EEE 315
Communication Engineering I

Lec4-Purpose and Types of Modulation

Modulation

- Modulation is a process that causes a shift in the range of frequencies in a signal.
- To modulate means “to change”.
- Modulation may be done by varying the amplitude, phase or frequency of a high frequency carrier in accordance with the amplitude of the message signal.
- This process involves: Baseband/message signal → Modulating signal

  Carrier signal

  Modulated signal

Baseband and Carrier Communication

Baseband Communication: In baseband communication, baseband signals are transmitted without modulation, that is, without any shift in the range of frequencies of the signal.

Carrier Communication: Communication that uses modulation to shift the frequency spectrum of a signal is known as carrier communication.

- Modulation can be Analog (AM/FM radios) or Digital (2G, 3G cellphones).

Purpose of Modulation

- Baseband signals produced by various information sources are not suitable for direct transmission.
- Modulation is extremely necessary in communication systems for one or more of the following reasons:
  - For Practical Antenna Length
  - For Increasing Operating Range
  - For Achieving Wireless Communication
  - To Suit the Medium or Channel Requirement
  - For Multiplexing

Purpose of Modulation

For Practical Antenna Length:

- Low frequency transmission and reception is not practical due to the large antennas required.
- In order to transmit a wave effectively, the length of the transmitting antenna should be approximately equal to the wavelength of the transmitting wave.
- We know that $\lambda = v/f$, where λ = wavelength, v = velocity of the wave = velocity of light = $3 \times 10^8 ms^{-1}$ and f = frequency of the wave (Hz).

Purpose of Modulation

- For example, to radiate a signal with frequency 20kHz directly into space, required antenna length = $\frac{3\times10^8}{20\times10^3} = 15000$ m, which is not practical.
- On the other hand, if by modulation, signal frequency is shifted to 20MHz, required antenna length = $\frac{3\times10^8}{20\times10^6} = 15$ m.

Purpose of Modulation

For Increasing Operating Range:

- The energy of a wave depends upon its frequency. The higher the frequency, the greater the energy possessed by it.
- As the baseband signal frequencies are small, they cannot be transmitted over large distances if radiated directly into space.
- The only practical solution is to modulate a high frequency carrier wave with the baseband signal and permit the transmission to occur at this high frequency carrier.

Purpose of Modulation

For Achieving Wireless Communication:

- At radio frequencies, the efficiency of radiation is poor.
- Efficient radiation of electrical energy is possible at high frequency.
- Modulation is always adopted in a wireless communication system, as a high frequency carrier has to be used.

To Suit the Medium or Channel Requirement:

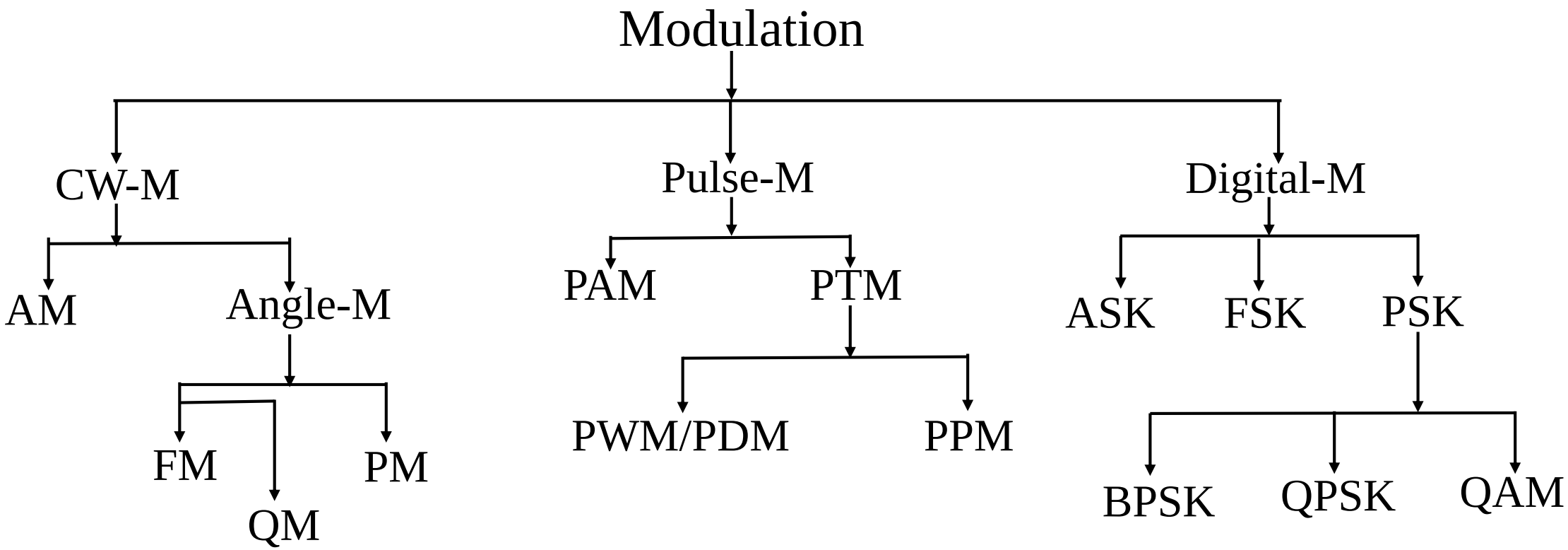
- Some sort of special modulation schemes are adopted to make the signal suitable for the communication channel or medium.

Purpose of Modulation

For Multiplexing:

- Multiplexing is used where multiple users share a same communication channel.
- For Frequency Division Multiplexing (FDM), modulation is required.

Types of Modulation



Types of Modulation

CW-M: Continuous Wave Modulation = Analog Modulation

Pulse-M: Pulse Modulation

Digital-M: Digital Modulation

AM: Amplitude Modulation

Angle-M: Angle Modulation

PAM: Pulse Amplitude Modulation

PTM: Pulse Time Modulation

ASK: Amplitude Shift Keying

Types of Modulation

FSK: Frequency Shift Keying

PSK: Phase Shift Keying

FM: Frequency Modulation

QM: Quadrature Modulation

PM: Phase Modulation

PWM/PDM: Pulse Width Modulation/Pulse Duration Modulation

PPM: Pulse Position Modulation

BPSK: Binary Phase Shift Keying

Types of Modulation

QPSK: Quadrature Phase Shift Keying

QAM: Quadrature Amplitude Modulation

The three broad categories of Modulation schemes shown have the following characteristics:

- Continuous-wave (CW) Modulation: Carrier wave is sinusoidal and the modulating signal is analog.
- Pulse Modulation: Carrier is a periodic pulse train.
- Digital Modulation: Carrier is sinusoidal but the modulating signal is digital.