

# BITT POLYTECHNIC

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Subject: Communication Systems Lab manual

Semester: 4<sup>th</sup> Semester ECE

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# COMMUNICATION SYSTEM LAB MANUAL

**DEPARTMENT OF ELECTRONICS AND COMMUNICATION  
ENGINEERING**

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## **SYLLABUS FOR Communication Lab-I**

### **EEC 552 COMMUNICATION LAB-I**

1. To study DSB/ SSB amplitude modulation & determine its modulation factor & power in side bands.
2. To study amplitude demodulation by linear diode detector
3. To study frequency modulation and determine its modulation factor
4. To study PLL 565 as frequency demodulator
5. To study sampling and reconstruction of Pulse Amplitude modulation system
6. To study Pulse Amplitude Modulation
  - a. using switching method
  - b. by sample and hold circuit
7. To study sensitivity, selectivity, and fidelity characteristics of super heterodyne receiver
8. To study Pulse Width Modulation and Pulse Position Modulation
9. To demodulate the obtained PAM signal by 2<sup>nd</sup> order LPF.
10. To plot the radiation pattern of dipole, Yagi-uda and calculate its beam width

## EXPERIMENT 1

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1. AIM: To study DSB/SSB amplitude modulation and determine its modulation factor.

2. APPARATUS REQUIRED:

S.No	Component name	Specification	Quantity
1.	DSB/SSB AM transmitter kit	ST2201	1
2.	CRO		1
3.	Patch cords	2mm	As per exp.

3. THEORY:

1. **Amplitude modulation**: Modulation is a process of translating information signal from low band frequency to high band frequency that suits the transmission medium. Information signal is usually of low frequency, so it cannot travel far. It needs a carrier signal of higher frequency for long distance destination. The inputs are carrier and information (modulating) signals while the output is called the modulated signal. Amplitude Modulation (AM) refers to the modulation technique where the carrier's amplitude is varied in accordance to the instantaneous value of the modulating or baseband signal's amplitude. An AM signal is represented as:

Sinusoidal carrier wave  $C(t)$  given as:

$$c(t) = A \cos wct \quad \begin{array}{l} A = \text{Max amplitude of the carrier wave} \\ Wc = \text{carrier frequency} \end{array}$$

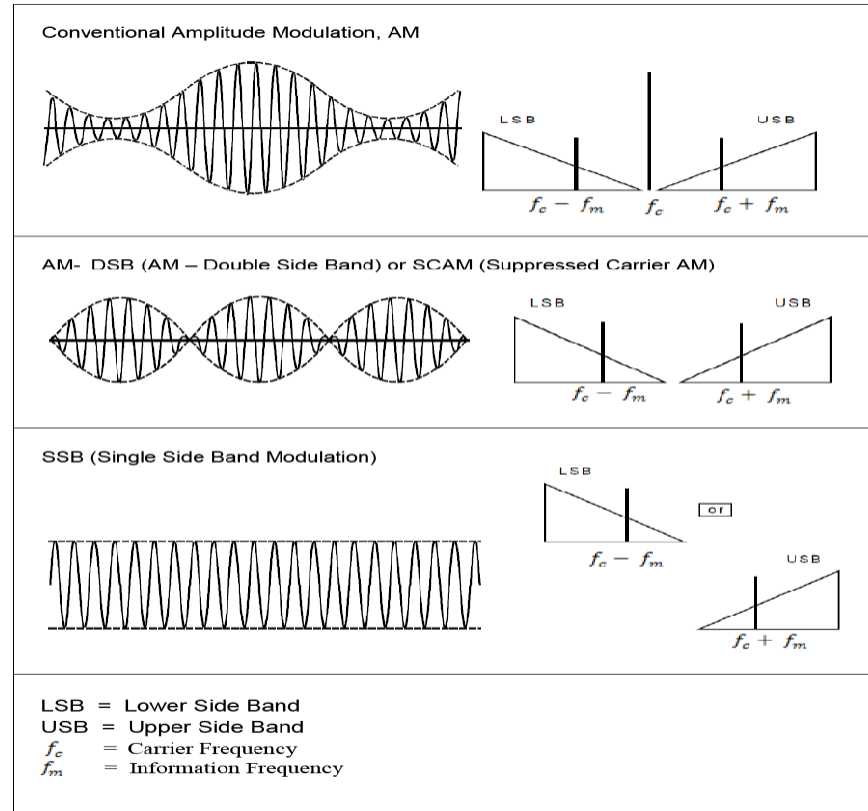
AM wave can be expressed as:

$$\begin{aligned} s(t) &= x(t) \cos wct + A \cos wct \\ s(t) &= [A + x(t)] \cos wct \end{aligned}$$

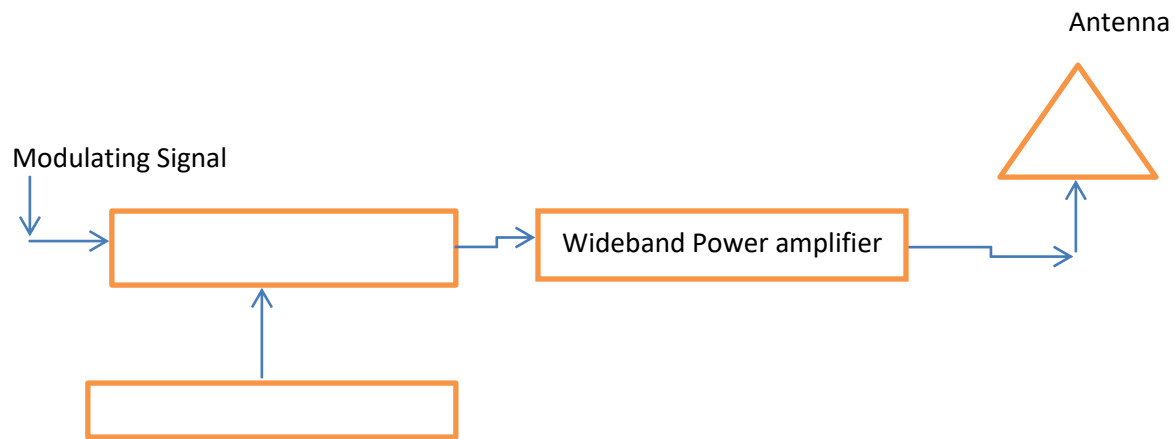
2. **Modulation Index**: The amount by which the amplitude of the carrier wave increases and decreases depends on the amplitude of the information signal and is known as modulation index or depth of modulation. The extent of amplitude variation in AM about a unmodulated carrier amplitude is measured in terms of a factor called modulation index.

$$m = \frac{V_{\max} - V_{\min}}{V_{\max} + V_{\min}} \times 100 \%$$

3. **Double side band transmitter**: The transmitter circuit produces the AM signal which is used to carry information over transmission to the receiver.



#### 4. CIRCUIT DIAGRAM:



**Block Diagram of Amplitude Modulation**

## 5. PROCEDURE:

1. Connections are made for the AM Modulator and Demodulator as shown in the circuit diagrams.
2. Frequency of the input carrier is fixed at constant amplitude of 1 volt and 150 KHz.
3. A message signal of 1 KHz at 0.5 volt amplitude is applied at the modulating signal input.
4. The  $V_{max}$  and  $V_{min}$  are measured and tabulated to calculate the Modulation Index  $m$
5. The amplitude of the message signal is varied in steps till the  $V_{min}$  reaches the minimum.
6. The same set of amplitude values are used for two or three modulating frequencies and values tabulated.
7. The maximum value of  $m$  is observed to be 1.
8. The demodulated message signal is observed from the output of the Envelope Detector and tabulated in the demodulator side of the tabulation..
9. A selection of RC network is important for a faithful recovery of the message signal.
10. All optimum parameters like  $V_{cc}$  are noted down.

## 6. OBSERVATION:

S.No	Modulated Wave		Modulation Index	
	$V_{max}$	$V_{min}$		
1,				
2.				
3.				
4.				

## 7. CALCULATION:

Formulae used:

$$\text{Modulation Index, } m = \frac{V_{max} - V_{min}}{V_{max} + V_{min}} \times 100 \%$$

$$\text{Power of Carrier Signal, } P_c = \frac{A_c^2}{2}$$

$$\text{Power of Side Band, } P_s = P_c \left[ 1 + \frac{m^2}{2} \right]$$

$$\text{Total power, } P = P_c + P_s$$

8. RESULTS AND DISCUSSION: Study of DSB/SSB AM signal has been done. Modulation Index has been calculated and power has been determined.

9. PRE EXPERIMENT Q.B:

1. Name three parameters of the carrier that can be varied to produce modulation.
2. Define amplitude modulation
3. Is the signal modulated when it transmits through a baseband communication system?
4. Define modulation index.

10. POST EXPERIMENT Q.B:

5. Explain why 100% modulation is *not* an ideal value.
6. Define over modulation.
7. What happens to the modulation index of an AM signal if the carrier level remains constant and the sideband level increases?
4. What is the main disadvantage of AM?

## EXPERIMENT 2

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1. AIM: To study amplitude demodulation by linear diode detector.

2. APPARATUS REQUIRED:

S.no.	Name of the component	Specification	Qty.
1.	CRO		1
2.	AM Transmitter-Receiver	ST2201	1
3.	Super heterodyne kit		1
4.	Patch cords	2mm	As per exp.

3. THEORY:

**Diode Detector:** The function of the diode detector is to extract the audio signal from the signal at the output of the IF amplifiers. It is similar to a half wave rectifier i.e. converting an input to a DC output. Diode conducts every time the input signal applied to its anode is more positive than the voltage on the top of the capacitor. When the voltage falls below the capacitor voltage, the diode ceases to conduct and voltage across the capacitor leaks away until next time the input signal is able to switch it again.

**Operating principle:** Let us assume that the operation is absent in the circuit, the detector output wave would be half rectified modulated signal. Now let us consider that the capacitor is introduced in the circuit.

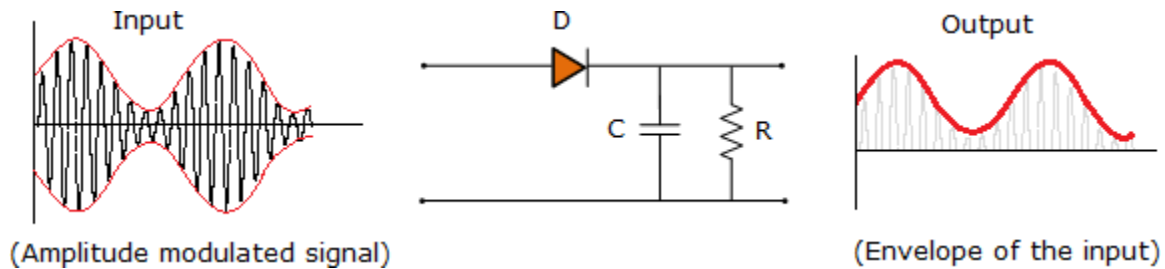
1. For +ve half cycle: The diode conducts and capacitor is charged to peak value of carrier voltage.

2. For -ve half cycle: The diode doesn't conduct, that means i/p carrier voltage is disconnected from the R-C circuit therefore capacitor starts discharging through the resistor R with the time constant  $t = RC$ . If T is suitably chosen, the voltage across capacitor C will not fall during the small period of -ve half cycle and by that time the next +ve half cycle appears. This cycle again charges the capacitor voltage.

Hence the output voltage across the capacitor C is a spiky modulating as baseband signal. This means that the voltage across the C is same as envelope of modulated carrier signal. These spikes are introduced because of charging and discharging of capacitor. Time constant RC should be large so that C discharges negligibly small.

4. CIRCUIT DIAGRAM:





## 5. PROCEDURE:

1. Connect and make the settings as per exp no 2.
2. Observe the signal flow from the input of diode detector to anode of diode D6, at its cathode, after the filter and at the output at TP 31.
3. vary the preset R 45 in the diode detector block while observing the output of diode detector.
4. see the variations in the detected output when you change the RC time constant of the filter formed by R 45 and C 32

## 6. OBSERVATION:

The output of CRO is traced with the help of tracing paper.

## 7. RESULTS AND DISCUSSION:

The study of amplitude demodulation of linear diode detector is carried out and the o/p (baseband) waveform from CRO is traced.

## 9. PRE EXPERIMENT Q.B:

1. Why carrier is suppressed in DSBSC signal and hw the original signal is demodulated at the receiver end.
2. How linear diode is different from others.
3. How demodulation occurs in AM signal. Which method is best and practically used?

## 10. POST EXPERIMENT Q.B:

1. What is the effect of capacitor in linear diode detector in demodulation of signal?
2. Why output is in form of spikes.

## EXPERIMENT 3

---

1. **AIM:** To study frequency modulation and determine its modulation factor.

(a). Study of FM signal using varactor modulator.

(b). Study of FM signal using reactance modulator.

2. **APPARATUS REQUIRED:**

	Audio Oscillator	Adjustable frequency & amplitude(300 Hz-3.4 KHz)
1.	2 types FM Modulator	Variable modulator Reactance Modulator
2.	Mixer/Amplifier	Allows FM i/p signal to be AM modulated by a noise i/p prior to demodulation
3.	Transmitter o/p frequency	455 KHz
4.	LPF	3.4 KHz cut off frequency
5.	Amplitude limiter	1 No.
6.	Power Supply	230 V $\pm$ 10%, 50 Hz
7.	Switched Faults	74 No.
8.	CRO	
9.	Patch cords	2mm

3. **THEORY:**

In frequency modulation instantaneous frequency  $\omega_i$  is varied linearly with a message or base band signal  $x(t)$  about an unmodulated carrier frequency  $\omega_c$ . That means the instantaneous value of the angular frequency  $\omega_i$  will be equal to the carrier frequency  $\omega_c$  plus a time varying component proportional to the baseband signal  $x(t)$ . Instantaneous frequency is given by:

$$\omega_i = \omega_c + k_f \cdot x(t) \qquad k_f = \text{frequency sensitivity}$$

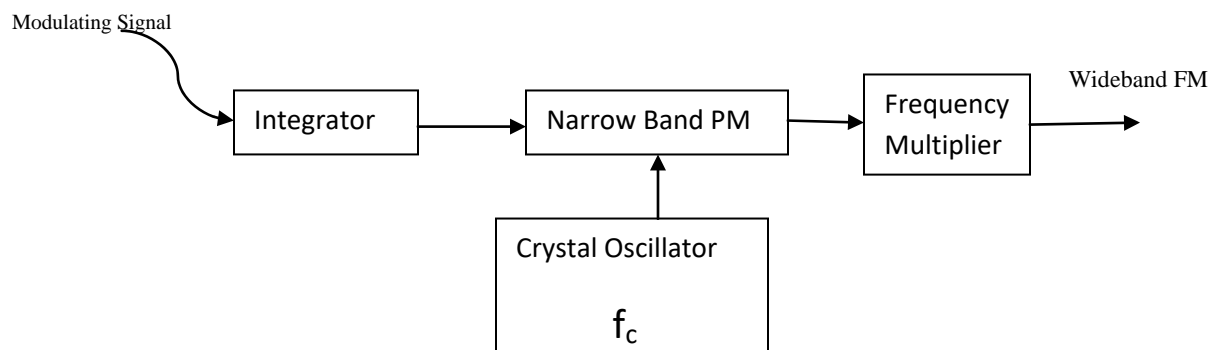
General expression for FM wave:

$$S(t) = A \cos[\omega_c t + k_f \int x(t) dt]$$

(a). Varactor Modulator : The variations in capacitance form part of the tuned circuit that is used to generate the FM signal to be transmitted. The tuned circuit sets the operating frequency of the oscillator and the varactor which is effectively in parallel with the tuned circuit. C1 is a DC blocking capacitor to provide DC isolation *between the oscillator and the collector of the transmitter*. L1 is an RF choke which allows the information signal to pass through the varactor but blocks the RF signal.

(b). Reactance Modulator: As in the circuit diagram , the left hand side is the varactor modulator which generates the un-modulated carrier. The capacitor C and the resistor R are two components used for the phase shifting and together with the transistor for the voltage controlled capacitor. This voltage- controlled capacitor is actually in parallel with the tuned circuit.

#### 4. CIRCUIT DIAGRAM:



Block Diagram for FM Generation

#### 5. PROCEDURE:

1. Initial conditions exist on the ST2202 board:

- a. All switched faults in OFF condition
- b. amplitude potentiometer (in mixer amp block) in fully clockwise position.
- c. VCO switch in OFF position.

2. Turn the audio oscillator block amplitude potentiometer to its fully clockwise position, and examine the block's output TP1 on an oscilloscope. Audio frequency sine wave is generated. Sine wave frequency is adjusted from 300 Hz to apox 3.4 KHz, adjusting audio oscillator frequency potentiometer.

3. Connect the output socket of the audio oscillator block to the input socket of the modulator circuit block.
4. Set the varactor switch to the varactor position. It selects the varactor modulator and also disables the reactance modulator to prevent any interference b/w the two circuits.
5. The output signal from varactor modulator block appears at TP 24 before being buffered and amplified by the mixer block.
6. Put the varactor modulator's carrier frequency potentiometer in its midway position. Note its sine wave of approx 1.2Vpp, centered on 0V. This is FM carrier and it is unmodulated as the varactor modulators audio input signal has zero amplitude.
7. The amplitude of the FM carrier (at TP 34) is adjustable by means of the mixer block's amplitude potentiometer, from zero to its potentiometer level. Turn the potentiometer slowly anticlockwise, note the amplitude of the FM signal can be reduced to zero. Return the amplitude potentiometer to fully clockwise position.
8. Vary the carrier frequency potentiometer and observe its effects.

(a). Operation of Varactor Modulator:

1. The information signal is applied to the base of the input transistor and appears amplified and inverted at the collector.
2. This low frequency signal passes through the RF choke and is applied across the varactor diode.
3. The varactor diode charges its capacitance in according to the information signal and therefore charges the total value of the capacitance in the tuned circuit.
4. The charging value of capacitance causes the oscillator frequency to increase and decrease under the control of information signal. The output is therefore a FM signal.

(b). Operation of Reactance Modulator:

1. The oscillator and tuned circuit provide the unmodulated carrier frequency and this frequency is passed on the collector of the transistor.
2. The capacitor and the resistor provide the 90° phase shift between the collector voltage and the current. This makes the circuit appears as a capacitor.
3. The charging information signal is applied to the base, it has the same effect as charging the bias voltage applied to the transistor and this would have the effect of increasing and decreasing the value of this capacitance.

4. As the capacitance is effectively in parallel with the tuned circuit, variations in the value will cause the frequency of resonance to change and hence the carrier frequency will vary in sympathy with the information signal input.

6. OBSERVATION:

S.No	Modulated Wave		Modulation Index	
	V <sub>max</sub>	V <sub>min</sub>		
1.				
2.				
3.				
4.				

7. CALCULATION:

Formulae used:

Modulation Index,  $m_f = \frac{\Delta f}{f_m}$

$$M_f = \frac{\Delta w}{w_m} = k_f \cdot V_m / w_m$$

7. RESULTS AND DISCUSSION:

The study of FM signal using reactance modulator and varactor modulator has been done.

9. PRE EXPERIMENT Q.B:

1. How FM is better than AM.
2. Define modulation index in FM.
3. Define Carson's rule for bandwidth in FM.

10. POST EXPERIMENT Q.B:

1. How FM can be generated from PM signal.
2. Name direct and indirect method of FM generation.
3. What are disadvantages of FM order?

## EXPERIMENT 4

1. OBJECTIVE: To study PLL 565 as frequency demodulator.

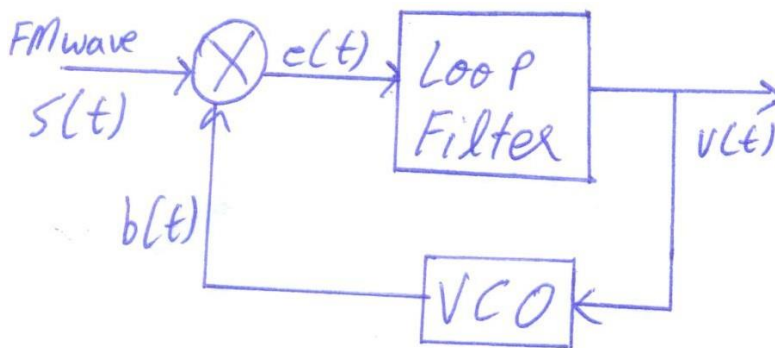
2. APPARATUS REQUIRED:

S.No.	Name of the Exp component	Specifications	Quantity
1	CRO		1
2	Fuction Generator	3.3 Mhz	1
3	Capacitors(4.7 uf,10pf)	Electrolytic	1
	Capacitors(0.1 uf)	Disc type	1
4	IC 565		1
5.	String strand wires		As per required

3. THEORY:

The process of getting a modulating or baseband signal from a frequency modulated signal is called demodulation or detection of signal. The electronic circuits which perform the demodulation process are called FM demodulation or detectors. It converts the FM signal into a corresponding AM signal with the help of frequency dependent circuits, i.e. the circuits whose output voltage depends on the input frequency. These circuits are known as frequency discriminators. A phase locked loop (PLL) is used in tracking the phase and frequency of the carrier component of an incoming FM signal. PLL is also useful for demodulating FM signals in presence of large noise and low signal power. PLL is a negative feedback system. It consists of a multiplier, a loop filter and voltage controlled oscillator (VCO).

4. CIRCUIT DIAGRAM:



Block Diagram of PLL (Phase Locked Loop)

## 5. PROCEDURE:

1. Switch on the power supply, CRO, function generator.
2. Disconnect the function generator input from pin no.2.
3. Observe the VCO o/p of PLL at pin no. 4 and measure its frequency.
4. Set the amplitude of the function generator at 2Vpp and connect it to pin no.2 of IC 565.
5. Vary the frequency from min frequency to the frequency beyond the calculated higher locked frequency that is  $f_2$  lock and observe the VCO output of which the PLL output starts following the input frequency continuously is lower capture frequency.
6. Vary the frequency in reverse direction at which the output of PLL starts following the input frequency id the higher capture frequency  $f_{c2}$  and frequency at which the output frequency of PLL. Ceases to follow the input frequency  $f_1$  lock.

### Part B:

1. Disconnect the RF synthesizer input from the circuit and connect the function generator input.
2. Switch ON the power supply, CRO, and function generator.
3. Find out the VCO output frequency  $f_0$ , capture range and lock-in range of the PLL ckt by varying the frequency of the function generator, using CRO.
4. Disconnect the function generator input from the PLL ckt.
5. Switch ON the RF synthesizer and set it to provide FM output referring the PLL. Parameter and set the modulating signal frequency at  $1/10^{\text{th}}$  of the VCO out frequency  $f_0$  of PLL. The frequency deviation of FM should be with the capture range of PLL.
6. Disconnect the function generator input from the ckt and apply the FM input to the PLL ckt.
7. observe the frequency of the demodulated output waveform from pin no.7 on CRO.
8. Measure the frequency of the demodulate output. This frequency should be equal to the modulating signal frequency.

## 6. OBSERVATION:

The output of CRO is traced with the help of tracing paper.

## 7. RESULTS AND DISCUSSION:

Hence phase locked loop has been studied as frequency demodulator using bread board.

## 9. PRE EXPERIMENT Q.B:

1. Define PLL.
2. Define frequency deviation.
3. What is sideband FM.?

## EXPERIMENT 5

1. AIM: To study sampling and reconstruction of Pulse Amplitude modulation system.

2. APP ARATUS REQUIRED:

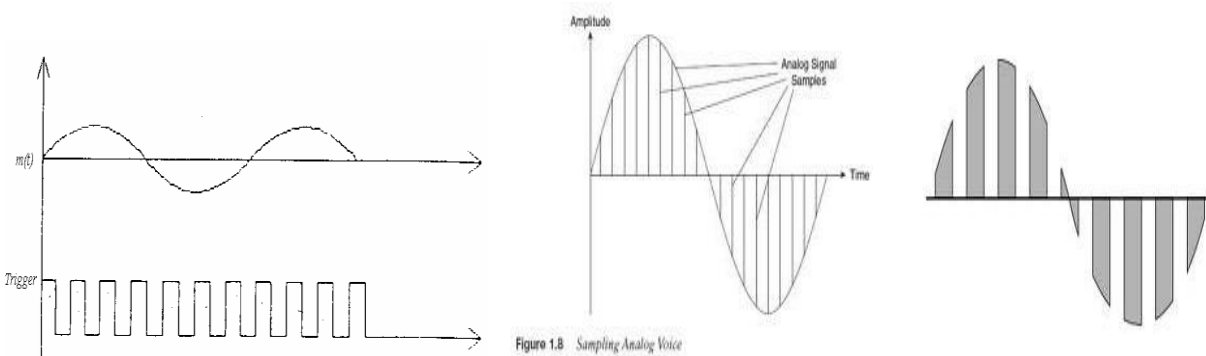
S.No.	Component name	Specification	Qty.
1.	PAM modulator	NV 6575	1
2.	CRO		1
3.	Patch cords	2mm	
4.	Power supply		

3. THEORY:

**Pulse Amplitude Modulation** - In Pulse Amplitude Modulation message information is encoded in the amplitude of a series of signal pulses. It is an analog pulse modulation scheme in which the amplitude of train of carrier pulse are varied according to the sample value of the message signal. A train of very short pulses of constant amplitude and fast repetition rate is chosen the amplitude of these pulse is made to vary in accordance with that of a slower modulating signal the result is that of multiplying the train by the modulating signal the envelope of the pulse height corresponds to the modulating wave .the Pam wave contain upper and lower side band frequencies besides the modulating and pulse signals. The demodulated PAM waves, the signal is passed through a low pass filter having a cut –off frequencies equal to the highest frequency in the modulating signal. At the output of the filter is available the modulating signal along with the DC component.PAM has the same signal to noise ratio as AM.

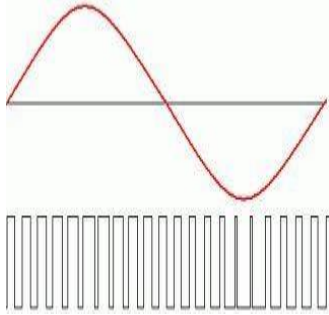
In PAM natural sampling, the pulse has varying top in accordance with signal variation. When these pulses are received at the receiver, it is always contaminated by noise. Then it becomes difficult to determine the shape of the top of the pulse and thus amplitude detection of the pulse is not accurate. Natural sampling uses chopping principle. This method is used practically if it satisfies Nyquist criteria. In this noise interference is minimum

4. CIRCUIT DIAGRAM:



Baseband Signal ,m(t), Pulse train Instantaneously Sampled Signal Naturally Sampled PAM





### PAM Signal

## 5. PROCEDURE:

### Modulation

1. Make the circuit as shown in circuit diagram
2. Set the pulse generator output to be 41V<sub>pp</sub> at 100HZ
3. Set AFO output at 2 V<sub>pp</sub> 100HZ
4. Observe the output wave form on a CRO
5. Tabulate the reading.

### Demodulation

1. Connect the circuit as shown in figure
2. Given the modulated output with AFO used to the input of the circuit.
3. Vary the potentiometer so that modulating signal is obtained.
4. Measure the amplitude of the signal and verify with that of the input.

## 6. OBSERVATION:

S.No.	Frequency(KHz)	SamplingTime(Ts)	T(μs)	Amplitude(V)
1.				
2.				
3				
4.				

## 7. RESULTS AND DISCUSSION:

Thus the pulse amplitude modulation was performed and its corresponding demodulation was also performed.

## 8. PRE EXPERIMENT Q.B:

1. Which device is used to track PAM frequency variations in the clock recovery circuit?
2. What kind of switches are commonly used in PAM multiplexers?
3. Define Nyquist Theorem?

9. POST EXPERIMENT Q.B:

1. What is the process of sampling an analog signal at a high rate?
2. Which multiplexing technique is used to transmit both digital and analog signals?
3. Why PAM is not preferable in digital transmission?

## EXPERIMENT 6

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1. AIM: To study Pulse Amplitude Modulation using

(a).using switching method

(b) sample and hold circuit.

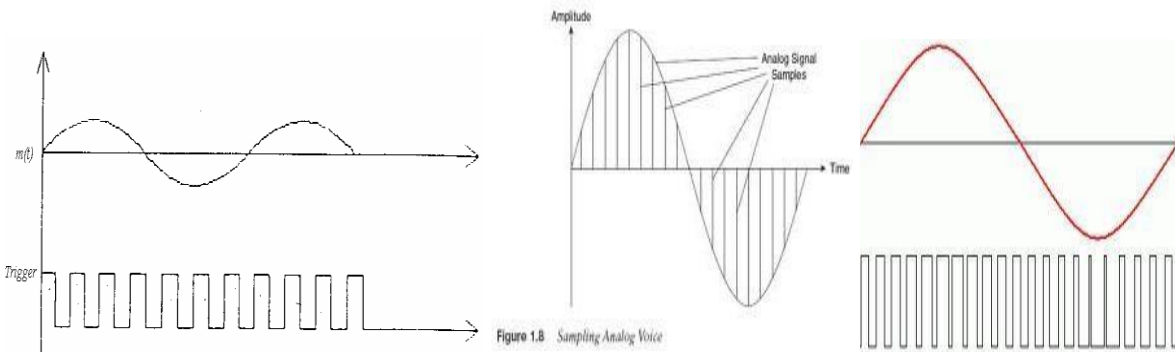
2. APPARATUS REQUIRED:

S.No.	Component name	Specification	Qty.
1.	PAM modulator & demodulator	NV 6575	1
2.	CRO		1
3.	Patch cords	2mm	
4.	Power supply		

3. THEORY:

In Pulse Amplitude Modulation message information is encoded in the amplitude of a series of signal pulses. It is an analog pulse modulation scheme in which the amplitude of train of carrier pulse are varied according to the sample value of the message signal. A train of very short pulses of constant amplitude and fast repetition rate is chosen the amplitude of these pulse is made to vary in accordance with that of a slower modulating signal the result is that of multiplying the train by the modulating signal the envelope of the pulse height corresponds to the modulating wave .the Pam wave contain upper and lower side band frequencies besides the modulating and pulse signals.

4. CIRCUIT DIAGRAM:



Baseband Signal ,m(t), Pulse train

Instantaneously Sampled Signal Naturally Sampled PAM

## 5. PROCEDURE:

(a).PAM- using switching method: It simply consists of a switch. If we assume that the closing time 't' of the switch approaches zero, then the output  $g(t)$  of this circuit will contain only instantaneous value of the input signal  $x(t)$ . Since the width of the pulse approaches zero, the instantaneous sampling gives a train of impulses of height equal to the instantaneous value of input signal  $x(t)$  at the sampling instant.

(b). PAM- using sample and hold circuit: Sample and hold circuit consists of two field effect transistors (FET) switches the capacitor. The sampling switch is closed for a short duration by a short pulse applied to the gate  $G_1$  of the transistor. During this period, the capacitor 'C' is quickly charged upto a voltage equal to the instantaneous sample value of the incoming signal  $x(t)$ . Sampling switch is opened and the capacitor 'C' holds the charge. The discharge switch is then closed by a pulse applied to gate  $G_2$  of the other transistors. Due to this capacitor 'C' is discharged to zero volts. The discharge switch is then opened and thus capacitor has no voltage.

## 6. OBSERVATION:

The output waveform of CRO is traced with the help of tracing paper.

## 7. RESULTS AND DISCUSSION:

The study of pulse amplitude modulation using switching method and by sample and hold circuit has been successfully.

## 8. PRECAUTIONS:

- (a). All patch cords should be connected properly.
- (b). Reading should be taken carefully from CRO.

## 9. PRE EXPERIMENT Q.B:

1. What is Pulse Amplitude modulation.
2. What is Nyquist Rate and Nyquist interval.
3. What is Aliasing and how it is reduced.

## 10. POST EXPERIMENT Q.B:

1. How we can the aperture effect in flat top pulses can be reduced.
2. What is natural sampling.
3. Explain in brief sample and hold method.

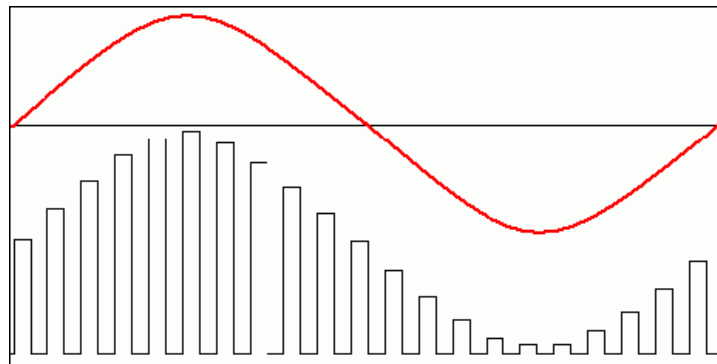
## EXPERIMENT 7

1. **AIM:** To study Pulse Amplitude Modulation using sample and hold circuit using bread board.

### 2. **APPARATUS REQUIRED:**

S.No.	Name of the Exp component	Specifications	Quantity
1	CRO		1
2	Function Generator	3.3 Mhz	1
3	Transistor	Npn	1
4	Resistors(27K,2.2K,270Ω)	¼ Watt	1
5	Electrolytic Capacitor,4.7		2
6	Capacitor,0.1µf	Disc type	1
7	Bread board		1
8	String strand wires		As per required

3. **THEORY:** Pulse-amplitude modulation, acronym PAM, is a form of signal modulation where the message information is encoded in the amplitude of a series of signal pulses. Demodulation is performed by detecting the amplitude level of the carrier at every symbol period. Pulse-amplitude modulation is widely used in baseband transmission of digital data.

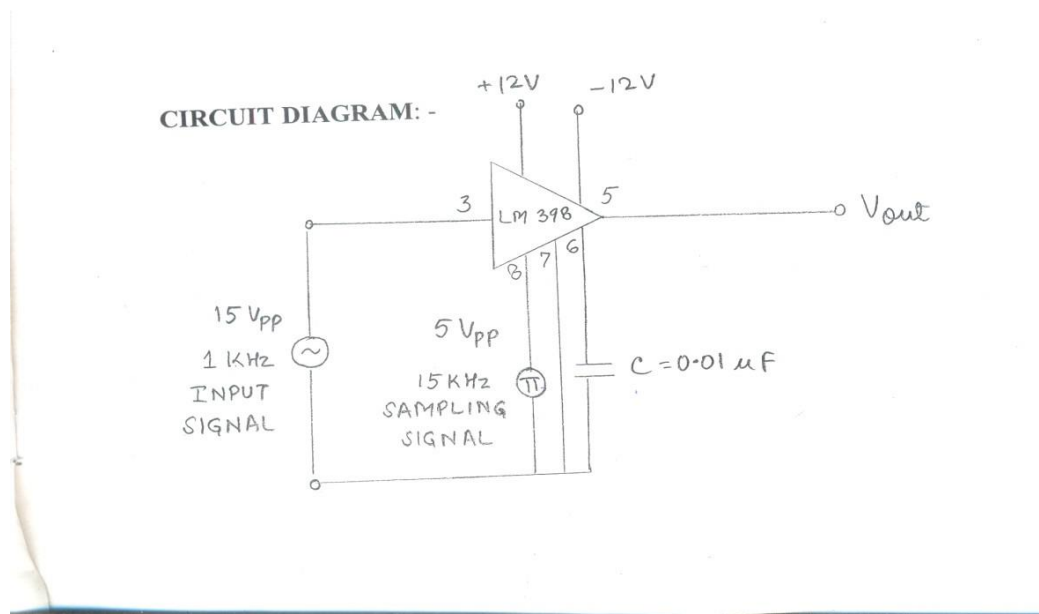


Formulae used:  $2f_m$  is less than or equal to the frequency of pulses.

$$F_m = 1/2\pi RC$$

$$C = 0.1 \mu f$$

#### 4. CIRCUIT DIAGRAM:



#### 5. PROCEDURE:

1. Connect the circuit as per the circuit diagram.
2. Switch on the power supply, function generator and CRO.
3. Set the appropriate values of amplitude and frequency of the modulating signal. and gating pulse respectively and note them.
4. Vary the amplitude of the modulating signal and observe the changes that take place in the modulating output.
5. Now pass the PAM output through RC filter network and vary the values of R & C till the satisfactory filter output is obtained.
6. Obtain the satisfactory output, note the frequency and amplitude of the reconstructed output.

#### 6. OBSERVATION:

S.No.	Modulating Signal		Gating Pulse	
	Amplitude	Frequency	Amplitude	Frequency
1.				
2.				
3.				
4.				

## 8. RESULTS AND DISCUSSION:

The study of pulse amplitude modulation using sample and hold circuit has been successfully done using bread board.

## 9. PRE EXPERIMENT Q.B:

1. What is Pulse Amplitude modulation?
2. What is Nyquist Rate and Nyquist interval?
3. What is Aliasing and how it is reduced.

## 10. POST EXPERIMENT Q.B:

1. What is flat top sampling?
2. Define Quantization.

## EXPERIMENT 8

1. AIM: To study Pulse Width Modulation and Pulse Position Modulation

2. APPARATUS REQUIRED:

S.No.	Component name	Specification	Qty.
1.	PWM modulator & demodulator	NV 6577	1
2.	CRO		1
3.	Patch cords	2mm	
4.	Power supply		

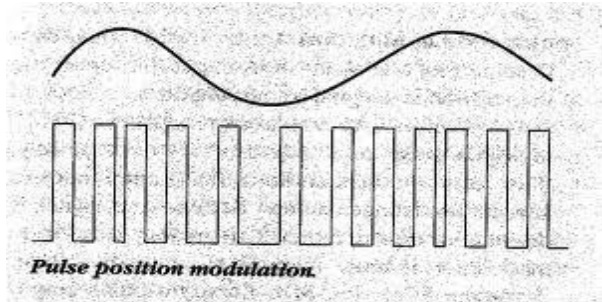
3. THEORY:

(a). Pulse Position Modulation: In PPM system, the position of the pulses relative to zero reference level, is varied in accordance with the instantaneous level of modulating signal. Amplitude and width of the pulses are kept constant. In this system, the position of each pulse is related to the position of the recurrent reference pulse. The N message bits are encoded by transmitting a single pulse in one of 2N possible time shifts. This is repeated every T seconds, such that the transmitted bit rate is N/T bits per second. It is primarily used for radio communication, control of aircrafts, cars etc.

(b). Pulse Width Modulation: In PWM system, the width of the pulse is varied in accordance with the instantaneous level of modulating signal. PWM is powerful technique for controlling analog circuits with a digital output. PWM is a way of digitally encoding analog signal levels. Through the use of high resolution counters, the duty cycle of a square wave is modulated to encode a specific analog signal level. The PWM signal is digital after modulation because at any given instant of time the signal is either ON or OFF. The term duty cycle describes the proportion of ON time and OFF time. The pulses of low duty cycle correspond to low power and high duty cycle corresponds to high power. The main advantage of PWM is that power loss in the switching devices is very low. It is used for controlling power to inertial electrical devices, made practical by modern electronic power switches.

4. CIRCUIT DIAGRAM:





## 6. OBSERVATION:

The output waveform of CRO is traced with the help of tracing paper.

## 8. RESULTS AND DISCUSSION:

The study of pulse width modulation and pulse position modulation has been carried out successfully.

## 9. PRE EXPERIMENT Q.B:

1. What is PWM.
2. What is PPM.

## 10. POST EXPERIMENT Q.B:

1. Describe the spectral representation of PPM and PWM.
2. Define PTM.
3. What are different types of PTM systems.

## EXPERIMENT 9

1. AIM: To study Pulse Width Modulation.

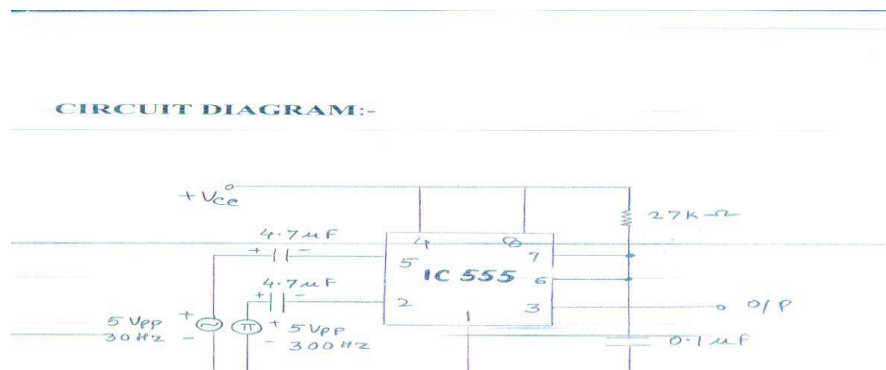
2. APPARATUS REQUIRED:

S.No.	Name of the Exp. component	Specifications	Quantity
1.	CRO		01
2.	Function Generator	3.3 MHz	01
3.	Transistor (NE-555)	Npn	01
4.	Resistors, 27K $\Omega$		01
5.	Capacitors- 4.7 $\mu$ F	Electrolytic	02
6.	Capacitors	Disc type	02
7.	Bread board		01
8.	Single strand wires		As per required

3. THEORY:

Pulse-width modulation (PWM) is a digital modulation technique, which converts an analog signal into a digital signal for transmission. The modulator converts an audio signal (the amplitude-varying signal) into a sequence of pulses having a constant frequency and amplitude, but the width of each pulse is proportional to the amplitude of the audio signal. The output switching transistor is on more of the time for a high amplitude signal and off more of the time for a low amplitude signal. The digital nature (fully on or off) of the PWM circuit is less costly to fabricate than an analog circuit.

4. CIRCUIT DIAGRAM:



## 5. PROCEDURE:

1. Switch on the power supply, function generator, CRO.
2. Adjust the frequency and amplitude of the modulating signal and trigger inputs respectively. The frequency ratio of trigger input and message signal must be 8 or 10.
3. Observe the waveform on the CRO and trace the waveform.
4. Pass the modulated output through the LPF and output of the filter to the input of an AC amplifier. The output of an AC is the demodulated output.

## 6. OBSERVATION:

The output waveform of CRO is traced with the help of tracing paper.

## 8. RESULTS AND DISCUSSION:

The study of pulse width modulation has been carried out successfully.

## 9. PRE EXPERIMENT Q.B:

1. What is PWM?
2. What is PPM?

## 10. POST EXPERIMENT Q.B:

1. Describe the spectral representation of PPM and PWM.
2. Define PTM.
3. What are different types of PTM systems?