دانشکده مهندسی برق

گزارش تمرین کامپیوتری 4

سیستم های مخابراتی

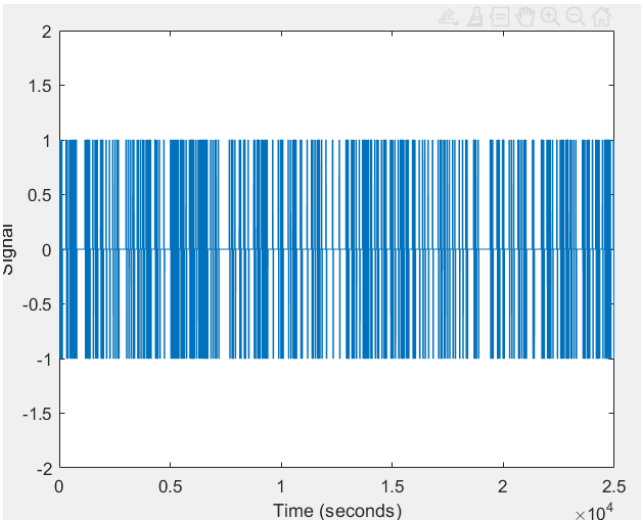
تهیه‌کننده:

زهرا ملکی

تابستان 1403

.1

Hear is the generated signal:



effective_bandwidth = 1 / Tb;
Effective Bandwidth: 0.02 Hz

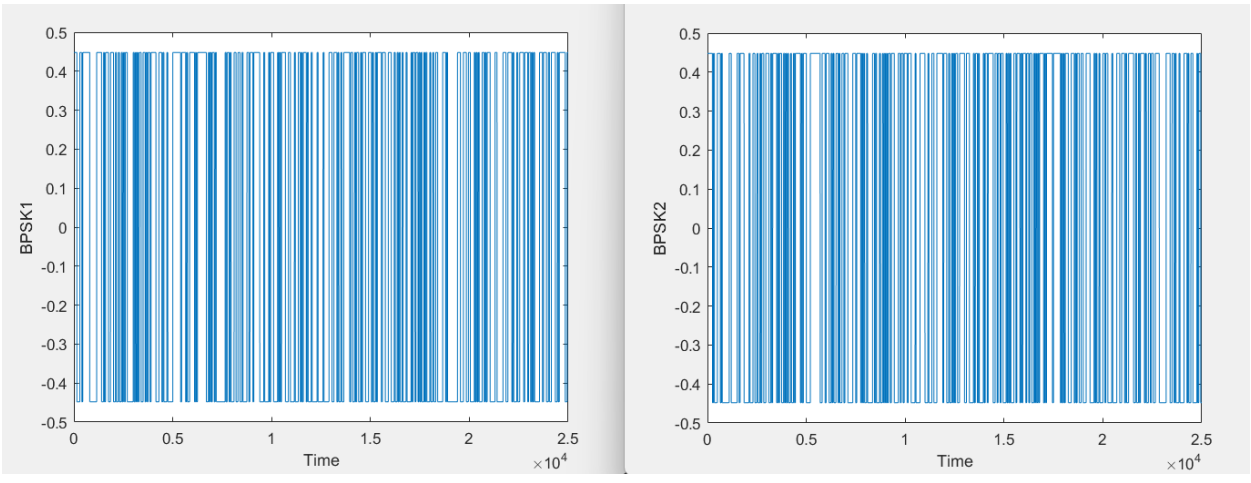
.2

power_noise = (norm(white_noise)^2) / (eta*Ts);
Power of Sampled White Noise: 0.39585

.4/3

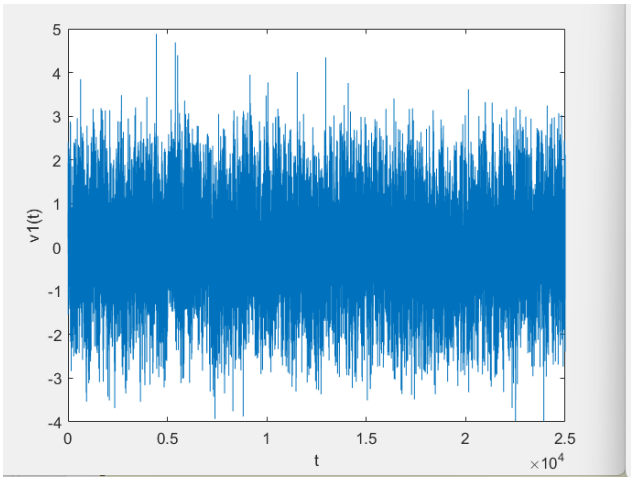
For the previous binary sequence and a new one:

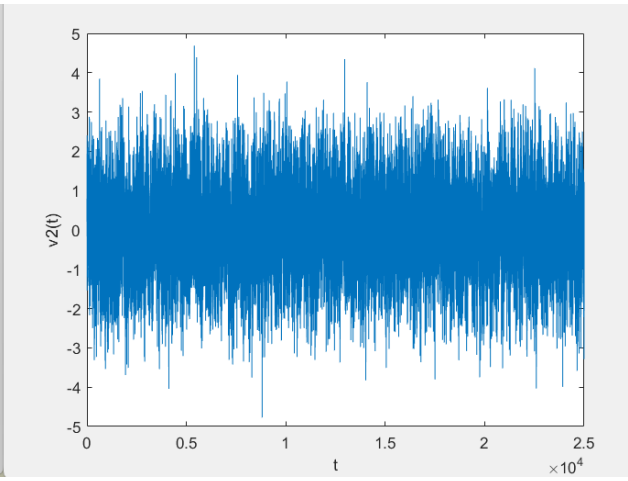
SNRe: -6.9745



.5

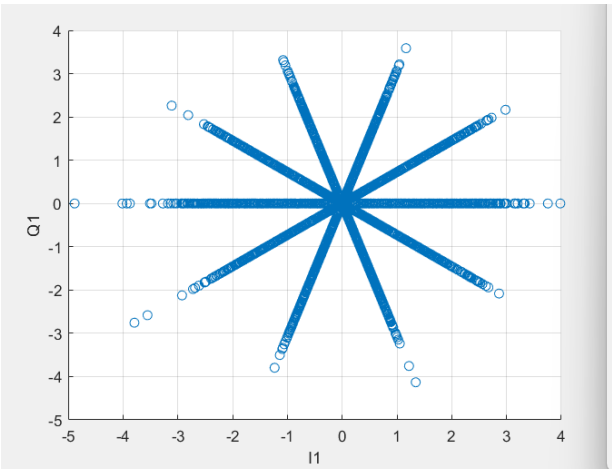
noise_sequence = randn(1, 500*Tb/Ts);

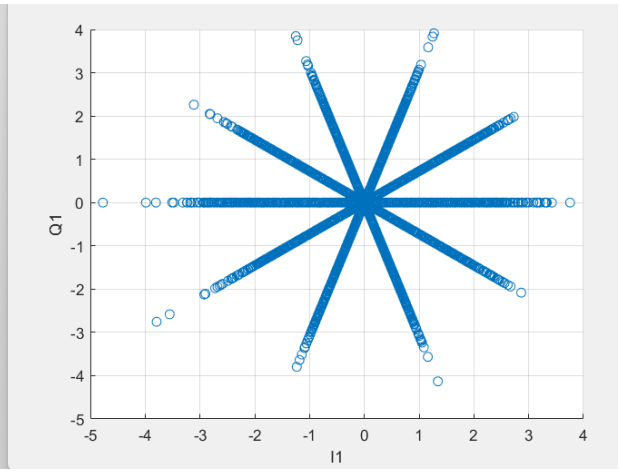




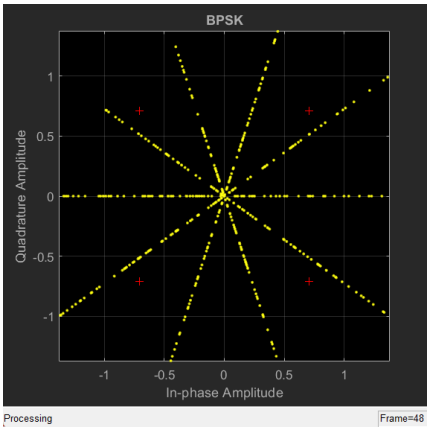
.6

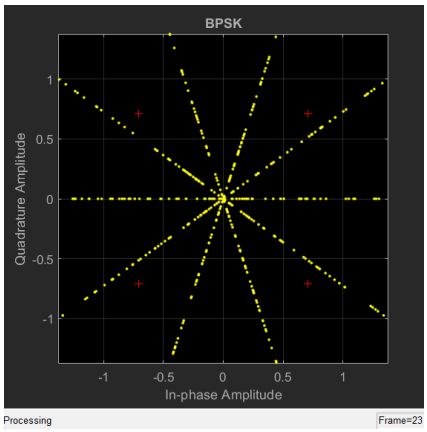
Using scatter:
symb_I2 = bpsk_noise_sequence2 .* cos(10*pi*t_noise/Tb);
symb_Q2 = bpsk_noise_sequence2 .* sin(10*pi*t_noise/Tb);
scatter(symb_I2, symb_Q2);



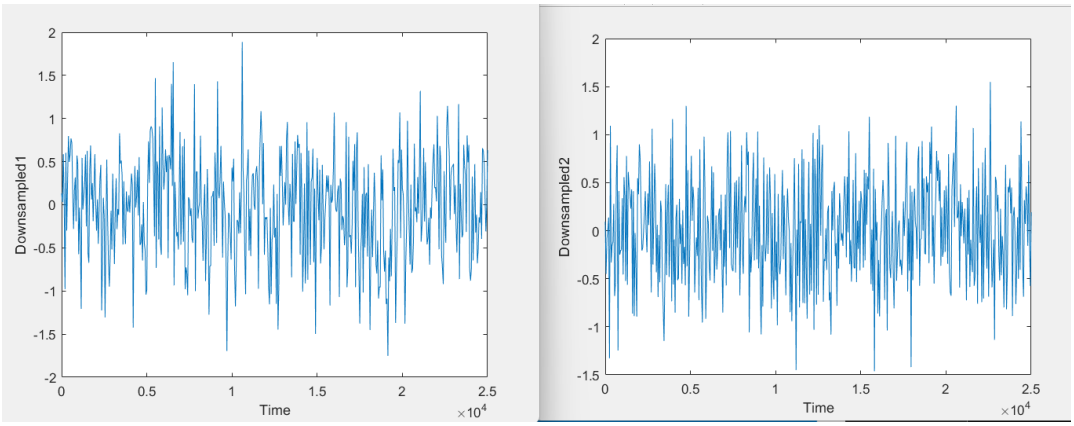


constellation =
comm.ConstellationDiagram('Title','BPSK','ShowTrajectory',false,'SamplesPerSymbol',1);
and the result is two gifs like below:





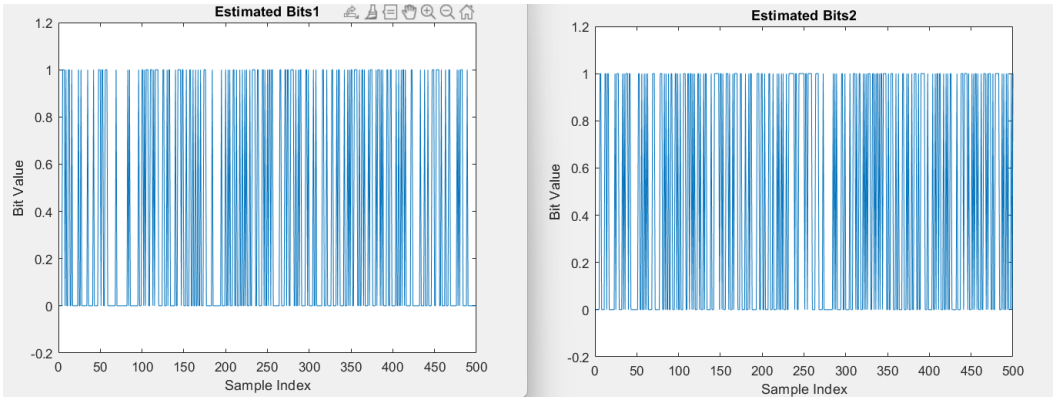
.7




```
filteredSignal1 = conv(symb_I1 + 1j * symb_Q1, filterCoeff);
filteredNoise1 = conv(bpsk_noise_sequence1 .* cos(10*pi*t_noise/Tb), filterCoeff);
n=round(Tb / Ts);
downsampledSignal1 = filteredSignal1(1:n:end);
downsampledNoise1 = filteredNoise1(1:n:end);
```

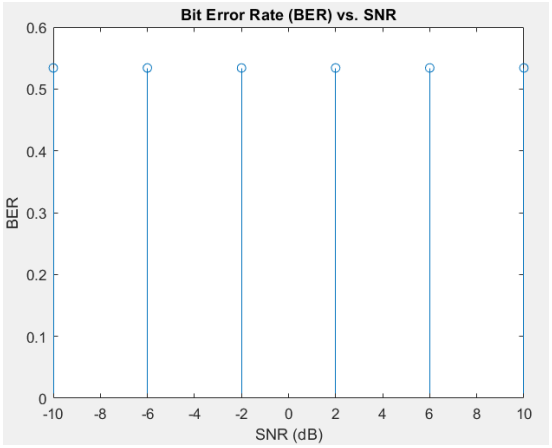
.8

Threshold Estimate 1: 0.8000
Threshold Estimate 2: 0.7000



.9

SNRe: -10 -6 -2 2 6 10

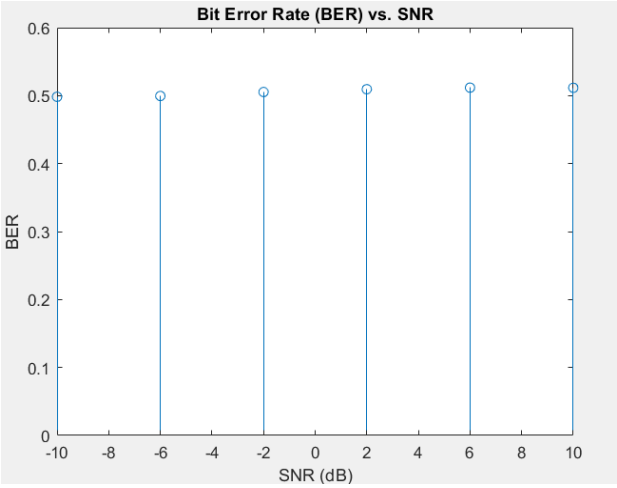



```
error_count = sum(abs(estimated_bits9 - binary_sequence));
BER(j) = error_count / 500;
```

.10

```
        error_count = sum(abs(estimated_bits9 - binary_sequence));
        error_count_total = error_count_total + error_count;

   BER(j) = error_count_total / (500 * 50);
```

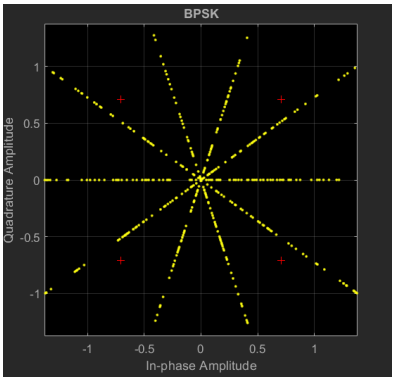


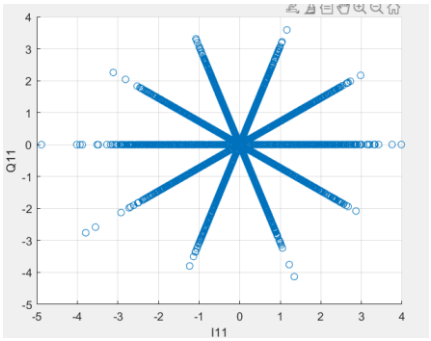
The theoretical BER for a BPSK (Binary Phase Shift Keying) modulation scheme in an AWGN (Additive White Gaussian Noise) channel can be calculated using the following formula:
BER = 0.5 * erfc(sqrt(10^(SNR/10)))
Which is compatible with the shown plot.

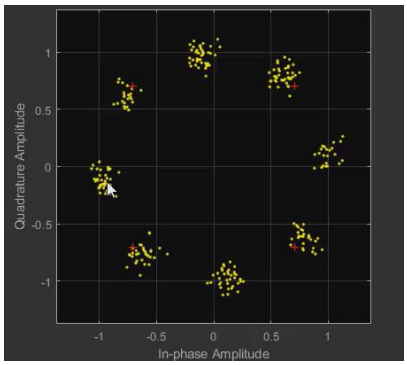
.11

```
offset_frequency = 0.001 * 1/Ts;
t_noise_offset = t_noise + offset_frequency;

symb_I11 = bpsk_noise_sequence1 .* cos(10*pi*t_noise_offset/Tb);
symb_Q11 = bpsk_noise_sequence1 .* sin(10*pi*t_noise_offset/Tb);
```







.12

Therefore, to determine an appropriate threshold for symbol detection in your specific system, you would need to perform empirical testing and conduct a more detailed analysis.

.13

I suggest using a matched filter that is capable of handling frequency offset while maintaining stability. To achieve stability against frequency offset, you can employ a Finite Impulse Response (FIR) filter. FIR filter is one of the stable filters that uses a sequence of coefficients (usually constant coefficients) to perform the filtering operation.

One of the methods for designing a frequency-matched FIR filter is through windowing. In this approach, we first determine the desired frequency response and then calculate the filter coefficients using a windowing function to apply appropriate weighting. After applying these coefficients to the input signal, the output signal will be frequency-matched to the desired frequency.