PDC

Unlike conveters which operate at 50 or 60 Hz,

- follow the 0^0, 0^r, $2\pi^r$ system inveters are HF systems. usually operating from few 10 to few 100 of KHz, and followed zero to $T/2$ to T system and all waveforms are drawn w.r.to (t)

- unlike conveters where it is w.r.to (ωt)

$$\boxed{T = 1/f}$$

Here we speak about half cycles which correspon to 0 to $T/2$, $T/2$ to T.

Power devices such as P mosfet, Pr BJT, IGBT are prefered over SCR. because natural commutation not possible in inverters because input is constant. and if used additional commutation ~~are~~ circuits required. which implement forced commutation.

Classification Of Inverters

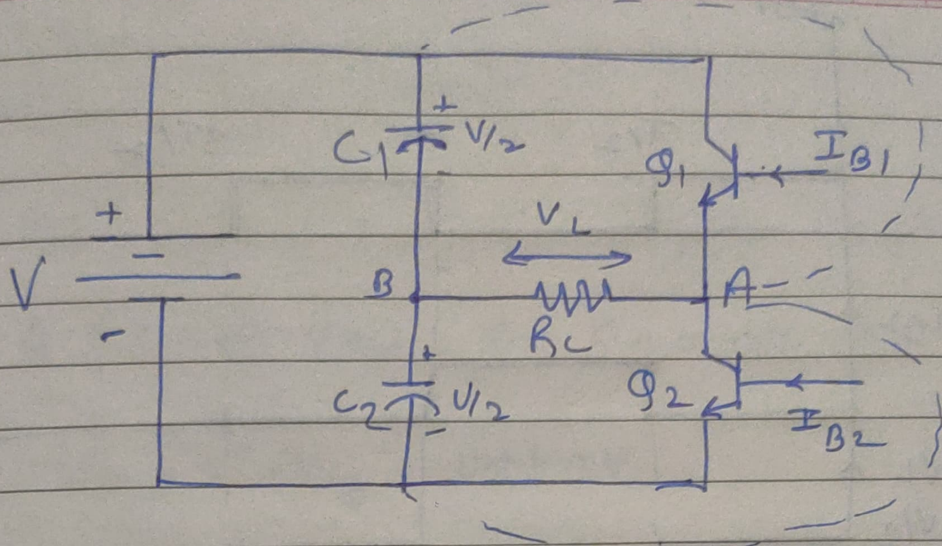
Inveter

- Nature of input
  - VSI (voltage source inverter)
  - input is AC voltage
  - CSI (DC current at input)
- No. of phase in output
  - 1ϕ (single phase)
  - 3ϕ (3 phase)
- Nature of output
  - Square
  - Cosisquare / qsw
  - pwm
  - sine wave
- power device used
  - Thiristerised
  - Transitarised
- Topology
  - Bridge - inverter
  - ~~push-pull inveter~~

Half ~~phase~~ Bridge inverter :-

The output of most ~~pha~~ basic inverter is square wave

To achive the default output of inverter i.e sq. wave with DC voltage as input we need to connect the load to the input within $V_{in} = \cancel{6}V_{in}$ two oppo. direct durin 2 half cycle i.e. 0 to $T/2$ & $T/2$ to T



The input V is voltage shared betn capacitor C_1, C_2 where $\boxed{C_1 = C_2 = C}$ as $V/2$ & $V/2$

$\boxed{V_L = \cancel{V_{ab}}\ V_{AB}}$ on application of I_{B1}

from t to t/2 (case 1)

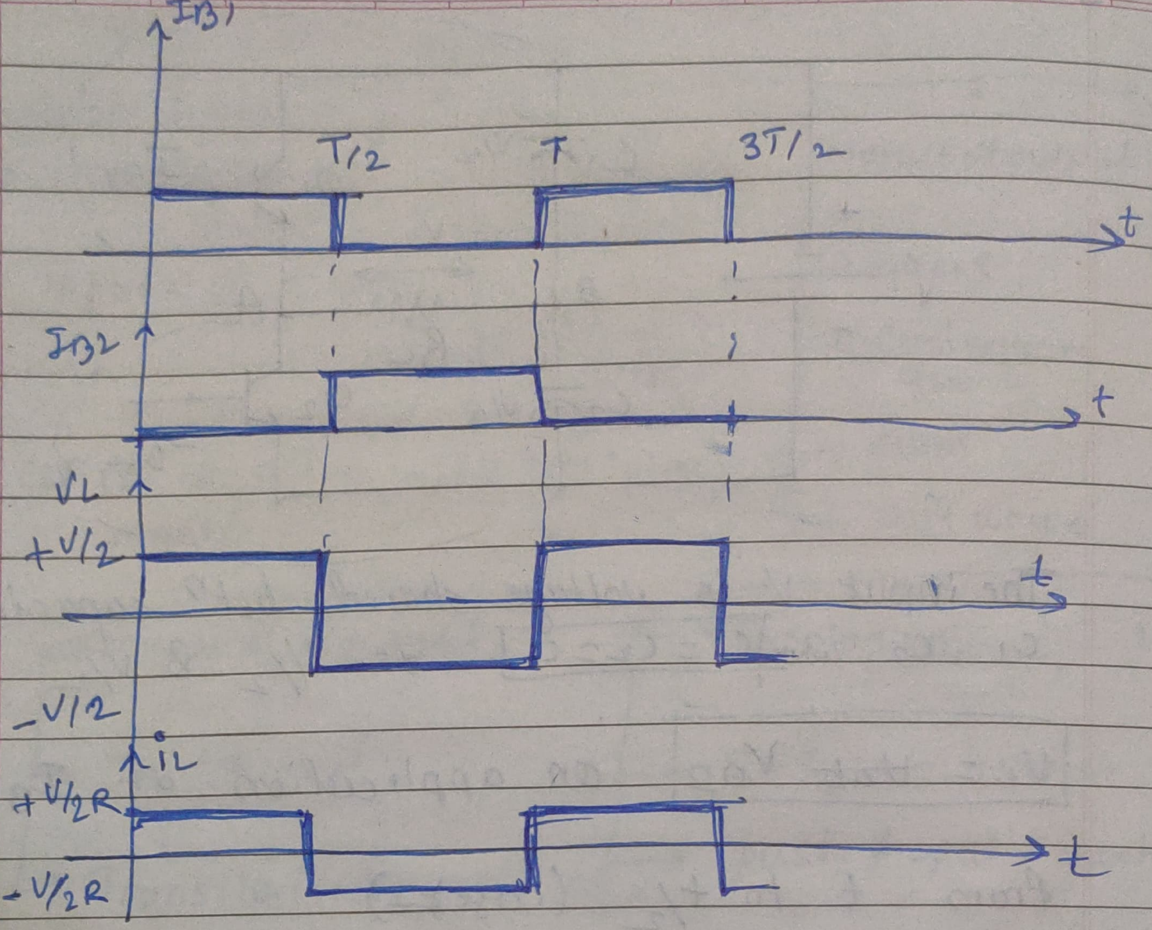
Q_1 = ON (short circuit) Q_2 = OFF (open circuit)

$\therefore V_{AB} = +V/2$ volt.

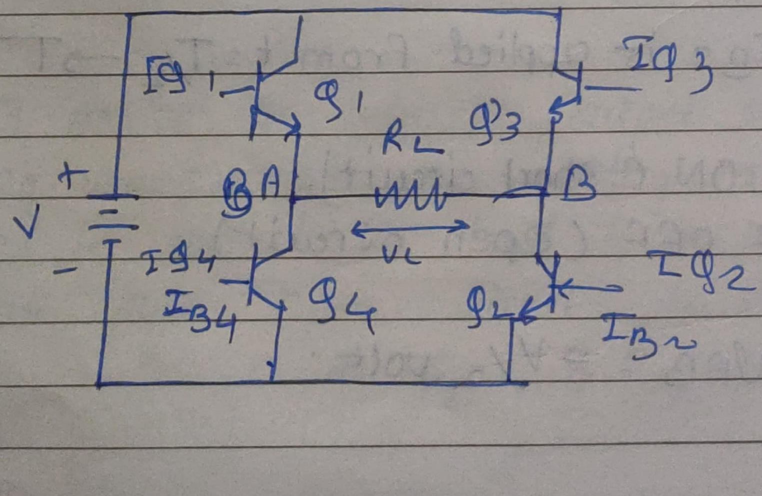
Case 2:
I_{B2} is applied from $t = T/2 \to T$.

Q_2 = ON (short circuit)
Q_1 = OFF (open circuit)

$V_{AB} = -V/2$ volt.



Full Bridge inverter



$V_L = V_{AB}$

Case 1) : $t=0 \longrightarrow T/2$

I_{B1}, I_{B2} is applied , $I_{B3}=0$, $I_{B4}=0$

$Q_1 Q_2 = ON$ (SC) , $Q_3, Q_4 = OFF$ (O.C)

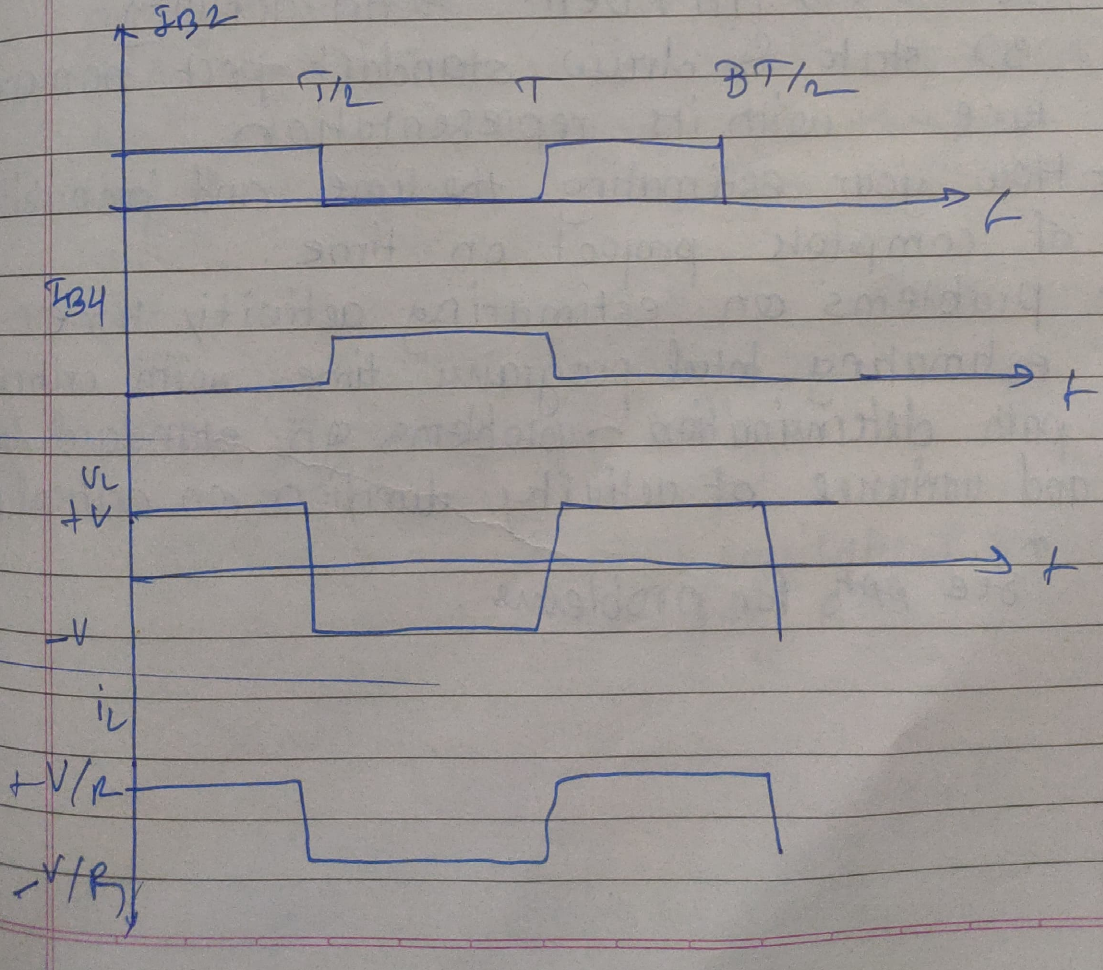
$V_{AB} = +V/2$ volt $= V_L$

Case 2)

I_{B3}, I_{B4} is applied $I_{B1}, I_{B2} = 0$

$Q_3 Q_4 = ON$ (SC) $Q_1, Q_2 = OFF$ (OC)

$V_{AB} = -V$ volt $= V_L$



Derive expression for

$$V_{L(rms)} = \left[\frac{1}{T}\int_0^T (V_L(t))^2 dt\right]^{1/2}$$

=

PM

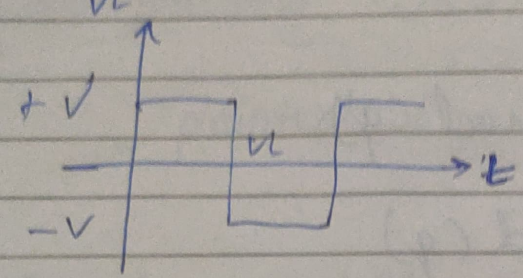
Problems on CPM & PERTS :-

- Diff. bet^n cpm & PERTS
- what are advantages of network ~~sharing~~ scheduling technique
- what are most common technique used for scheduling
- what are various network scheduling tech
- State what are management information that can be obtained from network fundamentals
- Define 1) An Event 2) An activity
  3) state & draw standart pert nomenclature with its representation
- How your estimating the time and probability of complete project on time.
- problems on estimating activity time. estimating total program time with critical path determination - problems on standard deviation and variance of activity durition on critical path

↑ see ppt for problems.

Fourier analysis of VL ~~The~~

The waveform for VL has a square wave nature as shown above. The Fourier series ~~eq~~ expansion of VL is represented as



$$V_L(t) = V_L(0) + \sum_{n=1}^{\infty} C_n \sin(\omega t + \phi_n)$$

$$V_L(0) = \frac{1}{T}\int_0^T V_L(t)\,dt.$$

$$= \frac{1}{T}\left[\int_0^{T/2} V_L(t)\,dt + \int_{T/2}^{T} V_L(t)\,dt\right]$$

$$= \frac{1}{T}\left[\int_0^{T/2} +V\,dt + \int_{T/2}^{T} (-V)\,dt\right]$$

$= 0$

$a_n = 0$ for $n = 1, 2, 3, 4.$

$b_n = 0$ for $n = 2, 4, 6, 8.$

$= \frac{4V}{n\pi}$ for $n = 1, 3, 5, 7 \cdots$

$$C_n = \sqrt{a_n^2 + b_n^2}$$

$$= \cancel{\sqrt{\;}}\ \cancel{b_n}$$

$$= b_n$$

$$= \frac{4V}{n\pi} \quad \dots \quad n = 1, 3, 5, 7 \dots\dots$$

IMP = PEAK Value of n^{th} harmonic of V_L

$$C_n = C_n(\text{peak}) = \frac{4V}{n\pi} = \left(\frac{1.27V}{n}\right)$$

$$C_n(\text{rms}) = \frac{C_n(\text{peak})}{\sqrt{2}} = \frac{2\sqrt{2}V}{n\pi} = \boxed{\frac{0.9V}{n}}$$

=

$$\phi_n = \tan^{-1}\left(\frac{a_n}{b_n}\right) = 0$$

—— oxo ——

For single phase full bridge square wave inverter DC input 48 V. Load = 4.8 Ω calculate

1) $V_L(DC)$ 2) $V_L(\text{rms})$ 3) $P_L(\text{rms})$

4) Peak value of 3^{rd} harmonics.

5) RMS value of 7^{th} harmonics.

6) harmonic voltage

→ $C_3 = \frac{1.27 \times 48}{3} = 20.32$ (peak)

$C_7 = \frac{0.9 \times 48}{7} = 6.1714$ (rms)

Given :-

$V = 48\,V$

$R_L = 4.8\,\Omega.$

$\boxed{V_{L(DC)} = 0}$

$V_L(rms) = V = 48\,V$

$P_L(rms) = \dfrac{V_L(rms)^2}{R_L} = \dfrac{(48)^2}{4.8} = 480W$

$\rightarrow C_{3(peak)} = \dfrac{4V}{n\pi} = \dfrac{4(48)}{3\pi} = \boxed{20.3V}$

$\rightarrow C_7(rms) = \left.\dfrac{2\sqrt{2}V}{n\pi}\right|_{n=7}.$

$= \dfrac{2\sqrt{2}(48)}{7\pi}$

$= \boxed{6.2\,V}$

$V_L(rms) = \sqrt{(V_{fund(rms)})^2 + (V_{Harmonic(rms)})^2}$

$\boxed{V_L(rms) = 48\,V}$

$V_{fund(rms)} = \left. C_{n(rms)}\right|_{n=1}$

$\cancel{= \left.\dfrac{4V}{n\pi}\right|_{n=1} = \dfrac{4(48)}{\pi}}$

$$= \frac{2\sqrt{2}V}{n\pi}\Big|_{n=1}$$

$$= \frac{2\sqrt{2}(48)}{\pi} = 43.21V$$

~~$V_L(rms)$~~ $V_{harmonic(rms)} = \sqrt{v_L(rms)^2 - V_{fund(rms)}^2}$

$$= \sqrt{(48)^2 - (43.2)^2}$$

$$= \underline{\underline{20.9227}}$$

Chopper :-

1) chopper is a PE system which converts DC input power into DC output power

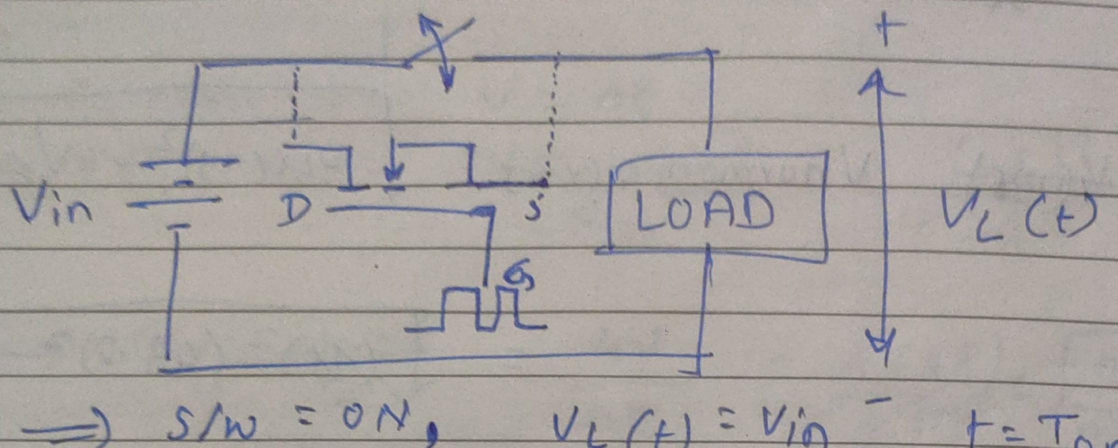
2) By DC input power we mean DC input voltage

3) By DC output power V_{mean} ~~V_{min}~~ = switching DC

4) in other words chopper ~~it~~ is a fixed input DC to a variable output DC conveter.

5) A potentio meter can fullfill the purpose metioned in point 4 but the solution suffers ~~the p~~ from continuous power disapition

an alternate sol^n is to put time controlled high freq. semiconverter swithch betn DC input & load as shown in : fig :



$\Rightarrow$ S/W = ON, $V_L(t) = V_{in}$ $t = T_{ON}$

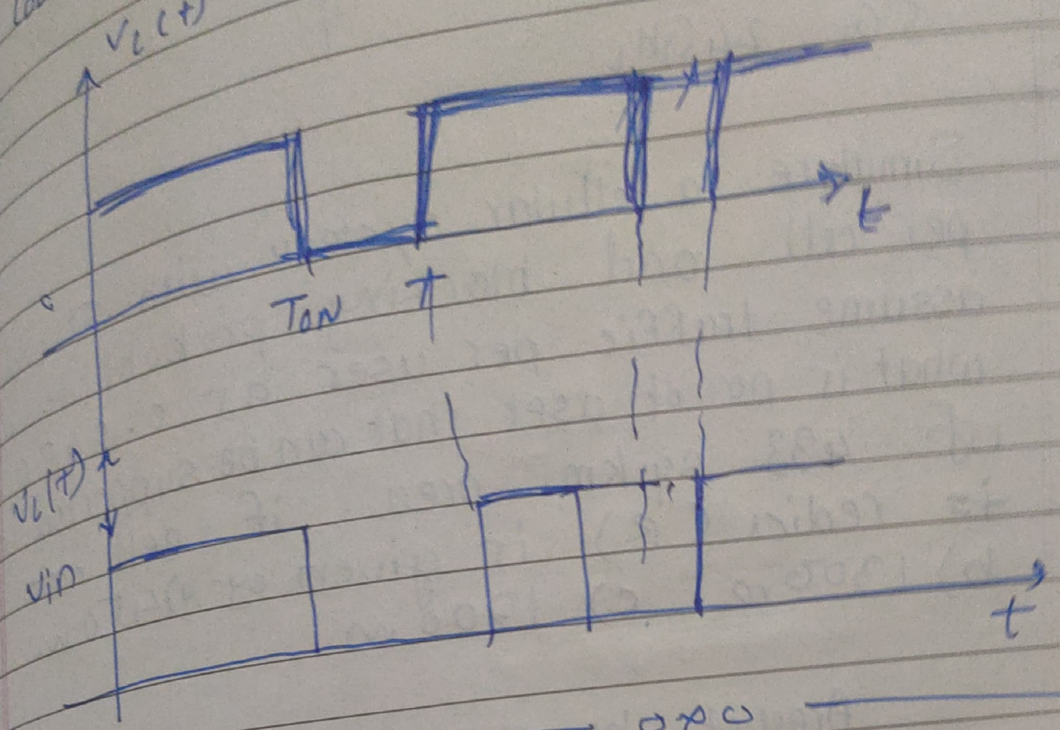
S/W = OFF, $V_L(t) = 0$; $t = T_{off}$

Power transistor are prefereel over thiristor as the SC switch coz they are control turn on control turn off type
i.e. the control voltage can be used for both firing & commutating the devices.

A suitable I_r, V_{GS}, V_{GE} can be used for firing / commutation of P-BJT P-MOSET, IGBT resp.

where in non-zero values above threshold are used for firing & zero values for commutation respectivly

Load voltage waveform.



0x0

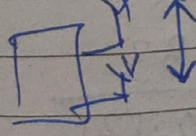
UNIT = 5

CN

wireless & mobile technologies, protocol and their performance evalution Network.

Pratical 6

Compute min. spacing req. betn antenna for independant fedding channel against operating corre feeder band for every genration of mobile standard



$d_{min} = \lambda/2$

$\lambda = c/f$

PDC

1) Expression for $V_{L(avg)}$, $V_{L(rms)}$
2) Range of δ / D
3) Justify that ckt is step-down chopper.
4) Chopper Efficiency (η)
Numerical on point q

Expression for $V_{L(avg)}$, $V_{L(rms)}$

$$\cancel{V_{L(avg)}} = \frac{1}{T}\int_0^T$$

From the V_L waveform

$$V_{L(avg)} = \frac{1}{T}\int_0^T V_L(t)\,dt$$

$$= \frac{1}{T}\int_0^{T_{ON}} V_{in}\,dt$$

$$= \frac{V_{in}}{T}\int_0^{T_{ON}} dt$$

$$= \frac{V_{in}\,T_{on}}{T}$$

$$= (\delta . V_{in})$$

$$\boxed{= D . V_{in}}$$

$$V_{L(rms)} = \left[\frac{1}{T} \int_0^T V_{L(t)}^2 \, dt . \right]^{1/2}$$

$$= \left[\frac{1}{T} \int_0^{T_{ON}} V_m^2 \, dt \right]^{1/2}$$

$$= \left[\frac{V_{in}^2}{T} \int_0^{T_{ON}} dt \right]^{1/2}$$

$$= V_{in} \left[\frac{T_{ON}}{T} \right]^{1/2}$$

$$= V_{in} \sqrt{\delta}$$

$$\boxed{= V_{in} \sqrt{D}}$$

2) Range of δ / D

* $\delta = \frac{T_{ON}}{T}$

$\because$ chopper is a fixed 'f' (frequency) / Fixed 'T'

$$\delta_{max} = \frac{T_{ON}\,(max)}{T} = \frac{T}{T} = 1 \ (100\%)$$

$\rightarrow T_{ON} \rightarrow T$

$T_{OFF} \rightarrow 0$

$$\delta_{min} = \frac{T_{ON}\,(min)}{T} = 0 \ (0\%)$$

$\rightarrow T_{ON} \rightarrow 0$

$T_{OFF} \rightarrow T$

$0 \leq \delta \leq 1 \Rightarrow 0 \leq \delta < 1$

multiplying Vin both side

$0 \leq \cancel{v} (\delta\, V_{in}) < V_{in}$

$$\boxed{0 \leq V_{L(avg)} < V_{in}}$$

3) Justify that ckt is STEP-DOWN chopper

The range of $V_{L(avg)}$ shows that since δ or D is kept < 1 $V_{L(avg)}$ can not exceed Vin, always less than Vin hence the above ~~chopper~~ ckt is known as step-down chopper / bulk converter.

q The chopper is driven by 200 V battery & drives a 10 Ω load. with duty cycle of 60% calculate

1) $V_{L(avg)}$

2) $V_{L(rms)}$

3) $P_{L(avg)}$

4) $P_{L(rms)}$

Values of Ton & Toff if chopper freq. is $\xrightarrow{}$ 10 kHz
tends to

$V_{L(avg)} = \delta . V_{in}$
$= 200 \times 0.6$
$= 120\ V$

$V_{L(rms)} = 200 \times \sqrt{0.6}$
$= 154.91$

$$P_L(avg) = \frac{V_L(avg)^2}{R}$$

$$= \frac{(120)^2}{10}$$

$$= 1440 \text{ W}$$

$$P_L(rms) = \frac{V_L(rms)^2}{R}$$

$$= \frac{(154.9)^2}{10}$$

$$\approx$$

$$= \boxed{2399.4}$$

——— oxo ——— oxo ——— oxo —

$$T = \frac{1}{f}$$

$$= \frac{1}{10 \text{ KHz}}$$

$$=$$

$$\delta = \frac{T_{on}}{T} = T_{ON} \cdot f$$

$$= 0.6$$

$$T_{ON} = \frac{0.6}{f} = \frac{0.6}{10 \text{ KHz}}$$

$$= 0.06 \text{ ms}$$

$$= 60 \text{ µs}$$

$$T_{OFF} = T - T_{ON}$$

$$= 100 \text{ µs} - 60 \text{ µs}$$

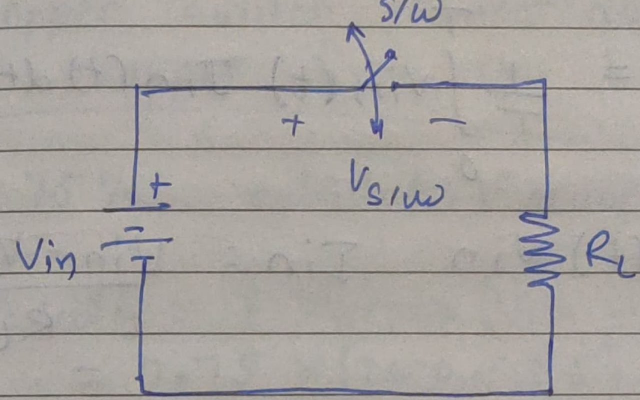
$$= 40 \text{ µs}$$

chopper efficiency

$$\eta = \frac{P_{out}}{P_{in}}$$

$$= \frac{P_{L(avg)}}{P_{in}}$$

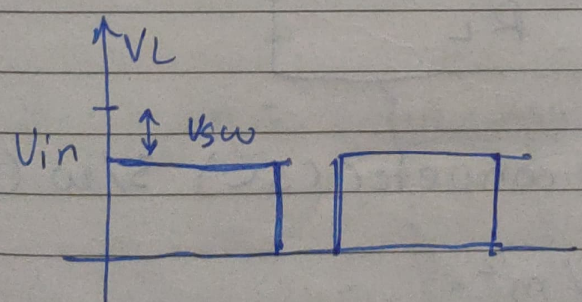
Consider the chopper circuit.



Practically the SC switch offers a non-zero on stage voltage drop.

$V_{sw} > 0$ thus when SC switch $= 0$

$V_L = (V_{in} - V_{sw})$



$$P_{L(avg)} = \frac{1}{T}\int_0^T P_L(t)\,dt$$

$$= \frac{1}{T}\int_0^T \frac{V_L(t)^2}{R_L}\,dt$$

$$= \frac{1}{T}\int_0^{T_{ON}} \frac{(Vin - Vsw)^2}{R_L} dt$$

$$= \frac{T}{TR} \boxed{\frac{\delta . (Vin - Vsw)^2}{R_L}}$$

$$P_{in}(t) = \frac{1}{T}\int_0^T P_{in}(t)\, dt.$$

$$= \frac{1}{T}\int_0^T Vin(t)\, I_{in}(t)\, dt$$

But $Vin(t)$ Vin $\quad I_{in} = \frac{Vin - Vsw}{R_L}$

$$= \frac{1}{T}\int_0^{T_{ON}} Vin \frac{(Vin - Vsw)}{R_L} dt$$

$$= \boxed{\frac{\delta . Vin(Vin - Vsw)}{R_L}}$$

For ideal semi conveter (SC) S/w (switch)

$Vsw = 0$

$$\eta = \frac{\frac{\delta . Vm^2}{R_L}}{\frac{\delta Vin^2}{R_L}} = 1$$

Non-ideal switch =

$$\boxed{\eta = \frac{(V_{in} - \delta V_{sw})^2}{V_{in}(V_{in} - V_{sw})}}$$

A step down chopper has a resistive load of 15Ω & input voltage 200V

A chopper switch offers an on state drop of 2.5V chopper freq. is 1 KHz

different in switch.

IMP D is 75% calculate 1) $V_L(avg)$ 2) $V_L(rms)$
3) efficiency

$V_L(avg) = \delta\ \cancel{V_L(avg)}\ (V_{in} - V_{sw})$

$= 0.75 \times (200 - 2.5)$

$= \cancel{150}\ 148$ ← for non-ideal sc s/w

$V_L(rms) = \cancel{\delta V_{in}}\ V_{in}\sqrt{D}$

$= \cancel{200 \times \sqrt{0.75}}\ (200 - 2.5)\sqrt{0.75}$

$= \cancel{173.2050}\ 171.04$

$\eta = \frac{V_{in} - V_{sw}}{V_{in}}$

$= \frac{200 - 2.5}{200}$

$\eta = 0.9875$

$\eta = \% = 98.75\%$

$$\eta = \frac{(V_{in} - V_{sw})^2}{V_{in}(V_{in} - V_{sw})}$$

$$= \frac{(200 - 2.5)^2}{200(200 - 2.5)}$$

$$= \frac{(197.5)^2}{200(197.5)}$$

Inverters

Performance parameter inverter
ideally inverter should give sinosidal voltage at its output.

However practical output are non-sinosidal. & thus contain fundamental & harmonic componentes.

Performance of inverter is evaluated by following factor

IMP 1) Harmonic factor of N Harmonic (HF_n)

Hf is ~~nature~~ measure of individual Harmonic ~~content~~ contribution in output

is define as ratio of Rms value of perticular Harmonic to Rms value of Fundamental Harmonic

Imp $$HF_n = \frac{V_{n(rms)}}{V_{1(rms)}}$$

2> THD : Total harmonic Distrotion

it is a measure of closeness in shape between output voltage waveform & fundamental component.

and it defined as ratio of ~~to~~ Rms value of ~~Harmo~~ total Harmonic content to fundamental component.

Imp $$THD = \frac{\sqrt{(V_{L(rms)})^2 - (V_{L(rms)})^2}}{V_{1(rms)}}$$

3. D.F : Distortion factor

Theory only

It indicates amount of harmonic that remain in output voltage waveform after it has been subjected to 2nd order attunation i.e. divide by n^2

$$DF = \frac{\sqrt{\sum_{n=2,3}^{n} \left(\frac{V_{n(rms)}}{n^2}\right)^2}}{V_{1(rms)}}$$

LOH = lowest order Harmonic

The lowest freq. harmonic with magnitude greter than or equal to 3% of magnitude of fundament is known as LOH.

↑ higer the frequency of LOH lower the distortion in current waveform

3 ϕ Inverter

It is called 3 ϕ b'coz the circuit gives 3 diff. load voltage waveforms curresp. to convention to 3ϕ 4 wire system i.e. R, Y, B, N.

- It is basically a bridge inverter, consisting of 3 vertical arms with each arm having two power switches prefarabally power thirestors. Thus 6 devices denoted as q_1 to q_6

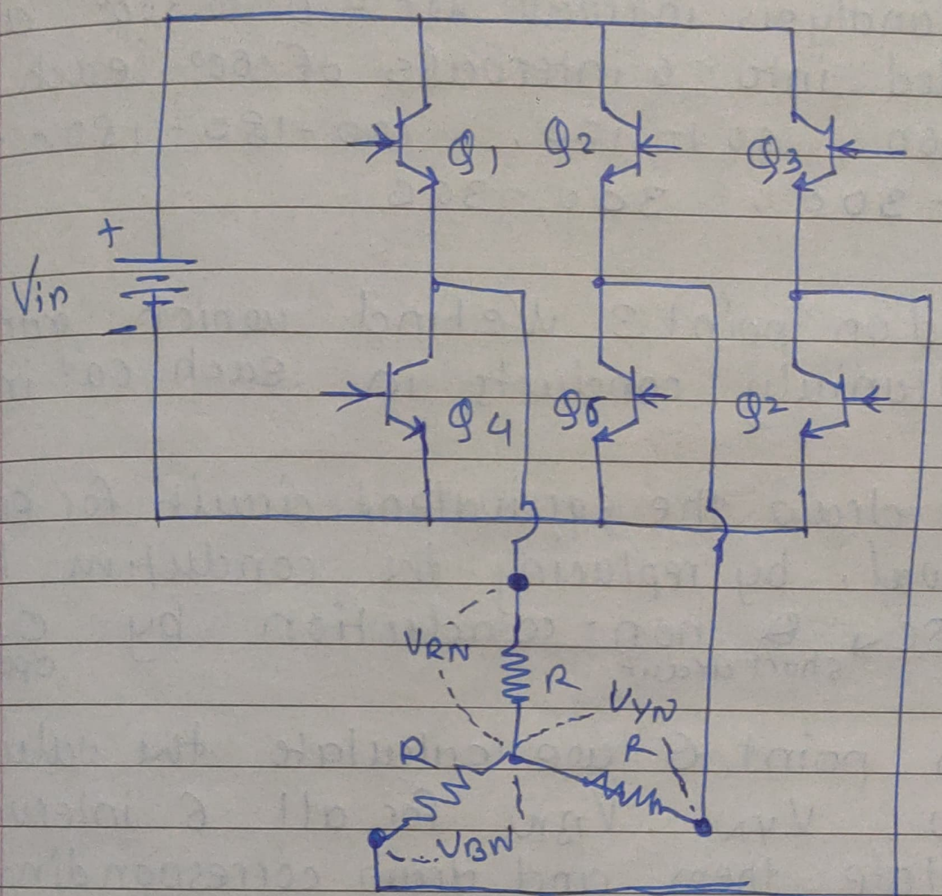
- The upper half of bridge uses ~~all~~ odd subscrip for devices, one(1) 3, 5 from left to righ

- while lower half has even subscripts i.e. 4, 6, 2 from left to right.

- R-phase output denoted as V subsript ~~R N~~ $V_{R,N}$ is obtained from left most arm, $V_{Y,N}$ from midder arm $V_{B,N}$ from right most arm.

The circuit drives a balanced start connected R - load referenced at N - (nutral point).

- This circuit can be operated in 2 mode
1) 180° mode 2) 120° mode



Firing Scheme:-

For X degree mode.

1) Transistor Q_1 is fired at $wt = 0°$ and conducts for X degrees.

2) Each sucessive transistor after Q_1 i.e. Q_2 to Q_6 is fired with delay of 60° relative to its precedance
↓
pahale wala

i.e g_2 is fired at $wt = 60°$ & conducts till $60° + x$, so on and ....

The base current waveform i.e I_{B1}, I_{B6} has drawn as per Rule 1 & 2

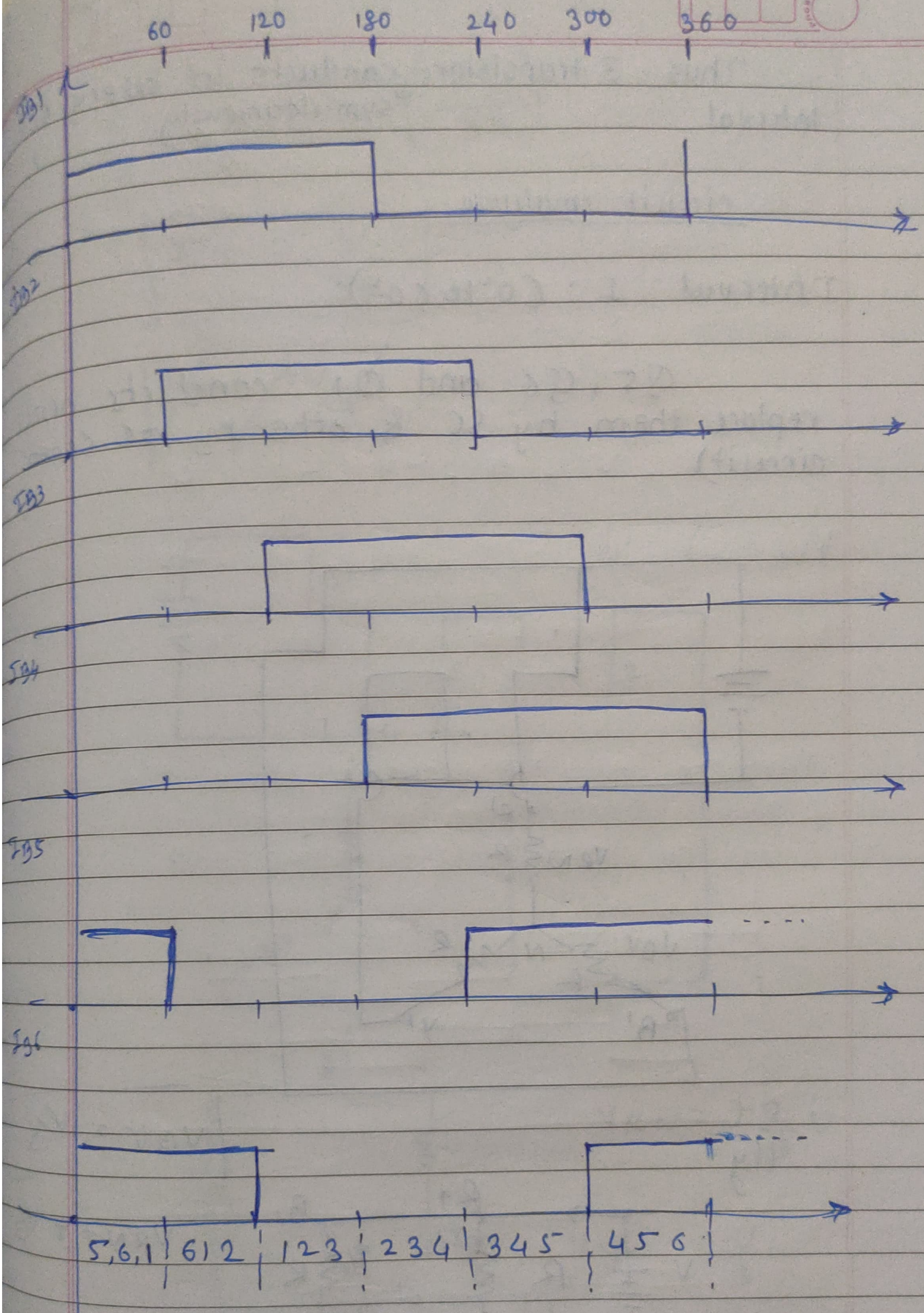
- The analysis interval $wt = 0°$ to $360°$ and divided into 6 intervals of $60°$ each. i.e. 0 to 60, 60 to 120, 120-180 - 180 - 240, 240-300, 300-360

- Based on point 3 We find which transistor simultaniuly conducts in each $60°$ interval

- We draw the equivalent circuit for each $60°$ interval, by replacing the condution transistor by SC (short circuit) & non-conduction by OC. (open circuit)

- from point 6 we calculate the values of V_{RN}, V_{YN}, V_{BN} for all 6 intervals, Tabulate them and draw corresponding waveforms. & draw meaninful condition for both line & phase voltages

- firing ~~fo~~ scheme for $x = 180°$



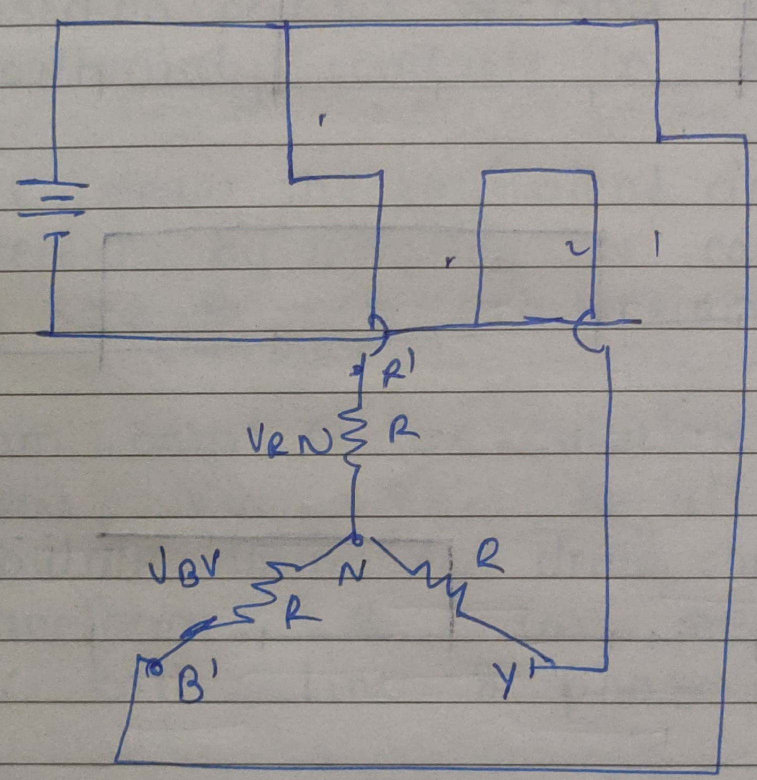
60
120
180
240
300
360
I_{B1}
I_{B2}
I_{B3}
I_{B4}
I_{B5}
I_{B6}
5,6,1
612
123
234
345
456

Thus 3 transistors conducts in every 600 interval
simultaniously

circuit analysis

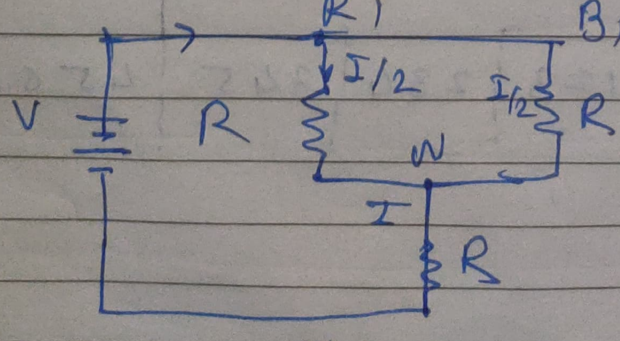
Interval 1 : (0° to 60°)

Q5, Q6 and Q1 conducts hence replace them by SC & other by OC. (open circuit)



$V_{BY} = V/3$

Ily



$V_{RN} = + V/3$

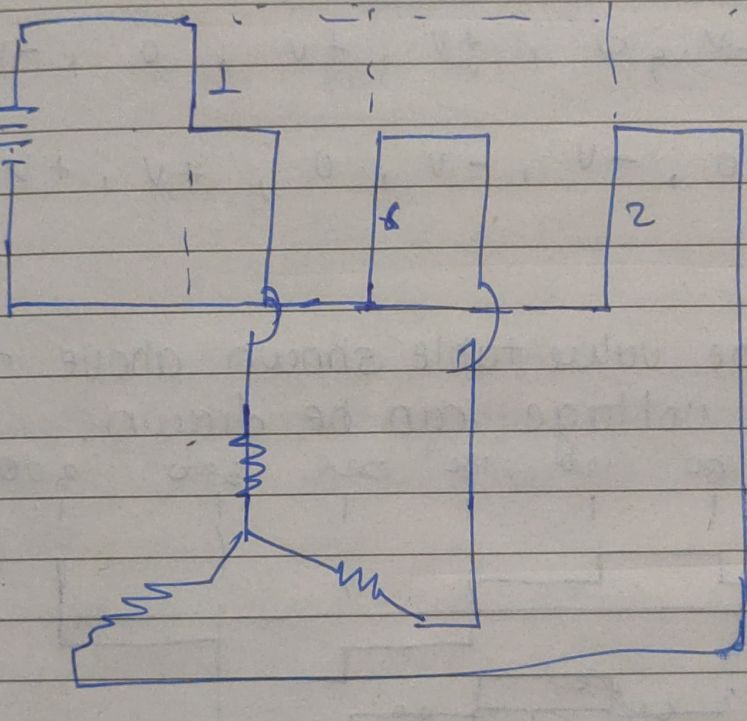
$V_{YN} = \frac{-2}{3}V$

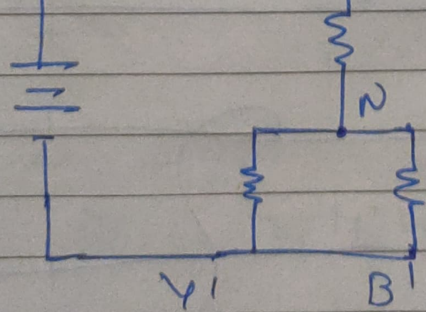
+ve / -ve depends on current direction

$$I = \frac{V}{3R/2} = \left(\frac{2V}{3R}\right)$$

$$\boxed{I/2 = \frac{V}{3R}}$$

$$\cancel{\boxed{V_{BN} = +V/3}}$$





$V_{RN} = +\frac{2}{3}V$

$V_{YN} - \frac{V}{3}$

$V_{BN} = -V/3$

$V_{RN} = +V/3,\ 2/3\,V,\ +V/3,\ \cancel{-\frac{2}{3}},\ -\frac{V}{3},\ -2V/3,\ \frac{-V}{3}$

$V_{YN} = -2V/3,\ -V/3,\ +V/3,\ +2V/3,\ +\frac{V}{3},\ \frac{-V}{3}$

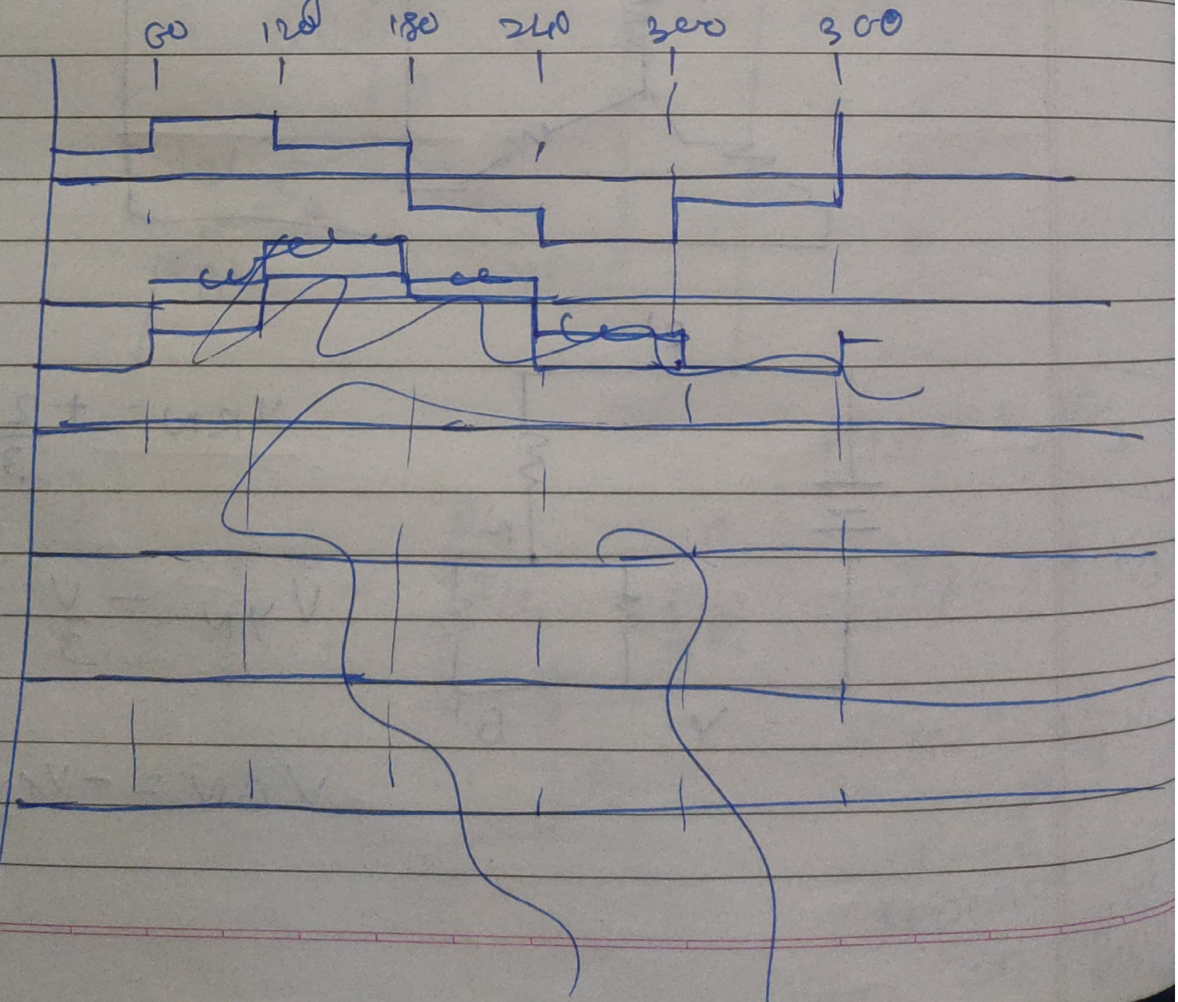
$V_{BN} = +V/3,\ -V/3,\ -2V/3,\ -V/3,\ +V/3,\ +\frac{2V}{3}$

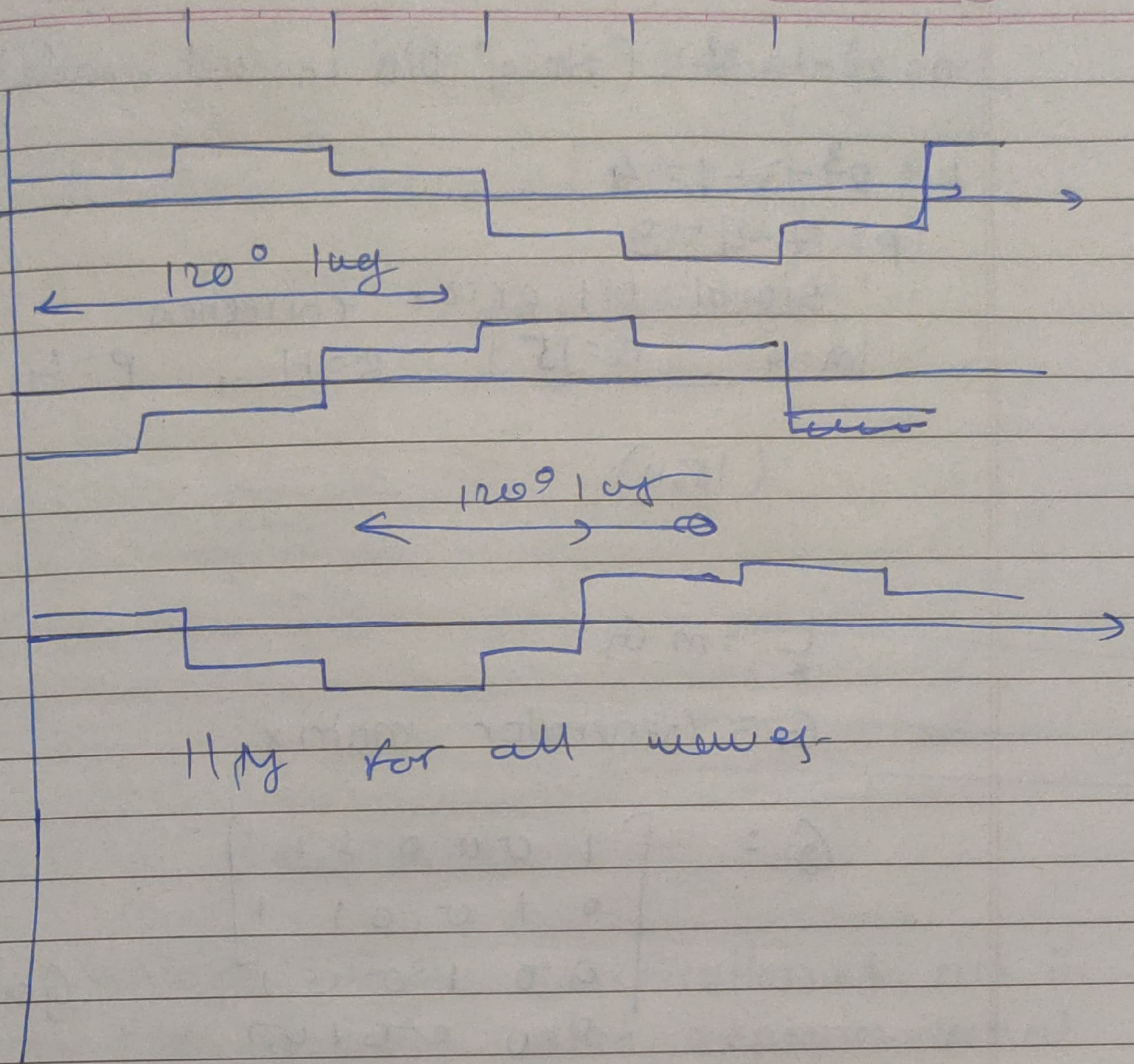
$V_{RY} = V,\ V,\ 0,\ -V,\ -V,\ 0$

$V_{YB} = -V,\ 0,\ +V,\ +V,\ 0,\ -V$

$V_{BR} = 0,\ -V,\ -V,\ 0,\ +V,\ +V$

From the value table shown above the phase & line voltage can be drawn.





An anylsis ller to above when done with $\alpha = 120°$ is called as 120° mode 3 ϕ bridge inverter

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CN

Hamming Code:-

(n, k)

$n = 2^m - 1$

$k = 2^m - m - 1$

P = No. of parity bits $= n - k$.

min any +ve integer ≥ 3

$m = 3$.

PPC

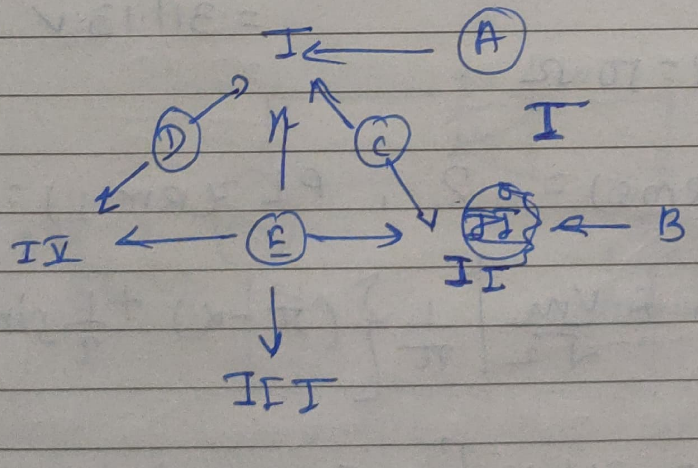
Dissipative Realsation (continuous Power Dissipation)

Alternative sol^n is "Non-Dissipative" sol^n

classification of choppers.

- Vo vs Vin
  - ⇒ Step-Down ($V_0 \leq V_{in}$) (BUCK)
  - Step-Up ($V_0 > V_{in}$ (Boost)
  - Step-Up-Down (Buck-Boost)
- Fly Back converter
- Quadrant of operation

class - A	I
-11- B	II
-11- C	I, II
-11- D	I IV
-11- E	I II III IV



Definition of AC-voltage controller.
It is PE-system, which takes fixed RMS signal as i/p & gives a variable-RMS signal as o/p.

ACU uses PAC (Phase - Angle control) Technique or
FAC (firing -||-) Technique

Circuit Diagram
AC voltage control / chopper / regulator

IMP

NUMERICAL ON ACV

1) An AC-voltage controller / AC Regulator is driven by 220 V, 50 Hz supply and drives a 50 Ω load. Calculate the following $V_L(Rms)$, $P_L(rms)$ if $\alpha = 60°$

→ Soln

Given

$\alpha = 60° = (\pi/3)^c$

$V_S(Rms) = 220\ V$, $V_m = V_S(Rms)\sqrt{2}$
$= 311.13\ V$

$R = 50\ \Omega$

$V_L(Rms) = ?$, $P_L(Rms) = ?$

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

$$= \frac{311.13}{\sqrt{2}}\left[\frac{1}{\pi}\left\{\left(\pi - \frac{\pi}{3}\right) + \frac{1}{2}\sin(120°)\right\}\right]^{1/2}$$

$$= 220\left[\frac{1}{\pi}\left\{2.09 + 0.433\right\}\right]^{1/2}$$

$= 197.15\ V$

$$P_L(rms) = \frac{V_L(rms)^2}{R} = \frac{(197.15)^2}{50} = \boxed{777.36\ W}$$

2

SCR Rating → voltage (PIV) =

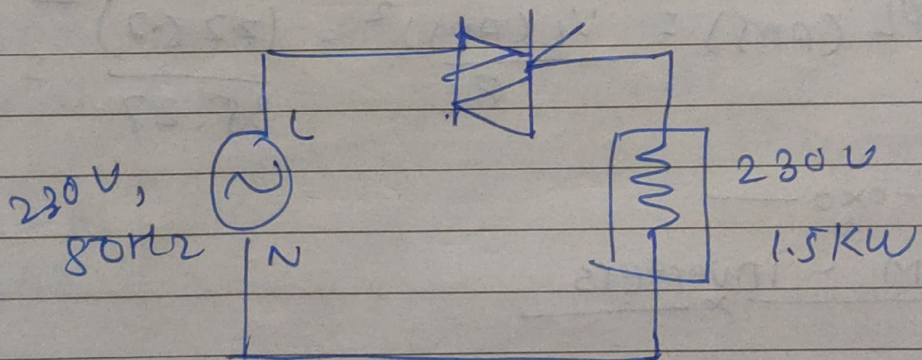
→ current → AVG

→ Rms

* Voltage Rating = :

Imp Type 2

An AC - Regulator shown below drives a 230V, 1.5kW Heater Calculate the value of Power Delivered to the load.



Soln : Given.

$\alpha = 30° = \left(\pi/6\right)^c$

$V_S(Rms) = 230V$

Heater Rating = 230 V, 1.5 kW

$P_{L(RMS)} = ?$

230 V, 1.5 kW Rating means, when Heater receivers 230 V supply it consumes 1.5 kW power.

$$P = V^2/R \Rightarrow R = V^2/P$$

$$P_{L(RMS)} = \frac{V_{L(RMS)}^2}{R_L}$$

$$V_{L(RMS)} = V_{S(RMS)} \left[\frac{1}{\pi}\left\{(\pi-\alpha) + \frac{1}{2}\sin(2\alpha)\right\}\right]^{1/2}$$

$$= \cancel{230} \left[\frac{1}{\pi}\right.$$

$$P_{L(RMS)} = \frac{V_{L(RMS)}^2}{R_L} = \frac{(226.7)^2}{35.27} = 1457.36$$

oxo

PWM - inverters

→ These can be defined similar to SW/QSW inverters

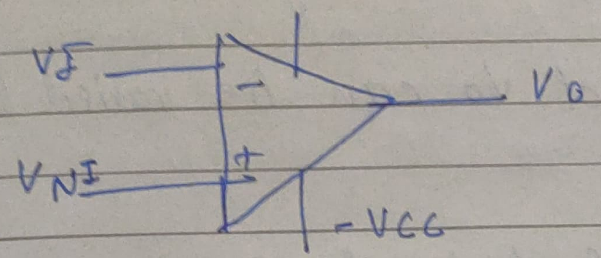
→ The V_L W/F has a PWM nature

classification of PWM

SPM (single pulse modulation)

MPM (multiple pulse modulation)

Sinusoidal - PWM



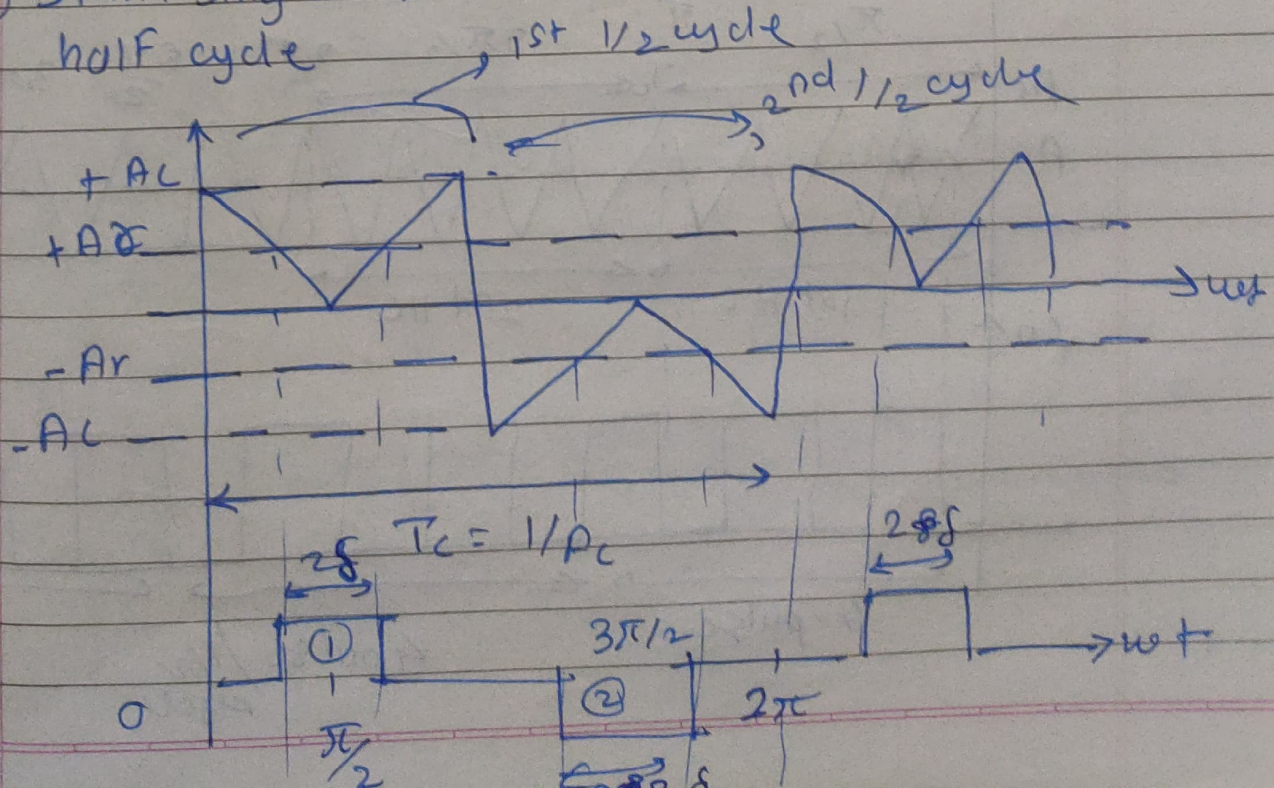
$|V_{sat}| \simeq 0.95\, V_{cc}$

$V_o = +V_{sat}$ if $V_{NI} > V_I$

$= -V_{sat}$ if $V_{NI} < V_I$

OPAMP comparator

a) SPM (single-phase modulation) :- 1 phase per half cycle



→ The w/f for Vo shows that it is "The Generic GSW"

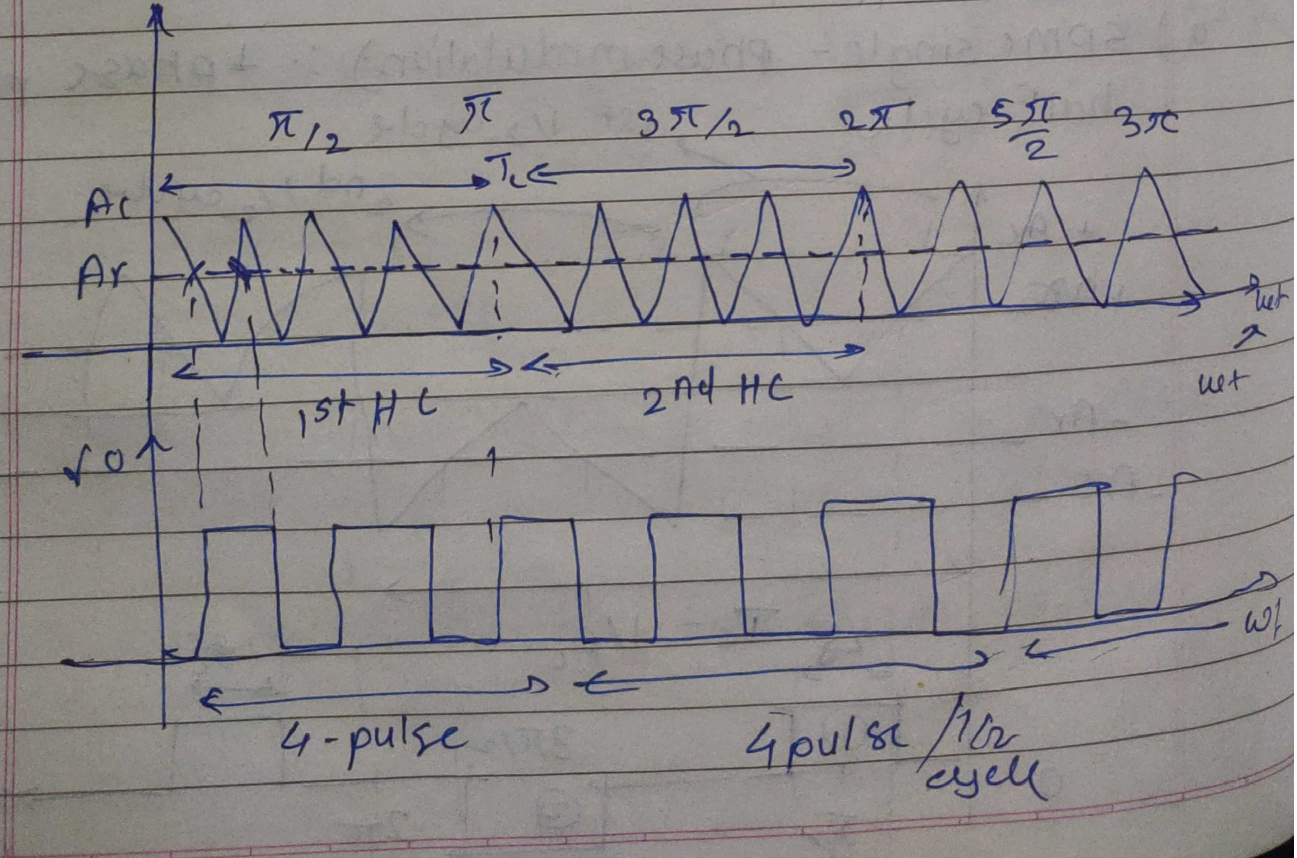
→ So GSW o/p is also called as single-Pulse modulation.

→ The value of '2δ' can be varied by changing levels (+Ar, −Ar)

→ The frequency of Vo can be varied by varying $f_c = 1/T_c$

→ Mathematical Analysis of SPM is exactly same as GSW

b) Multiple Pulse : PWM (Multiple pulse per Half-cycle)



w/f for Vo shows that we have 4 pulses per halfcycle.

Hence called as Multiple-pulse modulation.

By changing the level 'A_r', pulse-width can be changed.

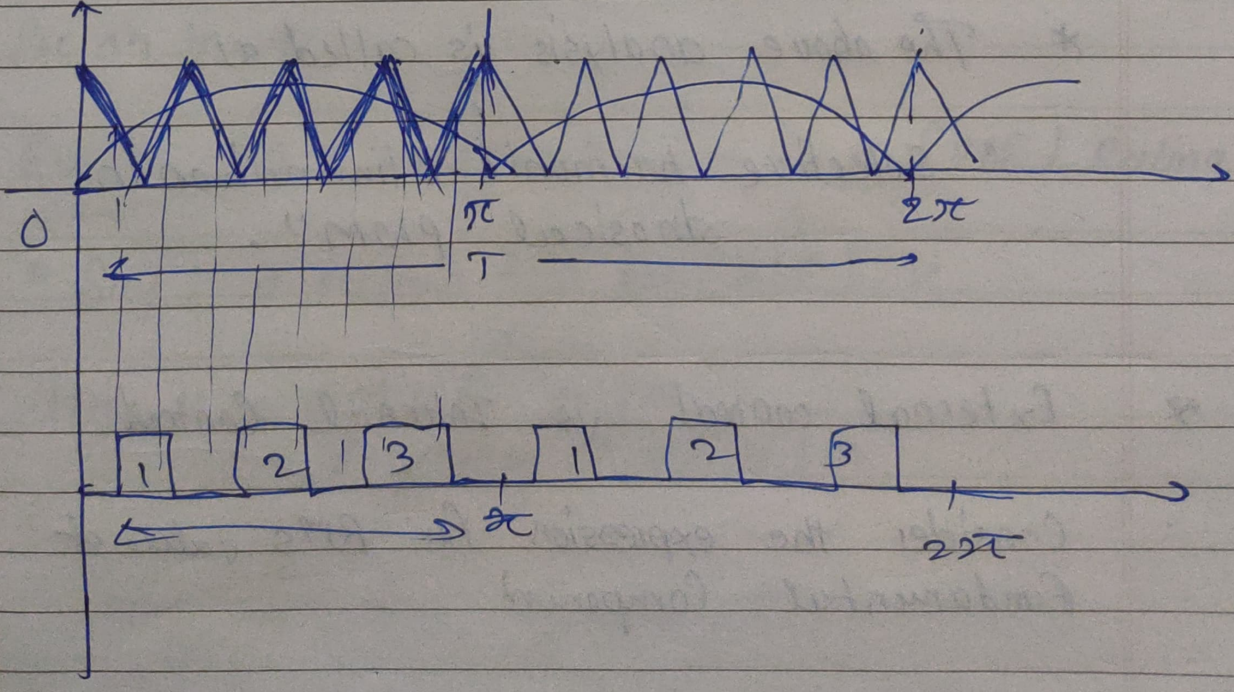
→ By changing frequency $f_c = \frac{1}{T_c}$ of carrier signal; frequency of o/p Vo can be changed.

<u>Disadvantage</u>

⊛ As. No. of pulses ↑ switching losses ↑

⊛ control scheme is complex in Nature.

Imp Sinusoidal PWM :-



* By observing and comparing carrier and Reference signal.

There are 3 cycles of carrier signal per Half-cycle of Reference signal.

We get 3 pulses / Half cycle after comparison

p = No. of pulses / Half-cycle $(0 \to \pi)/(\pi - 2\pi)$

At for above 'p' No of pulse in the o/p

All Harmonics Below $(2p-1)$ are eliminated.

eg. if $p = 3$ Then $(2p-1) = (2 \times 3 - 1) = 5$

→ Thus all Harmonics below 5th harmonic are absent

2nd, 3rd & 4th Harmonic are ABSENT.

* The above analysis is called as

" Selective harmonic Elimination in sinosical PWM".

* External control vs Internal Control.

Consider the expression for RMS value of Fundamental Component for Square-Wave Inverter.

$$V_{1(RMS)} = 0.9V \quad \text{——} (1)$$

for Quasi- Square Inverter — (2)

* Both Inverter is a fixed i/p DC system; so we should not vary 'r' in order to change RMS value

Varying 'V' to vary RMS values (O/P) is called as External method; which is not preferred.

So ways of changing RMS values; internally must be

v/f Control in Inverter :-

An Induction Motor (I.M) is a practical load for an inverter

Every IM is manufactered with a (V/F) Rating.

* Say; a certain I.M has $(V/F) = x$

Here V = RMS i/p to IM.
f = frequency of i/p to IM.

for Reliable operation of an I.M, value of (V/f) should remain constant

$$\boxed{N_s = 120 \cdot f/p}$$

If (f) i/p to I.M is ↑ or ↓ value of "v" should ~~alter~~ also be ↑ or ↓

Such that (V/f) Ratio remains equal to 'x'