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Experiment: 11
DELTA MODULATION

Objective: To demonstrate the delta modulation (DM) and demodulation technique. Show the sampled, quantized, encoded and decoded time domain signal. Show the input / output waveforms using Matlab code / Simulink in virtual mode.

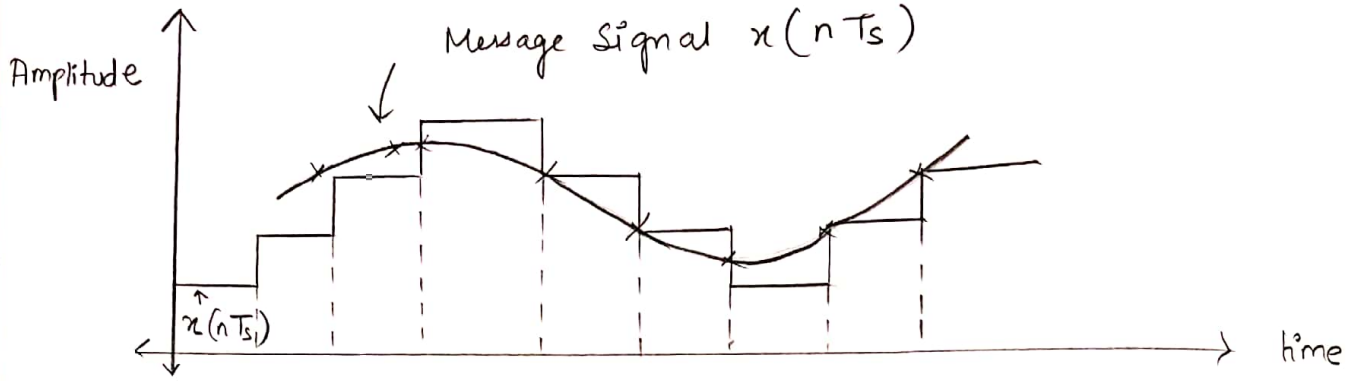
Software: Matlab

Theory:

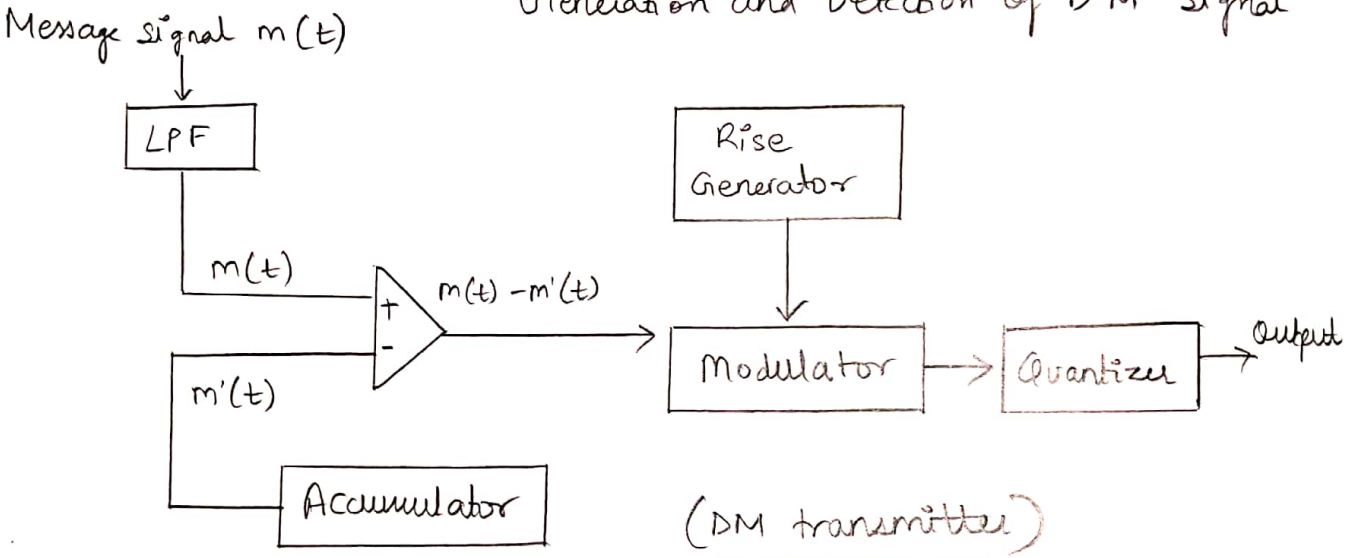
Delta modulation is a technique used to convert analog to digital and digital to analog signal. In this modulation, signal is sent in differential form, the data is encrypted / transmitted in 1 bit.

The analog signal is approximated with series of segments and each segment is compared to original analog to determine the change in relative amplitude. Hence only change in information is sent and if no change occurs it remains on the same state. This is simplified form of Differential Pulse Code Modulation and also called as 1 bit (2 level) version of DPCM. It provides a staircase approximation of over sampled base band signal. Here the difference between the present sample and previous approximated sample is quantized in two levels i.e. $\pm\Delta$ (delta).

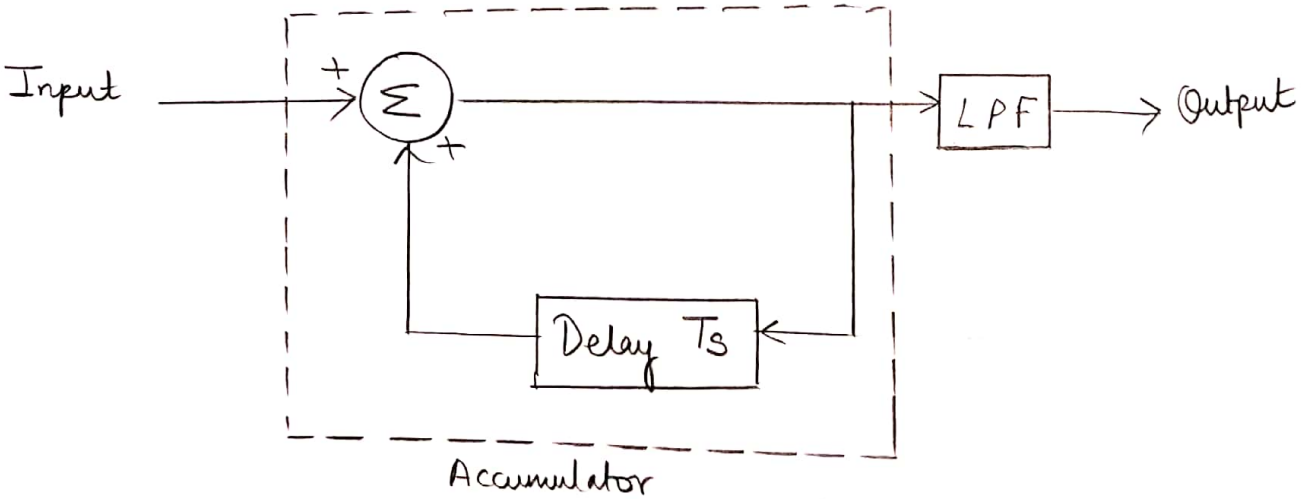
This is used for voice transmission.



Generation and Detection of DM Signal

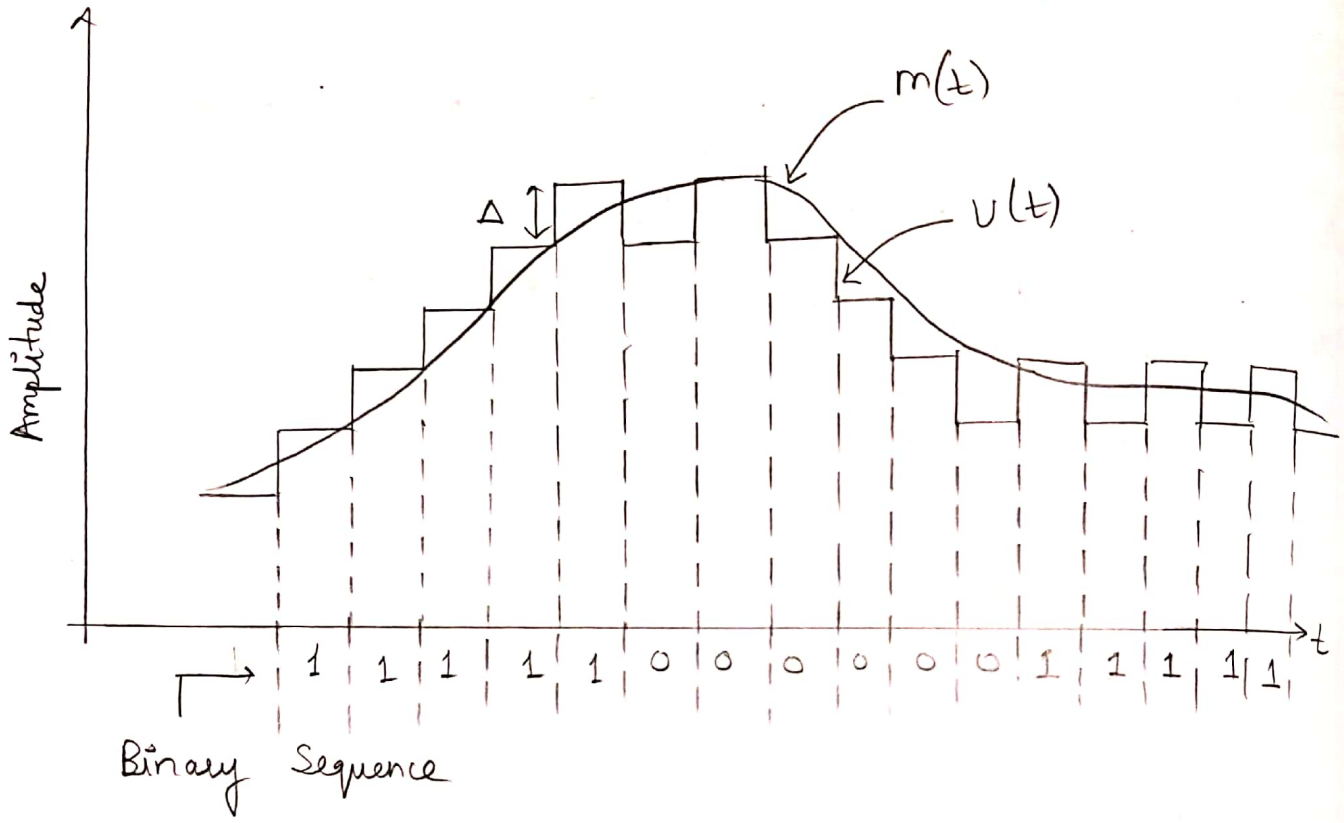


(DM transmitter)



(DM Receiver)

Waveform Representation of Delta Modulated Signal:



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Operating Principle:

- The operating principle of DM is such that, a comparison between present and previously sampled value is perform-ed, the difference of which decides the increment or decrement in the transmitted value.
- When the two sample values are compared either we get difference having positive polarity or negative polarity.
- If the difference in polarity is positive, then the step of the signal denoted by Δ is increased by 1.
- As against in case when difference polarity is negative then step of the signal is decreased, i.e reduction in Δ.
- When $+\Delta$ is noticed ie increase in step size then 1 is transmitted. However, in the case of $-\Delta$ i.e decrease in step size, 0 is transmitted.

Matlab Code:

```
% Delta Modulation
clc;
clear all;
close all;
predictor = [0 1];
partition = [-1:.1:.9];
Step = 0.2;
partition = [0];
codebook = [-1* step step];
```

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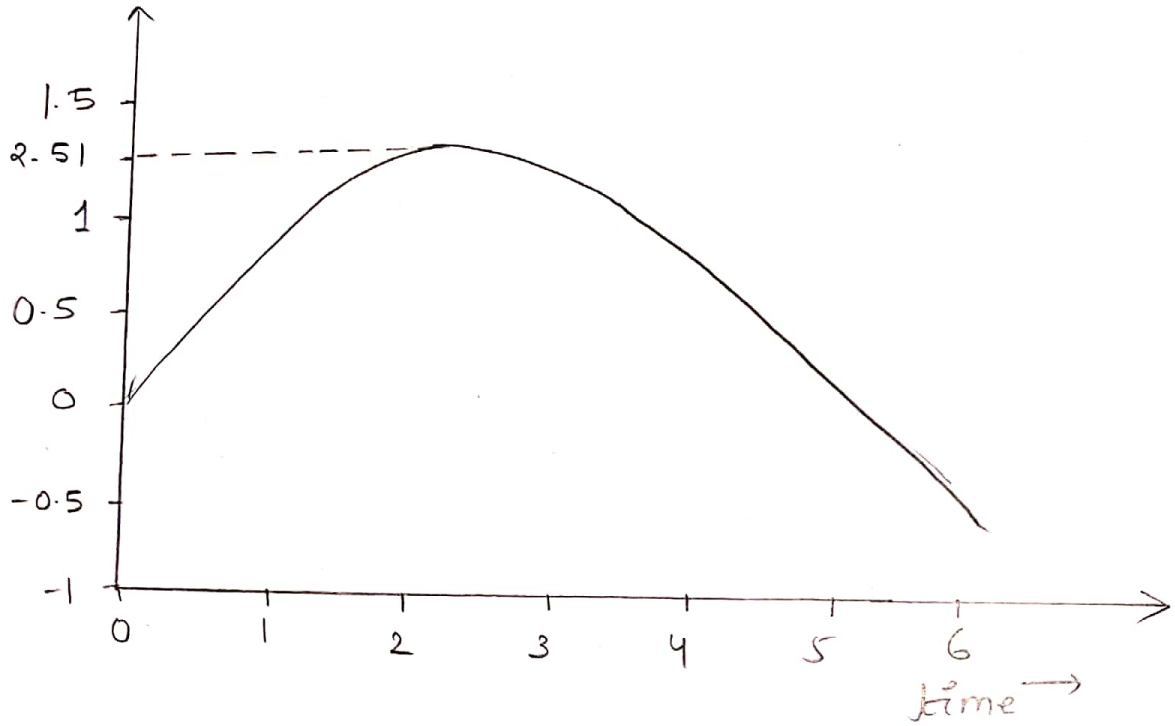
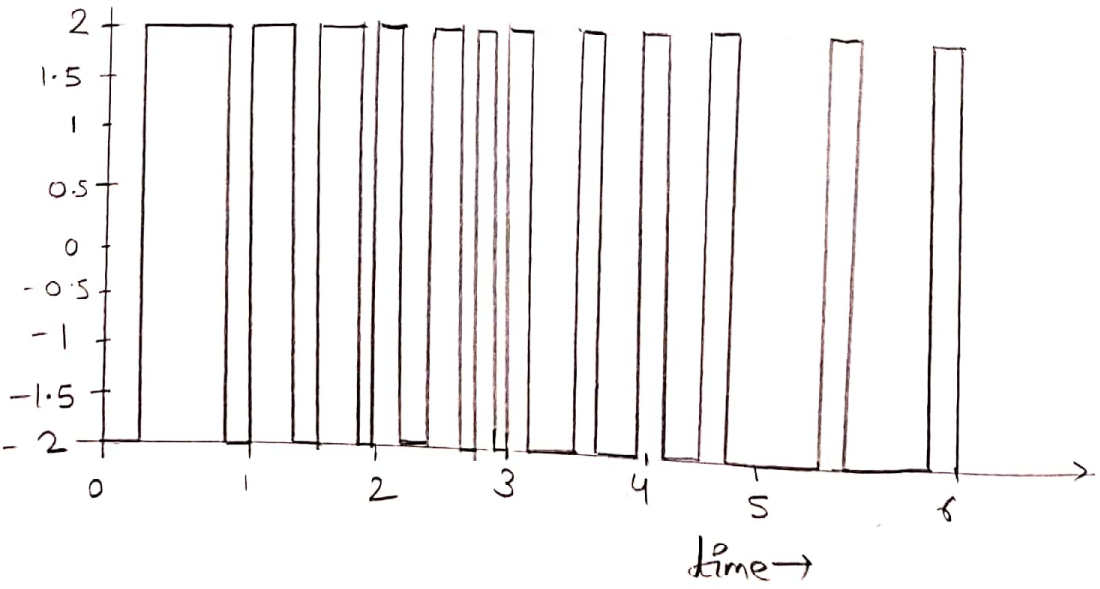
```
% DM quantizer
t = [0: pi/20 : 2*pi];
x = 1.1 * sin(2* pi *0.1*t);   % Analog signal

% Quantize x(t) using DPCM.
encoded_x = dpcmenco(x, codebook, partition, predictor);

% Try to recover x from the modulated signal
decoded_x = dpcmdeco (encode_x, codebook, predictor);
figure
plot (t,x);
xlabel ('time');
title ('original signal');
figure
stairs (t, 10*codebook (encoded_x+1), 'g');
xlabel ('time');
title ('DM output');
figure
plot (t, x);
hold;
stairs (t, decoded_x);
grid;
xlabel ('time');
title ('received signal');
```

$f_m = 0.1Hz$

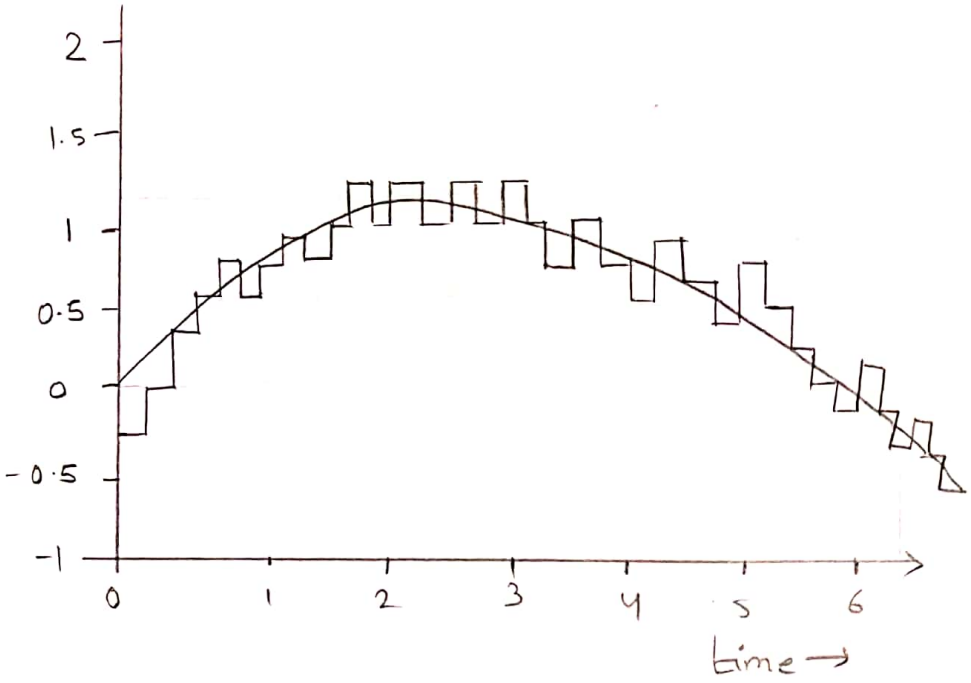
Original Signal



DM Output

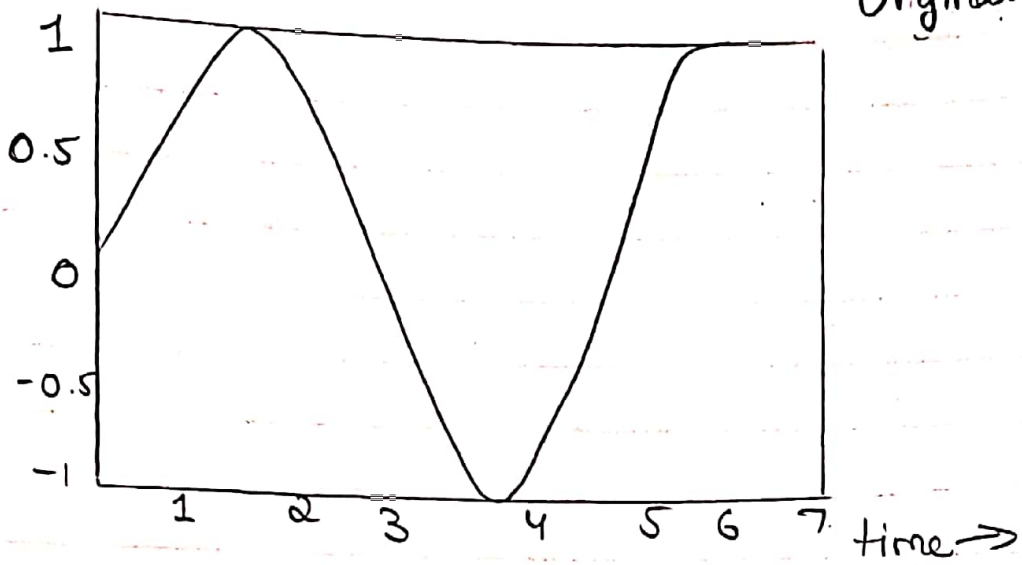


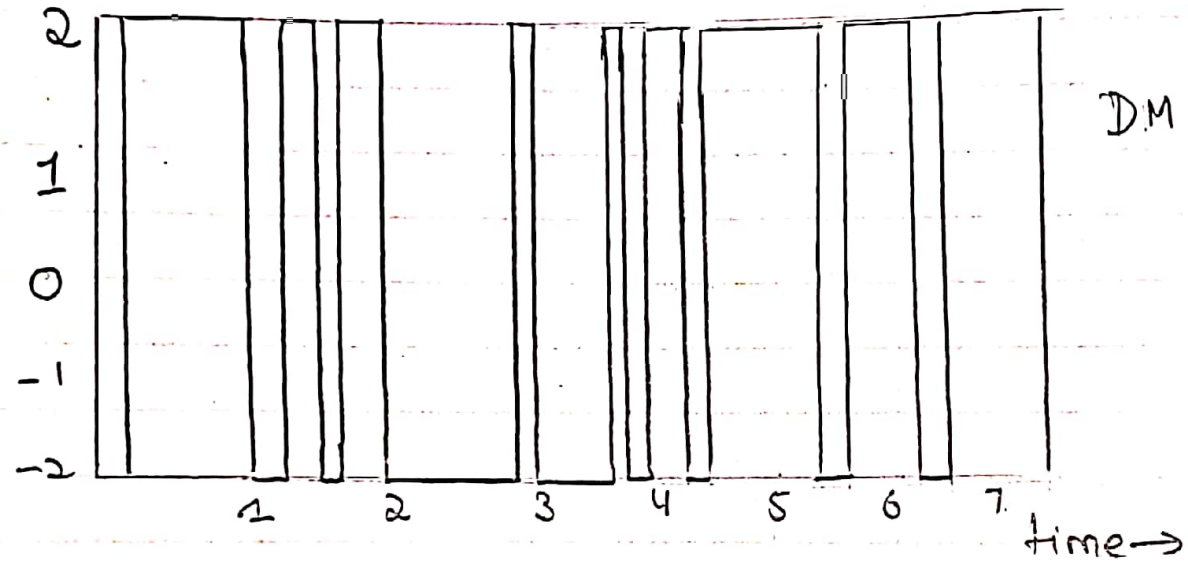
Received Signal:



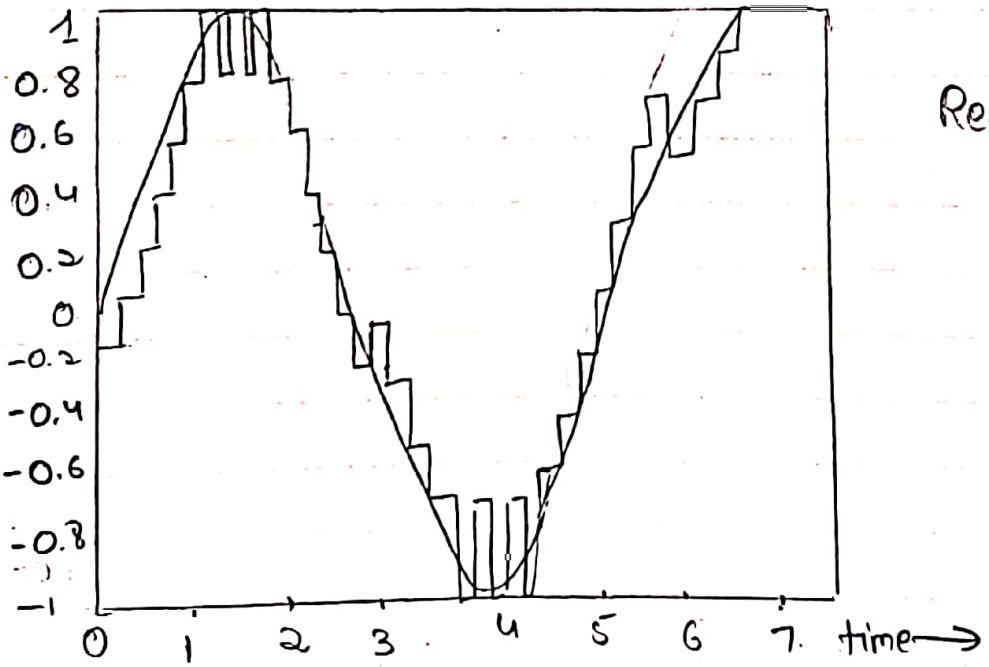
$f_m = 0.2$.

Orginal Signal





D.M Signal



Received Signal.

Advantages of Delta Modulation:

1) In delta modulation, amplitude of speech signal does not exceed maximum sinusoidal amplitude.
2) Due to transmission of 1 bit per sample, it permits low channel bandwidth as well as signalling rate.
3) PCM has sampling rate higher than Nyquist rate. The encode signal contains redundant infomatic. DPCM can efficiently remove this redundancy
4) ADC is not required. Thus permits generation and detection

Disadvantages of Delta Modulation:

1) Slope overload distortion (when Δ is small)
2) Granular noise (when Δ is large)
3) High bit rate

Applications:

It is widely used in radio communication devices voice storage and voice transmission.

Conclusion:-

Successfully demonstrated the Delta modulation technique and illustrated sampled, quantized/encoded, decoded waveforms in time domain using matlab software.