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Course: CSM 477 - Data Communication

1. Amplitude Modulation (AM)

Amplitude Modulation (AM) is a technique in which the amplitude of a carrier wave is varied in proportion to the message signal while keeping the frequency and phase constant. It is widely used in radio broadcasting but is susceptible to noise and interference.

Key points:

- AM is an analog modulation technique.
- In AM, the **amplitude** of a high-frequency **carrier wave** changes according to the amplitude of the **message signal**.
- **Frequency** and **phase** of the carrier wave remain constant.
- Used primarily for **AM radio broadcasting** (535 kHz to 1605 kHz).
- Simple and cost-effective equipment, but susceptible to **noise** and **interference**.
- Poor noise immunity and limited sound quality.

2. Phase Modulation (PM)

Phase Modulation (PM) is a modulation technique where the phase of the carrier wave is varied according to the amplitude of the message signal. PM is closely related to Frequency Modulation (FM) and is used in digital signal processing and telemetry communication systems.

Key points:

- PM is an analog modulation method.

- The **phase** of the carrier wave is altered proportionally to the amplitude of the **message signal**.
- Frequency and amplitude of the carrier wave remain constant.
- PM is closely related to Frequency Modulation (FM); phase changes indirectly affect frequency.
- Widely applied in digital communication systems, satellite telemetry, and signal processing.
- Offers better resistance to noise than AM but has a more complex implementation.

3. Frequency Modulation (FM)

Frequency Modulation (FM) is a method where the frequency of the carrier wave is varied by the amplitude of the message signal. FM provides better noise resistance compared to AM and is widely used in FM radio broadcasting and television sound transmission.

Key points:

- FM is an analog modulation technique.
- The **frequency** of a carrier wave is varied according to the amplitude of the **message signal**.
- The amplitude and phase of the carrier wave remain constant.
- Commonly used in **FM radio broadcasting** (88 MHz–108 MHz) and TV audio transmission.
- Provides superior sound quality and better immunity to noise than AM.
- Wider bandwidth is required compared to AM, leading to more spectrum usage.

4. Pulse Code Modulation (PCM)

Pulse Code Modulation (PCM) is a digital modulation technique in which an analog signal is sampled at regular intervals and quantized into a series of binary values. PCM is widely used in digital telephony, audio recording, and modern communication systems due to its high signal quality and resistance to noise.

Key points:

- PCM is a digital modulation method.
- Analog signals are converted into a digital format by **sampling**, **quantizing**, and encoding into binary form.
- **Sampling rate** must be at least twice the highest frequency present (Nyquist Rate).
- PCM offers excellent noise immunity and superior signal quality.
- Widely utilized in digital telephony, CD audio, and modern communication systems (e.g., Internet telephony, digital broadcasting).
- Requires more bandwidth and complex equipment compared to analog techniques.