Unit - IV

Digital Communication - base band transmission and reception - digital carrier - PCM. Delta modulation, generation and demodulation, signal to Noise ratio - Digital modulation Schemes - ASK, FSK, PSK, WDM (Quantitative only)

Introduction to Digital Communication

Digital modulation: Digital modulation is defined as changing the amplitude of the carrier signal with respect to the binary information or digital signal

Bit rate is the number of bits transmitted during one second b/w the transmitter and receiver or have occupied.

Band width efficiency :- Bandwidth efficiency is the ratio of the transmission bit rate to the minimum bandwidth required for a particular modulation.

Advantages:-

=> It has a better noise immunity

=> Repeaters can be used b/w transmitters & receivers

=> It becomes simpler and cheaper as compared to the Analog communication.

Disadvantages:-

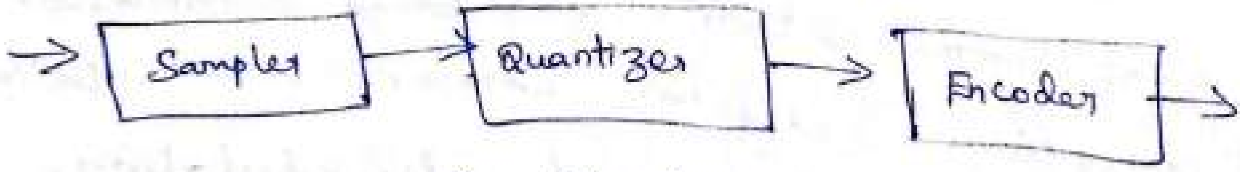
=> It requires a larger channel band width

=> Delta modulation needs synchronization incase of synchronous modulation.

PCM - pulse code modulation

pulse code modulation refers a form of source coding. It is a form of digital modulation techniques in which the code refers a binary word that represent digital data. the pulses are of fixed length and fixed amplitude

Transmitter Block Diagram.



Block diagram of Receiver

Pulse position modulation.

The position of a carrier pulse is altered in accordance with information contained in sampled waveform.

⇒ Sampling rate f_s must be atleast two times the highest frequency component of the Original Signal to be accurately represented $f_s >= 2f_m$.

Baseband signal receiver :-

A baseband signal receiver increases the signal to noise at the instant of sampling. This reduces the probability of error. The baseband signal receiver is also called optimum receiver.

Matched filter :- The matched filter is a baseband signal receiver, which works in presence of white Gaussian noise. The impulse response of the matched filter is matched to the shape of the input signal.

impulse response is given as

$$h(t) = [2K/N_0]\{x\}(T-t)\}$$

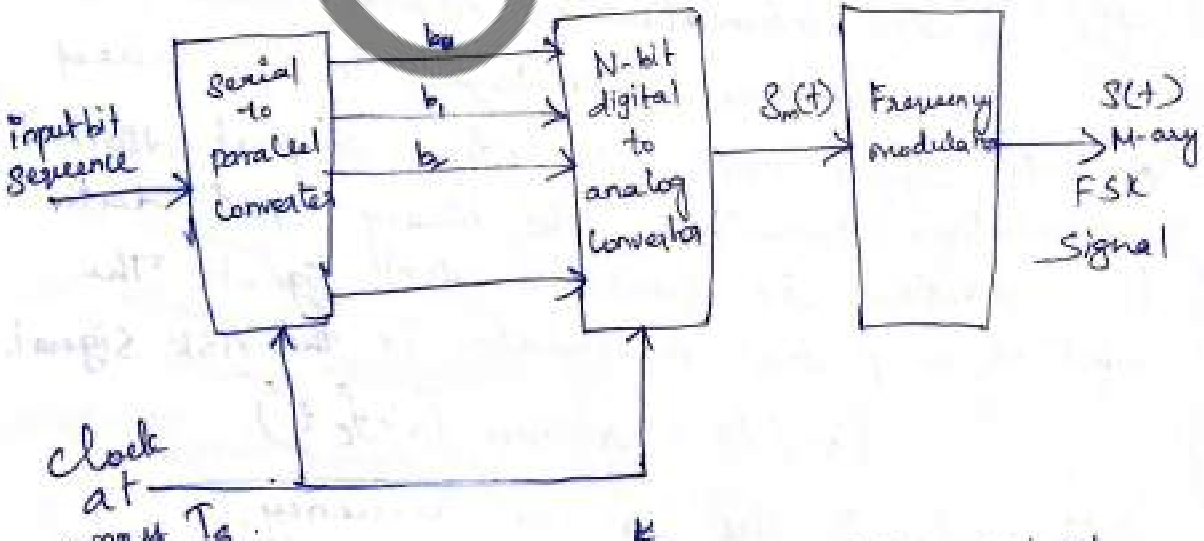
Here T is the period of sampling $x_1(t)$ and $x_2(t)$ are the two signals used for transmission.

Frequency shift Keying (FSK)

Frequency shift keying is the as changing amplitude of the carrier signal with respect to the binary information to digital signal.

Transmitter :- The M-ary FSK transmitter, the N successive bits are presented in parallel of digital to analog converter. These "N" bits forms a symbol at the output of digital to Analog converter. The $2^N = M$ possible symbols. The symbol is presented every $T_s = NT_b$ period. The output of digital to analog converter is given to a frequency modulator.

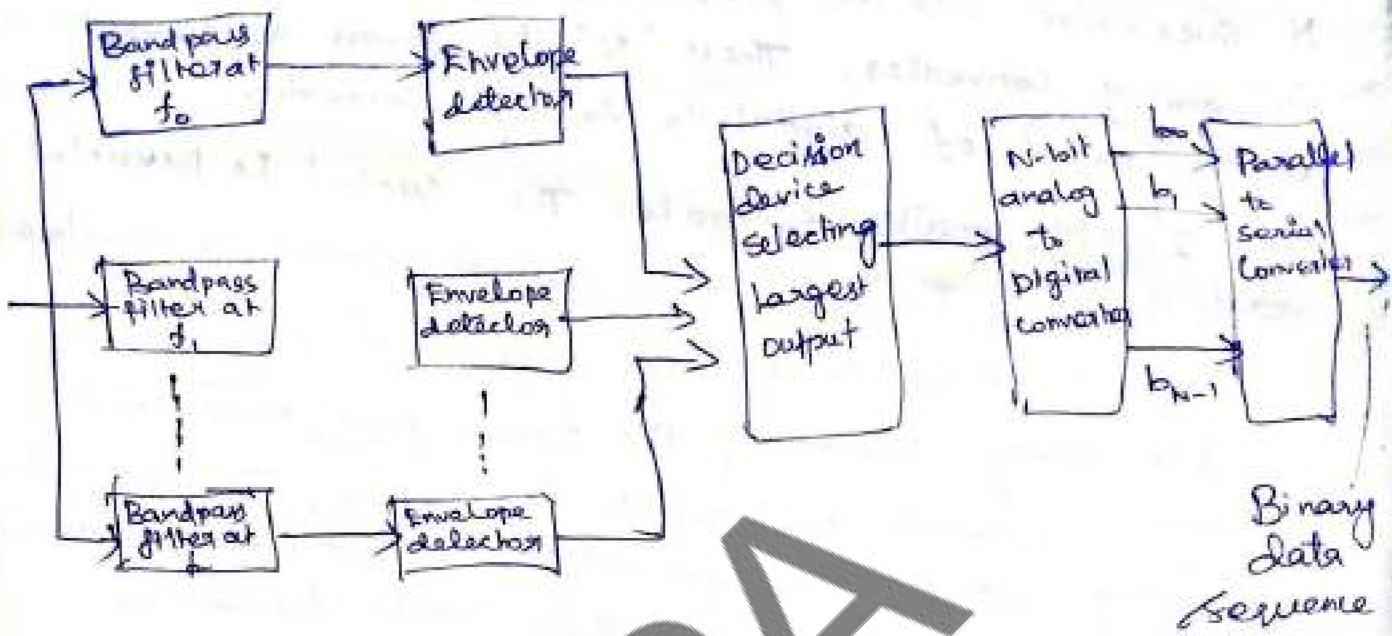
For every symbol, the frequency modulator Produces generates the output frequency. This particular frequency signal remains at the output for one symbol duration. Thus for "M" symbols, there are M frequency signals at the output of modulator. Thus the transmitted frequencies are $f_0, f_1, f_2 \ldots f_{M-1}$ depending upon the input symbol, to the modulator.



Receiver : The M-ary FSK is given to the set of M. bandpass filter. The center frequencies of those filters are $f_0, f_1, f_2 \ldots f_{M-1}$. These filters pass their particular frequency. The decision devices Produces its output depending upon the highest input.

⇒ Depends upon the particular symbol only one envelope detector will have higher output.

⇒ The output of other detectors will be very low. The output of the decision device is given to 'N' bit analog to digital converter. The analog to digital converter output is the 'N' bit symbol in parallel.



Amplitude Shift Keying:-

Amplitude shift keying is the as changing amplitude of the carrier signal with respect to the binary information or digital system.

The amplitude shift keying is also called on-off keying (OOK). This is the simplest digital modulation technique. The binary input data is converted to unipolar NRZ signal. The output of the product modulator is the ASK signal.

$$v(t) = a \sin(2\pi f_c t)$$

Here f_c is the carrier frequency.

and d is the data bit. which is either 1 or 0.

⇒ The binary data sequence d is given to the signal suitable for product modulator. The product modulator is passed through a bandpass filter for bandwidth limiting.

The output of the bandpass filter is the ASK signal.

This signal and other waveforms are shown.

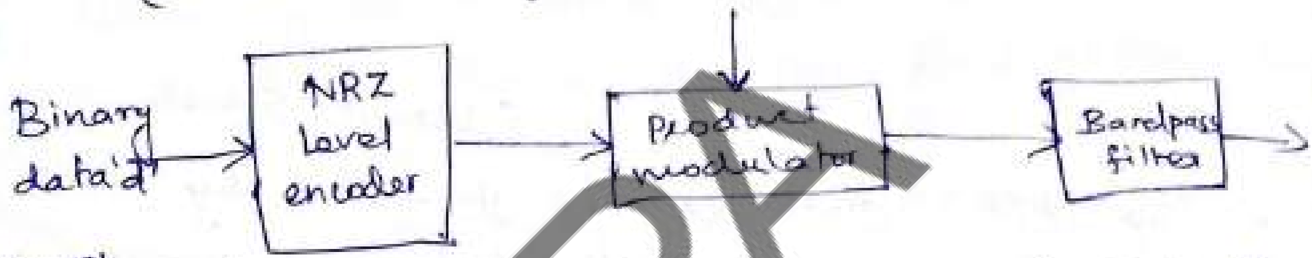
when $d = 0$ $v(t) = 0$ ⇒ No ASK signal

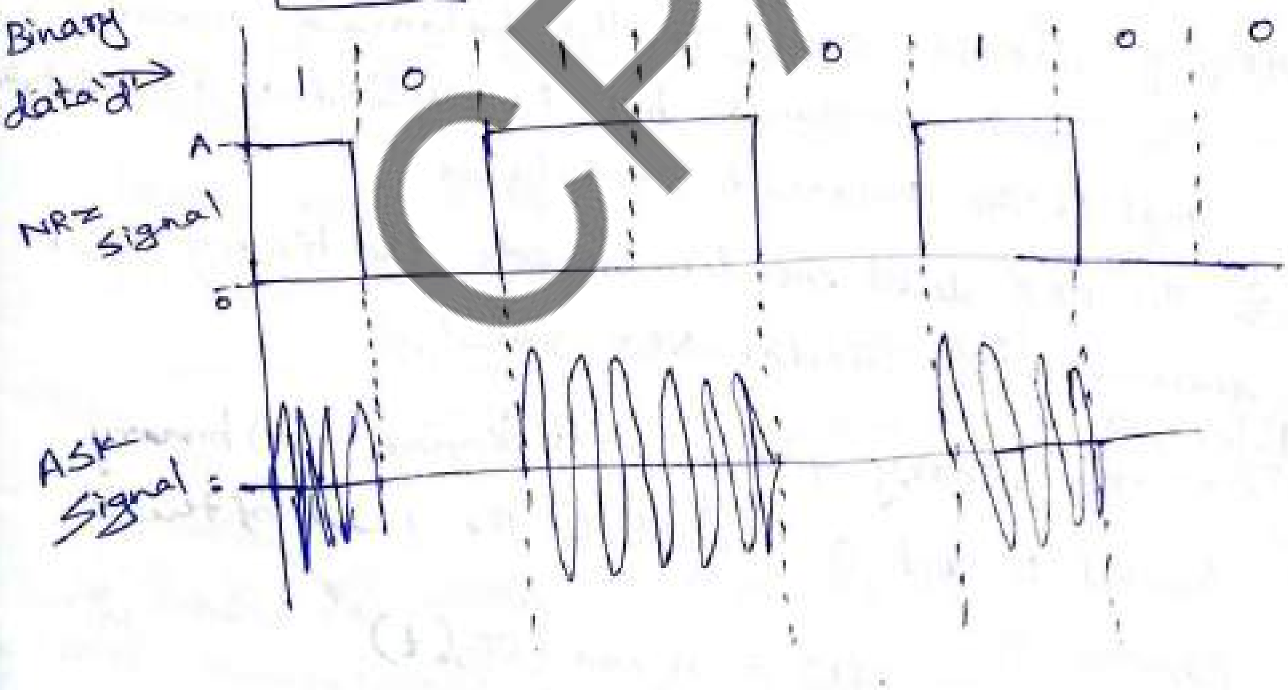
$d = 1$ $v(t) = \sin 2\pi f_c t$ ⇒ ASK is very sensitive to noise.

For ASK the ASK waveform is changed at the bit rate. Baud rate is given as,

Baud rate $= f_b$

(a) Block diagram of ASK modulator





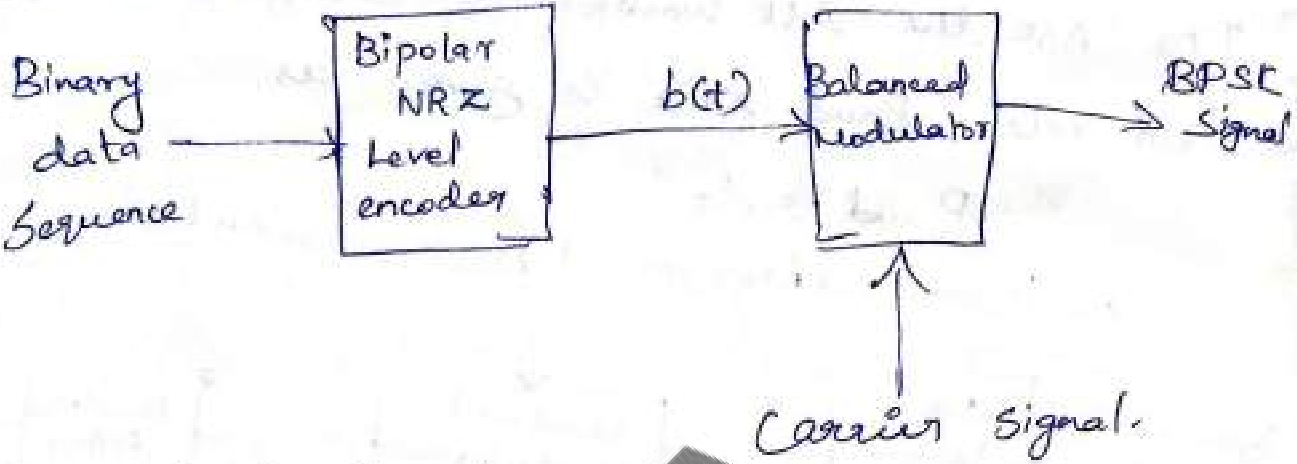
(b) Waveforms.

Phase shift keying :- phase shift keying is the changing amplitude of the carrier signal with respect to the binary information or digital signal.

(i) Binary phase shift keying (BPSK)

(ii) Quadrature phase shift keying (QPSK)

(i) Binary phase shift keying (BPSK)



⇒ The BPSK signal can be generated by applying carrier signal to the balanced modulator.

⇒ The baseband signal b(t) is applied as a modulating signal to the balanced modulator.

⇒ The NRZ level encoder converts the binary data sequence into bipolar NRZ signal.

Principle:-

⇒ In binary phase shift keying (BPSK) binary symbol 1 and 0 modulate the phase of the carrier.

$$s(t) = A \cos(2\pi f_0 t)$$

A represents peak value of sinusoidal carrier. In the standard 1Ω load register the power dissipated will be.

$$P = \frac{1}{2} A^2$$

$$A = \sqrt{2P}$$

(i) When the symbol is changed, the phase of carrier is changed by 180 degree (π filters)

Operation of the receiver.

(i) phase shift in received signal :- The signal undergoes the phase change depending upon the time delay from transmitter to receiver. The phase change is normally fixed phase shift in the transmitted signal. The phase shift be θ. The signal at the input of the receiver is,

$$S(t) = b(t)\sqrt{2P}\cos(2\pi f_0 t + \theta)$$

(ii) Square Law device :- This received signal a carrier is separated since this is coherent detection. The received signal is passed through a square Law device. At the output of the square Law device the signal will be,

$$\cos^2(2\pi f_0 t + \theta)$$

.Bandwidth of BPSK signal.

The spectrum of the BPSK signal is centered around the carrier frequency f_0.

If $f_b = \frac{1}{T_b}$, Then for BPSK the minimum frequency in the baseband signal f_b.

⇒ The main Lobe is centered around carrier frequency f_0 and extended from $f_0 - f_b$ to $f_0 + f_b$

Therefore Bandwidth of BPSK signal is

BW = Highest frequency - Lowest frequency in the main Lobe

$$= f_0 + f_b - (f_0 - f_b)$$

$$\boxed{BW = 2f_b}$$

Thus the minimum bandwidth of BPSK signal is equal to twice of the highest frequency contained in baseband signal.