

my best friend

GIPTA FINE QUALITY NOTEBOOKS



Experiment I

P1) Calculate the RMS values of the following waveforms using the formula

$$V_{RMS} = \sqrt{\frac{1}{T} \int_0^T v(t)^2 dt}$$

a) Sinusoidal waveform

$$v(t) = V_m \sin\left(\frac{2\pi}{T}t\right) \text{ for } 0 \leq t \leq T \quad \left\{ \begin{aligned} V_{RMS} &= \sqrt{\frac{1}{T} \int_0^T V_m^2 \sin^2\left(\frac{2\pi}{T}t\right) dt} \\ &= \sqrt{\frac{1}{T} V_m^2 \left[\frac{t}{2} - \frac{\sin\left(\frac{4\pi t}{T}\right)}{4\pi} \right]_0^T} \end{aligned} \right.$$

b) Square waveform

$$\left. \begin{aligned} v(t) &= V_m \text{ for } 0 \leq t \leq \frac{T}{2} \\ v(t) &= -V_m \text{ for } \frac{T}{2} \leq t \leq T \end{aligned} \right\} \quad \left\{ \begin{aligned} &= \sqrt{\frac{1}{T} V_m^2 \left[\left(\frac{T}{2} - \frac{\sin(4\pi T/T)}{4\pi} - \frac{T}{4\pi} + \frac{\sin(4\pi T/T)}{4\pi} \right) \right]} \\ &= \sqrt{\frac{1}{T} V_m^2 \cdot \frac{T}{2}} = \frac{V_m}{\sqrt{2}} \\ &V_{RMS} = \sqrt{\frac{1}{T} \left(\int_0^{T/2} V_m^2 dt + \int_{T/2}^T V_m^2 dt \right)} = \sqrt{\frac{1}{T} V_m^2 \left(\frac{T}{2} + \left(T - \frac{T}{2}\right) \right)} \end{aligned} \right.$$

c) Triangular waveform

$$\left. \begin{aligned} v(t) &= \frac{4V_m t}{T} \text{ for } 0 \leq t \leq \frac{T}{4} \\ v(t) &= 2V_m - \frac{4V_m t}{T} \text{ for } \frac{T}{4} \leq t \leq \frac{3T}{4} \\ v(t) &= -4V_m + \frac{4V_m t}{T} \text{ for } \frac{3T}{4} \leq t \leq T \end{aligned} \right\} \quad \left\{ \begin{aligned} &V_{RMS} = \sqrt{\frac{1}{T} \left[\int_0^{T/4} \frac{16V_m^2 t^2}{T^2} dt + \int_{T/4}^{3T/4} 4V_m^2 - \frac{16V_m^2 t}{T} + \frac{16V_m^2 T^2}{T^2} dt + \int_{3T/4}^T \frac{16V_m^2 t^2}{T^2} dt - \frac{32V_m^2 t}{T} \right]} \\ &= \sqrt{\frac{1}{T} \left(\frac{38}{12} V_m^2 T + \frac{6}{4} V_m^2 T \right)} \\ &= \sqrt{\frac{1}{T} \cdot \frac{50 V_m^2 T}{12}} = \frac{V_m}{\sqrt{3}} \end{aligned} \right.$$

P2 Calculate the average values of the rectified waveforms given in P1

using the formula given below,

$$\left. \begin{aligned} a) V_{AVG} &= \frac{1}{T} \int_0^T V_m \sin\left(\frac{2\pi}{T}t\right) dt = \frac{1}{T} \left(-V_m \cos\left(\frac{2\pi}{T}t\right) \right) \Big|_0^T = V_{AVG} = 0 \\ b) V_{AVG} &= \frac{1}{T} \left(\int_0^{T/2} V_m dt + \int_{T/2}^T -V_m dt \right) = \frac{1}{T} V_m \left(\frac{T}{2} - 0 + T - \frac{T}{2} \right) = V_{AVG} = V_m \\ c) V_{AVG} &= \frac{1}{T} \left[\frac{4V_m}{2T} \cdot \frac{T^2}{16} + \left(\frac{2V_m T}{2} - \frac{4V_m T^2}{2T} \cdot \frac{T}{4} - \frac{2V_m T}{4} + \frac{4V_m T^2}{2T \cdot 16} \right) \right] \\ &= \frac{1}{T} \left(V_m T - \frac{6V_m T}{4} + \frac{9V_m T}{4} \right) = \frac{1}{T} \cdot \frac{4V_m T}{4} = \frac{V_m}{4} \end{aligned} \right.$$

P3 Calculate the correction factor of sinusoidal, square and triangular waveforms.

Correction Factor = $\frac{V_{RMS}}{V_{AVG}}$

$$\left. \begin{aligned} a) \text{ Correction Factor} &= CF = \frac{V_{RMS}}{V_{AVG}} = \frac{V_m/\sqrt{2}}{0} = \infty \\ b) CF &= \frac{V_{RMS}}{V_{AVG}} = \frac{V_m/\sqrt{2}}{V_m} = \frac{1}{\sqrt{2}} \\ c) CF &= \frac{V_m/\sqrt{3}}{V_m/4} = \frac{4\sqrt{3}}{3} \end{aligned} \right.$$

P4 Concerning the explanations given in introduction, how can you correct the measurement error of square and triangular waveform if their RMS values are measured by an ordinary DMM? Explain your method in details.

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