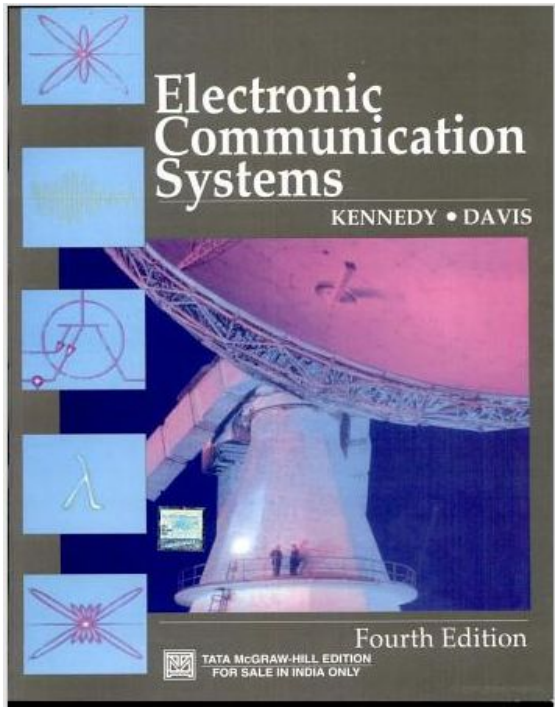
PRINCIPLES OF ELECTRONIC COMMUNICATION

Fundamentals of Analog Communication

Reference:

Electronic Communication Systems by Kennedy & Davis ,

4th edition,2004,TMH Edition



Amplitude Modulation

- OBJECTIVES:
  - *Explain the principle of electronic communication using a block diagram.*
  - *Define modulation and discuss the need for modulation.*
  - *Explain amplitude modulation using suitable waveforms, define modulation index and draw the spectrum*
  - *Derive expression for power content of AM signal.*
  - *List and describe different types of AM signal and compare them.*
  - *Explain the principle of AM demodulation process and super heterodyne receiver.*

Introduction

- What is Communication?
- What are different methods of Communication?

•*Refer history for more details*

Basic Communication System

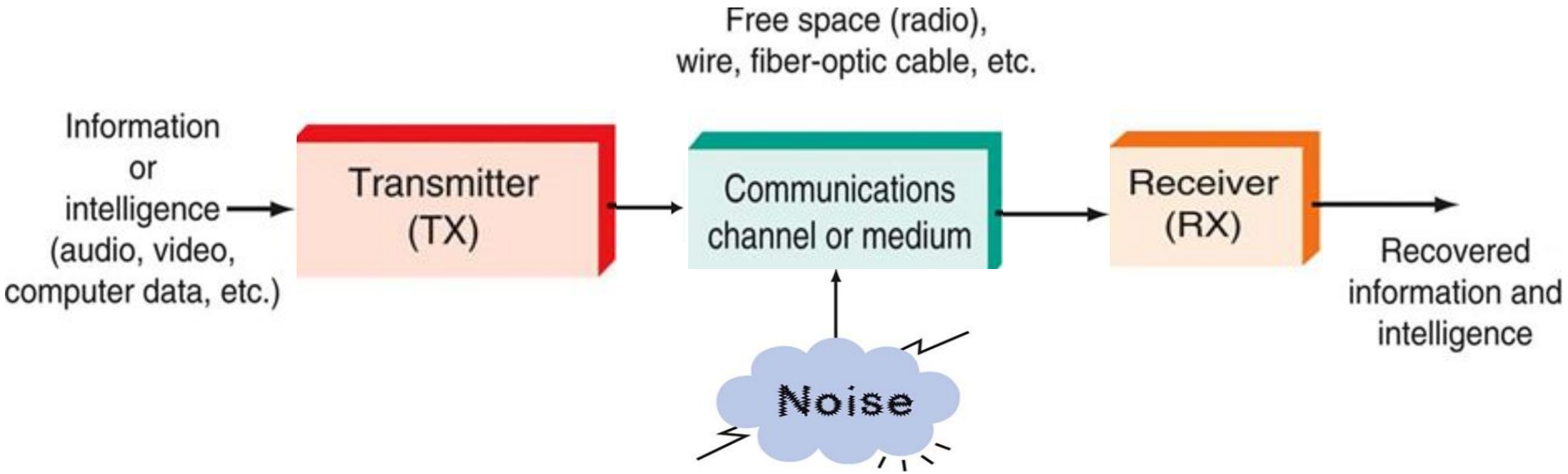


Fig.1.1 General model of a communication system

- Basic Components:
  - *Transmitter*
  - *Channel or Medium*
  - *Receiver*

Refer:Introduction.docx

Self Test

- *In a communication system, noise is most likely to affect the signal*

  a) At the transmitter

  b) In the channel

  c) In the information source

  d) At the destination

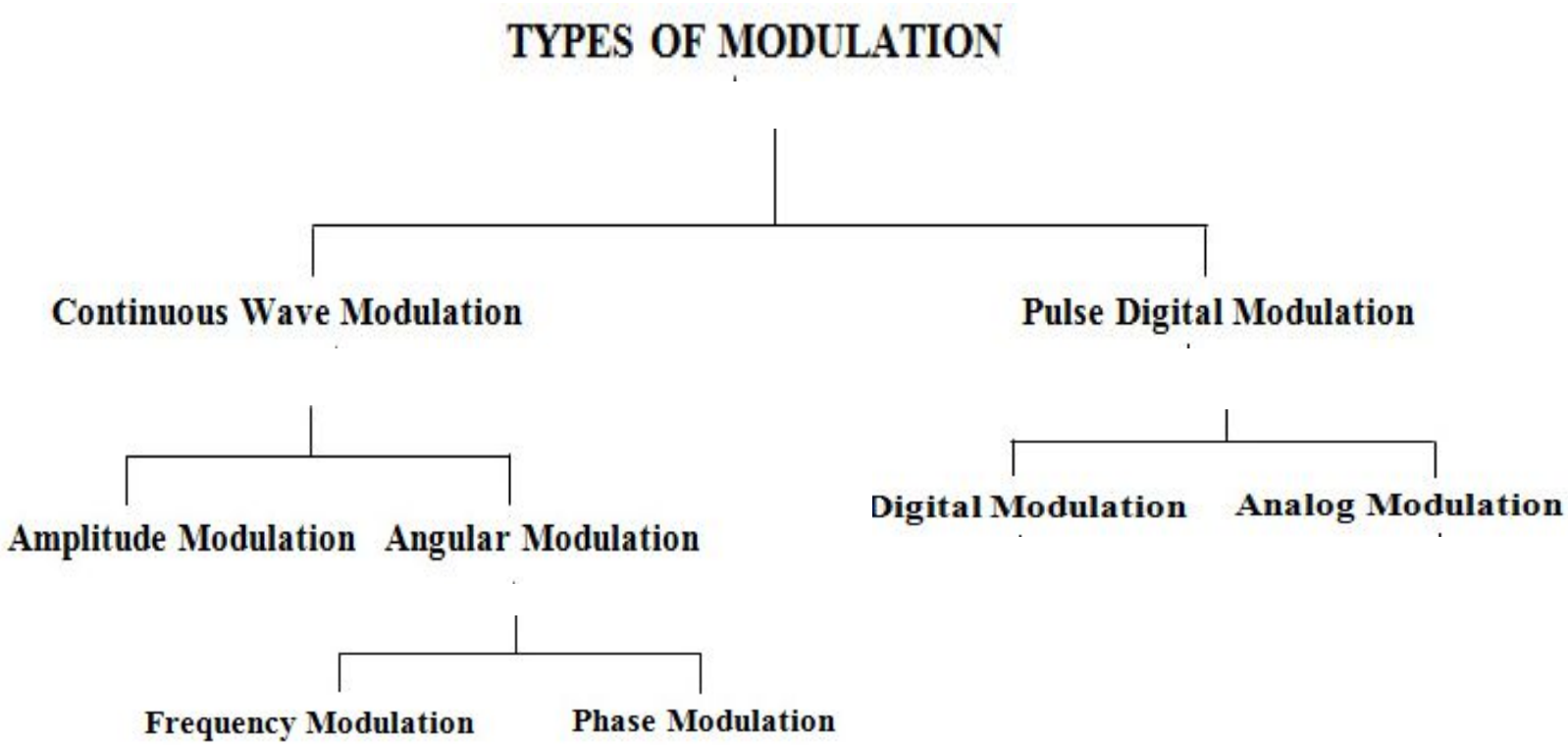
Modulation

- What is Modulation?

- Why modulation is necessary?
  - *To enable long distance communication*
  - *To reduce the height of the antenna*
  - *For multiplexing*
  - *To combat noise*

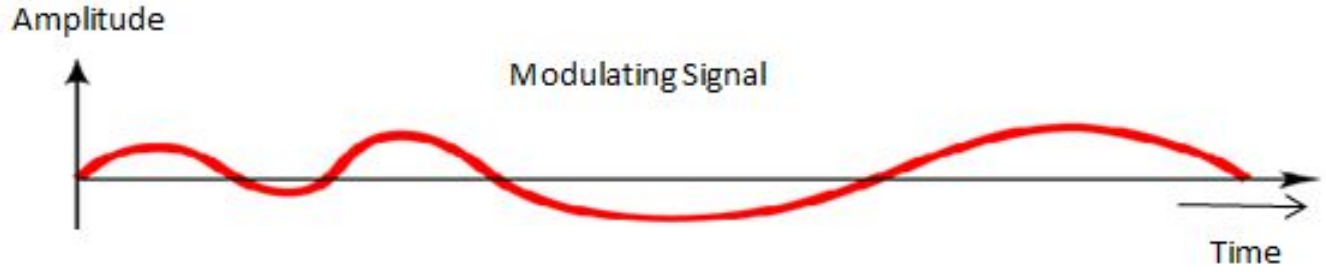
Refer*: Need for modulation.docx*

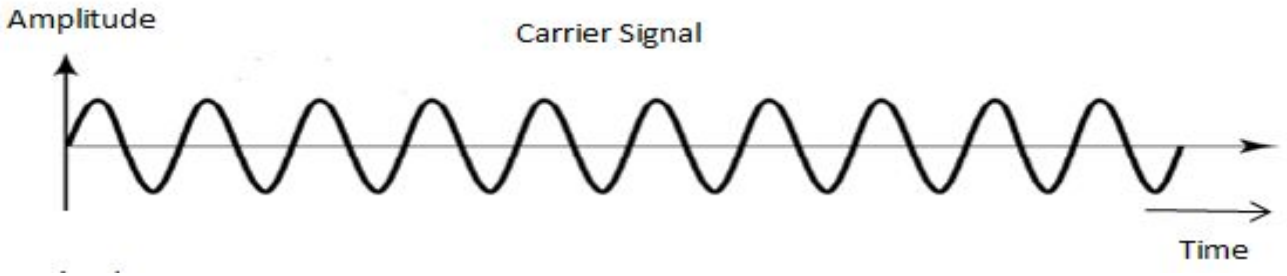
Analog Modulation

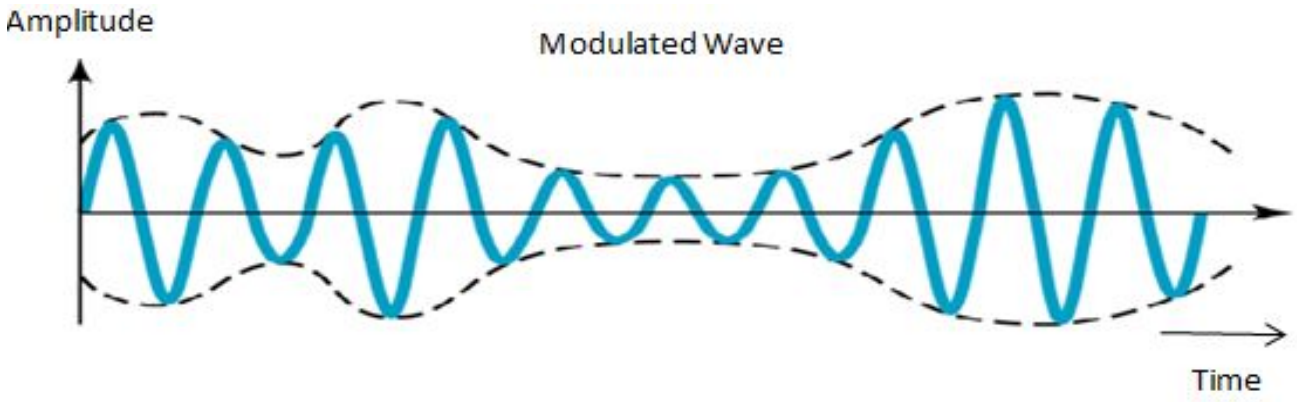


Amplitude Modulation

- What is AM?
- Graphical Representation:







Representation of AM for Single-tone modulation

- The modulating signal:

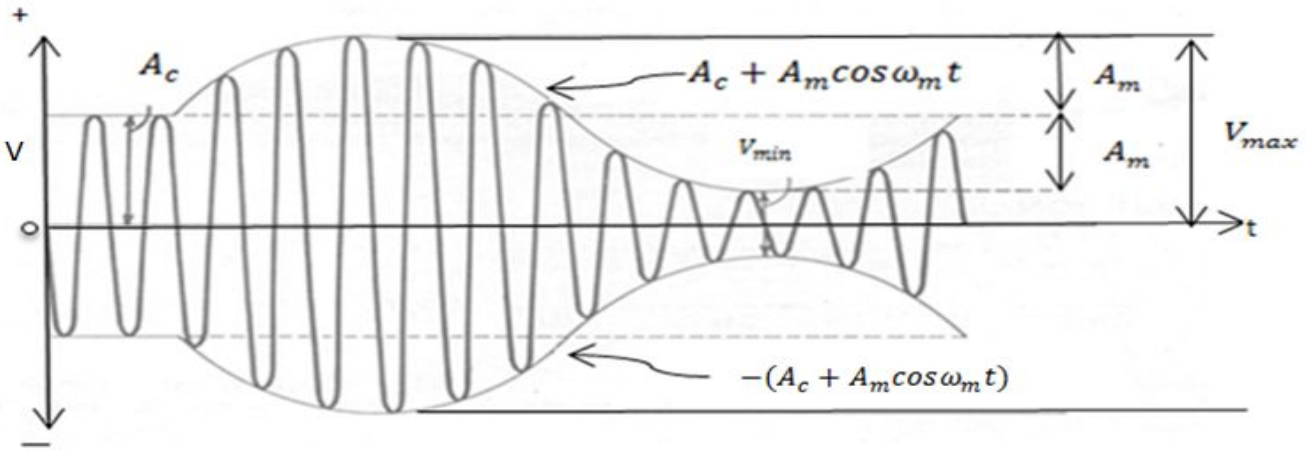
$$m(t) = A_m \cos(2\pi f_m t)$$

- The Carrier Signal:

$$c(t) = A_c \cos(2\pi f_c t)$$

- The AM signal

$$s(t) = A_c[1 + m \cos w_m t] \cos w_c t$$



Refer:[Description of AM wave.docx]

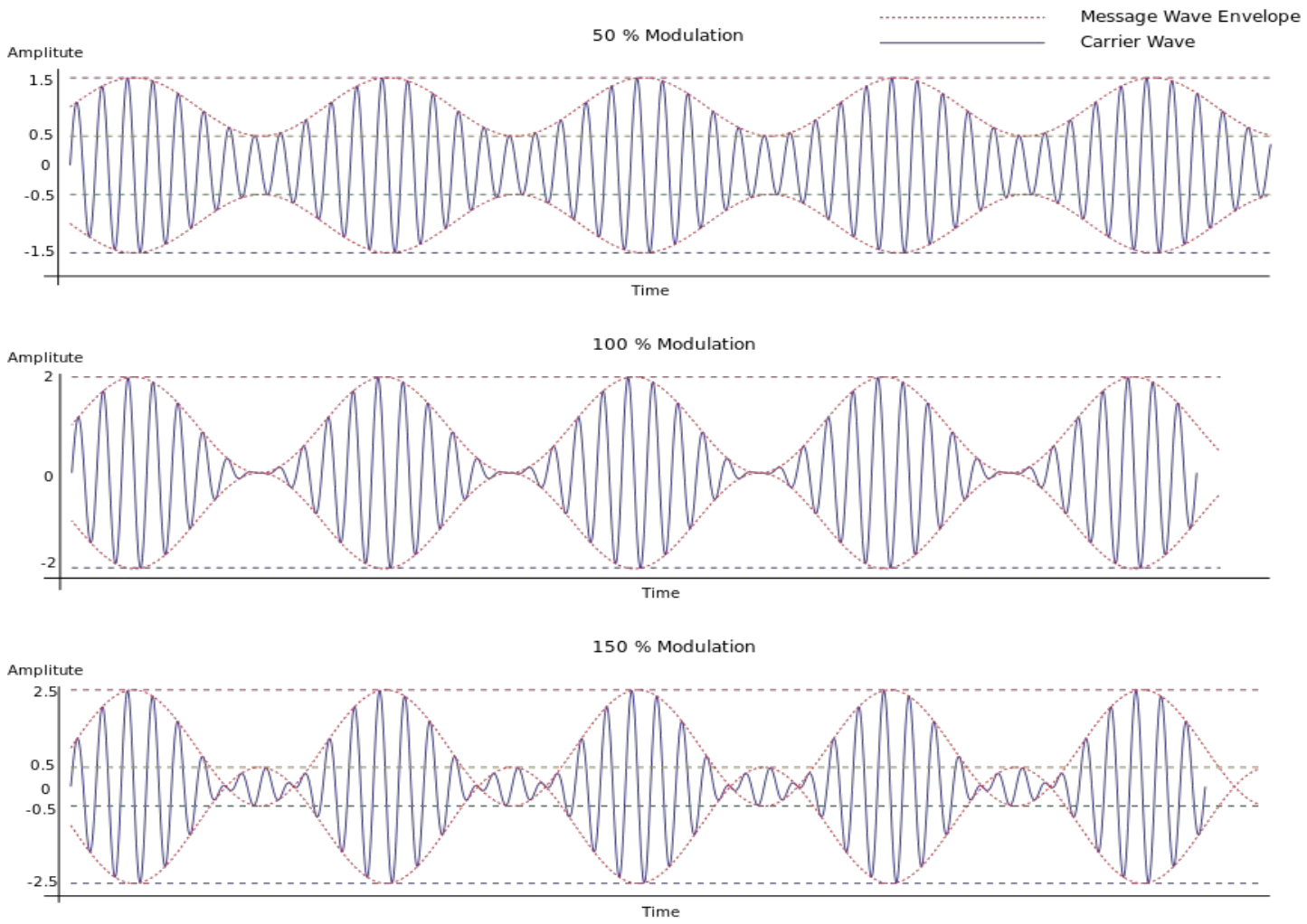
Modulation Index for AM wave

- Modulation Index

$$m = \frac{A_m}{A_c} = \frac{V_{\max} - V_{\min}}{V_{\max} + V_{\min}}$$

  - Under modulation when $m < 1$
  - Over modulation when $m > 1$
  - Perfect modulation when $m = 1$

Effect of modulation index on AM wave



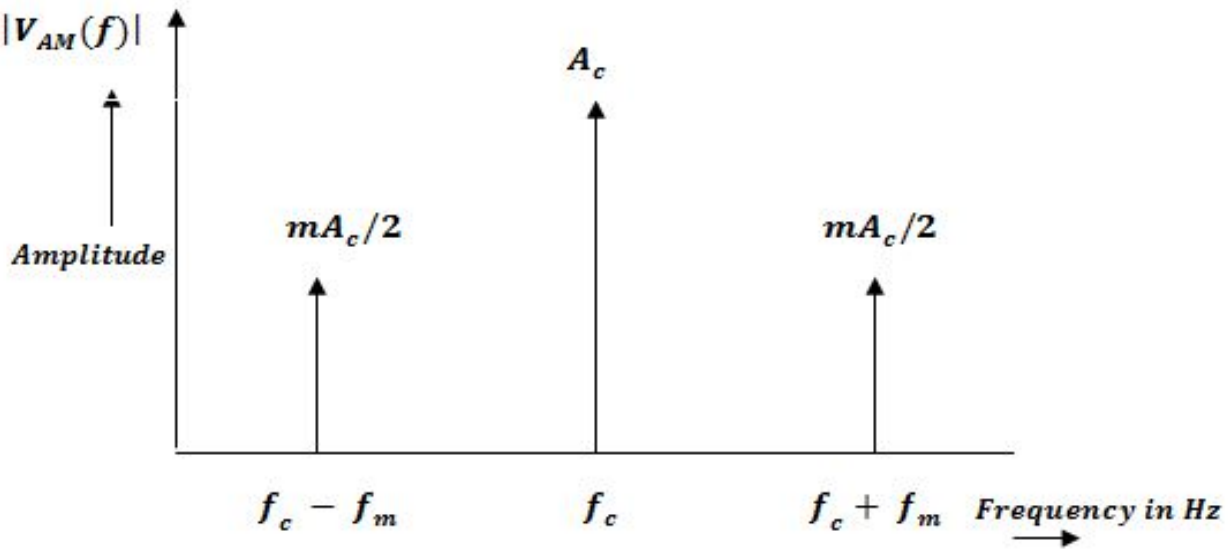
$m = 0.5$

$m = 1$

$m = 1.5$

Spectrum of AM wave

- $V_{AM}(t) = A_c \cos(2\pi f_c t) + \frac{mA_c}{2}\{\cos[2\pi(f_c+f_m)t] + \cos[2\pi(f_c-f_m)t]\}$



- *Upper side band frequency* $f_{USB} = f_c + f_m$
- *Lower side band frequency* $f_{LSB} = f_c - f_m$
- *Sideband Amplitudes* = $\frac{mA_c}{2}$
- *Bandwidth of AM* = $f_{USB} - f_{LSB} = 2f_m$

Refer :Spectrum of AM.docx

Power and Current in AM Wave

- Power in AM wave
  - $P_T = P_C + P_{TSB}$

$$P_T = P_c\left(1+\frac{m^2}{2}\right)$$

  - For m = 1

$$P_C = 66.66\%\, P_T$$

- AM Current
  - $I_T = I_C\{1 + (m^2/2)\}^{0.5}$ Refer: Power in AM wave.docx

Modulation by several sine waves

- Overall modulation index
  - $m = (m_1{}^2 + m_2{}^2 + \cdots \ldots)^{0.5}$
- Total Power
  - $P_T = P_C \left\{1 + \left(\frac{m_t{}^2}{2}\right)\right\}$
- Total Current
  - $I_T = I_C \left\{\left[1 + \left(\frac{m_t{}^2}{2}\right)\right]^{0.5}\right\}$

Exercises

1. The antenna current of an AM transmitter is 8A when only carrier is transmitted, but increases to 8.93A when carrier is modulated by a single sine wave. Find the percentage modulation. Determine the antenna current when the depth of modulation changes to 0.8.

   [Ans: m=70.1%, I_t=9.19 A]

2. When the modulation percentage is 75, an AM transmitter produces 10kW.How much of this is the carrier power? What would be the percentage power saving if the carrier and one of the sidebands were suppressed before transmission took place?

   [Ans: P_C=7.8kW, P_{saving}= 89.04 %,]

3. When a broadcast AM transmitter is 50 percent modulated, its antenna current is 12A. What will the current be when the modulation depth is increased to 0.9?

   [Ans: I_t=13.4 A]

Exercises

4. A 360-W carrier is simultaneously modulated by two audio waves with modulation percentages of 55 and 65, respectively. What is the total side band power radiated?

[Ans: 130.5 W]

4. An audio signal 10sin (2π1000t) amplitude modulates a carrier of 40sin (2 π 2000t). Find (a)modulation index (b)Sideband frequencies (c) Bandwidth.(d) Total power delivered if RL = 1KΩ (d)Amplitude of each side band components

[Ans: m=0.25, f_{usb}=3000Hz, f_{lsb}=1 KHz, BW= 2kHz, P_t=1.0325W, A_{sb}=5V]

Types of AM

- Double Side Band With Carrier (AM-DSB)
- Double Side Band-Suppressed Carrier (DSB-SC)
- Single Side Band (SSB)
- Vestigial Side Band (VSB)

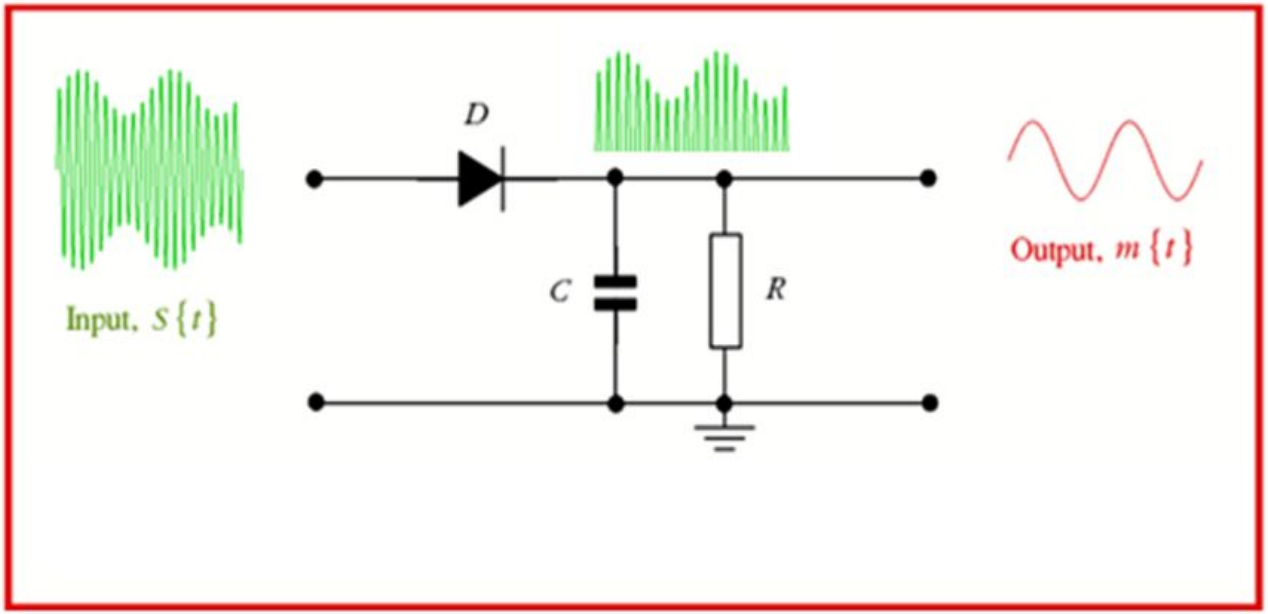
Refer :Types of AM wave.docx

Comparison of different types of AM

AM Scheme	Bandwidth	Carrier power	Side band power	% of power saving compared to AM DSB	Typical Applications
AM- DSB		66.67%	33.33%	NIL	AM radio broadcast
DSB-SC		NIL	33.33%	66.67%	Non-commercial systems
SSB		NIL	16.67%	83.33%	Carrier telephony systems, military applications

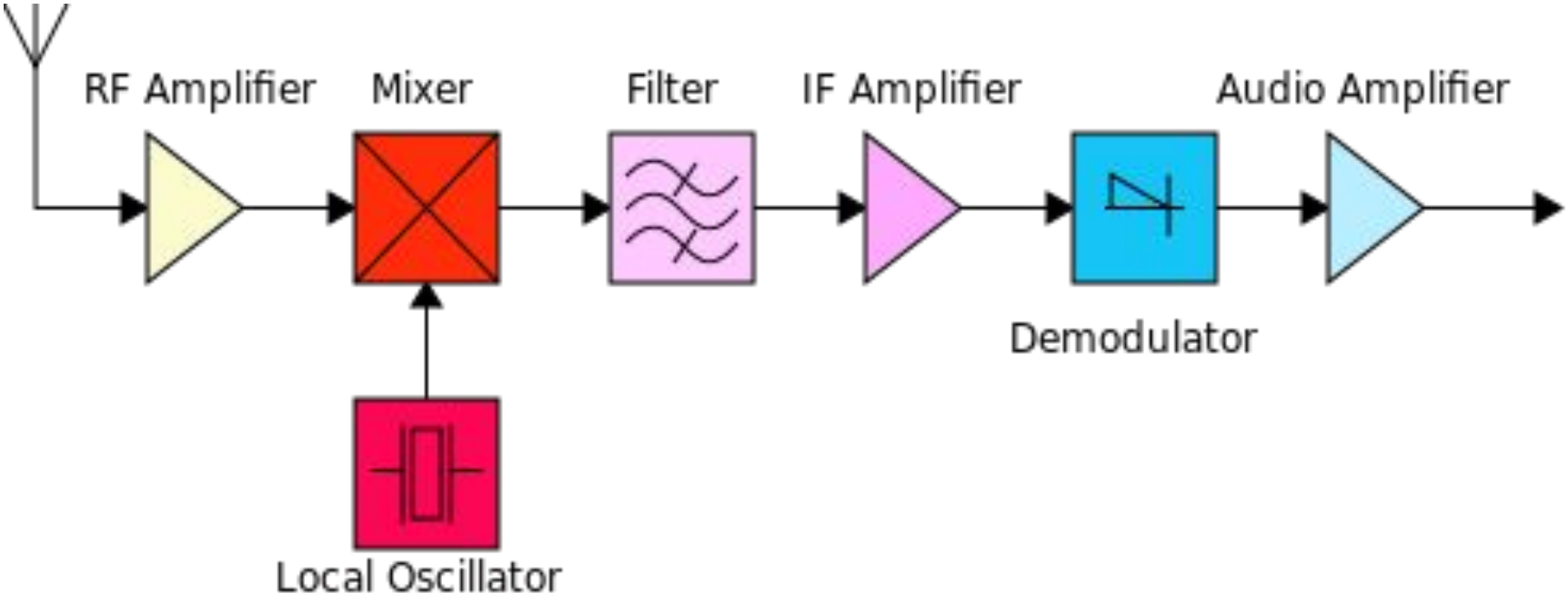
AM Detection

- AM Envelope Detector



Super heterodyne receiver

- Block Diagram:



Refer : Superheterodyne receiver.docx

Self Test

1) If the carrier of a 100 percent modulated AM DSB wave is suppressed, the percentage power saving will be

a) 50 b)150 c)100 d) 66.66

2) The modulation index of an AM –DSB wave is changed from 0 to 1. The transmitted power is

b) Unchanged b) Halved c) Doubled d) Increased by 50 percent

3) A carrier is simultaneously modulated by two sine waves with modulation indices of 0.3 and 0.4 . The total modulation index

a)Is 1 b) Cannot be calculated unless the phase relations are known

c) Is 0.5 d) Is 0.7

4) Amplitude modulation is preferred for broadcasting because

a) It is more noise immune than other modulation systems

b) Compared with other systems it requires less transmitting power

c) Its use avoids receiver complexity

d) No other modulation system can provide the necessary bandwidth for high fidelity

5) What is the ratio of modulating power to total power at 100 percent modulation in AM-DSB?

a) 1:3 b)1:2 c) 2:3 d)None of the above

Summary

In this module we have learnt:

- Basic principle of electronic communication
- Definition of modulation
- Need for modulation
- To draw the waveforms for amplitude modulated signal
- Modulation index and its significance
- Draw the spectrum of AM DSB signal
- The power and bandwidth of AM
- The different types of AM signal : AM DSB , DSB SC, SSB SC and VSB
- Demodulation of AM wave
- Working principle of super-heterodyne receiver