Noise

Exercise 1: A sinusoidal signal is being transmitted over a noisy telephone channel. The voltage of the signal is measured with an oscilloscope and is found to have a peak voltage of 1V.

Nearby machinery is adding noise onto the line. The voltage of this noise signal is measured with an RMS voltmeter as 100mVrms. The characteristic impedance of the line is 600Ω and it is terminated with that impedance. Why was an RMS voltmeter used? What is the signal power? What is the noise power? What is the SNR?

if noise is not sinusoidal, an rms meter must be used to measure power.

$P = \frac{V^2}{R}$ $R = 600\,\Omega$ $V^2 = (100\text{mV})^2 = 10^{-2}$

$\frac{1\text{E}-2}{600} = 16.667\text{E}-06$

$P = \frac{10^{-2}}{600} \approx 17\,\mu W$

$P_{signal} = \frac{V_{rms}^2}{R}$

Vrms for sinusoid is $\frac{1}{\sqrt{2}}$ $= 0.707$ of amplitude $= 1V$

$\therefore$ 0.707 Vrms.

$= \frac{\left(\frac{1}{\sqrt{2}}\right)^2}{600} = \frac{1}{1200} = 833\,\mu W$

$\frac{\left(\frac{1}{\sqrt{2}}\right)^2}{600} = 833.333\text{E}-06$

$SNR = \frac{1/2}{10^{-2}} = 50 = 17\text{dB}$

$10 \times \log \frac{\frac{1}{2}}{1\text{E}-2} = 16.990\text{E}00$

Exercise 2: Would you use AC or DC coupling to measure: (a) σ, (b) μ, and (c) the RMS power? Would you measure the average or RMS power in each case? What is the RMS power of the signal x if it has a mean (DC) value of $\mu = 2$ V and $\sigma = 3$ V?

(a) σ : AC — RMS

(b) μ : DC — average

(c) RMS : $\sqrt{AC^2 + DC^2}$

$\mu = 2 \quad \sigma = 3V$

$$\sqrt{4+9} = \sqrt{13} = $$

$\sqrt{2^2+3^2} =$

3.605551275

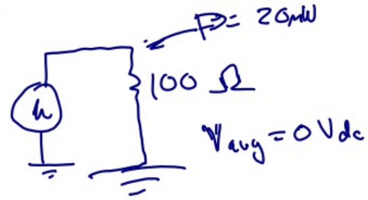
Exercise 3: What are the units of t?

$$\frac{\text{volts} - \text{volts}}{\text{volts}} = \text{unitless (no units)}$$

Exercise 4: The output of a noise source has a Gaussian (normally) distributed output voltage. The (rms) output power is 20mW and the output impedance is 100Ω. What fraction of the time does the output voltage exceed 300mV? Hint: the variance (σ^2) of a signal is the same as the square of its RMS voltage.

Exercise 4: The output of a noise source has a Gaussian (normally) distributed output voltage. The (rms) output power is 20mW and the output impedance is 100Ω. What fraction of the time does the output voltage exceed 300mV? Hint: the variance (σ^2) of a signal is the same as the square of its RMS voltage.

Some calculators will compute this ($P()$ function) or you can use the figure above.

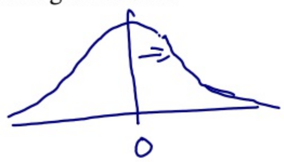


$P = 0.020 = \frac{V^2}{R}$

$R = 100 \quad V^2 = 2$

$V_{rms} = \sqrt{2} = \sigma = 1.414\ V$

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



$t = \frac{0.3 - 0}{1.414}$

$t = 0.212$

$P(v < 300\ mV) = 0.58$

$P(v > 300mV = 1 - 0.58 = 0.42$