PULSE MODULATION TECHNIQUES

INTRODUCTION

- Modulation is the process of frequency translation in which any one parameter(Amplitude, frequency or phase) of high frequency carrier signal is varied in accordance with instantaneous value of low frequency modulating signal.
- Modulation is either analog or digital.

INTRODUCTION

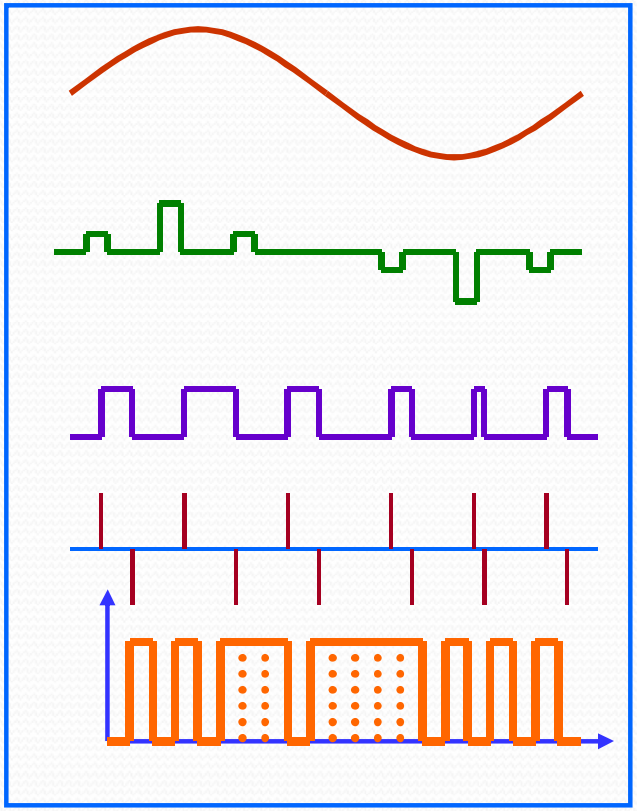
- Many signals in modern communication systems are digital
- Additionally, analog signals are transmitted digitally
- Digitizing a signal results in reduced distortion and improvement in signal-to-noise ratios

INTRODUCTION

- A digital signal is superior to an analog signal because it is more robust to noise and can easily be recovered, corrected and amplified. For this reason, the tendency today is to change an analog signal to digital data.
- The process of transmitting signals in the form of pulses (discontinuous signals) by using special techniques.

PULSE MODULATION INCLUDES

- Pulse Amplitude Modulation
- Pulse Width Modulation
- Pulse Position Modulation
- Pulse Code Modulation
- Delta Modulation



PULSE MODULATION

Analog Pulse Modulation

- Pulse Amplitude (PAM)
- Pulse Width (PWM)
- Pulse Position (PPM)

Digital Pulse Modulation

- Pulse Code (PCM)
- Delta Modulation(DM)

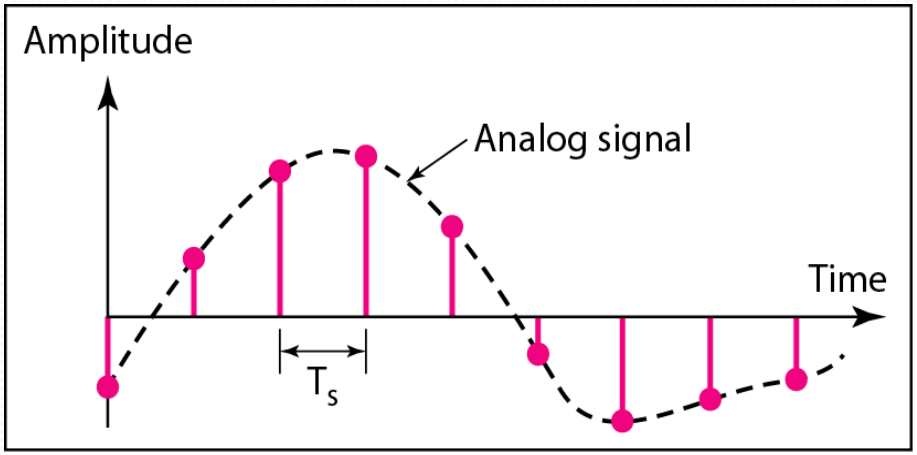
Sampling

- The process of transmitting signals in the form of pulses (discontinuous signals) by using special techniques.
- The signal is sampled at regular intervals such that each sample is propotional to the amplitude of signal at that instant.This technique is called “sampling”.
- Sampling is common in all pulse modulation techniques.

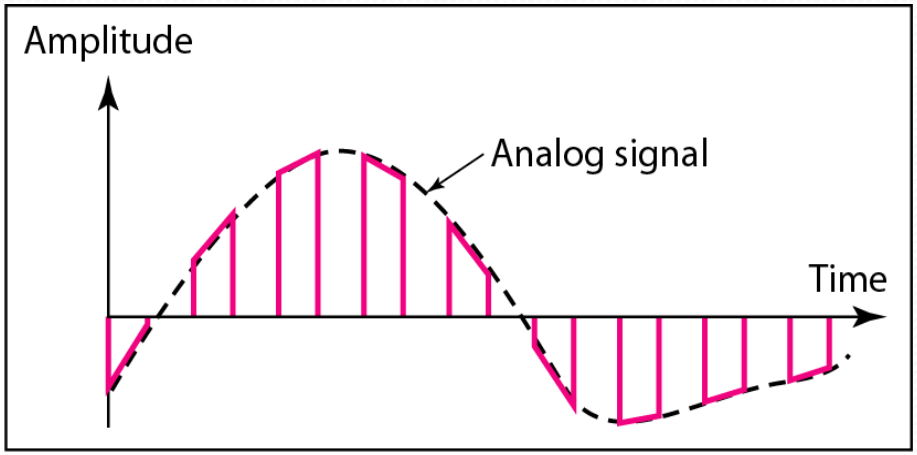
Sampling

- Analog signal is sampled every T_S secs.
- T_s is referred to as the sampling interval.
- $f_s = 1/T_s$ is called the sampling rate or sampling frequency.
- There are 3 sampling methods:
  - Ideal - an impulse at each sampling instant
  - Natural - a pulse of short width with varying amplitude
  - Flat top - sample and hold, like natural but with single amplitude value

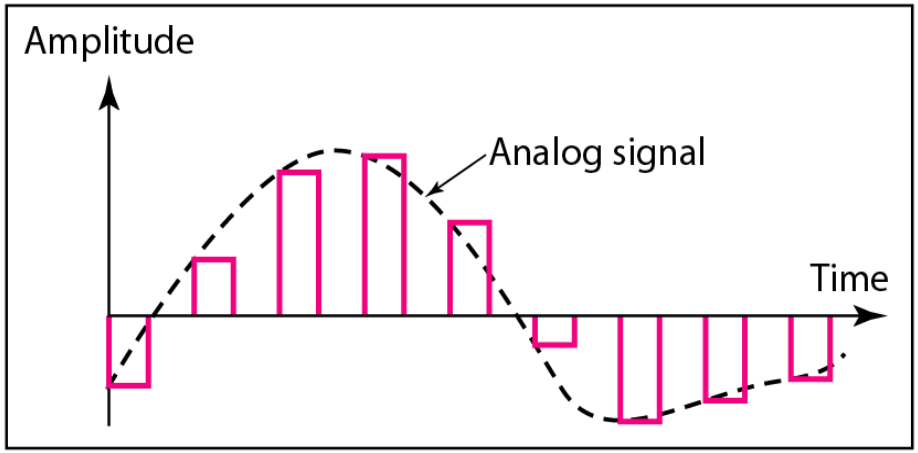
Three different sampling methods



a. Ideal sampling



b. Natural sampling



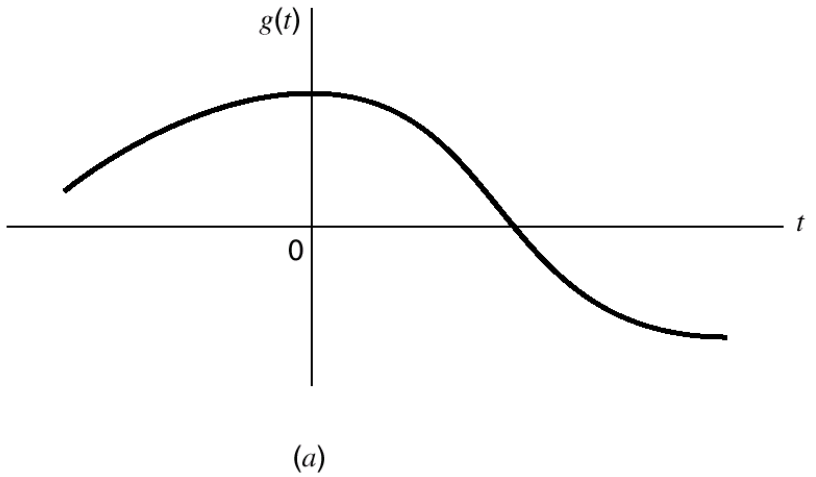
c. Flat-top sampling

Sampling Rate

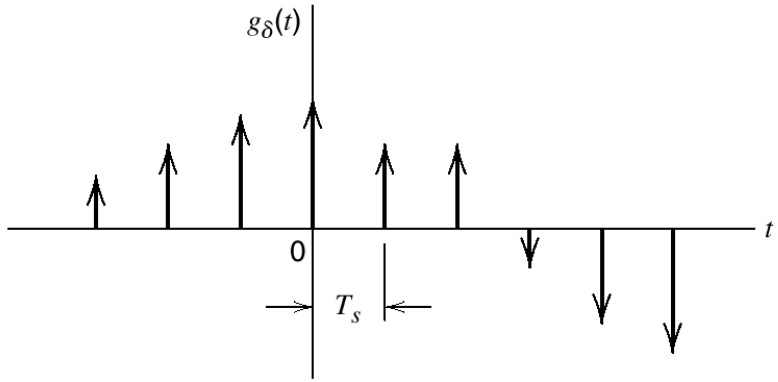
- Nyquist showed that it is possible to reconstruct a band-limited signal from periodic samples, as long as the sampling rate is at least twice the frequency of the of highest frequency component of the signal
  i.e. $f_s \geq 2f_m$

  where f_s is sampling rate
- Sampling rates that are too low result in **aliasing** or **foldover**

Sampling



(a)



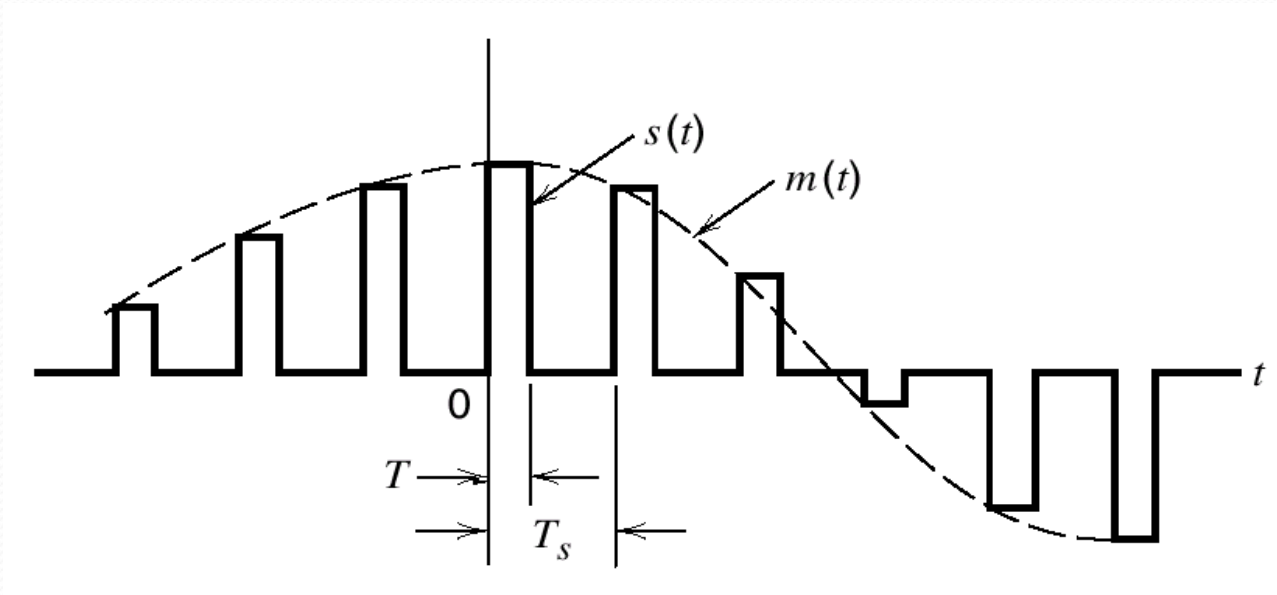
(b)

Sampling

- Sampling alone is not a digital technique
- The immediate result of sampling is a **pulse-amplitude modulation (PAM)** signal
- PAM is an analog scheme in which the amplitude of the pulse is proportional to the amplitude of the signal at the instant of sampling
- Another analog pulse-forming technique is known as **pulse-duration modulation (PDM).** This is also known as **pulse-width modulation (PWM)**
- **Pulse-position modulation** is closely related to PDM

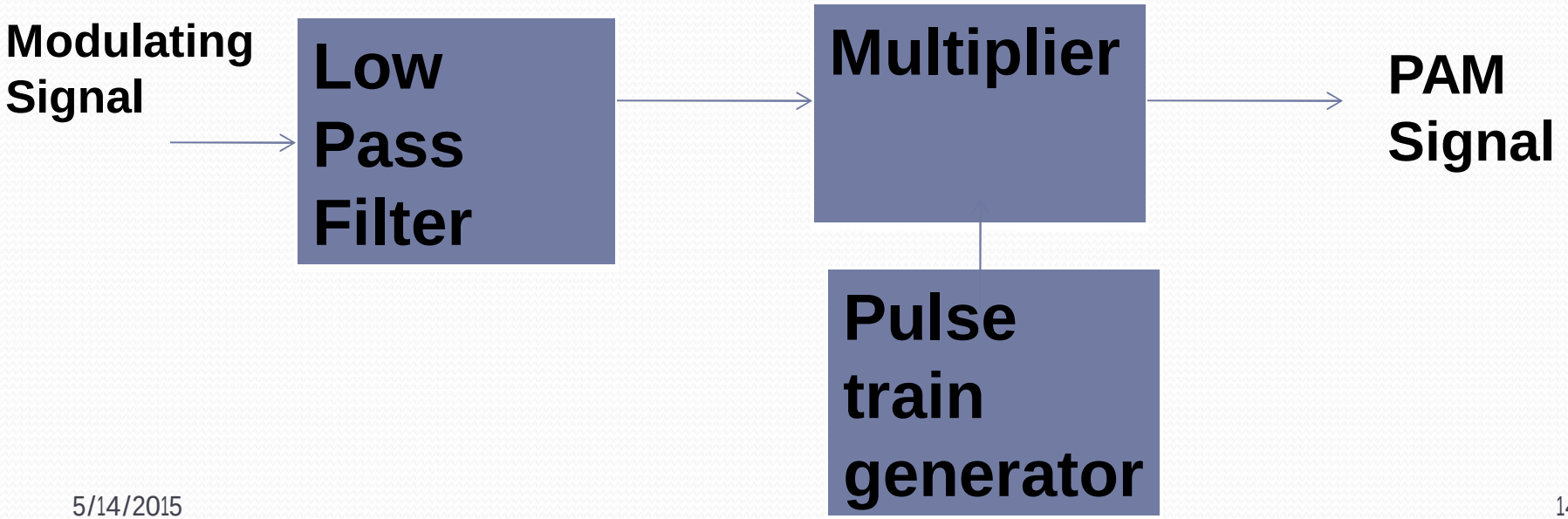
Pulse Amplitude Modulation

- In PAM,amplitude of pulses is varied in accordance with instantaneous value of modulating signal.



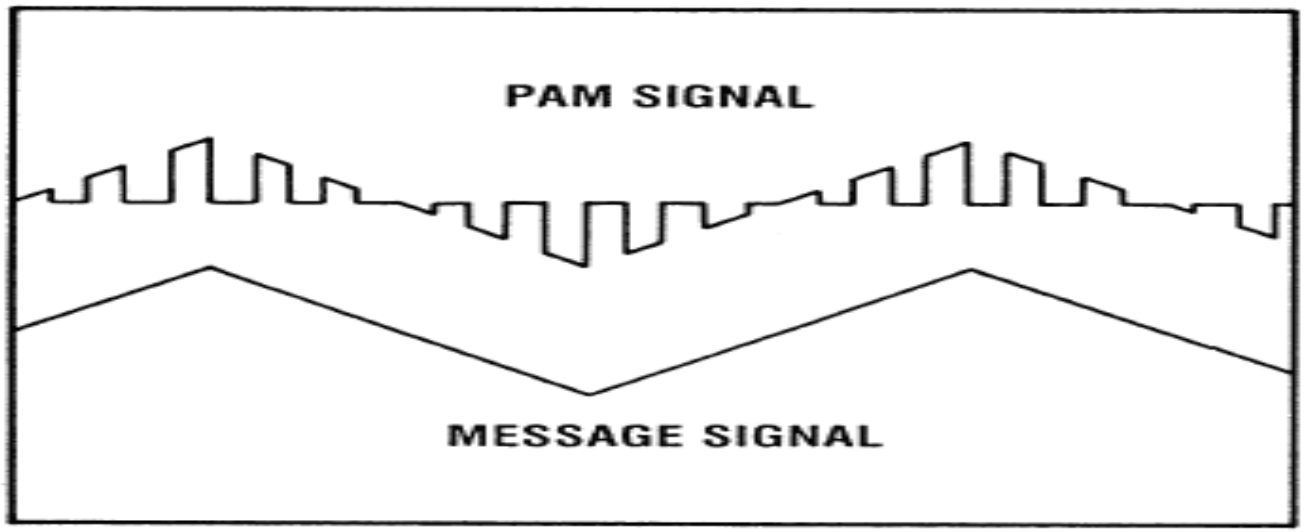
Pulse Amplitude Modulation

The carrier is in the form of narrow pulses having frequency fs.The uniform sampling takes place in multiplier to generate PAM signal.Samples are placed Ts sec away from each other.



Pulse Amplitude Modulation

- Depending upon the shape and polarity of the sampled pulses, PAM is of two types,
- **Natural PAM** sampling occurs when top portion of the pulses are subjected to follow the modulating wave.



Pulse Amplitude Modulation

- **Flat topped PAM** sampling is often used because of the ease of generating the modulated wave. In this pulses have flat tops after modulation.