6.3.2 TIME PERIOD

The time required by one A.C cycle to complete is called time period. It is represented by T and unit is second.

6.3.3 FREQUENCY

Number of complete A.C cycles per unit time

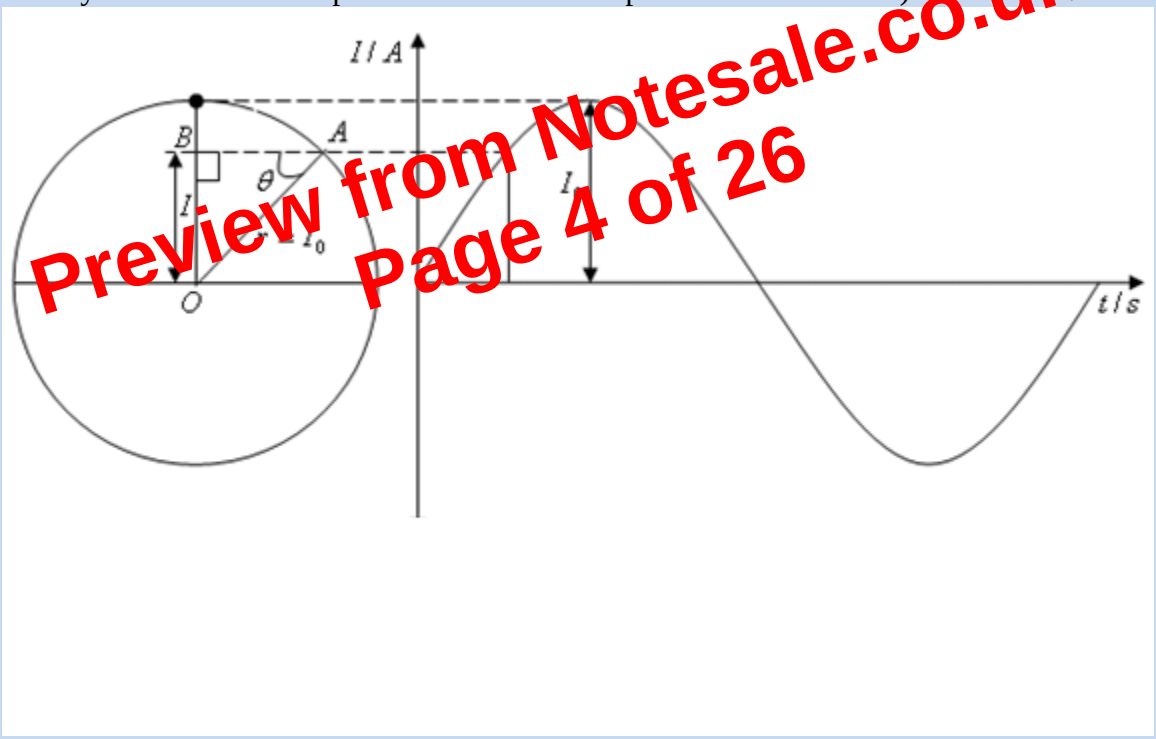
$$frequency(f) = \frac{No\ of\ \ cycles}{time}$$

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

Unit is Hertz.

6.4 RELATIONSHIP OF INSTANTANEOUS VALUE AND PEAK VALUE

Following is a graph for current versus time related to the phasor diagram (You are already familiar with this practice as done in simple harmonic motion.)



Consider the triangle OAB

$$\sin\theta = \frac{Perpedicular}{Hypotenuse} = \frac{I}{I_0}$$

So

$$I = I_0 \sin\theta$$

And

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

Where ω is angular frequency (not angular velocity), as this is the case of simple harmonic motion.

I = Current at any instant of time

I_0 = Peak current

Similarly if we want to get the relationship for voltage then it will be

$$\boxed{V = V_0 \sin \omega t}$$

6.5 POWER IN A RESISTOR WITH A.C:

In previous classes we have done calculations for power when current is D.C. Now we want to understand power in terms of A.C.

Suppose a resistor of 2Ω is provided with an A.C of $2A$.

For this case normally to calculate power we use following relationships.

$V = IR$

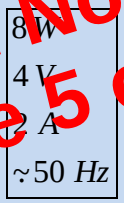
$V = 2 \times 2 = 4\,V$

And

$P = V \times I$

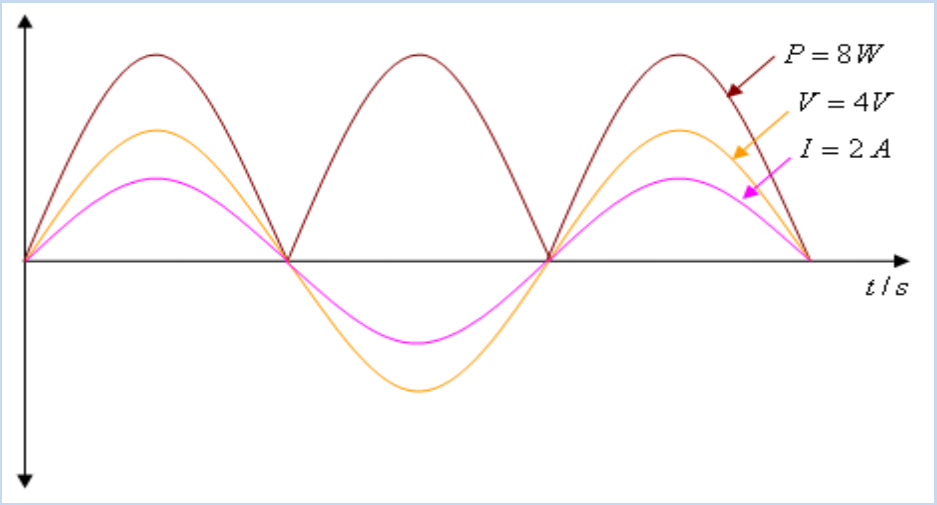
$P = 4 \times 2 = 8\,W$

You might have seen some A.C devices on which the specifications labels are pasted such as given below



What do you think? Is this a right label for the device? Before answering; first of all understand what the label says. It says that if this appliance is provided with $4\,V$ and $2\,A$ at a frequency of $50Hz$ then the output power of the appliance is $8\,W$.

Now let's draw graph for all these voltage, current and power on single axis.



If we directly calculate average then

$$I_{avg} = \frac{(+I_{peak})+(-I_{peak})}{2} = \frac{(+2)+(-2)}{2} = \frac{0}{2}$$

$$I_{avg} = 0\ A$$

Similarly

$$V_{avg} = \frac{(+V_{peak})+(-V_{peak})}{2} = \frac{(+4)+(-4)}{2} = \frac{0}{2}$$

$$V_{avg} = 0\ V$$

What a label!!!!!!!!!!

$4\ W$
$0\ V$
$0\ A$
$\sim 50\ Hz$

Think about this label on the appliance. No current required! No voltage required! Then what is $50 Hz$ and how power can be generated of $4\ W$?

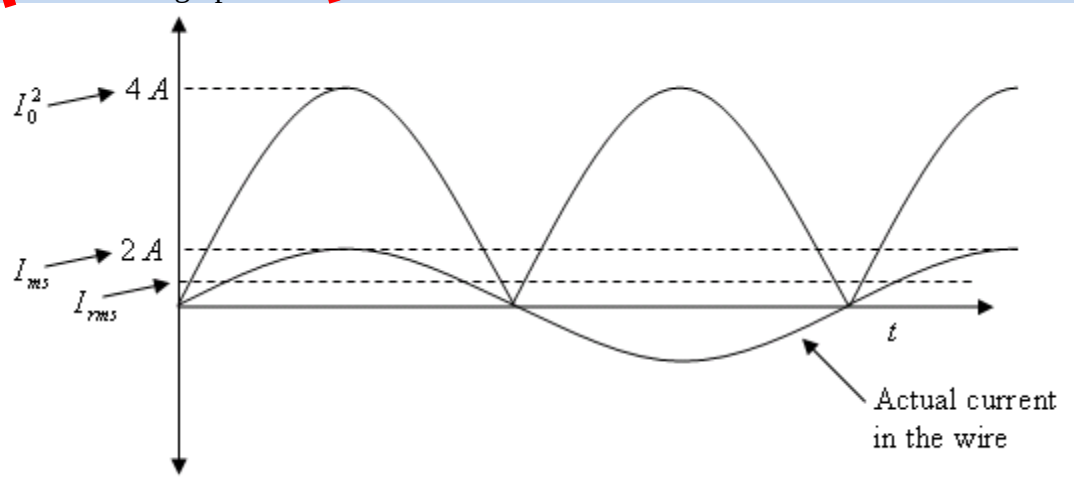
If an engineer gives this label, he will be thrown out of industry.

6.6.1 METHOD # 1

To resolve this problem, we first have to remove the negative values and there is only one way i.e.to square the values. So

$$I^2 = 4\ A$$

Now look at the graph



Now square values can't be labeled on device as well because the peak current in the wire is $2A$. Take mean of the square values i.e.,

$$I_{mean\ square} = \frac{0+4}{2} = 2\ A$$

And

$$I_{rms} = \frac{1}{\sqrt{2}} \times 2 = 1.1\ A$$

Again we got the same results.

6.6.3 METHOD # 3:

Suppose if

$$P_{mean} = \frac{1}{2} I_0^2 R$$

And

$$P_{mean} = I_{rms}^2 \times R$$

Then

$$I_{rms}^2 \times R = \frac{1}{2} I_0^2 R$$

So

$$\boxed{I_{rms} = \frac{1}{\sqrt{2}} \times I_0}$$

And

$$V_{rms} = I_{rms} \times R$$

$$= \frac{1}{2} I_0 \times R$$

$$V_{rms} = \frac{1}{2} V_0$$

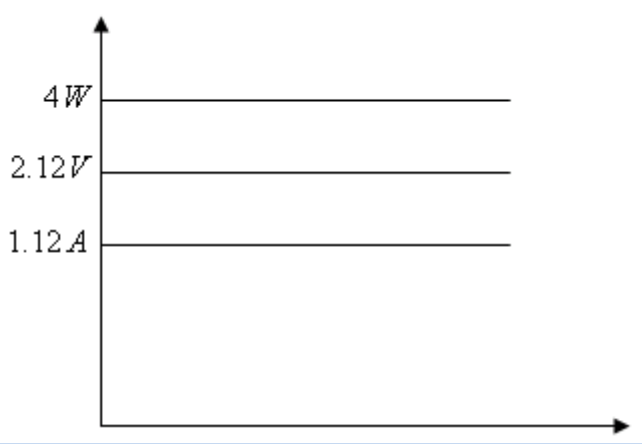
Again the results are same.

The easiest way to understand the problem is that

Suppose if $P_{peak} = 8\ W$

Then constant mean power $P_{mean} = 4\ W$

So from this point think in D.C if power is constant.



Then in D.C