A.c Measuring Instrument

Review on Alternating Signal:

The instantaneous values of electrical signals can be graphed as they vary with time. Such graphs are known as the ***waveforms*** of the signal. If the value of waveform remains constant with time, the signal is referred to as ***direct (d.c)*** signal; such as the voltage of a battery. If a signal is time varying and has positive and negative instantaneous values, the waveform is known as ***alternating (a.c)*** waveform. If the variation of a.c signal is continuously repeated then the signal is known as ***periodic*** waveform.

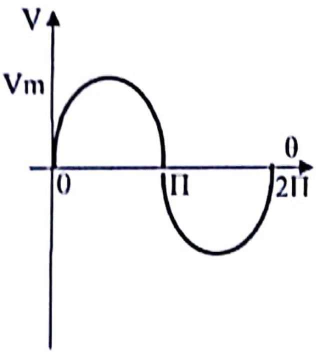
The ***frequency of a.c signal*** is defined as the *number of cycles traversed in one second*. Thus the time duration of *one cycle per second* for a.c signal is known as the ***period (T)***. Where the complete variation of a.c signal before repeated itself is represent one ***cycle***.

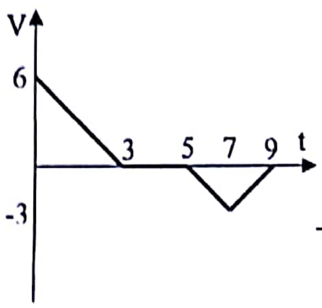
Average Values:

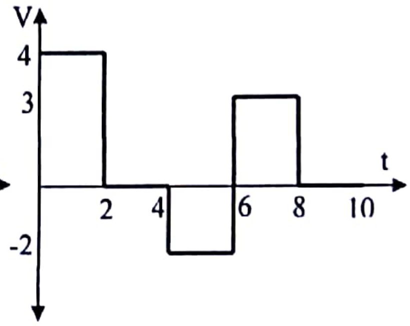
It is found by dividing the area under the curve of the waveform in one period (T) by the time of the period.

Average value= $\dfrac{\text{Algebraic sum of the areas under the curve}}{\text{Length of the curve}}$

$$Av = \frac{\sum areas}{T} \quad \text{……………… (1)} \qquad \text{or} \qquad Av = \frac{1}{T}\int_0^T f(t)dt \quad \text{……………… (2)}$$







$$Av = \frac{1}{2\pi}\int_0^{2\pi} VmSin\theta d\theta \qquad Av = \frac{\frac{1}{2}\times 3\times 6+\frac{1}{2}\times 4\times(-3)}{9} \qquad Av = \frac{4\times 2+(-2)\times 2+3\times 2}{10}$$

$$Av = -\frac{Vm}{2\pi}\left(Cos\theta \uparrow_0^{2\pi}\right)$$

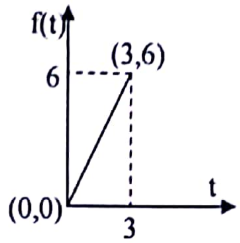
$$Av = -\frac{Vm}{2\pi}(1-1)=0$$

The average value for the figure below by using equation (2) is:

$Av = \dfrac{1}{T}\displaystyle\int_0^T f(t)dt$ we use the tangent equation for $(x_o,y_o)=(0,0)$, and $(x_1,y_1)=(3,6)$ to find the function of f(t)

$$\frac{y-y_1}{x-x_1}=\frac{y_2-y_1}{x_2-x_1} \quad \rightarrow \quad \frac{y-0}{x-0}=\frac{6-0}{3-0} \Rightarrow \frac{y}{x}=\frac{6}{3}=2 \Rightarrow\Rightarrow y=2x \qquad \boxed{f(t)=2t}$$

$$Av=\frac{1}{3}\int_0^3 (2t)dt$$

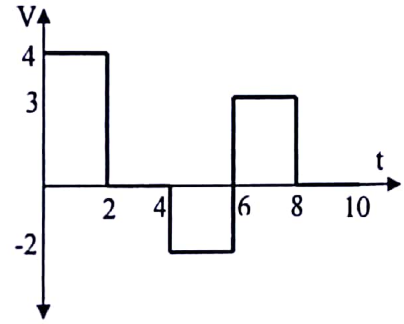


$$Av=\frac{2}{3}\left(\frac{t^2}{2}\uparrow_0^3\right) \qquad Av=\frac{1}{3}\left((3)^2-(0)^2\right)=\frac{9}{3}=3$$

Root Mean Square Value(effective value of a.c signal):

The r.m.s value of a waveform refers to its power capability. It is refer to the effective value of a.c signal because the r.m.s value equal to the value of a d.c signal which would deliver the same power if it replaced with a.c signal.

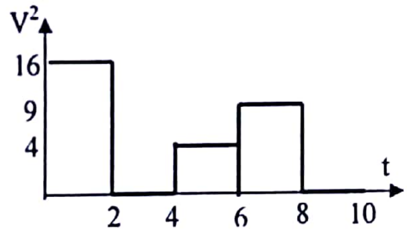
$$r.m.s=\sqrt{\frac{\sum area(V)^2}{T}} \qquad (\textit{for square waveform only})$$



1- $r.m.s=\sqrt{\dfrac{16\times 2+4\times 2+9\times 2}{10}}$

In general form the r.m.s value has the following aqua.

r.m.s= √Average $f(t)^2$

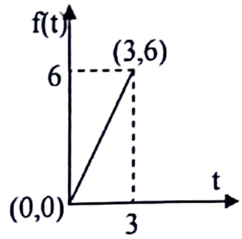


$$\boxed{r.m.s=\sqrt{\frac{1}{T}\int_0^T f(t)^2 dt}}$$

2- If f(t) = 2t then its r.m.s value is:

$$r.m.s=\sqrt{\frac{1}{3}\int_0^3 (2t)^2 dt}$$

$$r.m.s=\sqrt{\frac{4}{3}\left(\frac{t^3}{3}\uparrow_0^3\right)}=\sqrt{\frac{4}{9}\left((3)^3-(0)^3\right)}=\sqrt{\frac{4\times 27}{9}}=3.46$$



3- If f(t) = Vm Sinθdθ

$$r.m.s=\sqrt{\frac{1}{2\pi}\int_0^{2\pi} Vm^2 Sin^2\theta d\theta} \qquad r.m.s=\sqrt{\frac{Vm^2}{2\pi}\int_0^{2\pi}\frac{1-Cos2\theta}{2}d\theta}$$

$$r.m.s=\left\{\frac{Vm^2}{4\pi}\left[\int_0^{2\pi} d\theta-\int_0^{2\pi} Cos2\theta d\theta\right]\right\}^{\frac{1}{2}} \qquad r.m.s=\sqrt{\frac{Vm^2}{4\pi}\left[\theta\Big|_0^{2\pi}-\frac{1}{2}Sin2\theta\Big|_0^{2\pi}\right]}$$

$$r.m.s = \sqrt{\frac{Vm^2}{4\pi}[2\pi - 0]} = \sqrt{\frac{Vm^2}{2}} = \frac{Vm}{\sqrt{2}}$$