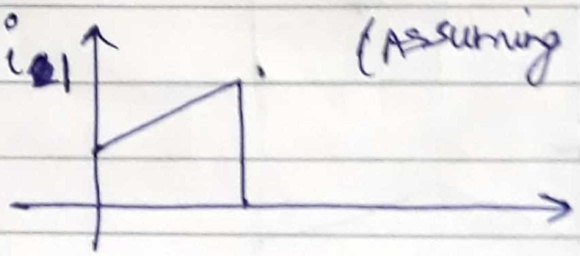
& leakage impedances → ? (small, ∴ voltage spike won't be that high)

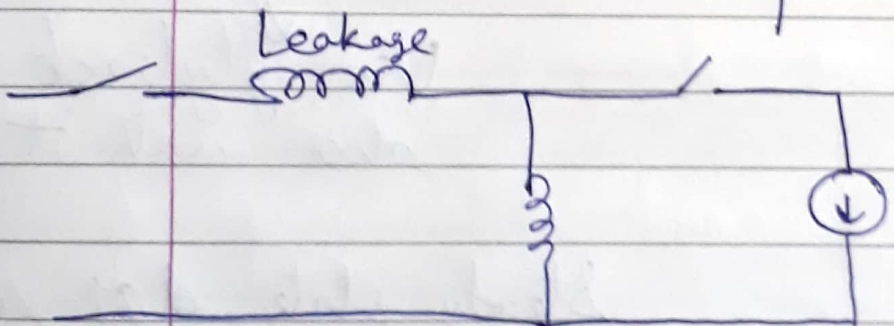
Ideal forward → Acts like a current source

S closed

$i_L = i_2$

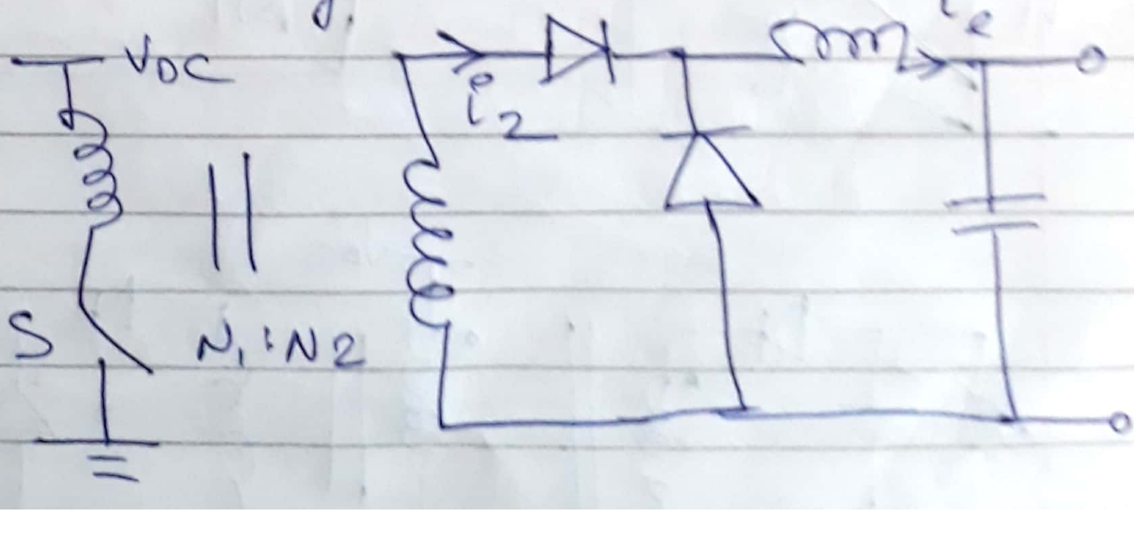
(Assuming leakage = 0)





∴ Leakage won't allow instantaneous ↑ in i_L when S closed

Non-ideal forward



S_1 & S_2 → Same, S_1 & S_2' → comp

S_1 closed, S_2' open

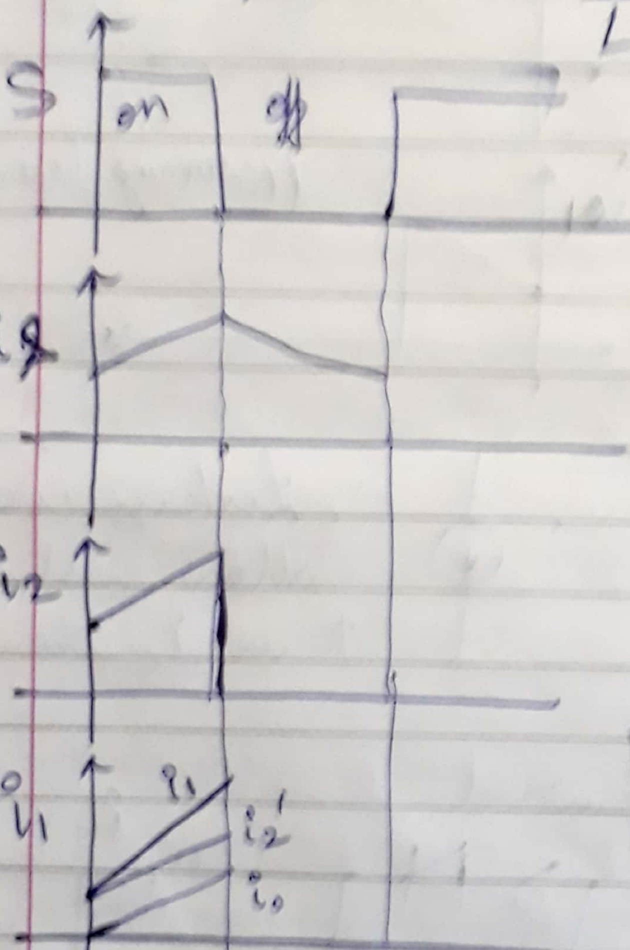
$\therefore\ i_2 = i_\ell$

$$i_1 = i_\ell + \frac{V_{dc}\,dt}{L_m}$$

ϕ doesn't decay, problem!

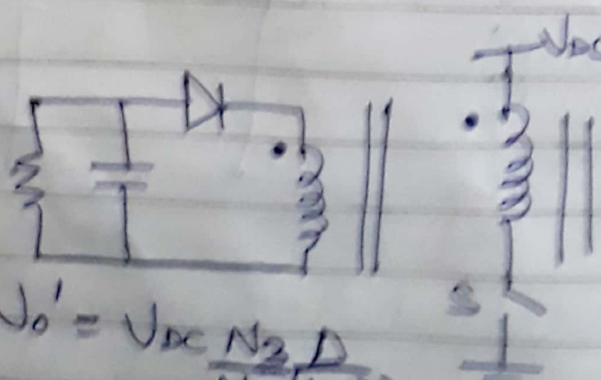
⇓

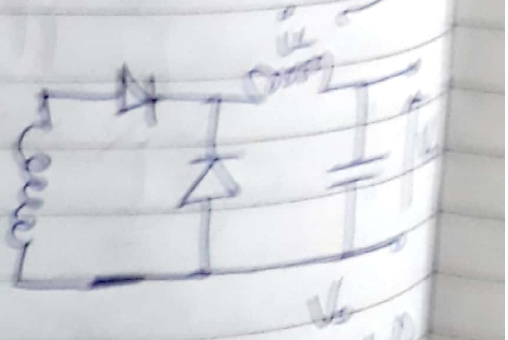
V_{dc} flyback also with it



Steady state, $\Delta\phi = 0$

$$\boxed{\frac{V_{dc}}{N_1} DT = \frac{V_o'}{N_2}(1-D)T}$$



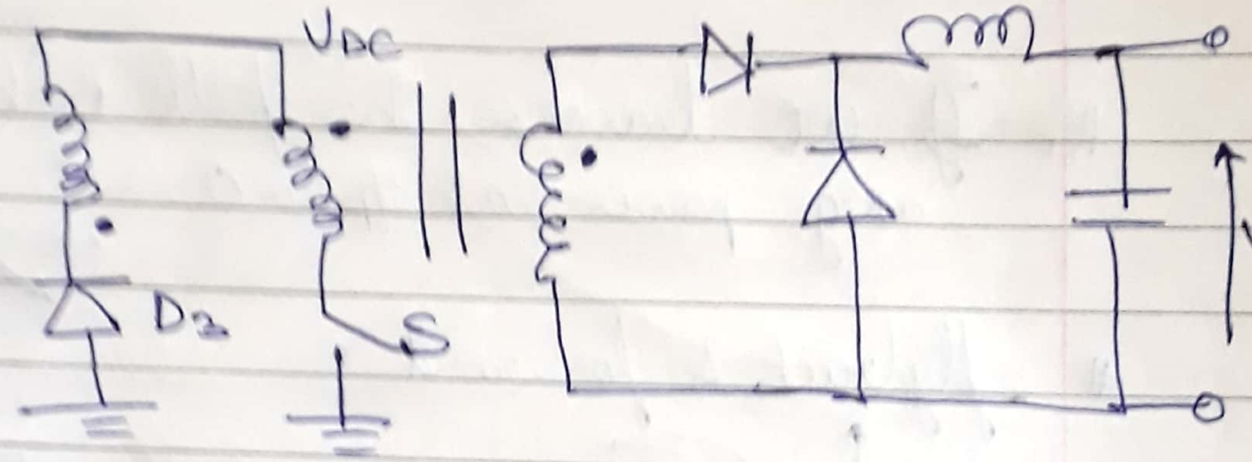


$$V_o' = V_{dc}\frac{N_2 D}{N_1(1-D)}$$

flyback ↗

$V_o = V_{dc}\frac{N_2}{N_1}D$

We take $N_1 = N_3 \rightarrow$ Easy for winding
N_3 has to carry only magnetising current
but N_1 has to carry magn. + load current
$N_3 \rightarrow$ thin, $N_1 \rightarrow$ thick.

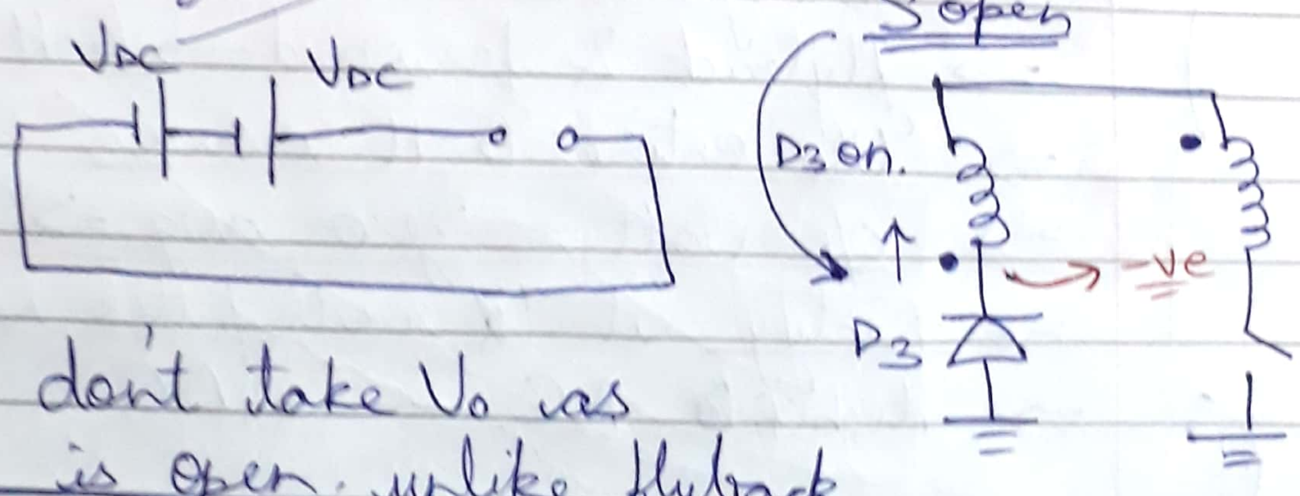


$\frac{V_{DC}\,DT}{N_1} \rightarrow \phi\uparrow$ $\frac{V_{DC}(1-D)T}{N_3 \text{ or } N_1} \rightarrow \phi\downarrow$

∴ If $D > 0.5$, $\phi\uparrow$ & will keep ↑.

∴ It is alway operated in discontn. conduction.

S voltage → As $N_1 = N_3$

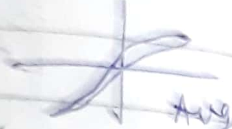


We don't take V_o as D_2 is open unlike flyback.

~~Flyback & Forward~~ for given power

Both use transformers, but forward boost use is better.

If we traverse the full B-H curve, avg power at o/p = 0.



Flyback & forward

Avg. o/p will not be 0.
⇒ DC offset.
⇒ core may get satⁿ.

~~High Power applications~~

If significant difference in i/p & o/p
⇒ Transformers
⇒ Flyback & forward → B-H loop problem
⇒ Use entire B-H curve.
⇒ o/p volt = zero avg ⇒ AC
⇒ Rectify it (small filter reqd.)
⇒ High f AC ⟶ DC

High 'f' DC ⟶ AC ⟶ DC.

- Loss = sP_2

↳ P_2 = Air gap / rotor power

Cu loss = sP_2

Power developed = $(1-S)P_2$

Bulk of power → IM, pump & fans.

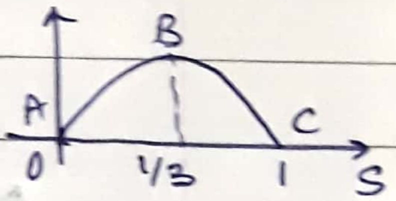
$$\boxed{T_e \propto N_r^2}$$

$$P.d = I_r^2 \times \frac{R_r(1-S)}{S}$$

$$T.d = \frac{I^2 R_r(1-S)}{N_s(1-S)\,S}$$

$$\therefore \frac{I^2 R_r}{N_s S} = k N_r^2 = k(1-S)^2$$

$$\therefore \boxed{I \propto (1-S)\sqrt{S}} \rightarrow$$



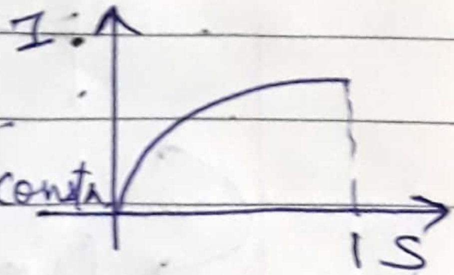
Ns & Nr can't be too diffⁿ. for fan ($T \propto \omega^2$) as s will be high. ⇒ sP losses ⇒ <u>heat</u>

If $T_e = k$, $\frac{I^2 R_r}{N_s S} = k \Rightarrow I \propto \sqrt{S}$

∴ s should be low

∴ I_r^2 losses ↑ with ↑ in s.

As T_e is constⁿ, I_p is also constⁿ

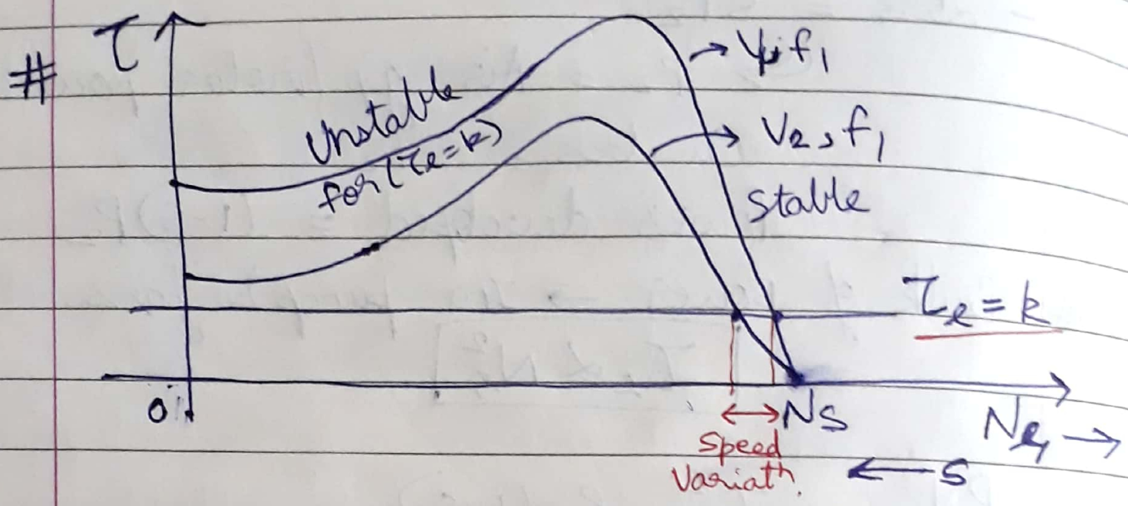


→ As s↑, N_r↓.

If N_r↓, $T_e \propto N_r^2$ ↓ ⇒ Input also ↓

& I also ↓ from B-C

∴ If $T_e = k$, s should be low & we need to change N_s.
∴ If $T_e \propto \omega_r^2$, s can be large & no need to change N_s.



$T_e \propto V_{ph}^2$ → $T_e \propto F_s . F_r$

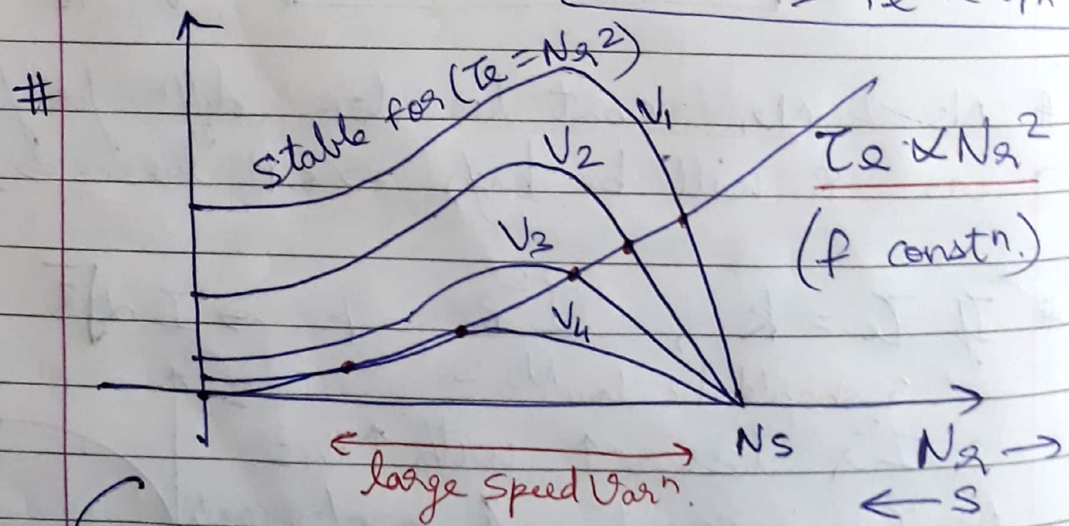
or $\propto \beta I$ → I in conductor

$\beta \propto V_{ph}$

$I \propto \beta$ & sN_s (rel. speed)

$\Rightarrow I \propto V_{ph}$ too.

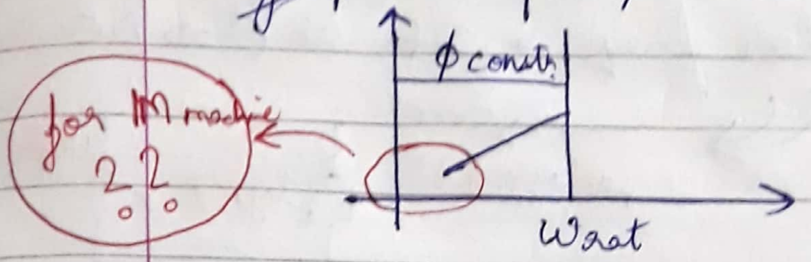
$\Rightarrow T_e \propto V_{ph}^2$



→ We can still make $\eta = \eta_{max}$
i.e. (variable = constant losses)
(Hint: Reduce ϕ, don't keep it constn.)
⇒ Const losses↓, variable anyways ↓ with load

$E\cancel{V} = 4.44 f \phi_m N_r$

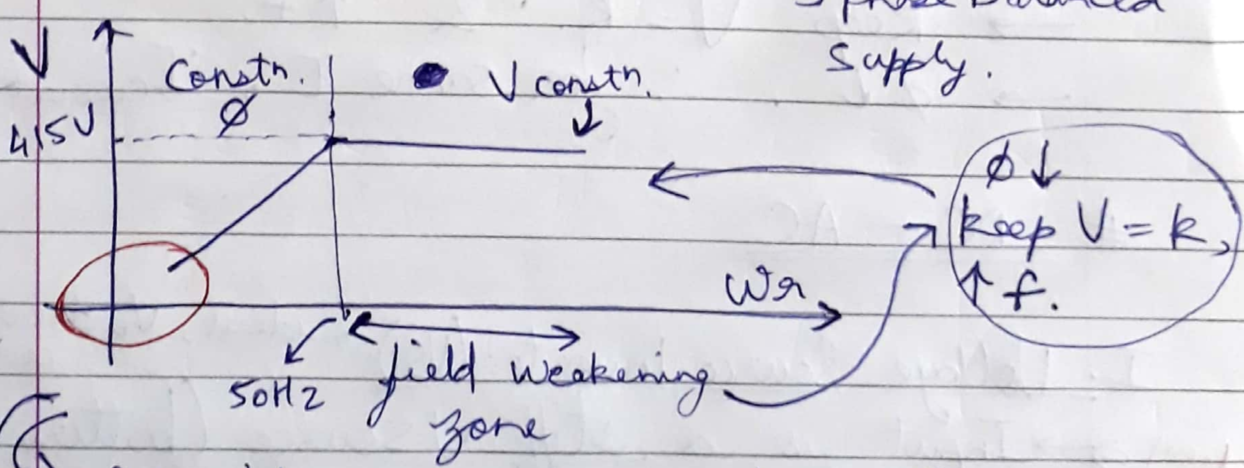
~~for~~ keep ϕ const $\Rightarrow \frac{V}{f} = k = $?



To keep rotor current constn.,
ϕ & SN_s must be constn. (Induced $\propto$ Induced voltage)

4 pole, 50Hz, 1455 rpm
At 415V, $\phi = \phi_{rated}$
$T = k$, $N_r = 1455$ rpm

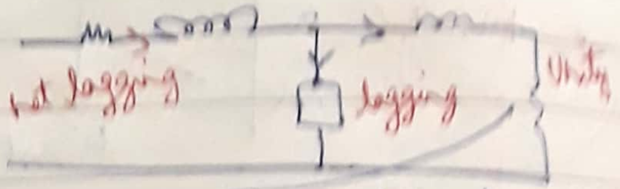
$SN_s = 45$ rpm
Now to keep I_r constn., SN_s = constn
To make $N_r = 900$ rpm,
$N_s = 945$ rpm (SN_s = constn)
$\Rightarrow$ Calc. f_1
Keep $\frac{\cancel{V}E}{f}$ const to keep $\phi = \phi_{rated}$.
$\because$ Need to generate 3 phase balanced supply.
$\Rightarrow$ Find V_1.



Q. Will it work for fan/pump?
A. No, $V = k$, $f \uparrow \Rightarrow \phi \downarrow \Rightarrow$ for same torque, $I \uparrow$
& on $\uparrow f$, T of fan needed also $\uparrow \Rightarrow I \uparrow\uparrow$.

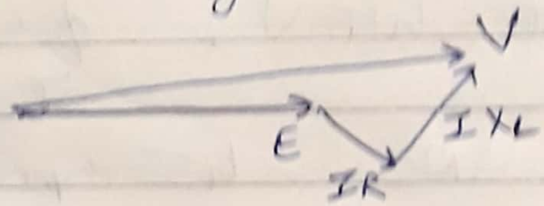
IM → always lagging.

↳ Rotor p.f is almost unity.
as rotor freq. = sf ≃ 0 ⇒ DC.



While for transformer, (✓) could be lead, lag, unity depending on load.

At low freq's, magnitude rules, $E = V - IR$,



$0 < \omega < \omega_{rated}$

→ constn. ϕ operatn. ⇒ E/f constn.
→ motor has capability to develop rated torque ⇒ control SNs.

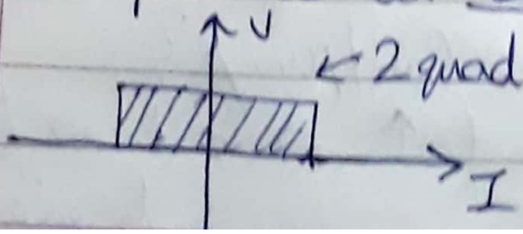
$\omega > \omega_{rated}$ (field weakening)

→ Keep $V = k$ & ↑ f.
→ $\phi \downarrow$, ∴ for same T, $I_{current} > I_{rated}$

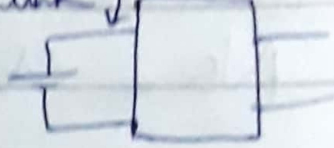
DC — AC

I. Voltage Source Inverter (VSI) → ideal, V_t doesn't change with load

Very popular → Input is a stiff V source (battery / capacitor)

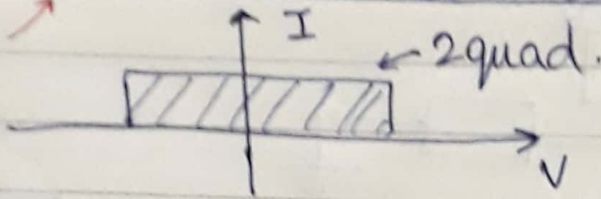


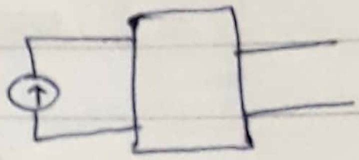
DC link



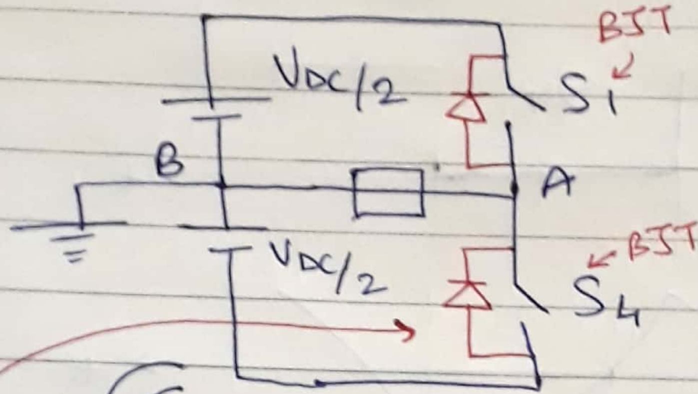
II. Current source Inverter (CSI)

Used at high powers

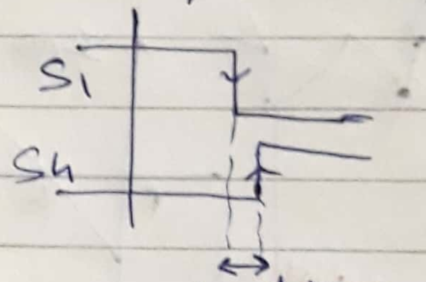




Half - Bridge



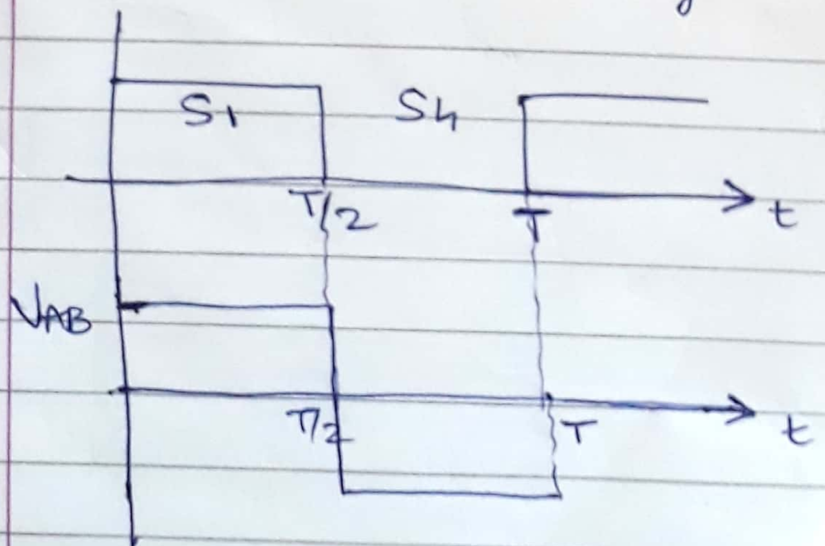
S_1 & S_4 are complimentary



S_1 & S_4 can't be closed at both time as then short circuit of volt. sources.

⇒ At high power (high V_{DC} too), current source is prefered as it can be shorted.

We want A.C ⇒ Avg. value = 0 ⇒ $\underline{D = 0.5}$.



$T/2 = 10\,mS$

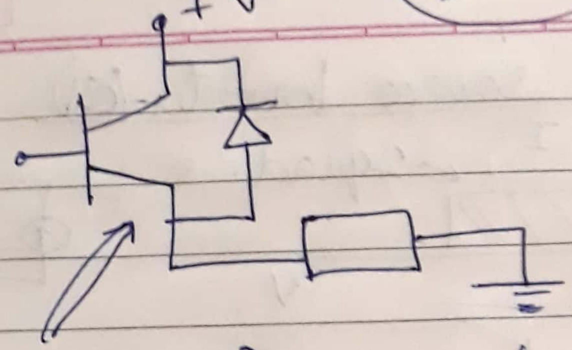
$\Rightarrow f = 50\,Hz$

If load is inductive & we open S_1, in transient, we need to provide a path as I can't change instantaneously.

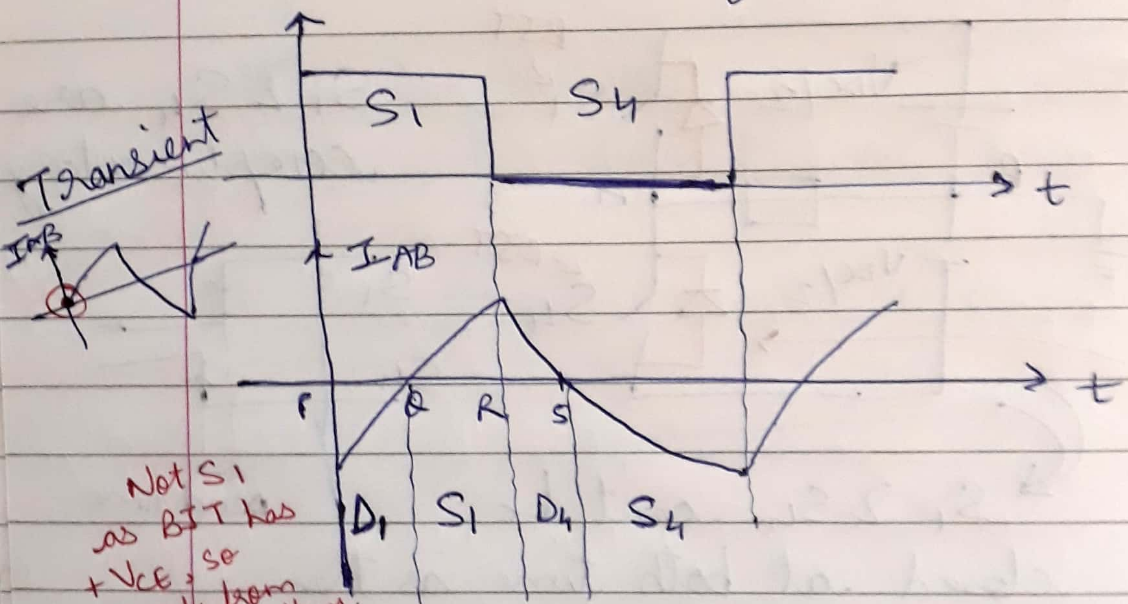
⇒ Put Diodes

$+V \rightarrow$ +ve only

#



Current 2 way, but voltage only 1 way



Not S_1 as BJT has $+V_{CE}$, so I only from C-E it allows.