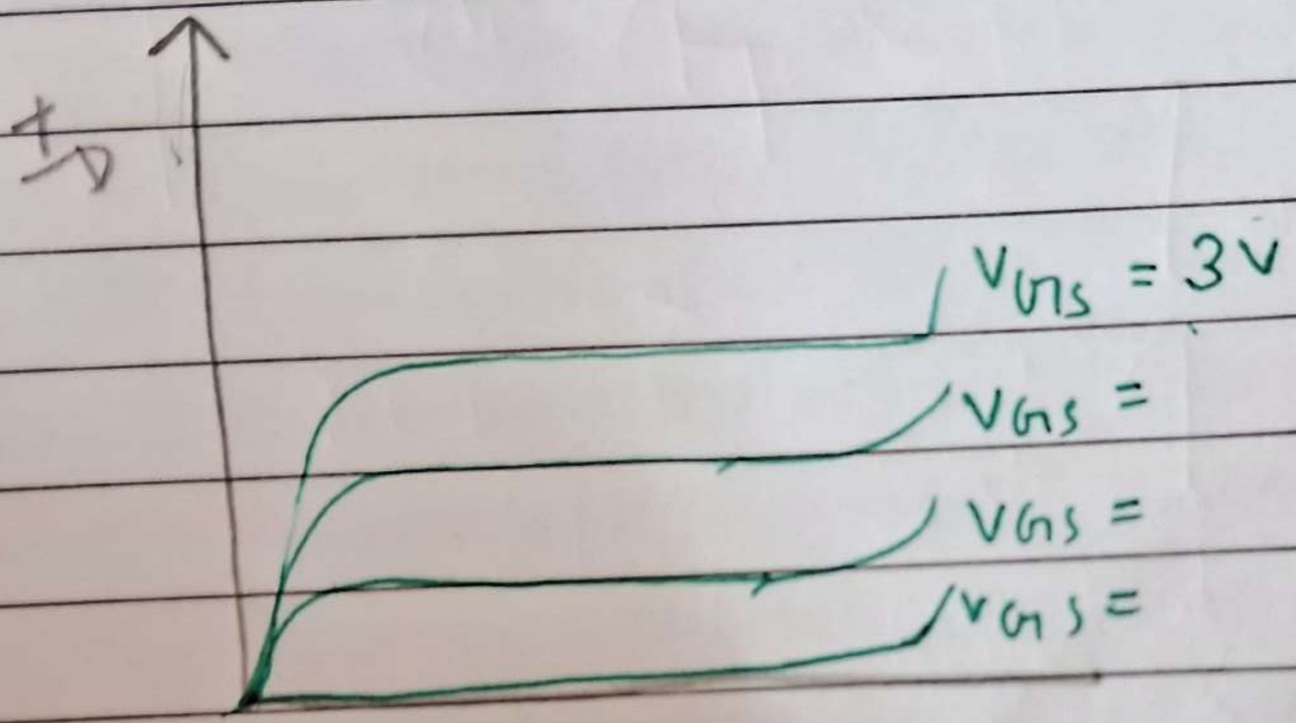
Depletion Mode :- If drain current ↑es

N type is doped



N channel
E - MOSFET




I_D
$V_{GS} = 3V$
$V_{GS} =$
$V_{GS} =$
$V_{GS} =$