Communication System Lab
(ECC 305)
Lab Manual

Department of Electronics Engineering
Academic Complex, 2nd Floor, Room No.215

INDIAN INSTITUTE OF TECHNOLOGY
(Indian School of Mines), DHANBAD
JHARKHAND-826004

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Experiment No: 01
Second Order Active Low Pass Filter

Aim: To design a Second Order Active Low Pass filter and find out the output voltage and gain.

Apparatus:

Function generator, MSO, Power supply.

Component required:

Resistor, (150kΩ, 27kΩ, 47kΩ) capacitor (1nf), Breadboard, IC 741

Theory:

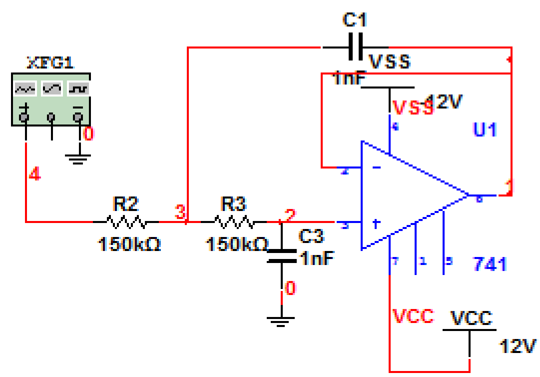
Filter is electronics circuit which perform, signal processing function especially to remove unwanted frequency component from the signal. A low pass filter pass low frequency signal but attenuate signal with frequency higher than the cutoff frequency.

For cut frequency fc=1/2πRC

fc=1kHz

Observation

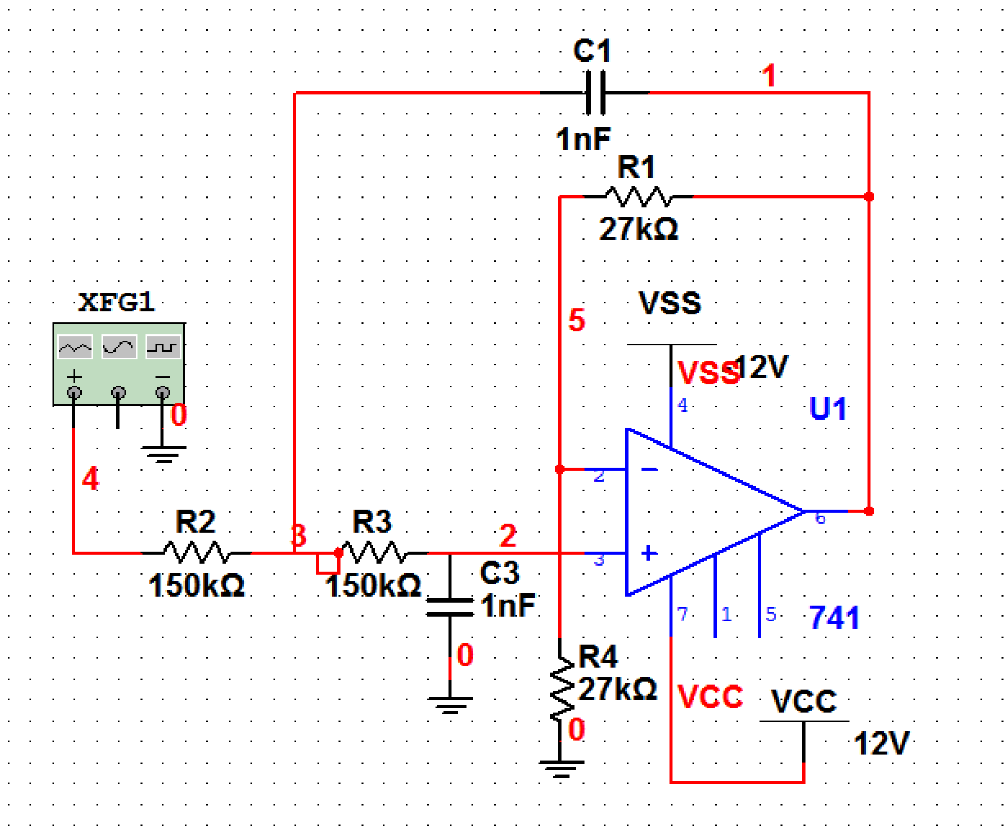
1. Unity gain 2nd order active low pass filter



Input voltage= 2 Vp-p (Peak to Peak Voltage)

S. No.	Frequency	Output Voltage (Peak To peak)	Gain = Vout /Vin

2. Butterworth second order low pass active low pass filter:



Gain required = 1.58 = 1+R1/R2 (For Butterworth filter)

From the standard Resistance values, 27k and 47k we get expect ratio.

Input voltage =2 Vp-p

S. No.	Frequency	Output Voltage(Peak To peak)	Gain = Vout /Vin

Observation and Conclusion:

Cutoff frequency for unity gain lo pass filter =

Cutoff frequency for Butterworth filter =

Precaution:

1. All connection must be properly.
2. Equipment and component must be checked before use.
3. Reading must be taken carefully.

Experiment No: 02
Second Order Active Bandpass Filter

Aim: To design a second order active bandpass filter and find out the output voltage and gain.

Apparatus:

Function generator, MSO, Power supply.

Component required:

Resistor, Capacitor, IC 741, Breadboards etc.

Theory:

Filters are electronics circuit which performs signal-processing function especially removes unwanted frequency component from the signal. A band pass filter passes frequency over a band, however attenuate the frequency lying beyond the band. Now,

f0= center frequency

A0= mid band gain

BW=band width

Q=Quality factor=f0/BW

An inverting band passes circuit shown in the figure. The expression for the nature of the resistance is as:

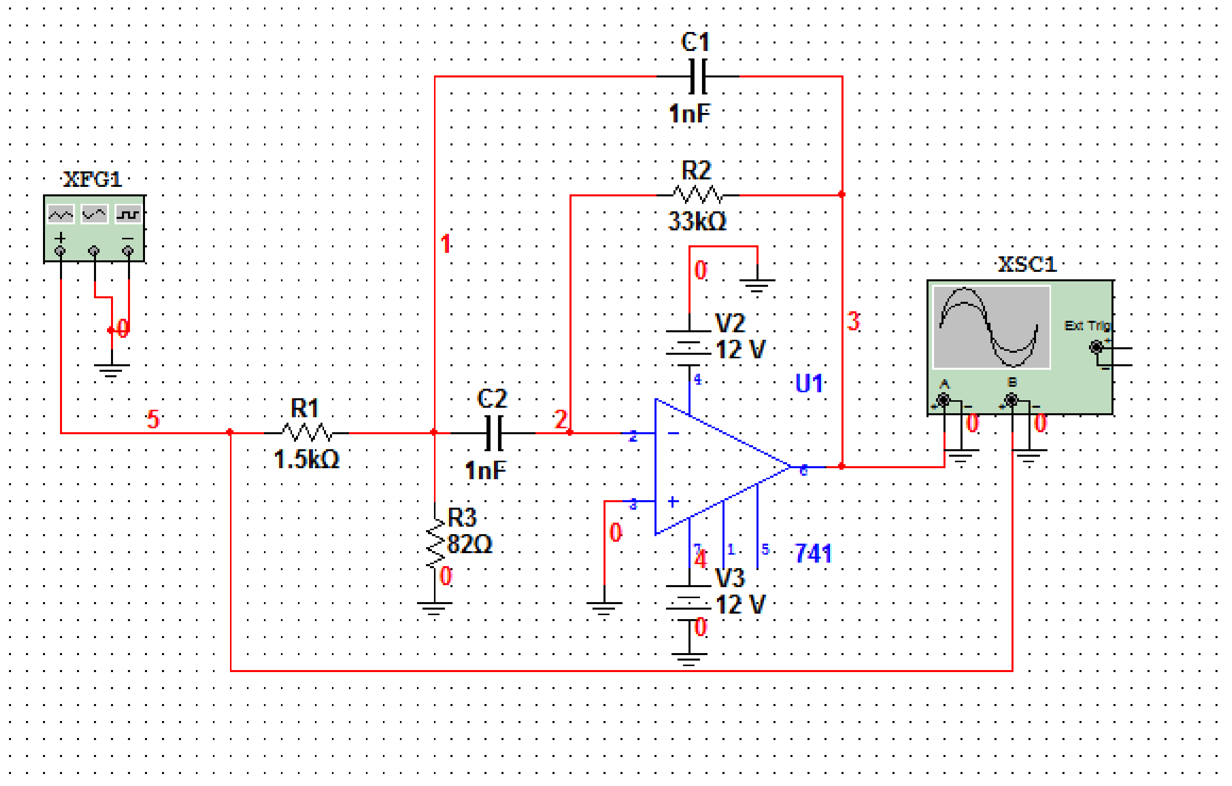
$$R1 = \frac{Q}{ACw_0}$$

$$R2 = \frac{Q}{(2Q^2 - A)Cw_0}$$

$$R3 = \frac{Q}{C_{eq}w_0}$$

Such a band pass section is useful in realization narrow band circuit is the pass-band is a function of the center frequency. The response of narrow band circuit is similar to that obtained with a simple series or parallel resonant circuit having a moderate Q. For this situation, the upper and lower 3dbB frequency f1 & f2 respectively are quite close so that so that the center frequency $f0 = \sqrt{f1f2}$ and bandwidth (f2-f1) is f0/Q.

Band Pass Filter



<u>Observation</u>

1. For f0= 10kHz

A0=10, C1=C2=1nf, Q=10

R1=……

R2=……

R3=……

Input Voltage= 2Vp-p

S. No.	Frequency	Output Voltage	Gain=(V0/V1)

- Observed center frequency =
- Low cut off frequency =
- Maximum Gain =

2. For f0= 20 kHz

A0=10, C1=C2=1nf, Q=10

R1=……

R2=……

R3=……

Input Voltage= 2Vp-p

S. No.	Frequency	Output Voltage	Gain=(V0/V1)

- Observed center frequency =
- Low cut off frequency =
- Maximum Gain =

Result:

Band Pass filter capable of passing a very small range of frequency with center frequency f0=10kHz and 20kHz have been successfully realized.

Precaution:

1. All connection must be properly.
2. Equipment and component must be checked before use.
3. Reading must be taken carefully.

Experiment No: 03
Generation of White Noise

Aim: To generate the white noise and limit the frequency range of the noise.

Equipments Required:

Mixed signal oscilloscope, Function generator, Breadboard, multi meter, multi output DC Supply**,**

Component Required:
Resistor (15 kΩ, 100 kΩ , 33 kΩ , 470 kΩ), Capacitors, Zener Diode(12V), IC741

Theory:
White noise is a random signal with a constant power spectral density. The term is used, with this or similar meanings, in many scientific and technical disciplines, including physics, acoustic engineering, telecommunications, statistical forecasting, and many more. White noise refers to a statistical model for signals and signal sources, rather than to any specific signal.

The samples of a white noise signal may be sequential in time, or arranged along one or more spatial dimensions. In digital image processing, the pixels of a *white noise image* are typically arranged in a rectangular grid, and are assumed to be independent random variables with uniform probability distribution over some interval. The concept can be defined also for signals spread over more complicated domain.

An infinite-bandwidth white noise signal is a purely theoretical construction. The bandwidth of white noise is limited in practice by the mechanism of noise generation, by the transmission medium and by finite observation capabilities. Thus, a random signal is considered "white noise" if it is observed to have a flat spectrum over the range of frequencies that is relevant to the context.

Narrow Band:

All most communication system of often deal with bend pass filter of signals. This filter’s bandwidths is just large enough to pass the modulator components of the receiving signal without distortion. This wide band is shaped into band limited noise. If the band width of this band limited noise is relatively small compared to the carrier frequency, then it is called narrowband band noise.

The spectral component of narrow band noise is around some mid-band frequency $+f_{c.}$ where f_c is the carriers frequency. The sample to function n(t) appear as somewhat similar to sine wave of frequency f_c which modulate slowly in both amplitude and phase. The power spectral density of the narrowband noise can be derive and used to analyses the performance of liner system.

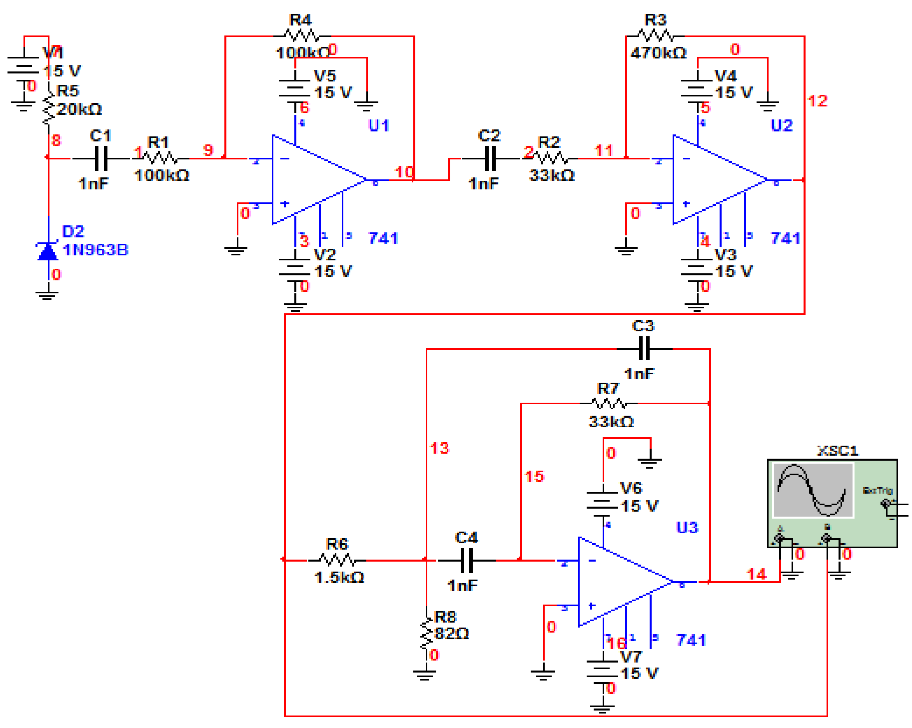
$$n(t) = n_I(t)cos2nf_ct - n_q(t)sin2nf_ct$$

Where f_c carrier frequency within the band

$n_I(t)$ in- phase component of n(t)

$n_q(t)$ quadrature component of n(t)

<u>Circuit Diagram of White Noise</u>



<u>Observation and Result:</u>

The white noise generated by 12 V zener diode is being fed to the amplifier and this noise along with the noise of IC741 is amplified much then being produced by zener diode.

This random signal or white noise when fed to band pass filter having different cut-off frequency give output as a narrow band , this narrow bend noise has time period according to the type of bend pass filter through which the noise was passes. For high frequency, we get signal or noise of lower time period and vice-versa.

Experiment No: 04
AMPLITUDE MODULATION & DEMODULATION

Aim: To study amplitude modulation and demodulation.

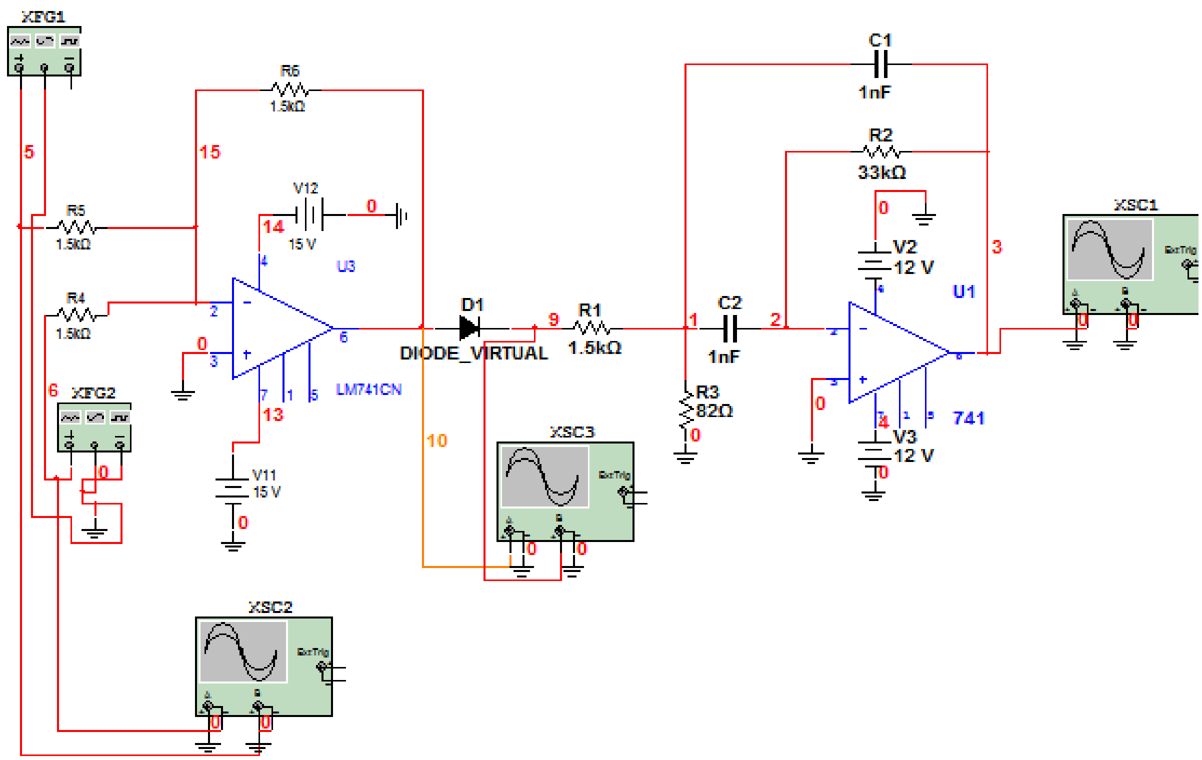
1. Measure modulation index.
2. Study under, over, and 100% modulation.
3. To demodulate AM signal and observe the trapezoidal figure on CRO.

Apparatus:

MSO, Function generator, Connecting probes, Connecting wires, Power supply.

Component required:

Resistor, Capacitor, IC741, OA79 Germanium diode (In Multisim use 1BH62 or virtual diode)



Theory:

Modulation is defined as the process by which some characteristics of a carrier signal is varied in accordance with a modulating signal. The base band signal is referred to as the modulating signal and the output of the modulation process is called as the modulation (modulated) signal. Amplitude modulation is defined as the process in which is the amplitude of the carrier wave is varied about a means values linearly with the base band signal. The envelope of the modulating wave has the same shape as the base band signal provided the following two requirements are satisfied:

1. The carrier frequency fc must be much greater then the highest frequency components fm of the message signal m (t) i.e. fc >> fm
2. The modulation index must be less than unity. if the modulation index is greater than unity, the carrier wave becomes over modulated.

Amplitude modulation index:

$$m = \frac{\text{Emax} - \text{Emin}}{\text{Emax} + \text{Emin}}$$

Emax = maximum peak to peak value of modulated signal.

Emin = minimum peak to peak value of modulated signal

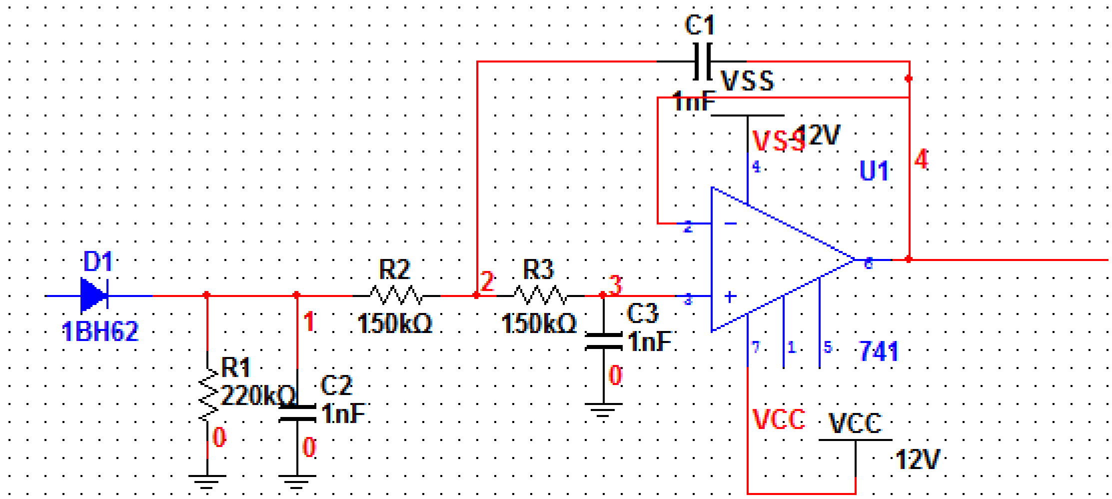
The modulation index must not allowed to exceed unity; else the –ve peak of the modulating waveform is clipped. This clipping not only causes distortion but also Interference. Depending on the value of modulating index there are three types of modulation

1. Under modulation (m<1).
2. Perfect modulation (m=1).
3. Over modulation (m>1).

Over modulation occurs when the magnitude of the peak negative voltage of modulating wave exceeds the peak carrier voltage. To ensure that peak value of modulating signal should not exceed the peak value of carrier signal.

Amplitude Demodulation

The process of detection provides a means of recovering the modulating signal from modulated signal. Demodulation is the reverse process of modulation. The detector circuit is employed to separate the carrier wave and eliminate the side bands. Since the envelope of an AM wave has the same shape as the message, independent of the carrier frequency and phase, demodulation can be accomplished by extracting envelope. This circuit is essentially a rectifier circuit followed by a capacitor across the output terminal.



Envelope Detector:

On the positive half cycle of the input signal, the capacitor C charges up to the peak voltage of the input signal, as the input falls below this voltage, the diode is cutoff because Vc is greater than V1.The capacitor discharges through R during the negative cycle. When V1>Vc diode conducts .The capacitor charges up to the new value of this cycle. The capacitor discharges slowly during cutoff and hence Vc charges negligibly. Thus during each +ve cycle C charges up to the new peak value and holds on to it till the next +ve cycle. The time constant RC is adjusted so that exponential decay of Vc follows the envelope.

<u>Results and observation:</u>

Calculate modulation index by using trapezoidal figure and compare with theoretical modulation index.

<u>Precaution:</u>

1. All connection must be properly.
2. Equipment and component must be checked before use.
3. Reading must be taken carefully.

Experiment No: 05

PULSE AMPLITUDE MODULATION & DEMODULATION

Aim: To perform pulse amplitude modulation and demodulation techniques.

Apparatus required:

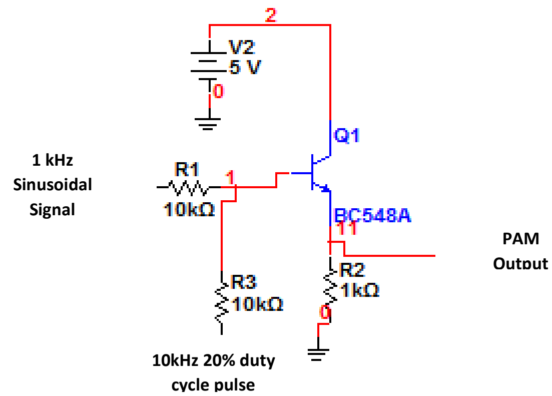
MSO, Function generator, Connecting probes, Connecting wires, Power supply.

Component Required:

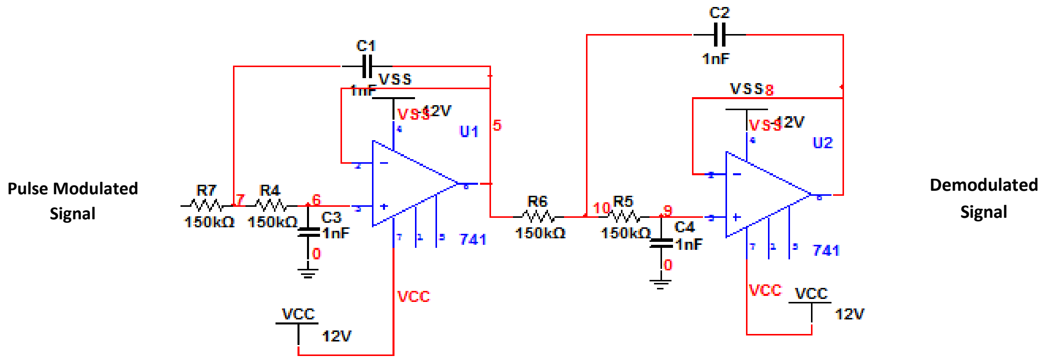
Transistor (BC 548), AFO, IC 741, Resistors, Capacitors.

Theory:

Pulse amplitude modulation is a scheme, which alters the amplitude of regularly spaced rectangular pulses in accordance with the instantaneous values of a continuous message signal. Then amplitude of the modulated pulses represents the amplitude of the intelligence. 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 contains 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.



Circuit diagram for Pulse Amplitude Modulation



Circuit diagram for Pulse Amplitude demodulation

<u>Observation:</u>

Amplitude of 10 kHz Pulse 0-4.7V

S. No.	Input DC Voltage	Output Pulse Amplitude

Offset Voltage for sinusoidal signal = …….V

RESULT:

Experiment No: 06
PULSE WIDTH MODULATION & DEMODULATION

Aim: To perform pulse width modulation and demodulation techniques.

Apparatus Required:

Mixed signal oscilloscope, Function generator, Breadboard, multi meter, DC power supply**,**

Component Required:

Resistor (5.6 kΩ, 6.8 kΩ, 10 kΩ , 100 kΩ), Capacitors (10nf, 0.1µf), Transistor (BC547/548), IC 555.

Theory:

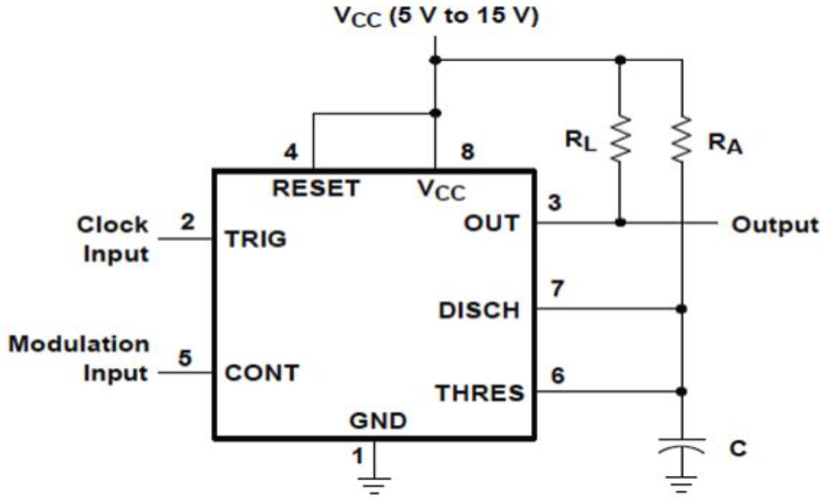
Pulse width Modulation (PWM) is a modulation techniques that control the width of the pulse, formally the Pulse Modulation based on modulator signal information. Its main use to allow the control the power supplied to electric device especially to inertial load.

The main advantage of PWM is that power loss in the switching device is very low. When a switch is off there is practically no current and when it is on and power is transferred to the load, there is a voltage of voltage and current is thus in both case close to zero. PWM also work with digital control, which become of their on/off nature can easily set the duty the duty cycle.

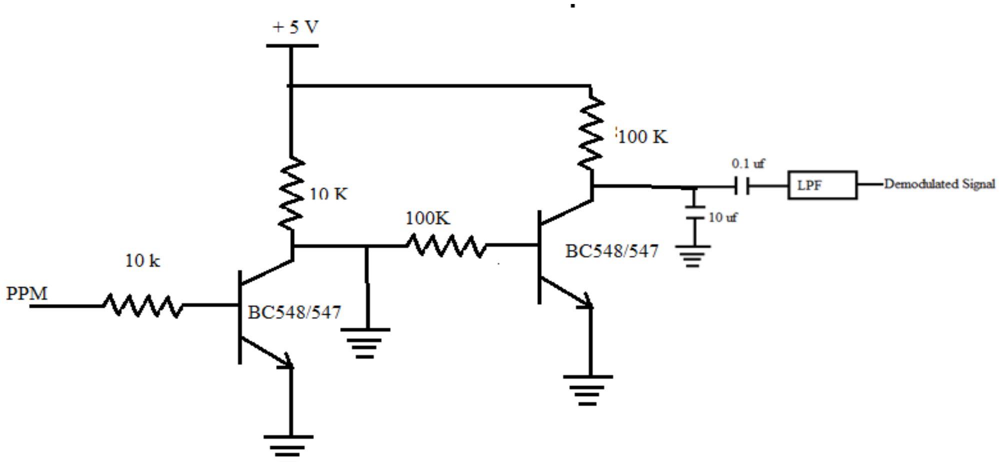
IC555:

The 555 timer IC is an integrated circuit (chip) used in a variety of timer, pulse generation, and oscillator applications. The 555 can be used to provide time delays, as an oscillator, and as a flip-flop element. Derivatives provide up to four timing circuits in one package. By applying a voltage to the control voltage input one can alter the timing characteristics of the device. In most applications, the control voltage input is not used. It is usual to connect a 10 nF capacitor between pin 5 and 0 V to prevent interference. The control voltage input can be used to build an astable multivibrator with a frequency-modulated output.

Circuit Diagram:



Demodulation Circuit:



Conclusions:

On the bases of observations we can observed that the duty cycle of the pulse width modulation signal varied according to modulating signal. Thus the information carried by the modulating signal was transferred and demodulated according to the variation in the width of the pulse train (changes in duty cycle)

Results:

Experiment No: 07
PULSE POSITION MODULATION AND DEMODULATION

Aim: Study of Pulse Position Modulation and Demodulation.

Apparatus required: MSO, Multiple Point DC Supply, Function generator.

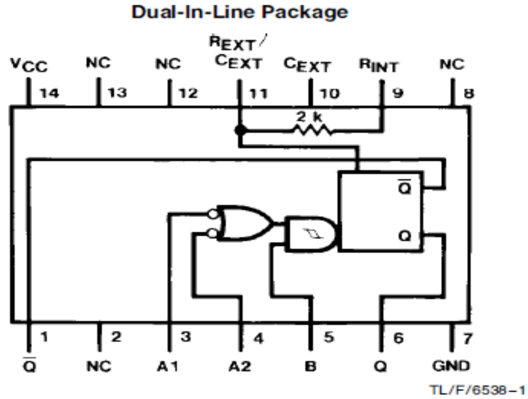
Components required: IC 555, IC 54121, Transistor (BC 548), IC 741, Resistors, Capacitors.

Theory:

In pulse position modulation, the amplitude and width of the pulse are kept constant, while the position of each pulses are kept constant, while the position of a reference pulse is changed according to the instantaneous sampled value of the modulating circuit. Thus, the transmitter and receiver is in synchronization. As the amplitude and width of the pulse are constant, the transmitter handles constant power output which is a definite advantage over PWM.

Pulse position modulator: It consist of a PWM generator followed by the monostable multivibrator. Since in PPM , output remain high for fixed duration from trailing edges of the PWM signal, the trailing edge of the PWM signal is used as a trigger input for the monostable multivibrator.

DM54/54121: It is a monostable multivibrator having both positive and negative edge triggering with complementary outputs. An internal 2kΩ resistor is provided for design convenience. A single external capacitor is used. Input (A) is active low trigger transition input and input (B) is an active high Schmitt trigger input that allows jitter free triggering input.



Order Number 54121DMQB, 54121FMQB,
DM54121J, DM54121W or DM74121N
See NS Package Number J14A, N14A or W14B

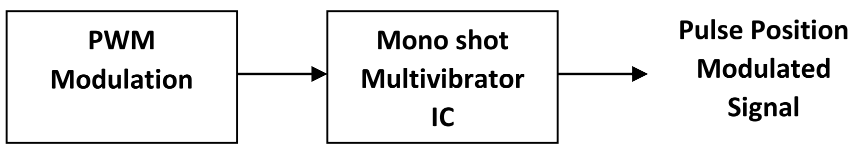
Function Table

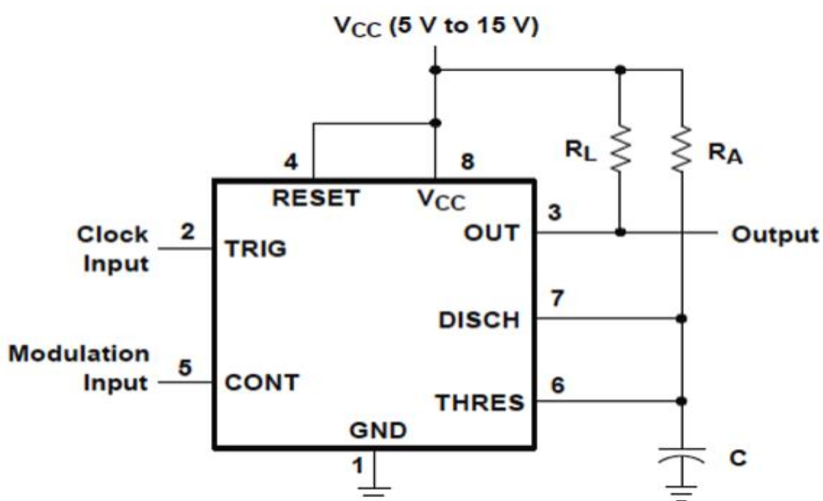
Inputs			Outputs	
A1	A2	B	Q	$\overline{Q}$
L	X	H	L	H
X	L	H	L	H
X	X	L	L	H
H	H	X	L	H
H	↓	H	⊓	⊔
↓	H	H	⊓	⊔
↓	↓	H	⊓	⊔
L	X	↑	⊓	⊔
X	L	↑	⊓	⊔

H = High Logic Level
L = Low Logic Level
X = Can Be Either Low or High
↑ = Positive Going Transition
↓ = Negative Going Transition
⊓ = A Positive Pulse
⊔ = A Negative Pulse

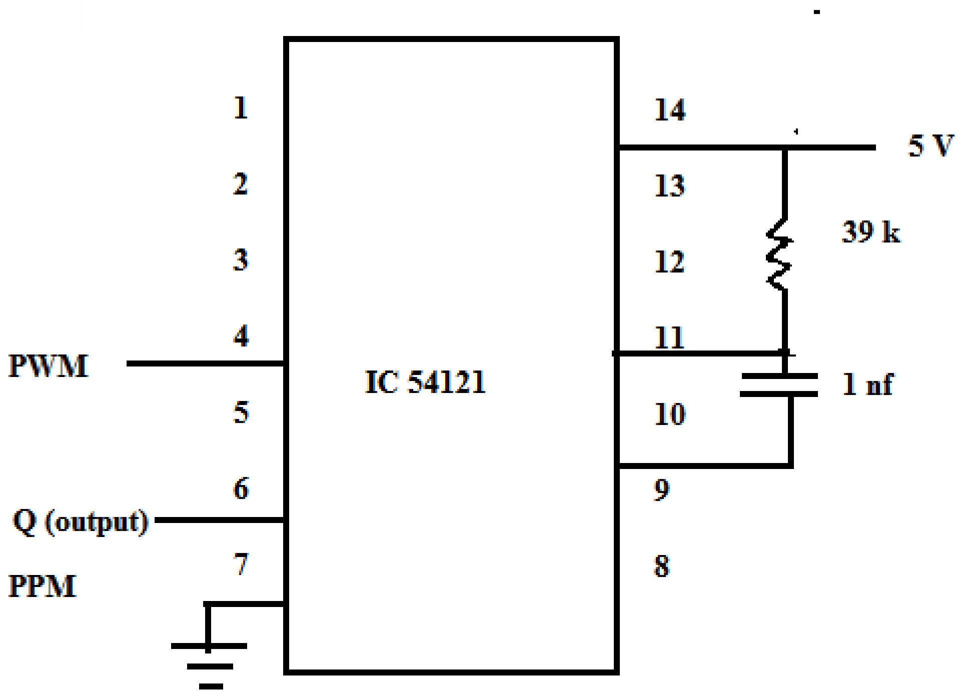
Schematic diagram and truth table of IC 54121

Modulation Circuit:

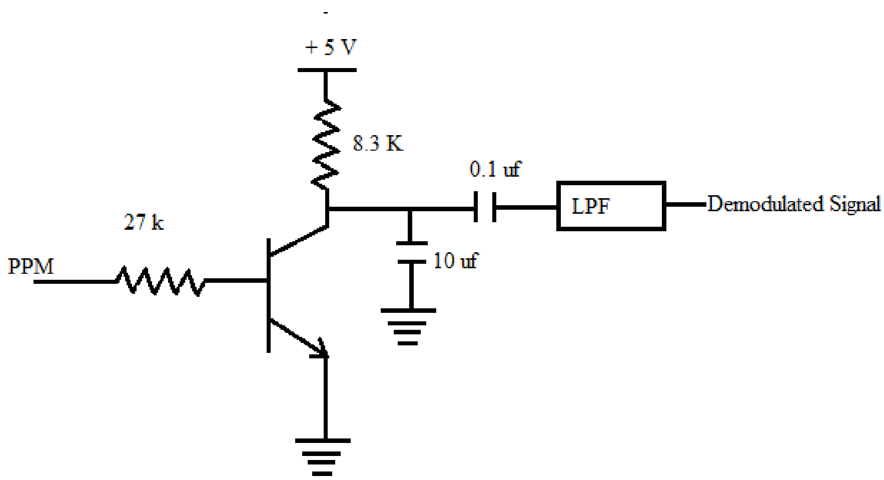




PWM Modulation



Demodulation Circuit:



Demodulation of PPM

Observation:

Result:

Experiment No: 08

ANALOG MULTIPLEXING AND DEMULTIPLEXING.

Aim: Study of Analog Multiplexing and De Multiplexing Techniques.

Apparatus and component required:

Function generator, DC power supply, MSO, IC7493, IC4051/MPC508, Resistor, wires.

Theory: It has been observed that most of the individual data-communicating devices typically require modest data rate. But, communication media usually have much higher bandwidth. As a consequence, two communicating stations do not utilize the full capacity of a data link. Moreover, when many nodes compete to access the network, some efficient techniques for utilizing the data link are very essential. When the bandwidth of a medium is greater than individual signals to be transmitted through the channel, a medium can be shared by more than one channel of signals. The process of making the most effective use of the available channel capacity is called **Multiplexing**. For efficiency, the channel capacity can be shared among a number of communicating stations. Most common use of multiplexing is in long-haul communication using coaxial cable, microwave and optical fibre. Fig.1 depicts the functioning of multiplexing functions in general. The multiplexer is connected to the demultiplexer by a single data link. The multiplexer combines (multiplexes) data from these 'n' input lines and transmits them through the high capacity data link, which is being demultiplexed at the other end and is delivered to the appropriate output lines. Thus, Multiplexing can also be defined as a technique that allows simultaneous transmission of multiple signals across a single data link.

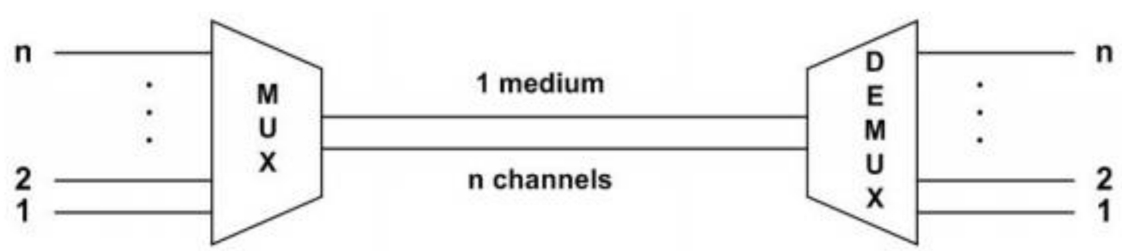


Fig. 1

In Time-division multiplexing all signals operate with same frequency at different times. This is a base band transmission system, where an electronic commutator sequentially samples all data source and combines them to form a composite base band signal, which travels through the media and is being demultiplexed into appropriate independent message signals by the corresponding commutator at the receiving end. The incoming data from each source are briefly buffered. Each buffer is typically one bit or one character in length. The buffers are scanned sequentially to form a composite data stream. The scan operation is sufficiently rapid so that each buffer is emptied before more data can arrive. Composite data rate must be at least equal to the sum of the individual data rates. The composite signal can be transmitted directly or through a modem. The multiplexing operation is shown in Fig. 2.

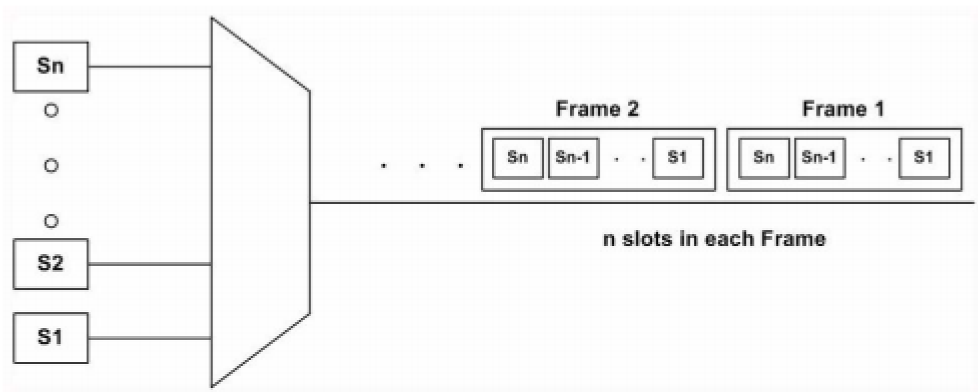


Fig. 2

The time slots are transmitted irrespective of whether the sources have any data to send or not. Hence, for the sake of simplicity of implementation, channel capacity is wasted. Although fixed assignment is used TDM, devices can handle sources of different data rates. This is done by assigning fewer slots per cycle to the slower input devices than the faster devices. Both multiplexing and demultiplexing operation for synchronous TDM are shown in Fig. 3.

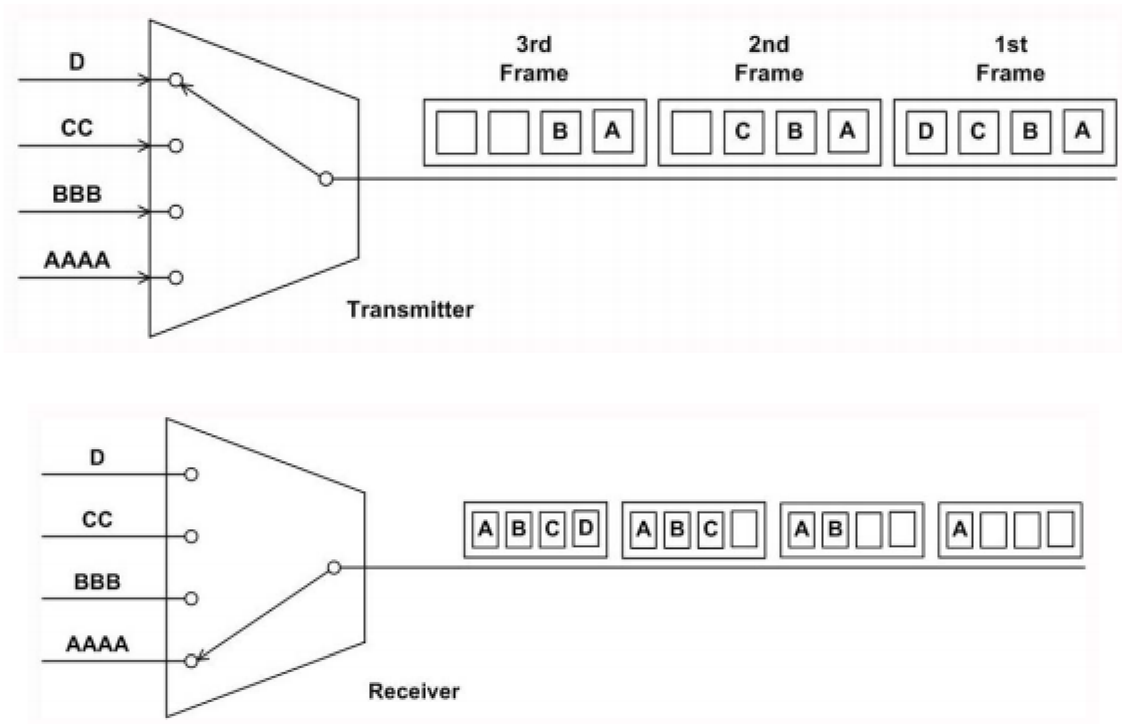


Fig.3

Multiplexing:

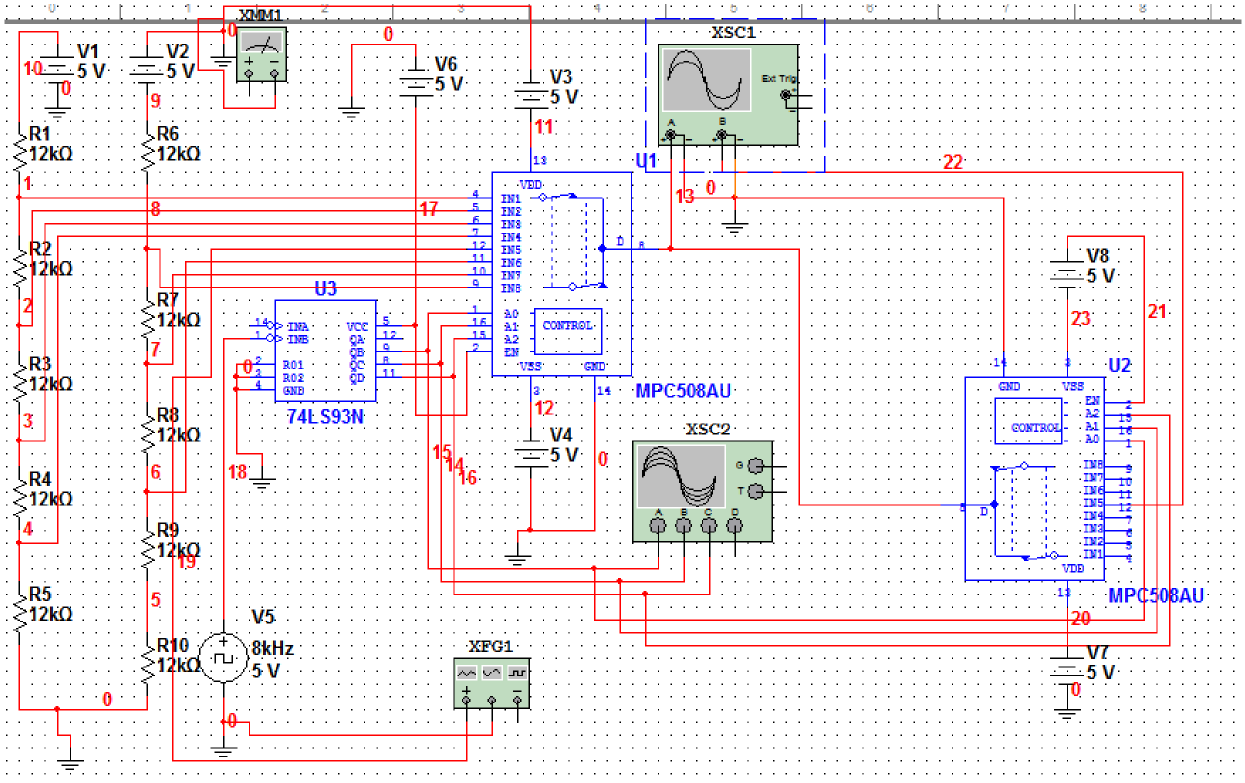
Here in the experiment analog multiplexer (IC4051) by providing different input signals at the input at the input lines and then selecting any of the given input signals though the control signal given in the form of a 3-bit combination ant the three control lines varying from 000 to 111, each corresponding to the input signal being transferred to output lines as per the control signal. The different signals for the input are generated through potential divider consist of ten resistors in series.

The output of the multiplexer 4051 is connected to the MSO with the control lines connected through 3-bit binary counter (IC7493) which has been provided with TTL clock frequency. The output of at the MSO is observed as a stair case.

De multiplexing:

The multiplexed output when connected to the analog de multiplexer (IC4051) and the control lines being the same as the three bit counter. We get 8-output signals which are same as being multiplexed earlier as can be viewed at MSO.

Circuit Diagram



Results:

Observation: