Alternating Current: Occurs when charge carriers periodically reverse their direction of motion.

Is related to DC by:

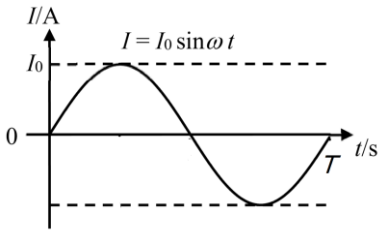
The root-mean-square value of an alternating current is that equivalent constant direct current that will dissipate the same power in a given resistive load.

$$I_{r.m.s.} = I_{d.c.}$$

Steps to calculate r.m.s. values for any AC graph

1. Square the $I - t$ *or* $V - t$ *graph*
2. Find area under graph in 1 period.
3. Divide the area by the 1 period to get the mean-square value.
4. Square-root the mean-square value to obtain the root-mean-square value.

Sinusoidal AC:



An equation to represent the current-time variation is

$$I = I_0 sin\omega t$$

Where:

I is the instantaneous value of current.

I_0 is the peak current.

T is the period.

ω is the angular frequency.

Root-mean-square values (r.m.s.) values:

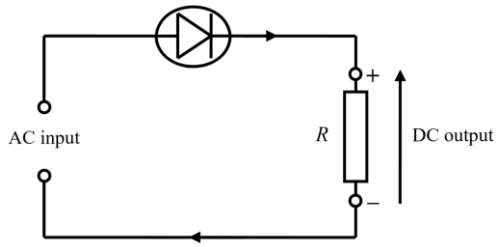
$$I_{r.m.s.} = \frac{I_0}{\sqrt{2}}$$

$$V_{r.m.s.} = \frac{V_0}{\sqrt{2}}$$

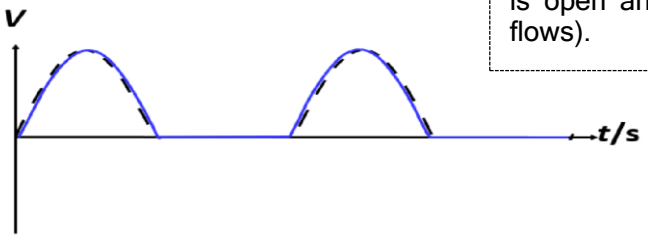
NOTE: These two formulae can only be used for sinusoidal waveforms.

Commercially, AC supply is quoted in terms of r.m.s. value.

Rectification (conversion of a.c. to d.c.)



Half-wave rectification using a diode.



NOTE:

The graph below is for the real case. For ideal diode, we assume zero resistance in forward bias (no p.d. across diode and the entire input exists across the load) and infinite resistance in reverse bias (the circuit is 'open' and no current flows).

Power Dissipation:

Maximum Power

$$P_{max} = I_0 V_0$$

Average Power

$$\langle P \rangle = I_{r.m.s.} V_{r.m.s.}$$

$$= I^2_{r.m.s.} R = \frac{V^2_{r.m.s.}}{R}$$

And for sinusoidal waveforms only.

$$\langle P \rangle = \frac{I_0}{\sqrt{2}} \frac{V_0}{\sqrt{2}} = \frac{1}{2} P_{max}$$

Non-ideality in transformers

is due to:

a) Energy dissipated as heat due to resistance of windings in coils. Can be minimized by using thick wires.
b) Alternating magnetic flux induces eddy currents in iron core and causes heating. Can be minimized by using laminated core.
c) Hysteresis loss occurs whenever the direction of magnetic flux is reversed thus causing some energy to be wasted. Can be minimized by using soft iron core.
d) Flux leakage if core is badly designed.

Transformer

A device that converts an alternating potential difference (or alternating current) from one value to another value. It works on principles of electromagnetic induction.

With no flux leakage:

$$\frac{N_s}{N_p} = \frac{E_s}{E_p}$$

And no power loss:

$$V_p = E_p$$

$$V_s = E_s$$

Thus,

$$\frac{N_s}{N_p} = \frac{V_s}{V_p}$$

Also,

$$V_p I_p = V_s I_s$$

And so,

$$\frac{N_s}{N_p} = \frac{I_p}{I_s}$$