In Class Problem:

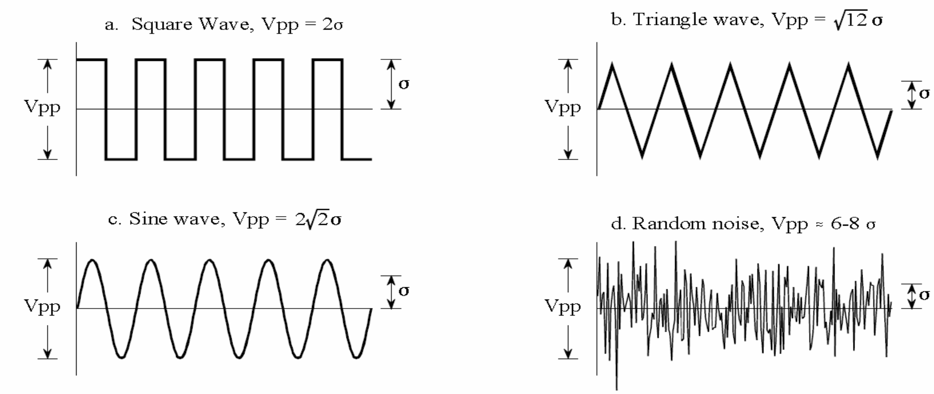
- What is the power in the fluctuation for each of these signals?

A) Square wave with $V_{pp} = 2\text{V}$

B) Sine wave with $V_{pp} = 2.828\text{V}$

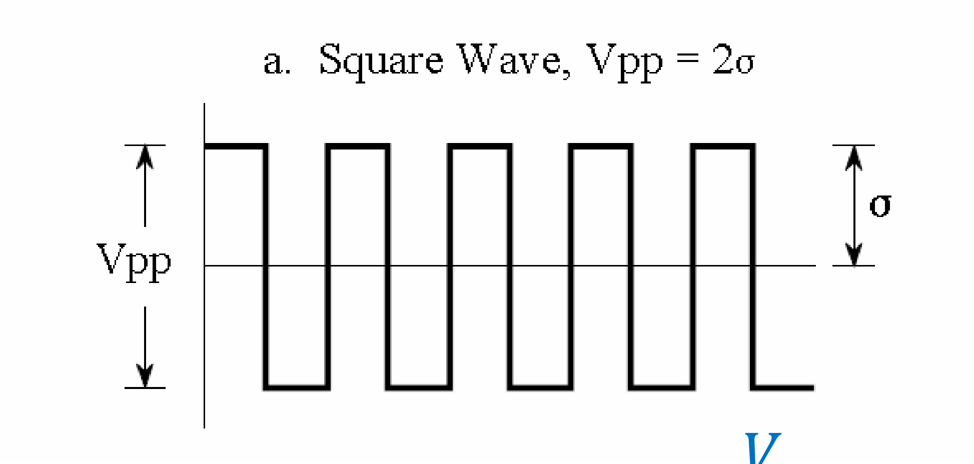
C) Triangular wave with $V_{pp} = 3.464V$

D) Random noise with $V_{pp} = 7\text{V}$



In Class Problem:

A) Square Wave with Vpp = 2V



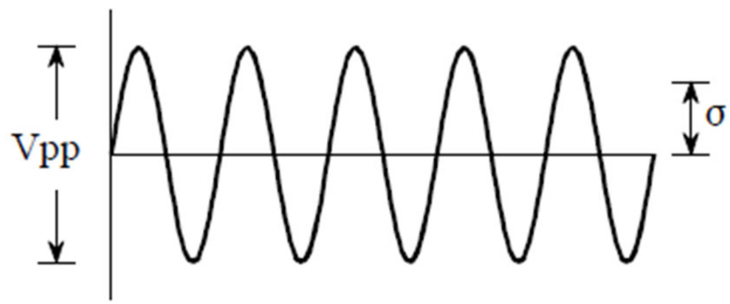
$$V_{pp} = 2\sigma \qquad \sigma = \frac{V_{pp}}{2}$$

$$\sigma = \frac{2V}{2} = 1V \qquad \sigma^2 = 1^2 = \mathbf{1W}$$

In Class Problem:

B) A Sine Wave with $Vpp = 2.828V$

c. Sine wave, Vpp = $2\sqrt{2}\sigma$

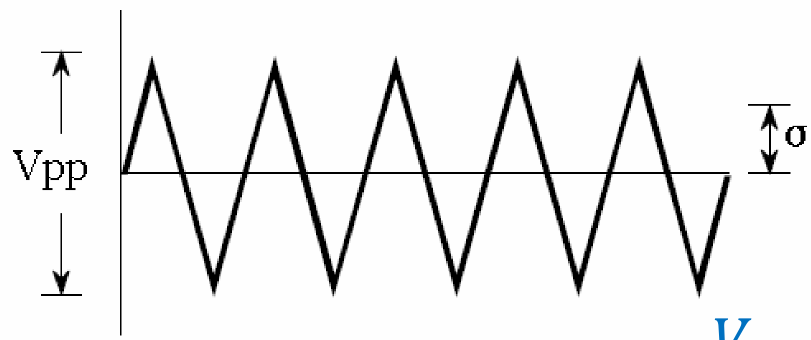


$$V_{pp} = 2\sqrt{2}\sigma \qquad \sigma = \frac{V_{pp}}{2\sqrt{2}}$$

$$\sigma = \frac{2.828V}{2\sqrt{2}} = 1V \qquad \sigma^2 = 1^2 = \mathbf{1W}$$

In Class Problem:

C) Triangle Wave with $Vpp = 3.464$V

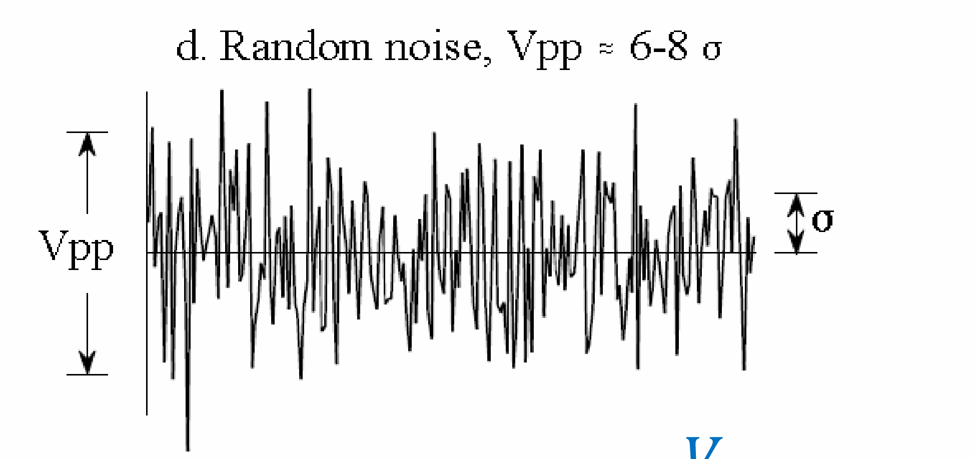


$$V_{pp} = \sqrt{12}\sigma \qquad \sigma = \frac{V_{pp}}{\sqrt{12}}$$

$$\sigma = \frac{3.464V}{\sqrt{12}} = 1V \quad \sigma^2 = 1^2 = \mathbf{1W}$$

In Class Problem:

D) Random Noise with $Vpp = 7V$



$V_{pp} \sim 6\sigma \text{ to } 8\sigma$ $\sigma \sim \frac{V_{pp}}{7}$

$\sigma = \frac{7V}{7} = 1V$ $\sigma^2 = 1^2 = \mathbf{1W}$

In Class Problem: Running Statistics

- If you have N-1 samples and a new sample x_i is acquired, how many calculations (multiply, add, divide, square root) are required to compute the new variance using :

  1) The standard calculation

  2) The running variance calculation

- What impact does this have on calculation time?

The Standard Calculation

- Recompute the mean

  $(N-1)$ additions, 1 divide

$$\mu = \frac{1}{N}\sum_{i=0}^{N-1} x_i$$

- Recompute the variance

$$\sigma^2 = \frac{1}{N-1}\sum_{i=0}^{N-1} (x_i - \mu)^2$$

$(N-1)$ subtractions, $(N-1)$ additions, $(N-1)$ multiplies , 1 divide

Total: $3(N-1)$ additions (and subtractions), $(N-1)$ multiplies, 2 divides

The Running Variance

$$\sigma^2 = \frac{1}{N-1}\left[\sum_{i=0}^{N-1} x_i^2 - \frac{1}{N}\left(\sum_{i=0}^{N-1} x_i\right)^2\right]$$

Running Sum of Squares

1 multiply (square), 1 addition

Running Sum

1 addition

Running Variance

1 multiply (square), 1 divide,
1 addition (subtraction), 1 divide

Total = 2 multiplies, 3 additions, 2 divides

In Class Problem

- The mean of a signal with noise is 3 volts
- The standard deviation of the signal is .35 volts
- Calculate the SNR as a numerical ratio and in decibels
- Calculate the coefficient of variation in %

In Class Problem

- The mean of a signal with noise is 3 volts
- The standard deviation of the signal is .35 volts
- Calculate the SNR as a numerical ratio and in decibels
- Calculate the coefficient of variation in %

$$SNR = \frac{\mu^2}{\sigma^2} = \frac{9W}{.1225W} = \mathbf{73.47}$$

$$SNR_{dB} = 10 \times \log_{10} SNR = 10 \times \log_{10}(73.47)$$

$$SNR_{dB} = \mathbf{18.66\ dB}$$

$$CV = \frac{\sigma}{\mu} \times 100\% = \left(\frac{.35V}{3V}\right) 100\% = \mathbf{11.67}\%$$