REVIEW

1. FULL WAVE RECTIFICATION: Using centre tap transformer
   - ➡ one diode conducts at a time
   - ➡ V rating of diode = 2 V(peak)

2 Common Cathode Configuration :- Diode whose Anode potential is maximum will conduct

3 Common Anode Configuration :- Diode whose Cathode potential is least will conduct

4 Uncontrolled bridge ➡ 2 diodes conduct at a time

- ➡ V rating of diode = peak of input voltage

Single Phase Semiconverter

α to $\pi \Rightarrow T_1\ D_2$ Conduct

π to $\pi+\alpha \Rightarrow D_2\ D_3$ Conduct

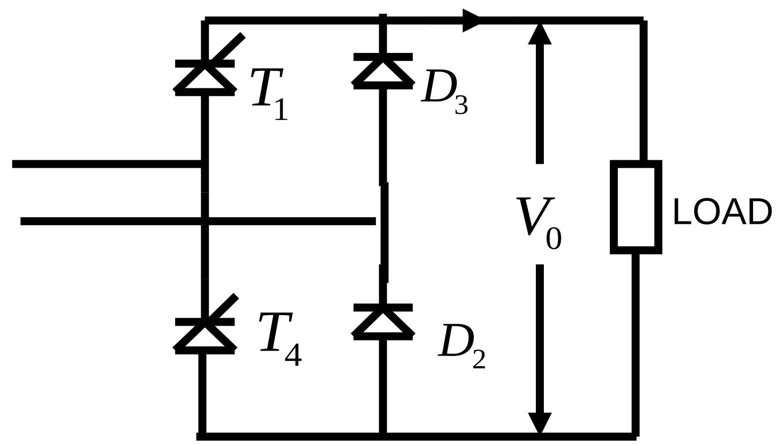
$\pi+\alpha$ to $2\pi \Rightarrow D_3\ T_4$ Conduct

2π to $2\pi+\alpha \Rightarrow D_2\ D_3$ Conduct

γ for $T = \pi - \alpha$

γ for $D = \pi + \alpha$

CASE I



$Case\ II$

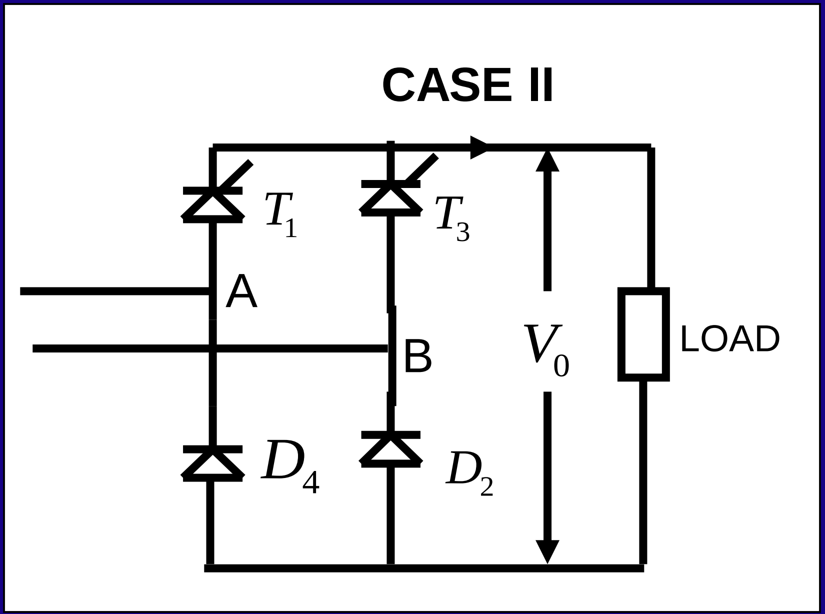
$\alpha\ to\ \pi \Rightarrow T_1\ D_2$ Conduct

$\pi\ to\ \pi+\alpha \Rightarrow T_1\ D_4$ Conduct

$\pi+\alpha\ to\ 2\pi \Rightarrow T_3\ D_4$ Conduct

$2\pi\ to\ 2\pi+\alpha \Rightarrow T_3\ D_2$ Conduct

$\gamma\ for\ T = \pi = \gamma\ for\ D$



$Av\ V_0 = \frac{V_m}{\pi}(1+Cos\alpha)$ is always +ve

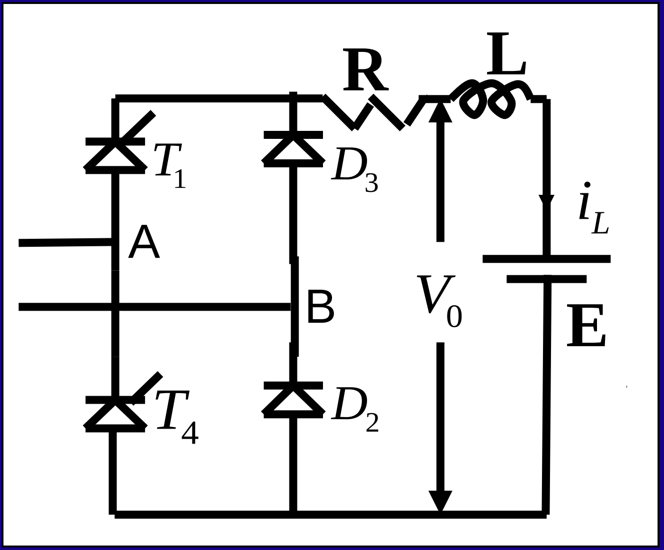
Instantaneous value of o/p V is either +ve or <u>0</u>

Displacement Factor $= Cos\left(-\frac{\alpha}{2}\right)$

I/p Line voltage is used to turn off the thyristor

$\Rightarrow$LINE COMMUTATED CONVERTER

R-L-E Load :

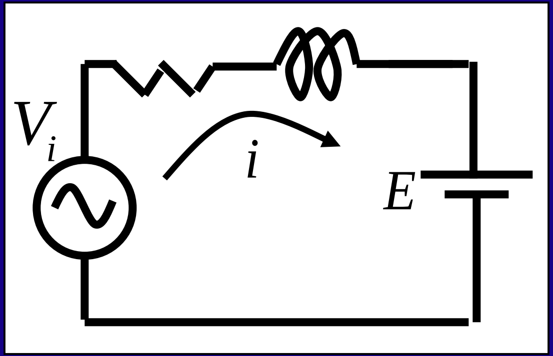


Load current is continuous

$$\alpha_{min} = 0$$

When T_1 & D_2 are conducting

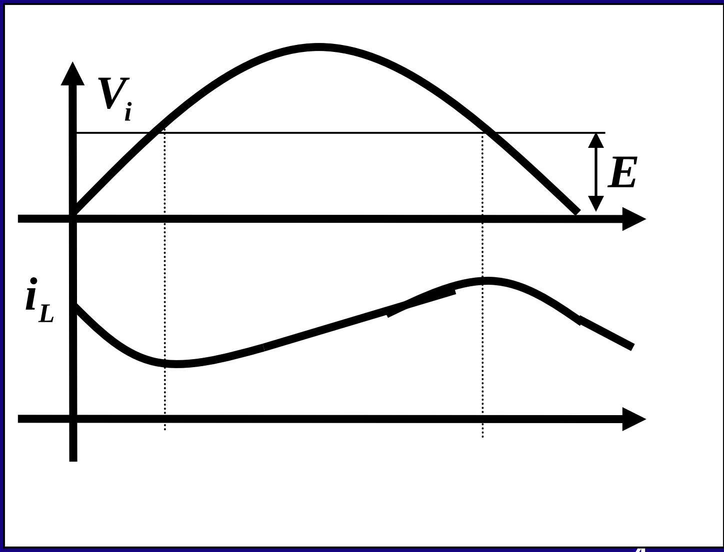
$$V_i = Ri + L\frac{di}{dt} + E$$



$$\frac{di}{dt} = \frac{V_i - E - Ri}{L}$$

$$= \frac{V_i - E}{L} \quad (If \;\; R \to 0)$$

$$\because till\; \omega t = \sin^{-1}\left(\frac{E}{V_i}\right),\; E > V_i$$



$\Rightarrow i$ is flowing through ckt=Due to $L\dfrac{di}{dt}$

$\Rightarrow$ Though T_1 & D_2 are conducting in the +ve half

$\Rightarrow {di}/{dt}$ is -ve

it becomes +ve when $\sin^{-1}\left(\dfrac{E}{V_i}\right) < \omega t < \left(\pi - \sin^{-1}\left(\dfrac{E}{V_i}\right)\right)$

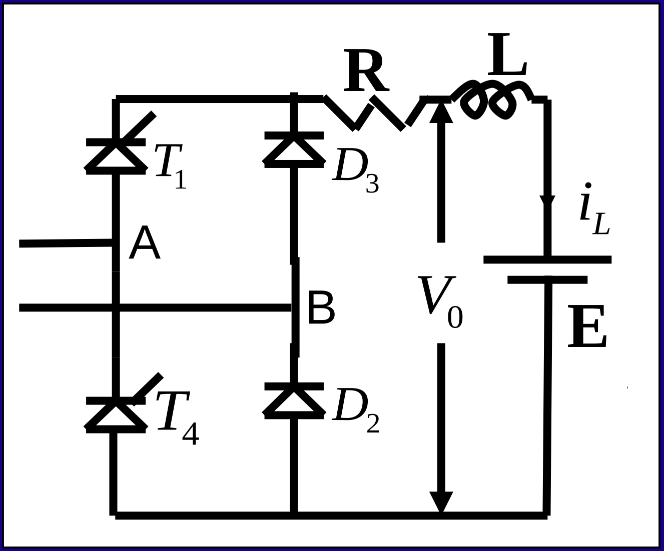
$if \ \ R \to 0$

Load I *is discontinuous* $(R-L-E)$

$\rightarrow$ Assume that load I becomes zero after π

$\rightarrow$ Also assume that SCR's are triggered at

$$\alpha > Sin^{-1}\left[\frac{E}{V_m}\right]$$



Recall : If I is continious $\alpha = 0$

(independent of type of Load)

If it is discontinious $\alpha_{\min} = Sin^{-1}\left[\frac{E}{V_m}\right]$

$\rightarrow$ Depends very much on load

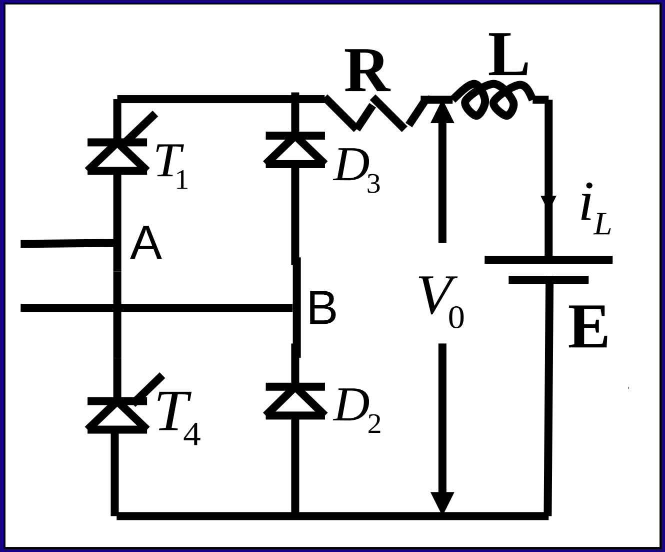
$\rightarrow$ SCR gets F.B at $\omega t = Sin^{-1}\left[\frac{E}{V_m}\right]$.

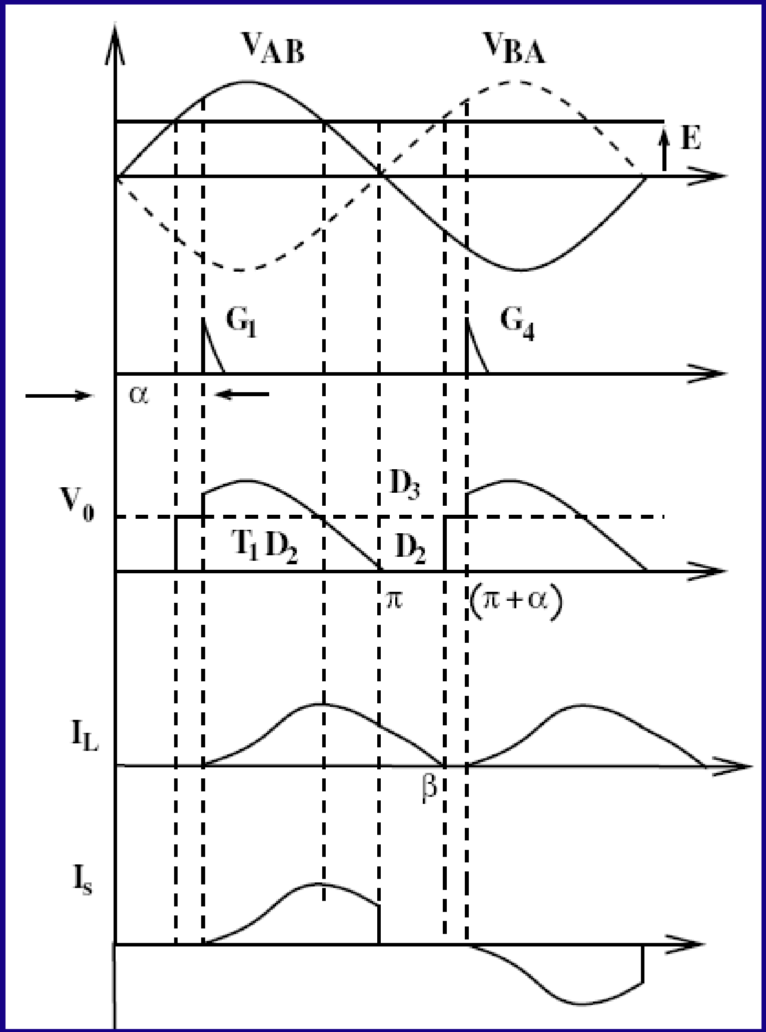
$\because$ It is triggered at $\alpha > Sin^{-1}\left[\dfrac{E}{V_m}\right]$???????

$\rightarrow T_1$ and D_2 start conducting

$\rightarrow V_0 = V_{in} = V_m Sin\,\omega t$ till $\omega t = \pi$

at $\omega t = \pi^+$, $D_3\ D_2$ start conducting $V_0 = 0$





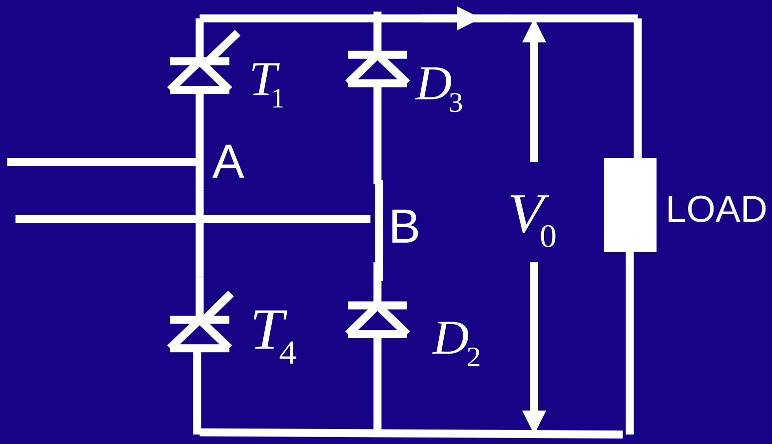
Till $i = 0$ at β

$\rightarrow \beta$ to $\pi + \alpha \rightarrow i_L = 0$

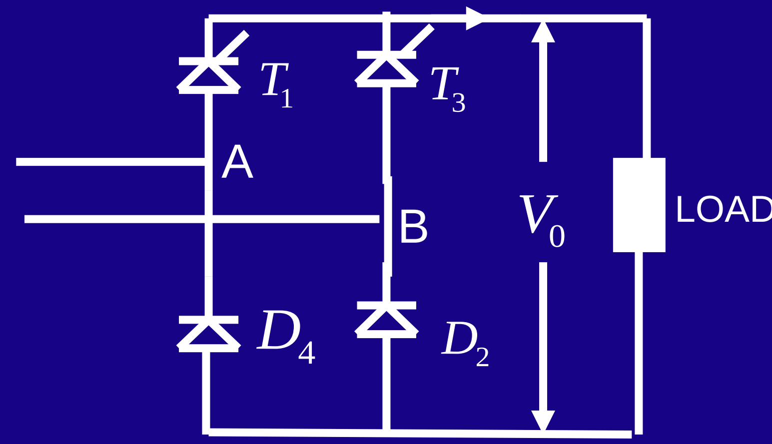
$V_0 = E$ (If load is $R - L, V_0 = 0$)

at $\pi + \alpha, T_4$ is triggered $\left(\text{is F.B. at } \pi + Sin^{-1}\dfrac{E}{V_{in}}\right)$

CASE I



CASE II



- DEVICE SHOULD TURN OFF BEFORE IT IS FORWARD BAISED

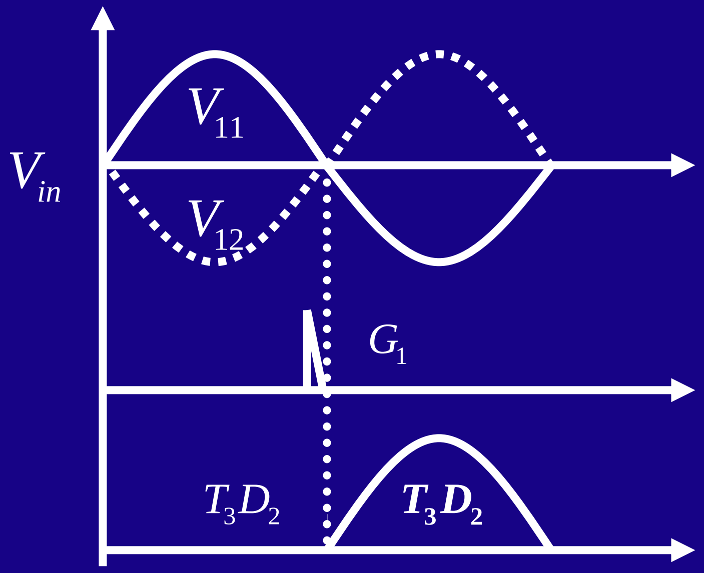
- OTHERWISE IT WILL NOT TURN OFF
  - COMMUTATION FAILURE

IN CASE I

AT $\omega T = \pi^+$, T_1 IS TURNED OFF

BECAUSE DIODE STARTS CONDUCTING

- CASE II
- T_1 CONTINUES TO CONDUCT TILL T_3 IS TRIGGERED
  T_3 CAN BE TURNED OFF ONLY BY TURNING ON T_1
- IF $\underline{\alpha \to \pi}$
- At $\omega t = \pi^+ \to T_3$ GETS FORWARD BAISED
- T_3 SHOULD ATTAIN ITS F.B.
  CAPABILITY BEFORE $\omega t = \pi^+$
- REQUIRES FINITE TIME
- IF AVAILABLE TIME < THE ABOVE TIME
  T_3 CONTINUOUS TO CONDUCT
- ½ WAVE EFFECT



1 If L *is* large, find the value of α if the av. value of i=100A

$\Rightarrow$ L is large

$\Rightarrow$ i is continious

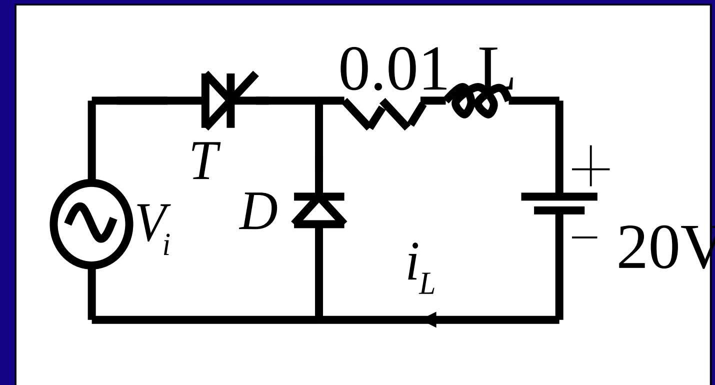
$\Rightarrow \alpha_{\min}$ *can be* $\underline{0}$

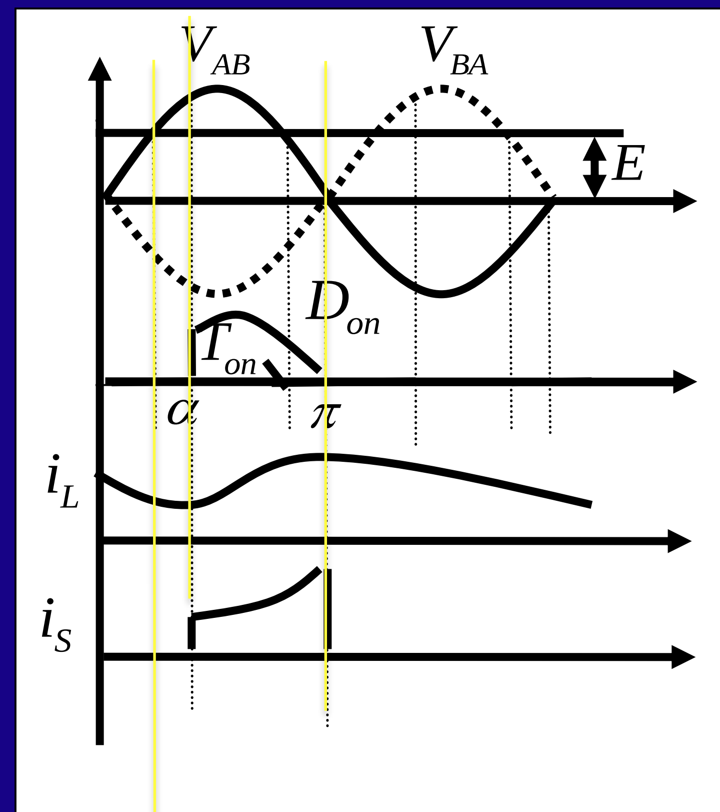
(independent of type of load)

When SCR is ON $V_0 = V_i$

Let α be the triggering angle

$\therefore$SCR conducts for α *to* π





$$At\,\omega t = \pi^{+}$$

Freewheeling diode turns on

when SCR is off D is ON

$$V_0 = 0$$

$$\text{Av. value of } I = \frac{\text{Av. voltage across } R}{0.01}$$

$$\therefore V_{av} \text{ across } R = 1V$$

(No instantaneous -ve voltage across load)

$$V_{av} \text{ across } L = 0$$

$$\therefore V_{av} = i_{av} R + E$$

$$\therefore V_{av} = 21$$

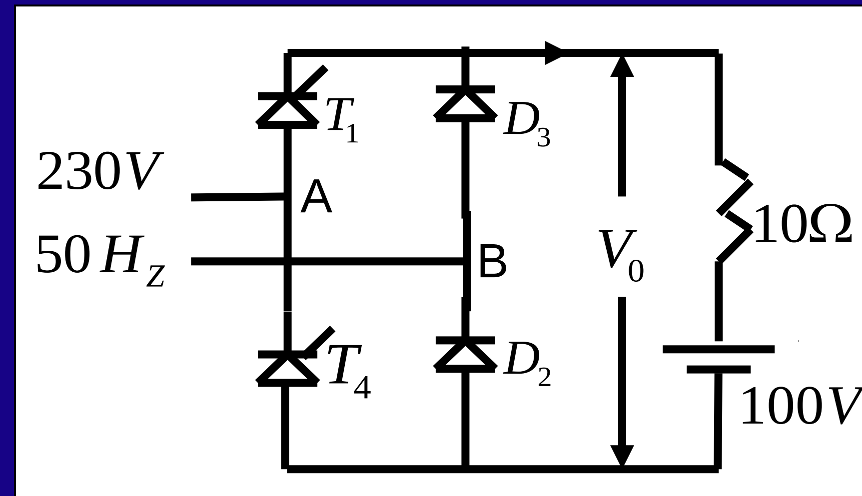
$$\therefore V_{av} = \frac{1}{2\pi}\int_{\alpha}^{\pi} V_m \, Sin\omega t \, d\omega t$$

$$21 = \frac{230\sqrt{2}}{2\pi}\left[1 + Cos\alpha\right]$$

$$\therefore \alpha = 53^{0}$$

2. For the circuit shown in fig. determine average value of load current for $\alpha = 60^0$

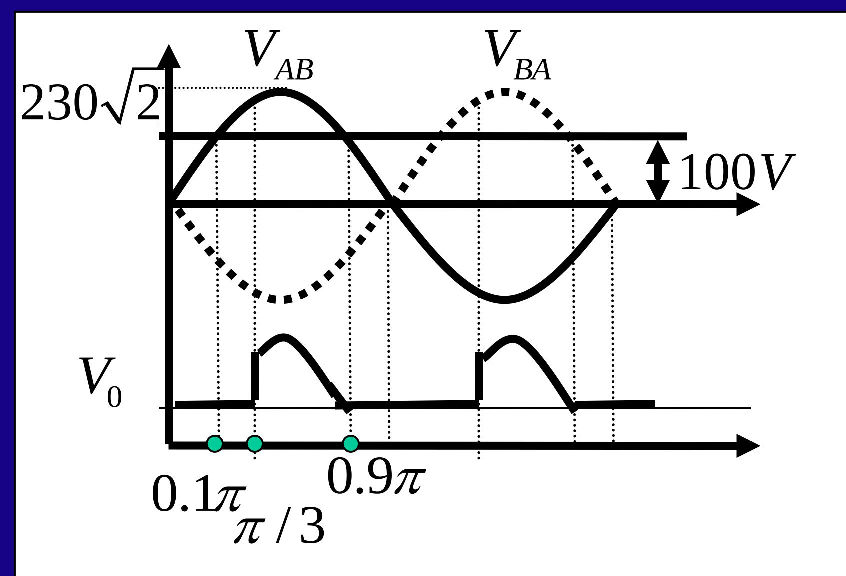
What is the new value of average current flowing through load if a large 'L' is connected in series with the load



Neglect the device drop

a) R-E Load:

$$\alpha_{\min} = \sin^{-1}\left(\frac{100}{230 * \sqrt{2}}\right) = 18^0 = 0.1\pi^c$$



Minimum value of α can be 18^0

But it is triggered at 60^0

It will turn off $= \pi - \alpha_{\min} = 162^0$

$$\Rightarrow 0 \; to \; 60^0 \; :- \qquad V_0 = E$$

$$60^0 \; to \; 162^0 \; :- \quad V_0 = V_m \, Sin\,\omega t$$

$$162^0 \; to \; 360 \; :- \quad V_0 = E$$

$\therefore$ Av. line voltage

$$= \frac{1}{\pi}\left[\int_0^{\pi/3} E d\omega t + \int_{\pi/3}^{0.9\pi} V_m Sin\,\omega t \, d\omega t + \int_{0.9\pi}^{\pi} E \, d\omega t\right]$$

$$= 193.45 \; V$$

$\therefore$ Av. value of load current $I_{av} = \dfrac{193.45 - 100}{10} = 9.345 A$

b **With large inductance in series with the load current becomes continious.**

$$\alpha = 60^0$$

$$\text{Av. value of o/p } Voltage = \frac{230\sqrt{2}}{\pi}(1 + Cos\alpha)$$

$$= 155\ V$$

$$Av.value\ of\ I = \frac{155 - 100}{10} = 5.5A$$

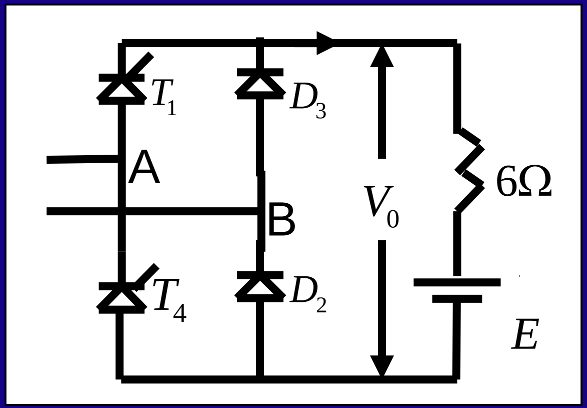
3.Av. value of $I_L = 1.8A$

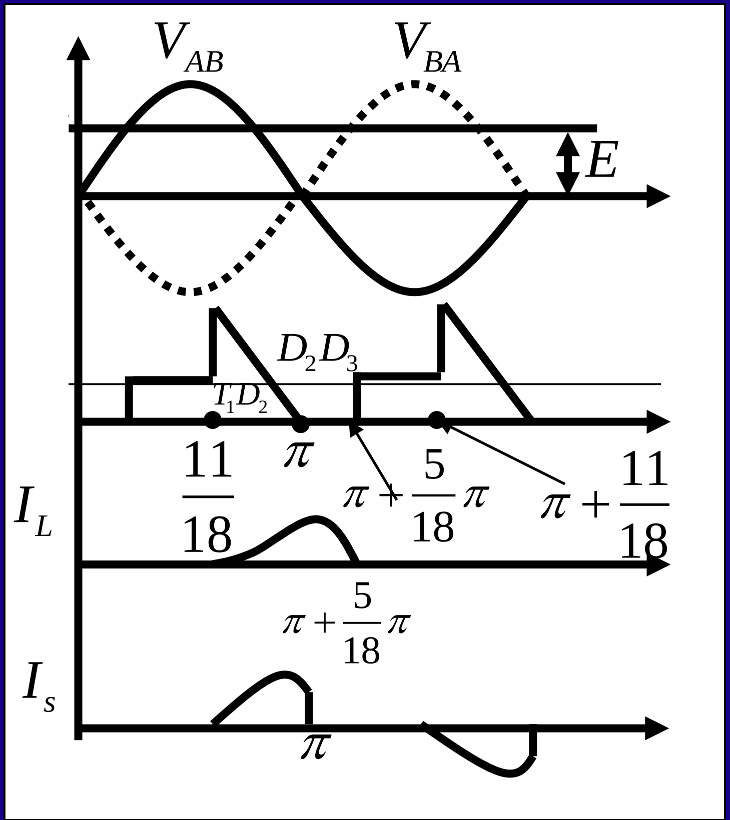
Triggering angle is maintained at 110^0

current seems zero at 50^0 beyond the zero crossing.

Sketch the load current and applied average voltage waveform.

$$\alpha_{\min} = Sin^{-1}\left[\frac{E}{V_m}\right]$$





From $\frac{11}{18}$ to π radian T_1 & D_2 conduct

$$V_0 = V_i$$

From π to $\left(\pi + \frac{5}{18}\pi\right)$

$V_0 = 0 \because D_2 \,\&\, D_3$ conducting

$$V_{av} = \frac{1}{\pi}\left[\int_{\frac{11\pi}{18}}^{\pi} V_m Sin\omega t\, d\omega t + \int_{\pi}^{\pi+\frac{5\pi}{18}} 0\, d\omega t + \int_{\pi+\frac{5\pi}{18}}^{\pi+\frac{11\pi}{18}} E\, d\omega t\right]$$

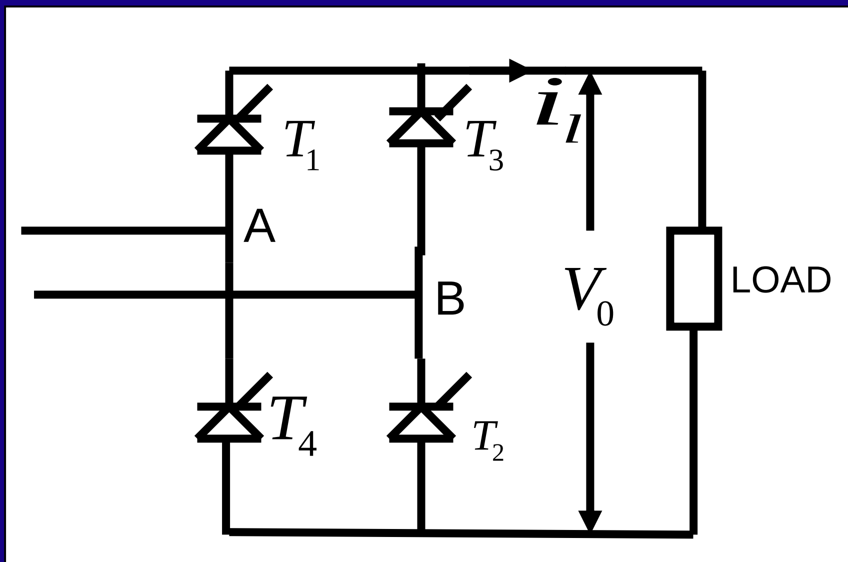
$$= \frac{1}{\pi}\left[230\sqrt{2}\left(Cos\frac{11\pi}{18}+1\right)+\frac{\pi}{3}E\right]$$

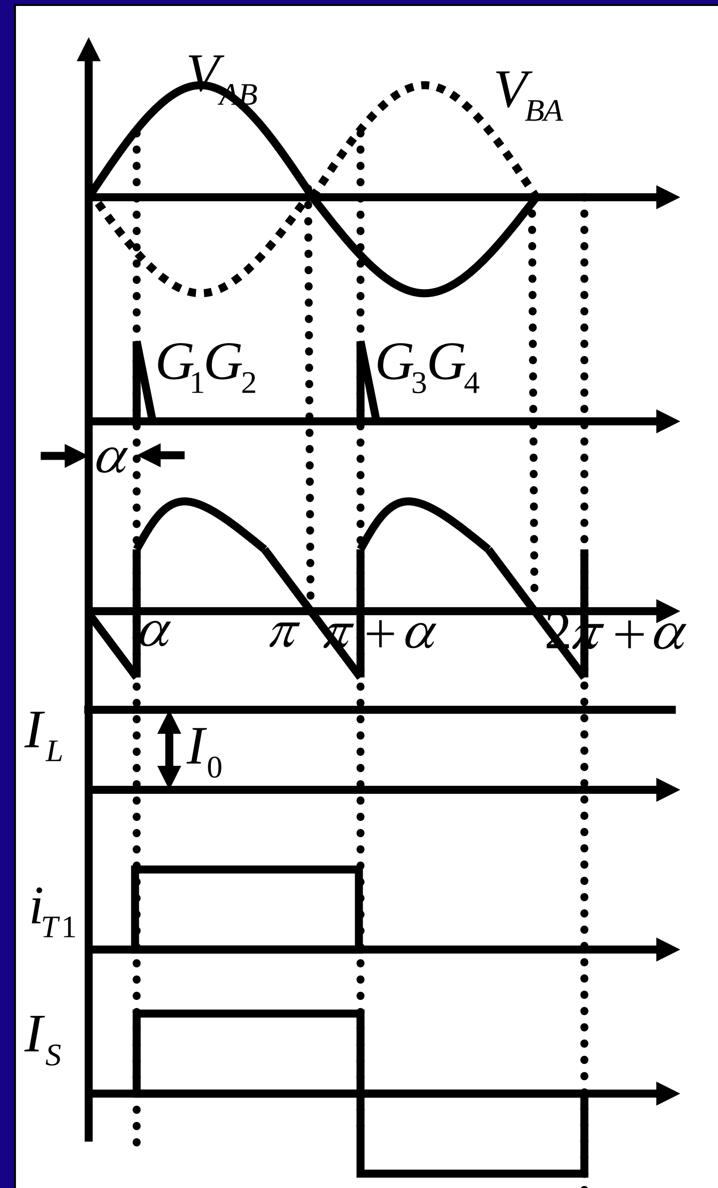
$$\therefore V_{av} = 68.12 + \frac{E}{3}$$

$$\therefore I_{av} = \frac{V_{av} - E}{R}\ , \ I_{av} = 1.8A, R = 6\Omega$$

$$\therefore\ E = 85.9V$$

FULL CONTROLLED BRIDGE (Two Quadrant Conf.)





- LOAD CURRENT IS CONSTANT & RIPPLE FREE
- IN THE +VE HALF T_1T_2 ARE F.B. & -VE HALF T_3T_4 ARE F.B.

T_1T_2 CONTINUE TO CONDUCT TILL T_3T_4 ARE TRIGGERED
($\because I_0$ IS CONTINUOUS)

α to $(\pi+\alpha)$

$V_0 = V_i = V_m \sin \omega t$

$i_s = I_L$

at $\omega t = \pi + \alpha$ T_3 & T_4 ARE TRIGGERED

POT. OF $A <$ POT. OF C

WHEN T_3 STARTS CONDUCTING

$V_K = POT.C$

$\Rightarrow$ -VE 'V' APPEARS ACROSS T_1

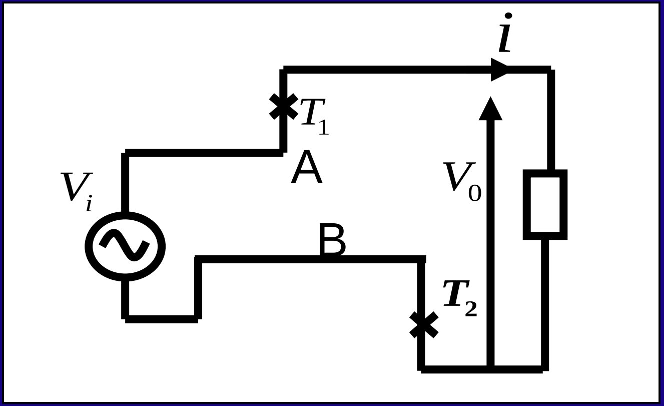
$\Rightarrow$ TURNS OFF

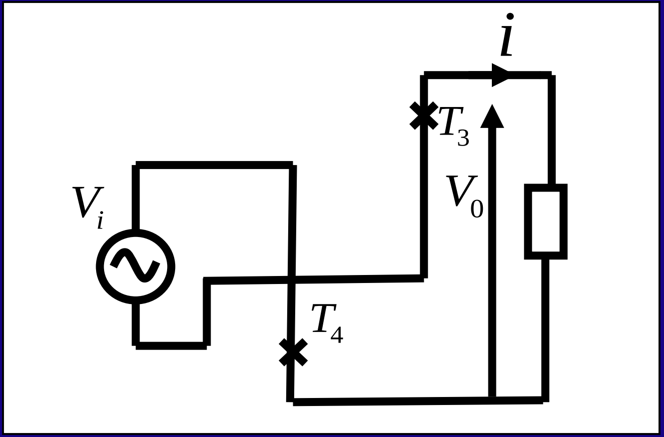
$\Rightarrow$ SIMILARLY T_2 TURNS OFF IN THE LOWER ARM

$i_s = i_L$

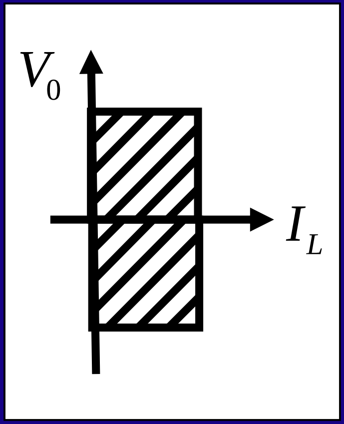
γ for each device is π rads

There are 2 pulses per cycle $\rightarrow$ Two pulse converter





$$V_0 = \frac{2}{2\pi}\int_{\alpha}^{\pi+\alpha} V_m \sin\omega t \, d\omega t = \frac{2V_m}{\pi}\cos\alpha$$



$\Rightarrow V_0$ +ve For $0 < \alpha < \pi/2$

-ve For $\pi/2 < \alpha < \pi$

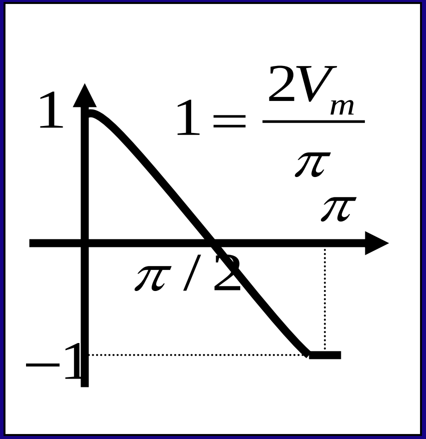
$\Rightarrow I_L$ is unidirectional

$\Rightarrow 2$ quardrant converter

$\Rightarrow 0 < \alpha < \pi/2$: 1^{st} quardrant operation

Input Power $=$ +ve $\rightarrow$ Converter

$\Rightarrow \pi/2 < \alpha < \pi$: 4^{th} quardrant operation



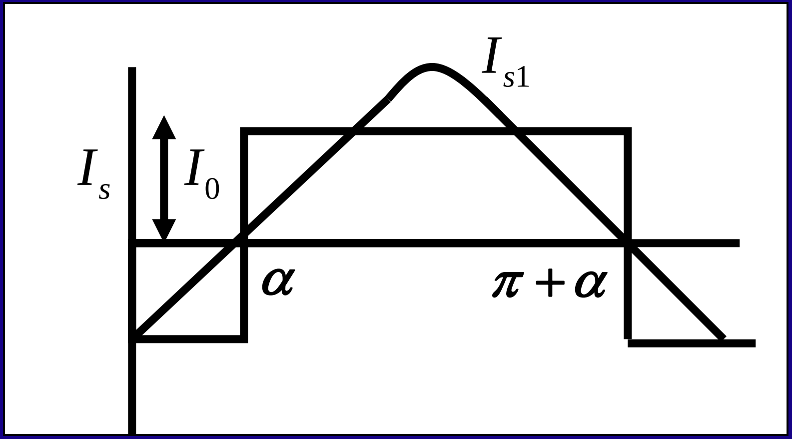
Input Power=-ve $\rightarrow$ Inversion

$$\theta_1 = \alpha$$

$Cos\theta_1 = Cos(-\alpha)$ (lagging)

$$I_{rms}\ of\ I_{s1} = \frac{2\sqrt{2}}{\pi} I_0$$

4/1.44pi.



$$RMS\ value\ of\ I_s = I_0$$

$$P.F. = \frac{2\sqrt{2}}{\pi} Cos\alpha = \frac{V_{s1} I_{s1} Cos\alpha}{V_{rms} I_{rms}} = \frac{2\sqrt{2}}{\pi} Cos\alpha$$

$\rightarrow lagging$