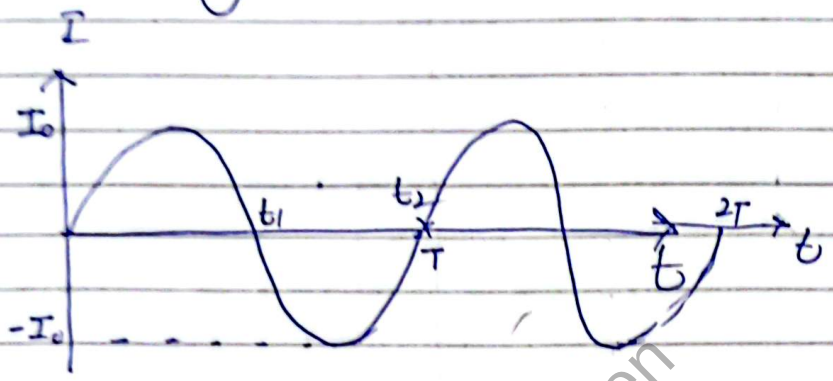
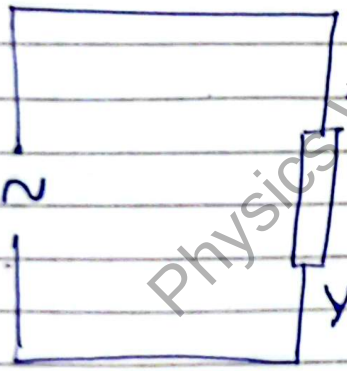
AC current

Alternating current (AC)

Current which changes direction periodically.

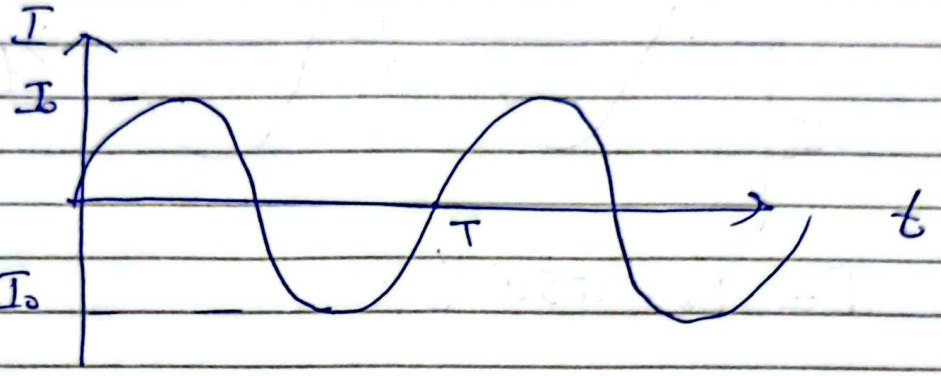




from 0 to t_1 current flows from x to y and from t_1 to t_2 current flows from y to X and this process repeats periodically.

Other types of AC current

① Sinosodal current



peak current: Maximum current

Equation

$$\boxed{I = I_0 \sin(\omega t)}$$

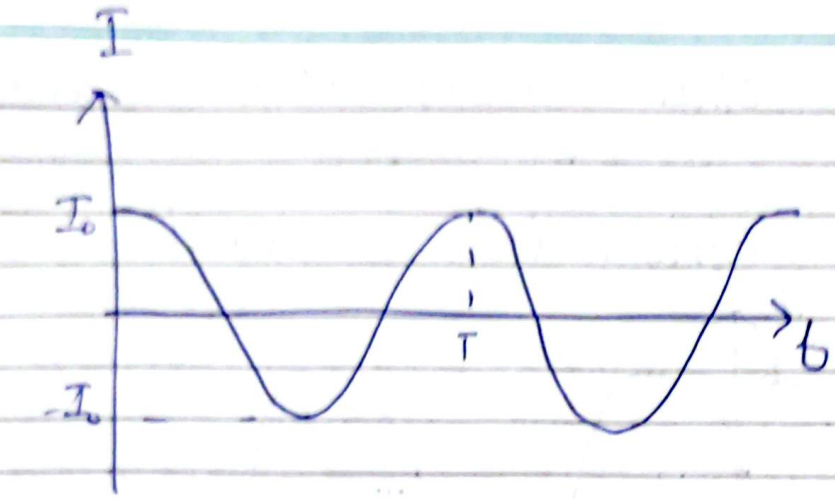
$\omega = \frac{2\pi}{T} = 2\pi f$ ... ω: angular frequency

$I = I_0 \sin(2\pi f t)$

f: frequency

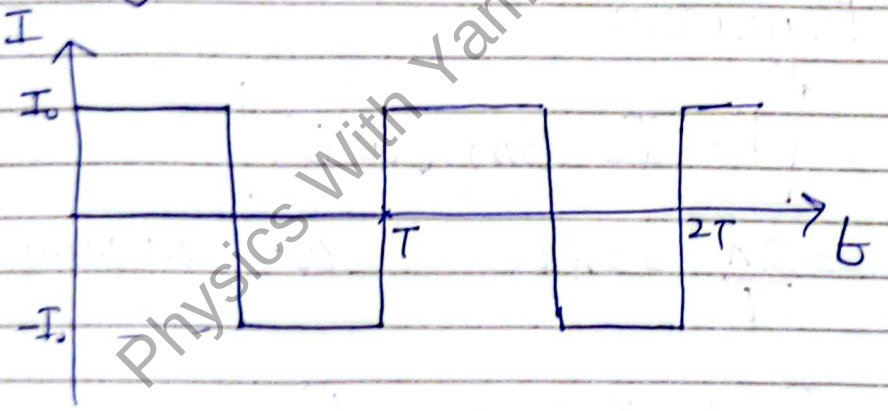
Number of cycles per unit time.

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

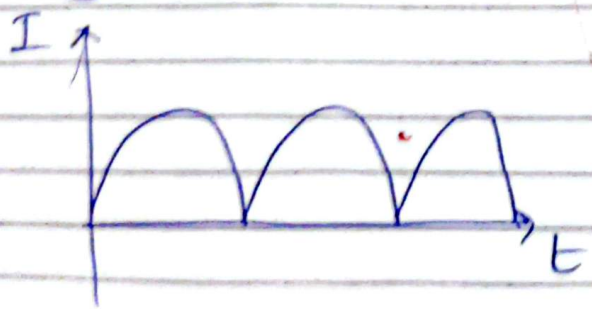


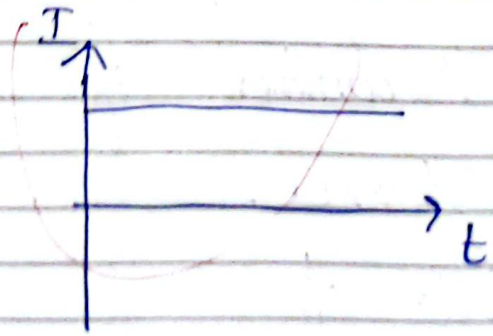
$I = I_0 \cos\omega t$

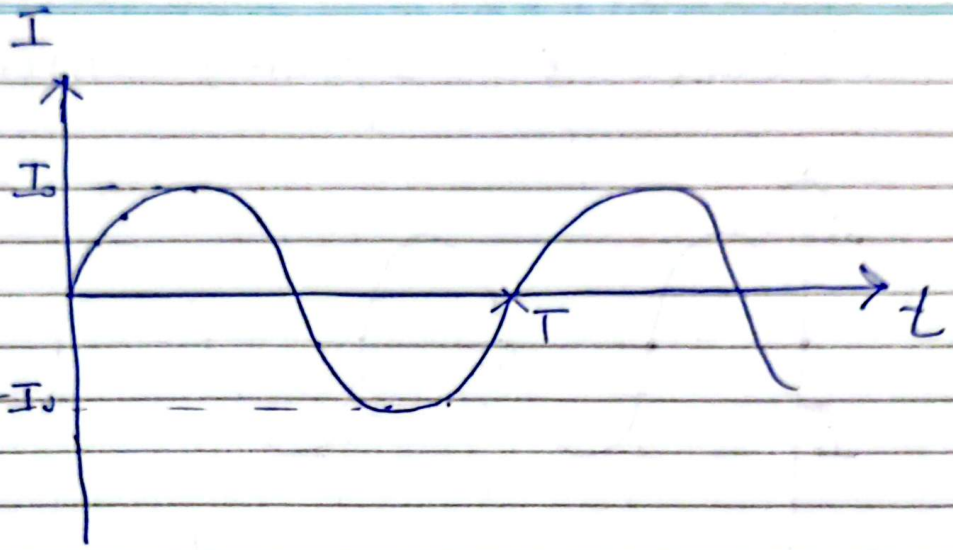
(2) Rectangular AC current



(3) Pure DC current







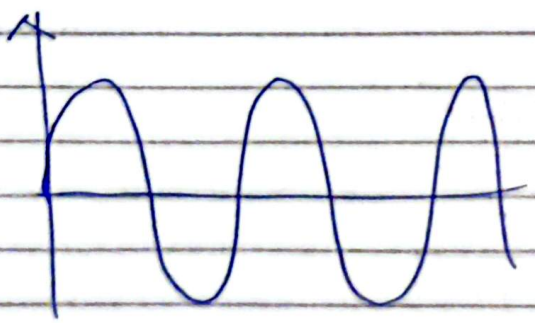
$I = I_0 \sin \omega t$

Mean current $\rightarrow \langle I \rangle$

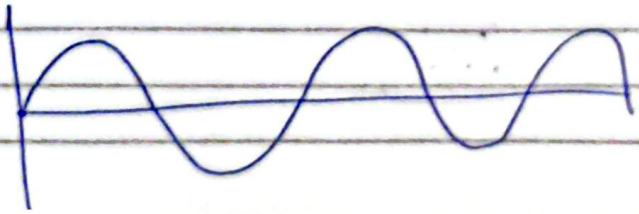
Mean current or average current is zero

$\langle I \rangle = 0$

average of sinusoidal current is zero.

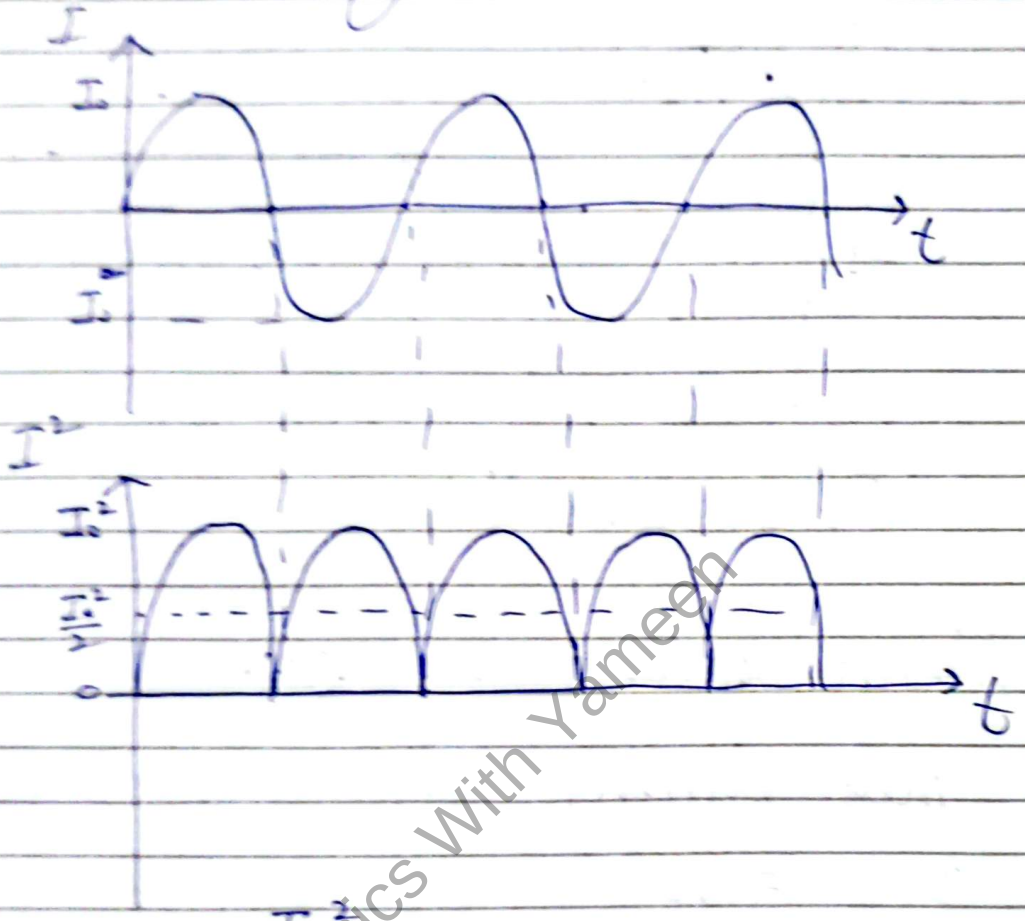


$\langle I_1 \rangle = 0$



$\langle I_2 \rangle = 0$

Average of squared current



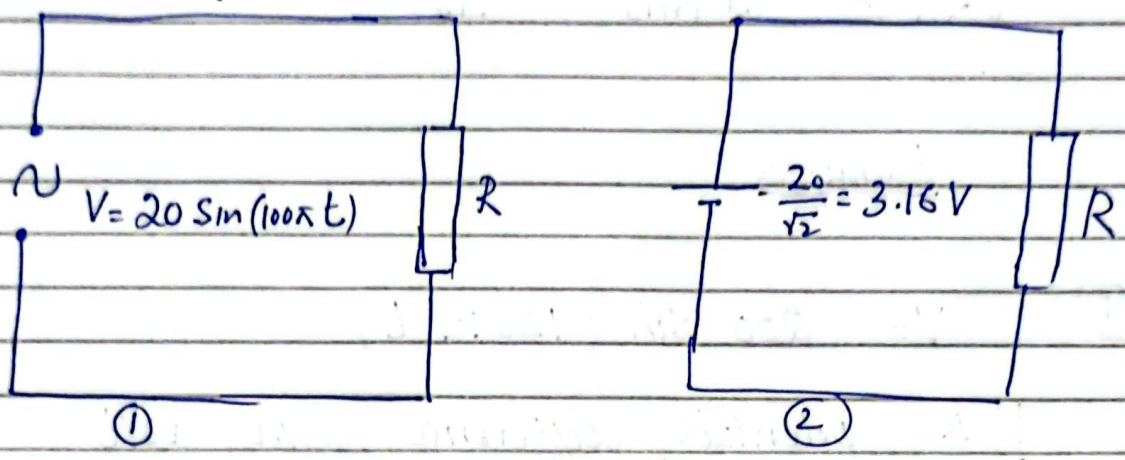
$$\langle I^2 \rangle = \frac{I_0^2}{2}$$

$\sqrt{\langle I^2 \rangle}$ = Root mean square value

$$I_{rms} = \sqrt{\frac{I_0^2}{2}}$$

$$\boxed{I_{rms} = \frac{I_0}{\sqrt{2}}}$$

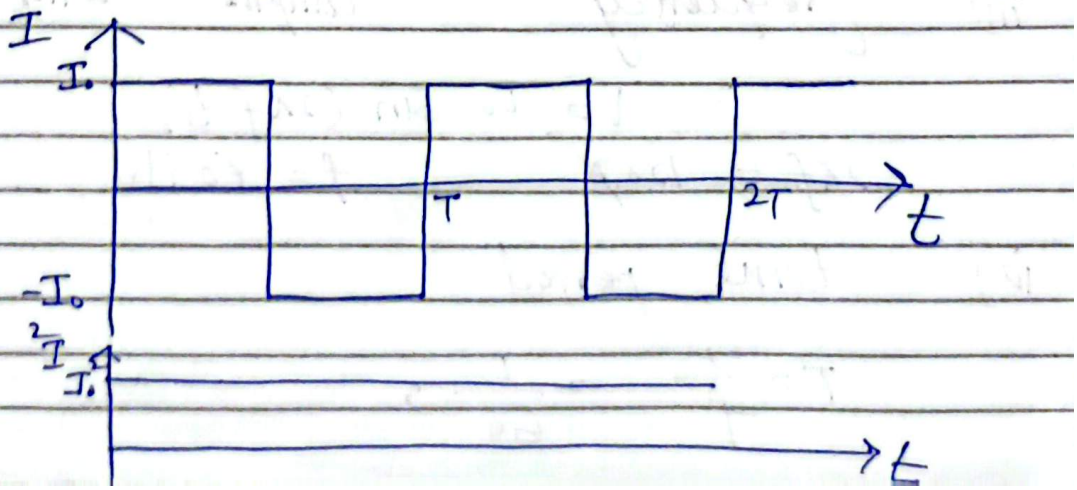
Definition of root-mean squared value



It is that value of direct current or voltage that gives same heating effect as AC current gives.

In above example same power is decipated along both resistors

Rms value of rectangular AC current



$$\langle I^2 \rangle = I_0^2$$

$$\sqrt{\langle I^2 \rangle} = I_{rms} = I_0$$

Examples

① $V = 200 \sin(120\pi t)$

V is potential difference in volt
t is in second

Find

i) peak voltage

$V_0 = V_{peak} = 200\ V$

ii) Average voltage $\langle V \rangle$

$\langle V \rangle = 0$

iii) frequency Compare with

$V = V_0 \sin(2\pi f t)$

$2\pi f = 120\pi$ $\quad f = 60\ Hz$

iv) time period

$T = \frac{1}{f} = \frac{1}{60}\ s$

Root mean squared voltage

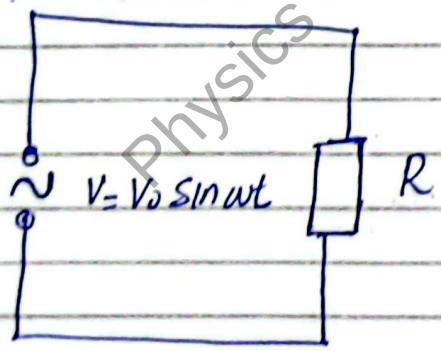
V_{rms} ?

$$V_{rms} = \frac{V_0}{\sqrt{2}} = \frac{200}{\sqrt{2}} = 141\ V$$

Power in AC

$$I = I_0 \sin \omega t$$

$$V = V_0 \sin \omega t$$



$$P = I^2 R$$

$$P = I_0^2 \sin^2 \omega t\ R$$

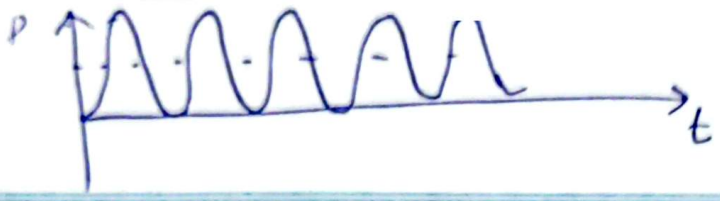
$$P = I_0^2 R \sin^2(\omega t)$$

$$P_{max} = I_0^2 R$$

$\sin^2 x_{max} = 1$

$\sin^2 x_{(min)} = 0$

$P_{min} = 0$



Average power

$$\langle P \rangle = \frac{I_0^2 R}{2}$$

$$\boxed{\langle P \rangle = I_{rms}^2 R}$$

$$I_{rms} = \frac{I_0}{\sqrt{2}}$$

$$I_{rms}^2 = \frac{I_0^2}{2}$$

$$P = VI$$

$$P = V_0 \sin\omega t \times I_0 \sin\omega t$$

$$P = V_0 I_0 \sin^2(\omega t)$$

$$\langle P \rangle = \frac{V_0 I_0}{2}$$

$$\langle P \rangle = \frac{V_0}{\sqrt{2}} \times \frac{I_0}{\sqrt{2}}$$

$$\sqrt{2} \times \sqrt{2} = 2$$

$$\therefore$$

$$\boxed{\langle P \rangle = V_{rms} \times I_{rms}}$$

$$P = \frac{V^2}{R}$$

$$P = \frac{V_0^2 \sin^2 \omega t}{R}$$

$$\langle P \rangle = \frac{V_0^2}{2R}$$

$$V_{rms} = \frac{V_0}{\sqrt{2}}$$

$$V_{rms}^2 = \frac{V_0^2}{2}$$

$$\boxed{\langle P \rangle = \frac{V_{rms}^2}{R}}$$

Rectification

process of converting AC to DC

There are two types of rectifications

① ~~Full~~ Half Wave rectification

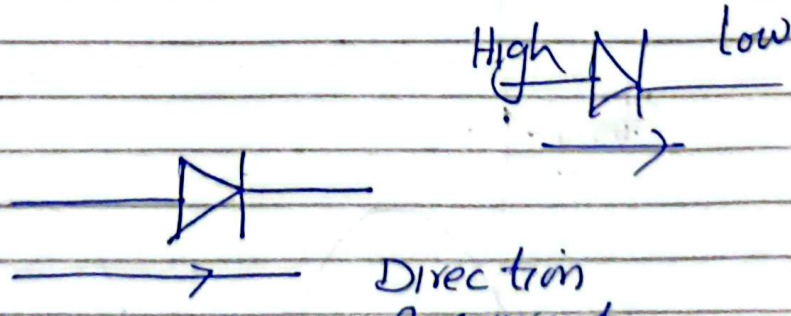
② Full Wave rectification

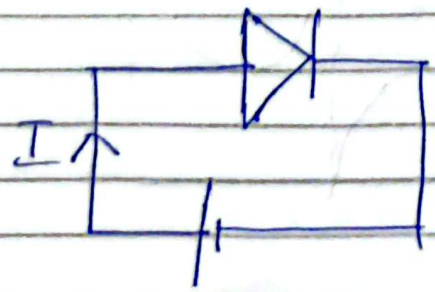
Half wave

Diode is used to perform rectification.

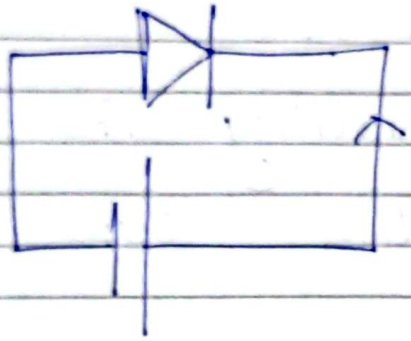
Diode allows current only in direction

Symbol



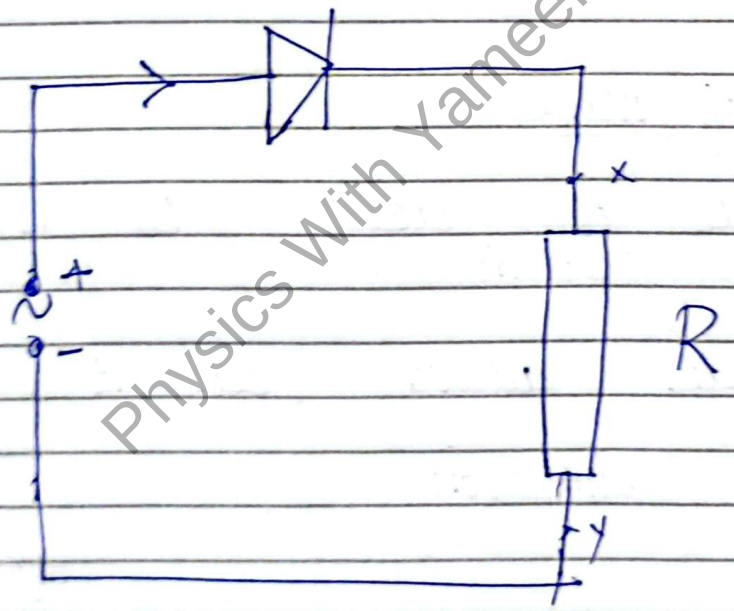


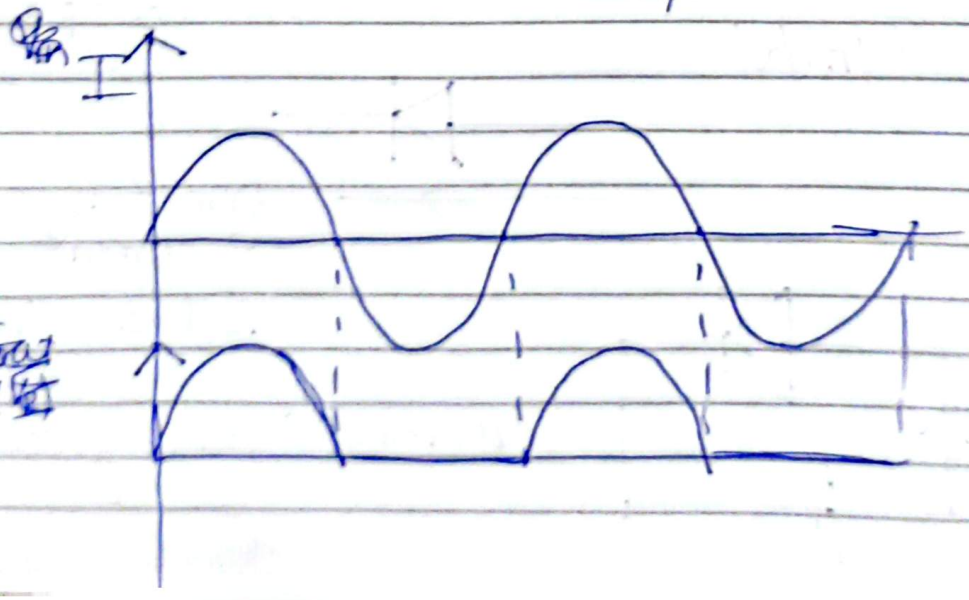
current will flow



No current will flow

Circuit of half wave rectification





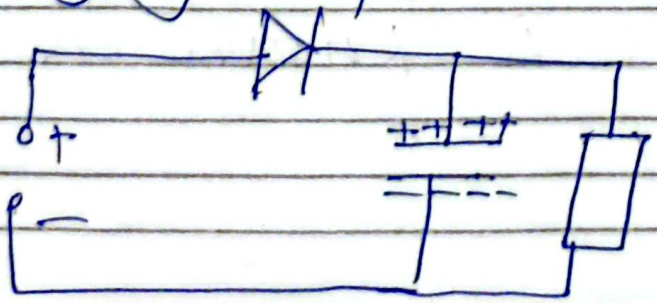
During positive half cycle of input current will flow through the diode and through resistor from x to y

During negative half cycle of input no current will flow through the resistor as diode is ~~reverse biased~~ not allowing current to pass.

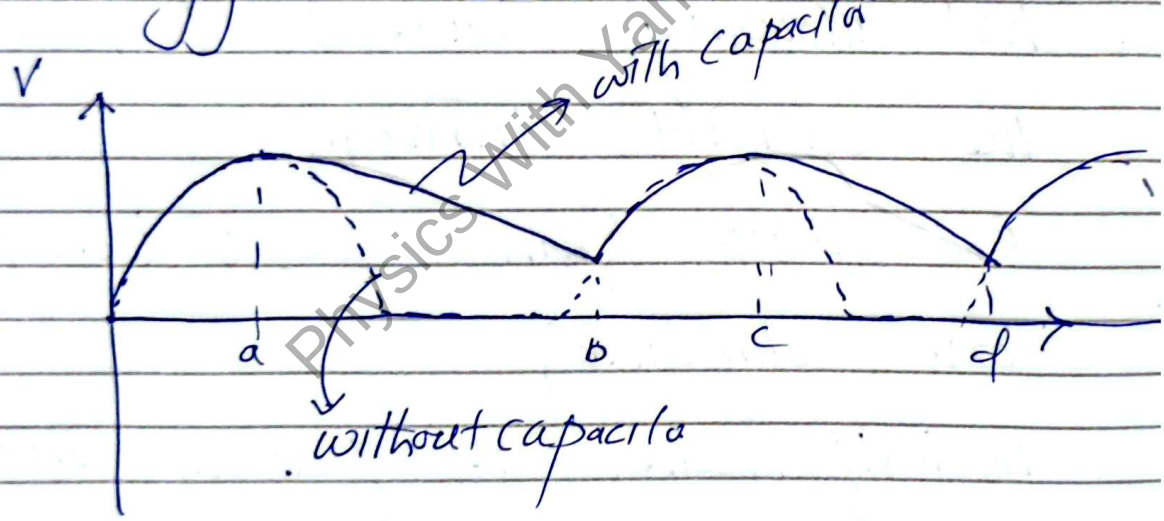
The current through resistor is always from x → y (only one direction)

In half wave rectification one cycle is stoped.

Applying Capacitor parallel to R



During positive half cycle capacitor will charge when During negative half cycle there is no current through the diode so capacita will discharge through R. Now it will supply energy to resistor

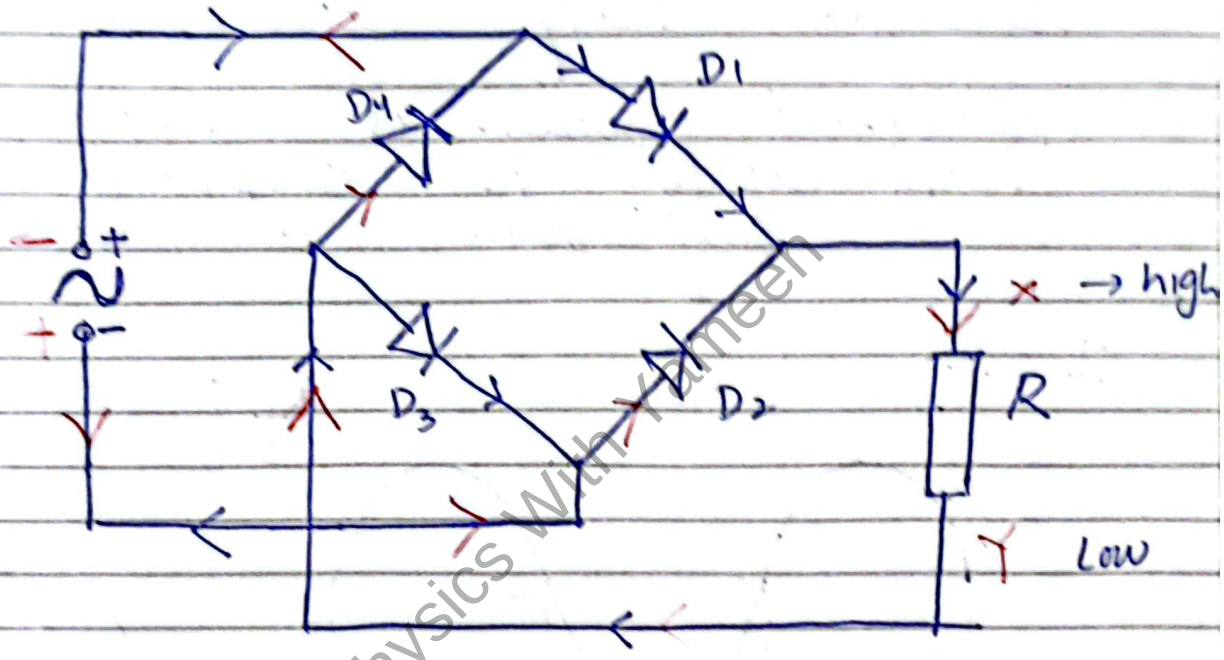


from a to b capacitor discharges
c " d

This process is known as smoothing

Full wave rectification

Four diodes are used

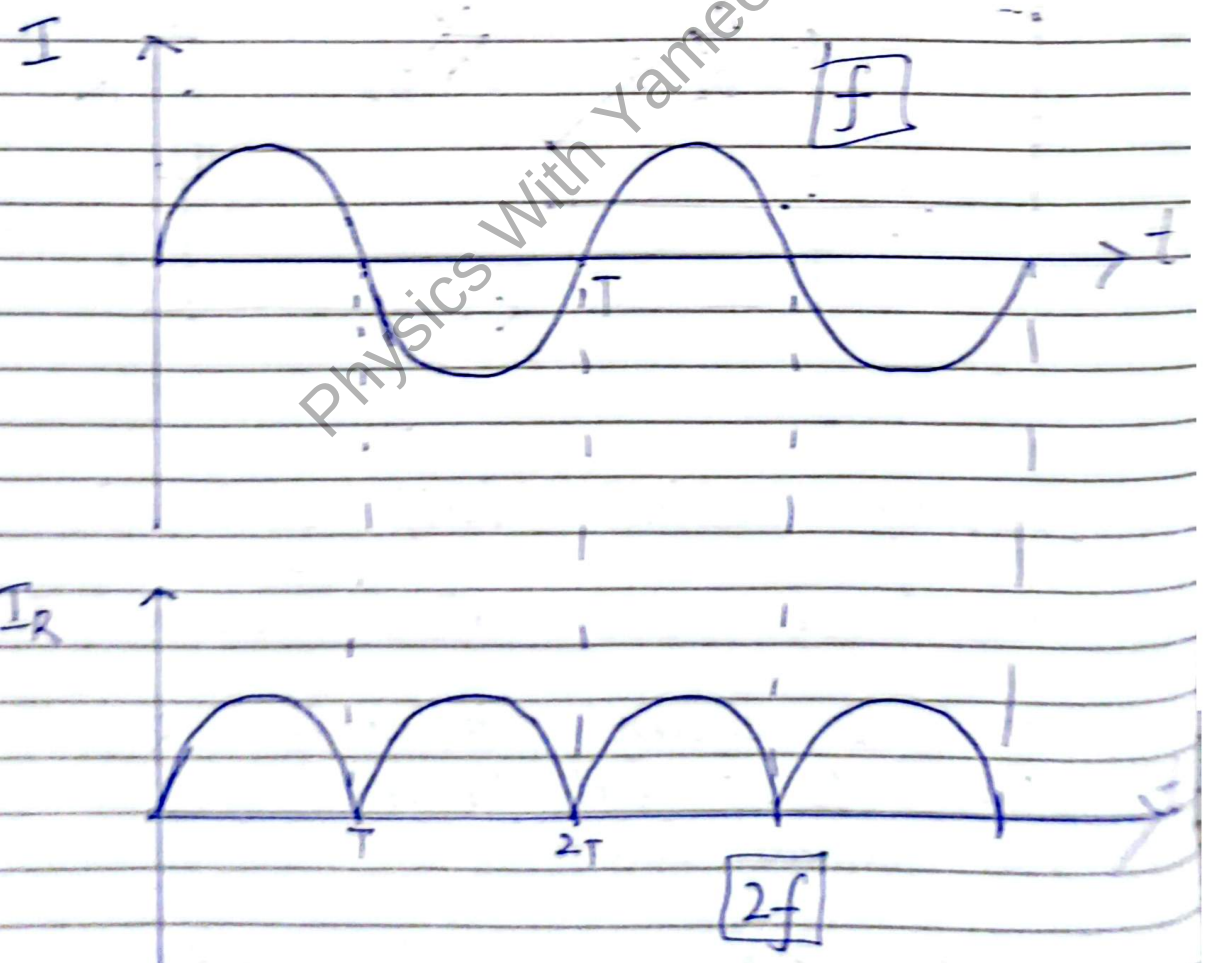


During positive half cycle D_1 and D_3 will allow current to pass so current through R is from x to y but D_2 and D_4 will not allow current.

During negative half cycle D_2 and D_4 will (forward biased (allow current)) but D_1 and D_3 will not. So direction

of current in this cycle is also from x to y in Resistor R.

In full wave rectification negative half cycle is reversed where as negative half cycle is stopped in half wave rectificat

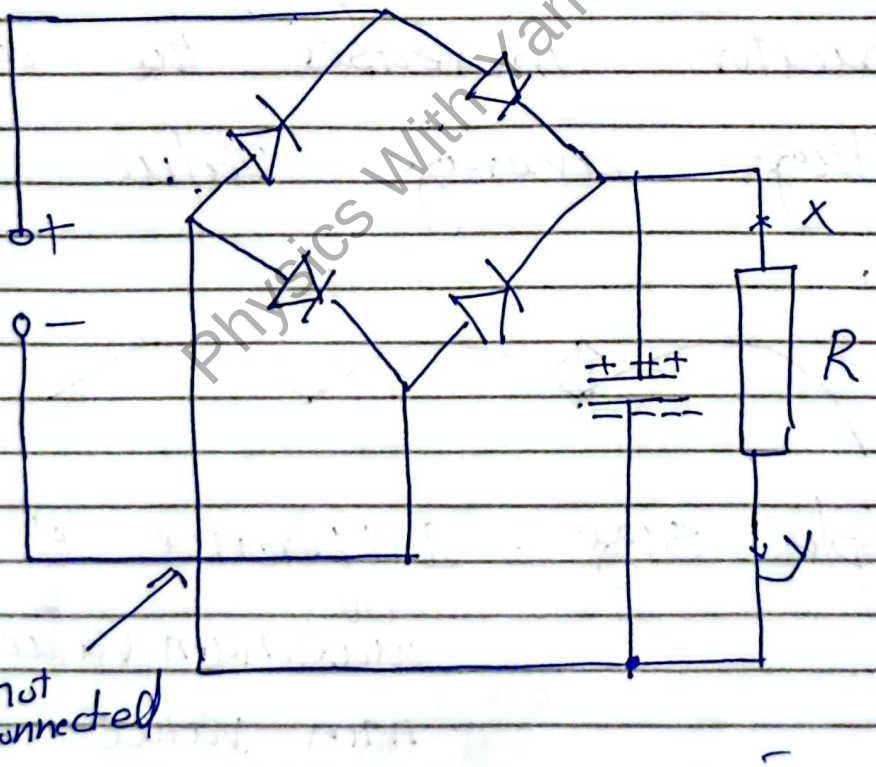


Frequency of rectified (Full wave) is two times the frequency of AC

Smoothing

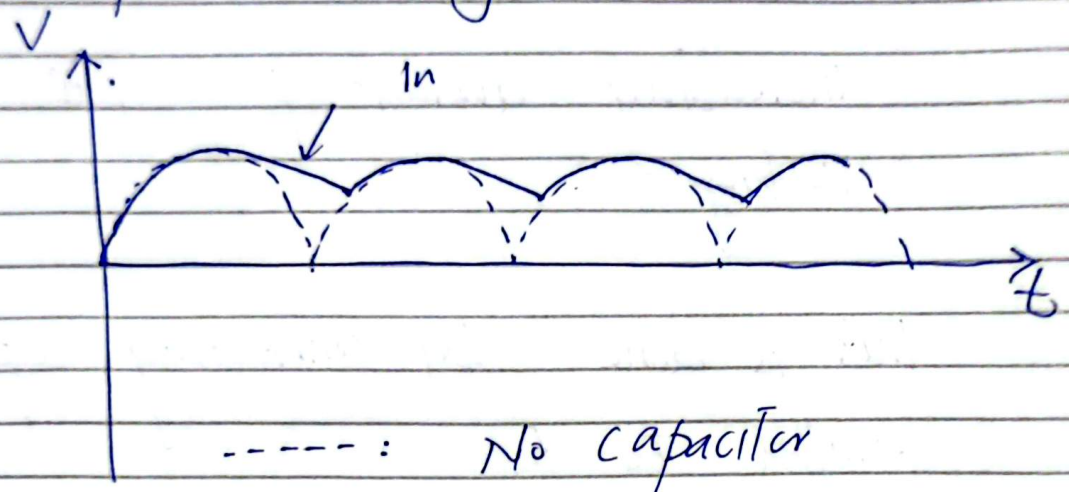
Increasing average of output voltage

This is done by connecting capacitor parallel to R



Capacitor will charge and then discharge through R

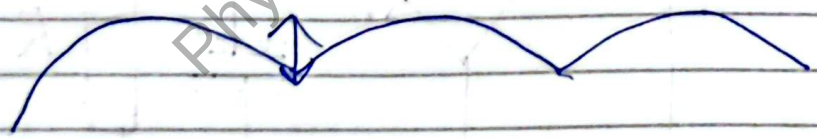
output voltage



----- : No capacitor

——— : In the presence of capacitor

Capacitor increases the output voltage average value

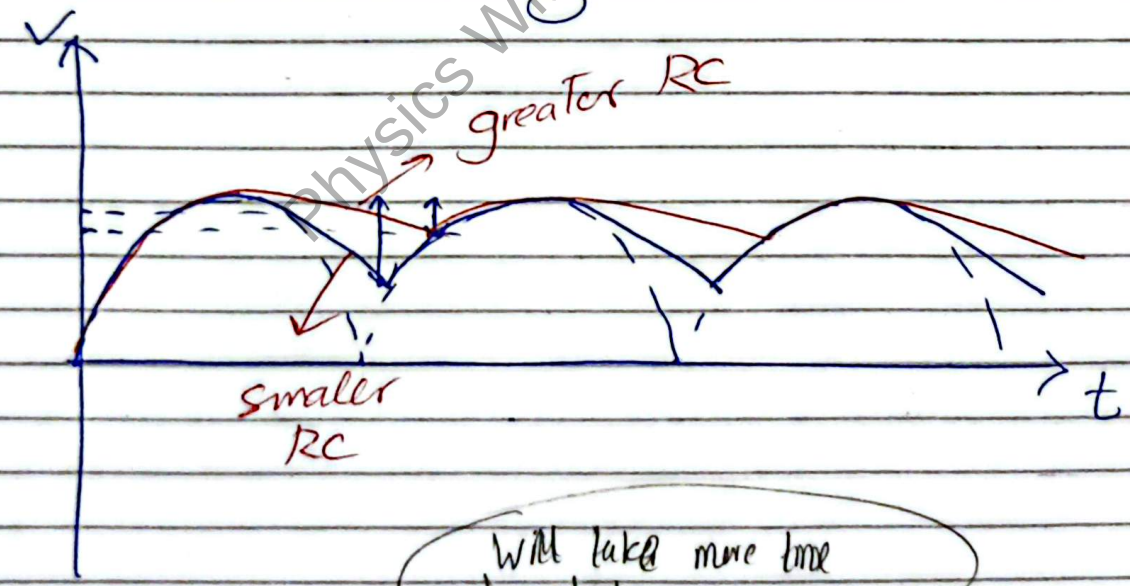


Ripple size : Difference of maximum value and min value

Capacitor decreases ripple size of output voltage

~~The~~ effect of value of R and C on ripple size.

You know $\tau = RC$ is time constant of this product is increased capacitor will discharge slowly so ripple size will decrease even it be zero



Will take more time to discharge