ILAHIA COLLEGE OF ENGINEERING AND TECHNOLOGY

AFFLIATED TO KTU

LABORATORY MANUAL

EC 332 COMMUNICATION ENGINEERING LAB

ELECTRONICS AND COMMUNICATION ENGINEERING DEPARTMENT

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC332	**Communication Engineering Lab (Analog & Digital)**	**0-0-3-1**	**2016**

Prerequisite: EC204 Analog Integrated Circuit, EC208 Analog Communication Engineering.

Course objectives:

- To provide experience on design, testing and analysis of few electronic circuits used in communication engineering.

List of Experiments:

Cycle I (Six experiments are mandatory)

1. AM generation using discrete components.
2. AM using multiplier IC AD534 or AD633.
3. AM detection using envelope detector.
4. IF tuned amplifier.
5. FM using 555 IC.
6. FM generation and demodulation using PLL.
7. Frequency multiplier using PLL
8. Pre-emphasis and de-emphasis circuits
9. Analog signal sampling & Reconstruction

Cycle II (Six mandatory)

10. Generation of Pseudo Noise Binary sequence using Shift registers
11. Time Division Multiplexing and Demultiplexing
12. Generation & Detection of DM/SIGMA DELTA/ ADM
13. Generation & Detection of PAM/PWM/PPM
14. Generation & Detection of BPSK/DPSK/DEPSK
15. Generation & Detection of PCM
16. 16 QPSK Modulation and Demodulation

Expected outcome:

The students will be able to understand the basic concepts of circuits used in communication systems.

EC 332 COMMUNICATION ENGINEERING LAB (ANALOG &DIGITAL)

Teaching scheme **Credits: 1**

3 hours practical per week

The laboratory portion of this course, through the Communication Engineering lab (Analog &Digital), is designed to provide experience on design, testing and analysis of few electronic circuits used in communication engineering.

LIST OF EXPERIMENTS

Sl.No	Title of Experiments
1	AM generation using discrete components
2	AM detection using envelope detector.
3	IF tuned amplifier.
4	FM generation and demodulation using PLL.
5	Frequency multiplier using PLL
6	Pre-emphasis & De emphasis Circuits
7	Time Division Multiplexing and De multiplexing
8	Generation & Detection of DM/SIGMA DEL
9	Generation & Detection of PAM/PWM/PPM
10	Generation & Detection of BPSK/DPSK/DEPSK
11	Generation & Detection of PCM
12	16 QPSK Modulation and Demodulation

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Sl. No	Name of Experiment	Page No	Date of allotment	Date of conduction	Sign/ Grade
1	AM generation using discrete components				
2	AM detection using envelope detector.				
3	IF tuned amplifier.				
4	FM generation and demodulation using PLL.				
5	Frequency multiplier using PLL				
6	Pre-emphasis & De emphasis Circuits				
7	Time Division Multiplexing and De multiplexing				
8	Generation & Detection of DM/~~SIGMA DEL~~				
9	Generation & Detection of PAM/PWM/PPM				
10	Generation & Detection of BPSK/~~DPSK/DEPSK~~				
11	Generation & Detection of PCM				
12	Psuedo Noise Random ~~16 QPSK Modulation and Demodulation~~ Generator				

Expt. No: 1 *Date: ____/____/____*

AM GENERATION USING DISCRETE COMPONENTS

OBJECTIVE:

To design and set up amplitude modulator circuit and calculate the value of modulation index.

HARDWARE REQUIRED:

Sl. No:	Items	Specification	Quantity
1	Resistors	480Ω, 10KΩ, 2.2K Ω, 120Ω	1,2,1,1
2	Capacitors	0.1μF, 0.01μF	1,2
3	Transistor	BF 195	1
4	Signal Generator		2
5	Power supply		1
6	Bread board		1
7	CRO		1

THEORY:

AMPLITUDE MODULATION

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 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.

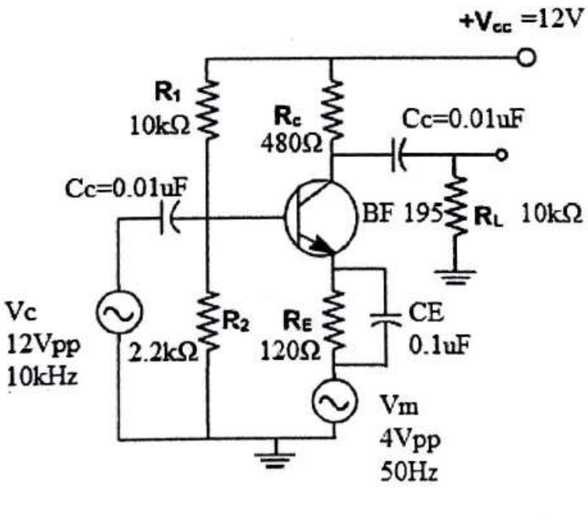
1. The carrier frequency fc must be much greater than the highest frequency components fm of the message signal m (t) i.e. fc >> fm.
2. The modulation index must be less than unity. If the modulation index is greater than unity, the carrier wave becomes over modulated.

PRE-LAB Questions:

1. Amplitude modulation and Demodulation.
2. Modulation Index.
3. Representation of AM signal.
4. Application of AM.
5. Bandwidth of AM.

EXPERIMENT SETUP:

AMPLITUDE MODULATION



DESIGN:

AMPLITUDE MODULATOR

Let Vcc = 12V, Ic = 10mA, $\beta = 100$, $f_C = 10kHz$, $I_E = I_C$.
V_{CE} =50% of Vcc = 6V
V_{RC} = 40% of Vcc = 4.8V
V_{RE} = 10% of Vcc = 1.2V
V_{RC} = IcRc
Rc = V_{RC}/Ic = 480Ω
$R_E = V_{RE}/I_E = 120\Omega$
Let the current through R_1 be $I_{R1} = 10\ I_B$ and $I_{R2} = 9\ I_B$
$V_{R2} = V_{BE}+V_{RE}$
V_{R2} =0.7+1.2
$R_2 = V_{R2}\ /\ 9\ I_B = 2.2k\Omega$
$R_1 = V_{R1}\ /\ 10\ I_B = 10k\Omega$
$X_{CE} = 1/2\pi fC_E = RE/10 = 12$
So $C_E = 2.65*10^{-4}\ \mu F$
Take it as 0.1μF
Choose $C_{in} = C_{cc} = 0.01\mu F$

IN LAB:

1. Verify whether the circuit is working as an amplifier. Check the DC conditions. Apply the input and measure the carrier wave amplitude at the output of the modulator.
2. Feed the modulating signal. Note down Vmax and Vmin of the AM signal.
3. Calculate the modulation index.
4. Now connect the demodulator circuit and observe its output.
5. Plot the output waveforms of modulator and demodulator.

CALCULATIONS:

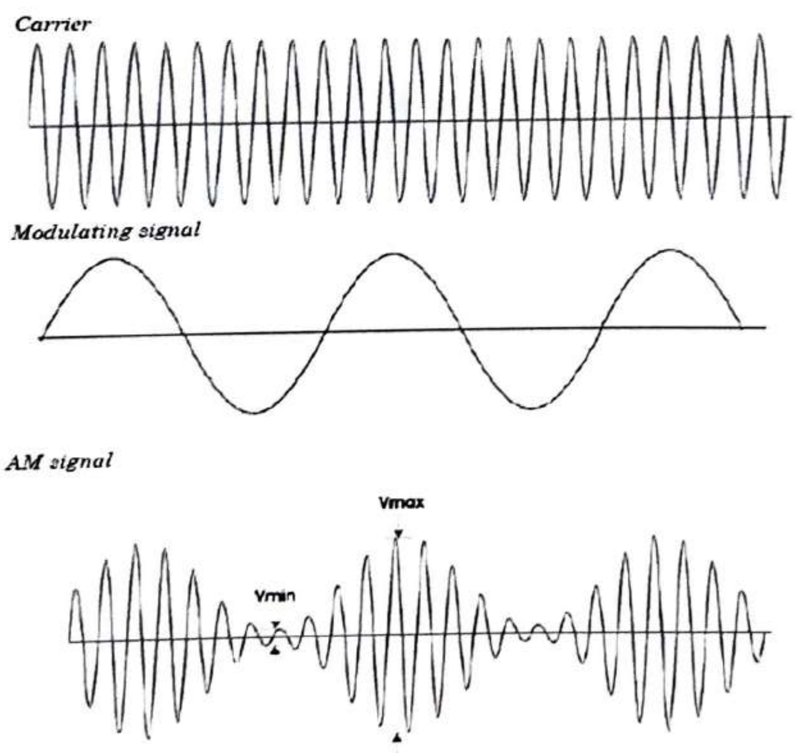
Amplitude of carrier signal = ……….V

Sl.No.	Vm(Volts)	V max(volts)	V min (Volts)	m	%m (m x100)

3.2 1.6

Modulation index, $m = \frac{V_{MAX} - V_{MIN}}{V_{MAX} + V_{MIN}}$

MODEL GRAPH:



POSTLAB Questions:

1. Based upon your general knowledge of AM and FM broadcasting by listening to the radio name the frequency occupied by AM and FM broadcast stations?
2. What will happen, if modulation index is greater than 100%?
3. Audio signals are not transmitted by electromagnetic waves. Justify the statement.
4. An amplitude modulated amplifier has a radio frequency output of 50w at 100% modulation. The internal loss in the modulator is low. What output power is required from the modulator?
5. In what stage modulation is done in high – power A.M transmissions?
6. What is the range of commercial AM broadcast bands?
7. Which kind of modulation is used in picture signal in Television broadcast?

RESULT:

Expt. No: 2 Date : ___/___/_____

AM DETECTION USING ENVELOP DETECTOR

OBJECTIVE:

To design and set up AM demodulator circuit and to observe the wave form.

HARDWARE REQUIRED:

Sl. No:	Items	Specification	Quantity
1	Resistors	480Ω, 10k, 2.2k, 120Ω	1,2,1,1
2	Capacitors	0.1μF, 0.01μF	1,2
3	Transistor	BF 195	1
4	Signal Generator		2
5	Power supply		1
6	Bread board		1
7	CRO		1

THEORY:

AMPLITUDE DEMODULATION

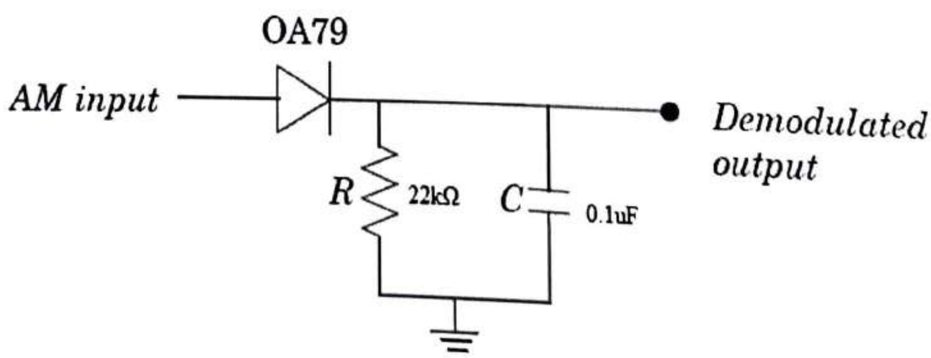
The process of detection provides a means of recovering the modulating Signal from modulating signal. Demodulation is the reverse process of modulation. The detector circuit is employed to separate the carrier wave and eliminate the side bands. Since the envelope of an AM wave has the same shape as the message, independent of the carrier frequency and phase, demodulation can be accomplished by extracting envelope. An increased time constant RC results in a marginal output follows the modulation envelope. A further increase in time constant the discharge curve become horizontal if the rate of modulation envelope during negative half cycle of the modulation voltage is faster than the rate of voltage RC combination ,the output fails to follow the modulation resulting distorted output is called as diagonal clipping : this will occur even high modulation index. The depth of modulation at the detector output greater than unity and circuit impedance is less than circuit load ($R_l > Z_m$) results in clipping of negative peaks of modulating signal. It is called —negative clipping.

PRE-LAB Questions:

1. Demodulation.
2. Representation of AM signal.
3. What is an envelope detector?
4. What is a diode detector?

EXPERIMENT SETUP:

AMPLITUDE DEMODULATOR



DESIGN:

AMPLITUDE DEMODULATOR

RC >> time period of carrier signal

Take RC=20T

$T = 1/f_c = 1/10\ KHz = 0.1ms$

Let $C = 0.1\mu F$.

Then $R = (20 * 0.1ms) / (0.1\mu F) = 22K\Omega$

IN LAB:

1. Now connect the demodulator circuit and observe its output.
2. Plot the output waveforms of modulator and demodulator.

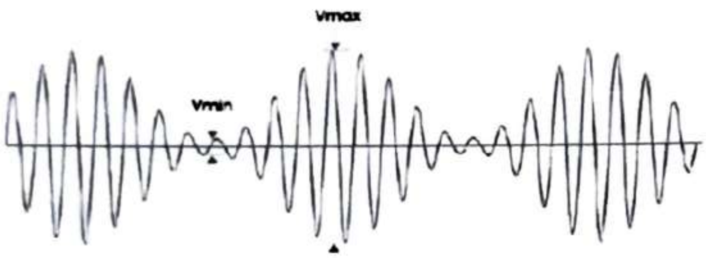
CALCULATIONS:

Amplitude of carrier signal = ...V

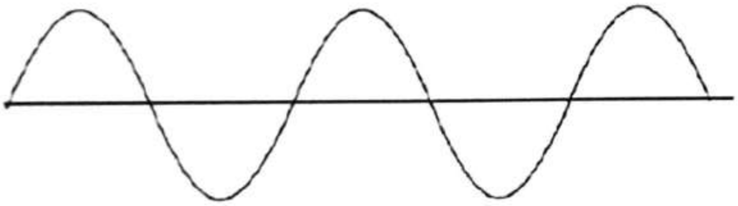
Sl.No.	Vm(Volts)	V max(volts)	V min (Volts)

MODEL GRAPH:

AM signal



Demodulated signal



POSTLAB Questions:

1. How demodulated signal differs from original signal in AM
2. The two important distortions that can appear in the demodulated output of an envelope detector are -------------- and -----------

RESULT:

Expt. No:3 **Date: ___/___/______**

IF TUNED AMPLIFIER

OBJECTIVE:

To design and set up a single tuned amplifier for a frequency of 455 kHz.

HARDWARE REQUIRED:

Sl. No:	Items	Specification	Quantity
1	Transistor	BF 495	1
2	Resistors	56KΩ, 10KΩ, 1.2kΩ	1 each
3	Capacitors	0.01μF, 10μF	1, 2
4	Inductor	3mH	1
5	Signal Generator		2
6	Power supply		1
7	Bread board		1
8	CRO		1

THEORY

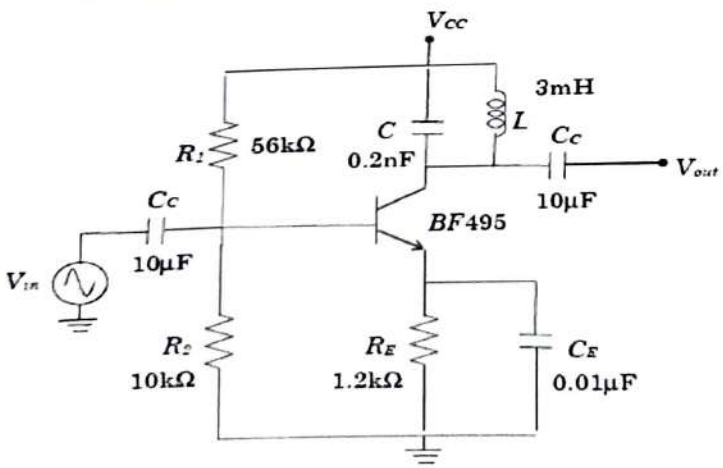
The LC-tuned amplifier is a special kind of frequency-selective network and these tuned amplifiers find application in the radio-frequency (RF) and intermediate-frequency (IF) sections of communications receivers and in a variety of other systems. Normally, the tuned amplifiers are small-signal voltage amplifiers in which the transistors operate in the "class A" mode that is, the transistors conduct at all times. The basic principle underlying the design of tuned amplifiers is the use of a parallel LCR circuit as the load, or at the input, of a BJT amplifier, since the circuit used in this experiment is a single tuned circuit, it is known as a single-tuned amplifier.

The general shape of the frequency response of a tuned amplifier is shown in Fig 1; and its response is characterized by the center frequency ω_o, the 3-dB bandwidth, and the skirt selectivity, which is usually measured as the ratio of the 30-dB bandwidth to the 3- dB bandwidth. In many applications, the 3-dB bandwidth is less than 5% of ω_o. This narrow-band property makes possible certain approximations that can simplify the design process.

PRE LAB QUESTIONS

1. Go through the datasheets of the components.
2. What is a tuned amplifier?
3. Define resonant frequency.
4. Why is the Q factor important in the design of tuned amplifier?
5. What are the properties of parallel and series tuned circuits?
6. How dc biasing conditions are chosen in the design of tuned amplifiers?

EXPERIMENT SETUP:



DESIGN:

Let $Vcc = 12V$
Choose BF 495

$V_{R_E} = 10\%$ of V

$R_E = V_{RE} / I_E =$

$I_B = Ic / \beta = 1m$

$V_{R_1} = V_{BE} + V_{R_E}$

$V_{R_2} = V_{cc} - V_{R_1}$

Assume $10I_B$

$R_2 = V_{R_1} / 9I_B =$

$R_1 = V_{R_2} / 10I_B$

Frequency, f =

$X_{CE} = 10\%$ of

Choose $C_E =$ 0

$$f = \frac{1}{2\pi\sqrt{LC}}$$

Choose L = 3

Choose $Cc =$ 1

IN LAB:

1. Set up t
2. Verify t

is the use of a parallel LCR circuit as the load, or at the input, of a BJT amplifier, since the circuit used in this experiment is a single tuned circuit, it is known as a single-tuned amplifier. The general shape of the frequency response of a tuned amplifier is shown in Fig 1; and its response is characterized by the center frequency ω_o, the 3-dB bandwidth, and the skirt selectivity, which is usually measured as the ratio of the 30-dB bandwidth to the 3- dB bandwidth. In many applications, the 3-dB bandwidth is less than 5% of ω_o. This narrow-band property makes possible certain approximations that can simplify the design process.

PRE LAB QUESTIONS

1. Go through the datasheets of the components.
2. What is a tuned amplifier?
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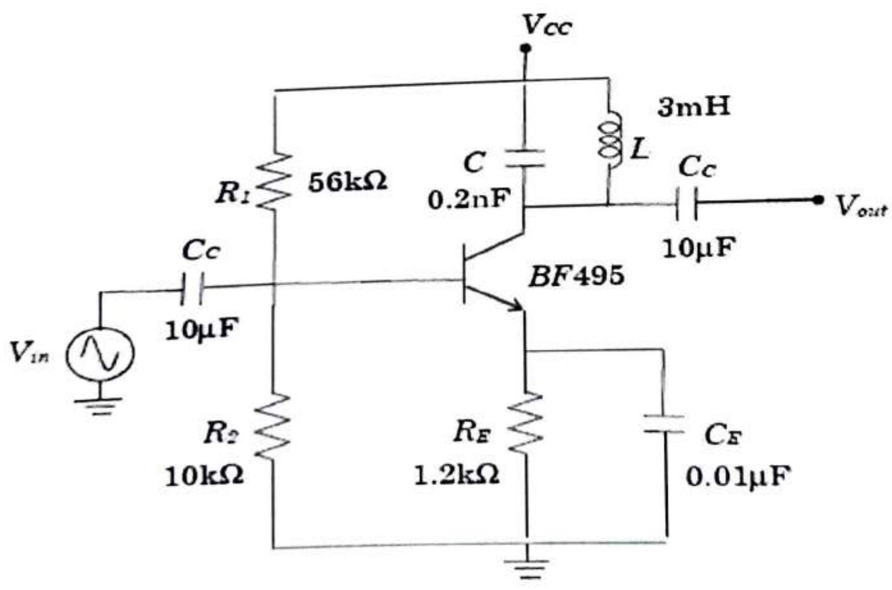
EXPERIMENT SETUP:



DESIGN:

Let V_{CC} = 12V and I_C = 1mA
Choose BF 495 Transistor; β = 50

V_{R_E} = 10% of V_{CC} = 1.2V, V_{CE} = 90% of V_{CC} = 10.8V
$R_E = V_{RE} / I_E$ = 1.2 / (1mA) = 1.2kΩ

$I_B = I_C / \beta$ = 1mA/50 = 0.02mA

$V_{R_2} = V_{BE} + V_{R_E}$ = 0.6V + 1.2V = 1.8V
$V_{R_1} = V_{CC} - V_{R_2}$ = 12V − 1.8V = 10.2V

Assume $10I_B$ is flowing through R_1 and $9I_B$ flowing through R_2

$R_2 = V_{R_1} / 9I_B$ = 1.8 / (9x0.02mA) = 10.5kΩ. Choose R_2 = 10kΩ
$R_1 = V_{R_2} / 10I_B$ = 10.2 / (10x0.02mA) = 50.5kΩ. Choose R_1 = 56kΩ

Frequency, f = 200 kHz
X_{CE} = 10% of R_E = 120Ω ⇒ C_E = 1 / (2π x 120 x 200 k) = 0.0079μF
Choose C_E = 0.01μF

$$f = \frac{1}{2\pi\sqrt{LC}} = 200kHz$$

Choose L = 3mH. Then $C = \frac{1}{4\pi^2 f^2 L}$ C = = 0.211nF.

Choose C_C = 10μF

IN LAB:

1. Set up the circuit as shown in the circuit diagram.
2. Verify the DC bias conditions of the transistor.

3. Vary the input frequency from 50 kHz to 350kHz and observe the output peak to peak
4. Amplitude
5. For each frequency step, calculate the gain of the amplifier in Db.
6. Plot the frequency response and calculate the bandwidth and Q factor.

OBSERVATIONS:

$V_{in} = 0.1V$

Frequency (kHz)	Log f	$V_{o\,p\text{-}p}$	Gain = V_o/V_{in}	Gain in dB = $20\log(V_o/V_{in})$
50				
.				
.				
.				
.				
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.				
.				
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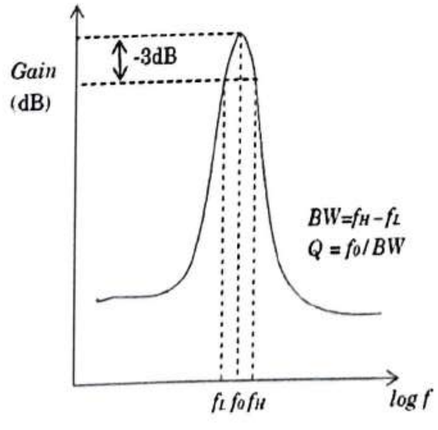
350				

MODEL GRAPH:



Frequency Response

CALCULATIONS:

1. Bandwidth of the amplifier $= f_h - f_l =$
2. Resonant frequency $= f_o =$
3. Quality factor of the circuit $= f_o / B.W =$

PRE LAB QUESTIONS

1. What are the applications of tuned amplifier?
2. Compute the voltage gain of the given tuned amplifier?
3. Explain class C operation.
4. What is an IF amplifier?

RESULT:

Expt. No: 4

Date: ___/___/_____

FM GENERATION AND DEMODULATION USING PLL

OBJECTIVE:

1. To design and generate frequency modulated wave and determine the modulation index.
2. To demodulate the modulated wave using FM detector.

HARDWARE REQUIRED:

Sl. No:	Items	Specification	Quantity
1	Resistors	12kΩ, 1kΩ	4,1
2	Capacitors	10Mf, 1μF, 0.01μF	2, 1, 3
3	PLL	IC 565	2
4	Signal Generator		2
5	Power supply		1
6	Bread board		1
7	CRO		1

THEORY

Frequency modulation is a process of changing the frequency of a carrier wave in accordance with the slowly varying base band signal. The main advantage of this modulation is that it can provide better discrimination against noise. In Frequency modulation the instantaneous Frequency of the carrier signal is varied by the modulating voltage. Basically, FM is the continuous time angle modulation technique and also it is a non-linear modulation process, which having the constant envelope. The bandwidth required for the FM is more compare then the AM. In frequency modulation, frequency of the carrier signal is modified in accordance with the instantaneous amplitude of the modulating signal. The frequency modulated signal is given by,

$$m(t) = V_c \cos(2\pi f_c t + m\sin(2\pi f_m t))$$

where **Vc** is the amplitude of the carrier signal, **fc** is the carrier frequency and **m** is the modulation index. The change in carrier frequency when it is acted on by a modulating signal is called frequency deviation. With FM, frequency deviation and modulation index are directly proportional to the amplitude of the modulating signal and the modulation index is inversely proportional to its frequency.

PLL is widely used for FM generation. The modulating signal is applied as control voltage to the VCO and hence the output frequency of the VCO is varied in accordance with the input signal. For demodulation, another 565 IC is used. The centre frequency of the VCO of the demodulator is made same as that of the modulator. If the PLL input is a FM signal and the VCO natural frequency is equal to the carrier frequency, then the correction voltage produced at the output of the phase comparator will be proportional to the frequency deviation and is thus, the demodulated signal.

PRE LAB QUESTIONS

1. Frequency modulation?
2. Advantages of FM over AM?
3. Write the expressions for modulation index, frequency deviation & bandwidth of FM.
4. What do you mean by carrier swing?
5. What should be the transmission band width of an FM signal with 75 KHz deviation and highest frequency of modulation 15 KHz?

DESIGN:

(a) FM Modulator:

Let $V^+ = 12V$ and $V^- = -12V$

Let free running frequency, $f_0 = \dfrac{1.2}{4R_1C_1} = 2.5kHz$

Take C_1=0.01µF $\Rightarrow$ R_1=12kΩ

(b) FM demodulator:

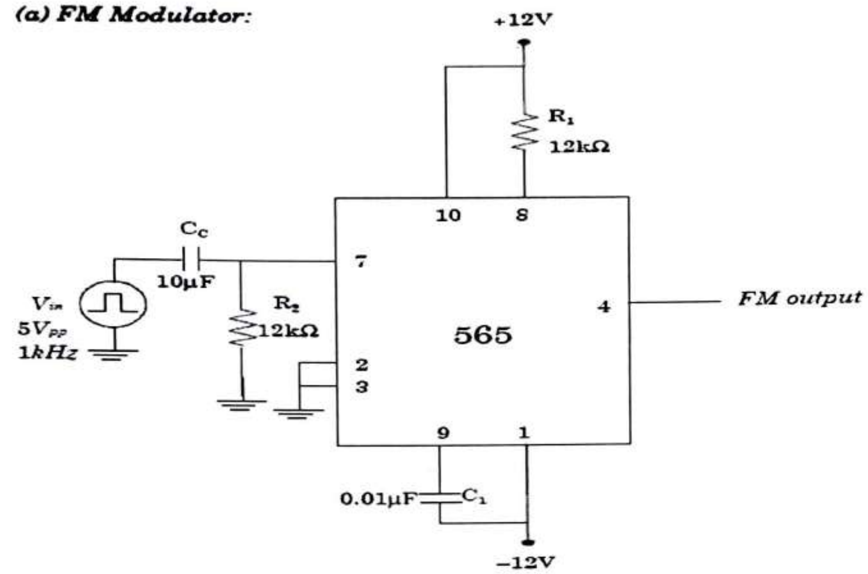
Let $V^+ = 12V$ and $V^- = -12V$

Let free running frequency, $f_0 = \dfrac{1.2}{4R_1C_1} = 2.5kHz$

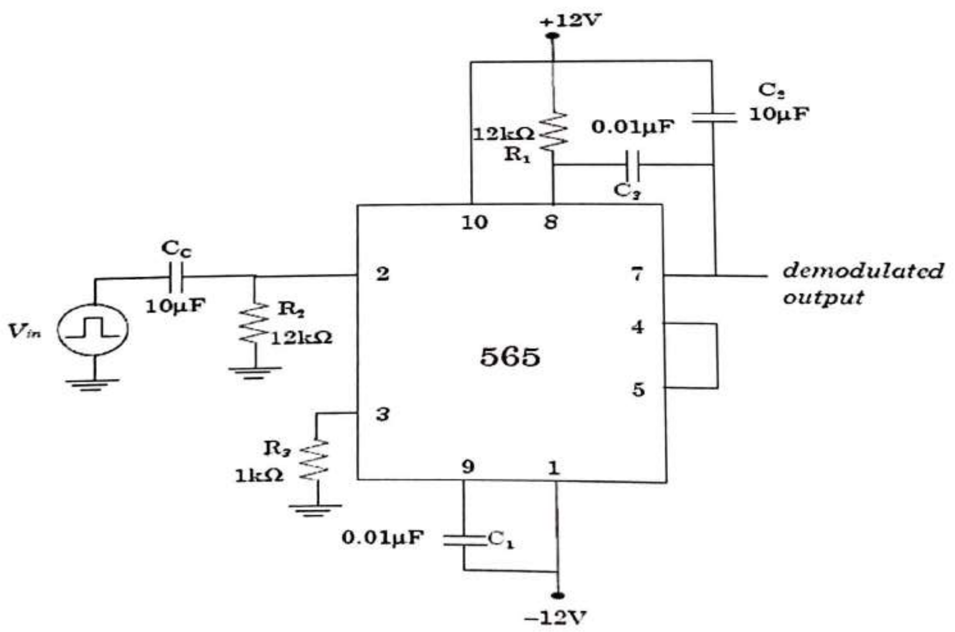
Take C_1=0.01µF $\Rightarrow$ R_1=12kΩ
Select C_3 = 0.01µF and C_2 = 10µF

EXPERIMENT SETUP:

(a) FM Modulator:



(b) FM demodulator:



IN LAB:

FM modulator:

1. Set up the FM modulator circuit as shown in the circuit diagram.
2. Without giving the modulating signal, observe the carrier frequency
3. Feed 5Vpp, 1 KHz square wave as modulating input and observe the output.
4. Vary the frequency of the modulating signal and measure f min and frequency deviation Δf for each step.
5. Evaluate the modulation index, m and bandwidth corresponding to each frequency.
6. Repeat step 4 by varying the amplitude of the modulating signal.

FM demodulator:

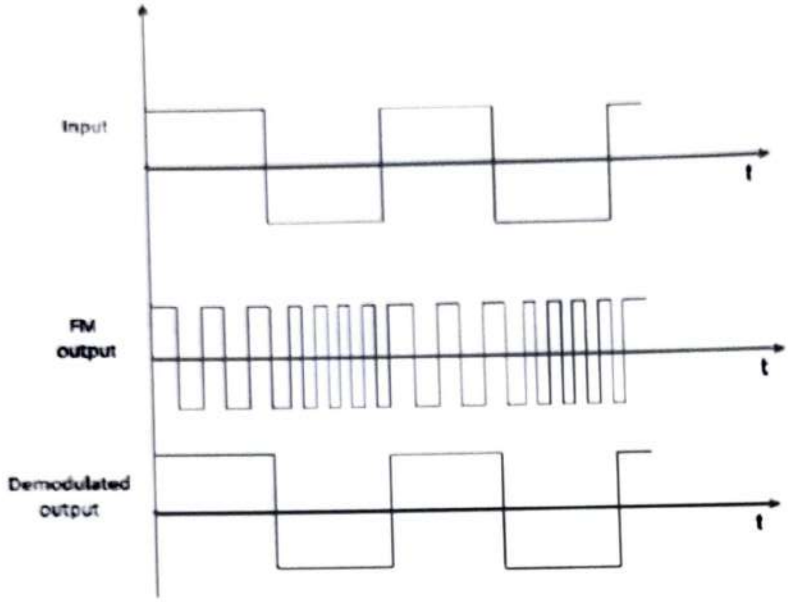
1. Set up the FM demodulator circuit as shown in the circuit diagram.
2. Feed FM signal to the circuit and observe the demodulated output.

OBSERVATIONS:

f_c = ...kHz

Sl.No.	f_m (kHz)	f_{min} (kHz)	Δf (kHz)= $\lvert f_c - f_{min} \rvert$	$m = \Delta f / f_m$	$BW = 2(\Delta f + f_m)$

MODEL GRAPH:



POST LAB QUESTIONS

1. What will be the changes in the wave under FM when the amplitude or frequency of the modulating signal is increased?
2. The FM stations have less noise while receiving the signal. Justify your answer.
3. What happens when a stronger signal and a weaker signal both overlap at the same frequency in FM?
4. Name two applications of FM?
5. Which mathematical expression is used to decide the side band amplitudes in a FM signal?

RESULT:

Expt. No: 5 *Date : ___/___/_____*

FREQUENCY MULTIPLIER USING PLL

OBJECTIVE:

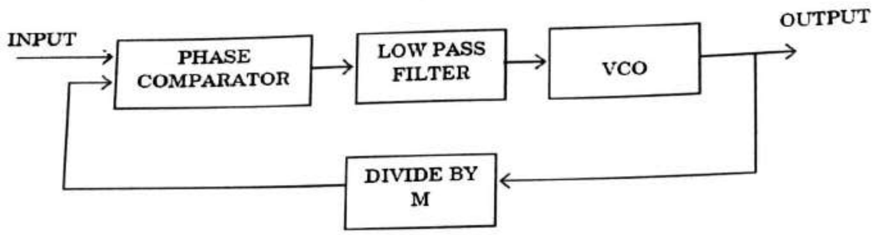
To design and set up a frequency multiplier using 565 PLL IC to multiply the input frequency by a factor 5.

HARDWARE REQUIRED:

Sl. No:	Items	Specification	Quantity
1	Resistors	56KΩ, 2.7KΩ, 20KΩ(pot)	1,1,1
2	Capacitors	10μF,0.01μF	1, 2
3	Counter	IC 7490	1
4	PLL	IC 565	1
5	Transistor	BC 107	1
6	CRO		1
7	Power supply		1

THEORY:

Frequency synthesizing is one of the applications of phase locked loop. The output frequency of a PLL is divided by M and applied as input to the phase detector. In locked condition, the divided frequency will be equal to the input frequency. So the output frequency of the VCO will be a multiple of the input frequency. The divide by M circuit is realized as a counter that produces one output pulse for every M input pulses.



PRE LAB QUESTIONS

1. Draw the pin diagram of IC565 and IC7490.
2. Draw the block diagram of frequency multiplier using IC565.
3. Differentiate between frequency multiplication and frequency translation.
4. What do you mean by harmonic tracking?

DESIGN:

Let the input frequency be 2kHz and the output frequency 10kHz.

$$f_0 = \frac{1.2}{4R_1C_1} = 2kHz$$

Let $C_1 = 0.01\mu F$. Then $R_1 = 15k\Omega$. Use 20k Pot.
Select $C_2 = 10\mu F$ and $C_3 = 0.01\mu F$

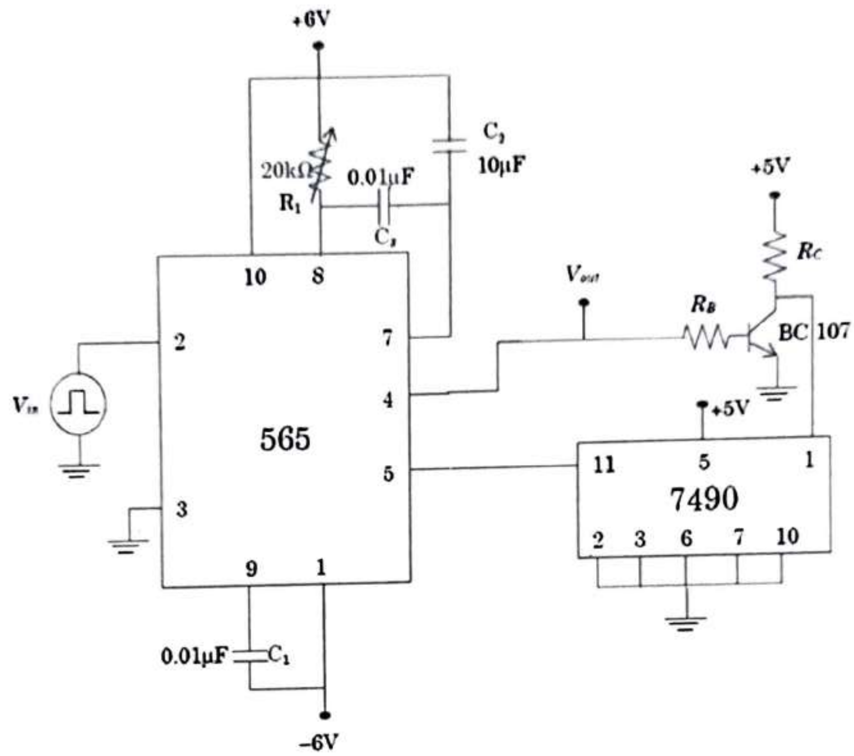
Choose BC107 transistor with $h_{fe} = 100$
Let $I_c = 2mA$

$$R_C = \frac{Vcc - V_{CE_{sat}}}{I_C} = \frac{5-0.2}{2mA} = 2.4k\Omega$$ Choose $Rc = 2.7k\Omega$.

Now $I_B = \frac{I_C}{h_{fe}} = \frac{2mA}{100} = 20\mu A$. Assume overdrive factor of 5, $I_B' = 5I_B$

$$R_B = \frac{V_{in} - V_{BE_{sat}}}{I_B} = \frac{6-0.7}{100\mu A} = 53k\Omega.$$ Choose $R_B = 56k\Omega$

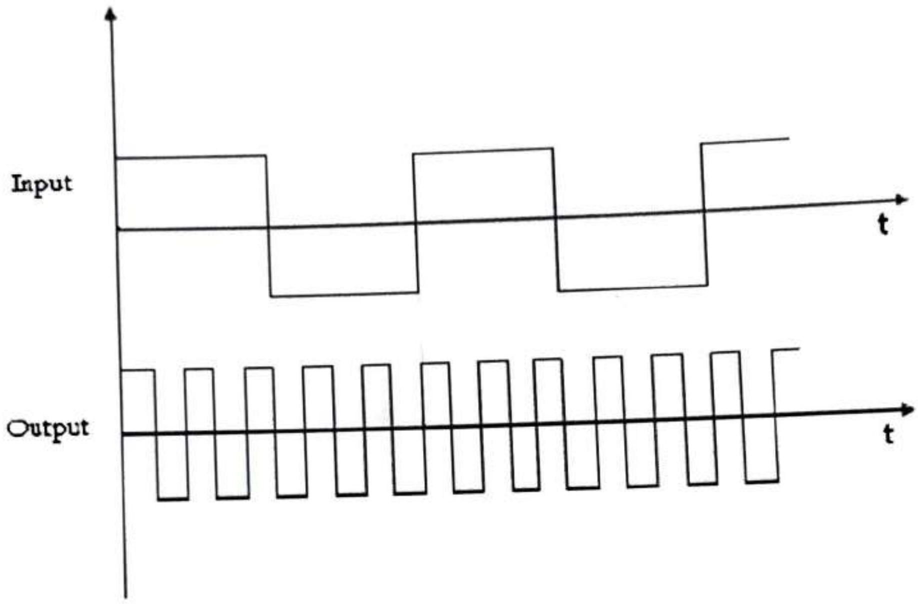
EXPERIMENT SETUP:



IN LAB:

1. Set up the circuit stage by stage and verify the working of IC565 and counter separately.
2. Measure the free running frequency of VCO at pin 4 with input signal set to zero and compare it with the design value.
3. Apply square input of 1Vpp at 2 kHz to pin 2.
4. Vary the VCO frequency by adjusting the potentiometer until the PLL is locked and measure the output frequency.

MODEL GRAPH:



POST LAB QUESTIONS

1. Drawbacks of frequency synthesizing by harmonic locking.
2. How is frequency stability obtained in a PLL by the use of VCO?
3. Design a circuit to multiply the frequency by 10.

RESULT:

Expt. No: 6

Date: ___/___/_____

PRE EMPHASIS AND DEEMPHASIS

OBJECTIVE:

1. To observe the effects of pre-emphasis on given input signal.
2. To observe the effects of De-emphasis on given input signal

HARDWARE REQUIRED:

Sl. No:	Items	Specification	Quantity
1	Op-amp	IC 741	2
2	Resistors	15KΩ,2.2KΩ,820Ω,100Ω	2,2,2,1
3	Capacitors	0.1μF	2
4	CRO		
5	Power supply		

THEORY

PRE-EMPHASIS:

The circuits are the transmitting side of the frequency modulator. It is used to increase the gain of the higher frequency component as the input signal frequency increased, the impendence of the collector voltage increase. If the signal frequency is lesser then the impendence decrease which increase the collector current and hence decrease the voltage.

DE-EMPHASIS:

The circuit is placed at the receiving side. It acts as allow pass filter. The boosting gain for higher frequency signal in the transmitting side is done by the pre-emphasis circuit is filtered to the same value by the low pass filter. The cut off frequency is given by the formula

Fc = 1/2π RC

Where R = 2 π fc L

PRE LAB QUESTIONS

1. What do you mean by pre emphasis and de emphasis? Why are they required in FM communication?
2. Briefly explain a simple pre emphasis circuit and a simple de emphasis circuit.

DESIGN:

Given $f_1 = \frac{1}{2\pi RC} = 2.12kHz$ and $f_2 = \frac{1}{2\pi rC}$ is not less than the highest audio frequency for which pre-emphasis is desired (15 kHz).

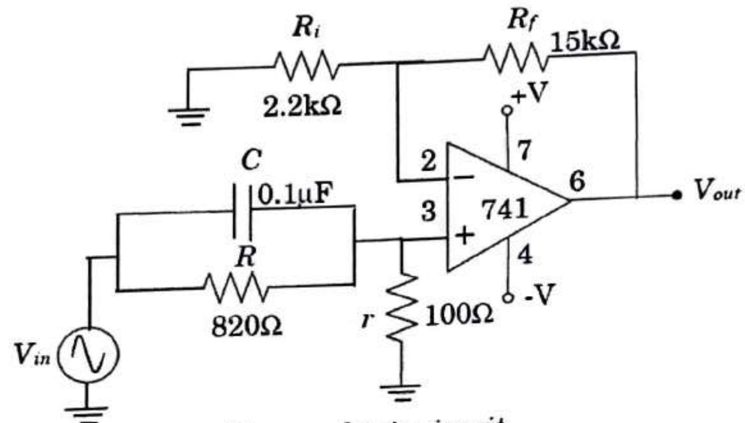
Let $C = 0.1\mu F$, then $\underline{R} = 751.1\Omega$. Choose $R = 820\Omega$

Also $r = 106.16\Omega$. Choose $r = 100\Omega$

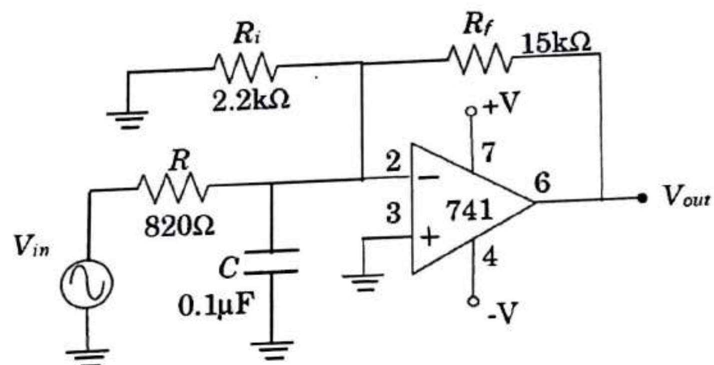
Gain = $1 + R_f/R_i = R/r = 7.5$

Let $R_i = 2.2k\Omega$, then $R_f = 16.5k\Omega$. Choose $R_f = 15k\Omega$.

EXPERIMENT SETUP:



Pre-emphasis circuit



De-emphasis circuit

IN LAB:

1. Set up the circuit as shown in the circuit diagram.
2. Feed a sinusoidal input of 1 KHz frequency.
3. Slowly increase the frequency of the input signal up to 20 KHz and observe the output. Tabulate the observations.
4. Draw the frequency response plots on semi-log graph sheet.

OBSERVATIONS:

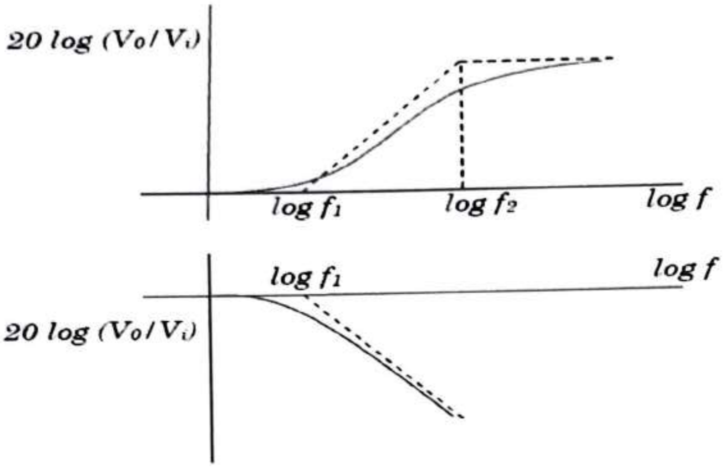
Table1: Pre-emphasis Vi = 20mV

Frequency (KHz)	Vo(mV)	log f	Gain in dB (20 log Vo/Vi)

Table2: De-emphasis Vi = 5v

Frequency (KHz)	Vo(mV)	log f	Gain in dB (20 log Vo/Vi)

MODEL GRAPH:



POSTLAB QUESTIONS

1. Which range of frequencies is more prone to noise interference?
2. How to reduce the noise during transmission in FM?
3. Which technique is used at the receiver side to reconstruct the original signal?
4. What should be the time constant for the de emphasis circuit?
5. Why pre-emphasis is done after modulation?

RESULT:

Expt. No: 7 *Date: ____/____/______*

TIME DIVISION MULTIPLEXING AND DEMULTIPLEXING

OBJECTIVE:

To demonstrate Time Division Multiplexing and demultiplexing using CD4016 Quad bilateral switch.

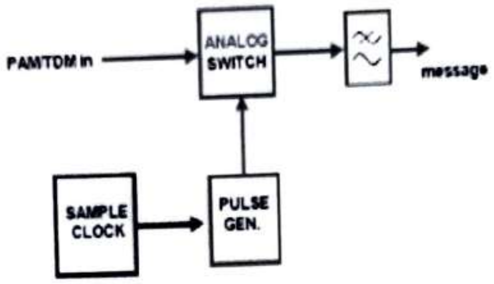
HARDWARE REQUIRED:

Sl. No:	Items	Specification	Quantity
1	Op-amp	IC 741	1
2	Resistors	10KΩ	2
3	IC	CD 4016	1
4	CRO		1
5	Function Generator		3
6	Power supply		1
7	Op-amp	IC741	1

THEORY

With time division multiplexing, transmissions from multiple sources occur on the same channel, but not at the same time. The transmissions from different sources are interleaved in the time domain. The incoming signals are divided into equal fixed-length time slots and after multiplexing, these are transmitted over a shared medium and reassembled into their original form after de-multiplexing.

In TDM, a set of switches operate at the transmitter in synchronism with another set of switches at the receiver. The switches at the transmitter sample the input signals and these samples are send to the receiver through the channel. CD4016 analog switch can be used to multiplex the data and up to 4 signals can be multiplexed.



PRE LAB QUESTIONS

1. What is multiplexing?
2. What is the need for multiplexing?
3. Compare synchronous and asynchronous TDM.
4. What are the different multiplexing techniques used in digital communication?
5. In what situation multiplexing is used?

DESIGN:

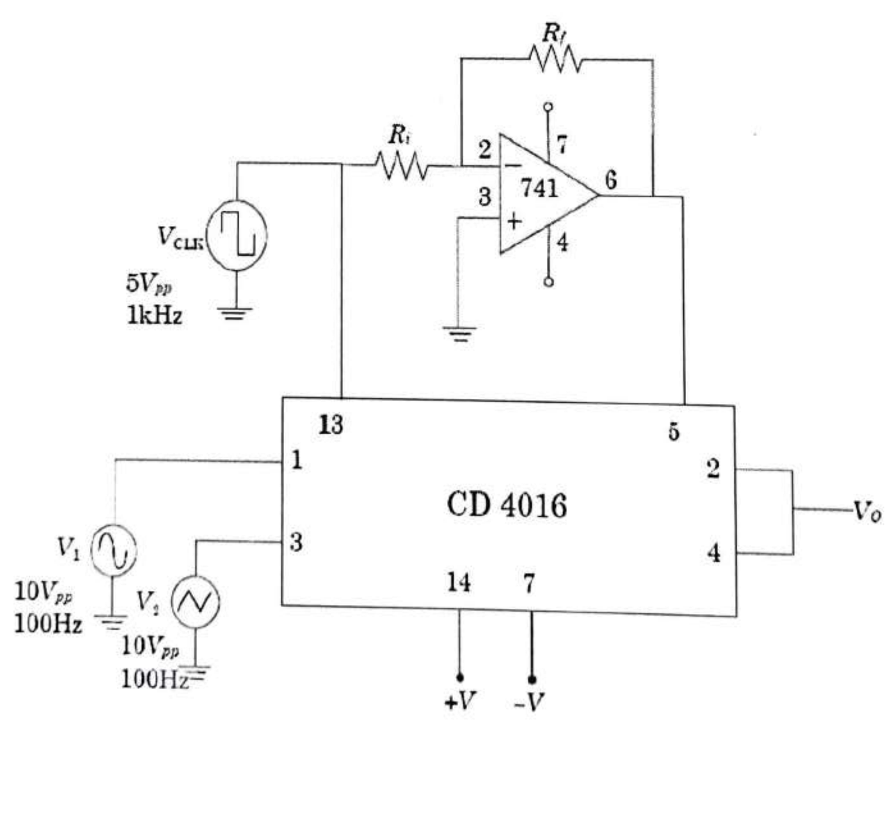
Select frequency of clock > 5 times frequency of input signals.
Let f_{in} = 100 Hz.
Select f_{clk} = 1 kHz

Inverter:
Gain of the inverter = -1
i.e. $-R_f/R_i = -1$ or $R_f = R_i$.
Let $R_i = 10k\Omega$, then $R_f = 10k\Omega$

POST LAB QUESTIONS

1. How is synchronization achieved in TDM?
2. What is the major drawback of digital communication?
3. Define bandwidth expansion factor.
4. What is difference between Frequency Division multiplexing and Wave Division Multiplexing?
5. Give the advantages of multiplexing
6. What is the effect of amplitude and frequency of input signals on output?

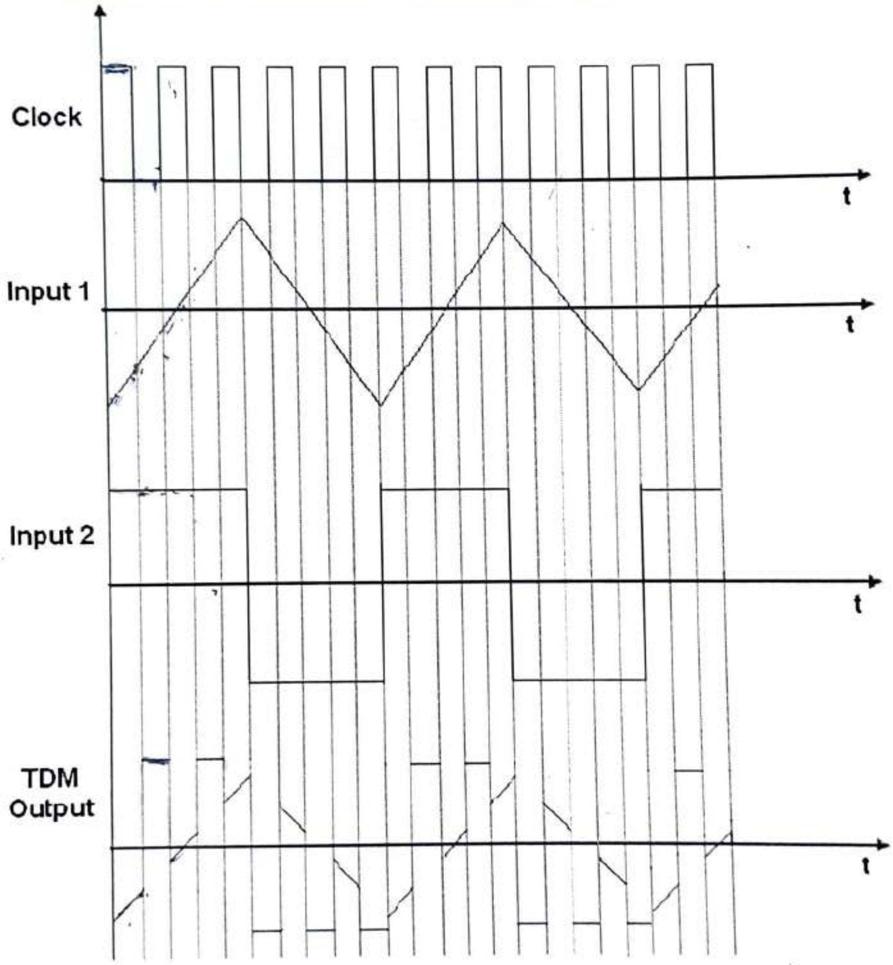
EXPERIMENT SETUP:



IN LAB:

1. Setup the circuit as shown in the circuit diagram.
2. Feed the inputs and verify whether each switch is working independently.
3. Short the pins 2 and 4 and observe the TDM output.

MODEL GRAPH:



RESULT:

Expt. No :8 **Date : ___/___/______**

GENERATION AND DETECTION OF DM

OBJECTIVE:

To design and generate a delta modulated and a demodulated wave.

HARDWARE REQUIRED:

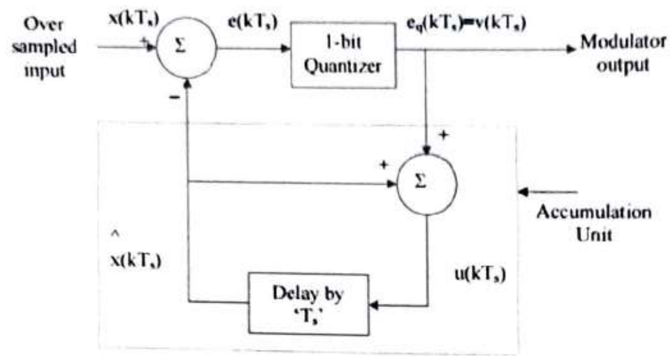
Sl. No:	Items	Specification	Quantity
1	IC	LM 741 7474 LM 311	1 1 1
2	Resistors	10KΩ 1KΩ	1 1
4	Signal Generator		2
5	Power supply		1
6	Bread board		1
7	CRO		1

THEORY

DELTA MODULATOR

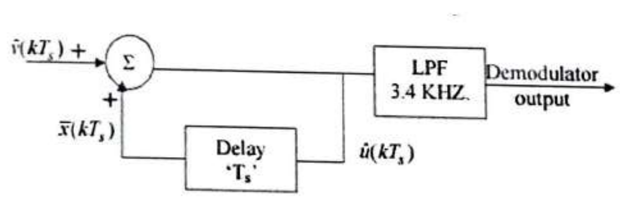
Delta modulation (DM) is a differential PCM scheme in which the difference signal is encoded into a single bit. This single bit is transmitted per sample to indicate whether the signal is larger or smaller than the previous sample. Circuit for delta modulation is shown in figure. This modulating signal *m(t)* and its quantized approximation m_(t) are applied to the comparator. Comparator provides a high level output when *m(t)*> m_(t) and it provides low level output when m(t) <*m_(t)*.

The LM 311 Chip is used in the circuit as the comparator. The output of the comparator is fed to a sample and hold circuit made by a D flip flop. The clock frequency to flip flop is selected at the sampling rate. Pulses at the output of D flip flop are bipolar by an op-amp comparator. Bipolar pulses are converted to analog signal before feeding to the comparator using a RC low pass filter.

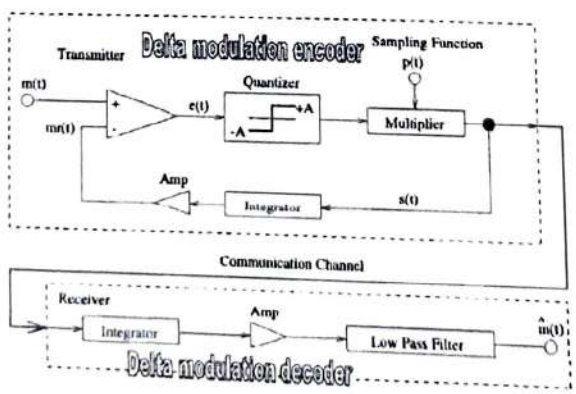


Block diagram of a delta modulator

DELTA MODULATOR



Demodulator structure for DM



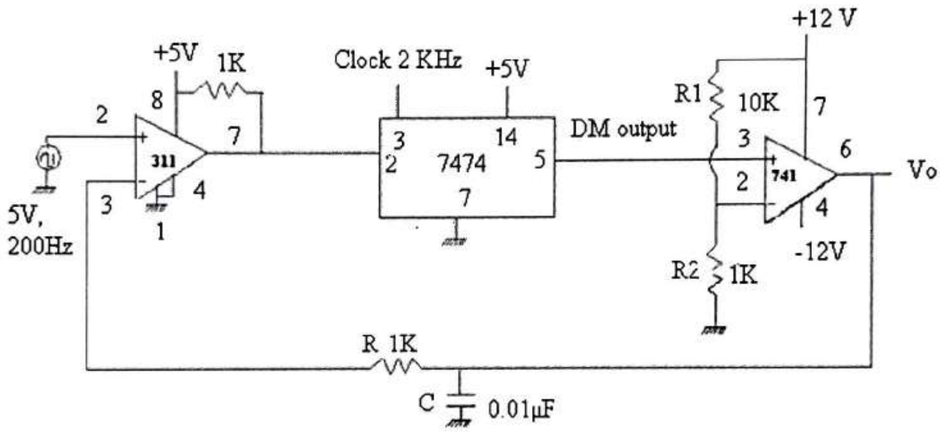
PRE LAB QUESTIONS

1. Define Delta modulation.

2. What are two unique features of Delta modulation?
3. What are the applications of Delta modulation?
4. What is the purpose of accumulator in DM?
5. What are differences between DM and DPCM?
6. What is the purpose of low pass filter?

EXPERIMENT SETUP:

DELTA MODULATOR



DESIGN:

Let the input signal amplitude be 5V and frequency be 200 Hz.

i.e. m(t)=5 sin(400*3.14*t)

Maximum slope of m(t)=2πfA

=2π*200*5

To avoid slope over load error, slope of m_ (t) should be more than that of *m*(t).

Vcc/RC >Emwm

Selecting Vcc =15v and C=0.01μf.we get R<228K.take R=100K.

Threshold voltage Vt= VR2 =1.35V

Therefore Vcc R2/ (R1+R2)=1.35V

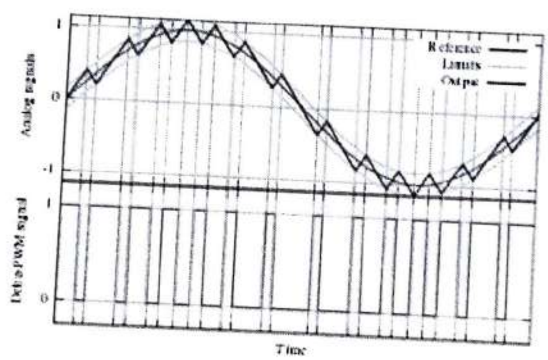
Take R2=1K. Then R1=10K

Let the clock frequency be 2 KHz.

IN LAB:

1. Connect the circuit as per circuit diagram.
2. Take the output at pin no:5 of IC 7474

MODEL GRAPH:



POSTLAB QUESTIONS

1. What is the slope overload effect?
2. What is granular noise and how it overcomes?
3. Write the advantage of DM over PCM?
4. What is the effect of the Low Pass Filter cut off frequency on output of demodulator?

RESULT:

Expt. No : 9 *Date : ___/___/______*

GENERATION AND DETECTION OF PAM/PWM/PPM

OBJECTIVE:

1. To set up Pulse Amplitude Modulator and Demodulator circuits and to observe the waveforms.
2. To set up Pulse Width Modulator and Demodulator circuits and to observe the waveforms.
3. To set up Pulse Position Modulator and Demodulator circuits and to observe the waveforms.

HARDWAREREQUIRED:

Sl. No:	Items	Specification	Quantity
1	Resistors	1.2k, 1.5 k, 8.2 k, 1K, 10K, 100K, 5.8K, 2.2K,3.9k, 3k, 10k, 680k	1,1,21,1,1,1
2	Capacitors	0.01μF,1Mf, 10μF, 0.001μF, 60μF	3,2,1,1,1
3	Function Generator	1MHz	1
	Transistor	BC 107	2
	Diode	0A79	1
4	Regulated Power Supply	0-30, MHz	1
5	CRO		1
6	IC 555		1
7	CRO Probes		1

THEORY:

Pulse amplitude modulation is a kind of digital modulation technique in which analog message signal is sampled at constant frequency - carrier frequency. The amplitude of uniformly spaced pulses is varied in proportion to the corresponding sample values of a continuous message m (t). A pulse of specified duration is used to sample the message signal. When the pulse is on, the message is sampled and when it is off no message is sampled. This is a basic step in the digitization of analog message signals. A simple way to implement this is to allow the message to be fed as the input to a switch and the switch ON/OFF time is controlled by the pulses at sampling frequency. The demodulation of PAM waveform can be implemented by using a low pass filter which passes message signal frequencies but blocks the carrier signal.

A PAM waveform consists of a sequence of flat-topped pulses.

1) Double polarity PAM => This is the PAM wave which consists of both positive and negative pulses shown as

2) Single polarity PAM => This consists of PAM wave of only either negative (or) Positive pulses. In this the fixed dc level is added to the signal to ensure single polarity signal. It is represented as

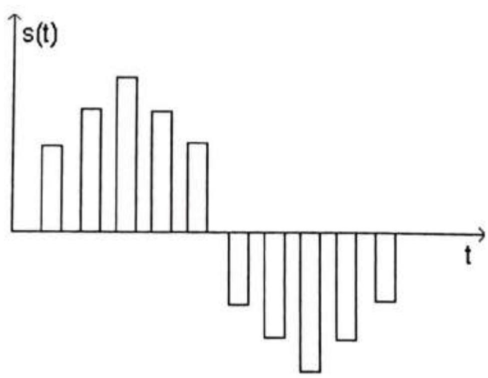


Fig: 1 Bipolar PAM signal

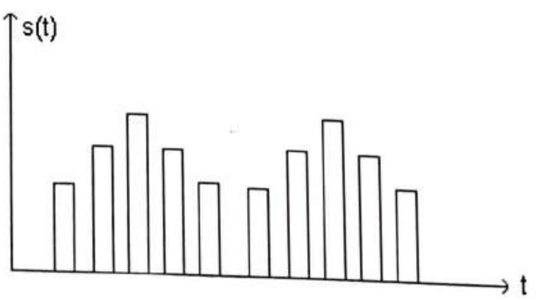


Fig: 2 Single polarity PAM

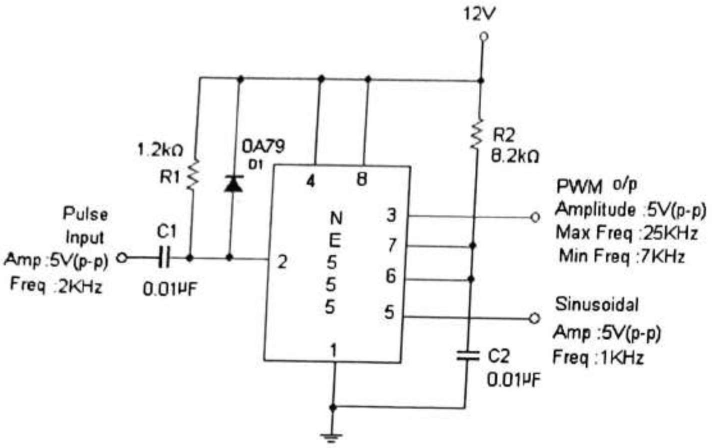
Pulse Time Modulation is also known as Pulse Width Modulation or Pulse Length Modulation. In PWM, the samples of the message signal are used to vary the duration of the individual pulses. Width may be varied by varying the time of occurrence of leading edge, the trailing edge or both edges of the pulse in accordance with modulating wave. It is also called Pulse Duration Modulation.

In Pulse Position Modulation, both the pulse amplitude and pulse duration are held constant but the position of the pulse is varied in proportional to the sampled values of the message signal. Pulse time modulation is a class of signaling techniques that encodes the sample values of an analog signal on to the time axis of a digital signal and it is analogous to angle modulation techniques. The two main types of PTM are PWM and PPM. In PPM the analog sample value determines the position of a narrow pulse relative to the clocking time. In PPM rise time of pulse decides the channel bandwidth. It has low noise interference.

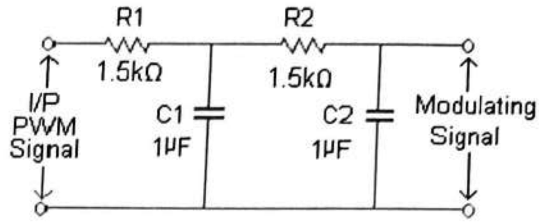
PRE LAB QUESTIONS

1. Define Pulse Amplitude Modulation (PAM).
2. State sampling theorem.
3. What is Pulse Width Modulation?
4. What are the other names for PWM?
5. Why is PWM used rarely in any sort of communication or broadcasting?
6. Define Pulse Position Modulation.
7. Write the transmission bandwidth of PAM signal?
8. What are the functions of reconstruction filter?
9. What is the purpose of Equalizer in PAM demodulator?

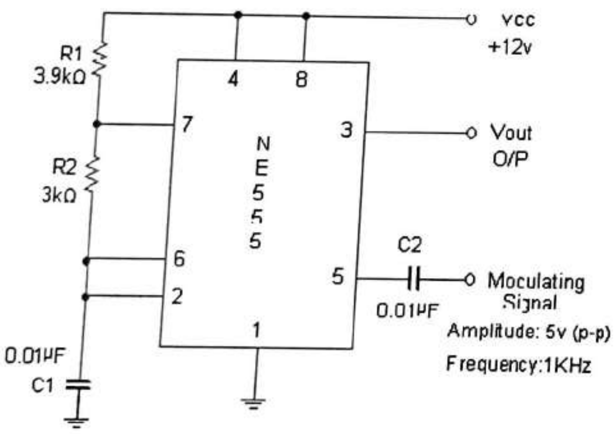
Pulse Width Modulation Circuit



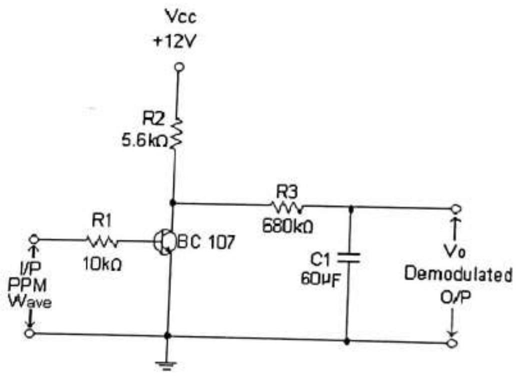
Demodulation Circuit



Pulse Position Modulation Circuit



Demodulation Circuit



IN LAB:

PAM

1. Connect the circuit as per the circuit diagram shown in the fig 3
2. Set the modulating frequency to 1KHz and sampling frequency to 12KHz
3. Observe the o/p on CRO i.e. PAM wave.
4. Measure the levels of Vmax & Vmin.
5. Feed the modulated wave to the low pass filter as in fig 4.
6. The output observed on CRO will be the demodulated wave.
7. Note down the amplitude (p-p) and time period of the demodulated wave. Vary the amplitude and frequency of modulating signal. Observe and note down the changes in output.
8. Plot the wave forms on graph sheet.

PULSE AMPLITUDE DEMODULATION:

1. Connect modulator circuit output to RC filter circuit (LPF).
2. Measure the amplitude and frequency of the demodulated signal from the CRO and verify with that of the modulating input.
3. Plot the demodulated waveform.

PWM

1. Connect the circuit as per circuit diagram shown in fig.
2. Apply a trigger signal (Pulse wave) of frequency 2 KHz with amplitude of 5v (p-p).
3. Observe the sample signal at the pin3.
4. Apply the ac signal at the pin 5 and vary the amplitude.
5. Note that as the control voltage is varied output pulse width is also varied.
6. Observe that the pulse width increases during positive slope condition & decreases under negative slope condition. Pulse width will be maximum at the +ve peak and minimum at the –ve peak of sinusoidal waveform. Record the observations.

7. Feed PWM waveform to the circuit of Fig.2 and observe the resulting demodulated waveform.

PPM

1. Connect the circuit as per circuit diagram as shown in the fig 1.
2. Observe the sample output at pin 3 and observe the position of the pulses on CRO and adjust the amplitude by slightly increasing the power supply. Also observe the frequency of pulse output.
3. Apply the modulating signal, sinusoidal signal of 2V (p-p) (ac signal) 2v (p-p) to the control pin 5 using function generator.
4. Now by varying the amplitude of the modulating signal, note down the position of the pulses.
5. During the demodulation process, give the PPM signal as input to the demodulated circuit as shown in Fig.2.
6. Observe the o/p on CRO.
7. Plot the waveform.

DESIGN:

PAM

One technique to implement PAM is to use transistor in switching mode. The flow of current from collector to emitter in a bipolar junction transistor is controlled by the voltage at its base. Choose the transistor BC107. For more details on BC107 see A.3. Apply the sinusoidal message signal of frequency $fm < 1\ kHz$ and amplitude $Em < 10\ Vpp$ at the collector. Apply a carrier at the transistor base through a resistor $10k\Omega$.The carrier pulse amplitude is set as $Ec = 10\ Vpp$ and frequency fc = 10KHz.

Demodulation

Demodulation is done using a _ RC filter. Design the filter as per the equation for upper cut-off frequency of a low pass filter,

$$f_{ct} = \frac{1}{2\pi R_d C_d}$$

$$1.5\ kHz = \frac{1}{2\pi R_d C_d}$$

Select $C_d = 0.01\mu F$. Then $R_d = 10k\Omega$. Choose $R_d = 10k\Omega$ standard resistor value.

CALCULATIONS:

PWM

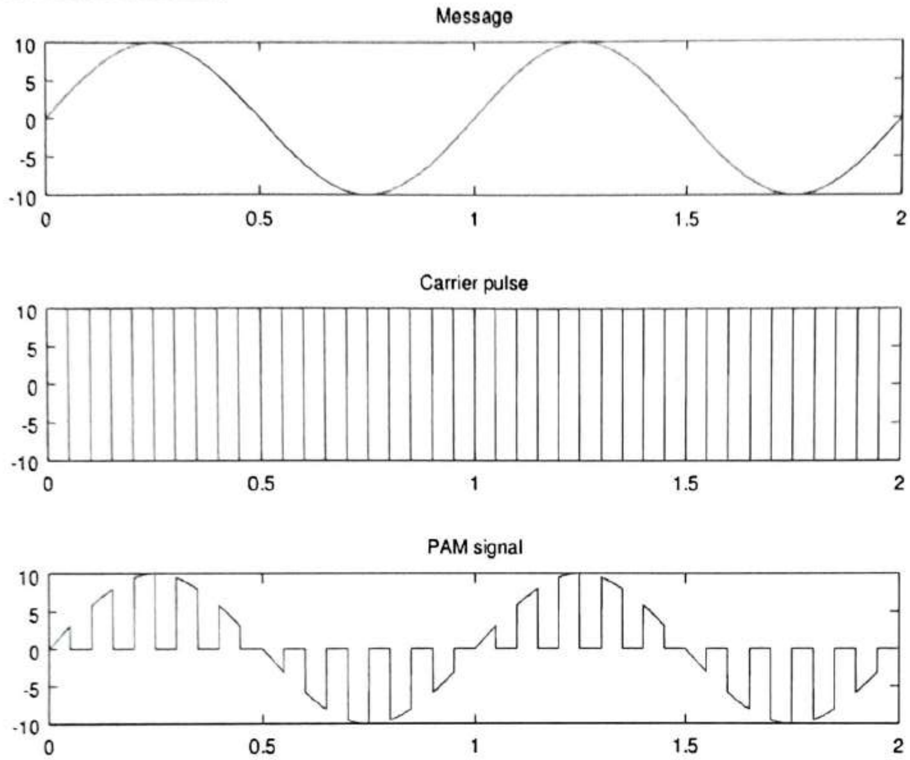
SL.No.	**Control voltage (V_{P-P})**	**Output pulse width (m sec)**

PPM

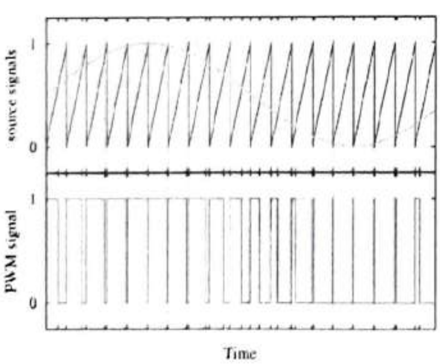
Modulating signal Amplitude(V_{P-P})	Time period(ms)		Total Time Pulse width ON (ms) period(ms)
	Pulse width ON (ms)	Pulse width OFF(ms)	

MODEL GRAPH:

PAM modulation



PWM modulation



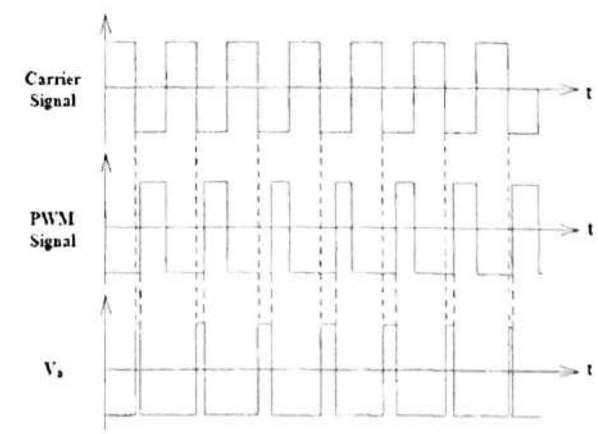
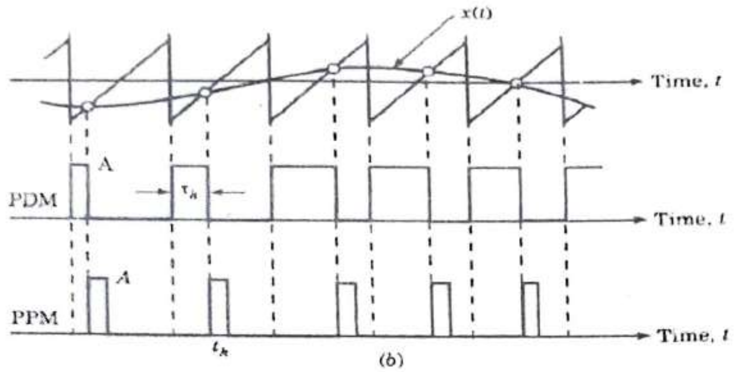
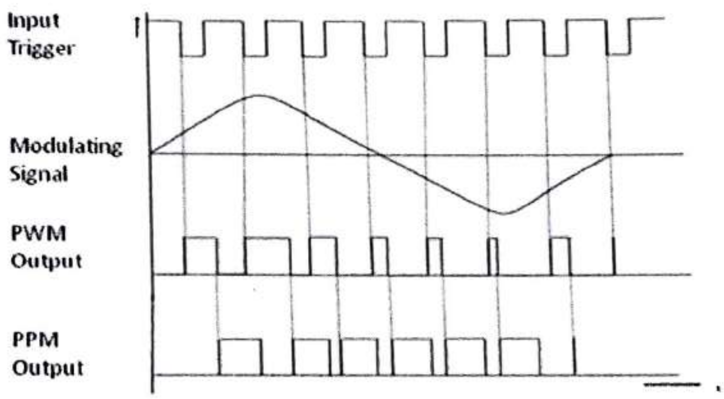


Figure 4-3 Block diagram of signal waveform of product detector PWM demodulator.

PPM modulation





POST LAB QUESTIONS

1. Where do you find the application of PAM?
2. Where does PWM technology find its applicability?
3. What is the main advantage of PPM over PAM and PWM
4. What are the demodulation methods for the flat-top sampled signal?
5. What are the disadvantages of PAM?
6. What are the disadvantages of PWM?
7. Compare PAM signal with other Pulse modulation.

RESULT:

Expt. No :10 ***Date : ____/____/______***

GENERATION AND DETECTION OF BPSK

OBJECTIVE:

To set up Binary PSK Modulator and Demodulator circuits and to observe the waveforms.

HARDWARE REQUIRED:

Sl. No:	Items	Specification	Quantity
1	Resistors	4.7KΩ	2
3	IC IC IC	7404 4066 741	1 1 1
4	Signal Generator		2
5	Power supply		1
6	Bread board		1
7	CRO		1

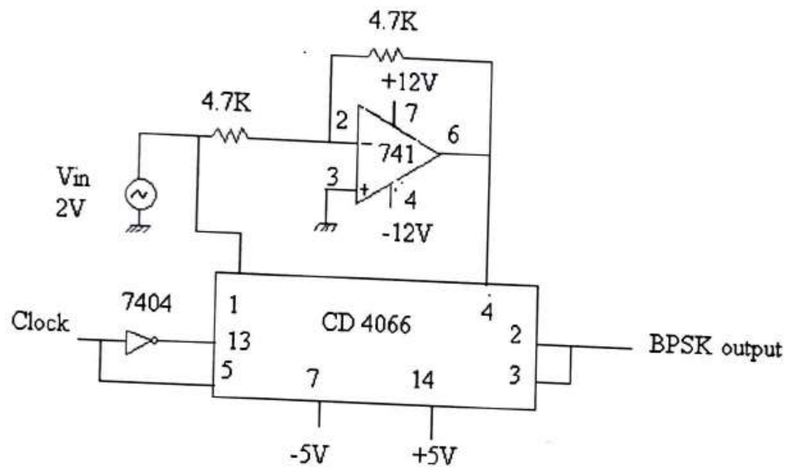
THEORY

BPSK GENERATION

BPSK is a digital modulation scheme that conveys data by changing, or modulating, the phase of a reference signal (the carrier wave).Any digital modulation scheme uses a finite number of distinct signals to represent digital data. PSK uses a finite number of phases, each assigned a unique pattern of binary digits. Usually, each phase encodes an equal number of bits. Each pattern of bits forms the symbol that is represented by the particular phase.

The demodulator, which is designed specifically for the symbol-set used by the modulator, determines the phase of the received signal and maps it back to the symbol it represents, thus recovering the original data. In this circuit the phase of the carrier wave is inverted according to the logic level of the input data i.e massage signal. Inverting amplifier using op-amp 741 IC is used to invert the phase of the input sine wave.

EXPERIMENT SETUP:



DESIGN:

Gain of inverting amplifier A=-Rf/Ri

Let the gain be -1 so that ratio is Rf/Ri=1.

Take Ri=Rf=4.7K

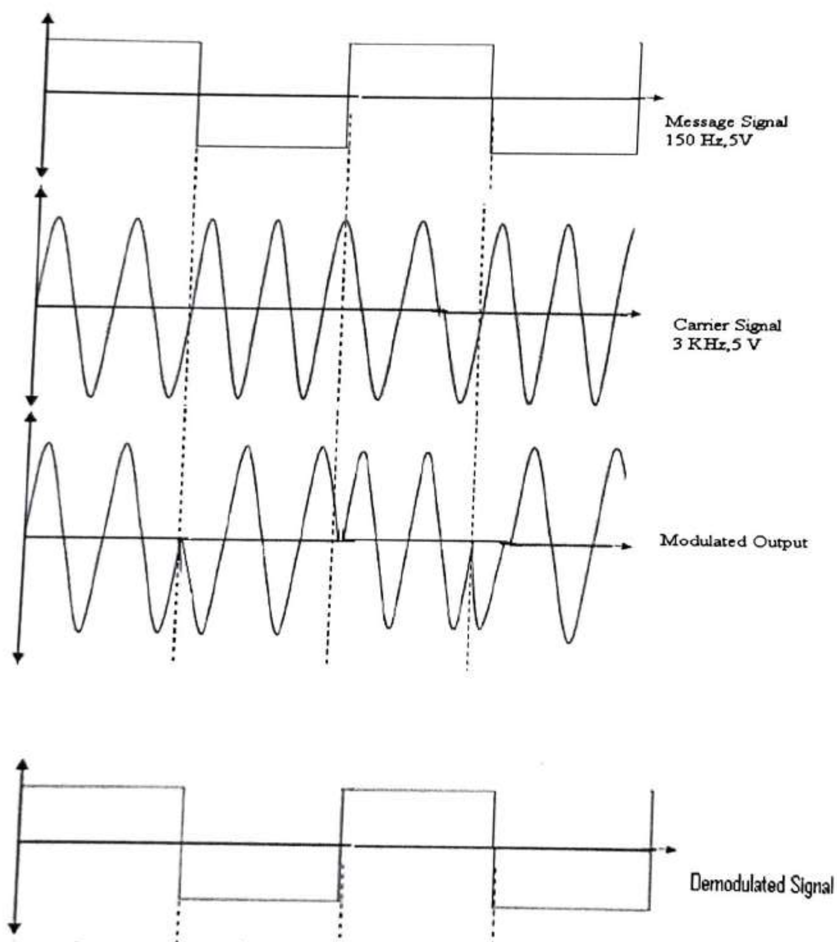
A 1K resistor is used to tie TTL gate output to 5V , for interfacing CMOS IC.

PREE LAB QUESTIONS

1. Define PSK?
2. Define QPSK and DPSK?

3. Why QPSK is called quadrature shift keying?
4. What is the advantage of PSK?
5. What is the disadvantage of PSK?

MODEL GRAPH:



RESULT:

Expt. No : **11** *Date :* ___/___/______

PULSE CODE MODULATION

OBJECTIVE:

To design and set up a pulse code modulator.

HARDWARE REQUIRED:

Sl. No:	Items	Specification	Quantity
1	IC	7493	1
2	OPamps	741, 311	3,1
3	Resisters	1k,4.7k,2.2k,47k,10k,22k,33k	2,1,2,1,7,4,1
4	Capacitor		
5	Potentiometer		
6	Transistor	BC 107	1
7	Signal Generator		1
8	DC source		1
9	Bread board		1
10	CRO		1

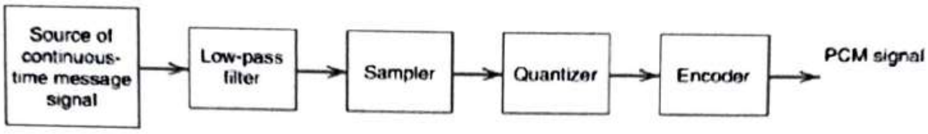
THEORY

PCM MODULATION

In the PCM circuit the input analog signal is sampled and quantized first and each quantized level is represented by a code number. It has excellent advantages compared to PAM and PWM.

The sampling of the input analog wave is done by a PAM circuit. DAC output and sampled output are compared by 311 IC. As long as the sampled output is high, comparator output remains high and the counting progresses.

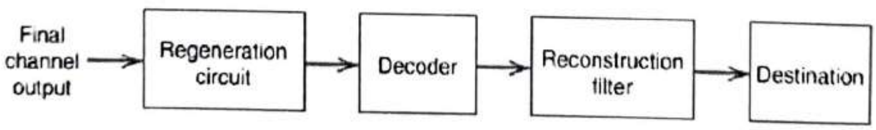
The meaning of source coding is the conversion from analog signal to digital signal. PCM modulation is commonly used in audio and telephone transmission. The main advantage is the PCM modulation only needs 8 kHz sampling frequency to maintain the original quality of audio. Figure (1) is the block diagram of PCM modulation. First of all is the low pass filter, which is used to remove the noise in the audio signal. After that the audio signal will be sampled to obtain a series of sampling values. Next, the signal will pass through a quantizer to quantize the sampling values. Then the signal will pass through an encoder to encode the quantization values and then convert to digital signal.



PCM DEMODULATION

Pulse Code Demodulation will be doing the same modulation process in reverse. Demodulation starts with decoding process, during transmission the PCM signal will effected by the noise interference. So, before the PCM signal sends into the PCM demodulator, we have to recover the signal into the original level for that we are using a comparator. The PCM signal is a series pulse wave signal, but for demodulation we need wave to be parallel.

By using a serial to parallel converter the series pulse wave signal will be converted into a parallel digital signal. After that the signal will pass through n-bits decoder, it should be a Digital to Analog converter. Decoder recovers the original quantization values of the digital signal. This quantization value also includes a lot of high frequency harmonics with original audio signals. For avoiding unnecessary signals we utilize a low-pass filter at the final part.

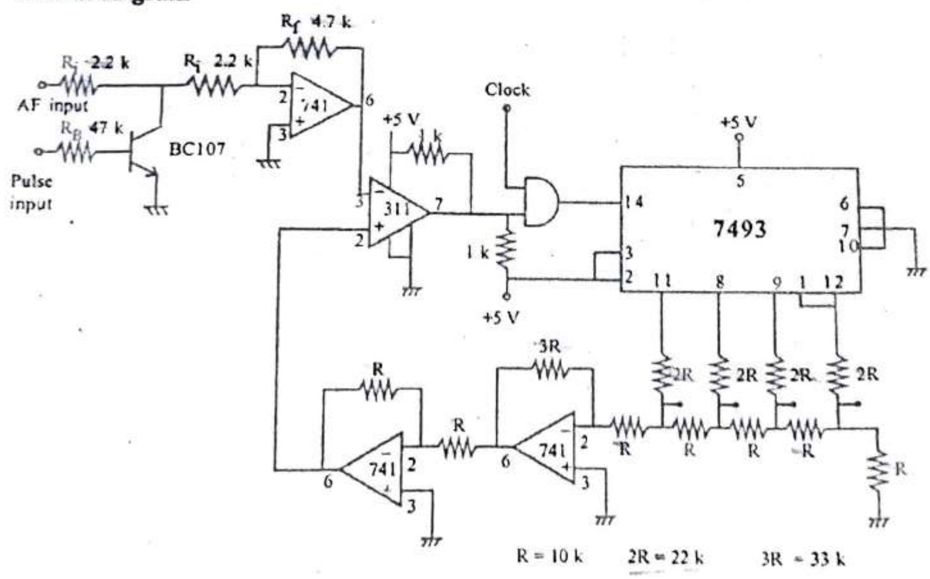


PRE LAB QUESTIONS

1. State sampling theorem.
2. What is aliasing?
3. Give the expression for aliasing error and the bound for aliasing error.
4. What is quantization?
5. What are the various steps involved in A/D conversion.
6. What will happen when sampling rate is greater than Nyquist rate ?
7. What will happen when sampling rate is less than Nyquist rate ?
8. Find the A/D Converter output for input DC voltage of 3.6V.
9. Mention some applications of PCM.
10. What is the function of Sample and Hold circuit?

EXPERIMENT SETUP:

Circuit diagram



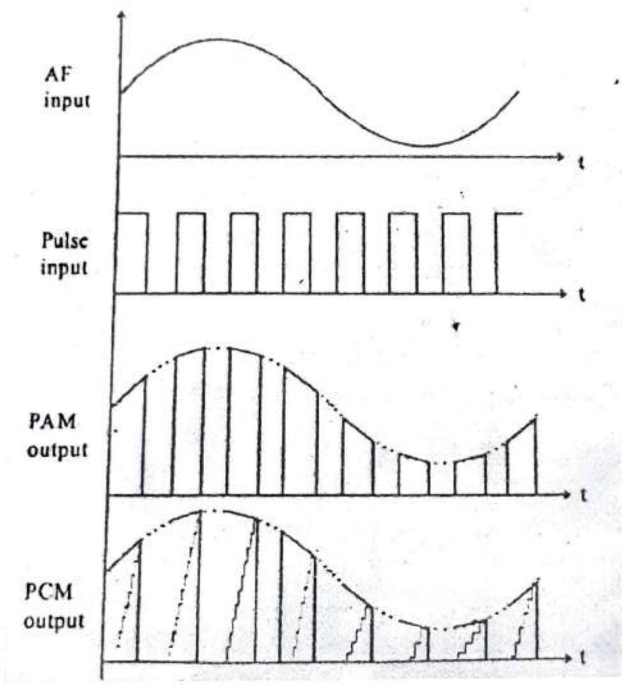
DESIGN:

Gain =1 Take R_f and R_i =4.7k. R_i is divided into two 2.2k resistors.

Design of DAC circuit:

Take R=4.7k, 2R=10k and 3R=15k.

Base resister R_B= (5-0.7)/100μA=43k. Select 3k.



RESULT:

Expt. No : 12

Date : ___/___/______

16-PSK MODULATION AND DEMODULATION

OBJECTIVE:

Write a program to set up a 16-PSK modulator and demodulator

SOFTWARE WARE REQUIRED:

1. MATLAB 2007

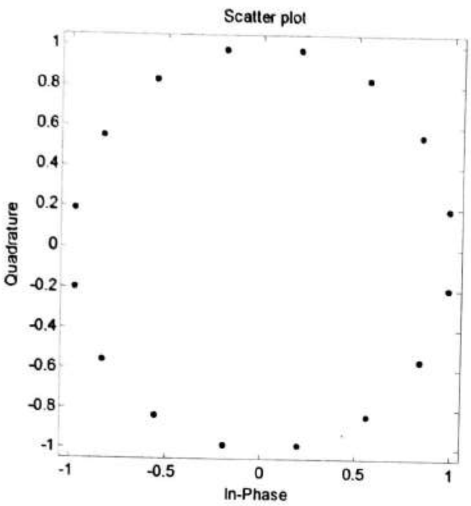
THEORY

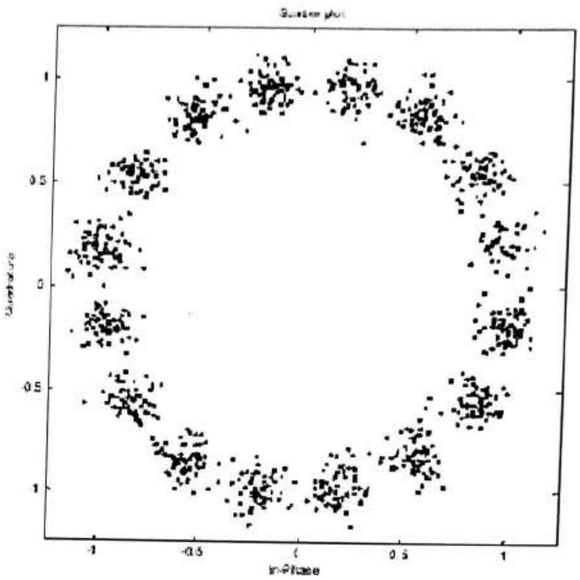
QPSK (Quadrature Phase Shift Keying) is a type of digital modulation scheme. QPSK is also known as Quaternary PSK. It is a type of M-ary PSK with the number of message signals transmitted M=4. If M=16 then this type of PSK is known as 16-PSK. The number of symbols $M=2^N$ where N is the number of bits per symbol. QPSK

MATLAB PROGRAM:

```
clc;
clear all;
% define number of symbols
M = 16;
%Generate random data symbols.
data = randi([0 M-1],1000,1);
%Modulate the data symbols.
txSig = pskmod(data,M,pi/M);
%Pass the signal through white noise and plot its constellation.
rxSig = awgn(txSig,20);
scatterplot(txSig)
scatterplot(rxSig)
% demodulate the signal
dataOut = pskdemod(rxSig,M,pi/M);
disp('Input data symbols');
disp(data);
disp('Demodulated data symbols');
disp(dataOut)
```

CONSTELLATION DIAGRAM:





PRE LAB QUESTIONS

1. What are the different digital modulation techniques?
2. What you mean by PSK
3. Define M-ary modulation techniques
4. Compare PSK, QPSK
5. Compare QPSK and

RESULT: