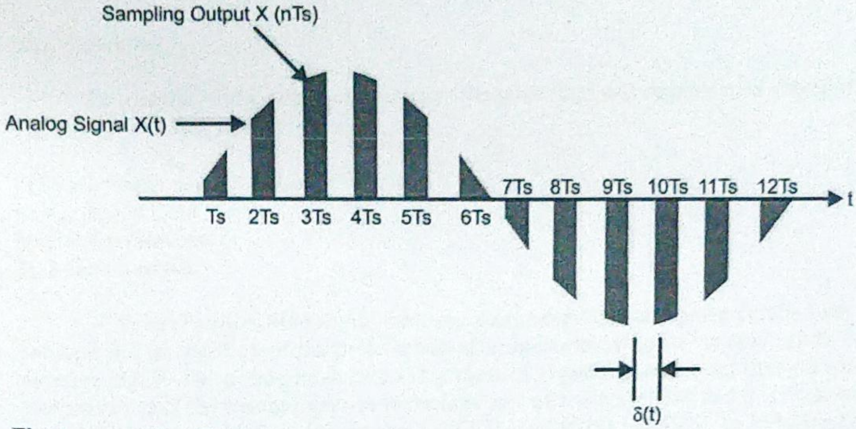
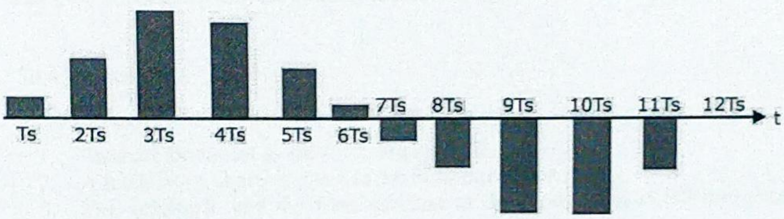
Natural Sampling Output



Flat top sampling Output



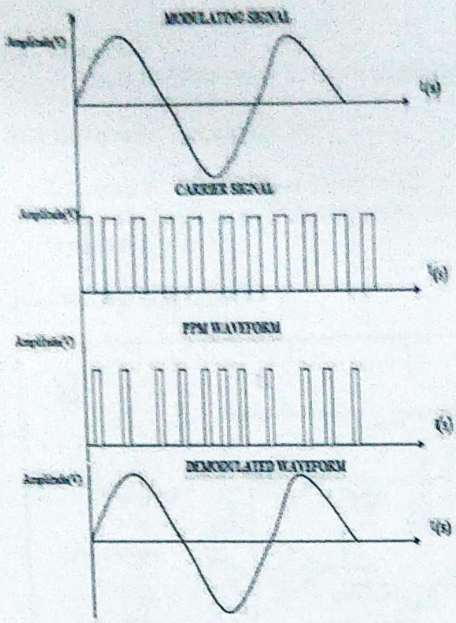
5a.6 Tabulation

Signal	Amplitude (V)	Time Period (ms)
Sinusoidal waveform	5.76	1 ms
Pulse Carrier waveform	5.4 V	125 µs
Sample Output	~~1.66 V~~ 5.52	125 µs
Sample and Hold Output	~~1.6 V~~ 6.48	12.5 µs
Flat Top Output	5.88	125 µs
Demodulated waveform	~~3.8~~ 2.8	1 ms

5a.7 Lab Result

Thus the PAM and its demodulation were performed and graphs were plotted.

5b.6 Model Graph:



5b.7 PPM Modulation

Name of the Signal	Amplitude(V)	Time Period(ms)	Frequency(Hz)
Message signal	5V	1ms	1kHz
Carrier Signal	5V	12.5µs	5kHz
Modulated Signal	5V	12.5µs	5kHz.

PPM Demodulation

Name of the Signal	Amplitude(V)	Time Period(ms)	Frequency(Hz)
LPF Signal	4V.	1ms	1kHz
Demodulated signal	10V	1ms	1kHz

2V

8/8

5b.8 Lab Result

Thus the Pulse Position modulation and demodulation were performed and graphs were plotted.

5c.5 Model Graph

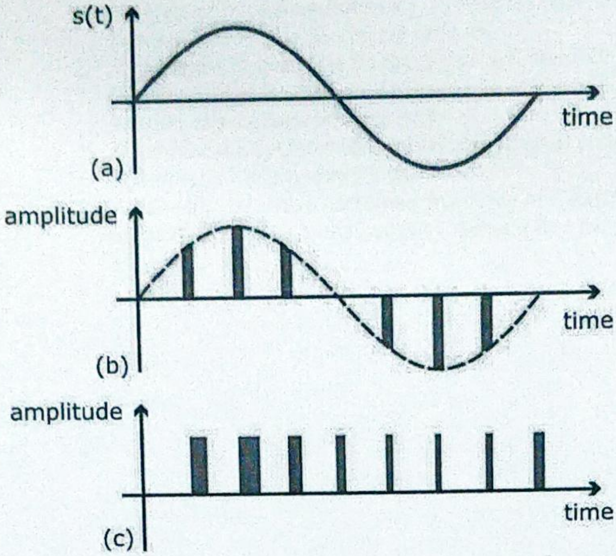


Figure 5c.3 (a) Input Waveform (b) PAM Waveform (c) PWM Waveform

5c.6 Tabulation

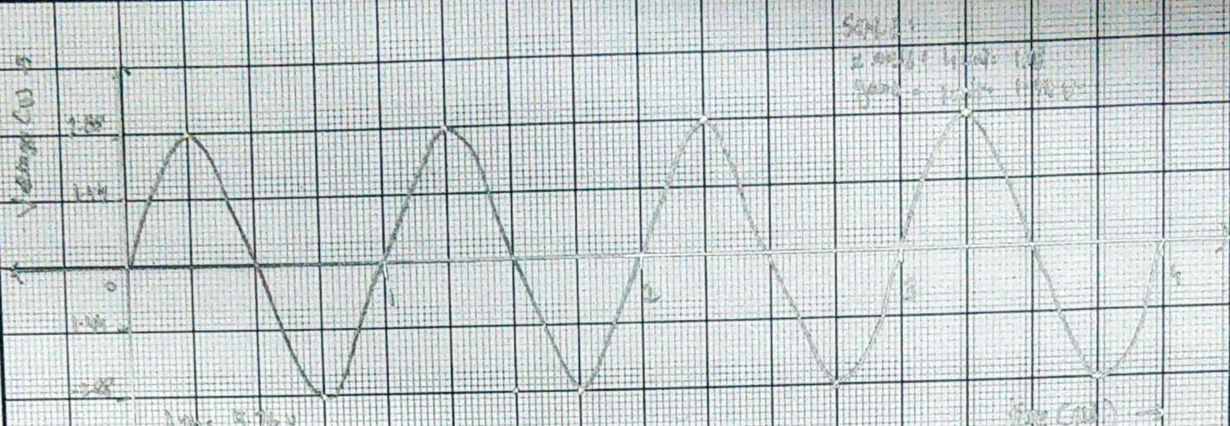
Signal	Frequency	Amplitude
Sinusoidal waveform	~~8~~kHz	5.7V
Pulse waveform	8kHz	5.4V
Demodulated waveform	1kHz	3.12
PWM	8kHz	4.0

5c.7 Pre Lab Questions

1. State Sampling Theorem.
2. Why Flat Top sampling more preferred than natural sampling?
3. What is Pulse width Modulation?
4. Compare different pulse modulation system.
5. What is Pulse Position Modulation?

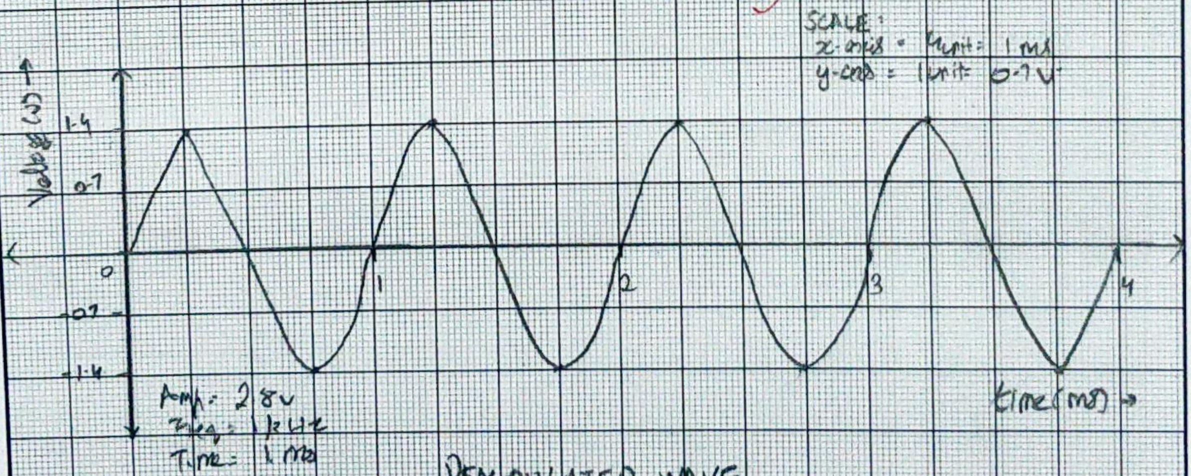
-ve : 72µs
+ve : 8µs

PULSE AMPLITUDE MODULATION (PAM)



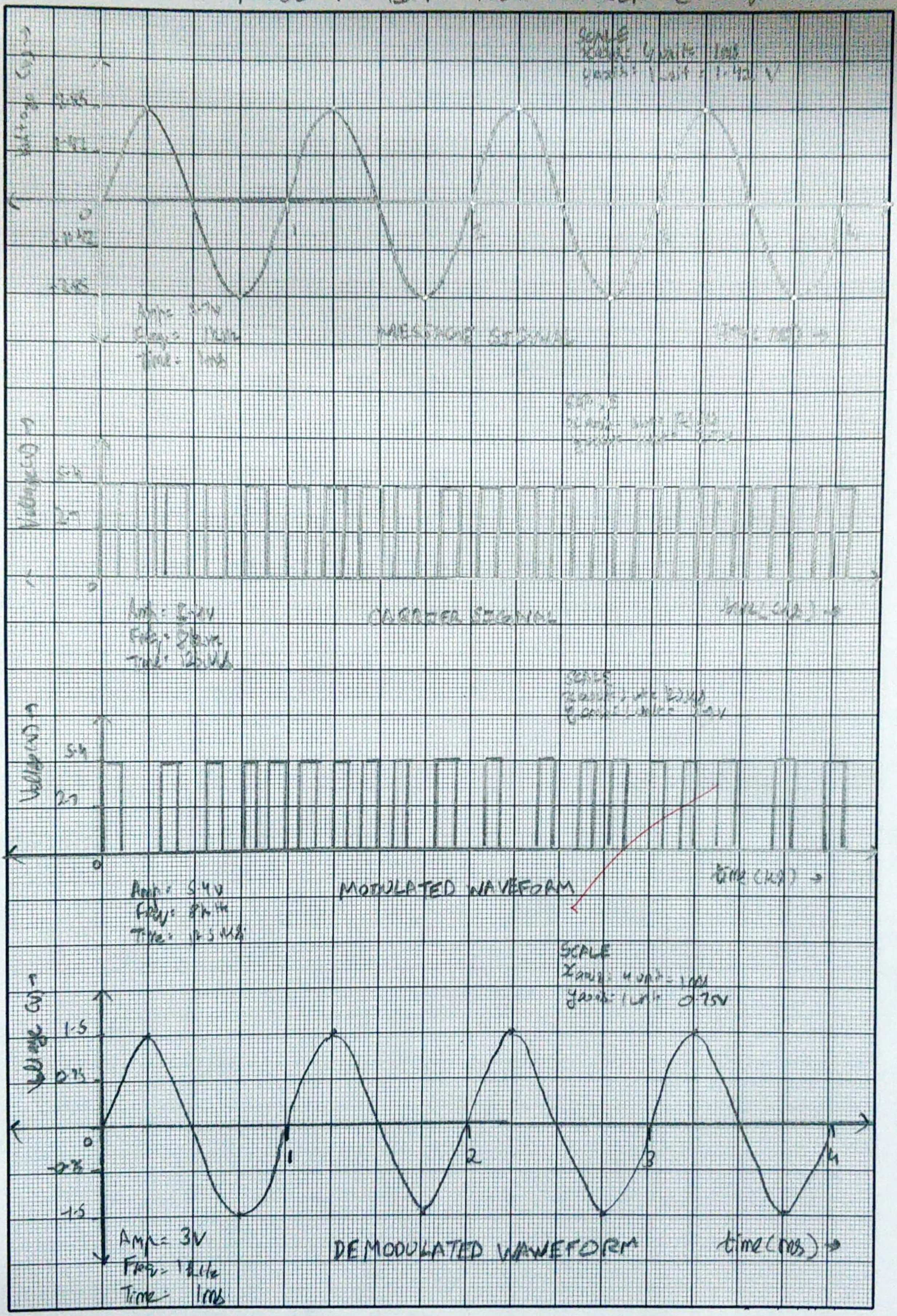
SINUSOIDAL WAVE

FLAT TOP OUTPUT

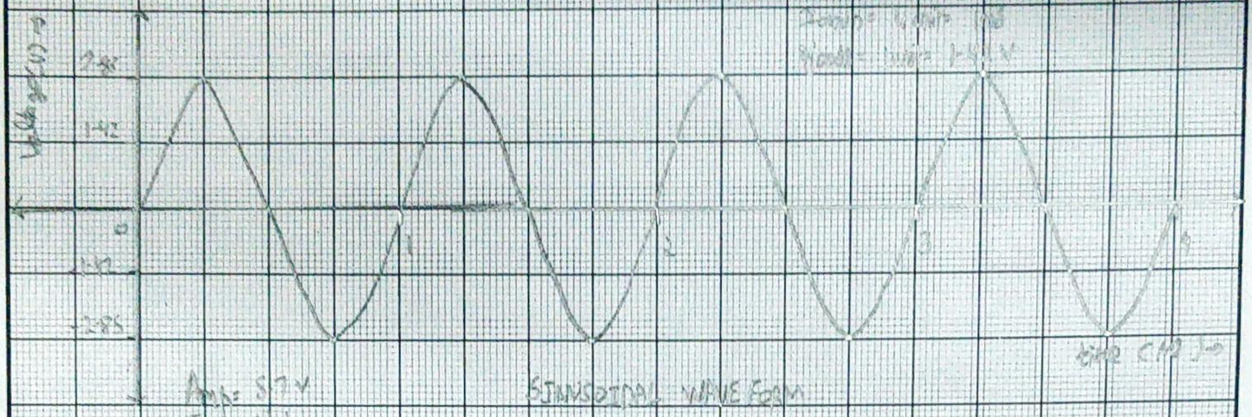


DEMODULATED WAVE

PULSE POSITION MODULATION (PPM)

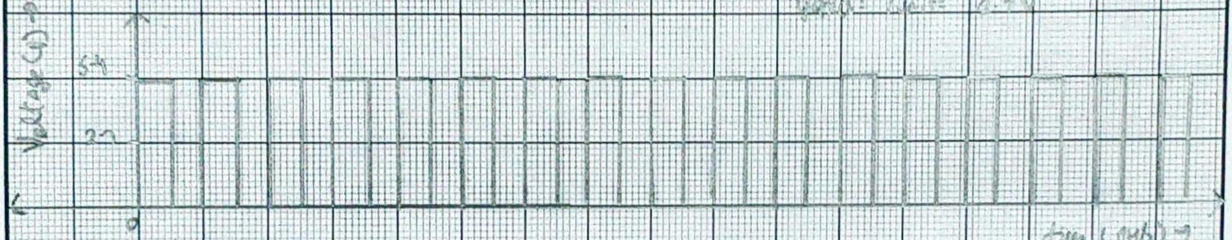


PULSE WIDTH MODULATION (PWM)



SINUSOIDAL WAVE FORM

Amp: 5.7 V
Freq: 1kHz
Time: 1ms



PULSE WAVEFORM

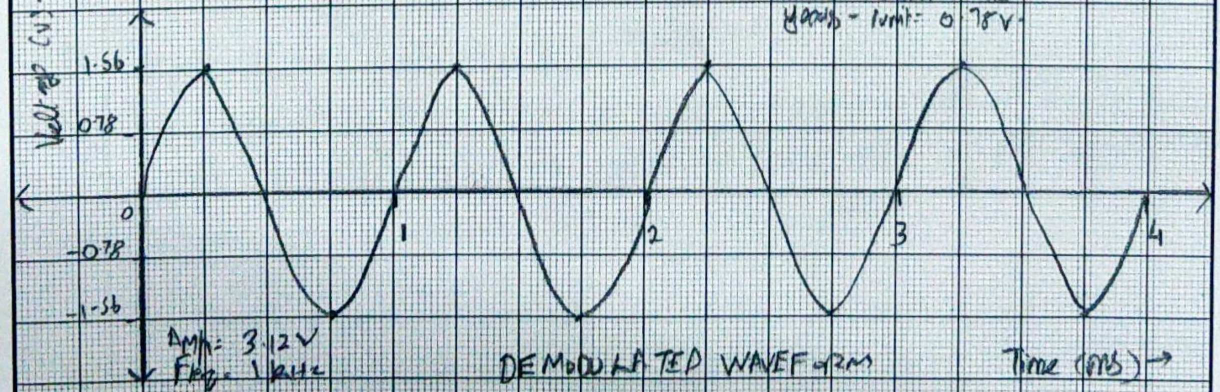
Amp: 5.4 V
Freq: 8 kHz
Time: 125 μs

SCALE
x axis: 1 unit: 125 μs
y axis: 1 unit: 2 V

MODULATED WAVE FORM

Amp: 4.0 V
Freq: 8 kHz
Time: 125 μs

SCALE
x axis: 4 unit: 1 ms
y axis: 1 unit: 0.78 V



DEMODULATED WAVEFORM

Amp: 3.12 V
Freq: 1 kHz
Time: 1 ms

Analog and Digital Communication Lab

Experiment - 5 PAM, PWM, PPM Modulation and Demodulation

I Pre-lab Questions

1. State Sampling Theorem

Soln. The sampling theorem specifies the minimum sampling rate at which a continuous-time signal needs to be uniformly sampled so that the original signal can be completely recovered or reconstructed by these samples alone.

2. Why flat top sampling is more preferred than natural sampling?

Soln. In flat top sampling, the top of samples are constant and are equal to instantaneous value of the signal while a more practical method of sampling is natural sampling in which the width of pulse is finite.

During transmission, noise is introduced at top of the transmission pulse which can be easily removed if the pulse is in the form of flat top.

3. What is Pulse width modulation?

Soln. Pulse width modulation is a method of reducing the average power delived by an electrical signal, by effectively chopping it up into discrete parts. The average value of voltage fed to the load is controlled by turning the switch between supply and load on and off at a fast rate.

4. Compare different pulse modulation system.

Soln. Pulse Amplitude Modulation (PAM) is an analog modulating scheme in which the amplitude of the pulse carrier values varies proportional to the instantaneous amplitude of the message signal.

Pulse Width Modulation (PWM) is an analog modulating scheme in which the duration or width or time of the pulse carrier varies proportional to the instantaneous amplitude of the message signal.

Pulse position Modulation (PPM) is an analog modulating scheme in which the amplitude and width of the pulses are kept constant, while the position of each pulse, with reference to the position of a reference pulse varies according to the instantaneous sampled value of the message signal

5 What is Pulse position Modulation?

Soln. PPM is an analog modulating scheme in which the amplitude and width of the pulses are kept constant, while the position of each pulse, with reference to the position of a reference pulse varies according to the instantaneous sampled value of the message signal

II Post-Lab Question:

1. A signal of maximum frequency 10 kHz is sampled at Nyquist rate. Find the time interval between successive samples.

Soln Given, $f_m = 10kHz$

By Nyquist rate,

$f_s \geq 2f_m \quad \therefore \quad f_s = 2 \times 10kHz = 20kHz$

Time interval $= \frac{1}{f_s} = \frac{1}{20k} = 0.05\,ms$ (or) $50\,\mu s$.

2. What is the Nyquist rate for the signal $x(t) = 2\cos(2000\pi t)\cos(7000\pi t)$

Soln. Given, $x(t) = 2\cos(2000\pi t)\cos(7000\pi t)$

$f_1 = \frac{\omega_1}{2\pi} = \frac{2000\pi}{2\pi} = 1000\,Hz$

$f_2 = \frac{\omega_2}{2\pi} = \frac{7000\pi}{2\pi} = 3500\,Hz$

$f_s = 2\,Max(f_1, f_2) = 2 \times 3500\,Hz$

$\boxed{f_s = 7000\,Hz}$

3. Which of the pulse modulation system would be affected if the Synchronization between transmitter and receiver fails?

Soln. Pulse Position Modulation (PPM). In PPM, data transmitted in short pulses have the same width and amplitude. The PPM changes the delay between pulses hence PPM needs synchronization.

4. Determine the Nyquist rate and Nyquist interval corresponding to signals given by, $x(t) = 1 + \sin(3000\pi t) + \cos(5000\pi t)$.

Soln
$$f_1 = \frac{3000\pi}{2\pi} = 1500 Hz$$

$$f_2 = \frac{5000\pi}{2\pi} = 2500 Hz$$

Nyquist rate $= f_s = 2 f_m = 2 \times 2500$
$= 3000 Hz$

5. A band limited with a max freq of 5kHz is sampled and is to be sampled. According to the sampling theorem find the sampling frequency.

Soln. By sampling theorem,

$$f_s = 2 f_m$$
$$= 2 \times 5 kHz$$
$$F_s = 10 kHz$$ is the sampling frequency