HW 4

Write a computer program, using the language of your choice, that will simulate a flat fading Rayleigh distributed channel. Specifically, write routines that will:

- Generate two sequences of i.i.d. Gaussian random variables.
- Pass each sequence through a low pass filter having a transfer function equal to $\sqrt{V(f)}$, where $V(f)$ is the Doppler power spectral density specified as:

$$V(f) = \begin{cases} \dfrac{k}{\sqrt{f_D^2 - f^2}}, & |f| < |f_D| \\ 0, & \text{otherwise.} \end{cases}$$

  where k is a constant needed to normalize the mean-square value of the fade amplitude, $f_D = vf_c/c$ is the maximum Doppler shift. Assume a vehicle speed of 60 mi/hr, a carrier frequency of 900 MHz and a symbol rate of 8000 symbol/sec. This results in a fade rate of $f_D T_s = 0.01$.
- The low pass filter can be constructed using an FIR filter designed to approximate the response of the ideal filter. You can use a 200-tap FIR filter for this work. Make sure that the output of the FIR filter is properly normalized to end up with a mean-square value of unity.
- The Rayleigh distributed fade will be the envelop of the two Gaussian random variables, one from each sequence.
- You need to submit the following:
  1. A hard-copy and a soft copy of a well-structured, well-commented program that accomplishes all of the above.
  2. Two graphs showing the autocorrelation function between the correlated Gaussian variables (one for the I and one for the Q components) up to a lag of 300 symbols. Draw also the theoretical autocorrelation function.
  3. The measured autocorrelation function of the generate Gaussian random sequences after the FIR filter and compare this with the autocorrelation function dictated by the Bessel function, i.e., $R(t) = J_0(2\pi f_D t)$.
  4. Two graphs showing the cumulative distribution functions (cdf's) of the generated fade amplitudes and phases and compare this to the theoretical cdf's of the Rayleigh and uniform random variables.