Complete Exercise Descriptions (1-25)

1. Sinc Function

The sinc function (sine cardinal) is also called the sampling function, given by sinc(x) = sin(pi*x)/(pi*x). Create a signal given by x(t) = sinc(1000*t). Plot this signal's representation over time from -0.05 to 0.05 seconds, and analyze its amplitude spectrum and phase spectrum.

2. Spectrum of the Sinc Function

Create the signal given by x(t) = sinc(2000*t) and analyze its time and frequency domain representation. Compare with the spectrum of the signal in Exercise 1.

3. FFT Interpolation

Create a signal that consists of a sum of sinusoidal signals with frequencies 2 Hz, 4 Hz, and 6 Hz. Use FFT to analyze the signal and adjust the FFT points for higher frequency resolution.

4. Spectrum of a Gaussian Pulse

Generate a Gaussian pulse with standard deviation sigma=0.1, and plot its amplitude spectrum using FFT.

5. Spectrum of a Sine Wave

Generate a sine wave with a frequency of 40 Hz, amplitude 12 V, and phase 2*pi/3 radians, sampled at 2 kHz over 1.5 seconds. Plot its time-domain signal and frequency-domain spectrum.

6. AM Modulation, Part I

Consider a message signal defined by s(t) = Am*sin(2*pi*fm*t) with Am=0.5 V and fm=2 Hz. Modulate it with a carrier of amplitude Ac=1 V and frequency fc=100 Hz. Plot the message, carrier, and modulated signals, including the envelope.

7. AM Modulation, Part II

Repeat the AM modulation from Exercise 6, changing the message amplitude to 1 V and 2 V, respectively. Comment on the resulting waveforms.

8. Modulation and Demodulation of a Speech Signal

Download the speech signal 3WORDS.WAV, read it using audioread, and plot its waveform and amplitude spectrum. Perform DSB modulation using a 100 kHz carrier and then demodulate with a Butterworth low-pass filter.

9. Speech Signal Demodulation with Non-Ideal Oscillator (Part I)

Repeat the demodulation process from Exercise 8 using a local oscillator with a slight phase offset (e.g., 0.1*pi). Compare results with the previous case.

10. Speech Signal Demodulation with Non-Ideal Oscillator (Part II)

Repeat demodulation as in Exercise 8, with a phase difference that varies randomly over time, i.e., delta_phi(t) = 0.9*pi*rand(t). Plot the demodulated signal and analyze results.

11. Aliasing Due to Undersampling

Generate a 60 Hz sine wave sampled at 400 Hz and 70 Hz, respectively. Display both sampled signals and discuss aliasing effects.

12. Sampling of a Music Signal

Download and load handel.mat. Plot and downsample the signal by a factor of 2, and observe the audio degradation.

13. Quantization and Encoding

Create a signal with x(t) = 2*sin(200*pi*t) + 5*cos(100*pi*t). Quantize it at 4 levels, plot its quantized representation, and perform simple binary encoding.

14. Additive White Gaussian Noise (AWGN)

Generate a Gaussian noise signal with specified mean and standard deviation, calculate and plot its periodogram and histogram for power spectral density analysis.

15. Shannon-Hartley Theorem

Write a program to compute the channel capacity C as a function of bandwidth B with a constant S/N0 ratio of 200. Plot C vs. B using a logarithmic scale for B.

16. Error Probability in Baseband Signaling Systems

Plot the error probability for three baseband modulation types over Eb/N0 from 0 to 40. Use a log-log scale for both axes.

17. Error Probability in Bandpass Signaling Systems

Plot error probabilities for ASK, PSK, and FSK over Eb/N0 range 0 to 40, and compare system performance.

18. QAM Modulation and Demodulation

Generate a 16QAM modulated signal with 10000 random integers. Plot its constellation, add AWGN at 12 dB, and calculate the Bit Error Rate after demodulation.

19. Simulation of Line Code Signaling

Consider binary sequence x[n] = [1 1 0 1 0 1 0 0 1 0]. Generate NRZ unipolar, NRZ bipolar, AMI, and Manchester coding for each bit and plot their time-domain representations.

20. Quantization with mu-law Compression

Quantize an exponential signal with mu-law compression (mu=255) and compare quantization errors with uniform quantization.

21. Text Entropy - Huffman Coding

Calculate letter frequency in a sample text, compute entropy, perform Huffman coding, and analyze code efficiency.

22. M-ary QAM Modulation

Use bertool to simulate BER for 4QAM, 16QAM, 32QAM, and 64QAM modulations under AWGN, and compare the BER at 10 dB SNR.

23. 8PSK Modulation with/without Coding

Simulate 8PSK BER performance with no coding, block coding, and convolutional coding under AWGN.

24. Spectrum of BPSK

Generate a BPSK modulated signal with a 100 kHz carrier and binary data stream. Plot both time-domain and frequency-domain representations.

25. Hamming Code

Create a program to implement the Hamming (7,4) code using MATLAB's hammgen function. Determine the parity and generator matrices, and verify the minimum distance of the code.