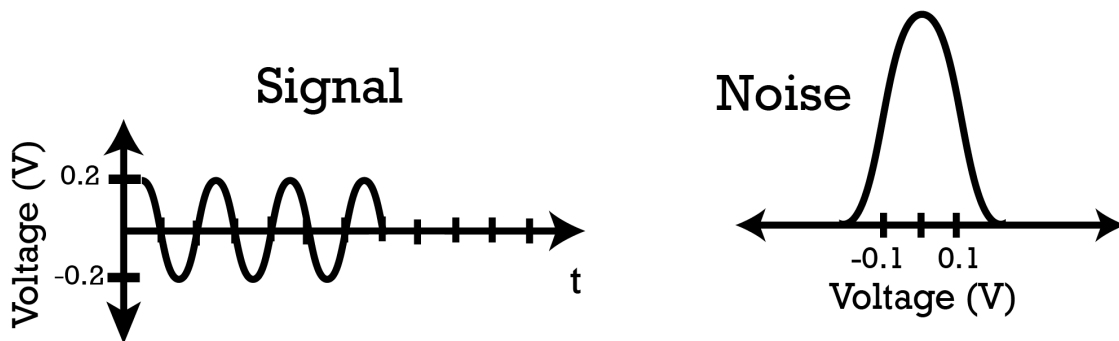


## Problems for Week 5: Noise

- 1) Assume that your receiver has a noise floor of -90 dBm (with reference to output), a transmit power of 6 kW, a survey height of 500 m, a center frequency of 60 MHz, a surface resolution of 200m, an antenna gain of 10 dB, and two-way in-ice losses of 10 dB/km.
  - a. Estimate the signal to noise ratio for a reflection from the ice surface.
  - b. Estimate the SNR for a bed reflection from a lake beneath 4 km of ice.
  - c. Estimate the SNR for a reflection from the sea surface.
- 2) Assume that your signal is a sine pulse (sketched below) to be measured in the presence of Gaussian random noise (with a voltage distribution sketched below) on a 50 $\Omega$  co-axial cable.

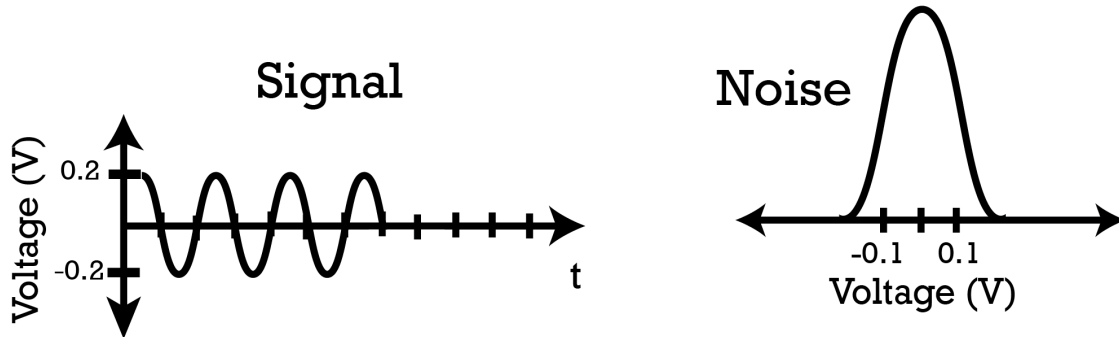


- a. What is the rms voltage of the signal?
- b. What is the rms voltage of the noise?
- c. What is the power of the signal?
- d. What is the power of the noise?
- e. What is the SNR?

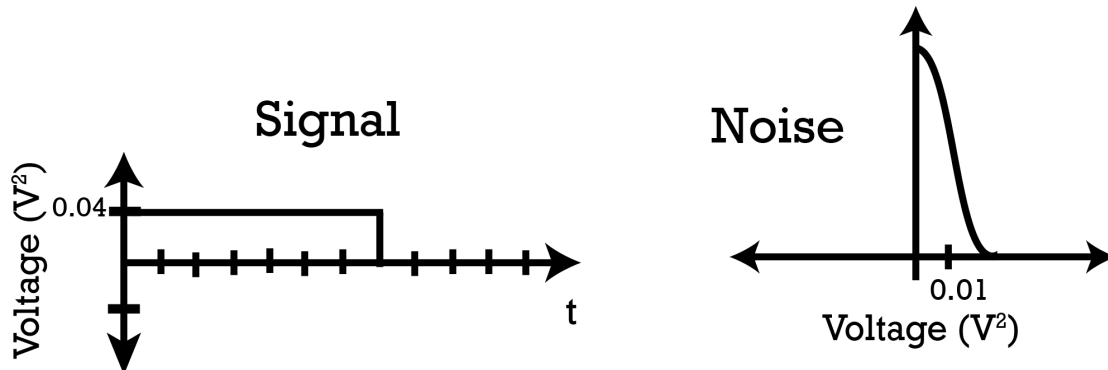
Assume two measurements of the signal and noise are coherently summed.

- f. Sketch the resulting signal time series and noise voltage distribution.
  - g. What is the new power of the signal?
  - h. What is the new power of the noise?
  - i. What is the new SNR?
- 3) Assume that you are acquiring airborne ice penetrating radar data from a survey height of 500 m above ice with a depth-averaged attenuation rate of 10 dB/km. If the surface is full of isotropic scatters and the surface return from nadir is measured to be 0 dBm, sketch the expected signal-to-clutter ratio for bed echoes as a function of ice thickness.

- 4) Assume that your signal is a sine pulse (sketched below) to be measured in the presence of speckle noise (with a voltage distribution sketched below).



The magnitude squared of the signal and speckle are also sketched below.



Assume two measurements of the signal and noise are coherently summed.

- Sketch the resulting signal, magnitude squared of the signal, speckle, and magnitude squared of the speckle.
- What is the ratio of the SNR for the resulting signal to the original?

Assume two measurements of the signal and noise are incoherently summed.

- Sketch the resulting signal, magnitude squared of the signal, speckle, and magnitude squared of the speckle.
- What is the ratio of the SNR for the resulting signal to the original?

- 5) Sketch a radargram for an ice sheet with a flat ice surface and a sloping bed (from 200 m to 2000 m deep) and showing the effect of:

- No Noise
- Surface Clutter
- Speckle
- Receiver Thermal Noise Floor
- All of the above (clutter, speckle, floor) with coherent summation
- All of the above (clutter, speckle, floor) with incoherent summation