SVR ENGINEERING COLLEGE

Approved by AICTE & Permanently Affiliated to JNTUA

Ayyalurmetta, Nandyal – 518503.Website: www.svrec.ac.in

Department of Electronics and Communication Engineering

DIGITAL COMMUNICATION SYSTEMS LABORATORY

III B.Tech (ECE) I Semester

2020-21

STUDENT NAME	
ROLL NUMBER	
SECTION	

SVR ENGINEERING COLLEGE

Approved by AICTE & Permanently Affiliated to JNTUA

Ayyalur metta, Nandyal – 518503.Website: www.svrec.ac.in

Department of Electronics and Communication Engineering

DEPARTMENT OF

ELECTRONICS AND COMMUNICATION ENGINEERING

CERTIFICATE

ACADEMIC YEAR: 2021-22

This is to certify that the bonafide record work done by

Mr./Ms.____

bearing

H.T.No.___________________of II B.Tech II Semester in the

analog communication Laboratory

Faculty In-Charge **Head of the department**

ECE DEPT VISION & MISSION PEOs and PSOs

Vision

To produce highly skilled, creative and competitive Electronics and Communication Engineers to meet the emerging needs of the society.

Mission

- Impart core knowledge and necessary skills in Electronics and Communication Engineering through innovative teaching and learning.
- Inculcate critical thinking, ethics, lifelong learning and creativity needed for industry and society
- Cultivate the students with all-round competencies, for career, higher education and self-employabilit.

I. PROGRAMME EDUCATIONAL OBJECTIVES (PEOS)

PEO1: Graduates apply their knowledge of mathematics and science to identify, analyze and solve problems in the field of Electronics and develop sophisticated communication systems.

PEO2: Graduates embody a commitment to professional ethics, diversity and social awareness in their professional career.

PEO3: Graduates exhibit a desire for life-long learning through technical training and professional activities.

II. PROGRAM SPECIFIC OUTCOMES (PSOS)

PSO1: Apply the fundamental concepts of electronics and communication engineering to design a variety of components and systems for applications including signal processing, image processing, communication, networking, embedded systems, VLSI and control system

PSO2: Select and apply cutting-edge engineering hardware and software tools to solve complex Electronics and Communication Engineering problems.

III. PROGRAMME OUTCOMES (PO'S)

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage

projects and in multidisciplinary environments.

12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

IV. COURSE OBJECTIVES

- To familiarize the students with basic analog communication systems.
- Integrate theory with experiments so that the students appreciate the knowledge gained from the theory course.
- Understand all types of analog modulation / demodulation principles.
- Substantiate pulse modulation techniques.
- To design and implement different modulation and demodulation techniques.
- To write and execute programs in MATLAB to implement various modulation

techniques.

V.COURSE OUTCOMES

After the completion of the course students will be able to

Course Outcomes	Course Outcome statements	BTL
CO1	Design and conduct experiments, analyze and interpret data of PCM & DPCM	L1
CO2	Design and conduct experiments, analyze and interpret data of DM & TDM	L4
CO3	Design and conduct experiments, analyze and interpret data of FSK, PSK, DPSK & QPSK	L3
CO4	Design different communication applications using digital modulation techniques	L2

VI.COURSE MAPPING WITH PO'S AND PEO'S

Course Title	PEO1	PEO2	PEO3	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
DC Lab	3	3	2	3	3	3	3	3	3	3	1	2	2	2	2

VII MAPPING OF COURSE OUTCOMES WITH PEO'S AND PO'S

Course Outcomes	PEO1	PEO2	PEO3	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	3	3	2	3	3	3	3	3	3	3	1	2	2	2	2
CO-2	3	3	2	3	3	3	3	3	3	3	1	2	2	2	2
CO-3	3	3	2	3	3	3	3	3	3	3	1	2	2	2	2
CO-4	3	3	2	3	3	3	3	3	3	3	1	2	2	2	2

LABORATORY INSTRUCTIONS

1. While entering the Laboratory, the students should follow the dress code. (Wear shoes and White apron, Female Students should tie their hair back).
2. The students should bring their observation book, record, calculator, necessary stationery items and graph sheets if any for the lab classes without which the students will not be allowed for doing the experiment.
3. All the Equipments and components should be handled with utmost care. Any breakage or damage will be charged.
4. If any damage or breakage is noticed, it should be reported to the concerned in charge immediately.
5. The theoretical calculations and the updated register values should be noted down in the observation book and should be corrected by the lab in-charge on the same day of the laboratory session.
6. Each experiment should be written in the record note book only after getting signature from the lab in-charge in the observation notebook.
7. Record book must be submitted in the successive lab session after completion of experiment.
8. 100% attendance should be maintained for the laboratory classes.

Precautions.

1. Check the connections before giving the supply
2. Observations should be done carefully.

INDEX

S. NO.	Name of the experiment	Page No.	Performed Date	Date of submission	Marks	Faculty Signature
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

SVR Engineering College

DEPARTMENT OF ECE

ANALOG COMMUNICTIONS LAB MANUAL

II-B.Tech (ECE), II- SEM.

Name of the Experiment **Page. No**

LIST OF EXPERIMENTS

9. SIMULATE AM AND FM SIGNALS AND FIND POWER SPECTRUM OF EACH SIGNAL. PLOT THE GRAPHS.

10. SIMULATE PAM AND PWM SIGNALS AND FIND POWER SPECTRUM OFEACH SIGNAL. PLOT THE GRAPH

11. GENERATE A COMPLEX GAUSSIAN NOISE (WITH ZERO MEAN UNIT VARIANCE). AND PASS THROUGH AN LTI SYSTEM. FIND THE POWER SPECTRUM DENSITY OF THE NOISE SIGNAL AVAILABLE AT THE OUTPUT OF LTI SYSTEM.

12. MAKE USE OF AM SIGNAL FROM EXPERIMENT NO. 9 ADD GAUSSIAN NOISE (WITH ZERO MEAN ANDUNITY VARIANCE) TO THE SIGNAL. EXTRACT THEINFORMATION BEARING SIGNAL USING SUITABLE SYSTEM.

13. SIMULATE HUFFMAN CODING.

Equipment & Software Required:

1. Computer Systems with latest specifications
2. Connected in LAN (Optional)
3. Operating system (Windows XP)
4. Simulations software (MATLAB)

Equipment:

1. Regulated Power Supply (0-30) V
2. CROs (0-20)MHz
3. Function Generators (0-3) MHz
4. RF Signal Generators (0-1000) MHz
5. MultiMate's
6. Required Electronic components(active and passive)for the design of experiments from 1

   -7
7. Radio Receiver Demo kits or Trainers.
8. RF power meter frequency range 0 — 1000MHz
9. Spectrum Analyzer

Note: Conduct experiments (9-12) using MATLAB software. Student has toperform minimum twelve Experiments

Course Outcomes:

After the completion of the course students able to

CO1: Understand different analog modulation techniques &Radio receiver characteristics.(L1)

CO2: Analyze different analog modulation techniques.(L3)

CO3: Design and implement different modulation and demodulation techniques.(L4)

CO4: Observe the performance of system by plotting graphs & Measure Radio receiver characteristics. (L2)

CO5: Simulate all digital modulation and demodulation techniques. (L5)

AMPLITUDE MODULATION &DEMODULATION

AIM: To study the function of Amplitude Modulation & Demodulation (under modulation, perfect modulation & over modulation) and also to calculated the modulation index.

APPARATUS :

1. Amplitude Modulation & Demodulation trainer kit.
2. C.R.O (20MHz)
3. Function generator (1MHz).
4. Connecting cords & probes.

INTRODUCTION

This Educational trainer is a useful educational kit for the demonstration of:

1. Amplitude modulation
2. Demodulation

This kit consists of wired circuitry of :

1. RF Generator
2. AF Generator
3. Regulated power supply
4. Modulator
5. Demodulator

Block Diagram Description:

1. RF Generator:

Colpitts oscillator using FET is used here to generate RF signal of approximately 1MHz Frequency to use as carrier signal in this Experiment .Adjustments for amplitude and frequency are provided on panel for ease of operation.

2. AF Generator:

Low frequency signal of approximately 2 KHz is generated using OP-AMP based wein bridge oscillator,required amplification and adjustable attenuation are provided.

3. Regulated power supply:

This consists of bridge rectifier,capacitor filters and three terminal regulators to provide required dc voltages in the circuit i.e +12v,_12v &150 mA each.

4. Modulator:

modulator section illustrates the circuit of modulating amplifier employing a transistor (BC 107) as an active device in common emitter amplifier mode.R1 and R2 estaiblishes a quiescent forward bias for the transistor .The modulatingsignal is fed at the emitter section causes the bias to increase or decrease in accordance with the modulating signal.
R4 is emitter resistance and C3 is by pass capacitor for carrier.
Thus the carrier signal applied at the base gets amplified more when the amplitude of the modulating signal is at its maximum and less when the signal bythe modulating signal output is a amplitude modulated signal.C2 couples the modulated signal to output of the Modulator.

5. Demodulator:

Demodulation involves two operations:
1. Rectification of the modulated wave and
2. Elimination of RF components of the rectified modulated wave.

Signal is applied to anode and output is taken from cathode, diode operates as half wave rectifier and passes only positive half cycle of the modulated wave.Further signal is applied to sharp low pass filter formed by Rd and CD,lowpass filter allows only low frequency signal to output and it bye passes RF component to the ground

Experimental procedure:

1. As the circuit is already wired you just have to trace the circuit accordingto the circuit diagram given above.
2. connect the trainer to the mains and switch on the power supply.
3. Measure the output voltages of the regulated power supply circuit i.e +12v and _12v.
4. Observe outputs of RF and AF signal generator using CRO, note that RF voltage is approximately 300mv pp of 1 MHz frequency and AF voltageis 10vpp of 2KHz frequency.

Modulator

5. Now connect RF and AF signals to the respective inputs of modulator.
6. Initially set both the signals at zero level.
7. Connect one of the input of oscilloscope to modulator output and other inputto AF signal.
8. Adjust RF signal amplitude with the help of potentiometer so the t output of the modulator is 300mv pp by keeping af signal at zero level.
9. Now vary the amplitude of af signal and observe the amplitude modulatedwave at output, note the percentage of modulation for different values of AF signal

%modulation= (B – A / B + A) X 100

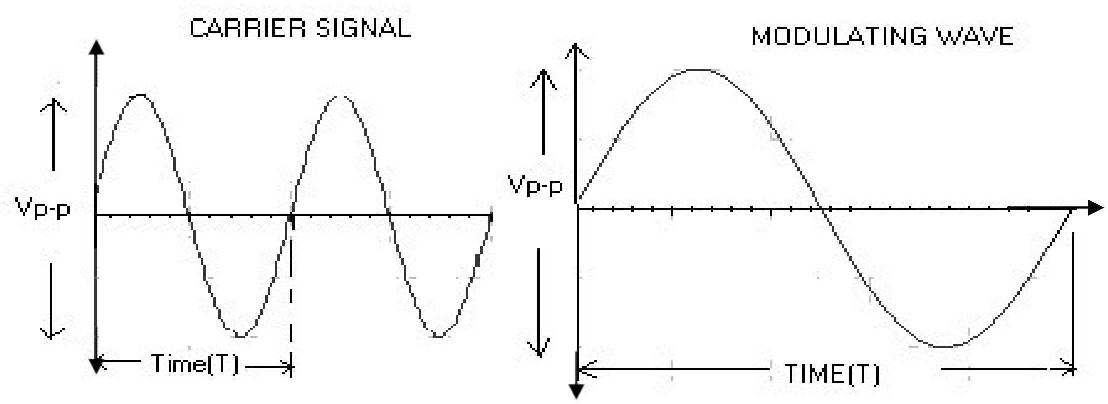
10. Observe 100% amplitude modulation and over modulation by varying amplitude of the AF signal.

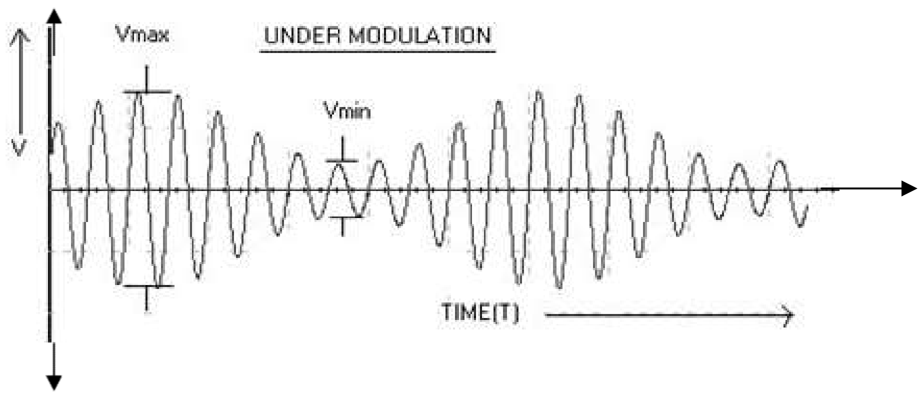
Demodulator

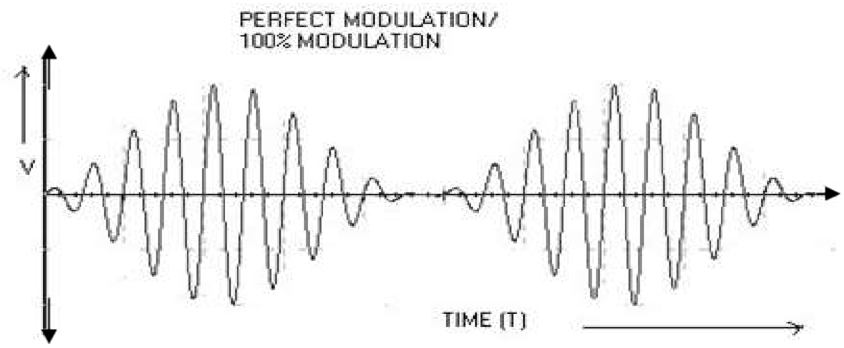
11. Now connect the modulator output to the demodulator input.
12. Observe demodulated signal at output of demodulator at approximately 50% modulation using oscilloscope.
13. Compare it with the original AF signal (Note : only wave shape, amplitudewill be attenuated, phase may change.)
14. Find the detected signal is same as the AF signal applied. Thus no information is lost in the process of modulation.
15. If you want to observe AM wave at different frequencies then connect AFsignal from external signal generator to the modulator and observe amplitude modulated wave ar different frequencies.

****

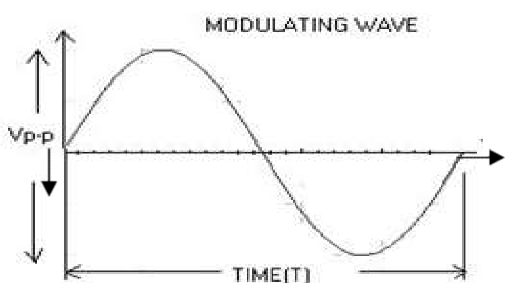
<u>EXPECTED WAVEFORMS</u>:-







Demodulated signal



QUESTIONS

1. Define AM and draw its spectrum?

2. Draw the phases representation of an amplitude modulated wave?

3. Give the significance of modulation index?

4. What is the different degree of modulation?

5. What are the limitations of square law modulato

GENERATION AND DETECTION OF DSB-SC SIGNAL.

AIM: To analyse the generation and detection of DSB-SC Modulatedsignal.

EQUIPMENTS/ APPARATUS REQUIRED :

Sl.No.	Name of the Equipment/ Component	Specifications/ Range	Quantity
1.	DSB- SC trainer kit		1
2.	Digital storage oscilloscope	100MHz,1GSa/S	1
3.	Patch cord		
4.	Connecting wires		As per requirement

THEORY:

In AM, there is a carrier and two side bands. The carrier itself does not carry any information. If the carrier is 100 % modulated by a signal, each side band is one fourth of the carrier's power. If receiver uses only one sideband, it is only one sixth of the total power radiated by the transmitter. One way to improve the AM transmitter's efficiency is to use a technique called as suppressed carrier modulation. Balance modulator is an AM modulator in which carrier and modulating signal are introduced in such a way that the output contains the two sidebands without the carrier that is double side band suppressed carrier (DSB-SC) AM.

PROCEDURE:

Modulation:

1. The circuit connection is made as shown in the circuit.
2. The power supply is connected to the trainer kit.
3. Set the amplitude and frequency of message sinusoidal signal as 0.5 V_{P-P} and 5 KHz respectively.
4. Set the amplitude and frequency of carrier sinusoidal signal as 1V_{P-P} and 100 KHz respectively.
5. Observe DSB-SC waveform on DSO.
6. Take the graph of DSB-SC modulated output waveform on the trace paper.

Demodulation:

1. The circuit connection is made as shown in the circuit.
2. The DSB-SC signal from DSB-SC generator is given as input to the demodulator circuit.
3. The demodulated output is observed on the DSO.
4. Observe DSB-SC demodulated output waveform
5. Take the graph of DSB-SC demodulated output waveform on the trace paper

BLOCK DIAGRAM:

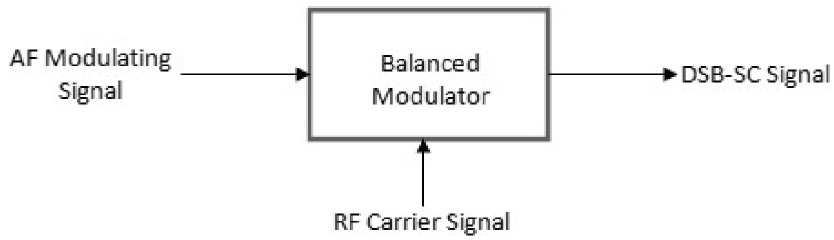


Fig4.1: Block diagram of DSB-SC modulation

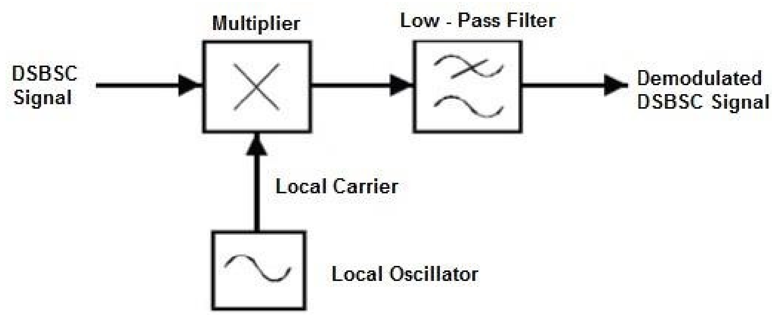
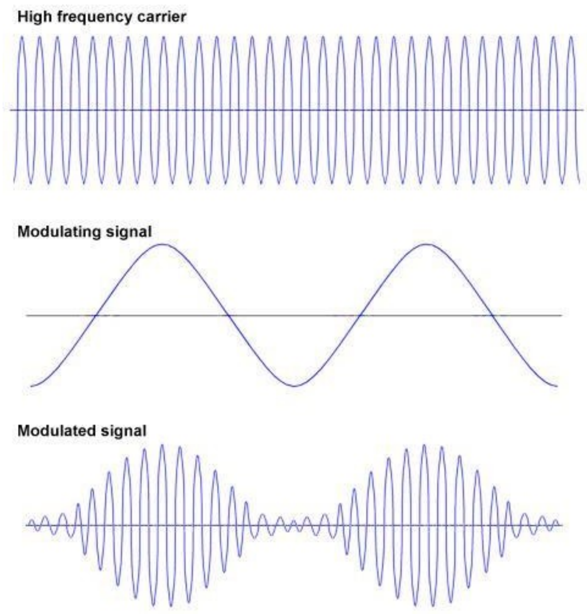


Fig4.2: Block diagram of DSB-SC demodulation

GRAPH



OBSERVATION:

Signal	Amplitude(Volts)	Frequency(KHz)
Message Signal		
Carrier Signal		
DSB-SC signal		

RESULTS: The DSB-SC amplitude modulation and demodulation were performed successfully and waveforms were obtained.

CONCLUSION: From the above experiment, we obtain the amplitude of demodulated signal is……..

PRECAUTIONS:

9. Do not use open ended wires to connect 230V, 50Hz power supply.
10. Check the connection before giving the power supply.
11. Observations should be done carefully.
12. Disconnect the circuit after switched off the power supply.

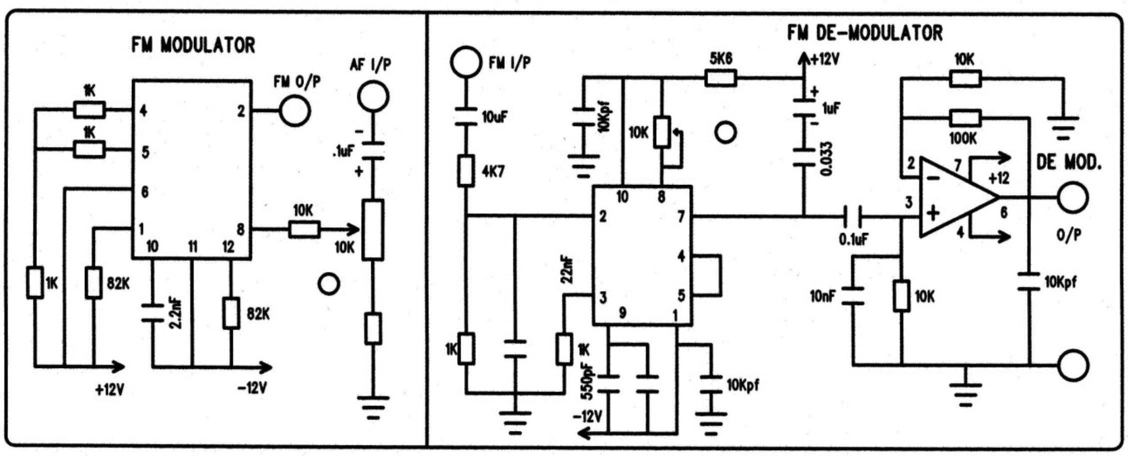
FREQUENCY MODULATION & DEMODULATION

AIM: To study the functioning of frequency modulation & demodulation and to calculate the modulation index, power.

APPARATUS:

1. Frequency modulation & demodulation trainer kit.
2. C.R.O (20MHz)
3. Function generator (1MHz).
4. Connecting chords & probes.

CIRCUIT DIAGRAM:



THEORY:

This kit consists of wired circuitry of:

1. AF generator.
2. Regulated power supply
3. Modulator.
4. Demodulator.

1. AF Generator:

This is an op-amp placed wein bridge oscillator. A FET input quad Op-Amp (ICTL084) is used here to generate low frequency signals of 500 Hz and 5KHz to use as modulating signal. In this experiment, a switch is provided to change the frequency. Required amplification is provided to avoid loading effect.

2. **Regulated power supply**:

This consists of bridge rectifier, capacitor filters and three terminal regulators to provide required dc voltages in the circuit i.e. +15 V, -15 V, +5V .

3. Modulator:

This has been developed using XR-2206 integrated circuit. The IC XR-2206 is a monolithic Function generator; the output waveforms can be both amplitude and frequency modulated by an external voltage. Frequency of operation can be selected externally over a range of 0.01 MHz. The circuit is ideally suited for communications, instrumentations and function generator applications requiring sinusoidal tone, AM, FM or FSK generation. In this experiment, IC XC-2206 is connected to generate sine wave, which is used as a carrier signal. The amplitude of carrier signal is 5vPP of 100 KHz frequencies.

4. Demodulator:

This had been developed using LM565 integrated circuit. The IC LM565 is a general-purpose phase locked loop containing a stable, highly linear voltage controlled oscillator for low distortion FM demodulation.

The VCO free running frequency f0 is adjusted to the center frequency of input frequency modulated signal i.e. carrier frequency which is of 100 KHz. When FM signal is connected to the demodulator input, the deviation in the input signal (FM signal) frequency which creates a DC error voltage at output of the phase comparator which is proportional to the change of frequency f. This error voltage pulls the VCO to the new point. This error voltage will be the demodulated version of the frequency modulated input signal

PROCEDURE:

1. Switch on the power supply of the kit (without making any connections).
2. Measure the frequency of the carrier signal at the FM output terminal with input terminals open and plot the same on graph.
3. Connect the circuit as per the given circuit diagram.
4. Apply the modulating signal of 500HZ with 1Vp-p.
5. Trace the modulated wave on the C.R.O & plot the same on graph.
6. Find the modulation index and power,bandwidth by measuring minimum and maximum frequency deviations from the carrier frequency using the CRO.

$$Mr = \frac{S}{f} = \frac{\text{maximum Frequency deviation}}{\text{modulating signal frequency}}$$

Power is denoted by P

P=VI cosǾ.

CosǾ = 1 (unity).

Bandwidth (B) = 2(Δf+fm)

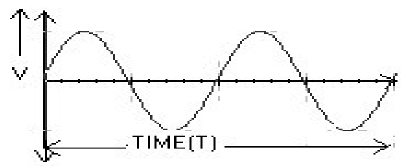
Δf =deviation freq

Fm = Highest frequency modulation

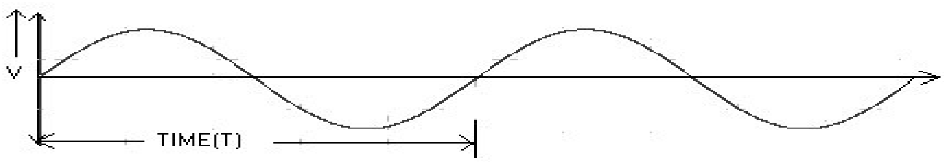
7. Repeat the steps 5& 6 by changing the amplitude and /or frequency of the modulating Signal.
8. For demodulation apply the modulated signal as an input to demodulator circuit and compare the demodulated signal with the input modulating signal & also draw the same on the graph.

EXPECTED WAVEFORMS

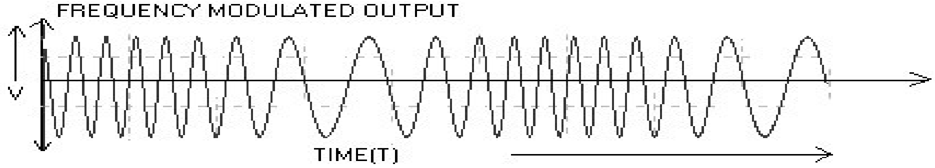
RF/CARRIER SIGNAL



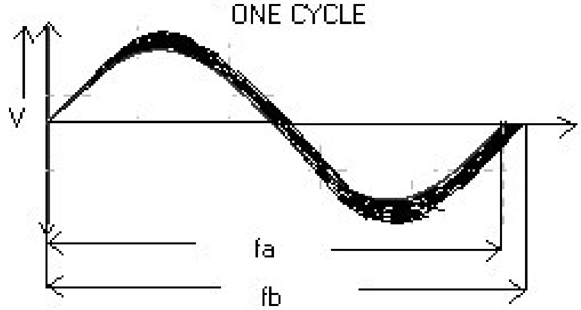
AF/MODULATING SIGNAL



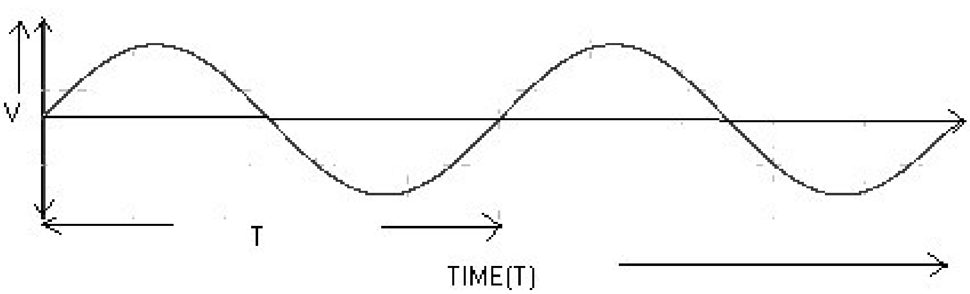
FREQUENCY MODULATED OUTPUT



FREQUENCY DEVIATION FOR ONE CYCLE



FREQUENCY DEMODULATED OUTPUT



NOTE: Note down all the input and output wave forms of the signals applied andobtained respectively.

QUESTIONS

1.Define frequency modulation?

2.Mention the advantages of indirect method of FM generation?

3.Define modulation index and frequency deviation of FM?

4.What are the advantages of FM?

5.What is narrow band FM?

6.Compare narrow band FM and wide band FM?

7.Differrntiate FM and AM?

8.How FM wave can be converted into PM wave?

9,State the principle of reactance tube modulator?

10.Draw the circuit of varactor diode modulator?

11.What is the bandwidth of FM system?

12.Want is the function of FM discriminator?

13.How does ratio detector differ from fosterseely discriminator?

14.What is meant by linear detector?

15.What are the drawbacks of slope detector?

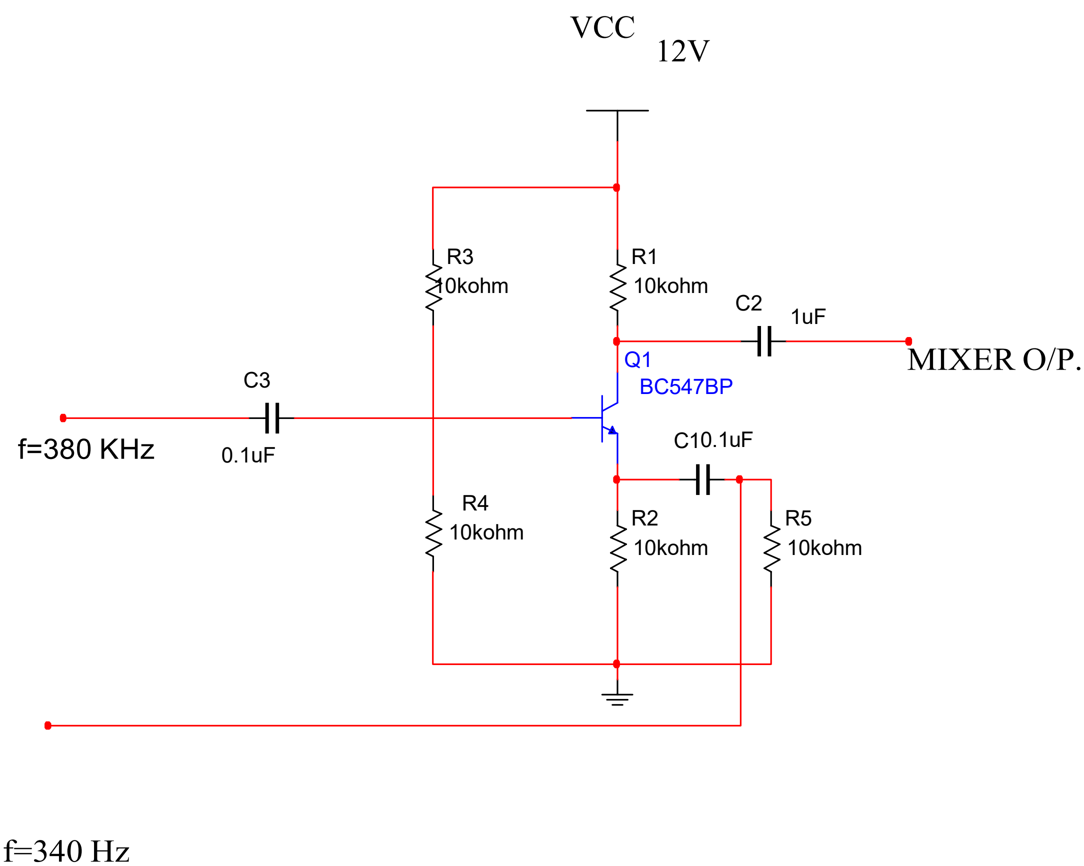
RESULT:

3.A) MIXER CHARACTERISTICS

AIM: To verify the characteristics of the mixer.

APPARATUS: Transistor BC-547, Resistors 10K-5, Capacitors 0.1μf-2, 1μf-1.

CIRCUIT DIAGRAM:



MIXER CIRCUIT

PROCEDURE:

1. Connections are to be made as per the circuit diagram.
2. Apply modulating signal with a frequency of f_m=340 Hz and a carrier signal with a frequency of f_c=380 KHz as shown in the circuit diagram.
3. Now observe the output across the collector.
4. This output signal is having a frequency which is equal to sum of modulating & carrier signal frequencies i.e., f_c+f_m.

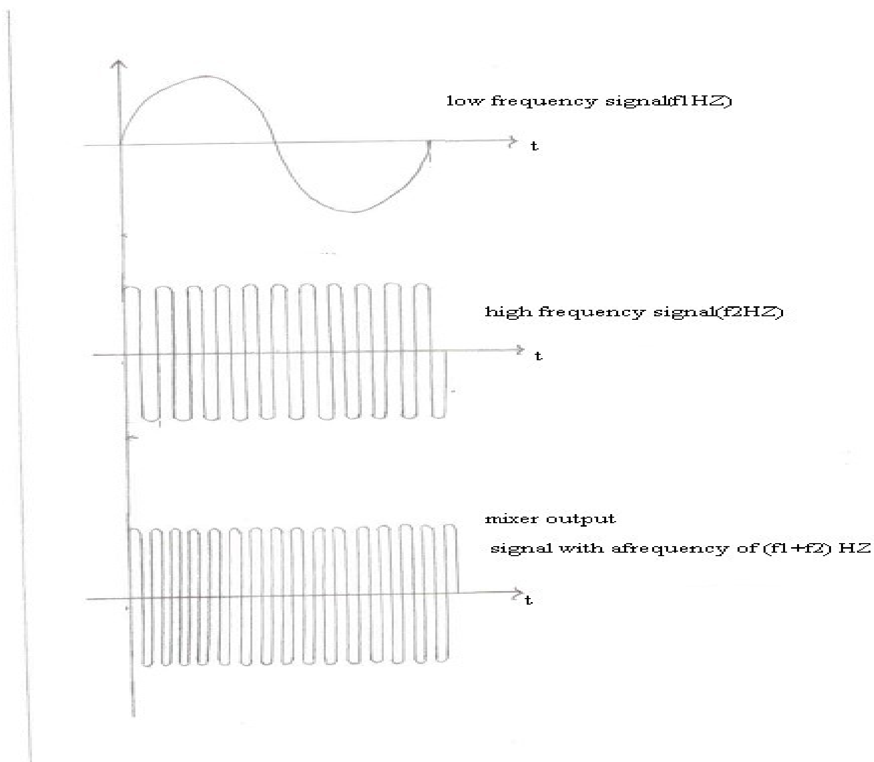
OBSERVATIONS:

Frequency of signal-1 f_m=................... Hz.

Frequency of signal-2 f_c=.................... Hz.

Frequency of output signal = ...Hz.

EXPECTED GRAPH:



RESULT:

PRE-EMPHASIS & DE-EMPHASIS

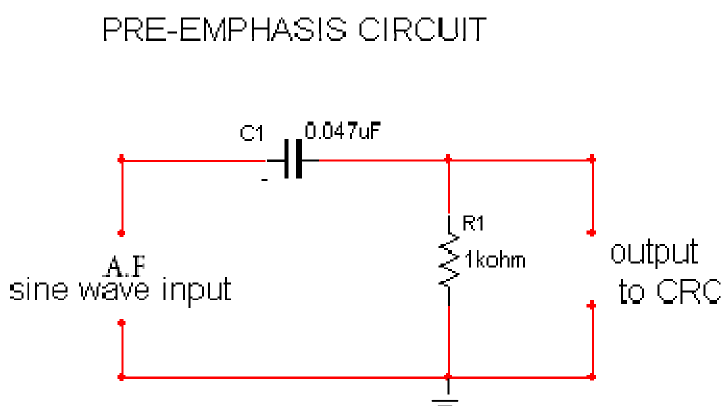
AIM: To study the functioning of Pre-Emphasis and De-Emphasis circuits.

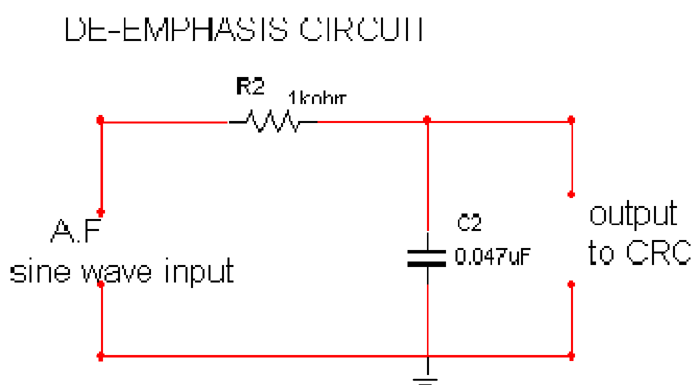
APPARATUS:

1. Pre-emphasis & De-emphasis trainer kits.
2. C.R.O (20MHz)
3. Function generator (1MHz).
4. Patch chords and Probes.

CIRCUIT DIAGRAM:

Example:-





THEORY:

Frequency modulation is much immune to noise than amplitude modulation and significantly more immune than phase modulation. A single noise frequency will affect the output of the receiver only if it falls with in its pass band.

The noise has a greater effect on the higher modulating frequencies than on lower ones. Thus, if the higher frequencies were artificially boosted at the transmitterand correspondingly cut at the receiver, improvement in noise immunity could be expected. This booting of the higher frequencies, in accordance with a pre-arranged curve, is termed pre-emphasis, and the compensation at the receiver is called de- emphasis.

If the two modulating signals have the same initial amplitude, and one of them is pre-emphasized to (say) twice this amplitude, whereas the other is unaffected (being at a much lower frequency) then the receiver will naturally have to de-emphasize the first signal by a factor of 2, to ensure that both signals have the same amplitude in the output of the receiver. Before demodulation, I.e. while susceptible to noise interferencethe emphasized signal had twice the deviation it would have had without pre-emphasis,and was thus more immune to noise. Alternatively, it is seen that when this signal is de-emphasized any noise sideband voltages are de-emphasized with it, and therefore have a correspondingly lower amplitude than they would have had without emphasis again their effect on the output is reduced.

The amount of pre-emphasis in U.S FM broadcasting, and in the sound transmissions accompanying television, has been standardized at 75 microseconds, whereas a number of other services, notably CCIR and Australian TV sound transmission, use 50 micro second. The usage of microseconds for defining emphasis is standard. 75 microseconds de-emphasis corresponds to a frequency response curve that is 3 db down at the frequency whose time constant is RC is 75 microseconds. This frequency is given by f=1/2□RC and it is therefore 2120 Hz; with 50-microseconds de-emphasis it would have been 3180 Hz. Figure I shows pre emphasis and de-emphasis curves for a 7 microseconds emphasis, as used in the united states.

If emphasis is applied to amplitude modulation, some improvement will also result, but it is not as great as in FM because the highest modulating frequencies in AM are no more affected by noise than any others.

Apart from that, it would be difficult to introduce pre-emphasis and de-emphasis in existing AM services since extensive modifications would be needed, particularly in view of the huge numbers is receivers in use.

PROCEDURE:

I- PRE-EMPHASIS

1. Connect the circuit as per the circuit diagram
2. Apply a sine wave to the input terminals of 2 $V_{P\text{-}P\ (Vi)}$
3. By varying the input frequency with fixed amplitude, note down the output amplitude (Vo) with respect to the input frequency.
4. Calculate the gain using the formula

   Gain = 20 log (V_O/ V_I) db

   Where V_O = output voltage in volts.

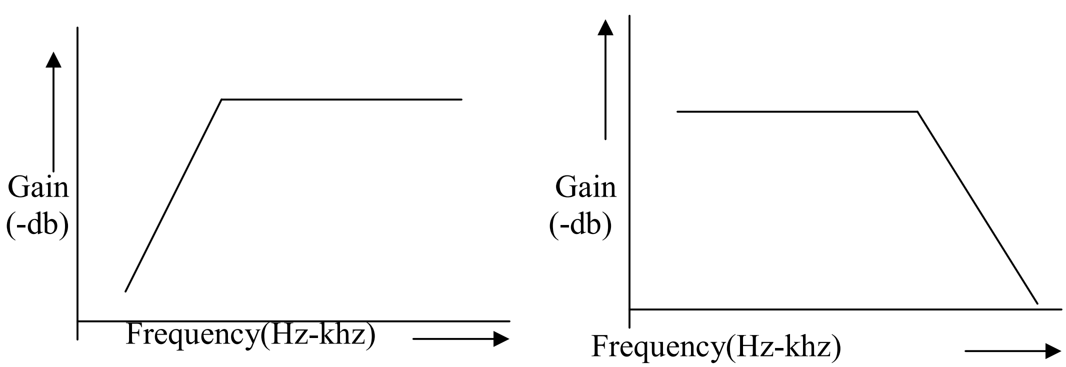
   V_I = Input voltage in volts.

   And plot the frequency response.

II- DE-EMPHASIS

1. Connect the circuit as per circuit diagram.
2. Repeat steps 2,3 & 4 of Pre-Emphasis to de-emphasis also.

EXPECTED WAVEFORMS



TABULAR COLUMN:-

V_I =2v

S.No	Input Frequency (50Hz to 20KHz)	Out put voltage (Vo) (volts)	GAIN 20 log (V_O/ V_I) db

RESULT:

QUESTIONS

1. What is the need for pre-emphasis?
2. Explain the operation of pre-emphasis circuit?
3. Preemphasis operation is similar to high pass filter explain how?
4. Deemphasis operation is similar to low pass filter justify?
5. What is de-emphasis?
6. Draw the frequency response of a pre-emphasis circuit?
7. Draw the frequency response of a de-emphasis circuit?
8. Give the formula for the cutoff frequency of the pre-emphasis circuit?
9. What is the significance of the 3db down frequency.

PULSE AMPLITUDE MODULATION &DEMODULATION

INTRODUCTION:

Pulse Amplitude Modulation & Demodulation is a self-contained kit for the demonstration of:

1. Pulse amplitude modulation Model DC-1
2. PAM Demodulation.

This kit consists of wired circuitry of:

1. AF Generator
2. Pulse Generator
3. Regulated power supply
4. PAM Modulator
5. PAM Demodulator
6. Small Signal amplifier.

BLOCK DIAGRAM DESCRIPTION:

1. AF Generator:

Low frequency signal of approximately 400Hz is generated using OP-AMP based wein bridge oscillator. FET input quad OP-AMP IC TL -084 is used, required amplification is provided to improve signal level. Potentiometer is provided to vary the output voltage of the oscillator.

2. Pulse Generator:

The sampling signal (pulse train) is generated using 555 timer. The timer is connected in astable mode to generate square wave with 30% duty cycle and 10v pp amplitude. Facility is provided to adjust out put frequency from 1 KHz to 6 KHz.

3. Regulated Power Supply:

This consists of bridge rectifier followed by capacitor filters and three regulators to produce required DC voltages in the circuit i.e. + 12V @ 150 mA each.

4. Modulator:

Pulse Amplitude modulator is designed using dedicated chip CD 4052. The CD 4052 is a differential 4-chnnel multiplexer having two binary control inputs A & B, and an inhibit input. The two binary input signals select one or four pairs of channels to be turned on and connect the differential analog inputs to the differential outputs.

In this experiment, the CD 4052 is connected in such a way that whenever sampling pulse occurs at control input A, input signal (AF) is allowed to output. At input and output of CD 4052, OP-AMP buffers (Voltage followers) are provided to avoid loading effects.

5. Demodulator:

Reconstruction of the original sinusoid from the samples (PAM signal) can be done using an integrator (Low pass filter) circuit that would 'fill in the gaps' between the samples. In this experiment a sharp 3-pole low pass filter of 100Hz is used to Demodulate PAM signal.

6. Amplifier:

OP-AMP based low frequency voltage amplifier is provided suitable gain to amplify the original AF signal from PAM demodulator. FET input quad OP-AMP IC TL-084 is used as an active device.

7. Regulated Power Supply:

This consists of bridge rectifier followed by capacitor filters and three regulators to produce required DC voltages in the circuit i.e. + 12V @ 150 mA each.

8. Modulator:

Pulse Amplitude modulator is designed using dedicated chip CD 4052. The CD 4052 is a differential 4-chnnel multiplexer having two binary control inputs A & B, and an inhibit input. The two binary input signals select one or four pairs of channels to be turned on and connect the differential analog inputs to the differential outputs.

In this experiment, the CD 4052 is connected in such a way that whenever sampling pulse occurs at control input A, input signal (AF) is allowed to output. At input and output of CD 4052, OP-AMP buffers (Voltage followers) are provided to avoid loading effects.

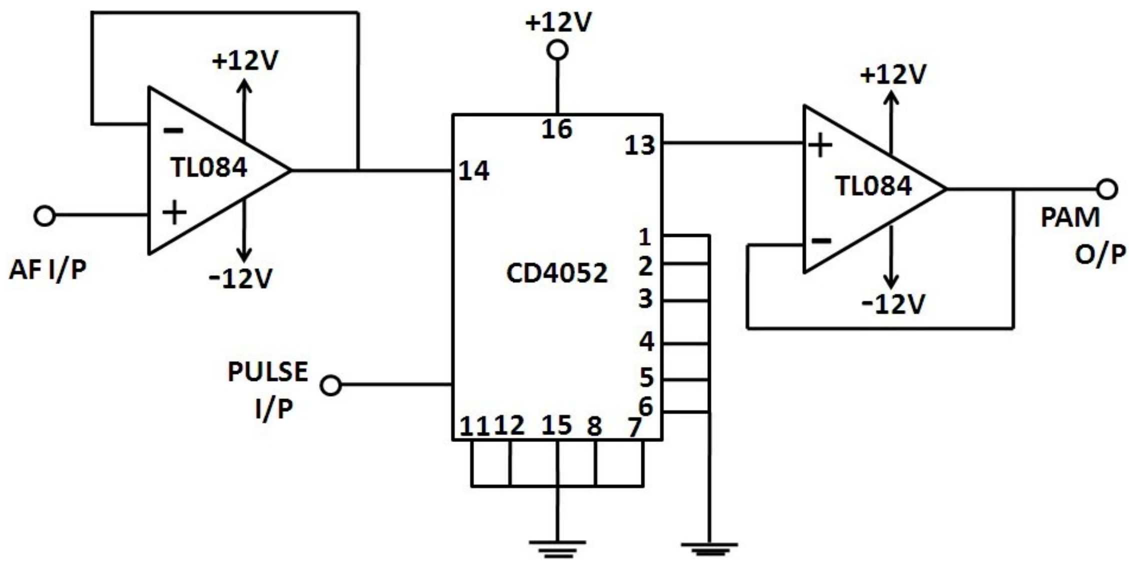
9. Demodulator:

Reconstruction of the original sinusoid from the samples (PAM signal) can be done using an integrator (Low pass filter) circuit that would ‘fill in the gaps’ between the samples. In this experiment a sharp 3-pole low pass filter of 100Hz is used to Demodulate PAM signal**.**

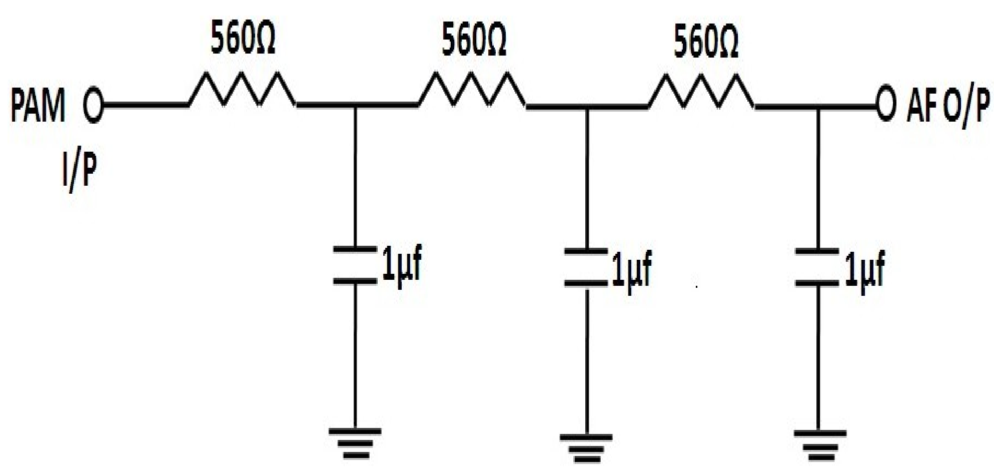
10.Amplifier:

OP-AMP based low frequency voltage amplifier is provided suitable gain to amplify the original AF signal from PAM demodulator. FET input quad OP-AMP IC TL-084 is used as an active device.

PAM MODULATOR CIRCUIT DIAGRAM:



PAM DEMODULATOR CIRCUIT DIAGRAM:



Experimental Procedure:

1. As the circuitry is already wired you just have to trace ~~the~~ circuit according to the circuit diagram given above.
2. Connect trainer to mains and switch on the power.
3. Measure the output voltages of regulated power supply circuit i.e. +12V.
4. Observe the output of AF generator and pulse generator using CRO and note that AF signal is approximately 3V P-P of 400Hz frequency and pulse generator output is pulse train of 10V P-P with frequency between 1 KHz and 6 KHz.

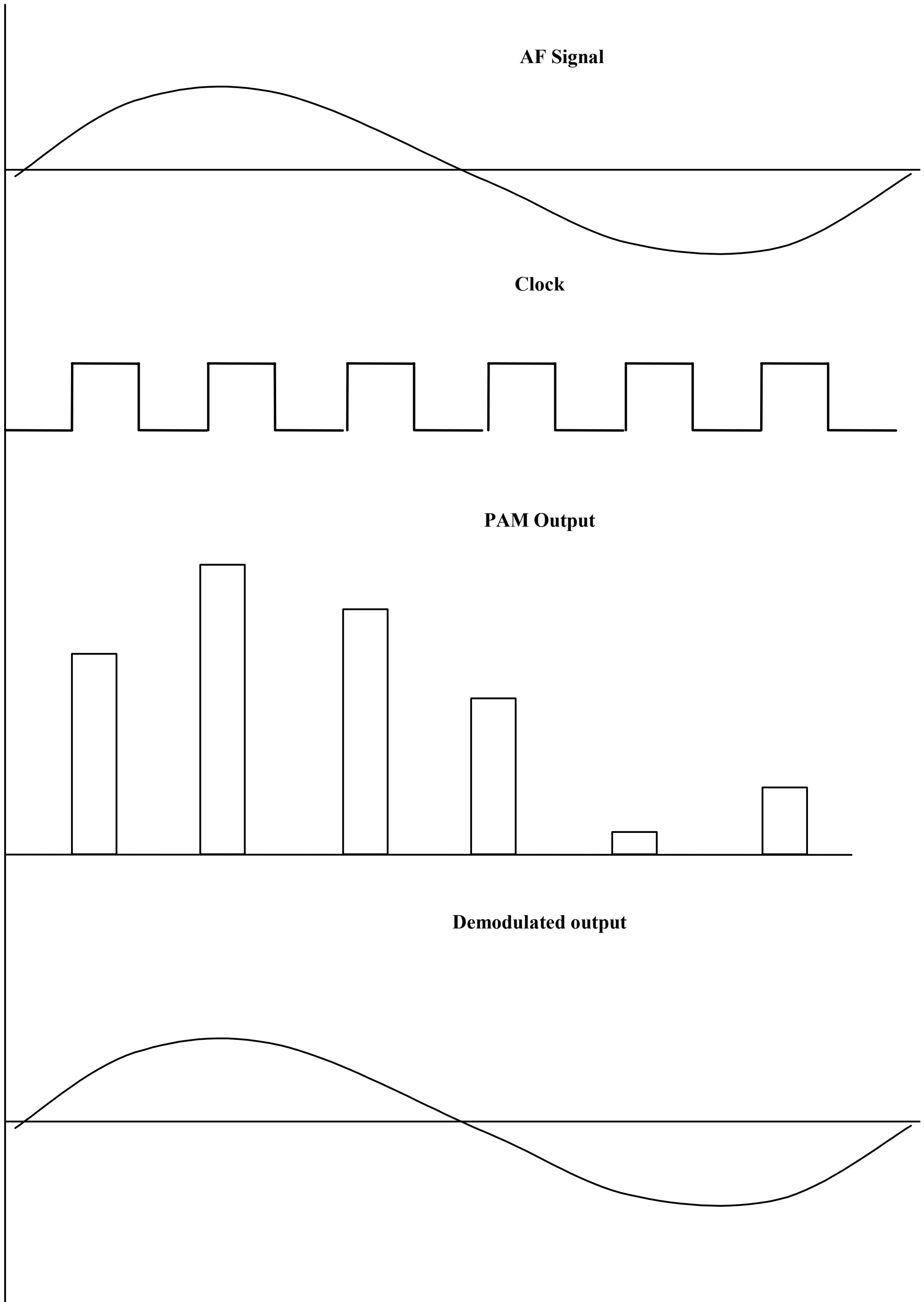
Modulator:

5. Connect pulse output and AF output to the respective inputs of modulator circuit.
6. Connect one of the input of oscilloscope to the modulator output and another to AF signal.
7. Initially set the amplitude of the AF generator to minimum level and sampling frequency to 1 KHz (by adjusting the preset provided in pulse generator block). Note down the output of modulator, by varying amplitude of modulating signal observe the modulator output so that you can notice the amplitude of the sampling pulses is varying in accordance with the modulating signal.

Demodulator:

8. Connect PAM wave input to demodulator input and set sampling pulse frequency to maximum (6 KHz).
9. Observe demodulated signals at output of demodulator, compare it with the original AF signal.
10. (Note: Only shape, amplitude will be attenuated)
11. You can observe the amplified signal by applying demodulated signal to amplifier.
12. Find the detected signal is same as the AF signal applied. Thus no information is lost in the process of modulation.

INPUT & OUTPUT WAVE FORMS



RESULT:

PULSE WIDTH MODULATOR & DEMODULATOR

INTRODUCTION:

This Educational trainer is useful kit to demonstrate PWM operation. thiskit consists of wired circuit of

1. Control signal generator
2. AF signal generator
3. **DC** source
4. **PWM** modulator Model –DC-02
5. **PWM** demodulator
6. Regulator Power Supply

Pulse width modulation (**PWM**) (also called Pulse duration modulation, or**PDM**) is used in communications applications and is widely used in motor control. The purpose of this experiment is to introduce you to a method of producing and observing **PWM** waveforms and methods of demodulation. After completing this experiment you will be able to

1. Understand **PWM**
2. Build a circuit to produce **PWM**
3. Design a circuit to demodulate **PWM**

CIRCUIT DESCRIPTION:

PWM Modulator:

A basic method of producing PWM and PPM is shown in figure. PWMmodulator consists of non-inverting adder and comparator. In adder circuit ramp (Saw-tooth) and modulating signal are added together and combined signals applied to the comparator. One of the input of the comparator is

connected to the dc source formed by preset PRI and other input is connected to the signal from adder. When there is no modulating signal
(AF-input) adder output is simply saw-tooth wave, so comparator inputs aresaw-tooth signal and dc voltage set by preset PRI. The output of the comparator is pulse of certain width, this pulse width is depend on dc voltage set by preset and discharging edge of the saw-tooth wave. When modulating signal is applied to the modulator reference level of the saw- tooth wave is charging to the input signal therefore the output pulse width is changing accordingly.

PWM Demodulator:

One method of demodulating PWM signal is shown in figure. Because thelength of the pulse in PWM is proportional to the amplitude of the analog input waveform and it is a rectangular pulse, the area under the PWM wave form andalso proportional to the amplitude of the input. Thus a simple integrator circuit will provide a waveform that resembles the original analog input. Of course smoothing must be done. Series of integrators will serve this purpose.

EQUIPMENT REQUIRED:

1. Pulse Width Modulator & DE-Modulator
2. Dual trace oscilloscope (Storage oscilloscope is desirable)
3. Digital multimeter.

EXPERIMENTAL PROCEDURE:

Observation of PWM with DC input voltage:

1. Study circuit operation thoroughly.
2. Switch on the trainer and measure the output voltages of the regulatedpower supply i.e. +5V and –5V.
3. Observe the output of the AF generator using CRO, note that the output is5V pp @ 400 Hz frequency.
4. Observe the output of the control signal generator i.e. ramp and referencepulse using CRO.
5. Connect ramp signal to the ramp input of the PWM modulator and dcsource output to AF input.
6. Connect one DMM to the dc source output and CH 1 input of the scope tothe PWM modulator output.
7. Measure the output pulse width at different input voltages starting from zero and note down the readings. (By this we can observe the output pulse width is varying in accordance with the input voltage as per theoryof PWM, the amplitude and position are fixed only width is varying)

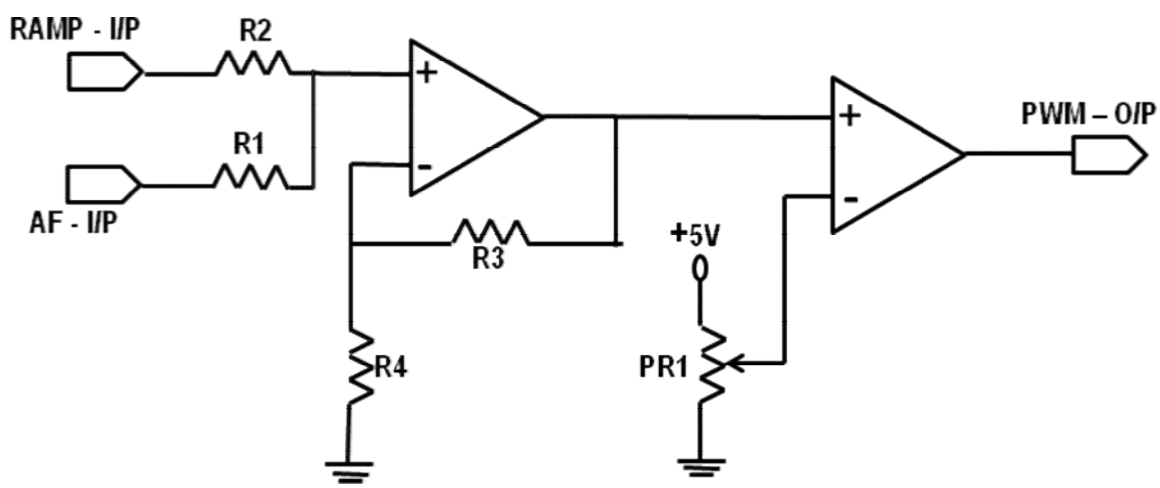
Observation of PWM with AC input signal:

8. Now connect AF signal instead of dc voltage to the modulator and observeoutput waveform (condition: scope is in dual mode, CH 1 is connected to AF signal and CH 2 is connected to PWM output, trigger source in CH 1,if you are using storage oscilloscope after setting AF input voltage observe output in stop mode).

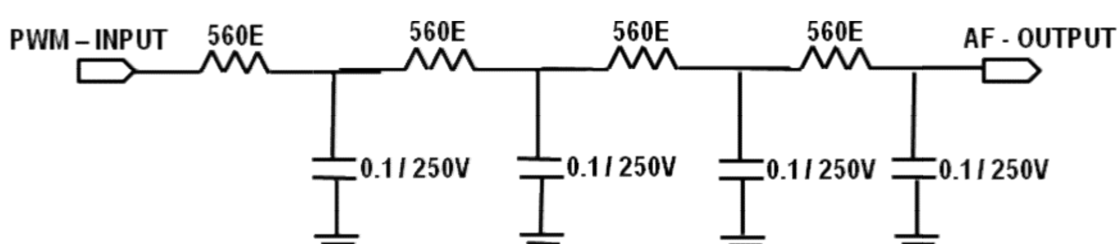
PWM Demodulation:

9. Remove connection from monostable input and connect it to PWM demodulator input.
10. Connect CH 1 to input AF signal and CH 2 to demodulator output and observe the output, compare it with original AF signal

PWM Modulator:

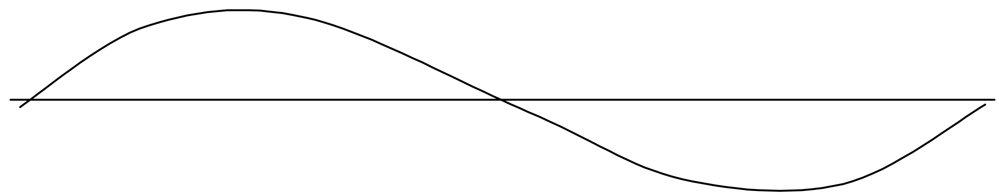


PWM Demodulator:



Input & output Wave forms:

AF Signal:



PWM Output:

PULSE POSITION MODULATOR & DE MODULATOR

INTRODUCTION:

This Educational trainer kit is useful to demonstrate PWM and PPM, this kit consists of wired circuit of Control signal generator
AF signal generator
DC source
PWM modulator
PWM to PPM converter
PPM to PWM converter
PWM demodulator
Regulator Power Supply

Pulse width modulation (**PWM**) (also called Pulse duration modulation, or **PDM**) is used in communications applications and is widely used in motor control. Pulse Position Modulation (**PPM**) is also a useful but not widely used technique. The purpose of this experiment is to introduce you to a method of producing and observing **PWM** waveforms and methods of demodulation. After completing this experiment you will be able to

Understand **PWM** and **PPM**
Build a circuit to produce **PWM**
Build a circuit to produce **PPM**
Design a circuit to convert from **PWM** to **PPM**
Design a circuit to convert from **PPM** to **PWM**
Design a circuit to demodulate **PWM**

CIRCUIT DESCRIPTION:

PWM Modulator:

A basic method of producing PWM and PPM is shown in figure. PWM modulator consists of non-inverting adder and comparator. In adder circuit ramp (Saw-tooth) and modulating signal are added together and combined signals applied to the comparator. One of the input of the comparator is connected to the dc source formed by preset PRI and other input is connected to the signal from adder. When there is no modulating signal (AF-input) adder output is simply saw-tooth wave, so comparator inputs are saw-tooth signal and dc voltage set by preset PRI. The output of the comparator is pulse of certain width, this pulse width is depend on dc voltage set by preset and discharging edge of the saw-tooth wave. When modulating signal is applied to the modulator reference level of the saw-tooth wave is charging to the input signal therefore the output pulse width is changing accordingly.

PPM Modulator:

Applying PWM signal to the monostable multivibrator can produce PPM. The output of the monostable is a pulse of selected width using external R and C components. Monostable is designed in such a way that falling edge of the PWM wave triggers the multivibrator and output remains high for certain time depend on RC time constant. As we know the output of the pulse width modulator is changing according to the input signal amplitude, which in turn triggers the monostable and output position changes.**PWM Demodulator:**

One method of demodulating PWM signal is shown in figure. Because the length of the pulse in PWM is proportional to the amplitude of the analog input waveform and it is a rectangular pulse, the area under the PWM wave form and also proportional to the amplitude of the input. Thus a simple integrator circuit will provide a waveform that resembles the original analog input. Of course smoothing must be done. Series of integrators will serve this purpose.

PPM Demodulation:

Demodulation of PPM can also be accomplished using several methods. One of the simplest is to convert the PPM waveform into a PWM waveform and then demodulate the PWM using the method just discussed.

PPM-PWM:

PPM waveform can be converted to PWM using JK Flip-Flop. From figure, the JK flip flop is level triggered and PPM signal is applied to the J input and reference signal (This is the synchronized signal with the saw-tooth signal applied to the PWM modulator) is applied to the K input, the output is taken from Q output. The output is high when reference signal is high and output is low when PPM is low or when both the inputs are high. So rising edge of the output is depend on reference pulse (which is synchronized with PWM rising edge) and falling edge is depend on PPM waveform (which is synchronized with falling edge of the PWM waveform).

EQUIPMENT REQUIRED:

PWM and PPM demonstrator trainer
Dual trace oscilloscope (Storage oscilloscope is desirable)
Digital multimeter.

EXPERIMENTAL PROCEDURE:
Observation of PWM and PPM with DC input voltage:

Study circuit operation thoroughly. Switch on the trainer and measure the output voltagesof the regulated power supply i.e. +5V and –5V. Observe the output of the AF generatorusing CRO, note that the output is 5V pp @ 400 Hz frequency.
Observe the output of the control signal generator i.e. ramp and reference pulse using CRO.
Connect ramp signal to the ramp input of the PWM modulator and dc source output to AF input.
Connect one DMM to the dc source output and CH 1 input of the scope to the PWM modulator output. Measure the output pulse width at different input voltages starting from zero and note down the readings. (By this we can observe the output pulse width is

varying in accordance with the input voltage as per theory of PWM, the amplitude and position are fixed only width is varying)
Now connect output of the PWM modulator to monostable multivibrator input and CH 2 input of the oscilloscope to the monostable output i.e. PPM output (Set scope in dual mode and trigger source in CH 1).Observe PWM and PPM waveforms for different values of the input voltage starting from zero (By this we can notice the output of monostable is PPM i.e. the pulse width is fixed and amplitude is constant only position is varying).

Observation of PWM and PPM with AC input signal:

Now connect AF signal instead of dc voltage to the modulator and observe output waveform (condition: scope is in dual mode, CH 1 is connected to AF signal and CH 2 is connected to PWM output, trigger source in CH 1,if you are using storage oscilloscope after setting AF input voltage observe output in stop mode). Similarly PPM waveform.

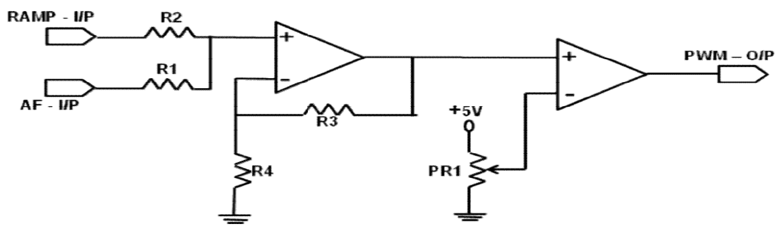
PWM Demodulation:

Remove connection from monostable input and connect it to PWM demodulator input. Connect CH 1 to input AF signal and CH 2 to demodulator output and observe the output, compare it with original AF signal

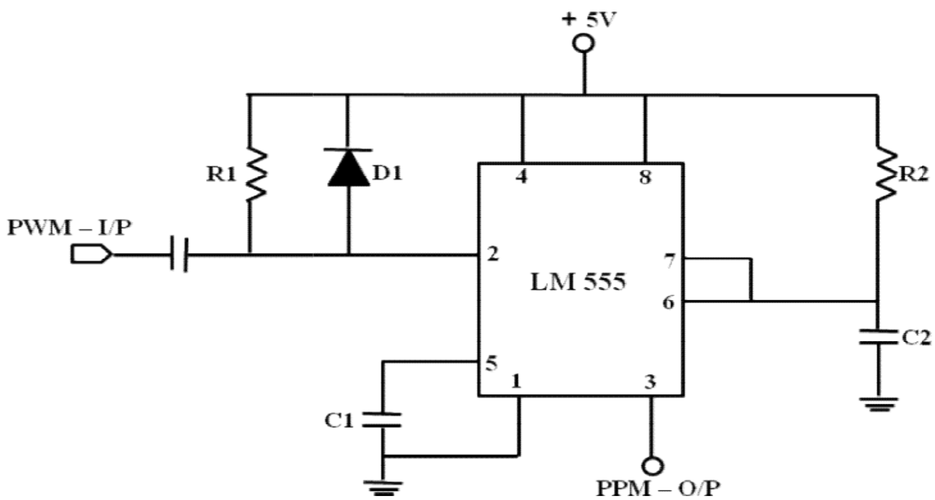
PPM demodulation:

Connect PPM and reference pulse signals to respective inputs of PPM – PWM converter circuit and output of the same circuit to PWM demodulator. (Scope should be set in dual mode, CH 1 is connected to input AF Signal, CH 2 to demodulator output and trigger source to CH 1). Observe the output signal and compare it with input AF signal.

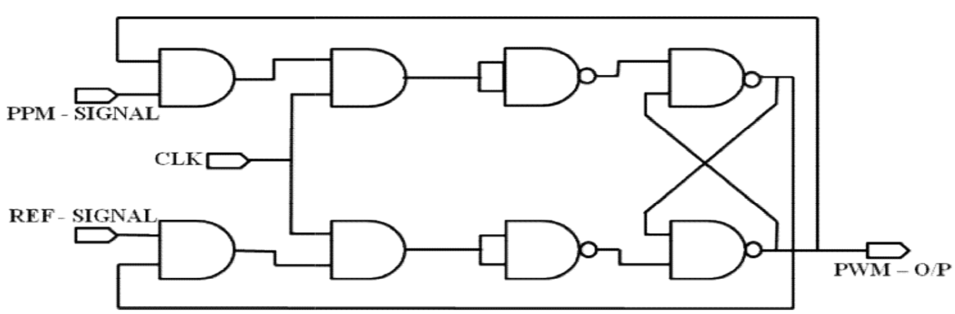
Note: The main problem in this experiment will be in triggering the oscilloscope to observe the waveforms, especially PPM



PWM Modulator:

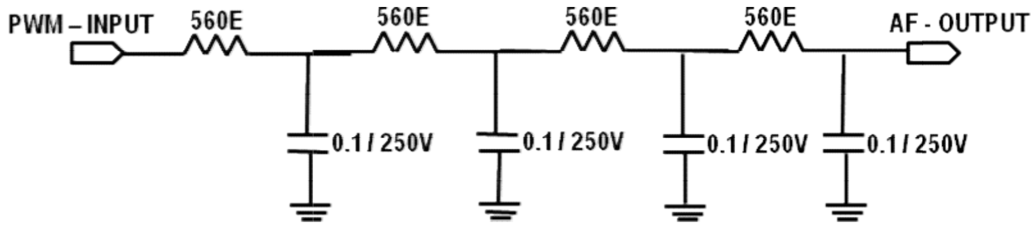


PWM – PPM (Monostable)



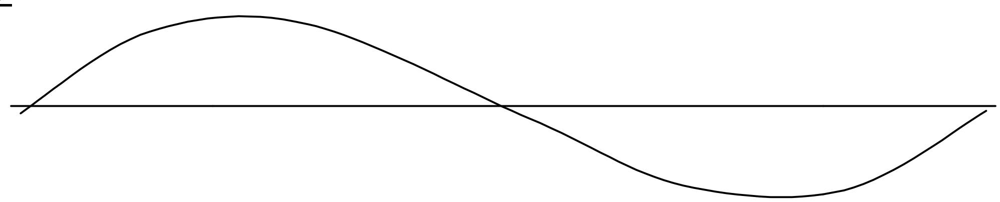
PPM – PWM (JK Flip-Flop)

PWM Demodulator:



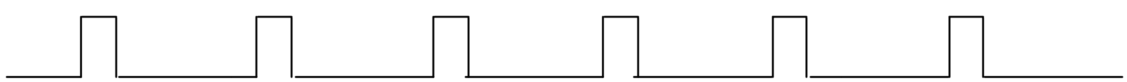
Input & output Wave forms:

AF Signal



PWM Output

PPM Output



7. RADIO RECEIVER MEASUREMENTS - SENSITIVITY & FIDELITY

AIM: To study the Radio receiver measurements i.e sensitivity, selectivity &fidelity

APPARATUS REQUIRED: Superhetrodyne receiver kit, connecting leads.

CIRCUIT DIAGRAM:

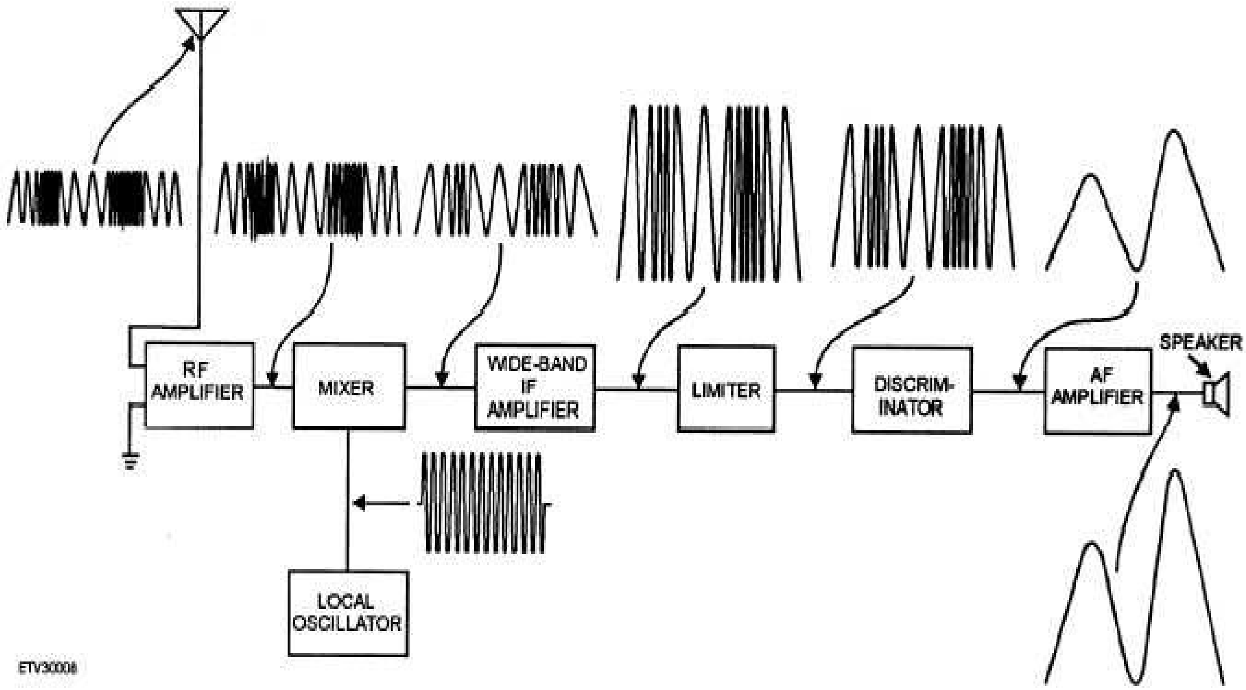


Fig. SUPERHETERODYNE RECEIVER

Theory:-

SUPERHETERODYNE RECEIVER The super heterodyne receiver was developed to overcome the disadvantages of earlier receivers. A block diagram of a representative super heterodyne receiver is shown in fig. Super heterodyne receivers may have more than one frequency-converting stage and as many amplifiers as needed to attain the desired power output. FM and AM receivers function similarly. However, there are important differences in component construction and circuit design because of differences in the modulating techniques. Comparison of block diagrams shows that electrically there are two sections of the FM receiver that differ from the AM receiver: the discriminator (detector) and the accompanying limiter. FM receivers have some advantages over AM receivers.

During normal reception, FM signals are static- free, while AM is subject to cracking noise and whistles. Also, FM provides a much more realistic reproduction of sound because of the increased number of sidebands.

PROCEDURE:

1. Connections are made as shown in the circuit diagram.
2. Ensure the Radio Receiver is in MW band.
3. Adjust the modulation index of AM signal at 30 % & fm = 400 Hz.
4. Let the receiver be tuned to 800 KHz. (can be anywhere between 540 KHz 1450 KHz).
5. Keeping the carrier frequency of the AM signal at 800 KHz, observe the demodulated signal.

Selectivity: -

The ability to reject adjacent unwanted signals. The spacing between the carrier frequencies allocated to different transmitters is limited by the available frequency spectrum. e.g. 9 kHz for broadcast in the medium waveband. The selectivity of a receiver is its ability to reject signals at carrier frequencies adjacent to the wanted carrier frequency. In the super heterodyne receiver see later) the selectivity is mainly determined by the gain versus frequency characteristics of the IF amplifier. The adjacent channel ratio is the ratio, in decibels of the input voltages at the wanted and adjacent channel signal frequencies necessary to produce the same output power.

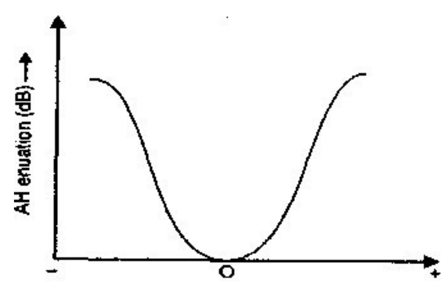


Fig. 5

PROCEDURE:

1. Connections are made as shown in the circuit diagram.
2. Ensure the Radio Receiver is in MW band.
3. Adjust the modulation index of AM signal at 30 % & fm = 400 Hz.
4. Let the receiver be tuned to 800 KHz. (can be anywhere between 540 KHz 1450 KHz).
5. Keeping the carrier frequency of the AM signal at 800 KHz, observe the demodulated signal.
6. changing the carrier frequency at 805, 810, 815 and 795, 790, 785 KHz.
7. Plot a graph of carrier frequency of AM signal Vs the amplitude of the output signal (Vo Vsfc).

Sensitivity: -

The ability to receive very small signals and produce an output of satisfactory signal to noise ratio. Usually expressed as the minimum input *signal (generally in micro volts), modulated at 400 Hz required to produce 50 mW* output power with a signal to noise ratio of 15 dB It is necessary to

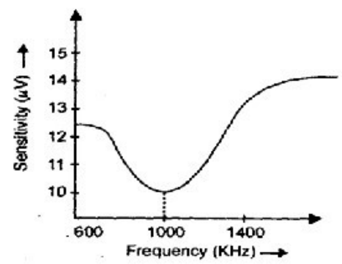


Fig. 4

include a signal to noise in the measurement of sensitivity because it would otherwise be possible for the output power to consist mainly of noise.

PROCEDURE:

1. Connections are made as shown in the circuit diagram.
2. Ensure the Radio Receiver is in MW band.
3. Adjust the modulation index of AM signal at 30 % & fm = 400 Hz.
4. Let the receiver be tuned to 800 KHz. (can be anywhere between 540 KHz 1450 KHz).
5. Keeping the carrier frequency of the AM signal at 800 KHz, observe the demodulated signal.
6. Vary the amplitude of the AM signal to get a standard value of output voltage (Volts). All the other parameters are kept constant (i.e., fc, fm, m).Note the change in the amplitude of the output signal.
7. Plot a graph of amplitude of input signal v/s carrier frequency of AM signal (Vi v/s fc).

Fidelity: -

The ability to preserve the exact shape of the information envelope of the carrier while the signal progresses through the receiver circuits

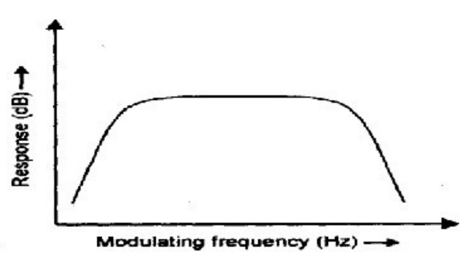


Fig. 6

PROCEDURE:

1. Connections are made as shown in the circuit diagram.
2. Ensure the Radio Receiver is in MW band.
3. Adjust the modulation index of AM signal at 30 % & fm = 400 Hz.
4. Let the receiver be tuned to 800 KHz. (can be anywhere between 540 KHz 1450 KHz).
5. Keeping the carrier frequency of the AM signal at 800 KHz, observe the demodulated signal.
6. Vary the frequency of the modulating signal keeping all other parameters constant (i.e., fc, VAM, m). Note the change in the amplitude of the outputsignal.
7. Plot a graph of amplitude of output signal Vs frequency of the modulating signal (Vo Vsfm).

RESULT:

8. MEASUREMENT OF HALF POWER BEAM WIDTH AND GAIN OF A HALF WAVE DIPOLE ANTENNA

AIM: to measure the half power beam width and gain of a half wave dipole antenna.

EQUIPMENT:

1) Transmitter antenna .
2) Receiver antenna.
3) AMS(antenna measurement system).

THEORY:

HALF POWER BEAM WIDTH:

In a radio antenna pattern , the half power beam width is the angle between the half power (-30dB)points of the main lobe ,when referenced to the peak effective radiated power of the main lobe .see beam diameter. Beam width is usually but not always expressed in the degreeand for the horizontal plane .

HALF WAVE DIPOLE ANTENNA:

the half wave dipole is a half wave length long .this is the shortest resonantlength the can be used for a resonant dipole .it also has a very convenient radiation pattern neglecting electrical inefficiency ,the antenna gain is equal to the directive gain.

CIRCUIT DIAGRAM:

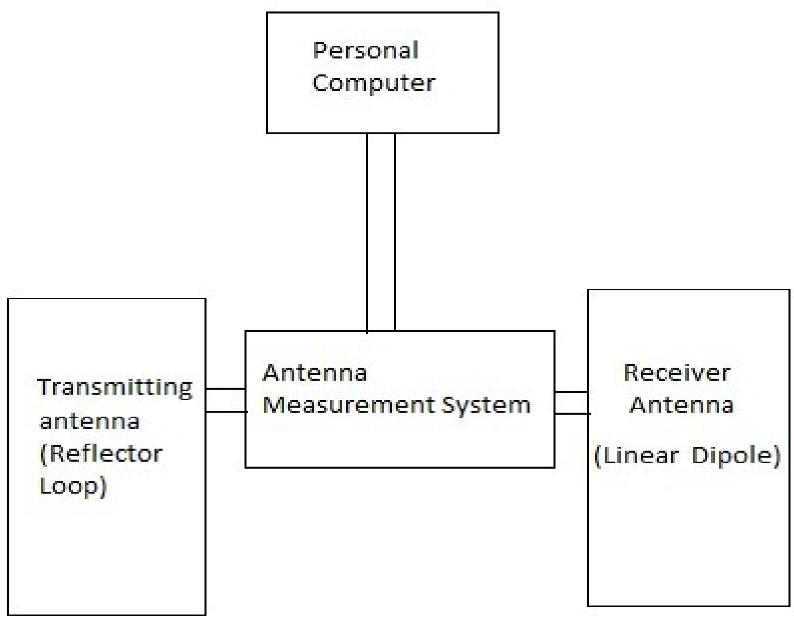
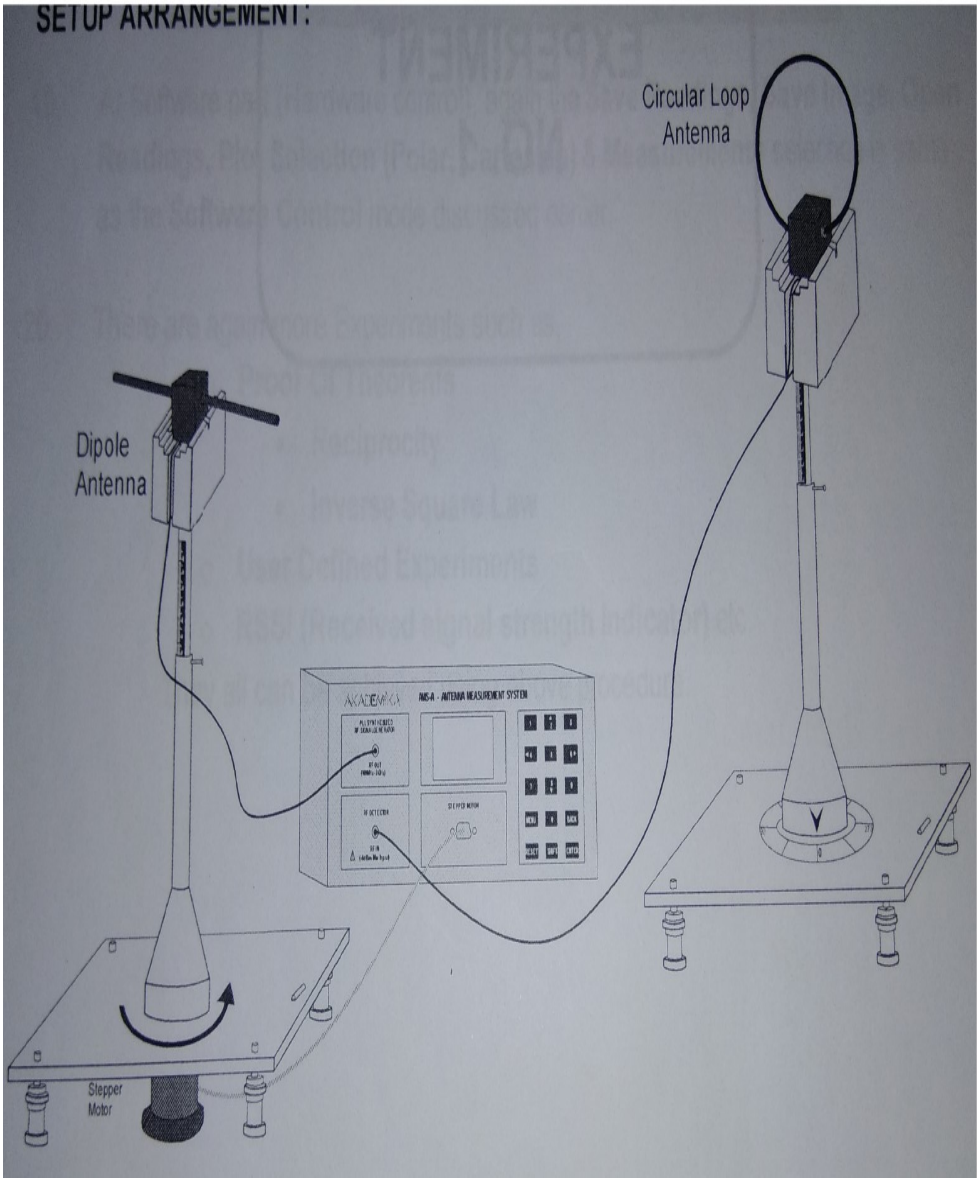
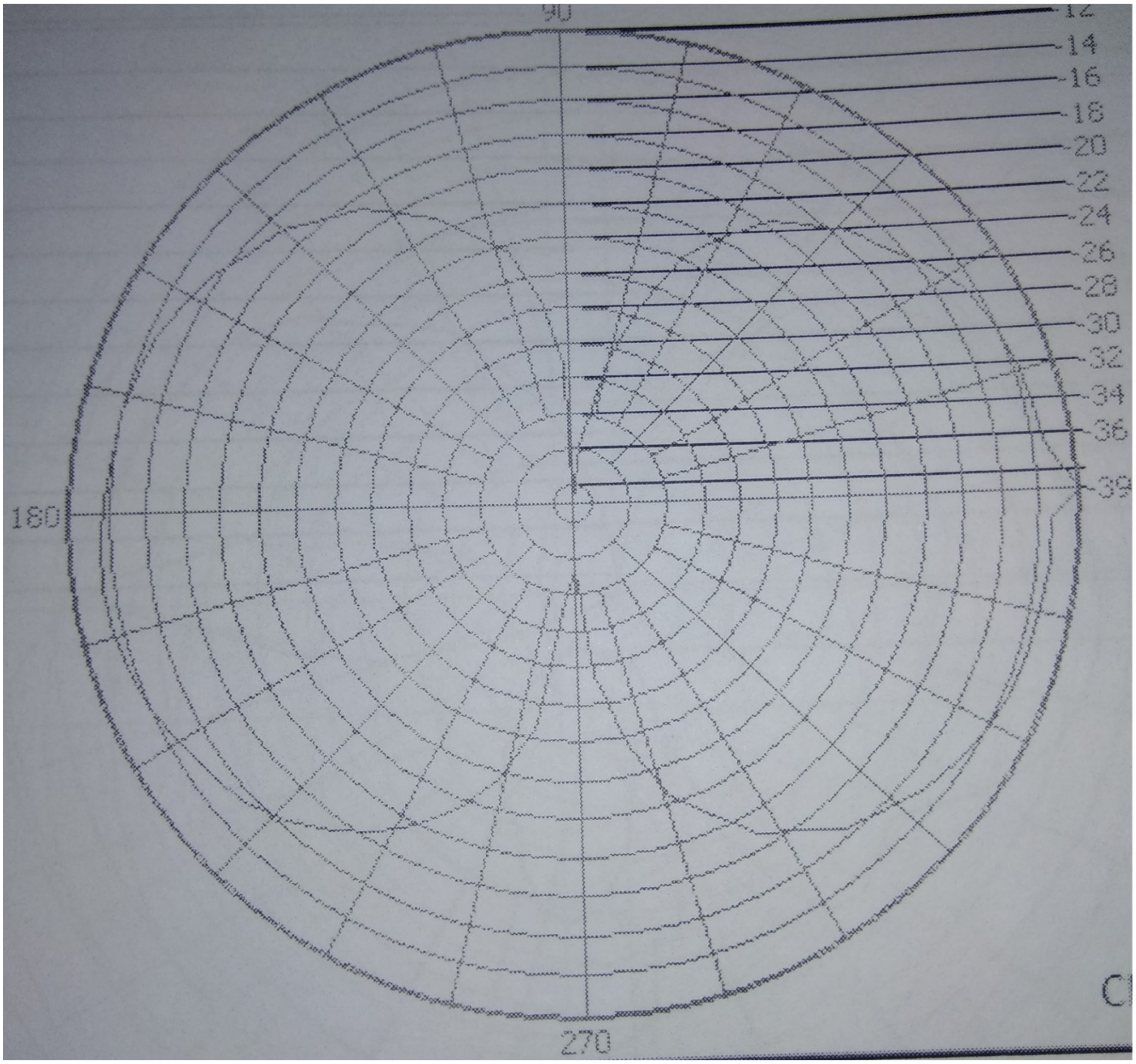


FIG: CIRCUIT DIAGRAM OF RADIO RECEIVER


SETUP ARRANGEMENT:
Circular Loop Antenna
Dipole Antenna
AMS-A - ANTENNA MEASUREMENT SYSTEM
Stepper Motor

WAVE FORMS:

RADIATION PATTERN



PROCEDURE:

1) Firstly turn on the PC and AMS.
2) Press menu and then press menu to select PC mode
3) Double click on AMS in PC and process enter in AMS .
4) In AMS (PC),go to file and select control and then select PC.

5) Select COM& part and then click on ok button.
6) Select main experiment for far field pattern .
   A) Experiment --------- copolarisation.
   B) Type of antenna------linear dipole.
   C) Name of RX antenna----- wire.
7) Then go for a start option
8) After radiation of receiver antenna ,go to measurement and then selectappropriate parameter.

PRECAUTIONS:

Set transmitting antenna and receiving antenna with o® inclination and connect them to RF generator and RF detector.

RESULT:

9. MEASUREMENT OF THE RADIATION PATTERN OF A LOOP ANTENNA IN PRINCIPAL AXIS

AIM: To measure the radiation pattern of a loop antenna in the principal axis.

APPARATUS:

1) Antenna me measurements system
2) Personal computer
3) Transmitter antenna
4) Rectangular loops receiving antenna

CIRCUIT DIAGRAM:

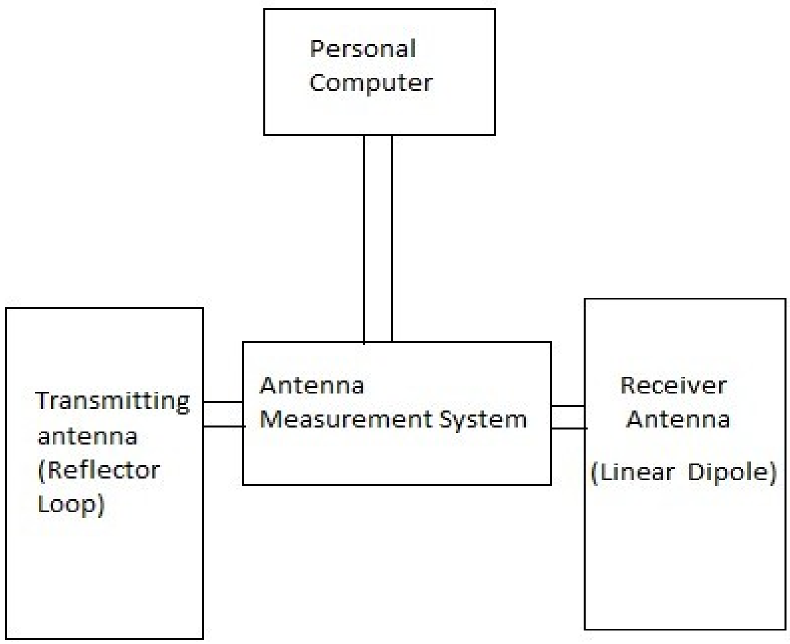
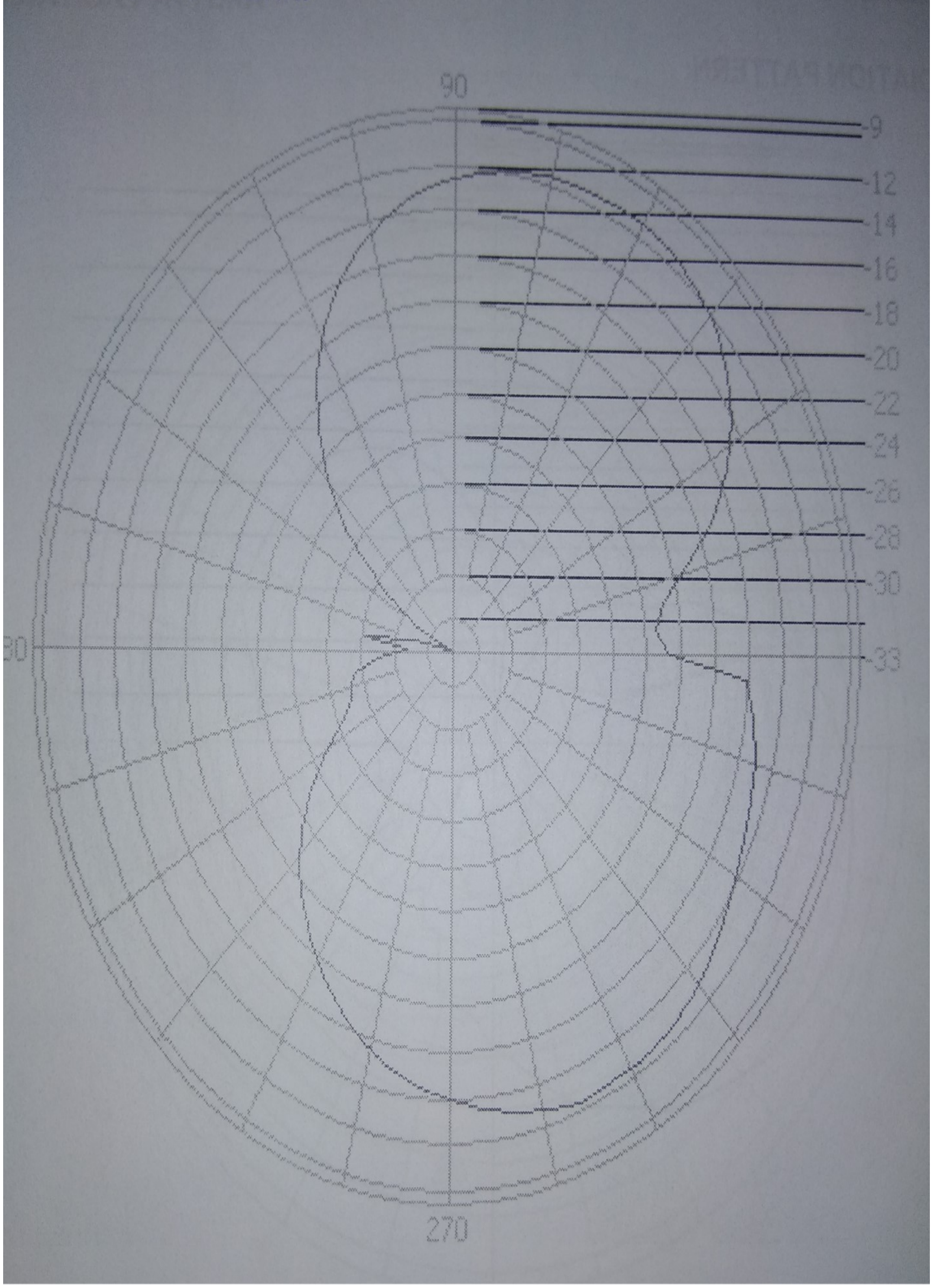
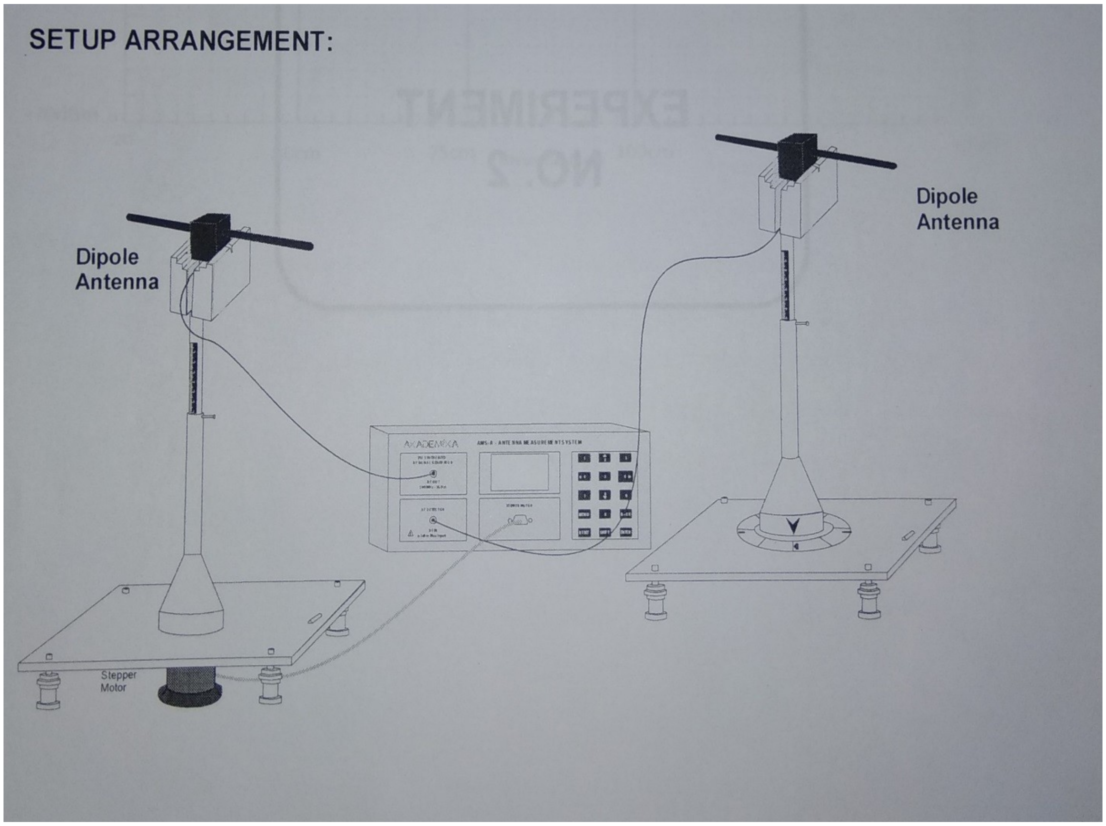


FIG: CIRCUIT DIAGRAM OF RADIO RECEIVER

RADIATION PATTERN:





PROCEDURE:

1) Turn on the personal computer and AMS
2) Press menu in AMS and then select PC
3) Now double click on AMS software in PC and press enter in AMS
4) Select com 8 part and then click on ok button.
5) Select main experiment –far field pattern.
   D) Experiment ------------ ----- copolarisation
   E) Type of antenna---------.---- wire
   F) Name of RX antenna ---. linear dipole

9) Then go for a start option
10) After radiation of receiver antenna ,go to measurement and then select appropriateparameter.

PRECAUTIONS:

Set transmitting antenna and receiving antenna with o® inclination and connect them to RF generator and RF detector.

RESULT: Hence the measurement of bandwidth pattern of a loop antenna in principalaxis has been verified.

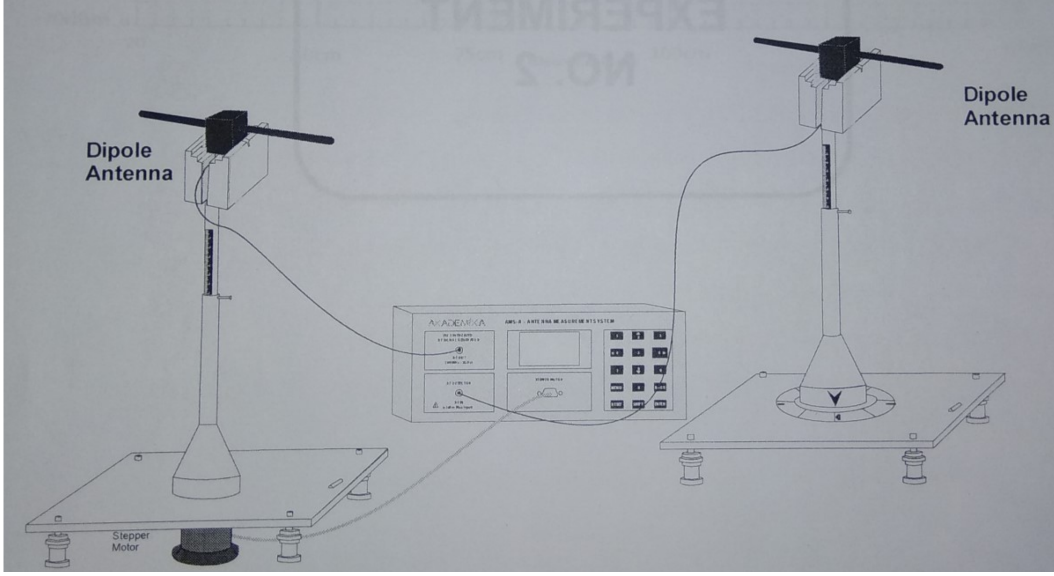
OBJECTIVE

To demonstrate that the transmitting and receiving radiation patterns of an antenna are equal and hence confirm the reciprocity theorem of antennas.

EQUIPMENT REQUIRED:

TX antenna	RX antenna	Transmitter input	Receiver output	Cable
Dipole RMSA	Dipole RMSA	Source (RF out)	Detector (RF input)	SMA To SMA cable
QTY =1	QTY =1	QTY =1	QTY =1	QTY =2

SETUP ARRANGEMENT:



RESULT:

INTRODUCTION TO MATLAB

The name MATLAB stands for matrix laboratory. MATLAB® is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation.MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar noninteractive language such as C or Fortran.

Typical uses include

- Math and computation
- Algorithm development
- Data acquisition
- Modeling, simulation, and prototyping
- Data analysis, exploration, and visualization
- Scientific and engineering graphics
- Application development, including graphical user interface building

To start MATLAB on a Microsoft Windows platform, select the Start -> Programs -> MATLAB 7.0.1 -> MATLAB 7.0.1, or double-click the MATLABshortcut icon on your Windows desktop. The shortcut was automatically created when you installed MATLAB. If you have trouble starting MATLAB, see troubleshooting information in the Installation Guide for Windows.

When you start MATLAB, it displays the MATLAB desktop, a set of tools (graphical user interfaces or GUIs) for managing files, variables, and applications associated with MATLAB.

Working with Matlab:

In MATLAB, a matrix is a rectangular array of numbers. Special meaning is sometimes attached to 1-by-1 matrices, which are scalars, and to matrices with only one row or column, which are vectors. MATLAB has other ways of storing both numeric and nonnumeric data, but in the beginning, it is usually best to think

of everything as a matrix. The operations in MATLAB are designed to be as natural as possible. Where other programming languages work with numbers one at a time, MATLAB allows you to work with entire matrices quickly and easily.

To do work in MATLAB, you type commands at the command prompt. Often these commands will look like standard arithmetic. Or function calls similar to many other computer languages. By doing this, you can assign sequences to variables and then manipulate them many ways. You can even write your own functions and programs using MATLAB's control structures. The following sections will describe the most commonly used commands on MATLAB and give simple examples using them.

Expressions:

Like most other programming languages, MATLAB provides mathematical expressions, but unlike most programming languages, these expressions involve entire matrices. The building blocks of expressions are

- ❖ Variables
- ❖ Numbers
- ❖ Operators

Variables:

MATLAB does not require any type declarations or dimension statements. When MATLAB encounters a new variable name, it automatically creates the variable and allocates the appropriate amount of storage. If the variable already exists, MATLAB changes its contents and, if necessary, allocates new storage.Variable names consist of a letter, followed by any number of letters, digits, or underscores. MATLAB uses only the first 31 characters of a variable name. MATLAB is case sensitive; it distinguishes between uppercase and lowercase letters. A and a are not the same variable. To view the matrix assigned to any variable, simply enter the variable name.

You can assign the values to variables by typing in equations. For example, if you type

```
>>x=5
```

MATLAB creates a 1-by-1 matrix named xand stores the value 5 in its single element. The output produced by the MATLAB

```
x =
     5
```

MATLAB uses ans for any expression you don't assign to a variable. For instance, if you type

```
>> 5
```

to MATLAB, MATLAB will

returnans =

5

and assign the value 5 to the variable ans. Thus, ans will always be assigned tothe most recently calculated value you didn't assign to anything else.

Numbers:

MATLAB uses conventional decimal notation, with an optional decimal point and leading plus or minus sign, for numbers. Scientific notation uses the letter e to specify a power-of-ten scale factor. Imaginary numbers use either i or j as a suffix. Some examples of legal numbers are

3 -99 0.0001

9.6397238 1.60210e-20 6.02252e23

1i -3.14159j 3e5i

All numbers are stored internally using the long format specified by the IEEE floating-point standard. Floating-point numbers have a finite precision of roughly 16 significant decimal digits and a finite range of roughly 10-308 to 10+308.

Operators:

Expressions use familiar arithmetic operators and precedence rules.

Symbol	Operation
+	Addition
-	Subtraction
*	Multiplication
/	Division
\	Left division
^	Power
'	Complex conjugate transpose
( )	Specify evaluation order

>>x= 1:4will return

x =

1 2 3 4

You can optionally give the colon a step size. For instance,

>>x=8:-1:5 will give

x =

8 7 6 5

and

>> x = 0:0.25: 1.25will returnx

=

0 0.25 0.5 0.75 1.0 1.25

The colon is a subtle and powerful operator, and we'll see more uses of it later.

Flow Control:

MATLAB has several flow control constructs:if,

else, and elseif

switch and case

for

while etc… …

if, else, and elseif:

The if statement evaluates a logical expression and executes a group of statements when the expression is true. The optional elseif and else keywords provide for the execution of alternate groups of statements. An end keyword, which matches the if, terminates the last group of statements. The groups of statements are delineated by the four keywords -- no braces or brackets are involved.

The basic command looks like if a > 0

x=a^2;

end

This command will assign x to be the value of a squared, if a is positive. Again, note that it has to have an end to indicate which commands are actuallypart of the if. In addition, you can define an else clause which is executed if thecondition you gave the if is not true. We could expand our example above to be if a>0

x = a^2;

else

x = -a^2

end

For this version, if we had already set a to be 2, then x would get the value 4, but if a was -3, x would be -9. Note that we only need one end, which comes after all the clauses of the if. Finally, we can expand the if to include several possible conditions. If the first condition isn't satisfied, it looks for the next, and so on, until it either finds an else, or finds the end. We could change our example to get

```
if a>0
        x
 =
a^2;
else if
a == 0


elseend
```

x = i;

x = -
a^2

For this command, it will see if a is positive, then if a is not positive, it will check if a is zero, finally it will do the else clause. So, if a positive, x will be a squared, ifa is 0, x will be i, and if a is negative,
then x will be the negative of a squared. Again, note we only have a single end after all the clauses.

For:

The for loop repeats a group of statements a fixed, predetermined number oftimes. A matching end delineates the statements.
. It is functionally very similar to the for function in C. For example, typingfor i=
1:4
end
will cause MATLAB to make the variable i count from 1 to 4, and print its valuefor each step. So, you would see
i = 1
i = 2
i = 3
i = 4
Every command must have a matching end statement to indicate which commands should be executed several times. You can have nested for loops. For example, typing

```
Form = 1:3
        for n= 1:3
                x(m,n)=m+n*i;
  end
end
```

will define x to be the matrixx
=

1.0000 + 1.0000i   1.0000 + 2.0000i   1.0000 + 3.0000i
2.0000 + 1.0000i   2.0000 + 9.0000i   2.0000 + 3.0000i
3.0000 + 1.0000i   3.0000 + 2.0000i   3.0000 + 3.0000i

The indentations in the for structure are optional, but they make it easier to figureout what the commands are doing.

While:

The while command allows you to execute a group of commands untilsome condition is no longer true. These commands appear between the while and its matching end statement. For instance, if we want to keep squaring x until it is greater than a million,

we would type

```
while x < 1000000
        x = x^2;
end
```

Scripts and Functions:

MATLAB is a powerful programming language as well as an interactive computational environment. Files that contain code in the MATLAB language are called M-files. You create M-files using a text editor, then use them as you would any other MATLAB function or command.

There are two kinds of M-files: Scripts, which do not accept input arguments or return output arguments. They operate on data in the workspace. Functions, which can accept input arguments and return output arguments. Internal variables are local to the function.

Scripts:

When you invoke a script, MATLAB simply executes the commands found in the file. Scripts can operate on existing data in the workspace, or they can create new data on which to operate. Although scripts do not return output arguments, any variables that they create remain in the workspace, to be used in subsequentcomputations.

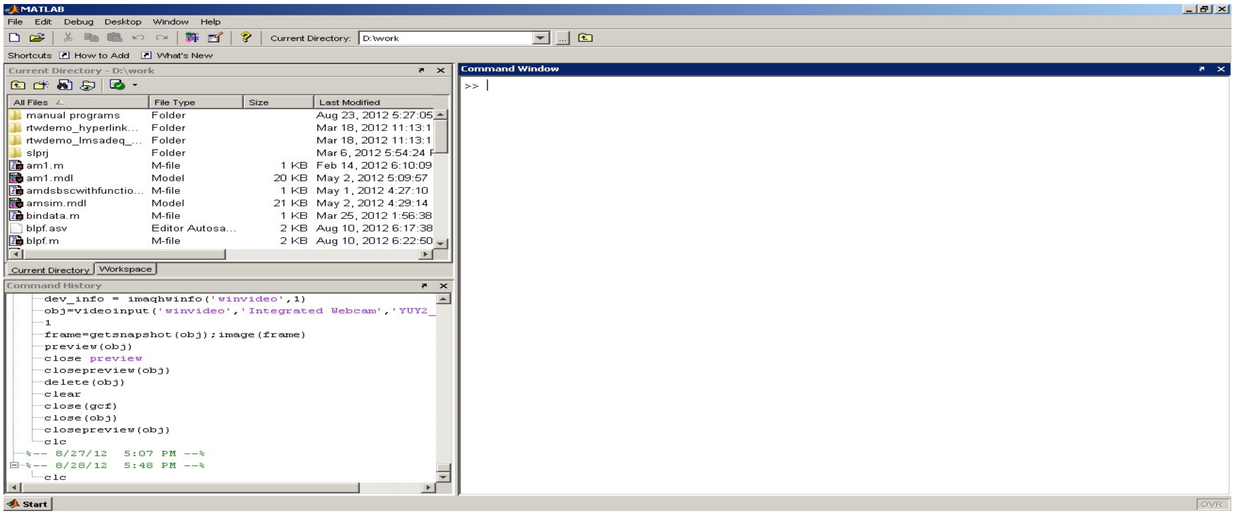
Functions:

Functions are M-files that can accept input arguments and return output arguments. The names of the M-file and of the function should be the same. Functions operate on variables within their own workspace, separate from the workspace you access at the MATLAB command prompt.

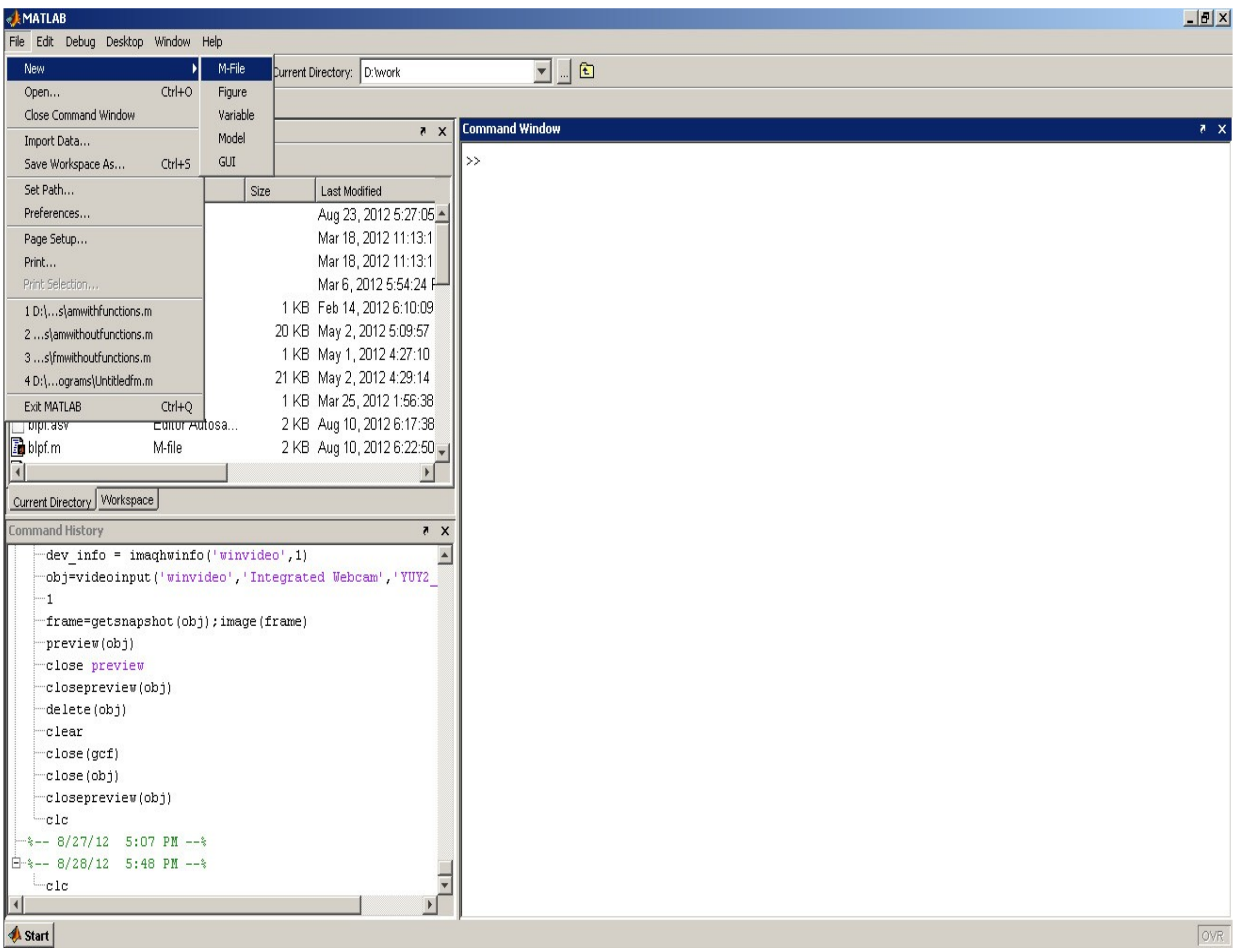
Procedure:

1. Open the MATLAB® software by double clicking its icon.

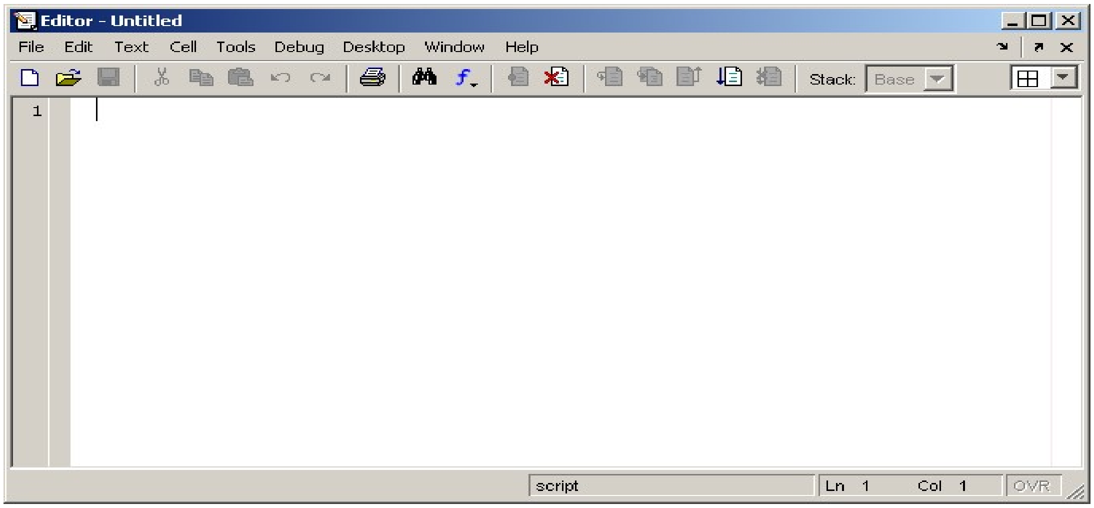
2. MATLAB® logo will appear and after few moments Command Prompt will appear.



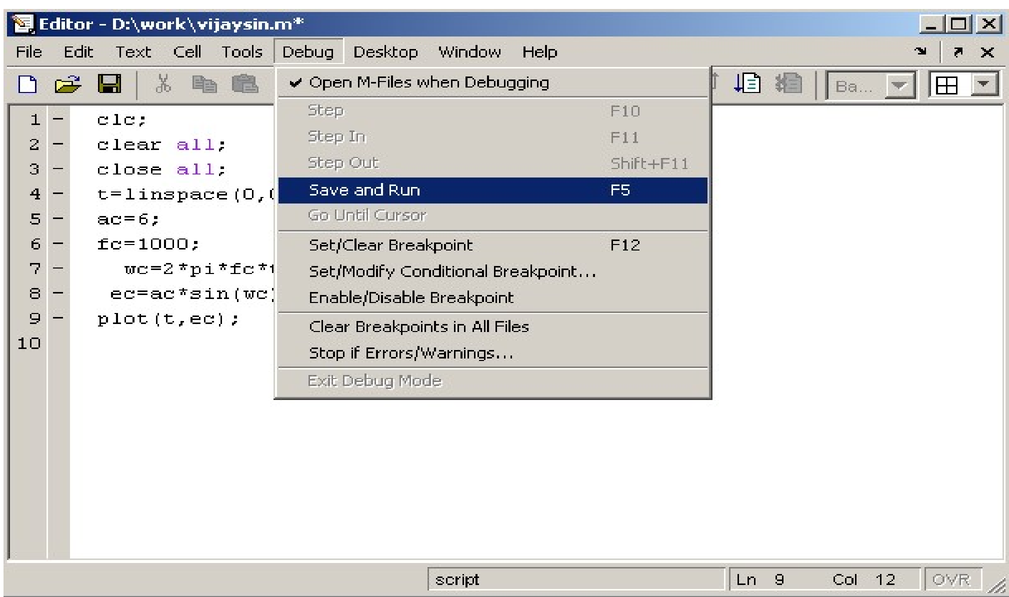
Go to the File Menu and select a New M- file. (File ?New?M-file) or in the left hand corner a blank white paper icon will be there. Click it once



3. A blank M- file will appear with a title ‘untitled’



1. Now start typing your program. After completing, save the M- file with appropriate name. Toexecute the program Press F5 or go to Debug Menu and select Run.



2. After execution output will appear in the Command window .If there is an errorthen with an

alarm, type of error will appear in red color.

3. Rectify the error if any and go to Debug Menu and select Run.

AMPLITUDE MODULATION AND DEMODULATION

AIM:

A. To generate the amplitude modulated signal(AM wave) by using given message signal and carrier signals in MATLAB software
B. To demodule the AM wave using envelope detector principle

Hardware and software requirements:

Personal computer(PC)

MATLAB Software 7.0.4

Theory:

In amplitude modulation, the amplitude of the carrier voltage varies in accordance with the instantaneous value of modulating voltage. Let the modulating voltage be given by expression,

$Vm = V_m \cos w_m t$

Where wm is angular frequency of the signal &Vm is the amplitude. Let the carriervoltage be given by expression,

$Vc = V_c \cos w_c t$

On Amplitude Modulation, The instantaneous value of modulated carrier voltage is given by,

$$V = V(t) \cos w_c t$$

$$V(t)=V_c + kaV_m \cos w_m t$$

$$V=V_c[1+ ma \cos w_m t] \cos w_c t$$

Where ma is modulation index and the modulation index is defined as the ratio ofmaximum amplitude of modulating signal to maximum amplitude of carrier signal.

$$ma= V_m / V_c$$

The demodulation circuit is used to recover the message signal from the incoming AM wave at the receiver. An envelope detector is a simple and yet highly effective device that is well suited for the demodulation of AM wave, for which the percentage modulation is less than 100%.Ideally, an envelop detector produces an output signal that follows the envelop of the input signal wave form

exactly; hence, the name. Some version of this circuit is used in almost allcommercial AM radio receivers.

PROGRAM:

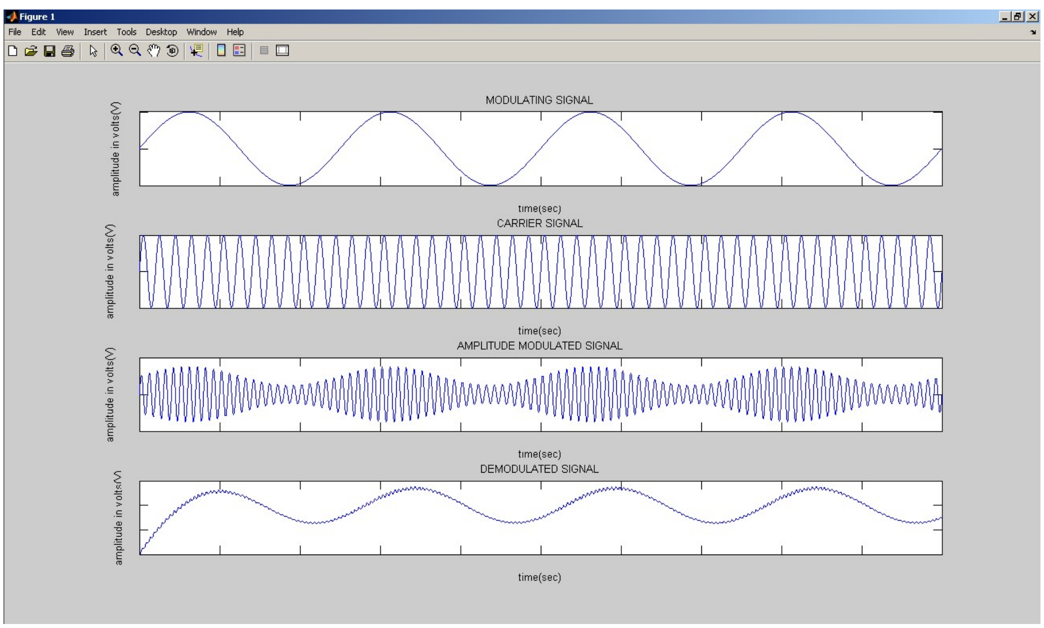
AM without functions:

```
clc
clearall
closeall
t=linspace(0,0.02,10000);%defining time range for the signalfc=5000;%frequency
of carrier signal
fm=200;%frequency of message signaql
fs=40000;%sampling frequency------------ fs>=2(fc+BW)
Am=5;%amplitude of the message signal Ac=10;%amplitude of
the carrier signal m=Am/Ac%modulation index for the AM wave
wc=2*pi*fc*t;%carrier frequency in radians
wm=2*pi*fm*t;%message frequency in radians
ec=Ac*sin(wc);%carrier signal
em=Am*sin(wm);%messagesignal
y=Ac*(1+m*sin(wm)).*sin(wc);%amplitude modulated signal
 z=y.*ec;                              %in synchronous detection the AM signal is
multiplied with carrier signal and passed through LPF
 z1=conv(z,exp(-t/0.000795));% the LPF filter response in time domain  is givenby exp(-
t/RC), the cut off frequency for filter should be fm=200
%F=1/(2*pi*R*C), replacing F=200, and
%assuming R=1k ohm then C=0.795MICROFARAD
%so RC=0.000795
%we will get the demodulated signal by convolving the AM signal with LPFresponse
l=10000;
subplot(4,1,1),plot(t(1:l),em(1:l))
```

```
xlabel('time(sec)');
ylabel('amplitude in volts(V)');
title('MODULATING SIGNAL');
subplot(4,1,2),plot(t(1:l/2),ec(1:l/2))
xlabel('time(sec)'); ylabel('amplitude
in volts(V)'); title('CARRIER
SIGNAL');
subplot(4,1,3),plot(t(1:l),y(1:l))
xlabel('time(sec)');
ylabel('amplitude in volts(V)');
title('AMPLITUDE MODULATED SIGNAL');

subplot(4,1,4),plot(t(1:l),z1(1:l))
xlabel('time(sec)');
ylabel('amplitude in volts(V)');
title('DEMODULATED SIGNAL');
```

Model Waveforms:



AM with functions:

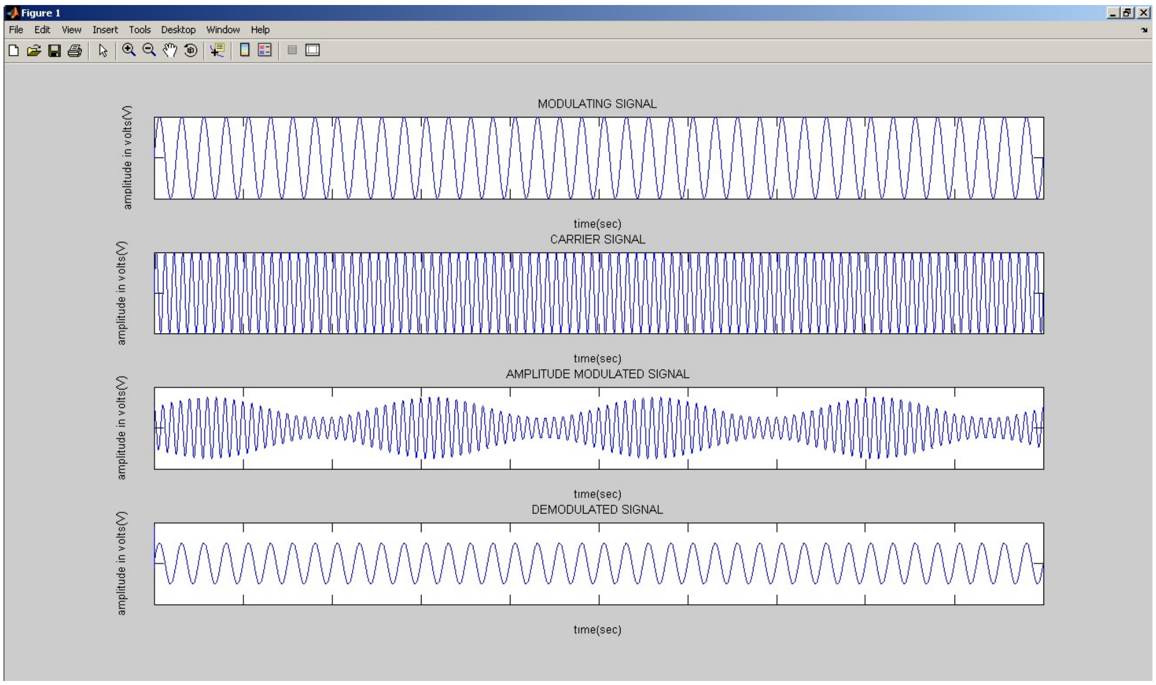
```
clc
clearall
closeall
t=linspace(0,0.2,100000);%defining time range for the signalfc=1000;%frequency
of carrier signal
fm=200;%frequency of message signal
fs=100000;%sampling frequency------------ fs>=2(fc+BW)
Am=5;%amplitude of the message signal Ac=10;%amplitude of
the carrier signal m=Am/Ac%modulation index for the AM wave
wc=2*pi*fc*t;%carrier frequency in radians
wm=2*pi*fm*t;%message frequency in radians
ec=Ac*sin(wc);%carrier signal
em=Am*sin(wm);%messagesignal
y=ammod(em,fc,fs,0,Ac);%amplitude modulated signal
z=amdemod(y,fc,fs,0,Ac);%demodulated AM signal l=100000;
subplot(4,1,1),plot(t(1:l),em(1:l))
xlabel('time(sec)');
ylabel('amplitude in volts(V)');
title('MODULATING SIGNAL');
subplot(4,1,2),plot(t(1:l/2),ec(1:l/2))
xlabel('time(sec)'); ylabel('amplitude
in volts(V)'); title('CARRIER
SIGNAL');

subplot(4,1,3),plot(t(1:l),y(1:l))
axis([0 0.02 -20 20])%setting axis dimensions
xlabel('time(sec)');
ylabel('amplitude in volts(V)');
```

```
title('AMPLITUDE MODULATED SIGNAL');

subplot(4,1,4),plot(t(1:l),z(1:l))
xlabel('time(sec)');
ylabel('amplitude in volts(V)');
title('DEMODULATED SIGNAL');
```

Model Waveforms:



Result:

FREQUENCY MODULATION AND DEMODULATION

AIM:

A. To generate frequency modulated signal and observe the characteristics ofFM wave using MATLAB software.
B. To demodulate a Frequency Modulated signal usingMATLAB software

Hardware and software requirements:

Personal computer(PC)

MATLAB Software 7.0.4

Theory:

Frequency modulation consists in varying the frequency of the carrier voltage inaccordance with the instantaneous value of the modulating voltage.Thus the amplitude ofthe carrier does not change due to frequency modulation. Let the modulating voltage begiven by expression:

$$V_m=V_m \cos w_m t.$$

Where $w_m$is angular frequency of the signal &$V_m$is the amplitude. Let the carriervoltage be given by expression,

$$V_c=V_c \sin(w_c t+\theta)$$

On frequency modulation, the instantaneous value of modulated carrier voltage isgiven by,

$$V_c=V_c \sin\phi, \text{ Where } \phi=w_c t+\theta;$$
$$\varphi=w_c t+k_f V_m 1/w_m \sin w_m t+\theta_1;$$

Hence the frequency modulated carrier voltage is given by,

$$V=V_c \sin[w_c t+k_f V_m/w_m \sin w_m t]$$

The modulation index is defined as the ratio of frequency deviation to frequencyof modulating signal mf=d/fm where deviation d=(fmax-fmin)/2.

FM with functions:

```
clc
clearall
closeall
Fs = 8000; % Sampling rate of signal
Fc = 100; % Carrier frequency
t = linspace(0,1,10000); % Sampling times
x = sin(2*pi*10*t) % Channel 1

dev = 50; % Frequency deviation in modulated signal
y = fmmod(x,Fc,Fs,dev); % Modulate both channels.
z = fmdemod(y,Fc,Fs,dev); % Demodulate both channels.


subplot(411),plot(t,x)
xlabel('time(sec)');
ylabel('amplitude in volts(V)');
title('MODULATING
SIGNAL');
subplot(412),plot(t,sin(2*pi*Fc*t
))xlabel('time(sec)');
ylabel('amplitude in volts(V)');
title('CARRIER SIGNAL');
subplot(413),plot(t,y)
xlabel('time(sec)');
ylabel('amplitude in
volts(V)');
title('FREQUENCY MODULATED SIGNAL');
subplot(414),plot(t,z)
xlabel('time(sec)');
ylabel('amplitude in volts(V)');
title('DEMODULATED
SIGNAL');
```

odel waveforms:

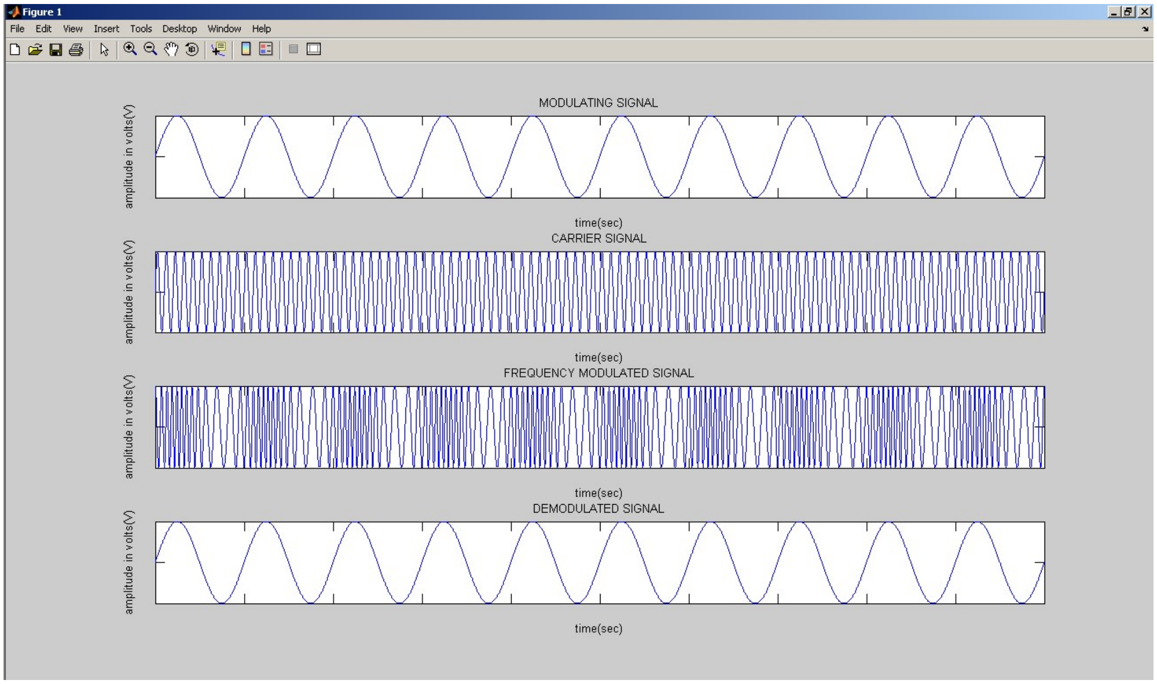


Figure 1
File Edit View Insert Tools Desktop Window Help
MODULATING SIGNAL
amplitude in volts(V)
time(sec)
CARRIER SIGNAL
amplitude in volts(V)
time(sec)
FREQUENCY MODULATED SIGNAL
amplitude in volts(V)
time(sec)
DEMODULATED SIGNAL
amplitude in volts(V)
time(sec)

Result:

1. PULSE WIDTH MODULATION

AIM: To write a MATLAB program to simulate the PWM wavefor the givenmessage signal

Hardware and software requirements:

Personal computer(PC)

MATLAB Software 7.0.4

Theory:

Pulse width modulation (PWM) encodes a signal into periodic pulses of equal magnitude but varying width. The width of a pulse at a given point in time isproportional to the amplitude of the message signal at that time. For example, the large value of the message yields a narrow pulse.

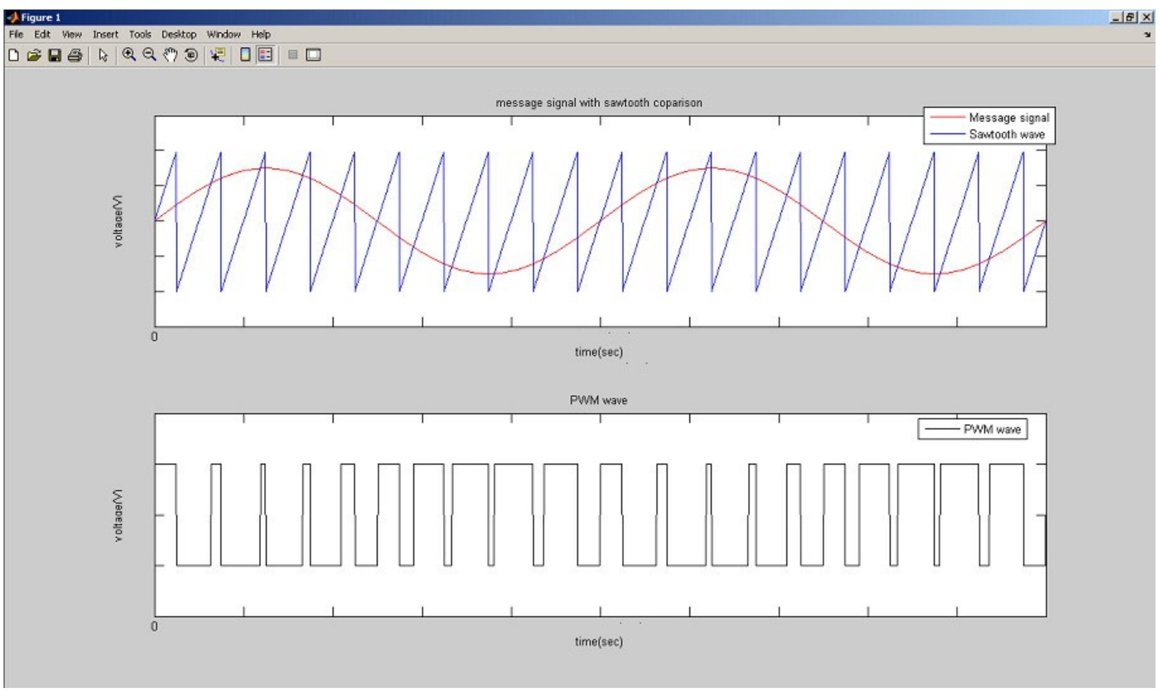
To implement the PWM, the message signal is compared with the sawtooth carrier. When the message signal is greater than the carrier, the comparator output becomes highand vice versa; the heights and lows can be represented by +1 or-1 respectively.The comparator output will be the pulse width modulated signal.

Program:

```
%PWM wave generation
clc;
clearall;
closeall;
t=0:0.001:2;
s=sawtooth(2*pi*10*t+pi);
m=0.75*sin(2*pi*1*t);
n=length(s);
for i=1:n
if (m(i)>=s(i))
pwm(i)=0;
```

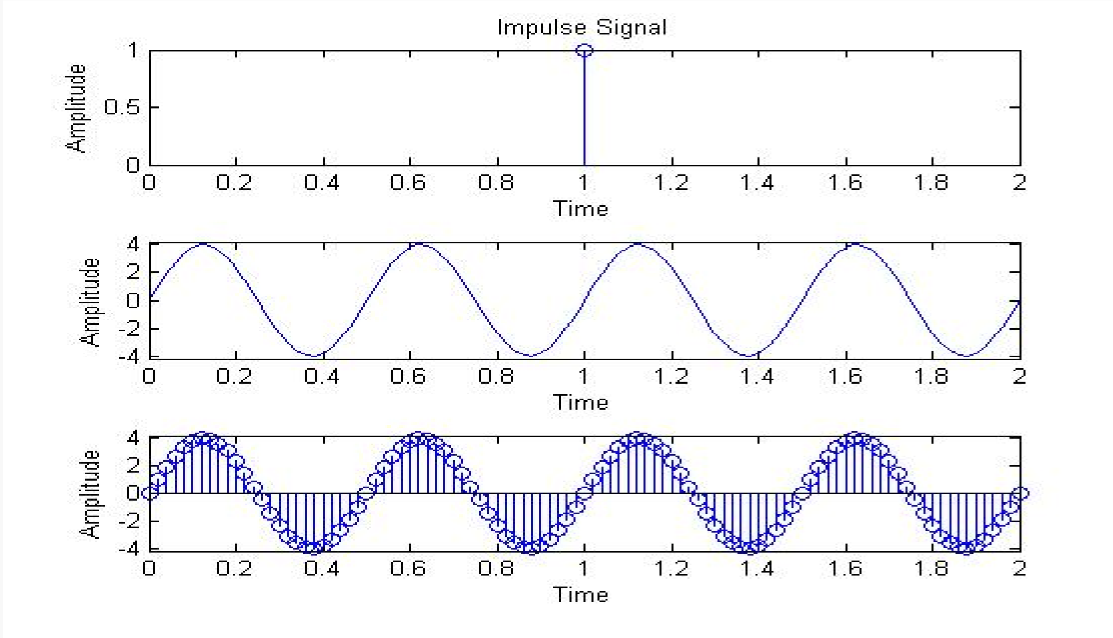
```
elseif (m(i)<=s(i))
pwm(i)=1;
endend
subplot(211),plot(t,m,'-r',t,s,'-b');axis([0 2 -1.5 1.5]);
title('message signal with sawtoothcoparison')
xlabel('time(sec)');
ylabel('voltage(V)');
subplot(212),plot(t,pwm,'-k')
axis([0 2 -0.5 1.5]);
title('PWM wave');xlabel('time(sec)');
ylabel('voltage(V)');
```

Model Waveforms:



MATLAB Code For PAM (**Pulse-amplitude modulation)**

```
% PAM using Natural Sampling
clc;
clear all;
close all;
fc= 100
fm= fc/10
fs= 100*fc
t=0:1/fs:4/fm;
Msg_sgl= cos(2*pi*fm*t);
Carr_sgl= 0.5*square(2*pi*fc*t)+0.5
Mod_sgl= Msg_sgl.*Carr_sgl;
tt= [];
for i=1:length(Mod_sgl);
    if Mod_sgl(i)==0;
        tt=[tt,Mod_sgl(i)];
    else
        tt=[tt,Mod_sgl(i)+2];
    end
end
figure(1)
subplot(4,1,1);
plot(t,Msg_sgl);
title('Message Signal');
xlabel('Time Period');
ylabel('Amplitude');
subplot(4,1,2);
plot(t,Carr_sgl);
title('Carrier Signal')
xlabel('Time Period');
ylabel('Amplitude');
subplot(4,1,3);
plot(t,Mod_sgl);
title('PAM Modulated signal')
xlabel('Time Period');
ylabel('Amplitude');
% subplot(4,1,4);
% plot(t,tt);
% title('PAM')
% xlabel('Time Period');
% ylabel('Amplitude');
```



Simulation / Generation of PAM Signal using MATLAB Code : Pulse Amplitude Modulation Using MATLAB