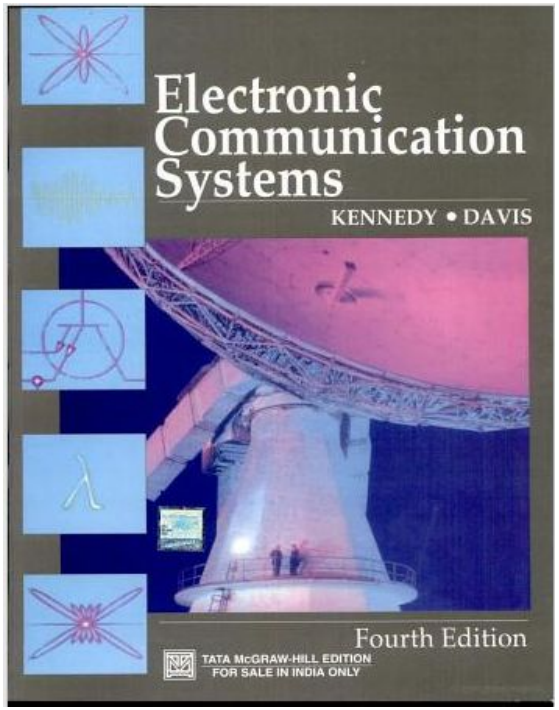
Part - III

Principles of Electronic Communication

Chapter-7: Fundamentals of analog Communication



Reference:

Electronic Communication Systems by Kennedy & Davis ,

4th edition,2004,TMH Edition

Module 2 : Frequency Modulation

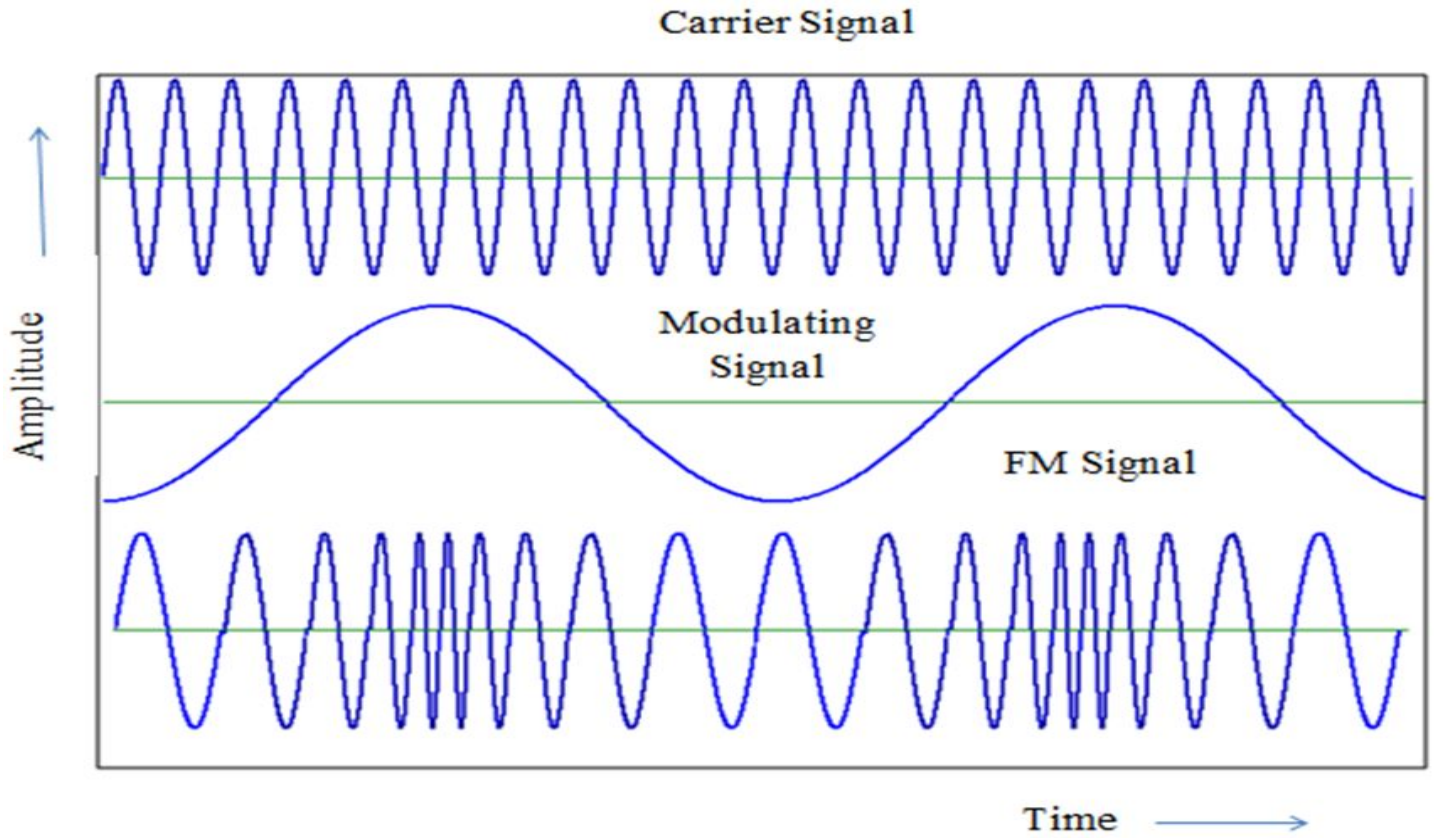
- Objectives:

At the end of this module, students will be able to:

- *Define Frequency Modulation(FM)*
- *Discuss the concept of FM using graphical illustration and mathematical representation*
- *Determine the modulation index and bandwidth of FM*
- *Distinguish between AM and FM*
- *Identify the areas of application of AM and FM*

Frequency Modulation

- *What is FM?*
- *Graphical Illustration of FM*



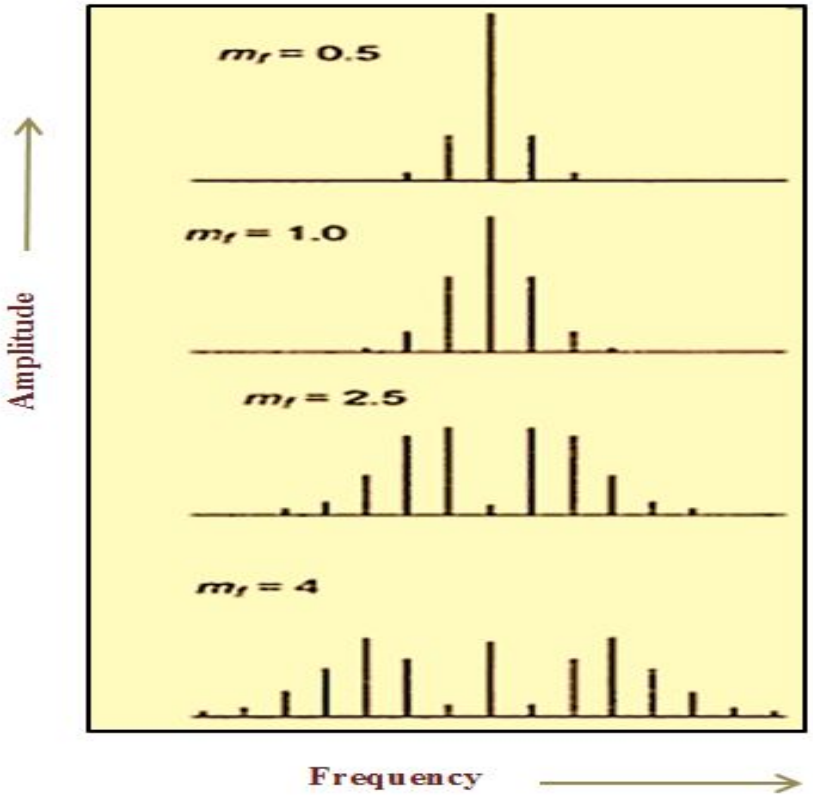
Frequency Modulation Contd.,

- **Mathematical Representation of FM**
  - $f_{FM} = f_C + K_f m(t)$
  - K_f is the frequency sensitivity, f_C is the carrier frequency
  - $m(t)$ is the modulating signal
  - $m(t) = A_m \cos(2\pi f_m t)$
  - $V_{FM}(t) = A_C \cos[\omega_C t + \beta \sin(2\pi f_m t)$,

    where the modulation index , $m_f = \beta = \frac{\Delta f}{f_m}$

Frequency Modulation Contd.,

- **Spectrum of FM wave**



$$\text{By Carson's rule, } Bandwidth \approx 2(\Delta f + f_m)$$

Refer Time domain analysis & spectrum of FM.docx

Frequency Modulation Contd.,

- Performance Parameters for the Comparison of AM and FM
  1. *Amplitude*
  2. *Frequency*
  3. *Modulation Index*
  4. *Noise Immunity*
  5. *Adjacent Channel Interference*
  6. *Bandwidth*
  7. *Circuit Complexity*
  8. *Coverage area*

Summary

In this module we have learnt:

- *Basic principle of frequency modulation*
- *Definition of frequency modulation, which is nothing but varying the frequency of a known signal called carrier in accordance with the amplitude of the message signal called modulating signal.*
- *To draw the waveforms for frequency modulated signal with respect to the chosen modulating and carrier signals.*
- *Modulation index gives the depth of modulation and is given by* $m_f = \beta = \frac{\Delta f}{f_m}$
- *The bandwidth is given by Carlson Rule given by Bandwidth = 2(Δf + f_m), where fm is the maximum frequency component of the modulating signal.*

Self Test

Indicate the false statement.

1. Frequency Modulation is used to
   A. Reduce the bandwidth
   B. Improve noise immunity
   C. Ensure that the information may be transmitted over long distances
   D. reduce transmitted power
2. The need for modulation is
   A. Length of the antenna will be constant
   B. Message signal amplitude reduces with distance.
   C. To multiplex multiple message signals and transmit on the same channel.
   D. A message is composed of unpredictable variations in both amplitude and frequency

Exercises

1. Given a FM equation $V_{FM}(t) = 10 \cos [2 \Pi 10^8 t + 5 \sin(2 \Pi 15000t)]$, Calculate Carrier frequency. Modulating frequency. Frequency deviation. Bandwidth using Carson's rule.
2. In an FM system when the audio frequency is 50Hz , modulating voltage is 2.5V , the deviation produced is 5KHz. If the modulating voltage is now increased to 7.5V, calculate the new value of frequency deviation. If the AF voltage is raised to 10V while the modulating frequency is dropped to 250Hz, what is the frequency deviation produced. Also calculate modulation index in each case.