

National University of Singapore
Department of Electrical and Computer Engineering
EE2012 Analytical Methods in ECE

Experiment III: Frequency Distribution of Random Signals used in Digital Communication (1/3 of the grade for experiments)

Report Due Date: 5 pm Last week of classes for the current semester

Report Contents: (1) Your activities, (2) Results, (3) Interpretation of results (4) Soft copy of the code developed on a diskette/CD.

Make and state any assumptions that you need to make.

Software simulation tool to be used: MATLAB

Consider a digital communication system that outputs either 1 or 0 every 0.5 sec at A. These outputs are modeled as outcomes of Bernoulli trials with $p(0) = p(1) = 0.5$. We wish to communicate these outputs from A to B. To achieve this, -2 volt for 0 and $+2$ volt for 1 is sent for 0.5 sec depending on which of the two possible outputs actually occurs. This is a digital communication system with data rate of 2 bits/sec.

Task 1 (MATLAB). Write a simple program to generate 1000 bits that need to be sent from A to B. Hint: You may use the program in Exp II to accomplish this.

Task 2 (MATLAB). Form the signal $s(t)$ that will be sent on the channel. Take its Fourier transform (FT) to get $S(f)$. $S(f)$ is defined as

$$S(f) = \int_{-\infty}^{+\infty} s(t) e^{-j2\pi ft} dt.$$

Assume $s(t)$ to be zero outside of the tossing intervals; that is $s(t) = 0$, $t < 0$, and $t > 500$. You may need to use numerical integration to get $S(f)$:

$$S(f) = \int_{-\infty}^{+\infty} s(t) e^{-j2\pi ft} dt \approx \sum_{i=-\infty}^{\infty} s(i\Delta t) e^{-j2\pi fi\Delta t} \Delta t.$$

Here time is discretized into intervals of width Δt . You may also need to discretize frequency f .

Task 3 (MATLAB). Plot $|S(f)|^2$ vs f . Comment on bandwidth of the signal $s(t)$.

Task 4 (Analytical). Write a closed form expression for FT $A(f)$ of $a(\tau) = 2.0 (1 - |\tau|/0.5)$, $|\tau| < 0.5$ and $a(\tau) = 0$ otherwise. For the sake of FT, τ plays the same role as t in integration.

Task 5 (MATLAB). Plot $A(f)$ vs f .

Task 6 (Analytical). Compare and contrast the plots for $A(f)$ and $|S(f)|^2$.

Task 7 (Analytical & MATLAB). Another 2000 bits (2 bits per sec) are sent from A to B via signal $r(t)$ starting at $t = 200$ sec. Carry out Task 2-6 for $r(t)$ as the transmitted signal.