2-11-19

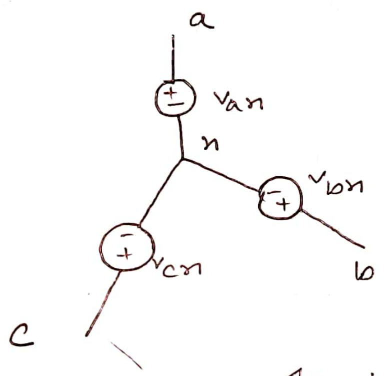
3-phase circuit

Single phase (1-ϕ): A single phase system consists of a generator connected to a pair of wire to load.

Three phase system (3-ϕ): A 3-phase system is produced by a generator consisting of 3-voltage sources having equal in magnitude and frequency but out of phase by 120° by ~~by~~ from one each other

Y-connected 3 phase source

Phase 3টা an, bn, cn



2টার difference 120°

$V_{an} = V_m \sin(\omega t + \theta)$

$V_{bn} = V_m \sin(\omega t + \theta - 120°)$

$V_{cn} = V_m \sin(\omega t + \theta + 120°)$

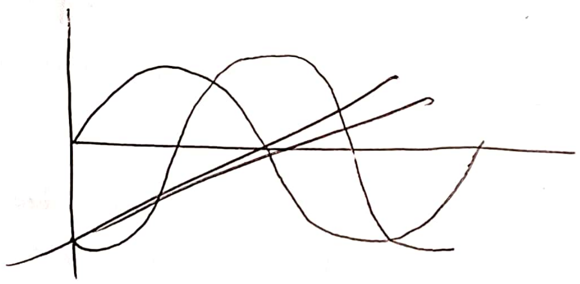
2টার distance −240° or 120°

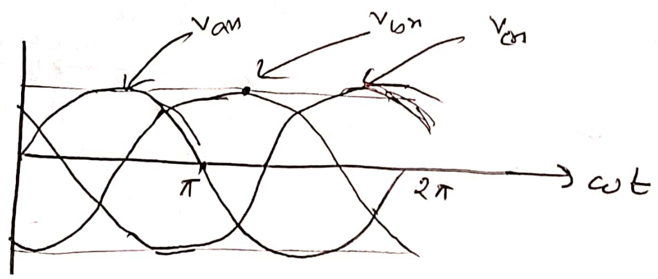
In phasor:

$V_{an} = V_m \angle \theta$

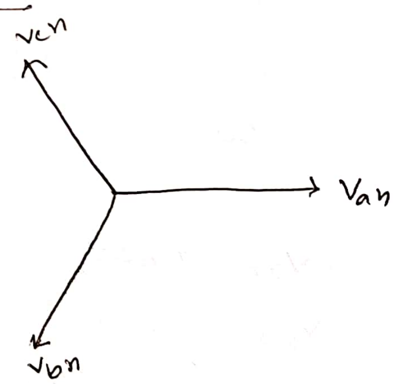
$V_{bn} = V_m \angle \theta - 120°$

$V_{cn} = V_m \angle \theta + 120°$





Phasor



Advantages

(1) The instantaneous power of a 3-phase system is constant and for single phase system, it is time varying or depends on time.

(2) 3-phase system is more economical than single phase system. To transmit same amount of power over same distance the ~~equal power~~ required copper of 3-phase system is less than single phase system.

(3) All the generated power are in 3-phase system

(4) The efficiency of 3-phase system is more than the single phase ″

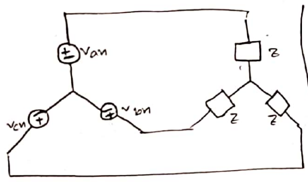
(5) 3-phase induction motors are self-starting but single ″ ″ ″ ″ not ″

Balanced 3-phase system: A 3-phase system is called b ″ if the voltage sources are equal in magnitude and frequency but out of phase in one each other by 120° and the loads are equal

$V_{an} = V_m \angle 0°$

$V_{bn} = V_m \angle -120°$

$V_{cn} = V_m \angle 120°$

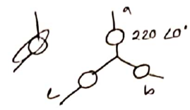


Source value equal
Frequency ″
120°
connected load same
→ balanced 3-φ system

Balance 3-φ system

Phase sequence: A ″ ″ of a 3-phase system is the time order in which the voltage sources pass through their respected maxima

Positive sequence



$\theta \to \theta - 120° \to \theta + 120°$

(-ve)/a-c-b sequence

(+ve)/a-b-c ″

$V_{an} = V_m \angle 0°$

$V_{bn} = V_m \angle +120°$

$V_{cn} = V_m \angle -120°$

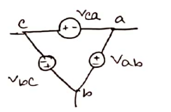
* a leads b, b leads c, c leads a then it is called a-b-c sequence or positive sequence
* a leads c, c leads b, b leads a, then it is called a-c-b sequence/negative sequence.

~~3-phase s~~

2 types of sources

(i) Y - connected

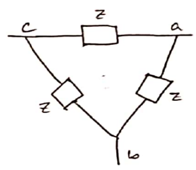
(ii) ∇ - ″ (কোনো natural point নাই)



2 types of loads

(i) Y - connected

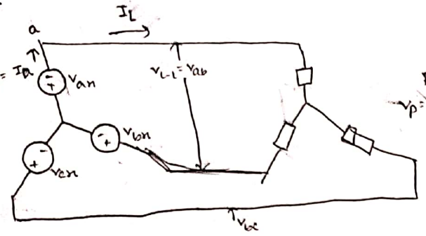
(ii) ∇ - ″



Scanned by CamScanner

03-10-2019

$V_{ab} = V_{ba}$
$= V_{ba} \angle 180°$



Phase voltages are $V_p = V_{an}, V_{bn}, V_{cn}$

Line voltages are $V_{L-L} = V_{ab}, V_{bc}, V_{ca}$

~~Line and~~

For Y-connected circuit, line current and phase current are in same phase, line voltages and line current are not equal ——

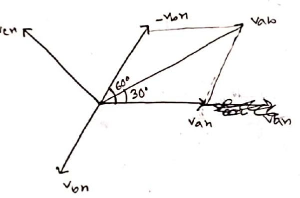
*abc sequence positive

$V_{ab} = V_{an} - V_{bn}$

Let, $V_{an} = V_m \angle 0°$

and for abc sequence

$V_{bn} = V_m \angle -120$



$V_{ab} = V_{an} + (-V_{bn})$

$= V_m \angle 0° - V_m \angle -120°$

$= \sqrt{3}\, V_m \angle 30° - \sqrt{3}\, V_m \angle 0° \cdot 1 \angle 30°$

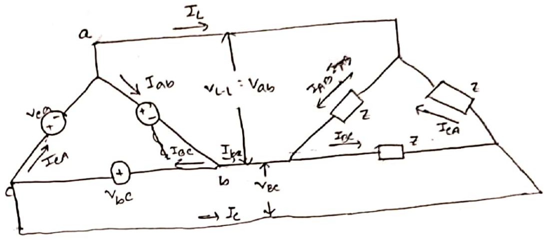
$= \sqrt{3}\, V_{an} \angle 30°$

$V_{L-L} = \sqrt{3}\, V \angle 30°$

$V_{ab} = |V_{an}| \cos 30° + |V_{bn}| \cos 30° = 2 |V_{bn}| \cos 30° = \sqrt{3}\, V_{bn}$

So for wye circuit,

phase current and line current are equal but L-L voltage leads phase voltage by 30° and the magnitude of L-Line voltage is $\sqrt{3}$ times by phase voltage



For Δ connected circuit, line and phase voltage are same.

$I_{ca} = I_a + I_{ab} \Rightarrow I_a = I_{ca} - I_{ab}$

Let,

$I_{ab} = I_m \angle \theta$

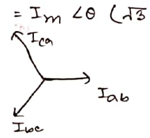
$I_{bc} = I_m \angle \theta - 120°$

$I_{ca} = I_m \angle \theta + 120°$

$I_a = I_m \angle \theta + 120° - I_m \angle \theta$

$= I_m \angle \theta \cdot 1 \angle 120° - I_m \angle \theta \cdot 1 \angle 0°$

$= I_m \angle \theta \, (\sqrt{3}, \angle 150) = \sqrt{3}\, I_{ab} \angle 150°$



For delta circuit line current is $\sqrt{3}$ times of phase current

For source, the line current leads phase current by 15

At load terminal

$I_a = I_{AB} - I_{CA}$

$= I_{AB} - I_{AB}\angle 120°$

$= I_{AB}(1 - 1\angle 120°)$

$= \sqrt{3}\ I_{AB}\angle -30°$

In case of load terminal, the line current is $\sqrt{3}$ times to phase current, the line current lacks phase current by 30° and

Y-Y   Y-Δ   Δ-Y   Δ-Δ

Q:

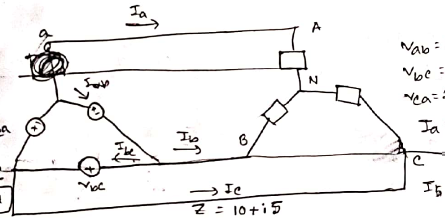
$V_{ab} = 220\angle 30°\ V$ and acb sequence

Find, $V_{AN} = ?$

$V_{BN} = ?$

$V_{CN} = ?$

And line current



$V_{ab} = 220\angle 30°$

$V_{bc} = 220\angle 30° + 120°$

$V_{ca} = 220\angle 30° - 120°$

$I_a = \frac{220/\sqrt{3}}{10 + j5}$ A

$I_b = \frac{220}{\sqrt{3}(10 + i5)}\angle 120°$ A

$I_c = \frac{220}{\sqrt{3}(10 + i3)}$

$V_{L-L} = \sqrt{3}\ V_p\angle 30° \Rightarrow V_p = \frac{V_{L-L}}{\sqrt{3}\angle 30°}$

$V_p = \frac{V_{bc}}{\sqrt{3}}\angle -30°$

$\therefore V_{AN} = \frac{V_{AB}}{\sqrt{3}}\angle -30°$

$= \frac{-220\angle 30°}{\sqrt{3}}\angle -30° = \frac{220}{\sqrt{3}}\angle 0°\ V$

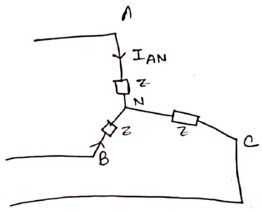
$V_{BN} = V_{AN}\angle +120° = \frac{220}{\sqrt{3}}\angle 30°\ V$

$V_{CN} = V_{AN}\angle -120° = \frac{220}{\sqrt{3}}\angle -120°\ V$

23-11-19

$I_L = \sqrt{3}\ I_P$

$V_L = I_P$



Let, $V_{AN} = V_m\cos(\omega t + \theta)$

$V_{BN} = V_m\cos(\omega t + \theta - 120°)$

$V_{CN} = V_m\cos(\omega t + \theta + 120°)$

Let, $i_{AN} = I_m\cos(\omega t)$

$i_{BN} = I_m\cos(\omega t - 120°)$

$i_{CN} = I_m\cos(\omega t + 120°)$

Instanteneous power.

$P(t) = V_{AN}i_{AN} + V_{BN}i_{BN} + V_{CN}i_{CN}$

$= V_mI_m\cos(\omega t + \theta)\cos(\omega t) + V_mI_m\cos(\omega t + \theta - 120°)\cos(\omega t - 120°)$
$+ V_mI_m\cos(\omega t + \theta + 120°)\cos(\omega t + 120°)$

$= \frac{1}{2}V_mI_m[\cos\theta + \cos(2\omega t + \theta) + \cos\theta + \cos(2\omega t + \theta - 240°) + \cos\theta + \cos(2\omega t + \theta + 240°)]$

Phase voltage এর pick value; phase current এর pick value

$= \frac{1}{2} V_m I_m [3\cos\theta + \cos(2\omega t+\theta) + 2\cos(2\omega t+\theta)\cos(240^\circ)]$

$= \frac{1}{2} V_m I_m [3\cos\theta + \cos(2\omega t+\theta) - \cos(2\omega t+\theta)]$

$= \frac{3}{2} V_m I_m \cos\theta$

where V_m is the pick value of phase voltage and

I_m " " " " " " current

Now, $P(t) = \frac{3}{2} V_{mp} I_{mp} \cos\theta$

For Y-connected system

$V_L = \sqrt{3} V_{mp}$

$I_{mL} = I_{mp}$

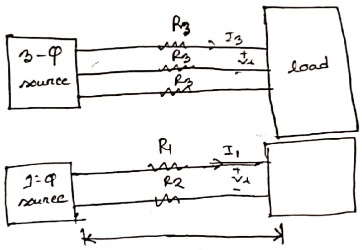
$P(t) = \frac{3}{2} \frac{V_{mL}}{\sqrt{3}} I_{mL} \cos\theta$

$= \frac{\sqrt{3}}{2} V_{mL} I_{mL} \cos\theta$

$= \sqrt{3} \frac{V_{mL}}{\sqrt{2}} \cdot \frac{I_{mL}}{\sqrt{2}} \cos\theta$

$= \sqrt{3} V_L I_L \cos\theta$

→ Rms value



Same distance

" power

" voltage

" copper lost

$P = \sqrt{3} V_L I_3 \cos\theta = V_L I_1 \cos\theta$

$\Rightarrow \sqrt{3} I_3 = I$

Cu loss in 3-Φ system $= 3 I_3^2 R_3$

Cu " " 1-Φ " $= 2 I_1^2 R_1$

$3 I_3^2 R_3 = 2 I_1^2 R_1$

$\Rightarrow 3 I_3^2 R_3 = 2 \times 3 I_3^2 R_1$

$\Rightarrow R_3 = 2R_1$

$R_3 = \frac{\rho L}{A_3}$

$R_1 = \frac{\rho L}{A_1}$

$R_3 = 2R_1$

$\frac{\rho L}{A_3} = 2 \times \frac{\rho L}{A_1}$

$\Rightarrow A_1 = 2A_3$

Vol. of Cu in 3-Φ $= 3A_3L$

" " " " 1-Φ $= 2A_1L$

$\therefore \frac{\text{wt. of Cu in 3-}\Phi}{\text{wt. of Cu in 1-}\Phi} = \frac{3A_3L}{2A_1L} = \frac{3}{2} \times \frac{1}{2} = \frac{3}{4}$

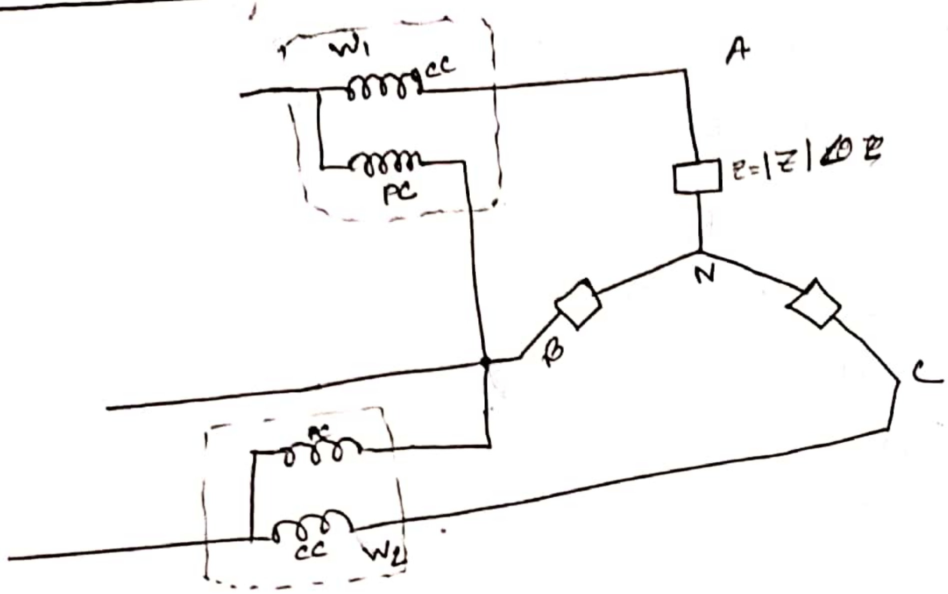
wt. of Cu in 3-Φ = 75% of wt of Cu in 1-Φ system

wt/volume একদম কম।

* এটাই advantage of 3-Φ system

Measurement of power of 3-Φ system :

2 wattmeter power



$P = V_{AB}\, i_{AN} + V_{CB}\, i_{CN}$

Let, $V_{AB} = V_{mL}\cos(\omega t + \theta)$ → $V_{BC} = V_{mL}\cos(\omega t + \theta - 120°)$

$i_{AN} = I_{mL}\cos(\omega t)$; $V_{CB} = V_{mL}\cos(\omega t + \theta - 120° + 180°)$

a-b-c sequence

$P = V_{mL}\cos(\omega t + \theta)\, I_{mL}\cos(\omega t) + V_{mL}\cos(\omega t + \theta + 60°)\, I_{mL}\cos(\omega t + 120°)$

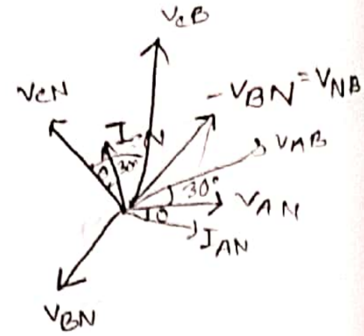
$= \frac{1}{2} V_{mL} I_{mL}\left[\cos\theta + \cos(2\omega t + \theta)\right] + \frac{1}{2} V_{mL} I_{mL}\left[\cos(\theta - 60°) + \cos(2\omega t + \theta + 180°)\right]$

$= \frac{1}{2} V_{mL} I_{mL}\left[\cos\theta + \cos(2\omega t + \theta) + \cos(\theta - 60°) - \cos(2\omega t + \theta)\right]$

$= \frac{1}{2} V_{mL} I_{mL}\left[2\cos\frac{2\theta - 60°}{2}\cos\frac{60°}{3}\right]$

$= \frac{\sqrt{3}}{2} V_{mL} I_{mL}\cos(\theta - 30°)$

$r\angle\theta = r\cos\theta + j\, r\sin\theta$



$$P = P_1 + P_2$$

$$P_1 = Re\left[V_{AB} I_{AN}^{*}\right]$$

$$P_2 = Re\left[V_{CB} I_{CN}^{*}\right]$$

$$V_{AB} = V_{AN} - V_{BN}$$
$$= V_{AN} + (-V_{BN})$$

$$V_{CB} = V_{CN} - V_{BN}$$

$$P_1 = Re\left[V_{AB} I_{AN}^{*}\right]$$
$$= Re\left[V_{Ab}\angle 30^\circ \cdot I_{an}\angle +\theta\right]$$
$$= V_{ab} I_{an} \cos(30^\circ + \theta)$$
$$= V_L I_L \cos(30^\circ + \theta)$$

$$P_2 = Re\left[V_{CB} I_{CN}^{*}\right] = V_{cb} I_{cn} \cos(30^\circ - \theta)$$
$$= V_L I_L \cos(30^\circ - \theta)$$

Two wattmeter, $P = P_1 + P_2$

$$= V_L I_L \cos(30^\circ + \theta) + V_L I_L \cos(30^\circ - \theta)$$
$$= V_L I_L \left[2\cos 30^\circ \cos\theta\right]$$
$$= V_L I_L \, 2 \cdot \frac{\sqrt{3}}{2} \cos\theta = \sqrt{3}\, V_L I_L \cos\theta$$

Electronics

V. K. Mehtab

Electronics is the branch of engineering which deals with the conduction of currents through semi-conductor and gases

Semi-conductor

A " is a material whose conductivity can be controlled by using proper doping.

Characteristics:

1) It's conductivity is in betn conductor and insulator
2) It is magnetic temperature coefficient i.e with the increase of " , the resistivity of semi-conductor materials is decreased.
3) The no. of valence electron is four.
4) It's conductivity can be contrealled by using doping
5) ~~It's conduction band~~
6) The no. e- in the conduction band of a semi. conductor material is depend on doping.

Difference among conductor, semi-conductor and insulator.

~~Inetri~~ Intrinsic semi-conductor

The semi conductor material in pure form is called ~~I Se~~ Instrinsic semi-conductor.

Extrinsive semi-conductor:

The semi conductor material in which penta-valent or tri-valent atom is added is called extrinsive semi-conductor.

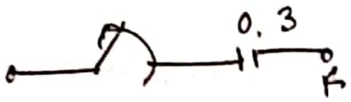
2 types: 1) ~~A~~ N-type 2) P-type

N-type ↓ penta valent — If penta valent like As is added to a pure semi-conductor

P-type ↓ tri-valent

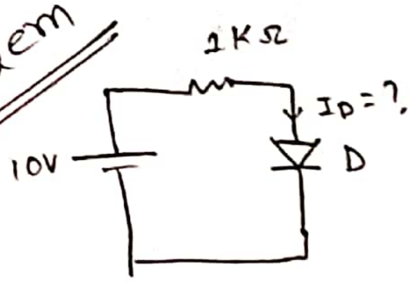
For Si Ge diode

$V_D > 0.3$

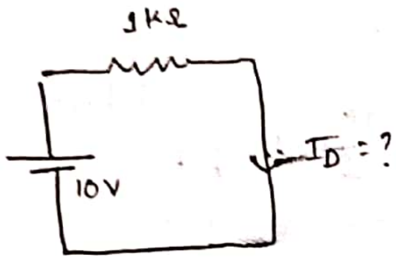


$V_D < 0.3$

Problem

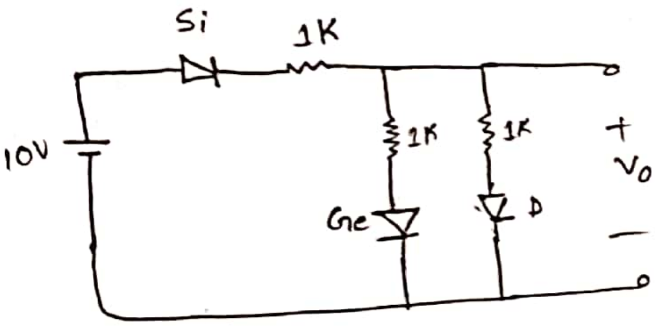


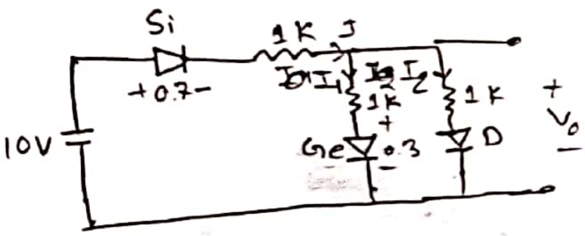
⇒



$I_D = \frac{10-0.7}{1K} = 9.3$

$I_D = \frac{10}{1K} = 10\,mA$





$I = I_1 + I_2$

$\Rightarrow \frac{9.3-V}{1} = \frac{V-0.3}{1} + \frac{V}{1}$

$\therefore V = 3.2V$

$I_1 = \frac{3.2-0.3}{1} = 2.9\,\mu A$

$I_D = 3.2 \times 10^{-3}\,A$

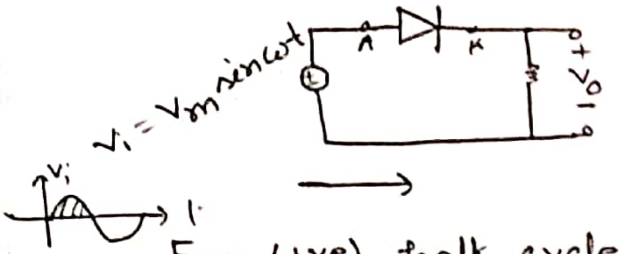
AC থেকে DC তে convert

03-12-2019

Rectifiers:

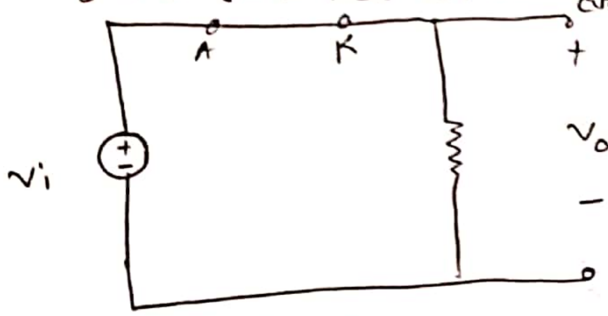
2 types ⇒ i) Half wave   ii) Full wave – { Bridge rectifier; Rectifier using centre-tap transformer }

Half wave rectifier:



For (+ve) half cycle of input

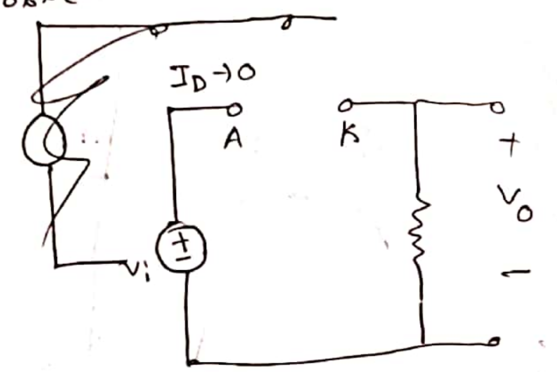
D → on (will act as an short circuit)



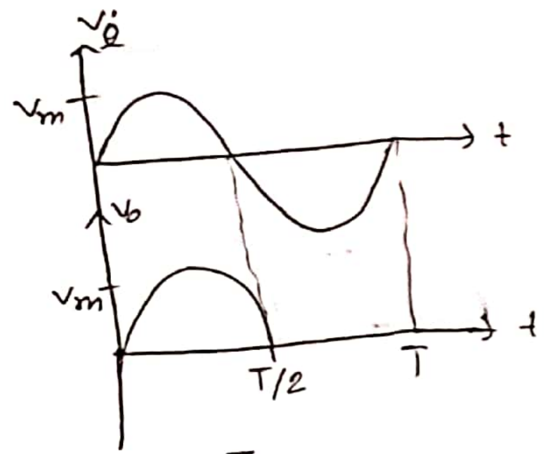
$\therefore V_o = V_i$

For (−) ve half of cycle of i

D → off (will act as an open circuit)



$V_o = 0 \cdot IR = 0$



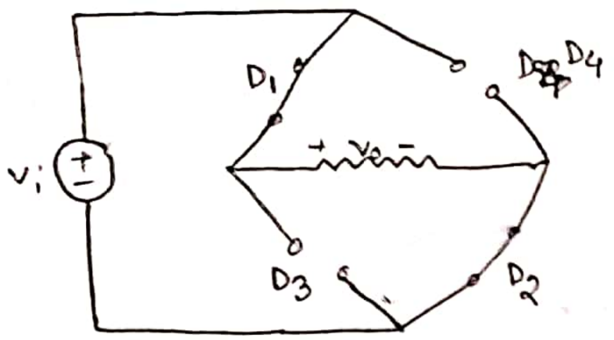
$$V_{AVG} = \frac{1}{T}\int_0^T v_o\,dT$$

$$= \frac{1}{T}\left[\int_0^{T/2} v_i\,dt + \int_{T/2}^{T} 0 \cdot dt\right]$$

$$= \frac{1}{T}\int^{T/2} V_m \sin\omega t\,dt = \frac{V_m}{T}\left[-\frac{\cos\omega t}{\omega}\right]_0^{T/2}$$

For (+ve) half cycle

$D_1 \rightarrow$ on, $D_4 \rightarrow$ off, $D_3 \rightarrow$ off ; $D_2 \rightarrow$ on

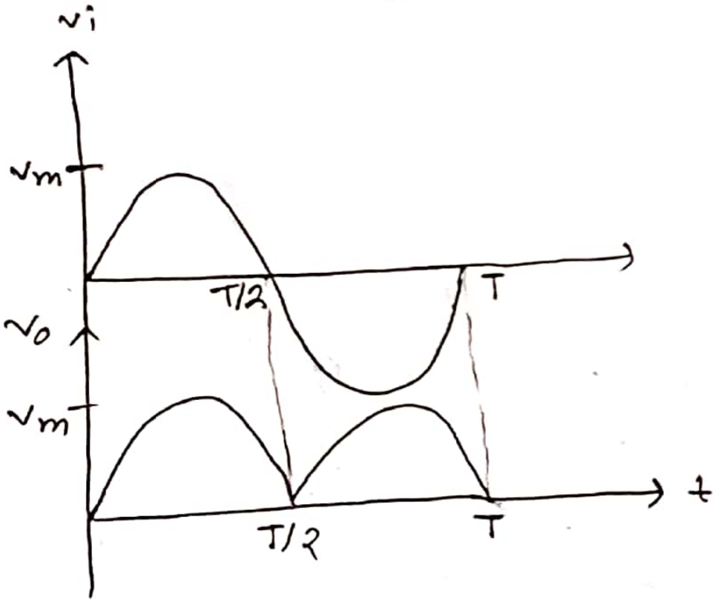


$v_o = v_i$

For (-ve) half c

$D_1, D_2 \rightarrow$ off $D_3, D_4 \rightarrow$ on

$v_o = -v_i$



Machine

(1) Faraday's laws of electromagnetic

(2) Right hand rule for generator and left hand rule fo[r] mot[or]

(3) Working ~~loop~~ principle of simple loop DC generator

(4) " " " " motor

(5) ~~Y duss~~ Why does the rotor of an induction motor rotate?

(6) Why the ~~belt~~ of a DC motor should never left ope[n]

Electronic machine থেকে 1 set or কম

Electronics → 1 set

DC → 3 set

12 → 1 set

9, 11 → 2 set

Practice problem example