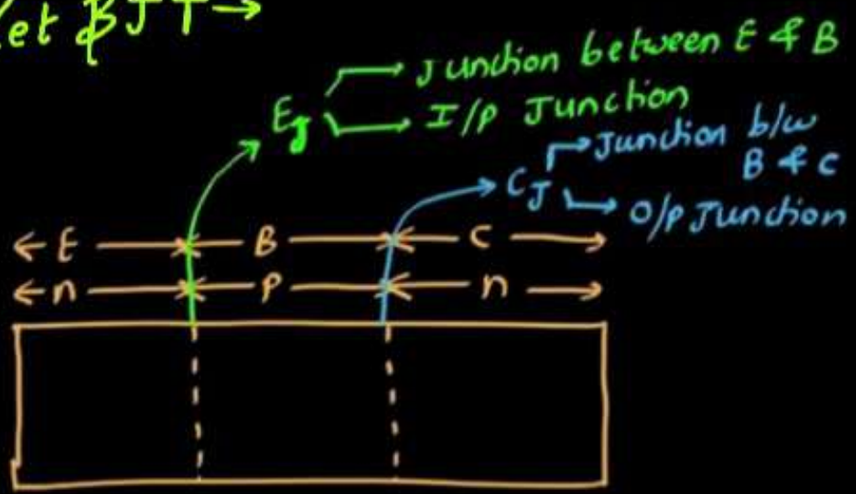
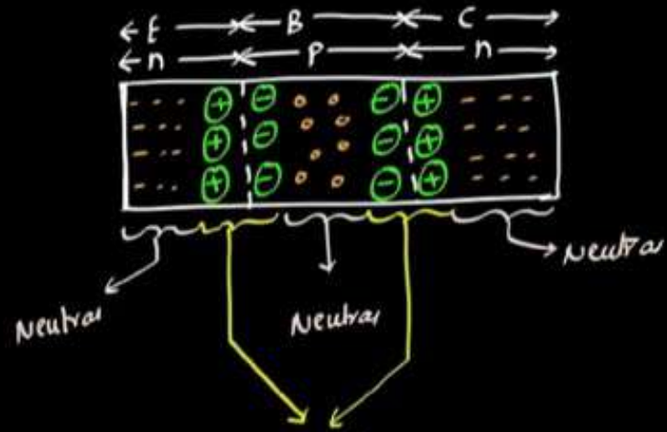
Principle behind Low Level injection →

Let BJT →



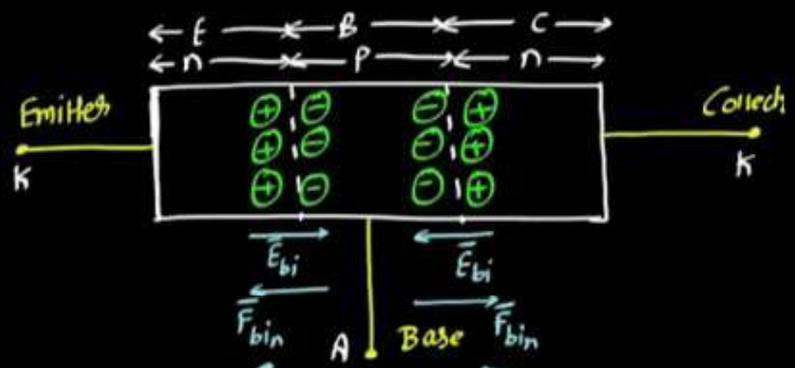


Electrically & Space charged

⇒ There are two Space charge regions

⇒ BJT has Two Capacitances.

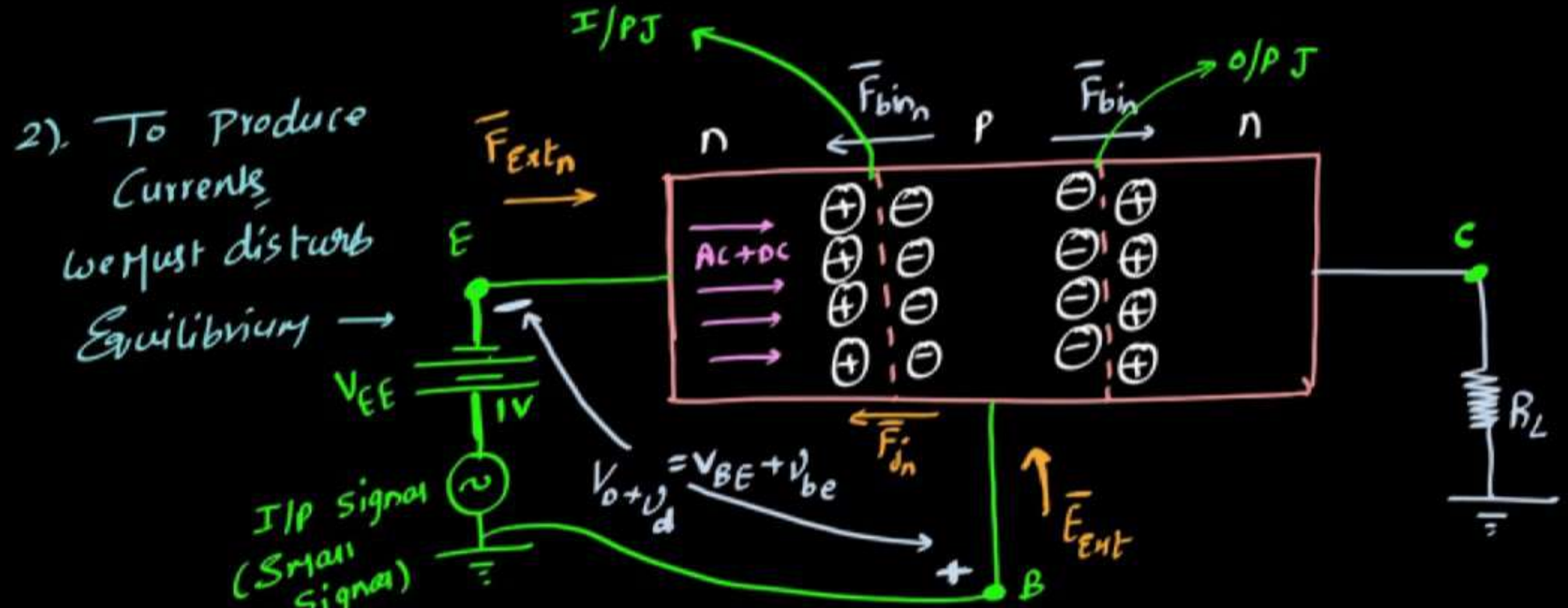
⇒ It Support Two Electric field profiles.

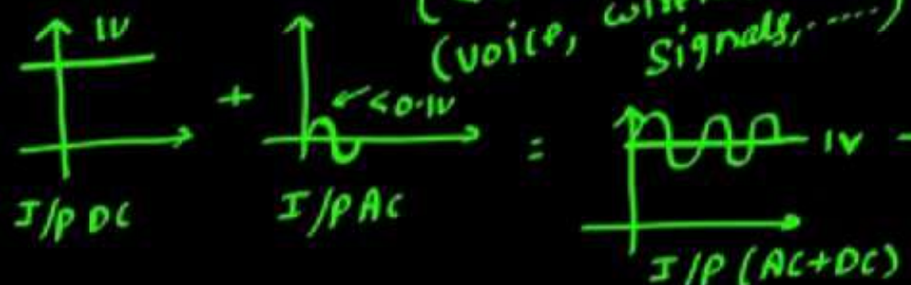


(carries Transport Equation is Valid. $[I_{T_n} = I_{n_{drift}} + I_{n_{diff.}} = 0]$)

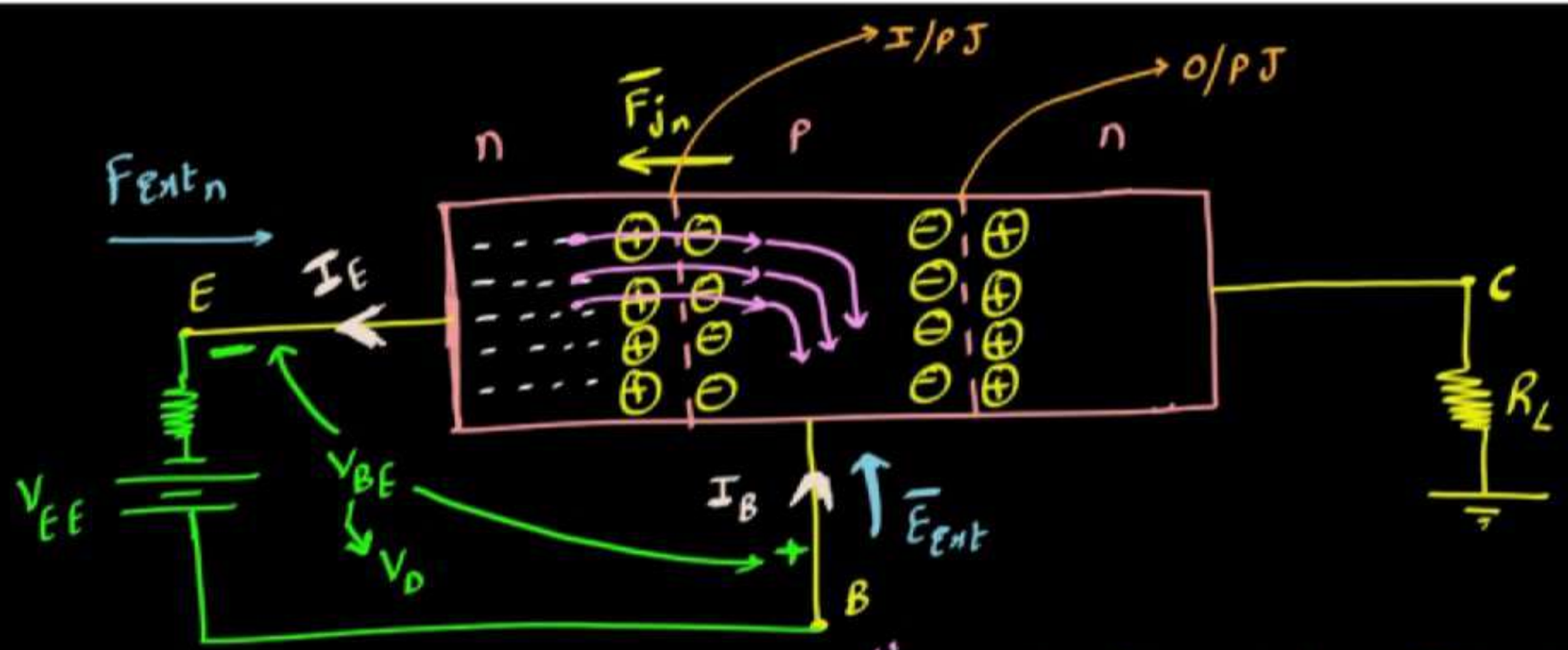
(carries Transport Equation is Valid. $[I_{T_n} = I_{n_{drift}} + I_{n_{diff.}} = 0]$.

2). To Produce Currents, we Must disturb Equilibrium →





As, I/P Small Signal is of very small value ⇒ AC+DC ≃ DC (Magnitude) → To Understand BJT Transport, Lets Considers only DC.



In this case

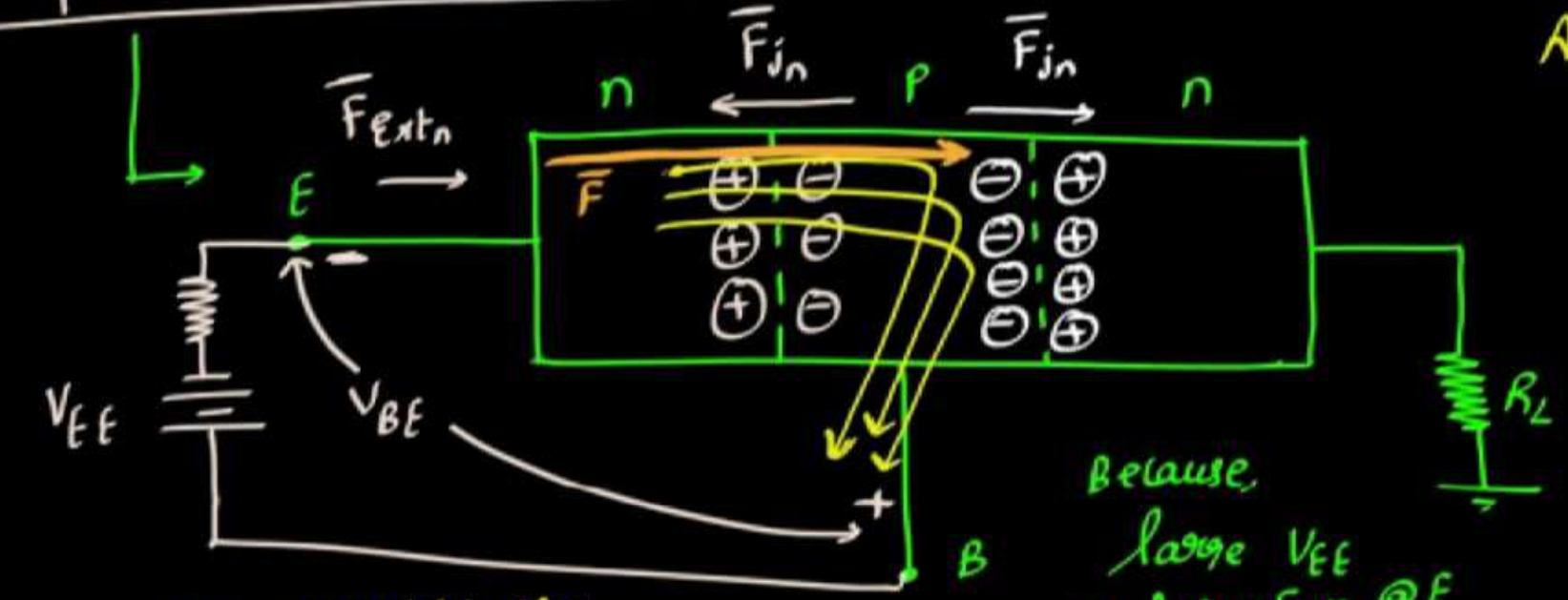
"Due to Base Voltage, I/P signal (or) I/P carriers (or) Emitter Majority carriers Unable to reach load."

$\Rightarrow$ I_E becoming I_B

NOT Advisable.

It shows higher I_B ⟶ Not Advisable.

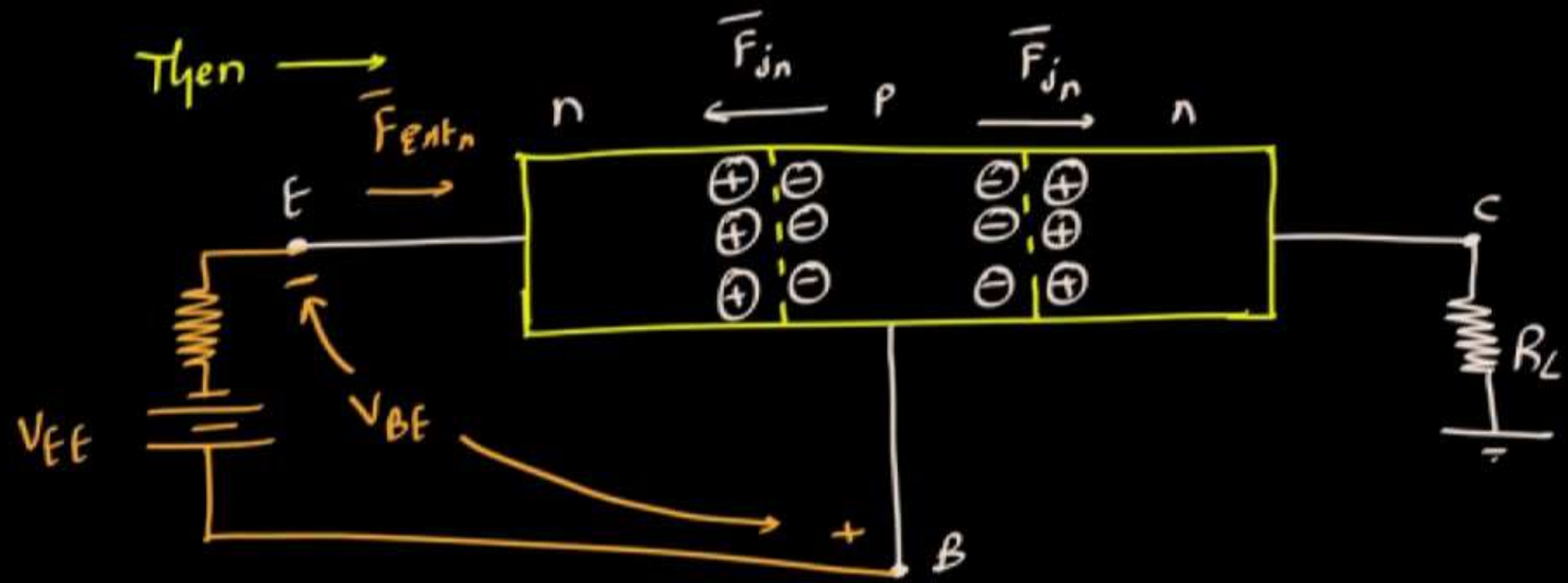
Then what to Do ?



Apply high voltage @ Emitter
⇓
V_{EE} → large
⇓
$\bar{F}_{Extn}$ → large.
⇓
But this is Not a good Idea.

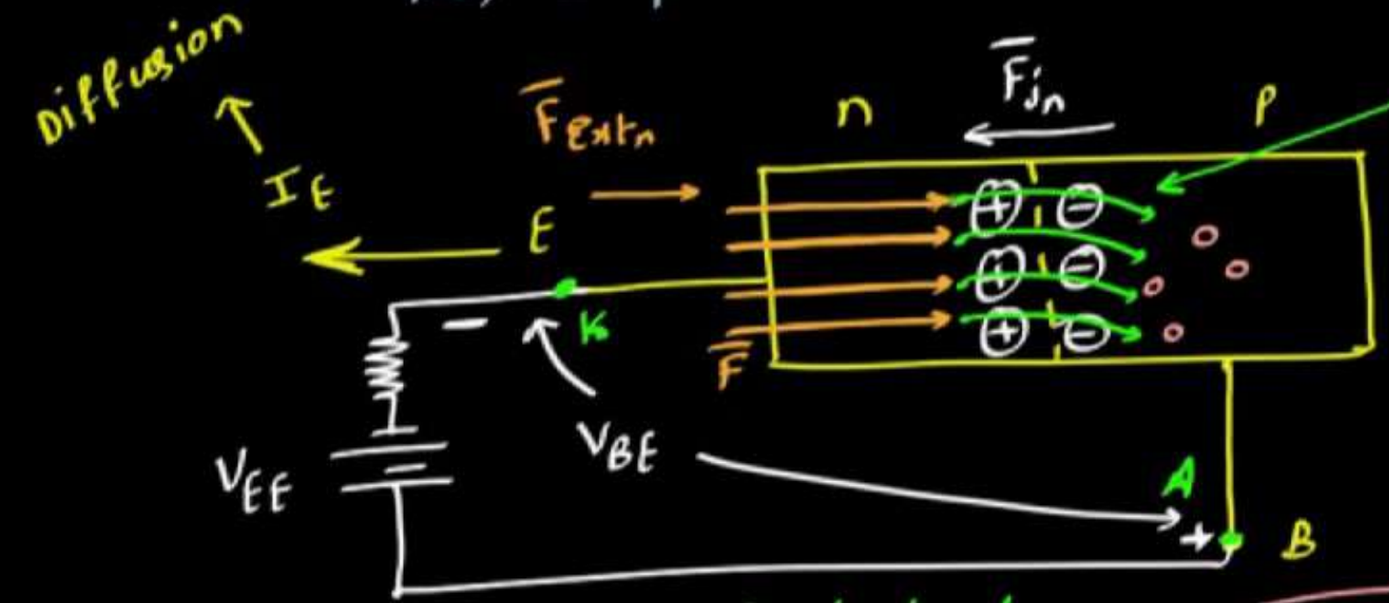
Because large V_{EE} ⇒ large Force @ E & large Vol. @ B.

Due to this carriers are Attracted to Base with high Force.



∴ Don't Apply large voltage @ Emitter as well as @ Base. } V_{EE} → Must be Small.
⇒ due to V_{EE}, if E_J is closed, that is Enough.

i.e., Consider Only Emitter Junction →

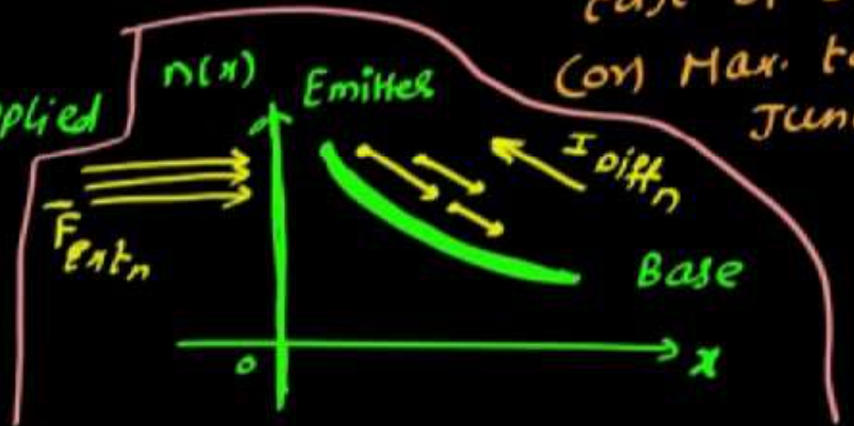


Electrons (or) Majority Carriers are diffused (injected) from E to B. → "Low Level injection".

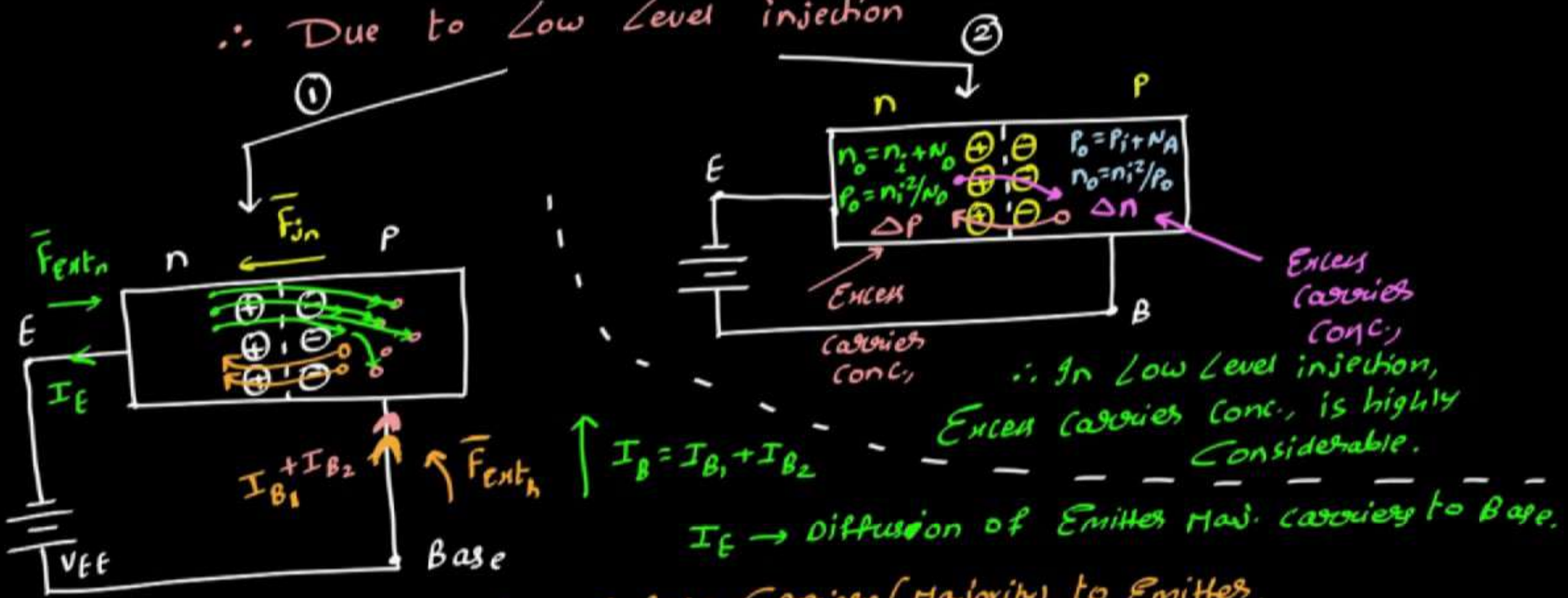
$\bar{F}_{ext_n}$ → Max. it can reach to Edge of dep. layer (or) Max. to Junction.

$V_A > V_K$ → E_J is closed.

⇒ Small Vol., @ E is Applied ///ly @ Base.



∴ Due to Low Level injection



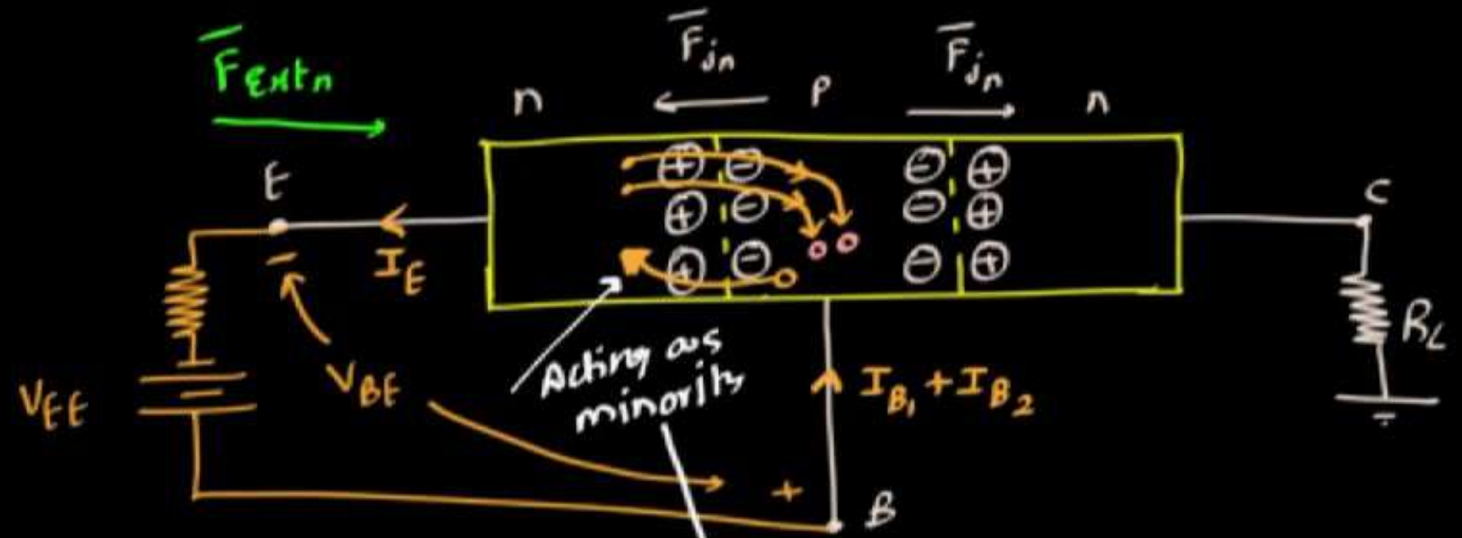
∴ In Low Level injection, Excess carriers conc., is highly Considerable.

$I_E \rightarrow$ Diffusion of Emitter Maj. carriers to Base.

$I_{B_1} \rightarrow$ Diffusion of Base carriers (Majority) to Emitter.

$I_{B_2} \rightarrow$ Re Combination of Emitter Majority carriers with Base Majority carriers.

3).



=> I/p Signal May get distorbed.

=> It is Advisable to Reduce leakage (or) Minority @ Emitter.

Emitter is Advisable to be Higher Doping in BJT.

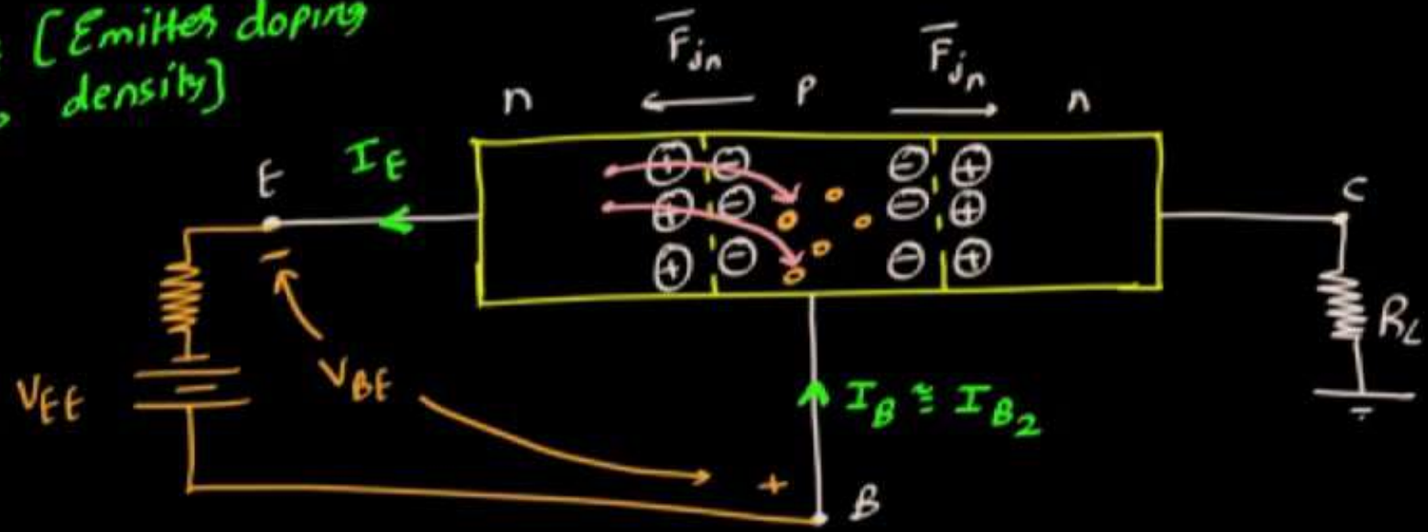
$\therefore I_{B_1} \rightarrow$ Negligible.

$\therefore I_B = I_{B_1} + I_{B_2} \simeq I_{B_2}$.

$\therefore$ As we know $\rightarrow$ minority Conc. $\propto \frac{1}{\text{Doping Conc.}}$ @ T = Const.

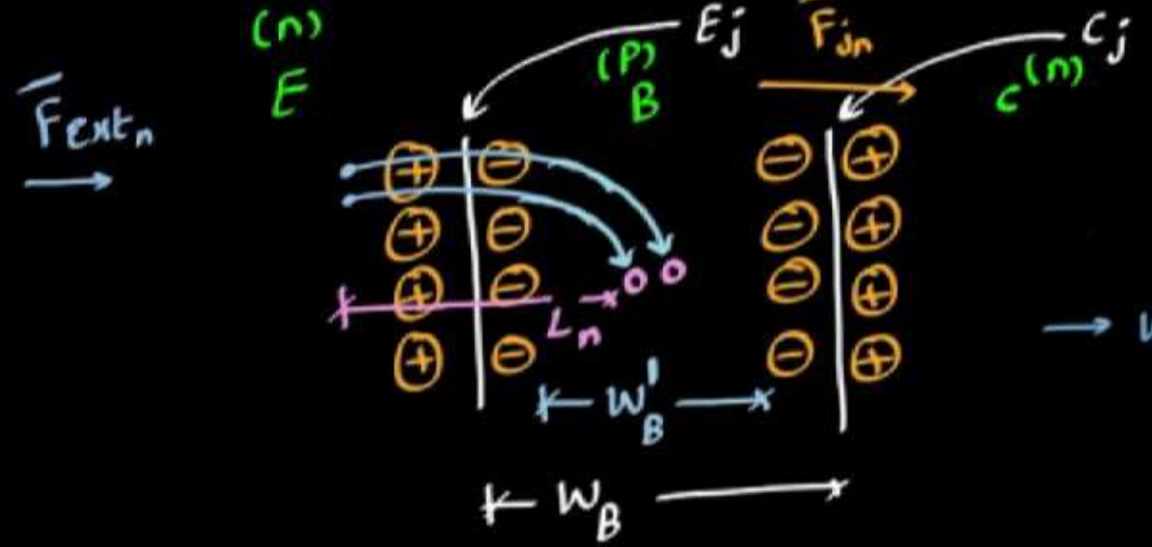
4). As N_E [Emitter doping density] is very high

$\Rightarrow W_{dep}$ @ Emitter is very low.



But I/p Signal Unable to reach load.
[due to low level injection].

How to Solve this issue?

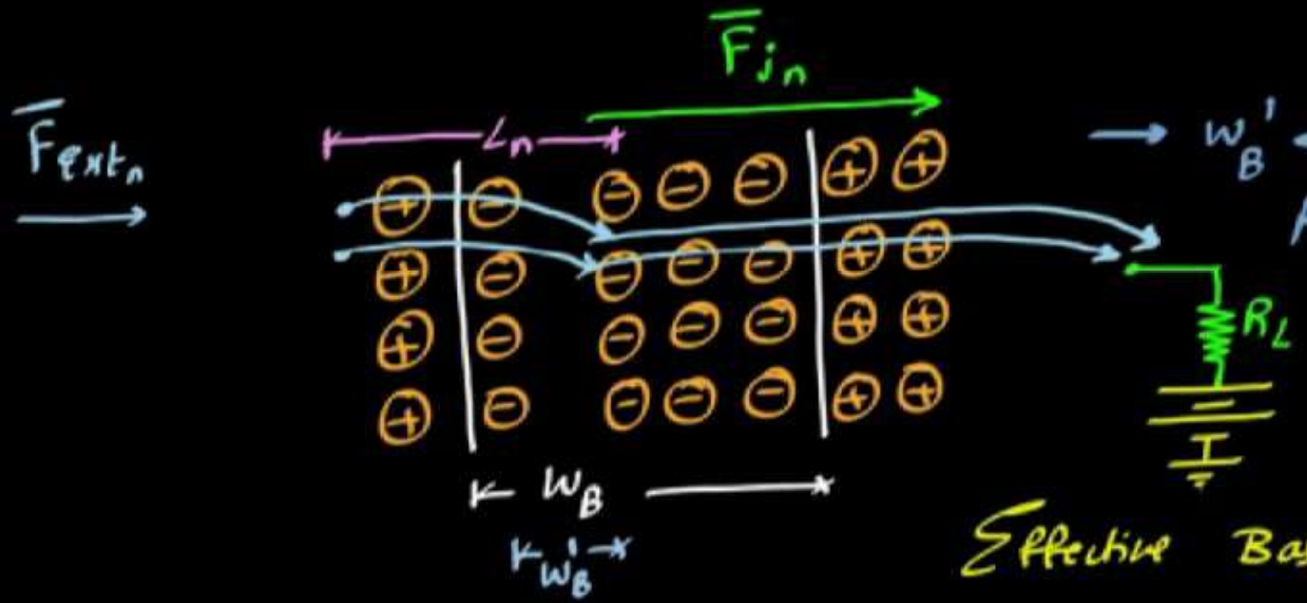


$W_B \rightarrow$ Base width.

$W_B' \rightarrow$ Effective Base width.
↓ where ∃ Recombination.

$L_n \rightarrow$ Diff. length of Emitter Majority Carriers.

$\rightarrow W_B' > (L_n)_E$
NOT Advisable.



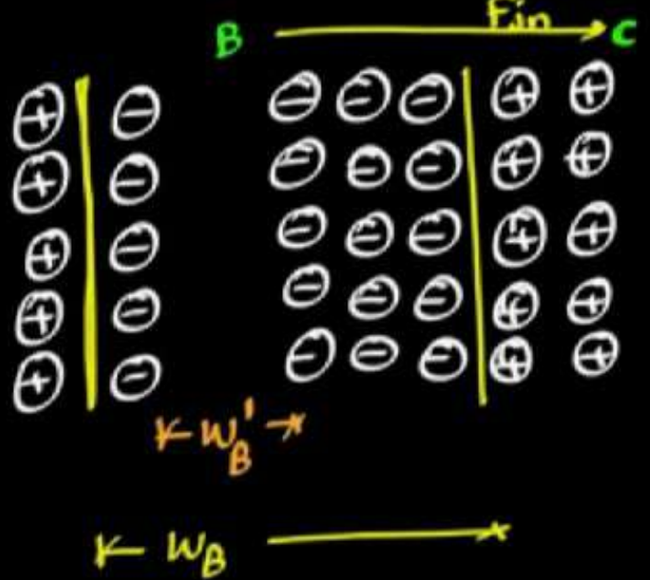
$\rightarrow W_B' < (L_n)_E$
Advisable.

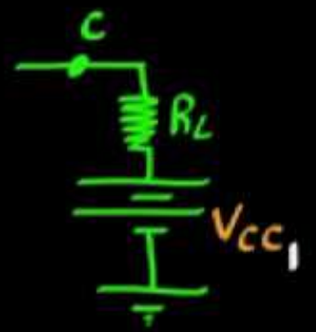
To Propagate Emitter Maj. Carriers (which Contains signal) to load, it is Advisable to Produce large $\bar{F}_{jn}$ @ C & W_B' to be reduced.

⇒ It is Always Advisable that, Effective Base width Must be less than diff. length of Emitter Majority Carriers.

$\therefore$ E

$\vec{F}_{ext_n}$ →





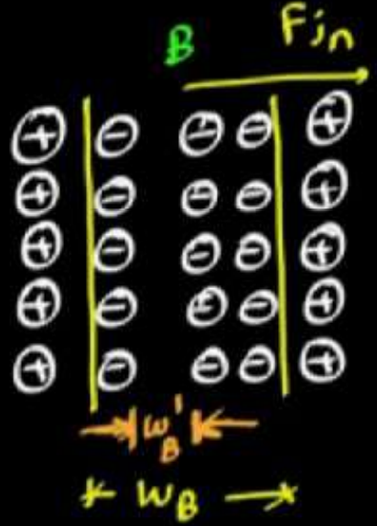
$W_B \rightarrow$ large.

$W_B' \rightarrow$ small.

$V_{CC_1} \rightarrow$ large.

E

$\vec{F}_{ext_n}$ →



$W_B \rightarrow$ small.

$W_B' \rightarrow$ small.

$V_{CC_2} << V_{CC_1}$.

It shows that, for Smaller to Medium V_{cc} voltage Applications (i.e., Smaller to Medium Gains) $\longrightarrow$ Advisable W_B to be Smaller.

But For large gains (or) larger V_{cc} Applications, Advisable $W_B \longrightarrow$ to be large.

But For Amplification, W_B' Must to be Small.

$(W_B' < (L_n)_E)$ For npn.

$(W_B' < (L_p)_E)$ for pnp.

∴ From Above Analysis →

I/PJ → F.Bias
O/PJ → R.Bias
↓
Suggested for Amplification.

Then →

Diffusion current (Low Level injection)