**Cosmos College of Management and Technology**

**Affiliated to Pokhara University**

**Saddobato, Lalitpur**

**Lab Report on:** Line Coding and Power Spectral Density analysis

**Lab report number:** 05

| **Submitted By** | **Submitted To** |
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**Lab Number:** 04

**Lab Title:** Line Coding and Power Spectral Density analysis

**Lab Objective**

1. Understanding Line Coding Schemes
2. Implementing Line Coding Algorithms
3. Analyzing Power Spectral Density (PSD)

**Theory**

Line coding is a method of converting digital data sequences into a digital signal. It involves representing binary data using various coding schemes that define how each bit is mapped to a physical signal. Line coding is crucial in digital communication systems to ensure reliable and efficient transmission of data.

Line coding schemes are specific techniques or algorithms used to encode binary data into a digital signal. Different line coding schemes employ various strategies to represent binary bits, determining the signal's characteristics, such as voltage levels, timing, and polarities. Common line coding schemes include Unipolar NRZ (Non-Return-to-Zero), Bipolar NRZ (Alternate Mark Inversion - AMI), Manchester encoding, and Polar NRZ.

A line coding algorithm is a set of rules and procedures used to convert binary data into a digital signal. It outlines the mapping of binary values to physical signal elements, addressing factors like voltage levels, duration of signal elements, and signal transitions. Line coding algorithms ensure that the encoded signal can be accurately transmitted and recovered at the receiver.

Power Spectral Density (PSD) analysis is a method used to examine the frequency content of a signal. It provides insights into how the power of a signal is distributed across different frequencies. In the context of line coding, PSD analysis helps to understand the spectral characteristics of the encoded digital signals. By analyzing PSD, one can assess the bandwidth requirements and potential interference of a communication system using

**CODE**

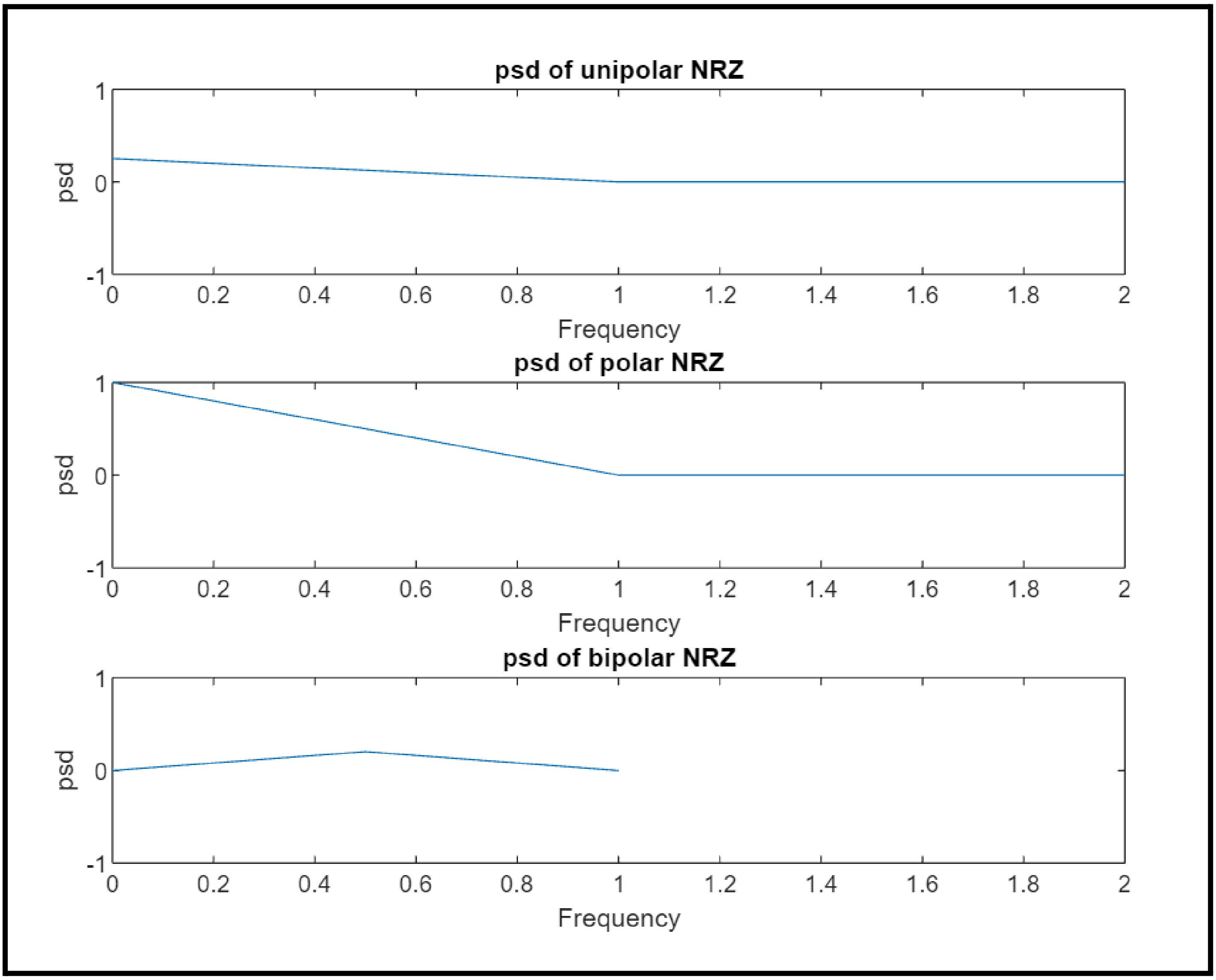
```
% 1. Unipolar NRZ (Non-Return-to-Zero) line coding
clear all;
close all;

td = 1:400;
s = [1 0 1 0];
d = s' * ones(1, 100);
d = d';
d = d(:);

plot(td, d);
axis([0 400 -1 2]);
xlabel('Time');
ylabel('Amplitude');
title('Unipolar NRZ format');

% 2. Bipolar NRZ (Alternate Mark Inversion (AMI)) line coding
clear all;
close all;

b = [0 1 1 0 0 0 0 0 1 1 1 1 0 1];
a = length(b);
count = 0;
i = 1;

while i < a
   if b(i) == 1
      count = count + 1;
      if rem(count, 2) == 0
         b(i) = -1;
      else
         b(i) = 1;
      end
   else
      b(i) = 0;
   end
   i = i + 1;
end

d = b' * ones(1, 100);
k = d';
```

```
p = k(:);
t = 1:1400;

plot(t, p);
axis([0 1400 -2 2]);
xlabel('Time');
ylabel('Amplitude');
title('AMI format');

% 3. Polar NRZ line coding
clear all;
close all;

b = [1 1 1 0 1 1 1 1 1 0 0 0 0 0];
amp = input('Enter the value amplitude (less than 5): ');

a = length(b);

for i = 1:a
   if b(i) == 1
      b(i) = amp / 2;
   else
      b(i) = -amp / 2;
   end
end

d = b' * ones(1, 100);
k = d';
p = k(:);
t = 1:1400;

plot(t, p);
axis([0 1400 -5 5]);
xlabel('Time');
ylabel('Amplitude');
title('Polar NRZ format');

% 4. Power Spectral Density (psd) of Unipolar NRZ Format
clear all;
close all;

f = 0:1:2;
```

```
A = 1;
Tb = 1;
n = f * Tb;
a = A * A * Tb;
b = sinc(n) .* sinc(n);
s = a / 4 .* b;

subplot(311);
plot(n, s);
axis([0 2 -1 1]);
xlabel('Frequency');
ylabel('psd');
title('psd of unipolar NRZ');

% Power Spectral Density (psd) of polar NRZ Format
s = a .* b;
subplot(312);
plot(n, s);
axis([0 2 -1 1]);
xlabel('Frequency');
ylabel('psd');
title('psd of polar NRZ');

% Power Spectral Density (psd) of Bipolar NRZ Format
A = 1;
Tb = 0.5;
n = f * Tb;
a = A * A * Tb;
c = pi * n;
b = sinc(n) .* sinc(n);
d = sin(c) .* sin(c);
s = a .* b .* d;

subplot(313);
plot(n, s);
axis([0 2 -1 1]);
xlabel('Frequency');
ylabel('psd');
title('psd of bipolar NRZ');
```

**Output**

Enter the value amplitude (less than 5): 4




**Discussion**

In this lab, the focus was on Line Coding and Power Spectral Density (PSD) analysis, crucial aspects of digital communication systems. The lab began by implementing three different line coding schemes: Unipolar NRZ, Bipolar NRZ (AMI), and Polar NRZ. Each coding scheme was visually represented in the time domain, providing insights into how binary data is encoded into digital signals.

Unipolar NRZ, represented by a straightforward voltage level scheme, was followed by Bipolar NRZ (AMI), where alternating marks and spaces were used to represent binary values. Polar NRZ, the third coding scheme, introduced amplitude modulation based on user input, creating positive and negative voltage levels.

Following the line coding implementations, the lab delved into Power Spectral Density (PSD) analysis. PSD provides a frequency-domain perspective on signals, allowing for the examination of the power distribution across different frequencies. Three different PSDs were plotted corresponding to the line coding schemes implemented earlier: Unipolar NRZ, Polar NRZ, and Bipolar NRZ.

Some of the key takes from this lab work is as follows:

1. Unipolar NRZ exhibited a concentrated power distribution around lower frequencies, typical for non-return-to-zero coding.
2. Polar NRZ, with its amplitude modulation, showed a broader power distribution across frequencies.
3. Bipolar NRZ (AMI) displayed power distribution concentrated around lower frequencies, similar to Unipolar NRZ.

**CONCLUSION**

In conclusion, this lab successfully covered the implementation of different line coding schemes and their Power Spectral Density analysis. The significance of each line coding scheme became evident through their unique representations in the time domain. Unipolar NRZ, Bipolar NRZ (AMI), and Polar NRZ each have their advantages and are suitable for different communication scenarios.

The PSD analysis further enriched our understanding by revealing the frequency characteristics of the encoded signals. This knowledge is crucial in the design and analysis of digital communication systems, as it helps in evaluating bandwidth requirements and potential interference.

Overall, the lab provided valuable insights into the practical aspects of line coding and highlighted the importance of PSD analysis in optimizing communication system performance.