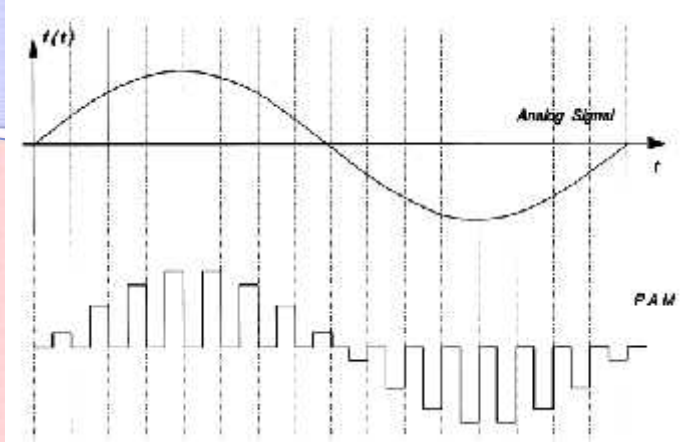

بسم الله الرحمن الرحيم

Ministry of Higher Education and Scientific Research
Foundation of Technical Education
Technical College / Al-Najaf

Training package in
Pulse Modulation
For students of second class



Lecturer
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1/ Over view

1 / A –Target population :-

For students of second class in
Communications Techniques Engineering Department

1 / B –Rationale :-

In analog pulse modulation, a periodic pulse train is used as the carrier wave, and some characteristics features of each pulse (e.g. Amplitude, Position, and Width) is varied in a continuous manner in accordance with the corresponding sample value of the message signal. Thus in analog pulse modulation, information is transmitted basically in analog form, but the transmission takes place at discrete times.

1 / C –Central Idea :-

Define pulse modulation.

2)PAM,PWM, and PPM

3) *Generation of PWM & PPM*

***4)* Comparison of Various Pulse Analog Modulation Methods**

1 / D –Objectives:-

-Explain how it applies to pulse communications.
- Described different modulation processes.
- Compare the different types of pulse systems.

2/ Pre test :-

Multiple Choice Questions With Answer

١ Which of the following pulse modulation system is analog?

(a) PCM (b) Delta modulation

(c) PWM (d) differential PCM

٢ **The transmission bandwidth used by PPM as compared to PAM signal Is**

(a) same **(b) smaller** **(c) larger**

٣

A TDM system requires

(a) lower bandwidth (b) low signal to noise ratio

(c) uses simpler circuit as compared FDM system.

٤

A total of n message each band limited to B, are time division multiplexed using PAM. The minimum bandwidth of the multiplexed will be

(a) B (b) B/2 (c) n B (d) 2nB

Pulse Modulation

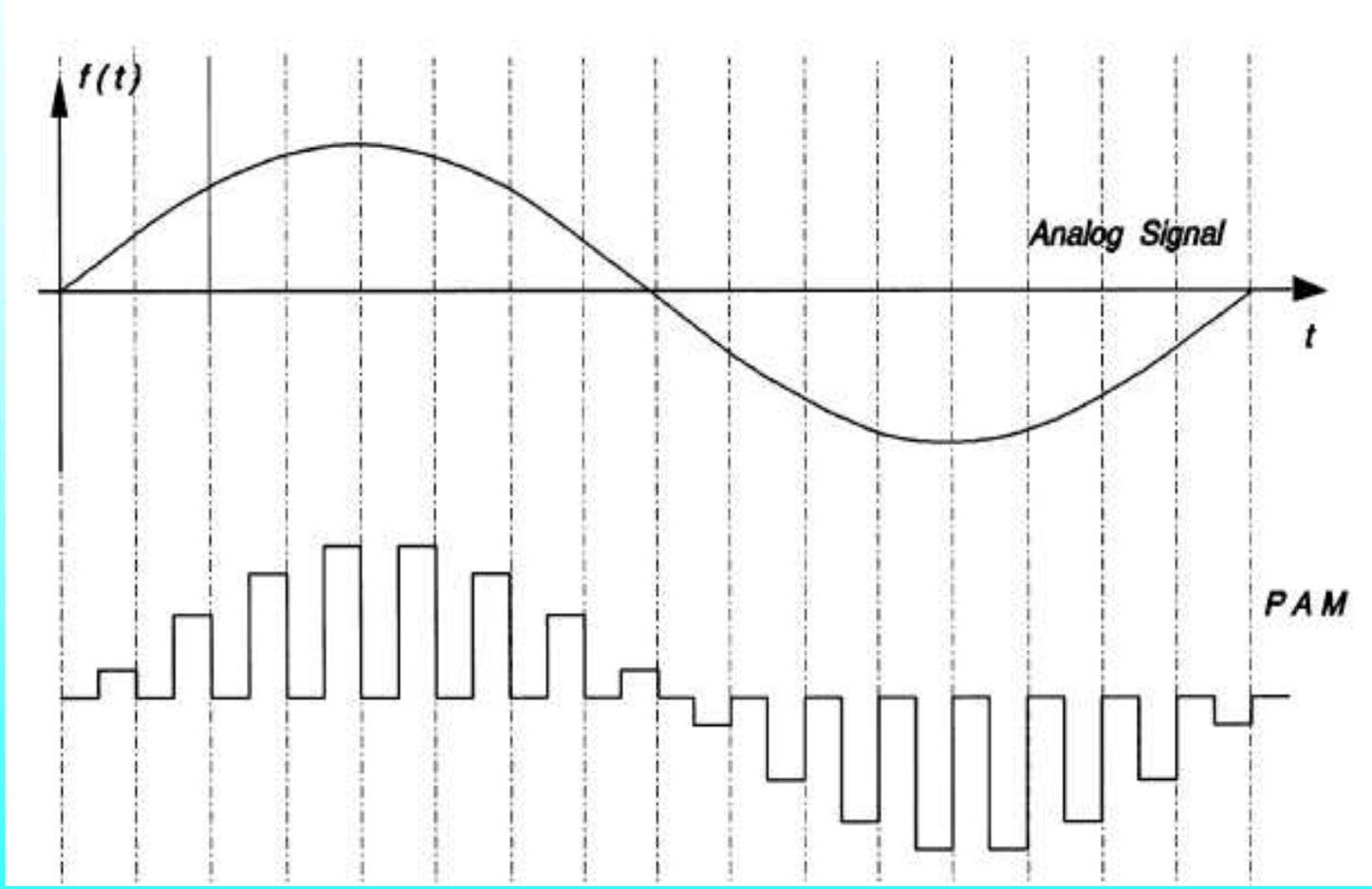
In analog pulse modulation, a periodic pulse train is used as the carrier wave, and some characteristics features of each pulse (e.g. Amplitude, Position, and Width) is varied in a continuous manner in accordance with the corresponding sample value of the message signal.

Thus in analog pulse modulation, information is transmitted basically in analog form, but the transmission takes place at discrete times.

Pulse Amplitude Modulation (PAM)

- PAM is the simplest and most basic form of analog pulse modulation. In PAM the amplitude of regularly spaced pulses are varied in proportion to the corresponding sample values of a continuous message signal, the pulses can be of a rectangular form or other appropriate shape.
- PAM as defined here is somewhat similar to natural sampling where the message signal is multiplied by a periodic train of rectangular pulses. However, in natural sampling the top of each modulated rectangular pulse varies with the message signal, whereas in PAM it is maintained flat.

The waveform of PAM signal is shown in figure below.



There are two operations involved in the generation of the PAM

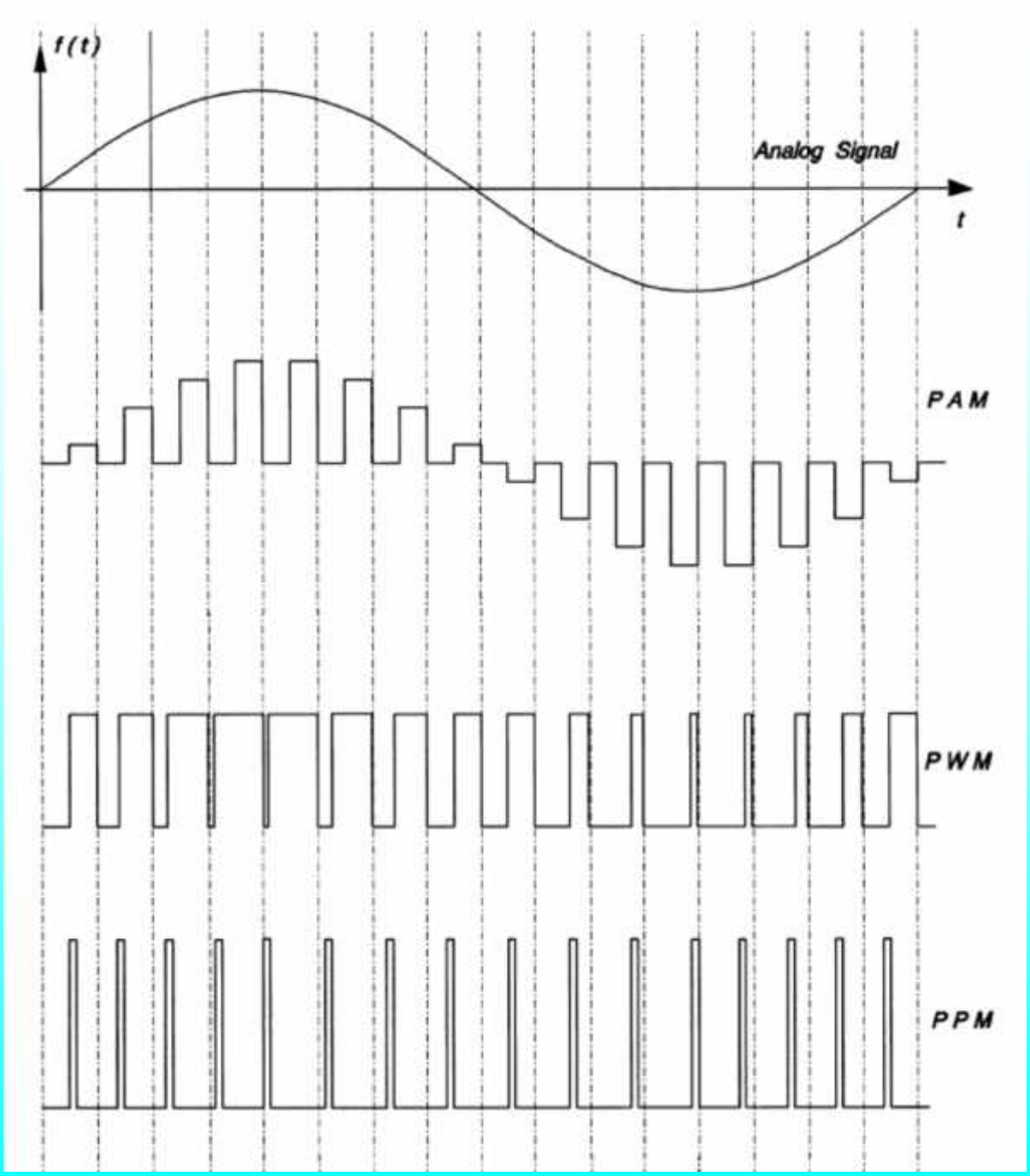
- (i) Instantaneous sampling of the message signal every Ts second, where the sampling rate fs=1/Ts is chosen in accordance with the

  sampling theorem.
- (ii) Lengthening the duration of each sample so obtained to some constant value (τ).

Other Types of Analog Pulse Modulation (PWM&PPM)

One type of pulse timing modulation uses constant amplitude pulses whose width is proportional to the value of message signal at the sampling instants. This type is designated as *pulse width modulation (PWM) or pulse duration modulation (PDM)* is also called.

Another possibility is to keep both the amplitude and the width of the pulses constant but vary the pulse position in proportion to the value of message signal at sampling instant. This is designated as *pulse position modulation (PPM)*.


f(t)
Analog Signal
t
PAM
PWM
PPM

- In PWM, the signal f(t) is sampled periodically at a rate fast enough to satisfy the requirements of the sampling theorem. At each sampling instant a pulse is generated with fixed amplitude and a width that is proportional to the sample value of f(t). A minimum pulse width is assigned to the minimum value of f(t).

- In PPM, these are sent as constant width, constant amplitude pulses. The minimum pulse delay is used to designate the minimum value of f(t) and the change in delay is proportional to the modulating signal. The constant of proportionality is the modulation constant.

Generation of PWM & PPM

- **Generation of PWM and PPM commonly employs various combinations of a sample and holed circuit, a precision ramp voltage generator and a comparator.**
- **The ramp generator produces a precision ramp voltage which has peak to peak amplitude slightly larger than the maximum amplitude range of the input signals. This ramp voltage is the basis for the amplitude to timing conversion and therefore must be accurately known.**

- The comparator is a high gain amplifier intended for two stated operation. If input signal is higher than a preset reference level, the output is held in one state (i.e. a given voltage level). Whenever the input signal level is less than the reference level, the output is held in the other state. Which output state is present, then, depends upon whether the input is above and below the threshold (reference level) of the comparator.

. The voltage reference level of the comparator is adjust so that there is always an intersection with the sum of the sample and hold circuit and ramp voltage. In this system, the first crossing of the reference level indicates the clock timing and the second crossing generates the variable trailing edge.

A convenient way to generate PPM is to use PWM waveform generated above and then trigger a constant width pulse generation those edge of the PWM waveform with a negative slope.

Comparison of Various Pulse Analog Modulation Methods:

PAM	PWM	PPM
Amplitude of the pulse is proportional to amplitude of modulating signal.	Width of the pulse is proportional to amplitude of modulating signal.	The relative position of the pulse is proportional to amplitude of modulating signal.
The bandwidth of the transmission channel depends on width of the pulse.	The bandwidth of the transmission channel depends on rise time of the pulse.	The bandwidth of the transmission channel depends on rising time of the pulse.

The instantaneous power of the transmitter varies.	The instantaneous power of the transmitter varies.	The instantaneous power of the transmitter remains constant.
Noise interference is high.	Noise, interference is minimum.	Noise, interference is minimum.
System is complex	Simple to implement	Simple to implement
Similar to amplitude modulation	Similar to frequency modulation	Similar to phase modulation

Example: For a pulse-amplitude modulated (PAM) transmission of voice signal having maximum frequency equal to fm = 3kHz, calculate the transmission bandwidth. It is given that the sampling frequency fs = 8 kHz and the pulse duration t = 0.1Ts.

Solution: The sampling period Ts is expressed as

$$T_s = \frac{1}{f_s} \quad \text{or} \quad T_s = \frac{1}{8 \times 10^3} \text{ seconds}$$

$$T_s = 0.125 \times 10^{-3} \text{ seconds}$$

$$T_s = 125« \text{ seconds}$$

$$^{2} = 0.1\ T_s$$

$$^{2} = 0.1 \times 125 = 12.5\ \text{«}\ \text{seconds}$$

$$BW \geq \frac{1}{2^{2}}$$

$$BW \geq \frac{1}{2 \times 12.5 \times 10^{-6}}$$

$$\geq \frac{1 \times 10^{6}}{25}$$

$$BW \geq 40\ kHz$$

Quiz /

١ **Define pulse modulation**

Pulse modulation is defined as that of the parameter of a pulse train is varied in accordance with the message signal or modulating signal.

٢ **Define Pulse Position Modulation**

Pulse Position Modulation is defined as the type of modulation in which the position of a pulse relative to its unmodulated time of occurrence is varied in accordance with message signal

5/ Post test :-

1. Pulse width modulation may be generated

(a) by differentiating pulse position modulation

(b) with a monostable multivibrator

(c) by integrating the signal

(d) with a free-running multivibrator

2. Three 4 kHz speech channel are ideally samples and time multiplexed. The required channel bandwidth is

(a) 4 kHz (b) 8 kHz (c) 12 kHz (d) 24 kHz

3. Indicate which of the following system is digital

(a) PPM (b) PWM (c) PDM (d) PCM

4. PAM signal can be recovered by

(a) a band pass filter (b) a low pass filter

(c) a high pass filter (d) None

References

1. T. R. Ganesh Babu, and G. Srinivasan: " Communication Theory and systems", 2006.

2. Sanjay Sharma: "Communication Systems (Analog and Digital) ".

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