SNS COLLEGE OF ENGINEERING

An Autonomous Institution

Coimbatore-641 107

Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19EC504-ANALOG AND DIGITAL COMMUNICATION

III YEAR/ V SEMESTER

UNIT 4 – DIGITAL MODULATION TECHNIQUES

TOPIC – Modulation techniques

OUTLINE

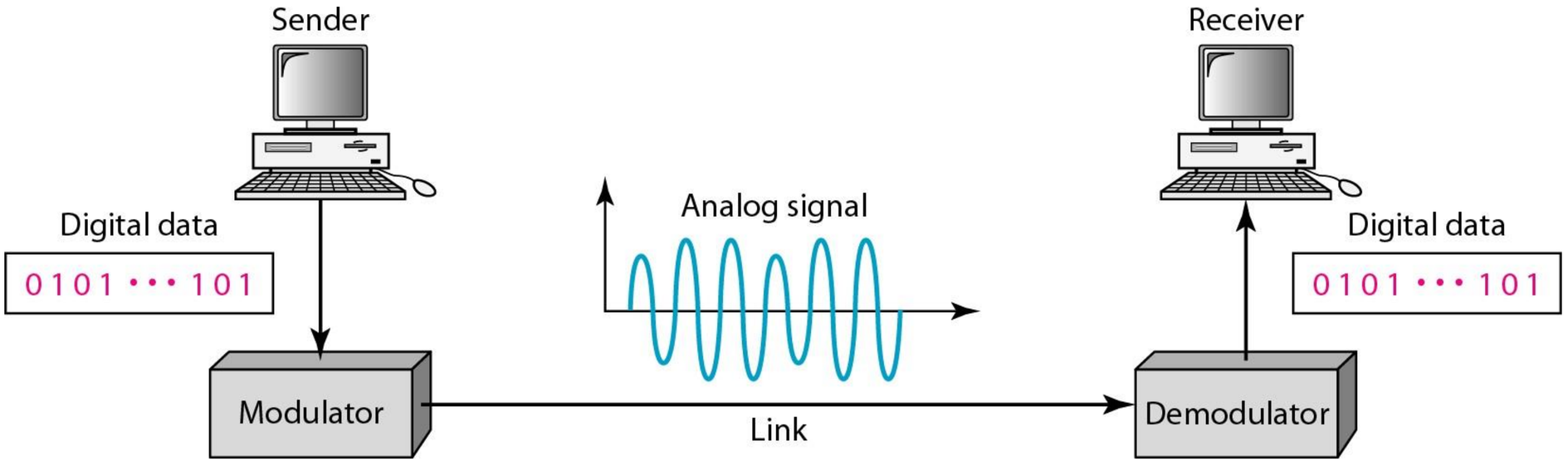
- Digital Introduction to digital modulation
- Relevant modulation schemes
- Geometric representations
- Coherent & Non-Coherent Detection
- Modulation spectra

Digital To Analog Conversion

- **Digital-to-Analog** conversion is the process of changing one of the characteristics of an analog signal based on the information in digital data.

Digital to Analog Conversion

- Digital-to-analog conversion is the process of changing one of the characteristics of an analog signal (carrier signal) based on the information in digital data.



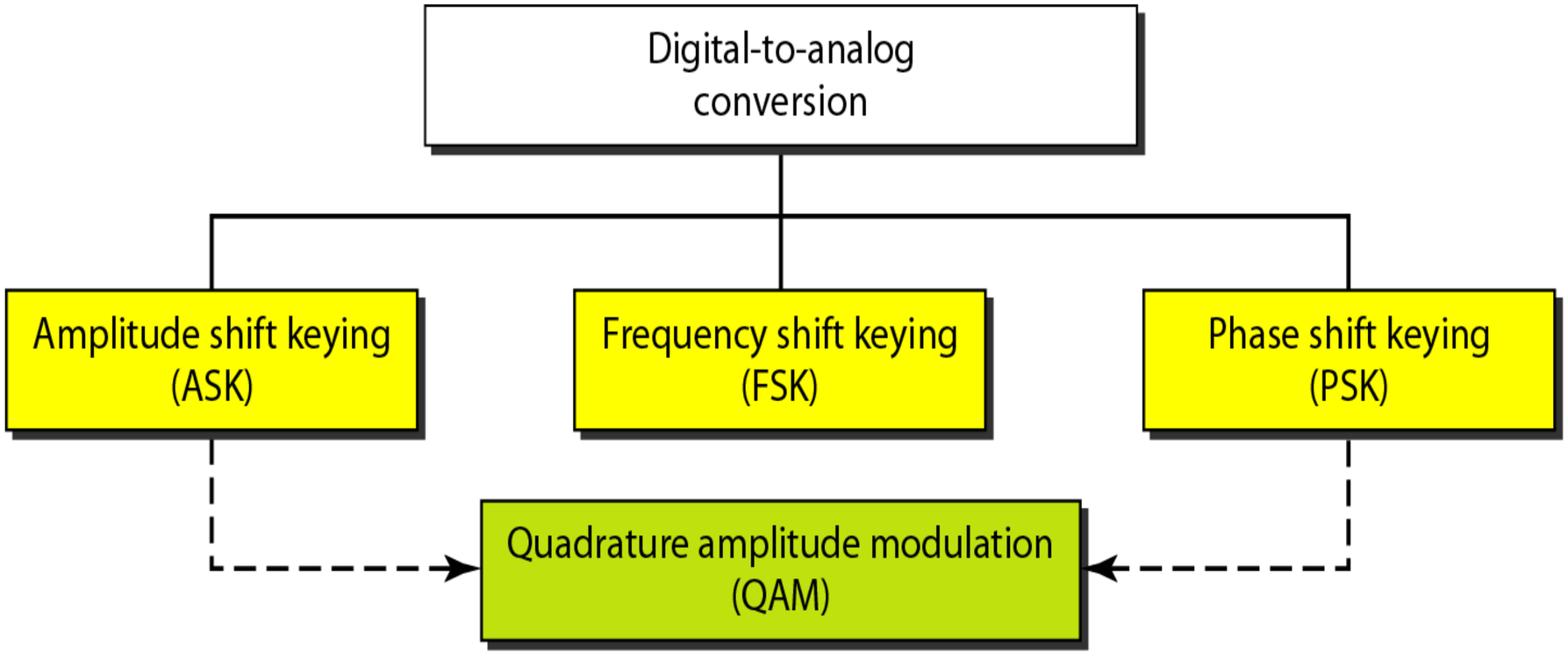
Digital /Analog converter

Analog /Digital converter

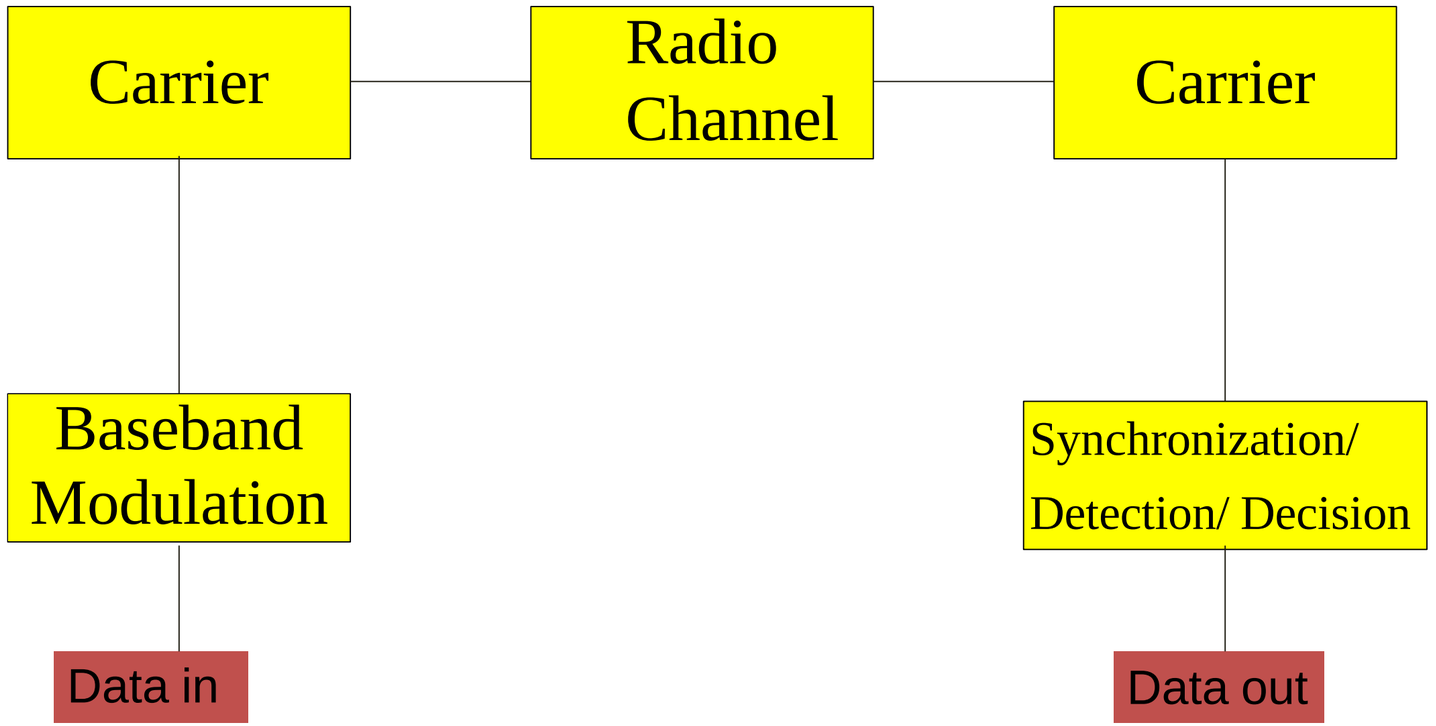
Need for Digital Modulation

- Digital modulation is required if digital data has to be transmitted over a medium that only allows analog transmission.
  - Modems in wired networks.
  - Wireless must use analogue sine waves.

Types


Digital-to-analog conversion
Amplitude shift keying (ASK)
Frequency shift keying (FSK)
Phase shift keying (PSK)
Quadrature amplitude modulation (QAM)

Modulation & Demodulation

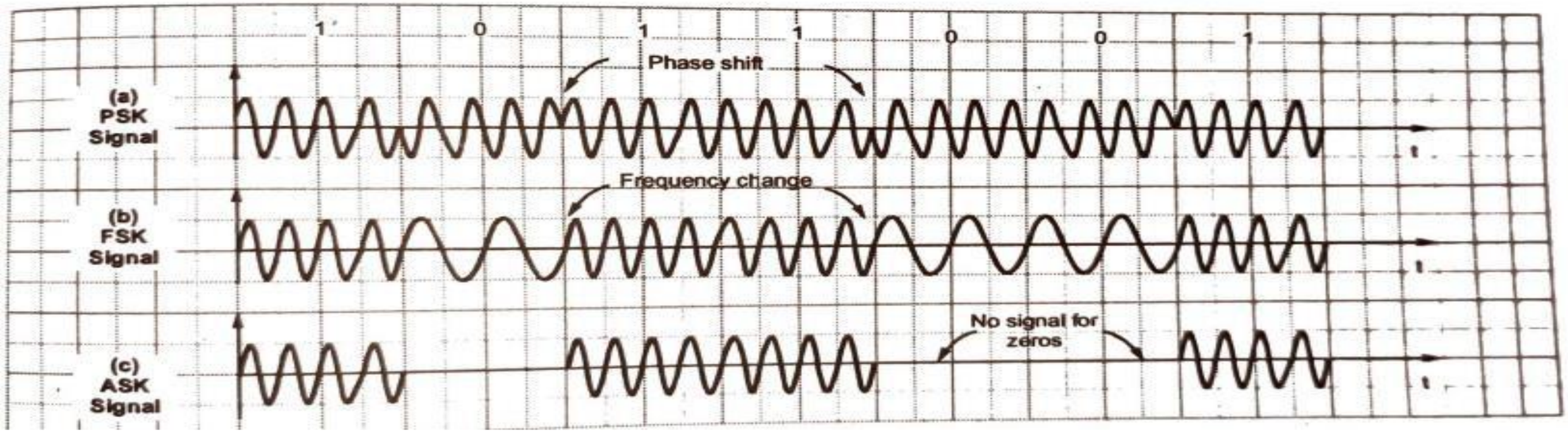


Modulation Techniques

1) **Phase Shift Keying (PSK)** : In this technique, the digital data modulates phase of the carrier.

2) **Frequency Shift Keying (FSK)** : In this technique, the digital data modulates frequency of the carrier.

3) **Amplitude Shift Keying (ASK)** : In this technique, the digital data modulates amplitude of the carrier.



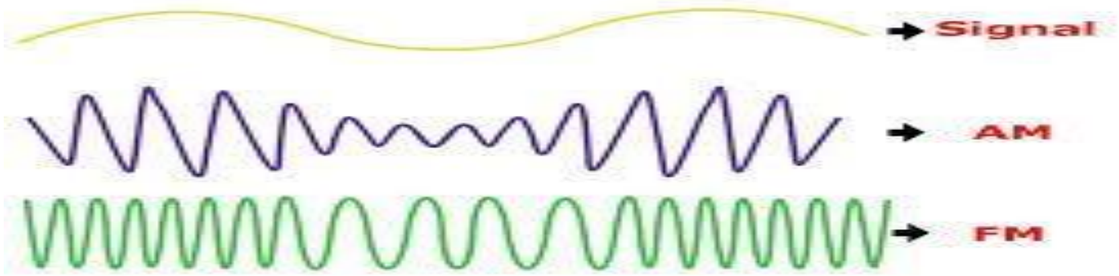
Modulation

- Modulation :

  process (or result of the process) of translation the baseband message signal to bandpass (modulated carrier) signal at frequencies that are very high compared to the baseband frequencies.

- Demodulation is the process of extracting the baseband message back the modulated carrier.

- An information-bearing signal is non- deterministic, i.e. it changes in an unpredictable manner.



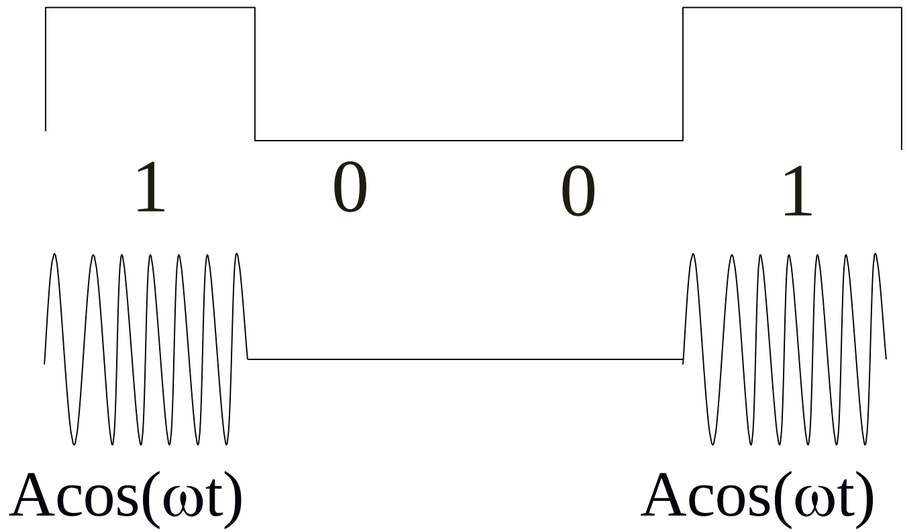
Need for Carrier

- Effective radiation of EM waves requires antenna dimensions comparable with the wavelength:
  - Antenna for 3 kHz would be ~100 km long
  - Antenna for 3 GHz carrier is 10 cm long
- Sharing the access to the telecommunication channel resources

Amplitude Shift Keying (ASK)

Baseband Data

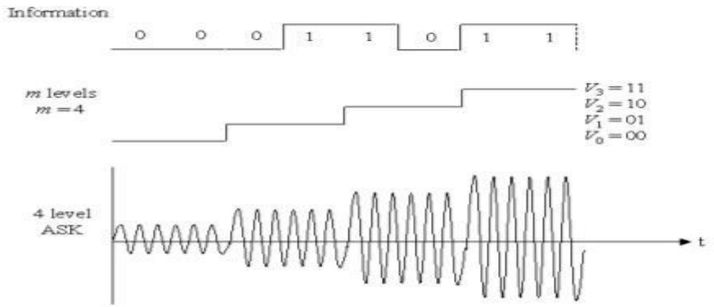
ASK modulated signal

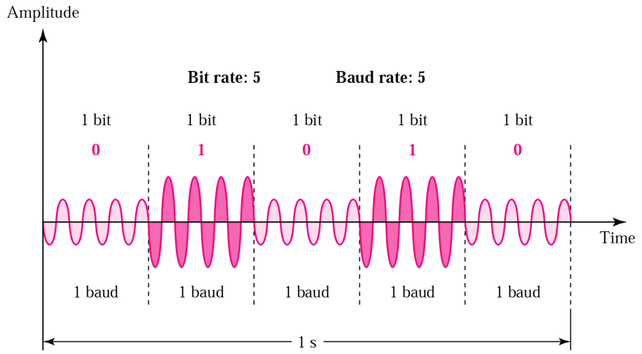


- Pulse shaping can be employed to remove spectral spreading
- ASK demonstrates poor performance, as it is heavily affected by noise, fading, and interference

Amplitude Shift Keying (ASK)

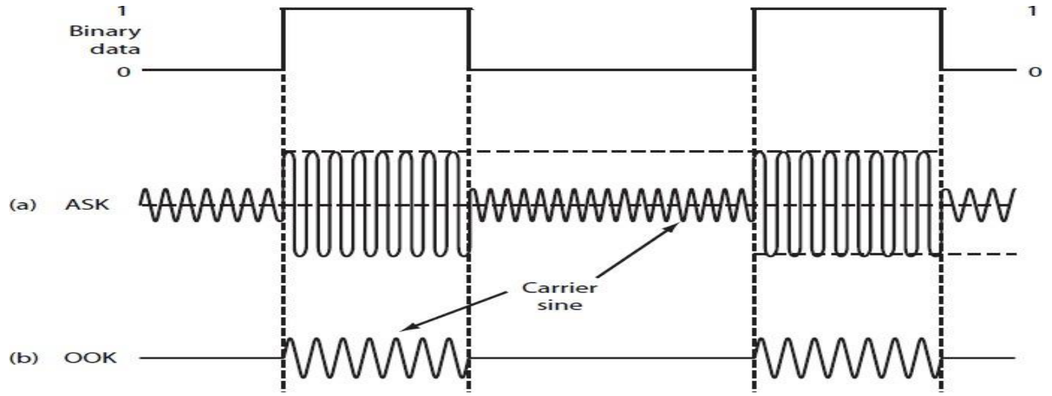
- In **ASK** the amplitude of the carrier signal is varied to represent binary 1 or 0.
  - Carrier signal is a high frequency signal that acts as a basis for the information signal.
  - Both frequency and phase remain constant while the amplitude changes.
  - The peak amplitude of the signal during each bit duration is constant, and its value depends on the bit (0 or 1).





Binary ASK (BASK) or On Off Keying

- Although we can have several levels of signal elements, each with a different amplitude, ASK is normally implemented using only two levels. This is referred to as binary amplitude shift keying.
- In ON OFF Keying: bit **0** is represented by the absence of a carrier and bit **1** is represented by the presence of a carrier .



Pros and Cons

- **Pros:**

ASK transmitter and receiver are simple to design. ASK needs less bandwidth than FSK.

- **Cons:**

ASK transmission can be easily corrupted by noise.

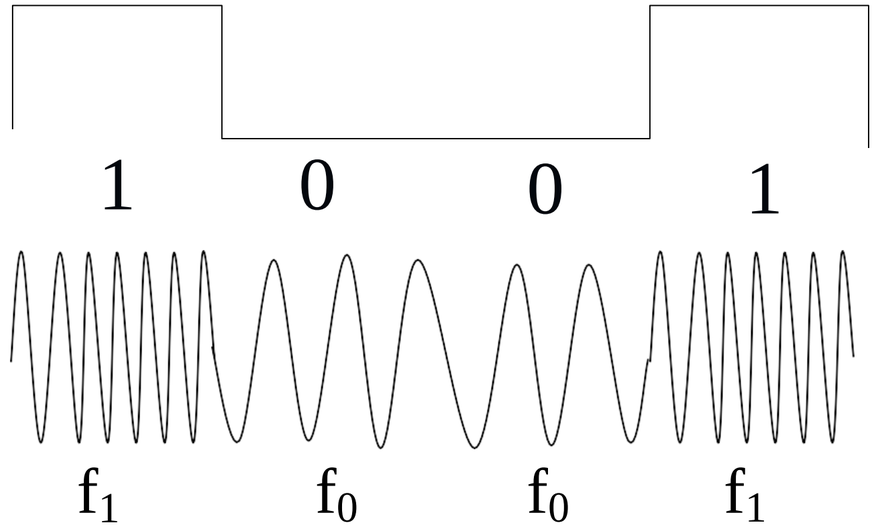
- **Application:**

- Early telephone modem (AFSK).
- ASK is used to transmit digital data over optical fiber.

Frequency Shift Keying (FSK)

Baseband Data

BFSK modulated signal

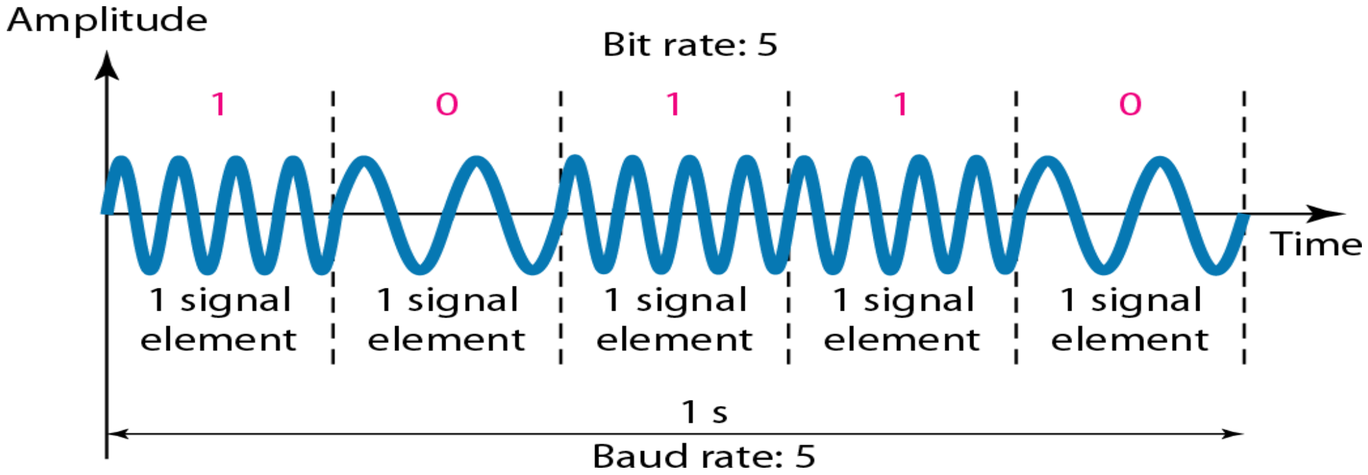


where $f_0 = A\cos(\omega_c - \Delta\omega)t$ and $f_1 = A\cos(\omega_c + \Delta\omega)t$

- **Example**: The ITU-T V.21 modem standard uses FSK
- FSK can be expanded to a M-ary scheme, employing multiple frequencies as different states

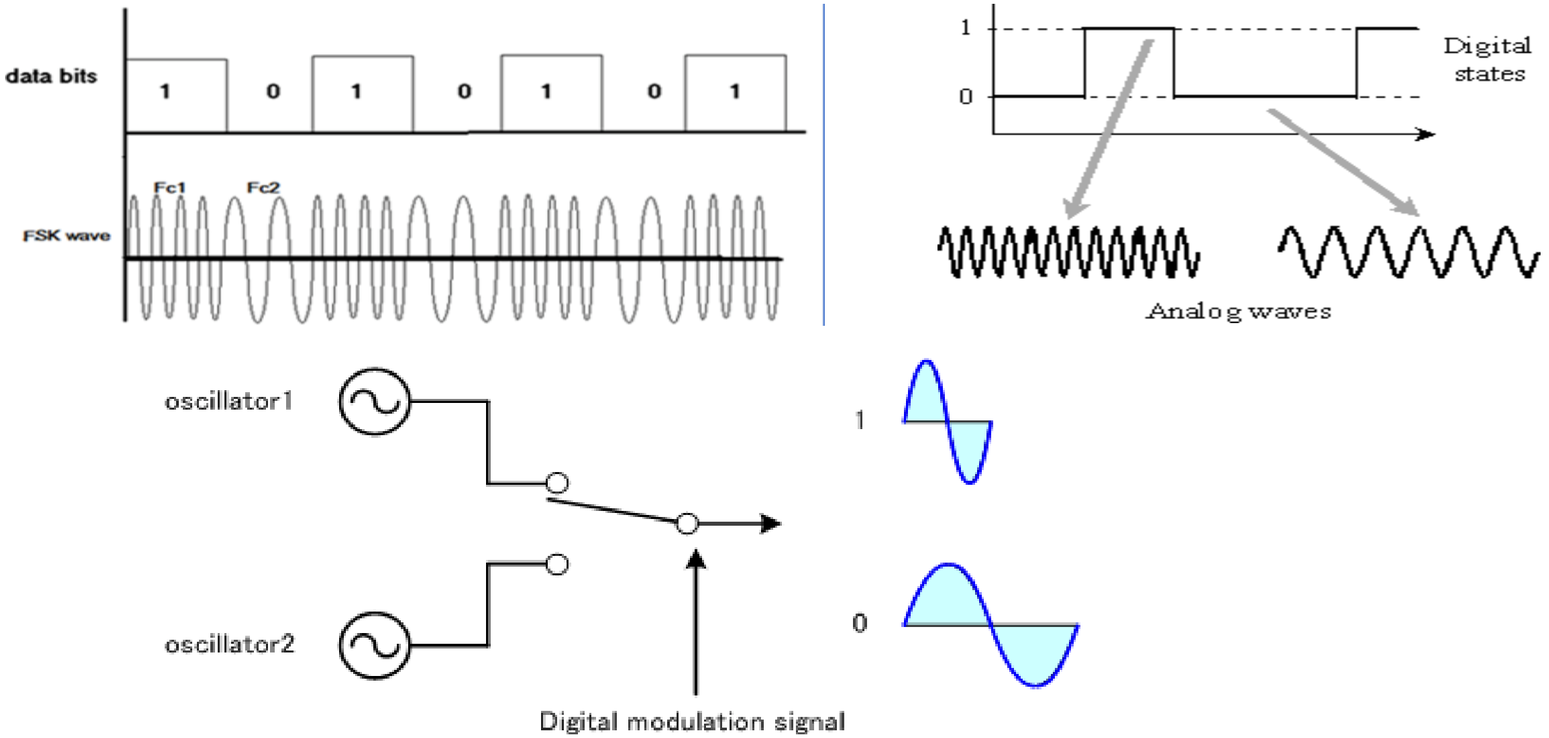
FSK (Frequency Shift Keying)

- The frequency of the carrier signal is varied to represent binary **1** or **0**.
- Both peak amplitude and phase remain constant while the frequency changes.
- The frequency of the signal during each bit duration is constant, and its value depends on the bit (0 or 1).



FSK Modulator

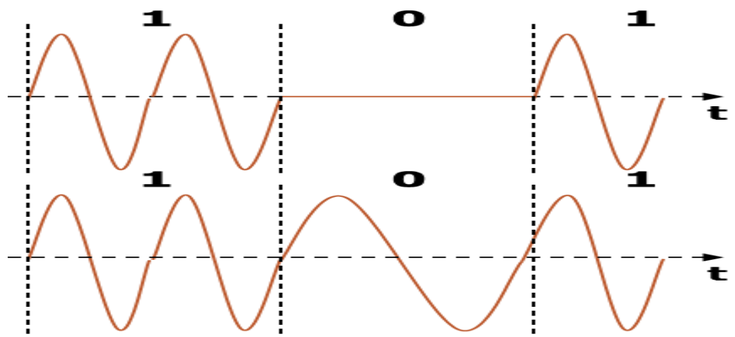
- One way to think about binary FSK (BFSK) is to consider two carrier frequencies



Switch between two oscillators accordingly

ASK and FSK

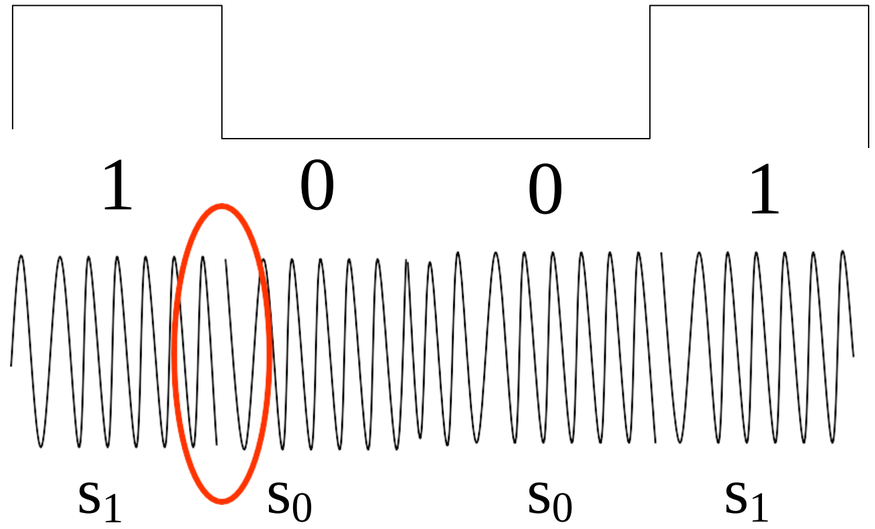
Amplitude Shift Keying (ASK)	Frequency Shift Keying (FSK)
• Very simple.	• Needs larger bandwidth.
• Low bandwidth requirements.	• More error resilience than AM.
• Very susceptible to interference	



Phase Shift Keying (PSK)

Baseband Data

BPSK modulated signal

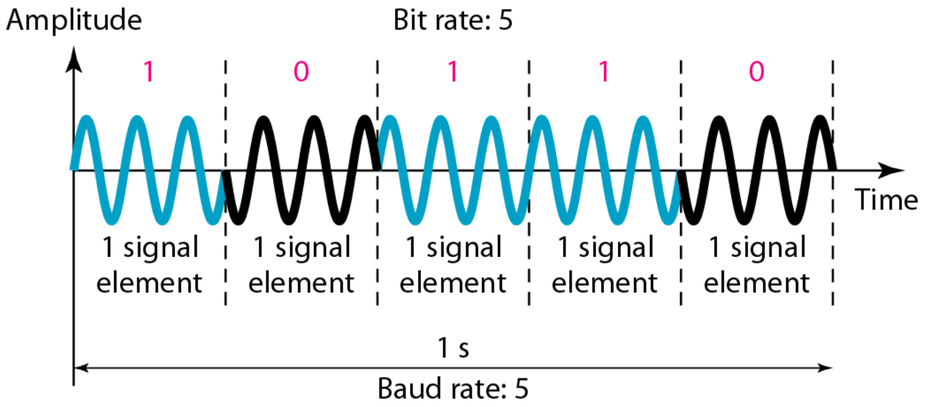


where $s_0 = -A\cos(\omega_c t)$ and $s_1 = A\cos(\omega_c t)$

- Major drawback – rapid amplitude change between symbols due to phase discontinuity, which requires infinite bandwidth. **Binary Phase Shift Keying** (BPSK) demonstrates better performance than ASK and BFSK
- BPSK can be expanded to a M-ary scheme, employing multiple phases and amplitudes as different states

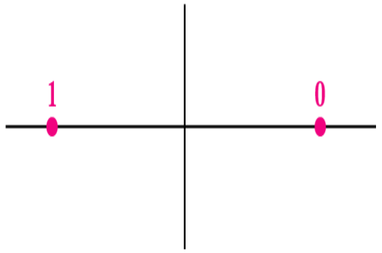
Phase Shift Keying

- In phase shift keying, the phase of the carrier is varied to represent two or more different signal elements (Both peak amplitude and frequency remain constant).
- In binary PSK, we have only two signal elements: one with a phase of 0°, and the other with a phase of 180°.



Bit	Phase
0	0
1	180

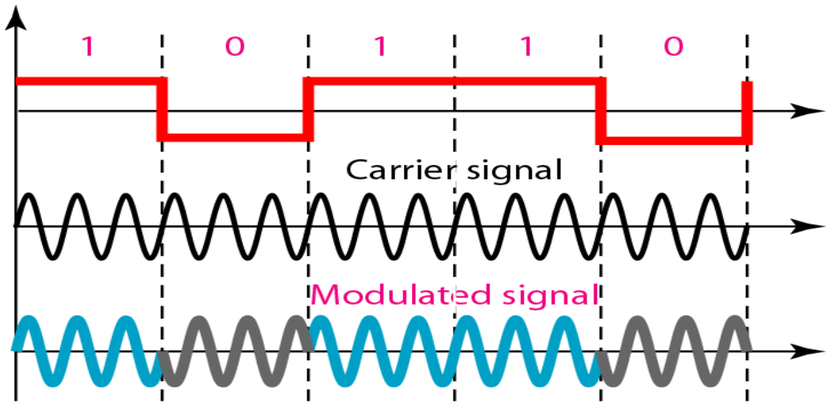
Bits



Constellation diagram

Bandwidth of Binary PSK

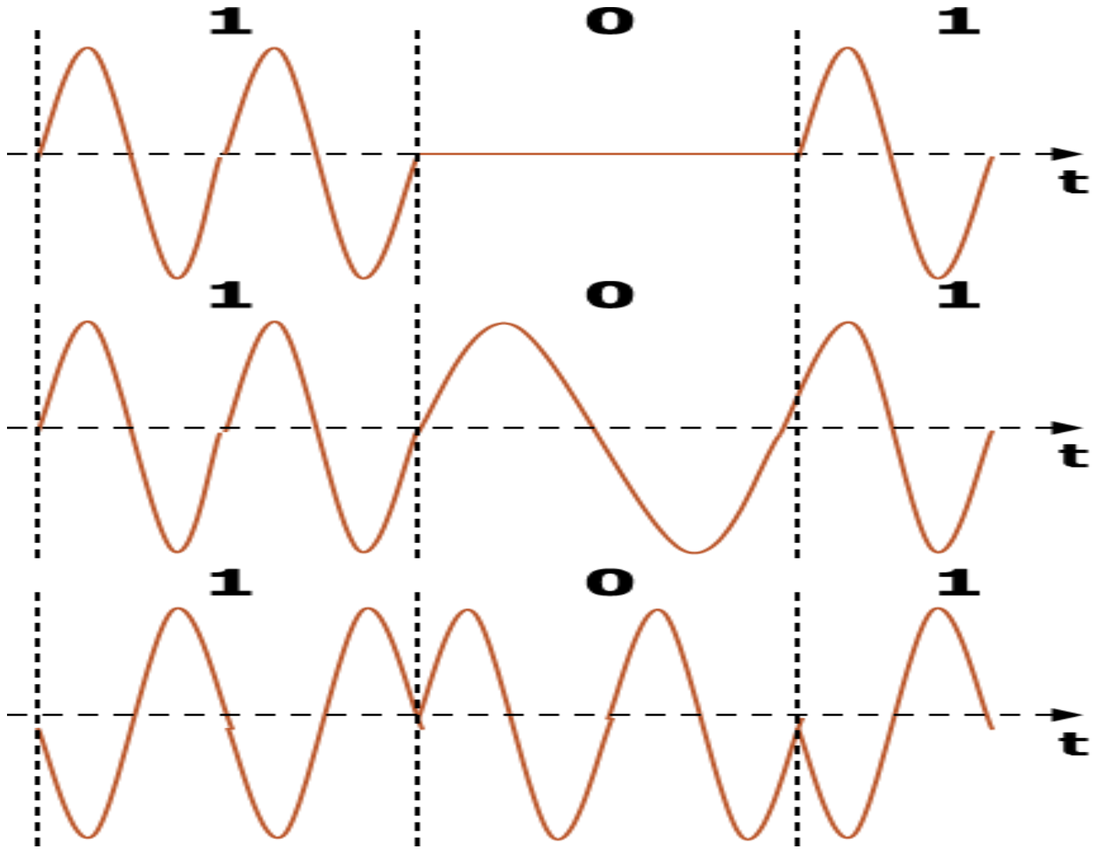
- PSK is less susceptible to noise than ASK.
- PSK is superior to FSK because we do not need two carrier signals.
- The implementation of BPSK :
  - the signal element with phase 180° can be seen as the complement of the signal element with phase 0°.



Digital Modulation Summary

Amplitude Shift Keying (ASK)	Frequency Shift Keying (FSK)	Phase Shift Keying (PSK)
• Very simple.	• Needs larger bandwidth.	• More complex.
• Low bandwidth requirements	• More error resilience than AM.	• Robust against interference.
• Very susceptible to interference		

Digital Modulation Summary




THANK YOU!