Department of Electronics and Electrical Engineering
Indian Institute of Technology Guwahati

Lab Sheet 1

EE531: Communication Systems Simulation Lab — Tuesday, January 5, 2021

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1) Write a script to generate the samples of a sinusoid whose frequency and sampling rate are specified by the user. Also display this in two separate figures, (i) as a continuous sinusoid, (ii) and as the individual samples. (hint: Use the plot and stem commands).
2) Write a script to generate a random vector of length 10000 using the *rand* command, and plot its histogram, and compare that against the uniform pdf in the range (0,1).
3) Repeat problem 4 using the randn and randi commands, and comment on the difference between the outputs of the three random number generators.
4) Write a function 'averg' to numerically evaluate the average of an input vector. You may only use the *for* loop and the *length* command.
5) Write a script to use the function 'averg' defined in problem 6 to evaluate empirical variance of an input random vector.
6) Write a function *gateduty(N,d)* to generate a rectangular pulse of length N with a duty cycle of $d\%$.
7) Write a script to generate M periods of *gateduty(N,d)*, and use the following commands to obtain the power spectral density of the generated signal.
   a. fft b.psd c. pwelch
   Comment on the so obtained in your lab record for different values of M, N and D, and different due to the use of different commands. What is the difference between these commands?
8) Write a function *sampmean(N)*, with an integer input N, for calculating the sample mean of N zero mean Gaussian random variables having unit variance.
9) Define a function *steperr(x,a,delta)* where x is a vector, and a and delta are scalers. The kth element of the output vector y is defined as $y(k) = 0$ if $|x(k) - a| < \delta$ and $y(k) = 1$ if $|x(k) - a| \geq \delta$.
10) Define a function $MSE(x, a)$ with x being a vector and a a scaler to calculate the mean squared difference between the entries of x and a.
11) Generate 10000 realizations of $t = sampmean(N)$ for values of N going from 1 to 100, calculate the corresponding mean squared error for each value of N using the MSE function, and plot MSE as a function of N in both linear as well as logarithmic scale. Comment on this behavior.
12) Find a way to calculate the probability of error using $steperr()$ for a given value of delta. With an error event being defined as the case when the sample mean of a zero mean Gaussian random variable exceeds the value delta. Use your method to calculate the probability of error in sampmean() as a function of N for $\delta = 0.1, 0.01, 0.001$.