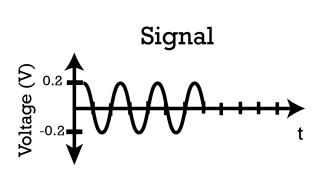
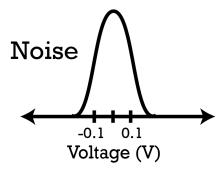
## **Problems for Week 5: Noise**

- 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, 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.



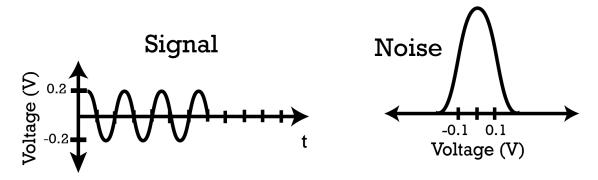


- a. What is the rms voltage of the signal?
- b. What is the rms voltage of the noise?
- c. What is the power of the signal?
- d. What is the power of the noise?
- e. What is the SNR?

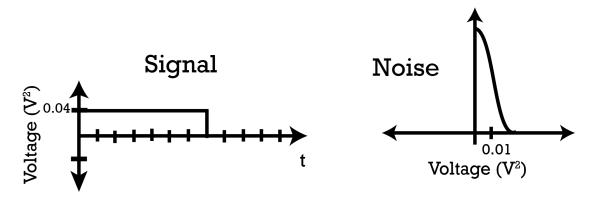
Assume two measurements of the signal and noise are coherently summed.

- 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.

- a. Sketch the resulting signal, magnitude squared of the signal, speckle, and magnitude squared of the speckle.
- b. 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.
  - c. Sketch the resulting signal, magnitude squared of the signal, speckle, and magnitude squared of the speckle.
  - d. 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:
  - a. No Noise
  - b. Surface Clutter
  - c. Speckle
  - d. Receiver Thermal Noise Floor
  - e. All of the above (clutter, speckle, floor) with coherent summation
  - f. All of the above (clutter, speckle, floor) with incoherent summation