# Lab-2


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# Matlab Experiment:

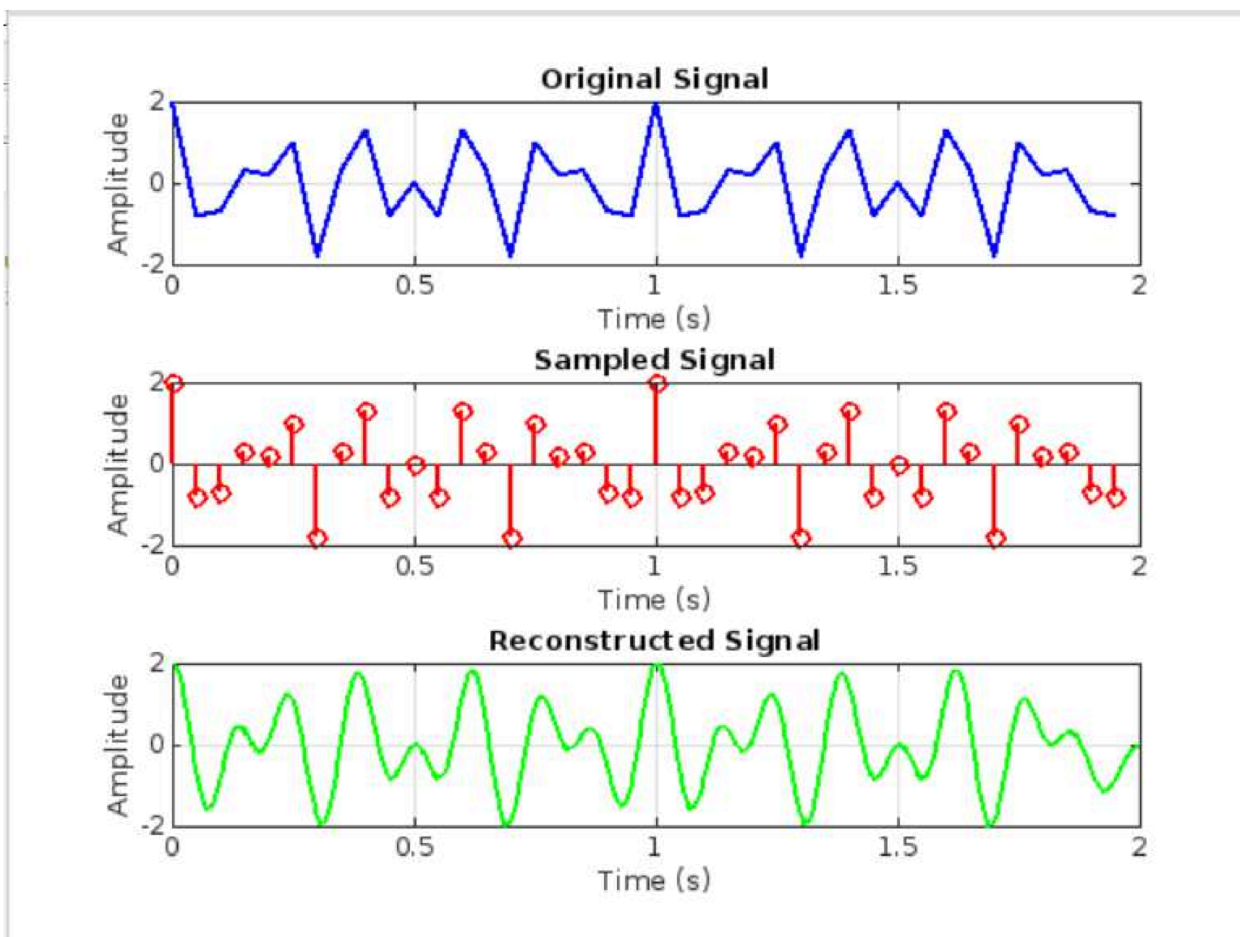
***Matlab Code:***

```
        Fs = 20; % Sampling frequency (20 Hz)
T = 1/Fs; % Sampling period
t = 0:T:2-T; % Time vector for 2 seconds
f1 = 5; % Frequency of first cosine signal (5 Hz)
f2 = 8; % Frequency of second cosine signal (8 Hz)
x = cos(2*pi*f1*t) + cos(2*pi*f2*t); % Original signal (sum of cosines)

% Sampling the signal
n = 0:length(t)-1; % Sample indices
x_sampled = cos(2*pi*f1*n*T) + cos(2*pi*f2*n*T); % Sampled signal

% Low-Pass Filter (LPF) using sinc interpolation
t_reconstruct = linspace(0, 2, 1000); % High-resolution time vector
x_reconstruct = zeros(size(t_reconstruct)); % Initialize reconstructed signal

for i = 1:length(n)
   x_reconstruct = x_reconstruct + x_sampled(i) * sinc(Fs*(t_reconstruct-n(i)*T));
end

% Plotting the results
figure;
subplot(3,1,1);
plot(t, x, 'b', 'LineWidth', 1.5);
title('Original Signal');
xlabel('Time (s)');
ylabel('Amplitude');
```

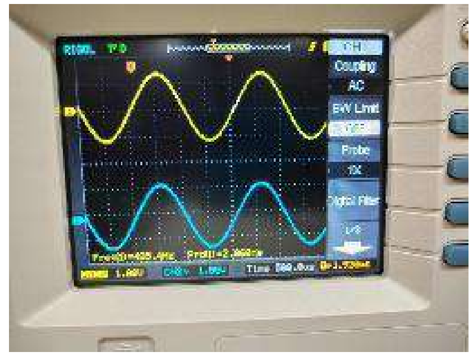
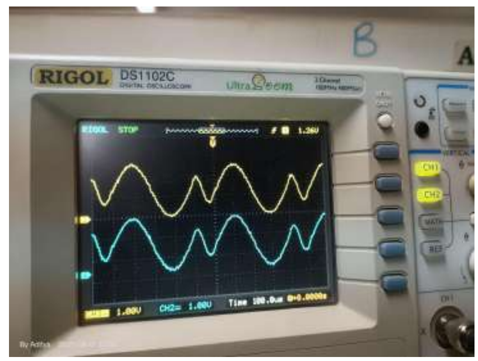
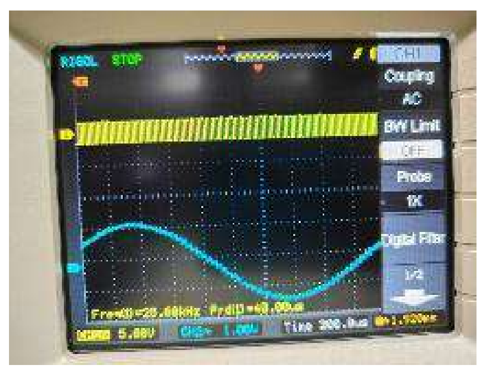
```
grid on;

subplot(3,1,2);
stem(n*T, x_sampled, 'r', 'LineWidth', 1.5);
title('Sampled Signal');
xlabel('Time (s)');
ylabel('Amplitude');
grid on;

subplot(3,1,3);
plot(t_reconstruct, x_reconstruct, 'g', 'LineWidth', 1.5);
title('Reconstructed Signal');
xlabel('Time (s)');
ylabel('Amplitude');
grid on;
```

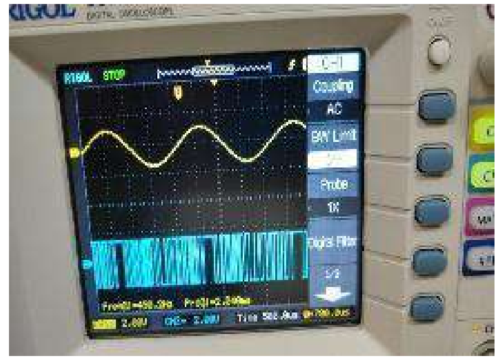
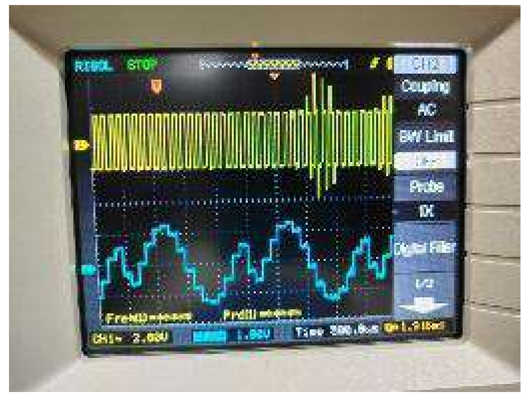
***Explanation:***
This MATLAB code samples a signal composed of two cosine waves (5 Hz and 8 Hz) at 20 Hz, reconstructs the signal using sinc interpolation (low-pass filtering), and then plots the original, sampled, and reconstructed signals for comparison.

***Output:***



# Experiment 1:

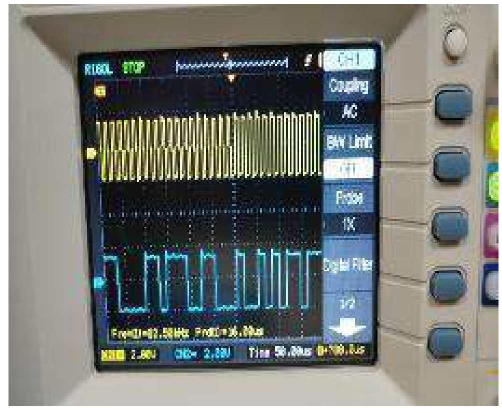
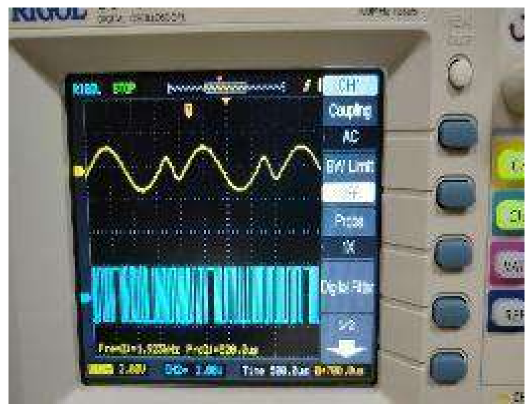
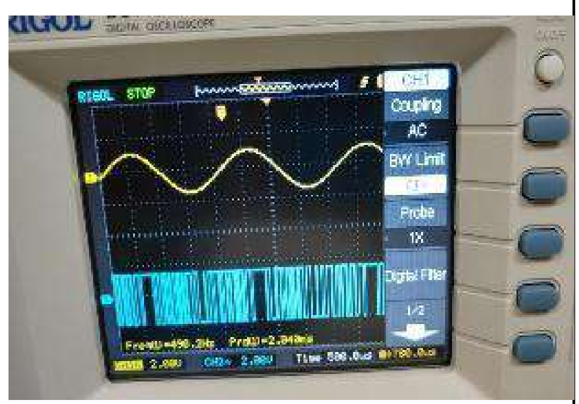
| Sr.no | Input signal and freq. | Sampling frq. | Input and Output signals |
|---|---|---|---|
| Sine/500 Hz | Channel1 | - |   |
| Arbitrary /1.5 KHz | Channel2 | - |   |
| Sine/500 Hz | Channel1 | 8 KHz |   |

| | | | |
|---|---|---|---|
| **Sine/500 Hz** | **Channel1** | **8 KHz** |  |
| **Arbitrary /500 Hz** | **Channel2** | **8 KHz** |  |
| **Arbitrary /500 Hz** | **Channel2** | **8 KHz** |  |

## *Conclusion:*

- Through this experiment, we learned how different input signal frequencies and sampling rates influence the signals observed in the oscilloscope.
- We learned that adjusting the sampling frequency is crucial for representing the original signal accurately.

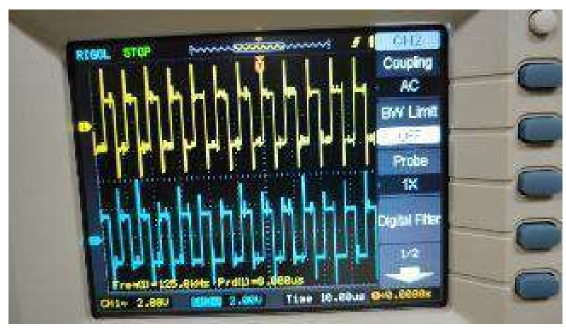
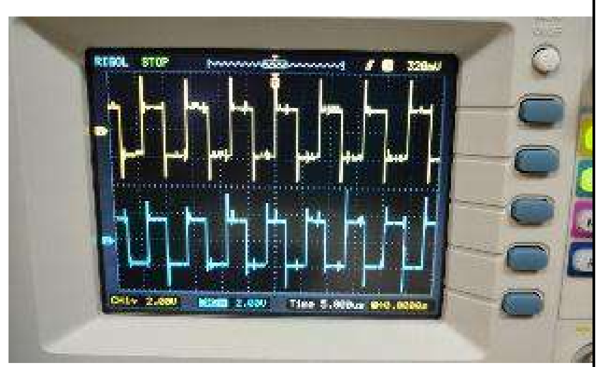
# Experiment-2:

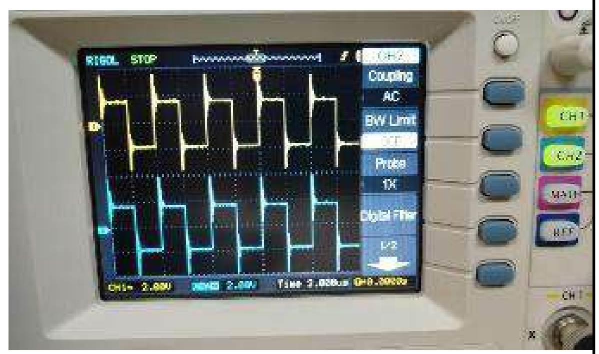
| Sr.no | Input signal and freq. | Sampling frq. | Input and Output signals |
|---|---|---|---|
| Sine/500 Hz | Channel1 | 8 KHz |  |
| Arbitrary/500 Hz | Channel1 | 8 KHz |  |
| Sine /500 Hz | Channel2 | 8 KHz |  |

## *Conclusion:*

- Through this experiment, we showed that the line speed frequency directly impacts the PCM clock and the PCM output.
- Changes in the line speed directly affected the timing and quality of the PCM output signal.

# Experiment-3:

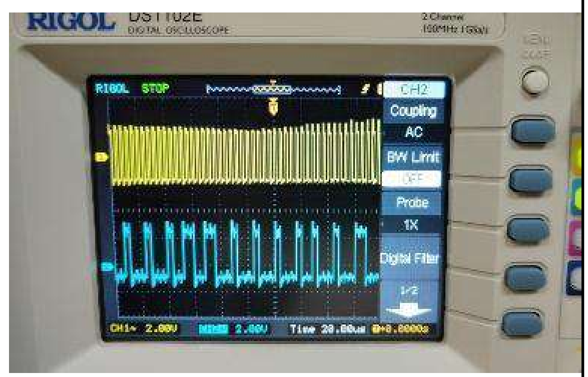
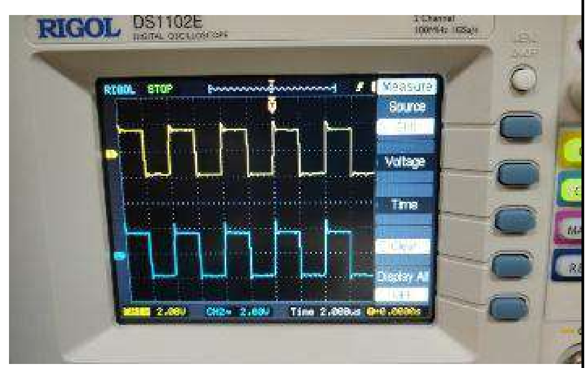
| **Sr.no** | **Input signal and freq.** | **Sampling frq.** | **Input and Output signals** |
|---|---|---|---|
| **Sine/500 Hz** | **Both** | **8KHz** |  |
| **Sine/500 Hz** | **Both** | **8 KHz** |  |

| | | | |
|---|---|---|---|
| **Sine/500 Hz** | **Both** | **8 KHz** |  |
| **Sine/500 Hz** | **Both** | **8 KHz** |  |

## *Conclusion:*

- Through this experiment, we learned how a 17 bit multiplexed output frame is structured with a framing pulse.
- The framing pulse is added for synchronization of frames.
- They help maintain alignment of channels within the frame.

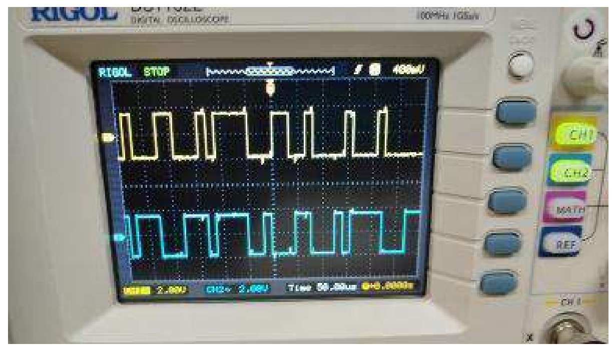
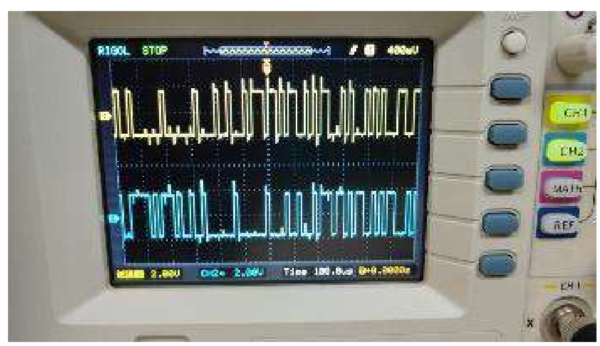
# Experiment-4:

| Sr.no | Input signal and freq. | Sampling frq. | Input and Output signals |
|---|---|---|---|
| **Sine/500 Hz** | **Both** | **8KHz** |  |
| **Sine/500 Hz** | **Both** | **8 KHz** |  |
| **Sine/500 Hz** | **Both** | **8 KHz** |  |

## *Conclusion:*

- Through this experiment, we learned how detecting the framing pulse enables the system to correctly synchronize and output a 16 bit frame.
- It helps us understand the critical role of the framing pulse in ensuring that the data is accurately aligned and transmitted in intended format.

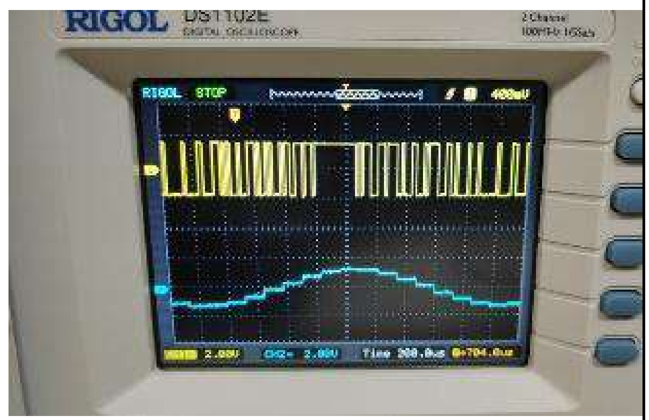
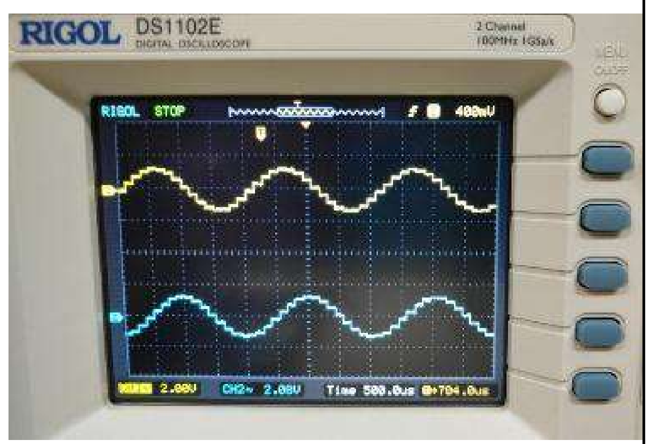
# Experiment-5:

| **Sr.no** | **Input signal and freq.** | **Sampling frq.** | **Input and Output signals** |
|---|---|---|---|
| **Sine/500 Hz** | **Channel1** | **8KHz** |  |
| **Arbitrary /500 Hz** | **Channel2** | **8KHz** |  |

## *Conclusion:*

- Through this experiment, we learned how PCM output was accurately separated into individual channels after demultiplexing.
- The framing pulse plays a key role in ensuring that each channel's signal was correctly identified and retrieved.
- This ensures integrity of original input signals throughout the process.

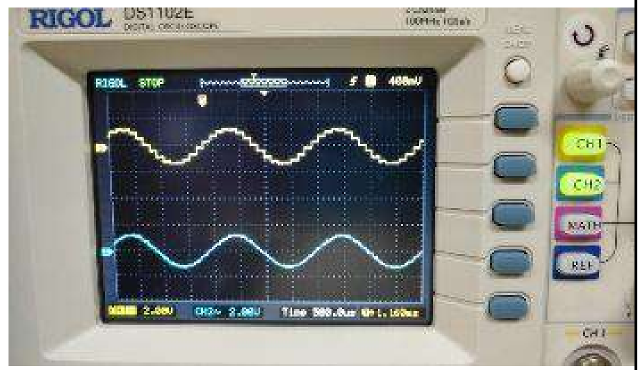
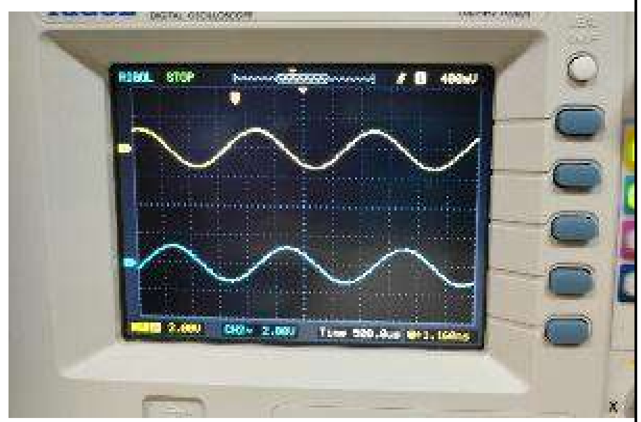
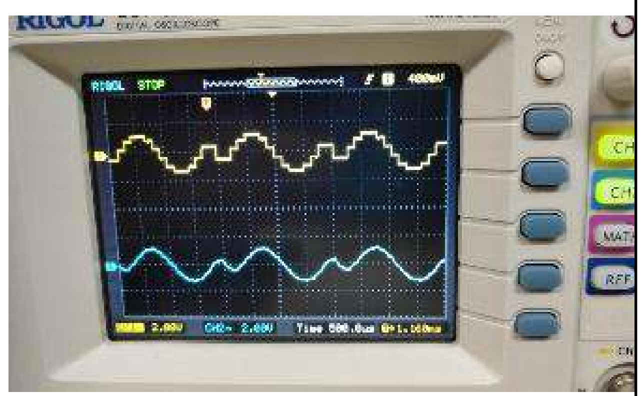
# Experiment-6:

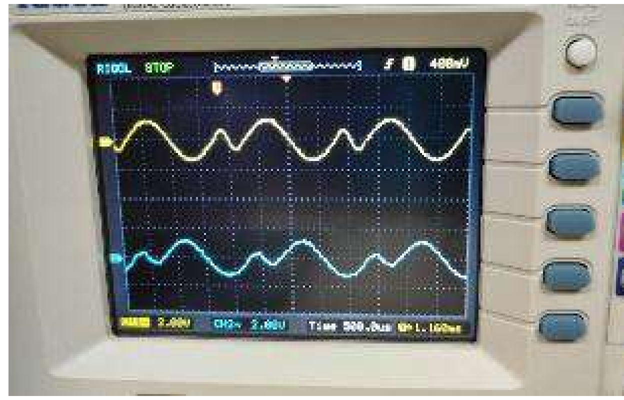
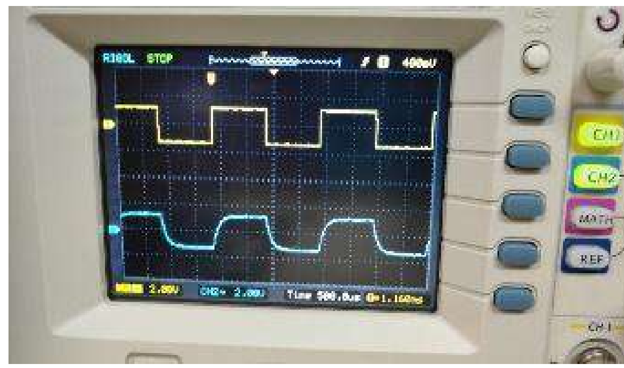
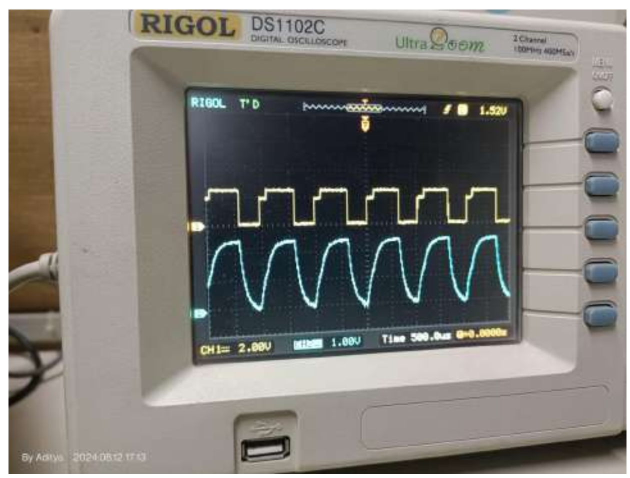
| Sr.no | Input signal and freq. | Sampling frq. | Input and Output signals |
|---|---|---|---|
| Sine/500 Hz | Channel1 | 8KHz |  |
| Sine/500 Hz | Channel1 | 8 KHz |  |
| Arbitrary/500 Hz | Channel2 | 8 KHz |  |

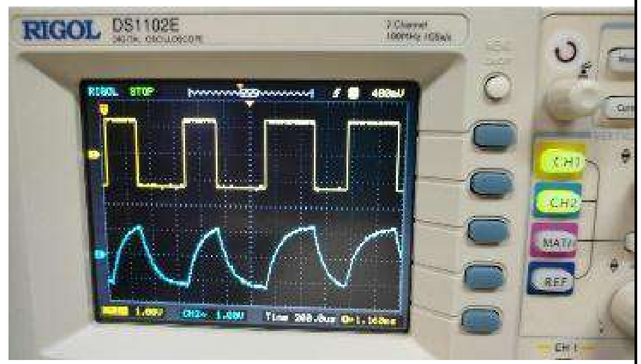
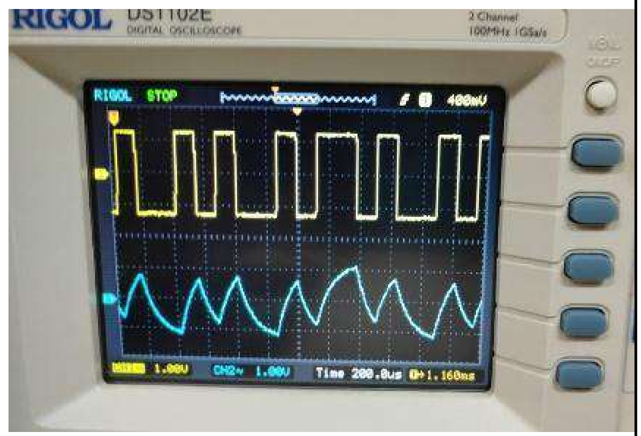
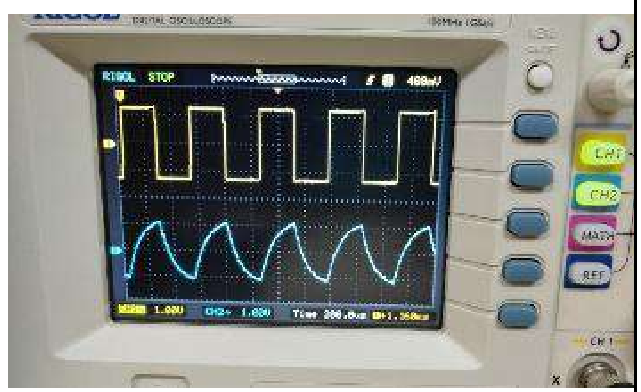
## *Conclusion:*

- Through this experiment, we learned how demodulated output from a TDM-PCM system accurately reconstructs the original input signal.
- By observing the signal at various points, we observe how the system effectively separates and retrieves each channel’s data.

# Experiment-7:

| Sr.no | Input signal and freq. | Sampling frq. | Input and Output signals |
|---|---|---|---|
| Sine/500 Hz | Channel1 | 8KHz |  |
| Sine/500 Hz | Channel1 | 8 KHz |  |
| Arbitrary/500 Hz | Channel2 | 8 KHz |  |

| | | | |
|---|---|---|---|
| **Arbitrary/500 Hz** | **Channel2** | **8 KHz** |  |
| **Square/500 Hz** | **Channel1** | **8KHz** |  |
| **Square/1 KHz** | **Channel1** | **8KHz** |  |

| | | | |
|---|---|---|---|
| **Square / 1.5KHz** | **Channel1** | **8KHz** |  |
| **Square / 3 KHz** | **Channel1** | **8kHz** |  |
| **Square / 2 KHz** | **Channel1** | **8kHz** |  |

## *Conclusion:*

- Through this experiment, we learned how the low pass filter effectively smoothes out the demodulated signal.
- It then converts the original square wave into a more rounded waveform due to the LPF's RC characteristics.