NACS 643 Homework #1-better
Spring 2009

1) Generate spikes for 10 s (or longer if you want better statistics) using a Poisson spike generator with a constant rate of r_0 =100 Hz, and record their times of occurrence.
   a) Plot the interspike interval histogram. What shape is it supposed to have theoretically?
   b) Compute the coefficient of variation of the interspike intervals. What is it, and how does that compare to the theoretical value?
   c) Compute and plot the Fano factor for spike counts obtained over counting intervals ranging from 1 to 100 ms. What are typical values, and how do they compare to the theoretical value?

2) Add a refractory period to the above Poisson spike generator by allowing the firing rate to depend on time. Initially, set the firing rate to a constant value, $r(t) = r_0$. After every spike, set $r(t)$ to 0, and then allow it to recover exponentially back to r_0 with a time constant τ_{ref} that controls the refractory recovery rate. In other words, for each spike, reset the firing rate so that it obeys $r(t) = r_0\left[1 - \exp\left(-t / \tau_{\text{ref}}\right)\right]$ for t **relative to that spike time**. (Before the first spike, you may use the constant rate, or the refractory recovery rate based on a fictitious spike at the start, which ever is easier.)
   a) For the case τ_{ref} = 10 ms, compute and plot the Fano factor for spike counts obtained over counting intervals ranging from 1 to 100 ms. How does it change as the interval duration increases?
   b) Plot the coefficient of variation of the interspike intervals as a function of τ_{ref} over the range 1 ms ≤ τ_{ref} ≤ 20 ms, and plot some of the interspike interval histograms. How does the coefficient of variation change as τ_{ref} increases? How do the shapes of the interspike interval histograms change as τ_{ref} increases?

3) Compute autocorrelation histograms of spike trains generated by a Poisson generator with a) a constant firing rate of 100 Hz, b) a constant firing rate of 100 Hz together with a refractory period modeled as in problem 2 with τ_{ref} = 10 ms, and c) a variable firing rate $r(t) = 100\left[1 + \cos\left(2\pi t / 25\text{ ms}\right)\right]$ Hz. Plot the histograms over a range from 0 to 100 ms. Comment on how the changes from a simple Poisson generator affect the other two autocorrelation histograms.