



EEEN 462 – ANALOGUE COMMUNICATION

FREQUENCY MODULATION (FM) - TEST YOUR KNOWLEDGE

SECTION A: MULTIPLE CHOICE QUESTIONS

1. What is the primary advantage of FM over AM?

- a) Higher bandwidth
- b) Better noise immunity
- c) Simpler demodulation
- d) Lower power consumption

Answer: b) Better noise immunity

2. In FM, the frequency deviation is proportional to

- a) Amplitude of the modulating signal
- b) Frequency of the modulating signal
- c) Phase of the carrier
- d) Both a and b

Answer: a) Amplitude of the modulating signal

3. The modulation index (β) in FM is given by

- a) $\Delta f / f_m$
- b) $f_m / \Delta f$
- c) $\Delta f \times f_m$
- d) $1 / (\Delta f \times f_m)$

Answer: a) $\Delta f / f_m$

4. Carson's rule estimates the bandwidth of an FM signal as

- a) $2(\Delta f + f_m)$
- b) $2(\Delta f - f_m)$
- c) $\Delta f + f_m$
- d) $\Delta f - f_m$

Answer: a) $2(\Delta f + f_m)$

5. The process of recovering the original signal from an FM wave is called

- a) Modulation
- b) Demodulation
- c) Frequency mixing
- d) Heterodyning

Answer: b) Demodulation

6. Which of the following is NOT a type of FM detector?

- a) PLL
- b) Ratio detector

- c) Foster-Seeley discriminator
- d) Envelope detector

Answer: d) Envelope detector

7. **Pre-emphasis in FM is used to**

- a) Reduce high-frequency noise
- b) Increase modulation index
- c) Decrease bandwidth
- d) Improve carrier stability

Answer: a) Reduce high-frequency noise

8. **The capture effect is a characteristic of**

- a) AM
- b) FM
- c) PM
- d) PWM

Answer: b) FM

9. **Narrowband FM has a modulation index typically**

- a) $\beta \ll 1$
- b) $\beta \approx 1$
- c) $\beta \gg 1$
- d) $\beta = 0$

Answer: a) $\beta \ll 1$

10. **The frequency spectrum of an FM signal contains**

- a) Only the carrier frequency
- b) Carrier and an infinite number of sidebands
- c) Carrier and two sidebands
- d) Only sidebands

Answer: b) Carrier and an infinite number of sidebands

SECTION B: SHORT ANSWER QUESTIONS

11. **Define frequency deviation (Δf) in FM.**

Answer: The maximum change in carrier frequency from its rest value due to modulation.

12. **What is the significance of the modulation index (β) in FM?**

Answer: It determines the number of significant sidebands and bandwidth of the FM signal.

13. **Why is FM less susceptible to noise than AM?**

Answer: Noise primarily affects amplitude, and FM detectors ignore amplitude variations.

14. **Differentiate between narrowband FM and wideband FM.**

Answer: Narrowband FM has $\beta \ll 1$ (small bandwidth), while wideband FM has $\beta \gg 1$ (large bandwidth).

15. What is the role of a limiter in an FM receiver?

Answer: It removes amplitude variations (noise) before demodulation.

16. Explain the term "de-emphasis" in FM systems.

Answer: It attenuates high frequencies at the receiver to reverse pre-emphasis and reduce noise.

17. How does a PLL demodulate an FM signal?

Answer: The PLL locks onto the FM signal's frequency variations and outputs the modulating signal.

18. What is the effect of increasing the modulating frequency (FM) on bandwidth in FM?

Answer: Bandwidth increases due to more sidebands being significant.

19. Why is FM not used for long-distance communication like AM?

Answer: FM requires line-of-sight propagation and is limited by the curvature of the Earth.

20. Give two applications of FM.

Answer: FM radio broadcasting, Two-way analogue mobile communications.

SECTION C: NUMERICAL PROBLEMS

21. An FM signal has a frequency deviation of 75 kHz and a modulating frequency of 15 kHz. Calculate the modulation index.

Solution:

$$\beta = \Delta f / f_m = 75 / 15 = 5$$

Answer: 5

22. Using Carson's rule, find the bandwidth of an FM signal with $\Delta f = 50$ kHz and $f_m = 10$ kHz.

Solution:

$$BW = 2(\Delta f + f_m) = 2(50 + 10) = 120 \text{ kHz}$$

Answer: 120 kHz

23. An FM transmitter operates at 100 MHz with $\Delta f = 25$ kHz. If the modulating signal is 5 kHz, determine the frequency range of the transmitted signal.

Solution:

$$f_{\max} = f_c + \Delta f = 100 \text{ MHz} + 25 \text{ kHz} = 100.025 \text{ MHz}$$

$$f_{\min} = f_c - \Delta f = 100 \text{ MHz} - 25 \text{ kHz} = 99.975 \text{ MHz}$$

Answer: 99.975 MHz to 100.025 MHz

24. An FM signal has $\beta = 4$ and $f_m = 5$ kHz. Find the frequency deviation.

Solution:

$$\Delta f = \beta \times f_m = 4 \times 5 = 20 \text{ kHz}$$

Answer: 20 kHz

25. Calculate the bandwidth of an FM signal with $\Delta f = 60$ kHz and $f_m = 12$ kHz using Carson's rule.

Solution:

$$BW=2(60+12)=144 \text{ kHz}$$

Answer: 144 kHz

SECTION D: LONG ANSWER QUESTIONS

26. Explain the generation of FM using the Armstrong method (indirect method).

Answer:

- Narrowband FM is generated using a phase modulator.
- Frequency multiplication increases both carrier frequency and deviation.
- Mixing adjusts the carrier to the desired frequency.

27. Compare FM and PM in terms of:

- a) Definition
- b) Relationship between modulating signal and deviation
- c) Bandwidth

Answer:

- a) FM varies frequency, PM varies phase.
- b) In FM, $\Delta f \propto$ amplitude of modulating signal; in PM, $\Delta \phi \propto$ amplitude.
- c) Both have similar bandwidth, but PM may have higher sidebands at higher frequencies.

28. Describe the working of a Foster-Seeley discriminator with a diagram.

Answer:

- Uses a tuned transformer to convert FM to AM.
- Diodes detect amplitude variations, producing the original signal.

29. Derive the expression for instantaneous frequency in FM.

Answer:

$$f_i = f_c + k_f \times m(t)$$

where k_f is frequency sensitivity, $m(t)$ is the modulating signal.

30. Discuss the advantages and disadvantages of FM over AM.

Answer:

Advantages:

- Better noise immunity
- Constant amplitude $\rightarrow$ efficient power amplification

Disadvantages:

- Larger bandwidth required
- Complex circuitry