Date 23/09/19

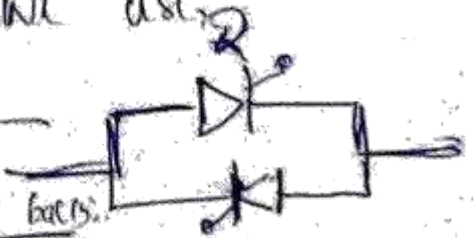
Unit - IVI

A.c to A.c Controlled Converters:

→ transformer converts fixed A.c to variable A.c (frequency is same).

→ Auto transformers, tap changer, saturable reactor used fixed A.c to variable D.C. (size, weight, cost, losses)

→ Here disadvantages are more, by avoiding this we use,

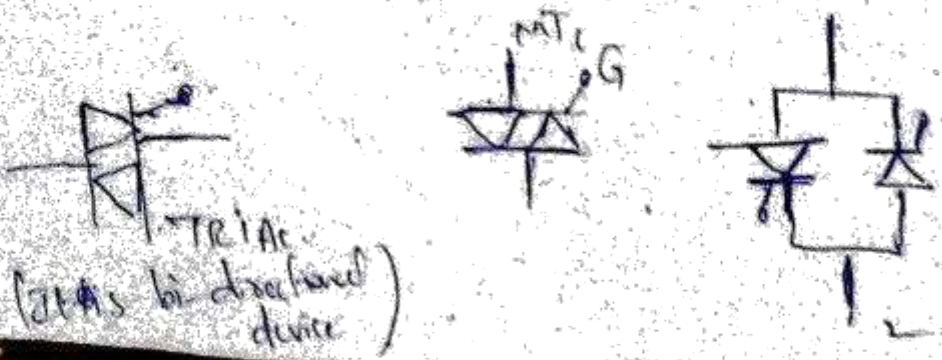


(Advanced devices)

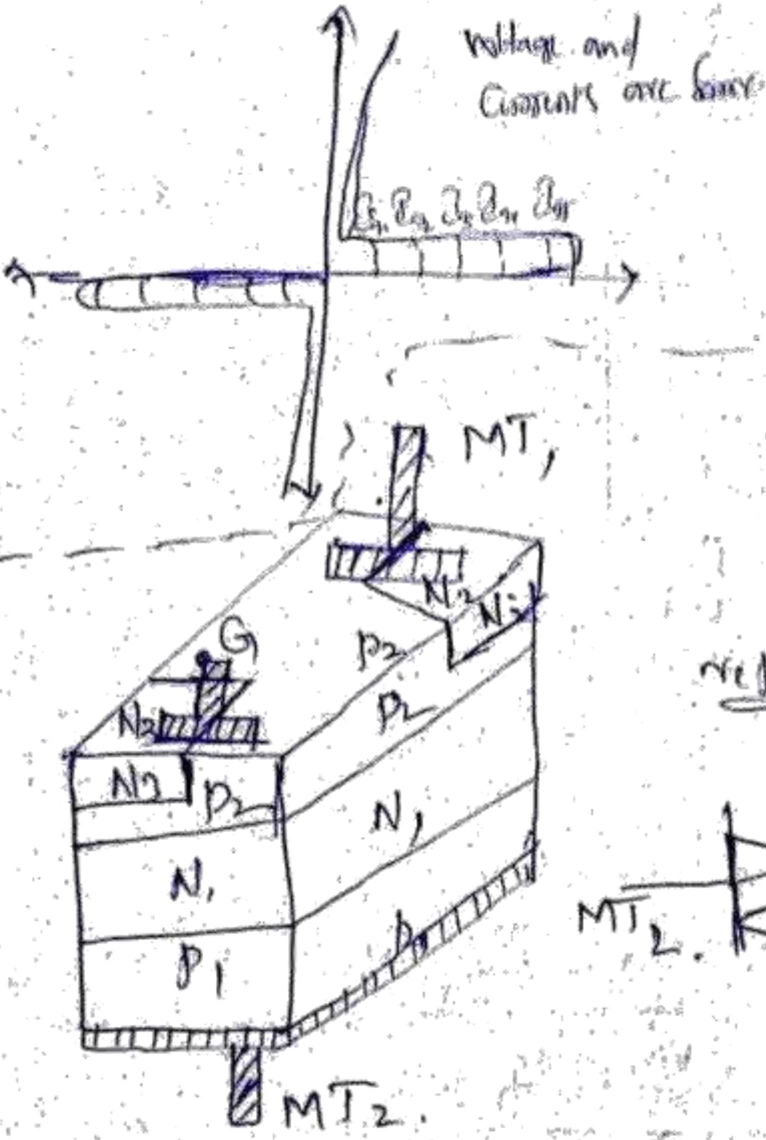
drawbacks:
(i) device temperature increases, the device may be damaged

Applications:

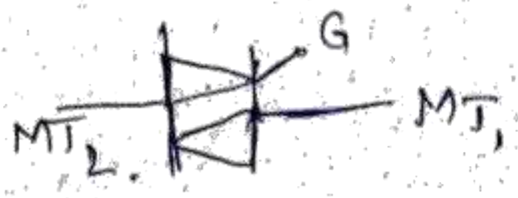
→ Speed control of AC drives
→ furnaces → induction field.
→ Static VAR compensators.



(acts as bi-directional device)



represented by



Operation:-

→ It Can be operated by "4" modes

Mode-1:-

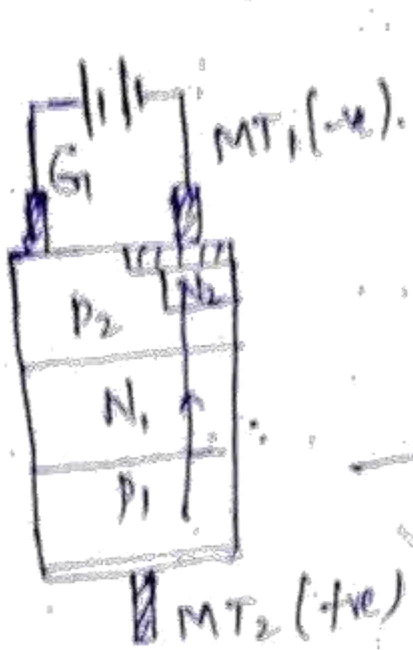
→ MT_2 terminal +ve w.r.t MT_1 &
Gate terminal is positive.

Mode-2:-
MT_2 is +ve and Gate is Negative.

mode-3:- MT_2 is -ve and Gate is +ve.

mode-4:- MT_2 is -ve and Gate is -ve.

(i). Mode :-



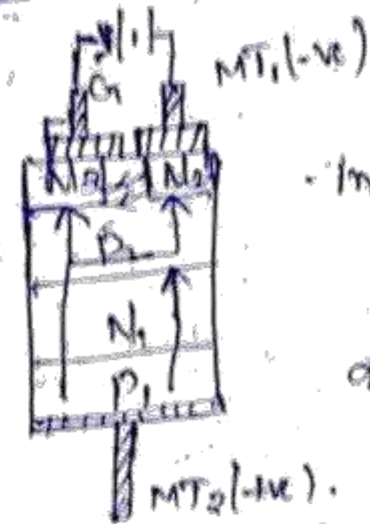
J_1, J_3 are forward bias

J_2 are reverse bias

→ There is no flow of Current.

→ The device is very sensitive to operate.

(ii) Mode - (ii) :-



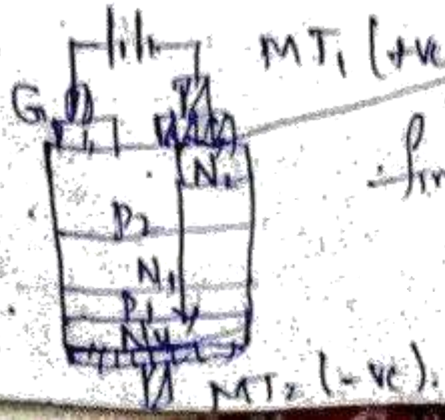
Gate is Applied holes are injected to N3.

· Initial Current path is $P_1 N_1, P_2, N_3$ due to potential difference the Current is diverted to N_3 to ...

final Conduction $P_1 N_1, P_2 N_2$.

→ In this mode the device is Not sensitive.

Mode (iii) :-

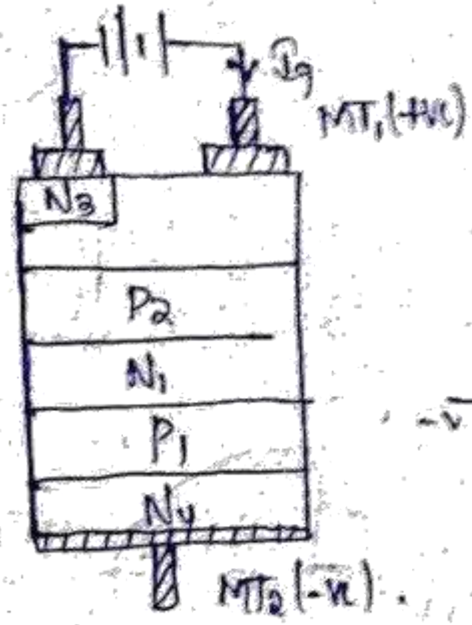


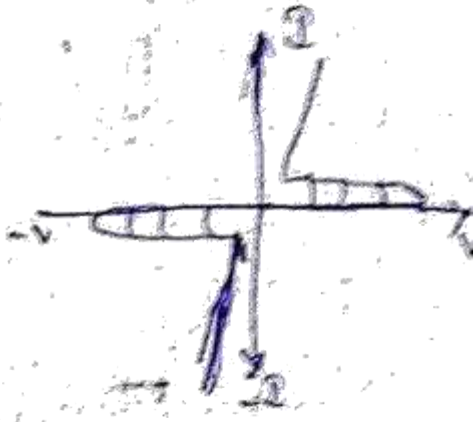
→ holes are injected.

The device is not more sensitive.

· final Conduction path is $P_2 N_1 P_1 N_4$, 24/09/19

Mode IV :-





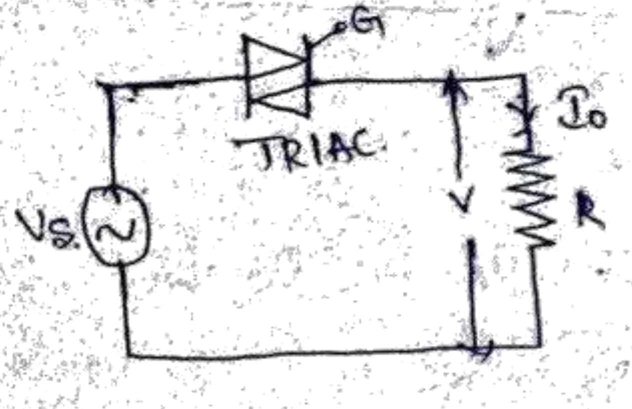
⇒ The device is operated sensitively.

→ TRiac is operated in 1st mode & 4th mode.

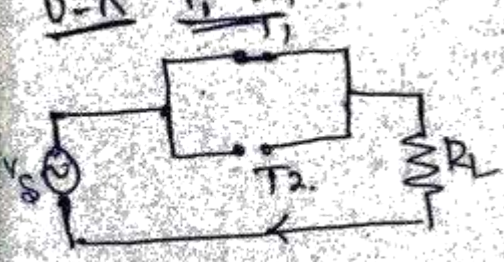
→ Diode is un Controlled devices.

* Control techniques of Triac :-

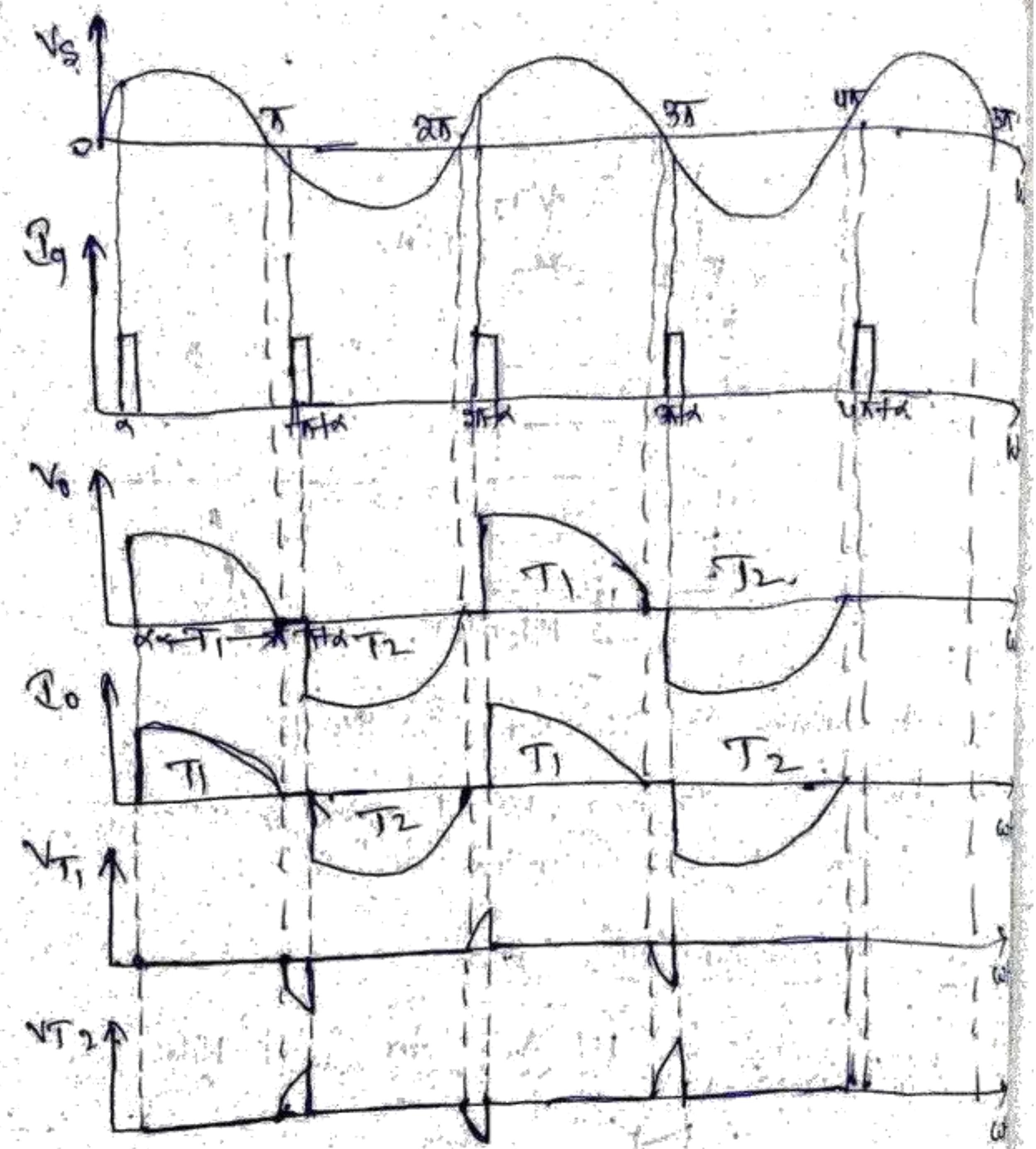
(i) phase Control (or) 1-ϕ A.c voltage Control With R-L :-



0-π T_1 ON



π-2π T_2 - ON.



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The average value of the sine wave form is always zero

The rms value of o/p voltage is.

$$V_{orms} = \left[\frac{1}{\pi}\int_{\alpha}^{\pi} V_m^2 \sin^2 wt \, dwt\right]^{1/2}$$

$$V_{orms} = \frac{V_m}{\sqrt{2}}\left[\frac{1}{\pi}\left[(\pi-\alpha) + \frac{1}{2}\sin 2\alpha\right]\right]^{1/2}$$

$$I_{orms} = \frac{V_{orms}}{R}$$

The average power delivered to load,

$$P = \frac{V_{orms}^2}{R} = I_{orms}^2 \cdot R.$$

$$= \frac{V_m^2}{2\pi R}\left[(\pi-\alpha)+\tfrac{1}{2}\sin 2\alpha\right].$$

$$= \frac{V_s^2}{\pi R}\left[(\pi-\alpha)+\tfrac{1}{2}\sin 2\alpha\right].$$

Where $\boxed{V_m = \sqrt{2}\cdot V_s}$

maximum power is delivered to load '$\alpha = 0$'.

i.e., $P_{max} = \dfrac{V_s^2}{R}$.

$$\text{power factor} = \frac{\text{Real power}}{\text{Apparent power}} = \frac{V_s I_1 \cos\phi_1}{V_s \cdot I_{rms}}$$

$$= \frac{I_1 \cos\phi_1}{I_{rms}}.$$

$I_1 = \dfrac{I_{1m}}{\sqrt{2}}$ = r.m.s value of fundamental Component of load Current.

$I_{r.m.s} = I_{orms}$ = rms value of load (or) source Current.

Real power delivered to load $= \dfrac{V_{orms}^2}{R}$.

Apparent power delivered to load = $V_s I_{rms}$

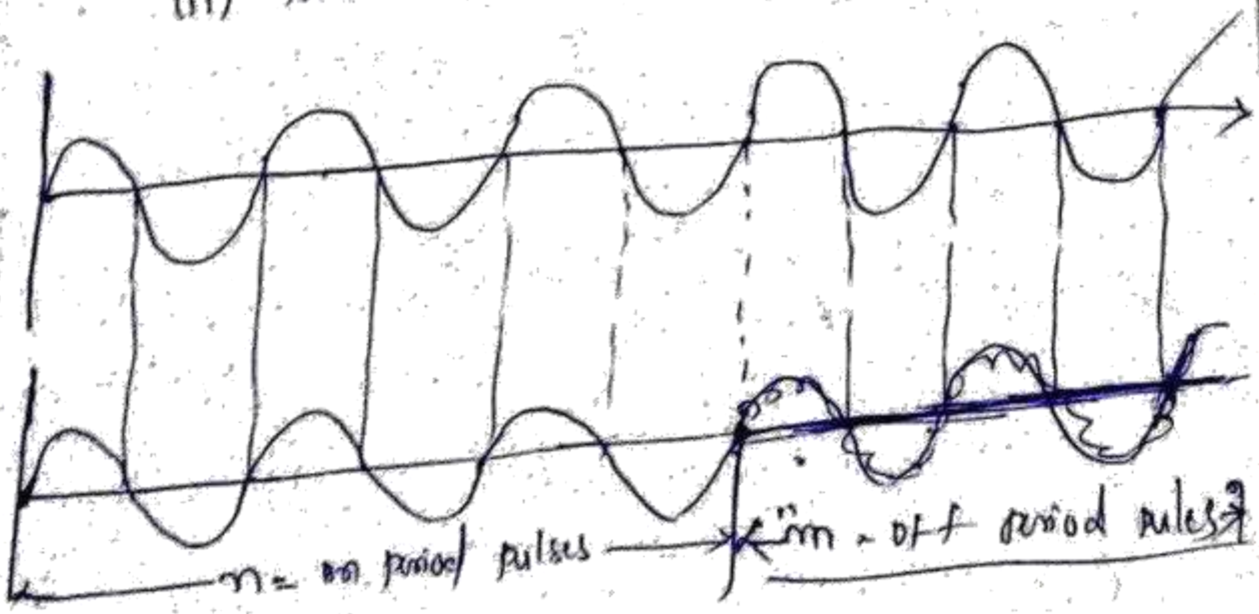
$= V_s \cdot I_{orms} = V_s \cdot \frac{V_{orms}}{R}$

$$p.f = \frac{V_{orms}^2/R}{V_s \cdot V_{orms}/R} = \frac{V_{orms}}{V_s}$$

Integral time Control :-

→ These Applications are used in Machine time Constant

(ii) Thermal time Constant.



Rms value of o/p voltage V_{orms}

$$V_{orms} = \frac{1}{\text{periodicity}} \left(\int_0^{2\pi} V_m^2 \sin^2 \omega t \, d\omega t \text{ for 1st cycle} \right.$$

$$+ \int_0^{2\pi} V_m^2 \sin^2 \omega t \, d\omega t \text{ for 2nd on Cycle}$$

$+ \int_0^{2\pi} V_m^2 \sin^2\omega t \, d\omega t$ for n^{th} on cycle.

$$V_{orms} = \left[\frac{n}{2\pi(n+m)} \int_0^{2\pi} V_m^2 \sin^2\omega t \, d\omega t\right]^{1/2}$$

$$V_{orms} = \left[\frac{n V_m^2}{4\pi(n+m)} \int_0^{2\pi} (1 - \cos 2\omega t) \, d\omega t\right]^{1/2}$$

$$V_{orms} = \frac{V_m}{\sqrt{2}} \sqrt{\frac{n}{n+m}} = V_s \cdot \sqrt{\frac{n}{n+m}}$$

$$= V_s \cdot \sqrt{k}$$

where,

k = duty cycle of AC voltage control.

power delivered to load $P = \frac{V_{orms}^2}{R} = \frac{V_s^2}{R}\left(\frac{n}{n+m}\right)$

$$= \frac{k \cdot V_s^2}{R}$$

RMS value of i/p current I_s = R.M.S value of load current

i/p VA = V_s (rms value of source current)

$$= V_s I_s = V_s \cdot I_{orms} = V_s \cdot \frac{V_{orms}}{R}$$

power delivered to load = i/p V-A × p.f

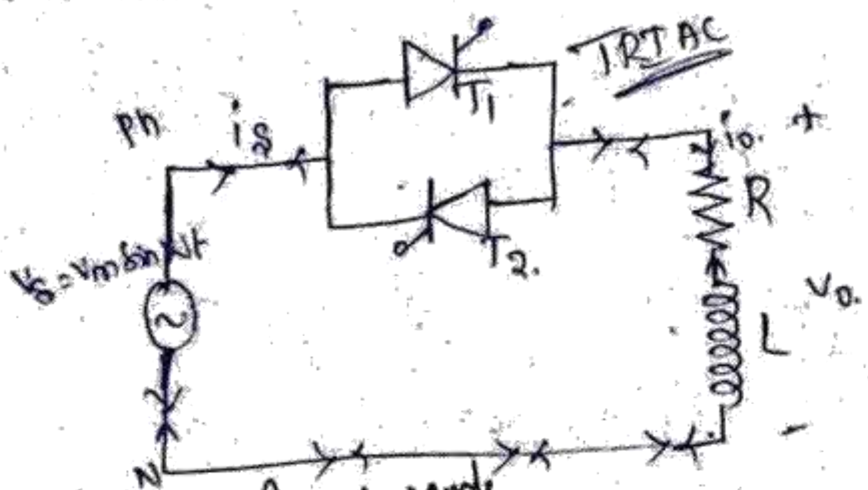
$$\text{i/p p.f} = \frac{V_{orms}^2}{R} \cdot \frac{R}{V_s \cdot V_{orms}}$$

$$= \frac{V_{orms}}{V_s} = \sqrt{\frac{n}{n+m}} = \sqrt{k}$$

Thyristor Current $(I_{Tm}) = \frac{k \cdot I_m}{\pi}$

RMS thyristor Current $(I_{TR}) = \frac{I_m \sqrt{k}}{2}$.

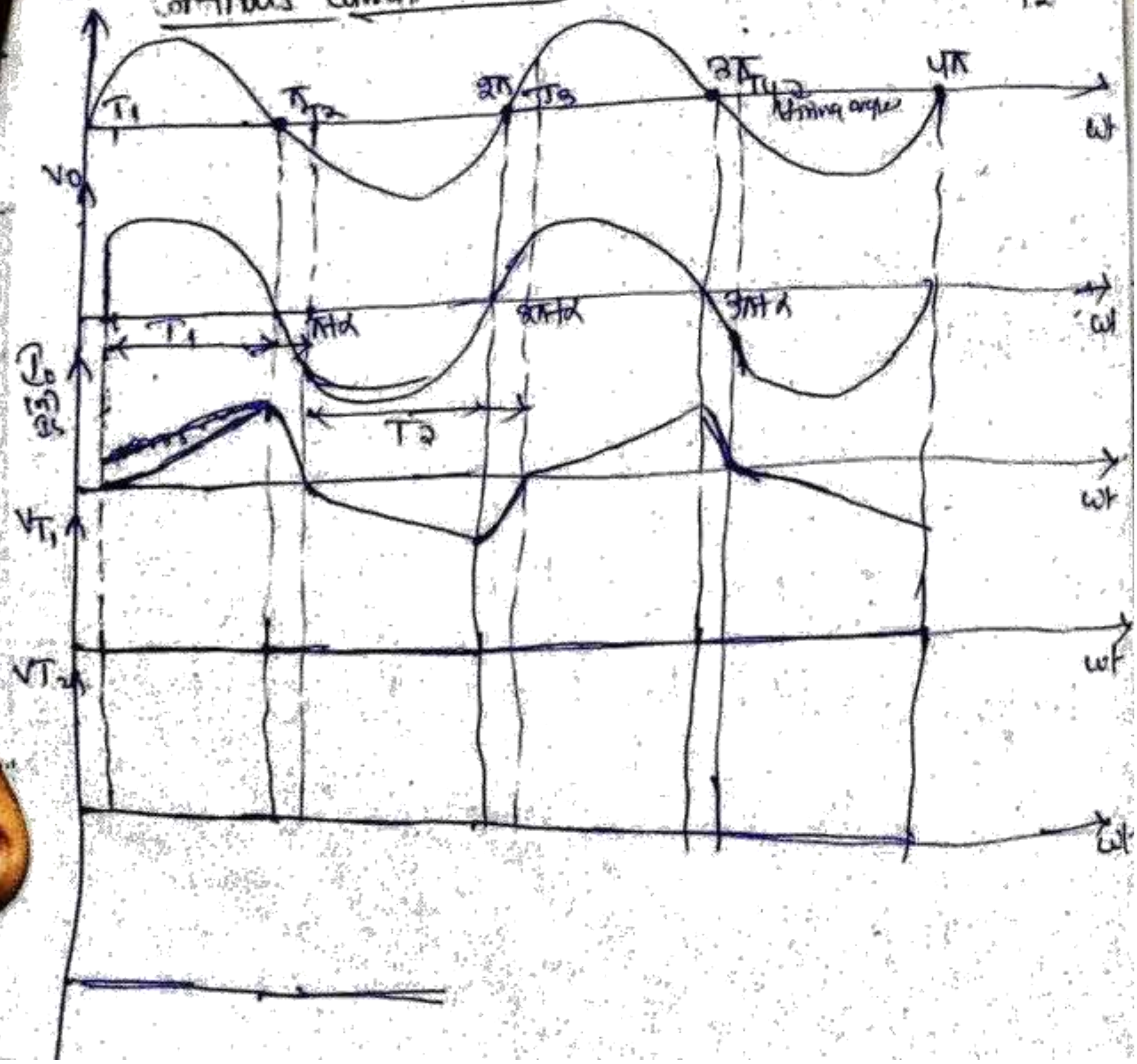
* 1-φ A.C Voltage Controlled With R-L Load:



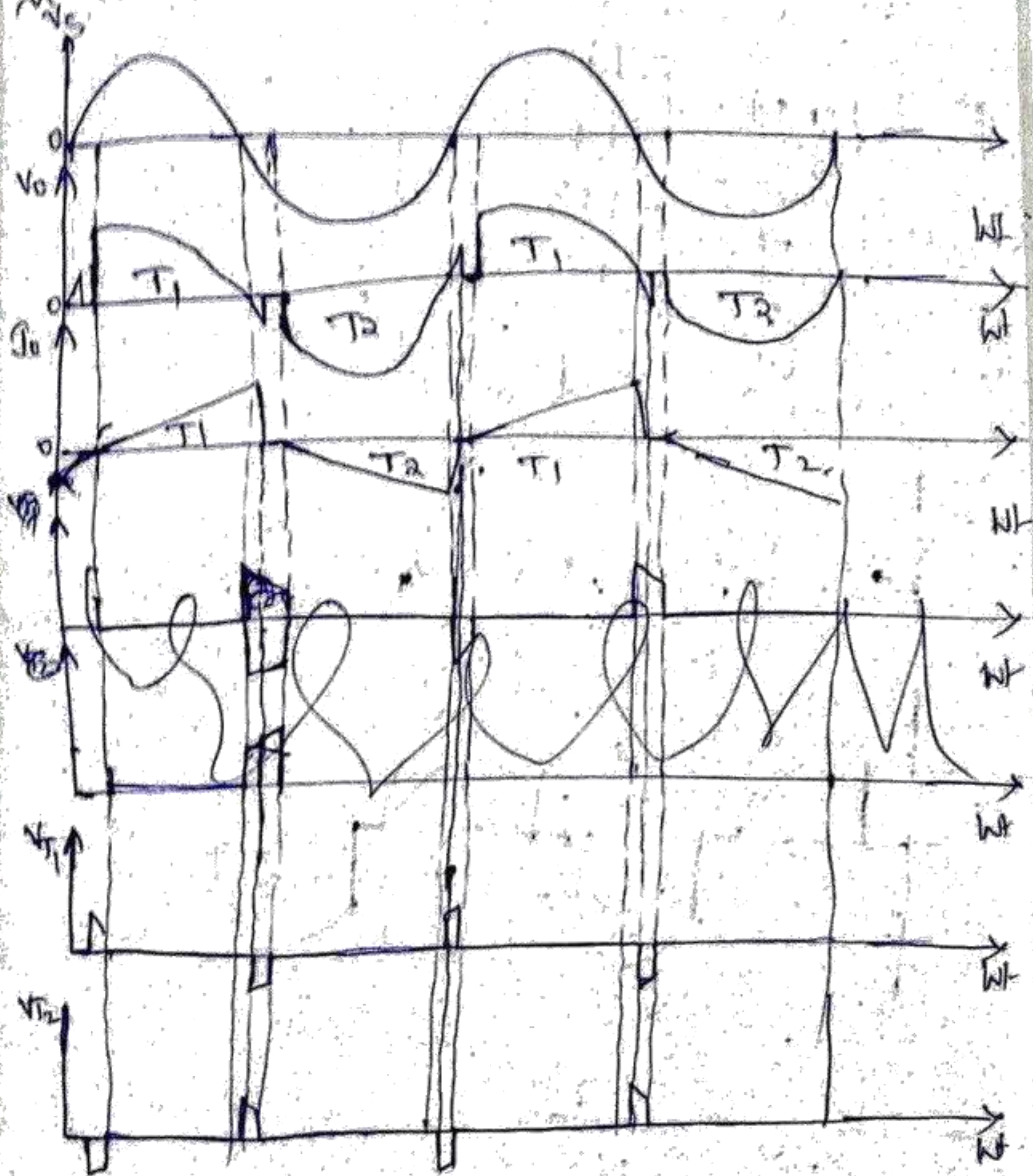
0 - π, 2π - 3π } +ve
T1 → F.B
T2 → R.B

π - 2π, 3π - 4π } -ve
T1 → R.B
T2 → F.B

Continuous Current Mode



Dis Continuous Current mode :-



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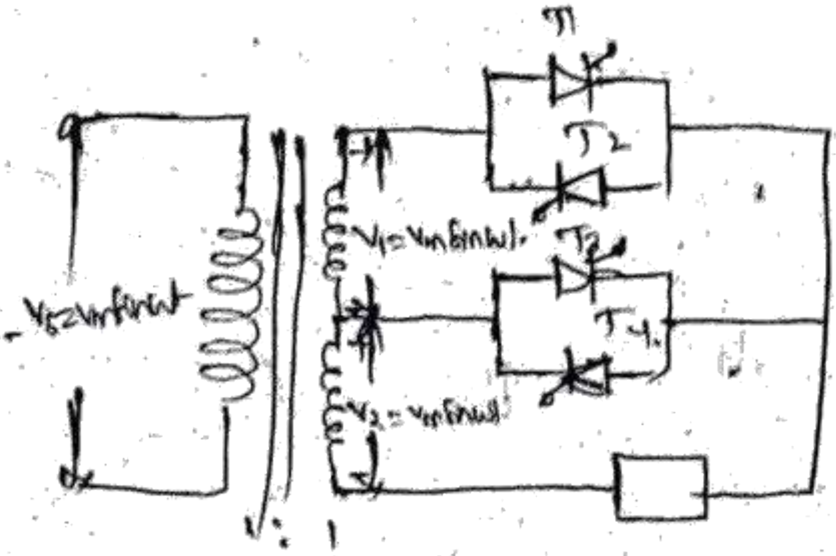
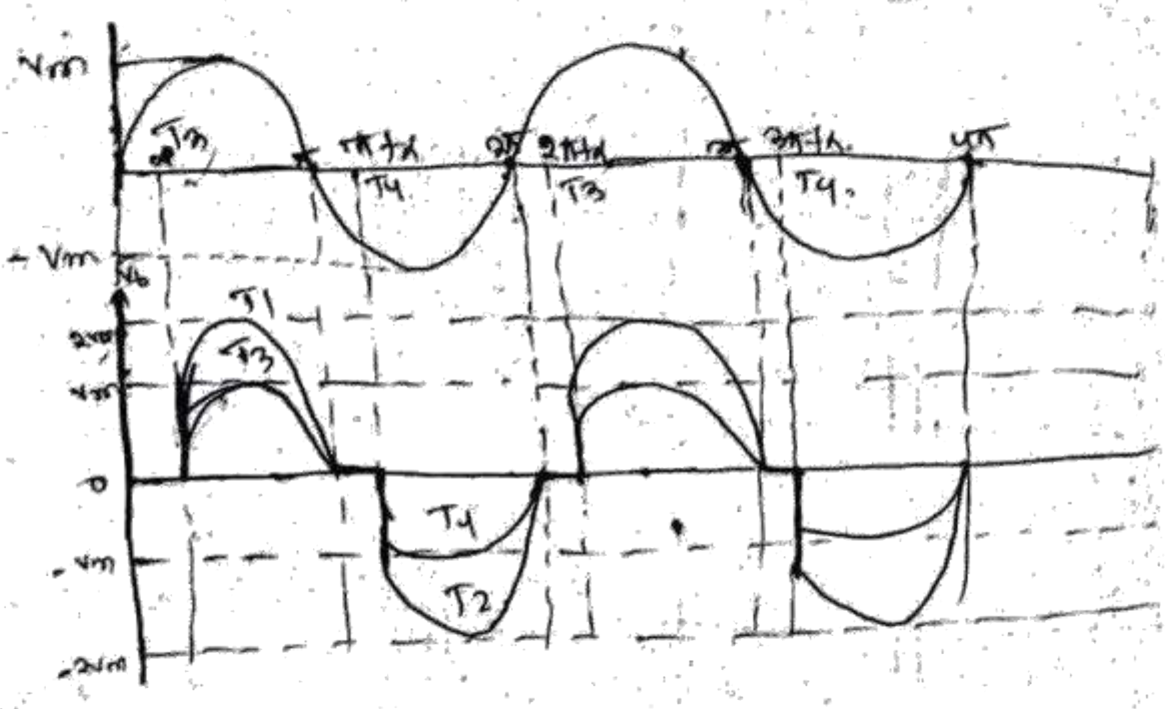
$$V_{orms} = \left[\frac{1}{\pi}\int_{\alpha}^{\pi+\alpha} V_m^2 \sin^2 \omega t \, d\omega t\right]^{1/2}$$

$$V_{orms} = \frac{V_m}{\sqrt{2}} = V_s.$$

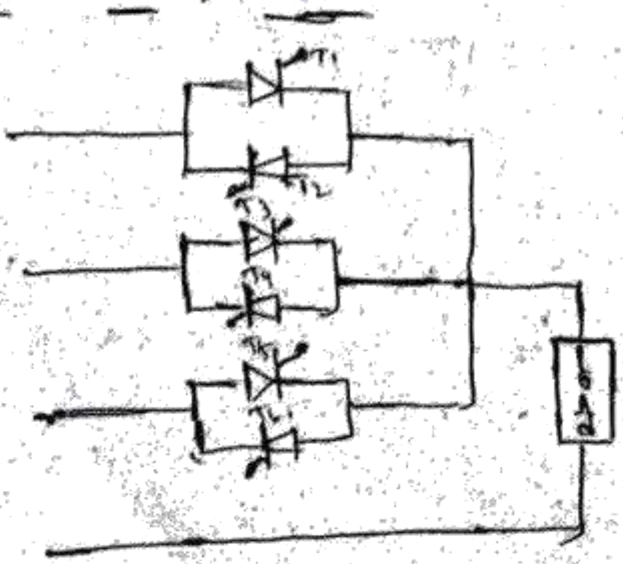
$$I_{orms} = \frac{V_{orms}}{R}$$

Tap Changing Transformer:-

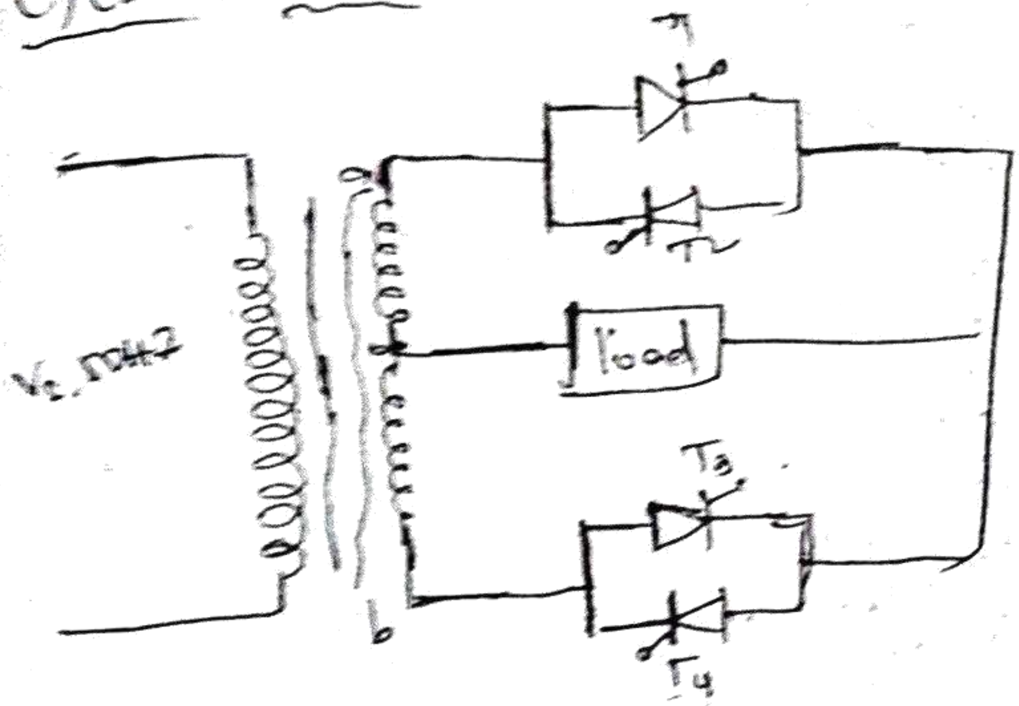




3-φ A.C voltage Control:-



Cyclo Converter:-



⇒ Step down Converter ⇒ line Commutation method.
• Step up Converter ⟶ forced Commutation Ckt.