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Thursday
15.20
Studi

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

$v(t) = V_m \sin\left(\frac{2\pi}{T} t\right)$ for $0 \le t \le T$

$$V_{RMS} = \sqrt{\frac{1}{T}\int_0^T V_m^2 \sin^2\left(\frac{2\pi}{T}\right) dt}$$

$$= \sqrt{\frac{1}{T} V_m^2 \left(\frac{1+\cos(2(2\pi t/T))}{2}\right) d}$$

$$= \sqrt{\frac{1}{T} V_m^2 \left[\left(\frac{T}{2} - \frac{\sin(4\pi T/T}{2} \frac{T}{4\pi}\right)\right]_0^T}$$

$$= \sqrt{\frac{1}{T} V_m^2 \cdot \frac{T}{2}} = \boxed{\frac{V_m}{\sqrt{2}}}$$ //

b) Square waveform

$v(t) = V_m$ for $0 \le t \le \frac{T}{2}$

$v(t) = -V_m$ for $\frac{T}{2} \le t \le T$

$$V_{RMS} = \sqrt{\frac{1}{T}\left(\int_0^{T/2} V_m^2 \, dt + \int_{T/2} V_m^2 \, dt\right.} = \sqrt{\frac{1}{T} V_m^2 \left(\frac{T}{2} \cdot 0 + (T-\right.}$$

$$\boxed{V_{RMS} = V_m}$$ //

c) Triangular waveform

$v(t) = \frac{4V_m t}{T}$ for $0 \le t \le \frac{T}{4}$

$v(t) = 2V_m - \frac{4V_m t}{}$ for $\frac{T}{4} \le t \le \frac{3T}{4}$

$v(t) = -4V_m + \frac{4V_m t}{T}$ for $\frac{3T}{4} \le t \le T$

$$V_{RMS} = \sqrt{\frac{1}{T}\left[\int_0^{T/4} \frac{16V_m^2 t^2}{T^2} + \int_{T/4}^{3T/4} 4V_m^2 - \frac{16V_m^2}{T} + \frac{16V_m^2 T^2}{T^2} - \frac{32V_m T}{T} t + \int_{3T/4}^{T} 16V\right.}$$

$$V_{RMS} = \sqrt{\frac{1}{T}\left(\frac{38}{12} V_m^2 T + \frac{6}{4} V_m^2 T\right)}$$

$$= \sqrt{\frac{1}{T} \cdot \frac{56 V_m^2 T}{12}} = \boxed{\frac{V_m}{\sqrt{3}}}$$ //

P2 Calculate the average values of the rectified waveforms given in P1 using the formula given below.

$$V_{average} = \frac{1}{T}\int_0^T |v(t)| \, dt$$

a) $V_{AVG} = \frac{1}{T}\int_0^T V_m \sin\left(\frac{2\pi}{T}\right) dt = \frac{1}{T}\left(-V_m \cos\left(\frac{2\pi}{T}\right)\frac{T}{2\pi}\Big|_0^T\right) = \boxed{V_{AVG} = 0}$

b) $V_{AVG} = \frac{1}{T}\left(\int_0 |V_m| \, dt + \int_{T/2} |-V_m| \, dt = \frac{1}{T} V_m \left(\frac{T}{2} - 0 + T - \frac{T}{2}\right) = \boxed{V_{AVG} = V_m}\right.$

c) $V_{AVG} = \frac{1}{T}\left[\frac{4V_m}{2T} \cdot \frac{T^2}{16} + \left(\frac{2V_m T}{2} - \frac{4V_m T^2}{2T} \cdot \frac{T^2}{4} - \frac{2V_m T}{4} + \frac{4V_m T^2}{2T\,16}\right]\right.$

$V_{AVG} = \frac{1}{T}\left(V_m T - \frac{6V_m T}{4} + \frac{9V_m T}{4}\right) = \frac{1}{T} \cdot \frac{4V_m T}{4} = \boxed{\frac{V_m}{4}}$ //

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

$$\text{Correction Factor} = \frac{V_{RMS}}{V_{average}}$$

a) Correction Factor $= CF = \frac{V_{RMS}}{V_{AVG}} = \frac{V_m \sqrt{2}}{0} = \infty$ //

b) $CF = \frac{V_{RMS}}{V_{AVG}} = \frac{V_m}{V_m} = \boxed{1}$ //

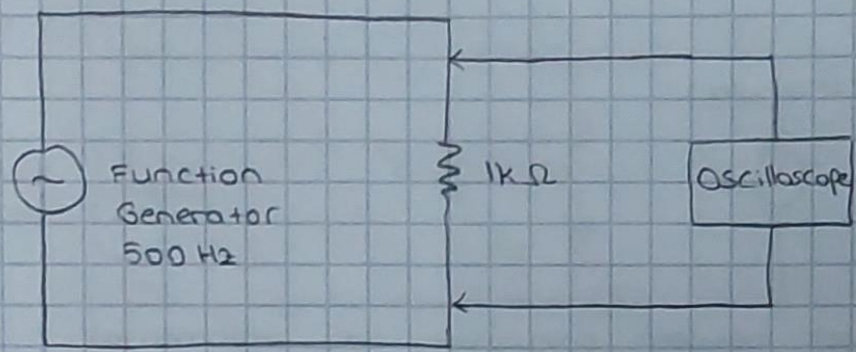
c) $CF = \frac{V_m/\sqrt{3}}{V_m/4} = \boxed{\frac{4\sqrt{3}}{3}}$ //

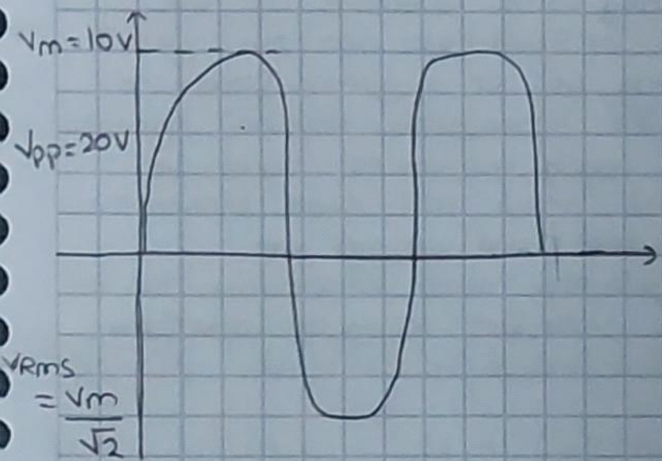
P4 Concerning the explanations given in introduction, how can you correct the measurement error of square and triangular waveform if their RMS values are measured by an ordinary DMM? Explain your method in details.

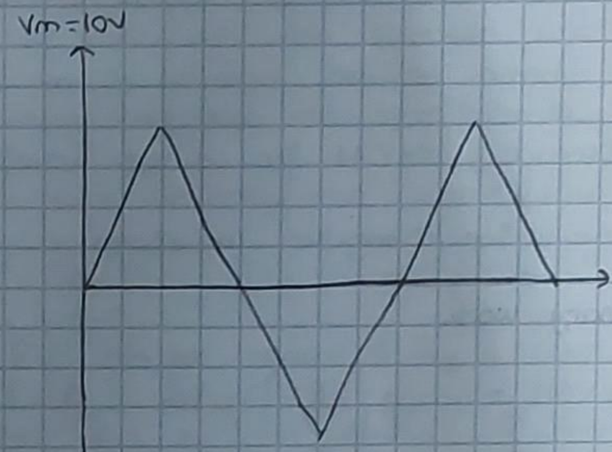
A

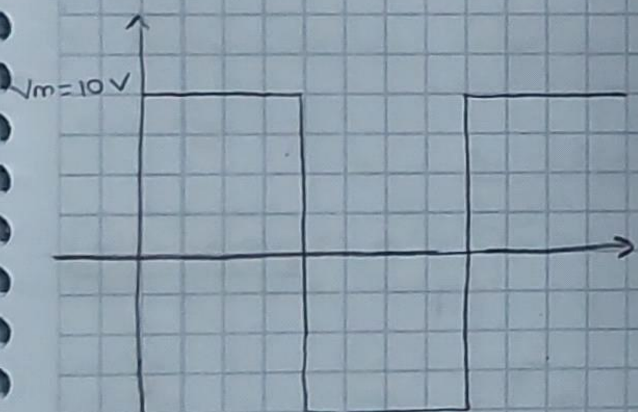
EXPERIMENT-1

Avarage and Rms value









	Theoretical	Vdmm(Rms)	Vosc (Rms)
sin	$V_m/\sqrt{2}$	6.9	6.83 V
square	V_m	9.4	9.67 V
triangular	$V_m/\sqrt{3}$	5.6	5.57 V