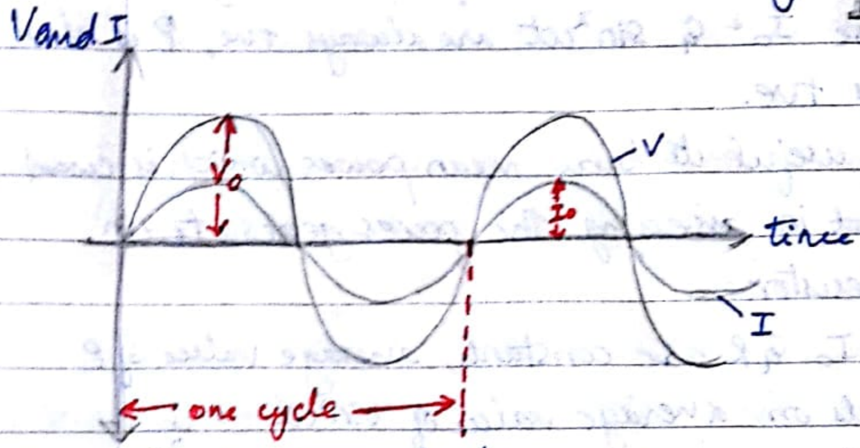
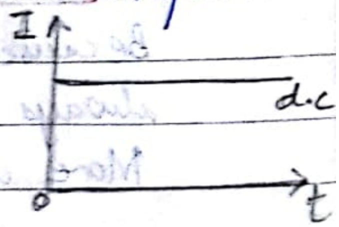
Alternating Currents

* **Period**: The time period T of an alternating p.d. or current is the time taken for one complete cycle.
* **Frequency**: The frequency of an alternating p.d. or current is the number of cycles in one second.
* Peak values of voltage (V_0) and current (I_0) are their maximum values in a cycle i.e. amplitude.





Graph shows that:

- current & voltage varies cyclically
- i.e. half of the cycle, +ve & other half it is −ve.
- at any instant in time, I & V have a particular magnitude & direction given by the graph.
- V & I vary like a sine wave & ∴ described as sinusoidal.
- V & I are in phase.
- At time t,

  $I = I_0 \sin \omega t$

  $V = V_0 \sin \omega t$

of the form $x = x_0 \sin \omega t$ for sinusoidal curve.

* The peak value of the current or voltage is I_0 or V_0, the amplitude of the oscillating current or voltage.
* Peak-to-peak value is used, this means $2I_0$ or $2V_0$ or twice the amplitude.

* **Power:**

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

$\therefore$ $P = I_0^2 R \sin^2 \omega t$ = power @ any instant.

Because I_0^2 & $\sin^2 \omega t$ are always +ve, P is also always +ve.

More useful to know mean power which is used ~~assessed~~ in assessing the power generated in the resistor.

Since I_0 & R are constants, average value of P depends on average value of $\sin^2 \omega t = \frac{1}{2}$

$\therefore \langle P \rangle = \frac{1}{2} I_0^2 R = \frac{1}{2} V_0^2 R$

This is half the maximum power.

Avg. value of square of current/p.d. ~~as~~ can be used.

$\langle I^2 \rangle = \frac{1}{2} I_0^2$ and $\langle V^2 \rangle = \frac{1}{2} V_0^2$

* Root-mean-square (rms) values
→ aka effective value
→ equivalent to a steady direct current
→ d.c of value I = ac. of value I_{rms}
• The rms value of the current or voltage is that value of the direct current or voltage that would produce heat at the same rate in a resistor.
• The rms value of an ac is that steady current which delivers the same average power as the d.c. to a resistive load.

$I_{rms} = \frac{I_0}{\sqrt{2}}$ **rms value = $\frac{\text{peak value}}{\sqrt{2}}$** $V_{rms} = \frac{V_0}{\sqrt{2}}$

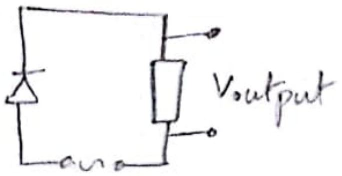
* $I_{rms} = \sqrt{\langle I^2 \rangle} = I_0 \sqrt{2} = 0.707 I_0$
* $V_{rms} = \sqrt{\langle V^2 \rangle} = V_0 \sqrt{2} = 0.707 V_0$

$V_{rms} = \langle V \rangle = \frac{V_0}{\sqrt{2}}$ $\langle I \rangle = \frac{I_0}{\sqrt{2}}$

* Transformer
→ It is a pair of mutually inductive coils used to convey a.c. power from one coil to the other.
→ $\frac{N_s}{N_p} = \frac{V_s}{V_p} = \frac{I_P}{I_s}$ for ideal transformer.

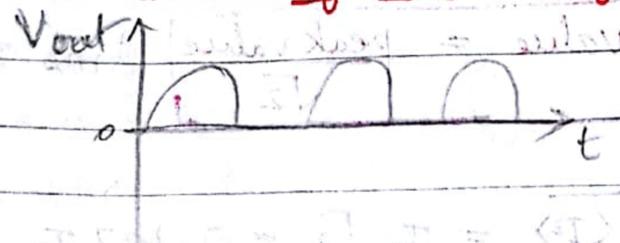
$P = V_p I_p = V_s I_s$

$\therefore \frac{V_p}{V_s} = \frac{I_s}{I_p}$



* Rectification is the process by which alternating current is converted to direct current.

→ Suppose a single diode is connected to an a.c. circuit ⇒ unidirectional flow of I ⇒ output voltage across resistor will consist only of the +ve half-cycles of the input of voltage.
The diode has rejected the −ve part of the input, producing a unidirectional current that fluctuates considerably, rather than a d.c.
This is called half-wave rectification.

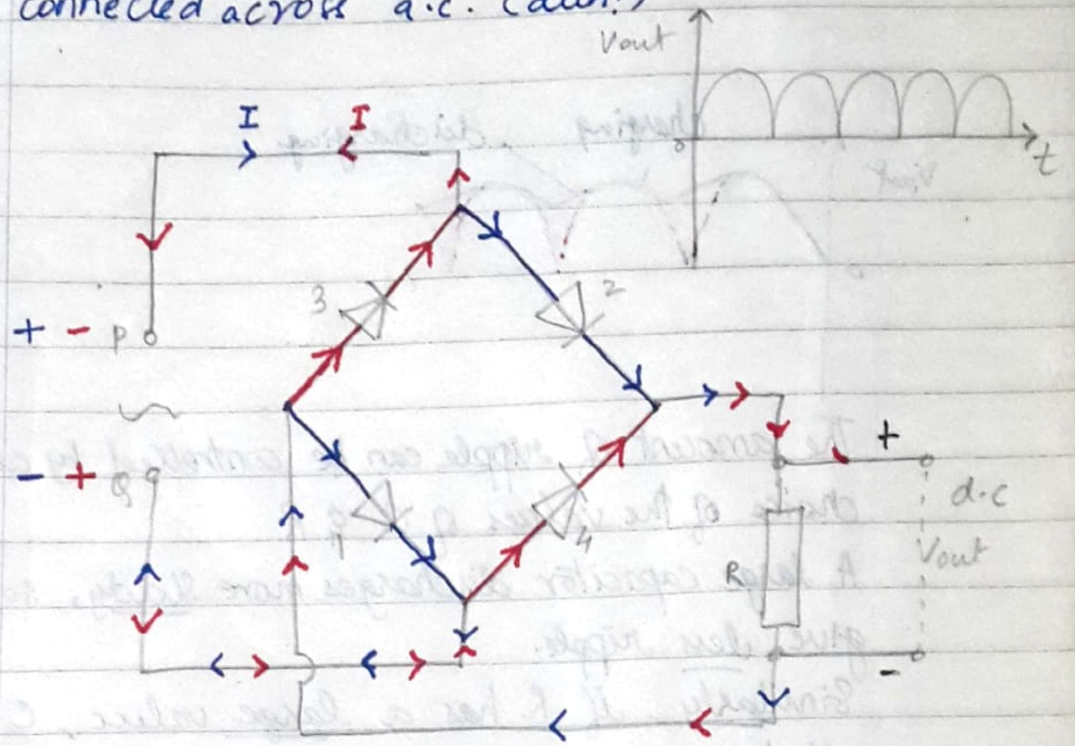


For one half of the time the voltage is zero & this means that the power available from a half-wave rectified supply is reduced.

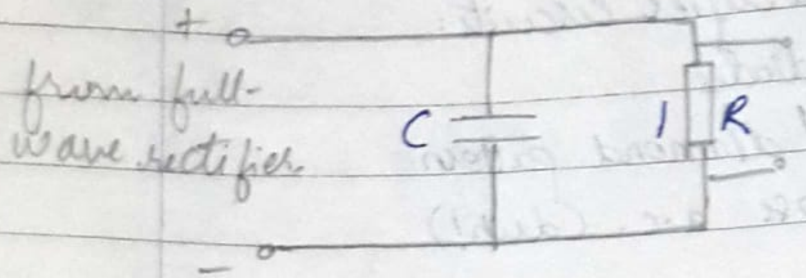
→ To overcome this problem of reduced power, a bridge rectifier is used.
It is more satisfactory also to make use of the −ve half-cycles of the input & reverse their polarity. This process is called full-wave rectification.

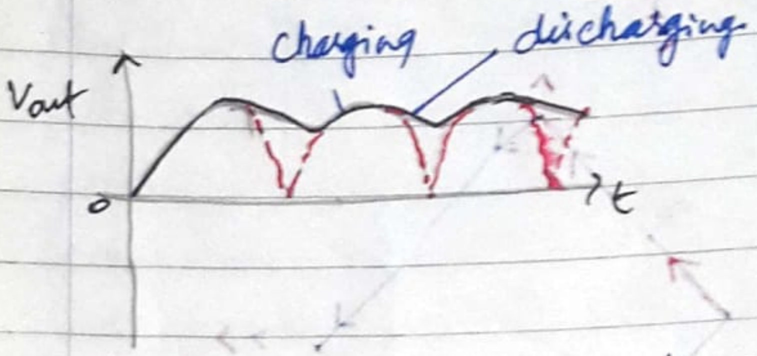
can also use LEDs

The bridge-rectifier circuit:
- consists of 4 diodes
- arranged in a diamond pattern
- connected across a.c. (duh!)



* Note that in both halves of the cycle, current flows the same way (downwards) through R, so the top end of R must be +ve.
* The circuit has produced unidirectional current but the output is still not a good approximation to the steady d.c. required for most electronic equipment.
* A capacitor is inserted across the output terminals of the bridge circuit. It charges up on the rising part of the half-cycle & then discharges as the Voutput falls. The effect is to reduce the fluctuations in the unidirectional output. This process is called ~~so~~ <u>smoothing</u>.





The amount of ripple can be controlled by careful choice of the values of C & R.
A large capacitor discharges more slowly, so will give less ripple.
Similarly, if R has a large value, C will discharge more slowly.
In practice, the greater the value of R×C, the smoother the rectified a.c.
However, if R & C have large values, it will be difficult to change the value of the voltage quickly.