Chapter 8
Modulation and Demodulation

One Mark questions (knowledge)

1. What is modulating signal?
2. What is a carrier signal?
3. What is modulation?
4. Define amplitude modulation.
5. Define modulation index of an AM wave.
6. Define percent of modulation for an AM wave.
7. What is over modulation in AM?
8. Write the expression for total power of an AM wave.
9. Write the current relation for AM wave.
10. Define transmission efficiency of an AM wave.
11. Write the expression of transmission efficiency for AM signal in terms of modulation index.
12. Write an expression for the total modulation index of an AM wave when a carrier wave is modulated by several sine waves.
13. Expand DSB-SC.
14. Expand SSB-TC.
15. Expand SSB-SC.
16. Define frequency Modulation.
17. What is resting frequency?
18. Write an expression for instantaneous voltage of frequency modulated wave.
19. Define Modulation index of FM.
20. Write the expression for the modulation index of FM.
21. Define percent of modulation for FM wave.
22. Define frequency deviation in FM.
23. Define deviation ratio in FM.
24. What are guard bands in FM?
25. What are significant sidebands in FM?
26. Define Carrier Swing in FM.
27. What is the maximum permitted frequency deviation in FM broadcast band?
28. What is Pre-emphasis?
29. What is De-emphasis?
30. Define demodulation.
31. What is an envelope detector?
32. Define sensitivity.
33. Define selectivity.
34. Define fidelity.
35. What is intermediate frequency?
36. What is the function of a mixer in a radio receiver?
37. What is the function of a local oscillator in a radio receiver?
38. Name the most common device used for AM detection.
39. Expand AGC.
40. What is the main purpose of AGC?

41.What are transmission lines?
42.What is an antenna?
43.Name the antenna used in RADAR application.
44.Write any one application of horn antenna.
45.Write any one application of micro strip antenna.
46.What is digital communication?

One Mark questions (understanding)

1. How is the length of antenna related to frequency of the signal?
2. Write an expression for the instantaneous voltage of an AM wave.
3. Write an expression for modulation index of AM in terms of V_m and V_C.
4. How many sidebands are present in an AM wave?
5. Which components of the AM wave carry information?
6. Write an expression for amplitude of sidebands present in AM wave.
7. Write an expression for the bandwidth of an AM wave.
8. Write an expression for modulation index of an AM wave in terms V_{max} and V_{min}.
9. What happens when the modulation factor in an AM exceeds unity?
10. Why is the transmission of sidebands important in AM?
11. Expand DSB-SC.
12. Expand SSB-TC.
13. Expand SSB-SC.
14. Why are guard bands used in FM?
15. How many sidebands are present in FM wave?
16. In which type of modulation Pre-emphasis and De-emphasis networks are essential?
17. Name the circuit which separates the modulating signal and the carrier signal in a radio receiver.
18. Mention the function of limiter in FM.
19. Mention the value of IF for AM.
20. Mention the value of IF for FM.
21. Which type of antenna is used in small electronic devices?
22. Which frequency signals are processed by micro strip antenna?

One mark questions (skill)

1. Sketch the AM wave for $m_a<1$.
2. Sketch the AM wave for $m_a >1$.
3. Sketch the AM wave for $m_a =1$.
4. Mention any one application of transmission line.
5. Write any one application of helical antenna.
6. Write any one application of Yagi antenna.
7. Write any one application of loop antenna.

Two Mark questions (knowledge)

1. Mention the different types of modulation?

2. What is amplitude modulation? What is the value of m_a?
3. What is the range of modulation index in AM? Write the frequency expression for sidebands.
4. Define Modulation index of an AM wave. What is its significance?
5. Define transmission efficiency of AM and write its relation with m_a.
6. What are the advantages of SSB system over conventional DSB system?
7. What are the disadvantages of single side band transmission?
8. Define frequency modulation. Write an expression for instantaneous voltage of FM wave.
9. Draw the frequency spectrum of an FM wave.
10. What is carrier swing? Write an expression for carrier swing of an FM.
11. What is the purpose of a buffer amplifier stage in a transmitter?
12. What is Pre-emphasis? Where is it used?
13. What is De-emphasis? Where is it used?
14. What are the basic functions of radio receiver?
15. What are the characteristics of a good radio receiver?
16. Define the terms sensitivity and selectivity with respect to a radio receiver.
17. Define the terms stability and fidelity with respect to a radio receiver.
18. What are the advantages of super heterodyne receiver?
19. What is the need of IF amplifier in receivers?
20. What is the purpose of a discriminator in an FM broadcast receiver?
21. What are the advantages of FM over AM?
22. What are the disadvantages of FM system?
23. What are the applications of AM?
24. Name the primary constants of transmission lines?
25. Mention any two types of antenna.

Two Mark questions (understanding)

1. Why modulation is necessary?
2. What is over modulation and why is it not preferred in AM?
3. How many side bands are present in AM wave? Mention their amplitude.
4. Name the frequency components present in an AM wave? Which component carries information?
5. Explain briefly the principle of super heterodyne receiver.
6. How many sidebands are present in FM wave? Write the expression for Bandwidth.
7. Explain the need of AFC in FM transmitter.
8. Distinguish between Pre-emphasis and De-emphasis.
9. Why is demodulation required?
10. What do you mean by AGC? Why is it necessary for a receiver?
11. Describe the basic differences between AM and FM receivers.
12. Mention any two limitations of AM.
13. Distinguish between Loop antenna and Horn antenna.
14. Distinguish between analog communication and digital communication.

Two Mark questions (skill)

1. Draw the frequency spectrum of an AM wave and label it.
2. Draw the circuit of varactor diode modulator.

3. Draw the equivalent circuit of transmission line for low frequency.
4. Draw the equivalent circuit of transmission line for high frequency.
5. Write any two applications of Horn antenna.
6. Write any two applications of digital communication.

Three Mark questions (knowledge)

1. What is modulation? Briefly explain the need for modulation.

Three Mark questions (understanding)

1. Explain the frequency spectrum of an AM wave.
2. Explain the frequency spectrum of an FM wave.
3. Explain the following characteristics of a radio receiver.
   a. Sensitivity
   b. Selectivity
   c. Fidelity
4. Derive an expression for modulation index of an AM wave in terms of Vmax and Vmin.
5. Derive an expression for the total power of AM wave.
6. Briefly explain the function of an AM diode detector.
7. Describe basic operation of a varactor diode FM generator.
8. Distinguish between AM and FM.

Three Mark questions (skill)

1. Sketch the waveforms of AM wave for m_a=0.5, m_a=1and m_a=1.5
2. Draw the block diagram of AM transmitter.
3. Draw the circuit of an AM diode detector.
4. Draw the block diagram of SHD AM radio receiver.
5. Draw the block diagram of SHD FM radio receiver.
6. Draw the block diagram of digital communication.

Five Mark questions (knowledge)

1. With a block diagram explain the various stages of FM transmitter.

Five Mark questions (understanding)

1. Derive the voltage expression of an AM wave with relevant waveforms.
2. Derive an expression for the instantaneous value of a FM wave.

Five Mark questions (skill)

1. Draw the block diagram of AM transmitter and explain the various stages.
2. Draw the schematic diagram of a diode AM detector and describe its operation.
3. Draw the block diagram of super heterodyne AM radio receiver and explain the function of each block in brief.

4. Draw the block diagram of super heterodyne FM radio receiver and explain the function of each block in brief.

PROBLEMS:

1. Calculate the modulation index of AM wave if sinusoidal wave of peak value 4V is used to modulate the carrier of peak value of 5V.

   (Ans:0.8)
2. In AM the maximum and minimum amplitudes of a sinusoidal modulated wave are 4V and 1V. Determine the percentage modulation.

   (Ans: 60 %)
3. The amplitude of signal and carrier of an amplitude modulated wave are 4 V and 6 V respectively. Calculate V_{min} of the amplitude modulated wave.

   (Ans:2.04 V)
4. A sinusoidal carrier signal of peak amplitude 5V and frequency 100 kHz is amplitude modulated by a 5 kHz signal of peak amplitude 3 V. What is the modulation index? Draw the spectrum of the modulated signal.

   (Ans: 0.6,105 kHz, 95 kHz)
5. A modulating signal 10 $\sin(2\pi X10^3 t)$ is used to modulate a carrier signal 20 $\sin(2\pi X10^4)t$. Find the (a) modulation index (b) percentage modulation (c) frequencies of the sideband components and their amplitude (d) bandwidth of the amplitude modulated signal.

   (Ans:0.5,50 %, 9 kHz,11kHz,2 kHz)
6. A transmitter radiates 8 kW of power with carrier unmodulated and 10.125 kW when amplitude modulated. Calculate the percent of modulation.

   (Ans: 72.88%)
7. A radio transmitter is radiating a total power of 135 W when the modulation index is 0.7. What is the carrier power being radiated by the AM transmitter? (Ans:108.43 W)
8. An AM signal has a 15 W carrier and 1.5 W in each sideband. What is the percentage of modulation?

   (Ans: 63.24%)
9. Determine the power content of the carrier and each of the sidebands for an AM signal having a percent modulation of 80% and a total power of 2200 W.

   (Ans:1666 W.66 W,266.67 W)
10. Determine the percent modulation of an AM wave whose total power content is 2500 W and whose sidebands each contain 300 W. (Ans: 79.5 %)
11. The antenna current of AM transmitter is 15 A when un modulated but rises to 18 A when modulated. Calculate the depth of modulation.

    (Ans: 0.938)
12. An antenna has an impedance of 50 Ω. A un modulated AM signal produces a current of 4.8 A. The percentage of modulation is 90.Calculate (a) the carrier power (b) the total power and (c) sideband power.

    (Ans:1152 W, 1613 W, 461 W)
13. The antenna current of an AM transmitter is 8A when only the carrier signal is transmitted. It increases to 8.93A when the carrier signal is modulated by a sinusoidal signal. Find the modulation index and percentage of modulation. Determine the antenna current when modulation index is changed to 0.8.

    (Ans: 0.7,70%,9.2A)

14. What is the power developed in an amplitude modulated wave in a load of 100 Ω, when the peak voltage of the carrier is 100V and the modulation index is 0.5?

(Ans: 18.75 W)

15. A carrier signal having 10V peak amplitude is amplitude modulated by three different modulating signals with peak amplitude levels of 2V, 3V and 4V respectively. Compute the modulation index of resultant complex AM signal.

(Ans: 0.538)

16. An AM transmitter has un modulated carrier signal power 100W which is modulated by three modulating signals simultaneously with modulation indices as of m_{a1} = 0.2, m_{a2} = 0.4, m_{a3} = 0.5.Determine the modulation index of complex AM signal.

(Ans: 0.67)

17. An FM signal has a deviation of 10 kHz and a modulating frequency of 5 kHz, calculate the modulation index.

(Ans: 2)

18. Calculate the frequency deviation for an FM signal with a modulating frequency at 5kHz and a modulating index of 5.

(Ans:25 kHz)

19. Determine the modulation index of an FM carrier having a frequency deviation of 25 kHz and a modulating signal of 5 kHz. Also determine the carrier swing.

(Ans: 12.5,50 kHz.)

20. A 93.2 MHz carrier is frequency modulated by a 5 kHz sine wave. The resultant FM signal has a frequency deviation of 50kHz. Find the carrier swing of the FM wave. Determine the highest and lowest frequencies attained by the modulated signal. What is the modulation index of the FM wave?

(Ans:100 kHz,93.25 MHz,93.15 MHz,10)

21. Determine the percent modulation of an FM signal which being broadcast in the 88-108 MHz band, having a carrier swing of 110 kHz.

(Ans:73.33)

22. A FM wave is represented by $10 \sin[2\pi X10^{8}t + 5 \sin 2\pi X200t]$. Determine (a) the carrier and modulating frequency, (b) the modulation index and (c) maximum deviation.

(Ans: 100 MHz, 200Hz, 5.1 kHz)

23. A frequency modulated signal is given by $75 \sin[2\pi X5X10^{6}t + 6 \sin 200\pi t]$ Determine (a) the modulating signal frequency,(b) the carrier frequency,(c)peak deviation,(d) the deviation ratio, and (e) the modulation index.

(Ans: 100 Hz, 5 MHz,600 Hz, 750,6)

24. Determine the frequency of the modulating signal which is producing an FM signal having a bandwidth of 60 kHz when the frequency deviation of FM signal is 10 kHz.

(Ans: 20 kHz)

25. An FM radio has a frequency deviation of 30 kHz. The modulating frequency is 4 kHz. Calculate the bandwidth needed. What is the new bandwidth if the deviation is reduced to 15 kHz?

(Ans: 68kHz,38 kHz)

26. A super heterodyne receiver using an intermediate frequency of 455 kHz is receiving a modulated signal of 910 KHz. What is the frequency of local oscillator? What could be its image frequency?

(Ans: 1365 kHz, 1820 kHz)