

328

11

SCORING INDICATORS

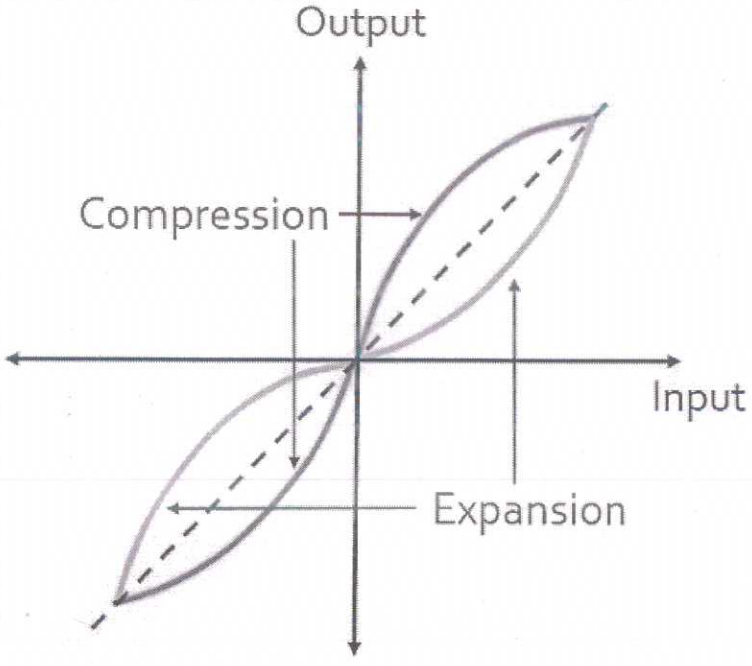
COURSE NAME : Digital Communication

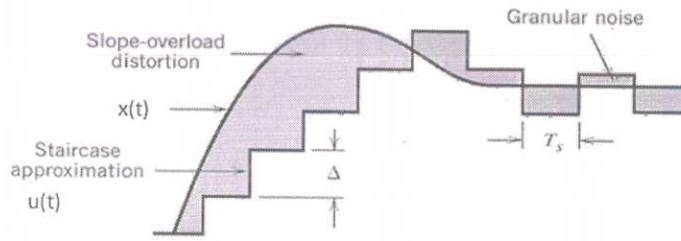
COURSE CODE : 5043D

(21)

QID: 2109230102

Q No	Scoring Indicators	Split score	Sub Total	Total score
	PART A			9
I. 1	4000	1	1	
I. 2	The process of mapping continuous infinite values to a smaller set of discrete finite values.	1	1	
I. 3	1) bandwidth requirement of dpcm is less compared to pcm. 2) quantization error is reduced because of prediction filter. 3) numbers of bits used to represent . One sample value are also reduced compared to pcm.	0.5x2	1	
I. 4	In TDMA, guard time and in FDMA guard time separates adjacent bands/channels	1	1	
I. 5	Simplex, half duplex or full duplex (any two) Synchronous and asynchronous	0.5x2	1	
I. 6	Error detection and correction Data security, error control (any two)	0.5x2	1	
I. 7	Hamming code, Convolution code	0.5x2	1	
I. 8	TDMA, FDMA, CDMA (any two)	0.5x2	1	
I. 9	Orthogonal frequency-division multiplexing is a method of data transmission where a single information stream is split among several closely spaced narrowband sub-channel frequencies instead of a single Wideband channel frequency.	1	1	
	PART B			24
II. 1	<ul style="list-style-type: none"> • It is fast, more accurate, and more reliable than analog communication. • The data with the help of digital communication can be quickly transmitted upto long distances. • The detection and correction of errors is easy. • It allows easy removal of noise, cross-talk, or any interference in the signal. • It is inexpensive due to advanced technologies and compact size. 	0.5x6	3	

	<ul style="list-style-type: none"> • The transmission speed of signal is high. • It facilitates video and audio conferencing, allowing quick meetings and discussion with several people. It saves time and effort. 			
<p>II. 2</p>	<p>It is a type of quantization error, which usually occurs in analog audio signal, while quantizing it to digital. For example, in music, the signals keep changing continuously, where a regularity is not found in errors. Such errors create a wideband noise called as Quantization Noise.</p> <p>Quantization error is the inherent uncertainty in digitizing an analog value as a result of the finite resolution of the conversion process. The difference between an input value and its quantized value is called a Quantization Error. Quantization error depends on the number of bits in the converter, along with its errors, noise, and nonlinearities.</p>	<p>1.5x2</p>	<p>3</p>	
<p>II. 3</p>	<div style="text-align: center;">  <p>Comanding Curve</p> </div> <p>Comanding is a technique of achieving non-uniform quantization. It is a word formed by the combination of words compression and expanding. Comanding is done in order to improve SNR of weak signals.</p>	<p>2 fig +1</p>	<p>3</p>	



Slope Overload Distortion

This distortion is caused due to large dynamic range of the input signal. Because When the input signal rising rate is very high, then the staircase signal cannot approximate it correctly.

II. 4 So it creates large error between the original input signal $X(t)$ and the staircase approximated signal. This noise (error) is known as slope overload distortion.

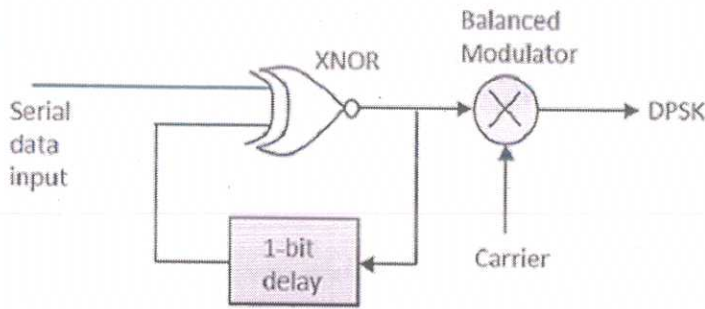
Granular Noise (Idle Noise)

This noise (error) occurs when the step size is too large in comparison to small variations in the input signal.

So because of large step size in comparison to the signal having very small variations or constant; error is introduced between the input signal and the approximated staircases signal. This error is known as the granular or idle noise.

Figure or Explanation is OK for 3 Marks.

3



DPSK Modulator

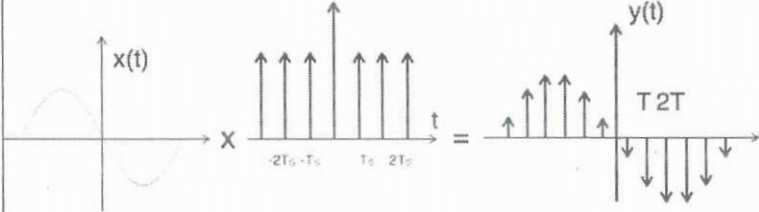
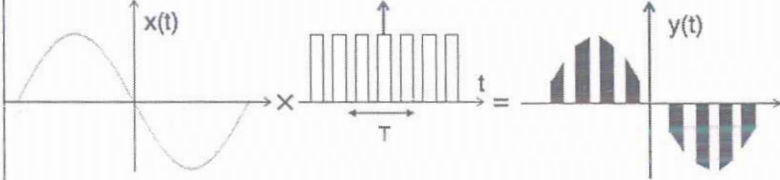
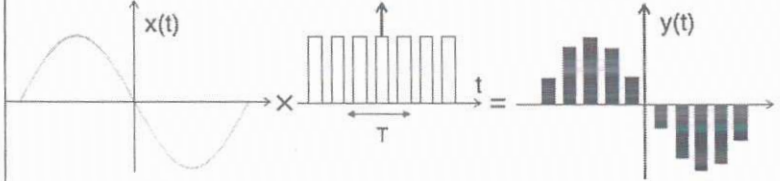
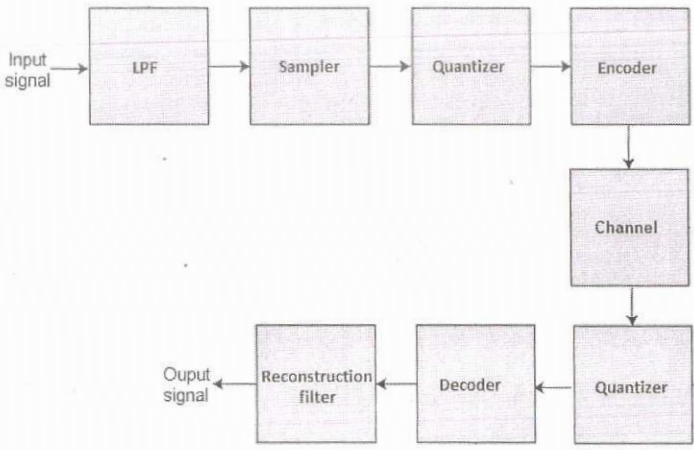
II. 5

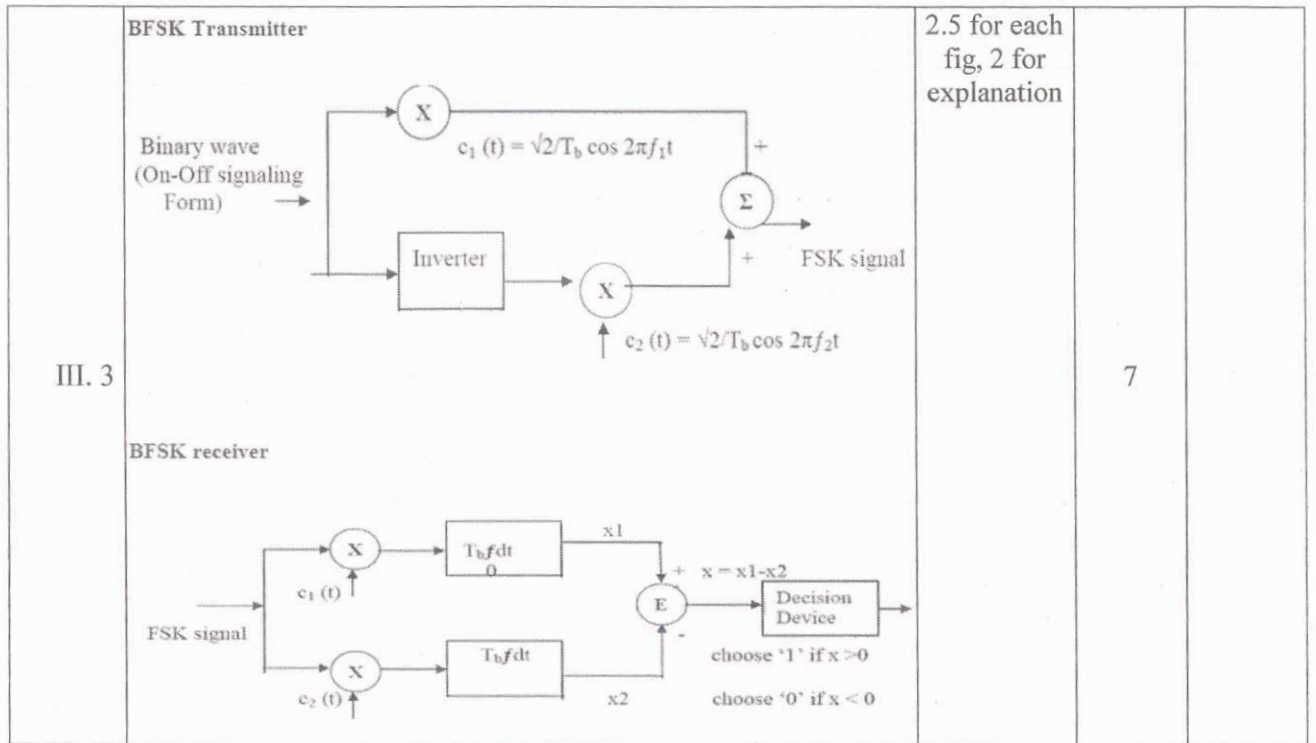
The DPSK stands for “Differential phase-shift keying”. It is one type of phase modulation used to transmit data by altering the carrier wave’s phase. In this, the modulated signal’s phase is moved to the element of an earlier signal. The phase of the signal tracks the low or high state of the earlier element. This kind of phase-shift keying doesn’t require a synchronous carrier on the demodulator.

2 fig +1

3

II. 6	<p>The Shannon Hartley theorem relates the channel capacity, bandwidth, signal power, and noise power to calculate the maximum achievable data rate. It provides a mathematical formula that quantifies the trade-off between the amount of information that can be transmitted and the level of noise present in the communication channel.</p> $C = B * \log_2(1 + S/N)$			1 +2 for equation	3	
II. 7	<p>Multicarrier modulation, MCM is a technique for transmitting data by sending the data over multiple carriers which are normally close spaced. Multicarrier modulation has several advantages including</p> <ol style="list-style-type: none"> 1. resilience to interference, 2. resilience to narrow band fading and 3. resilience to multipath effects. 			1x3	3	
II. 8	<p>A coded sequence of 1s and 0s with specific autocorrelation properties is known as a pseudo-noise (PN) sequence.</p> <p>Both the transmitter and receiver are informed of the PN sequence, which is a deterministic, periodic signal. The signal appears to have the statistical properties of sampled white noise since the signal is deterministic. Thus to an unauthorized listener, it appears as a random signal.</p>			3	3	
II.9	<p>The use of orthogonal subcarriers allows more subcarriers per bandwidth resulting in an increase in spectral efficiency.</p> <p>In a perfect OFDM signal, Orthogonality prevents interference between overlapping carriers. In FDM systems, any overlap in the spectrums of adjacent signals will result in interference.</p> <p>In OFDM systems, the subcarriers will interfere with each other only if there is a loss of orthogonality. For example, frequency error will cause the subcarrier frequencies to shift so that the spectral nulls will no longer be aligned resulting in inter-subcarrier-interference</p>			1x3	3	
II.10	Category	FHSS	DSSS	Any 3 Points 1x3	3	
	Working	Data signals hop between different frequencies	Frequency stays the same			
	Signal transmission rate	Up to 3Mbps	Up to 11Mbps			

	Decoding	Straightforward	Requires an algorithm			
	Noise tolerance	Highly resistant to noise and interference	Sensitive and easily affected by noise			
	Distance consideration	Transmission doesn't depend on distance	Distance affects DSSS data transmission			
PART C						
	<p>Impulse sampling.</p> 					42
III. 1	<p>Natural sampling.</p> 			3 for list and exp, 4 for fig	7	
	<p>Flat Top sampling.</p> 					
III. 2				4 for fig, 3 for explanation	7	



2.5 for each
fig, 2 for
explanation

III. 3

7

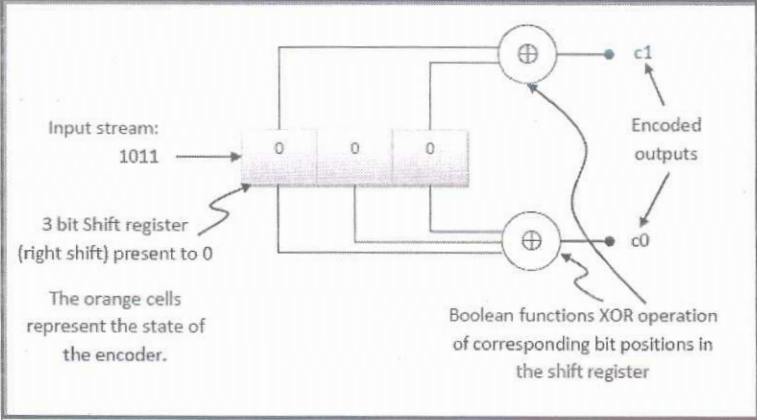
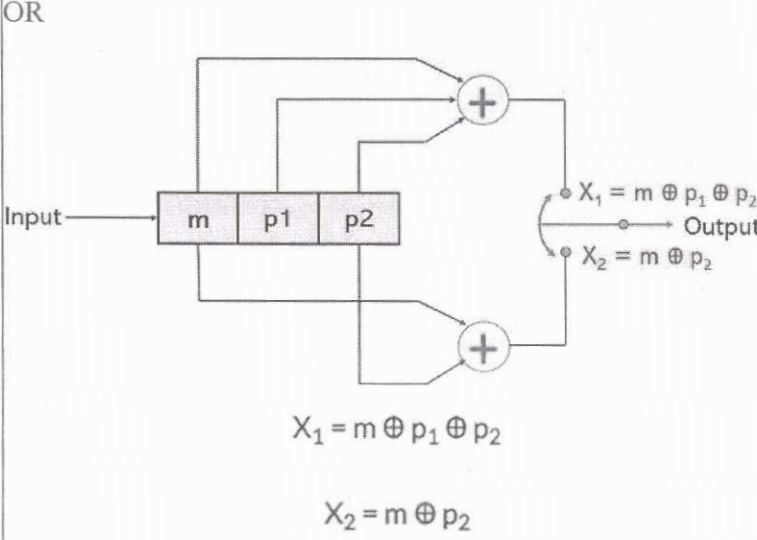
S. No.	Synchronous Transmission	Asynchronous Transmission
1.	In Synchronous transmission, data is sent in form of blocks or frames.	In Asynchronous transmission, data is sent in form of bytes or characters.
2.	Synchronous transmission is fast.	Asynchronous transmission is slow.
3.	Synchronous transmission is costly.	Asynchronous transmission is economical.
4.	In Synchronous transmission, the time interval of transmission is constant.	In Asynchronous transmission, the time interval of transmission is not constant, it is random.
5.	In this transmission, users have to wait till the transmission is complete before getting a response back from the server.	Here, users do not have to wait for the completion of transmission in order to get a response from the server.
6.	In Synchronous transmission, there is no gap present between data.	In Asynchronous transmission, there is a gap present between data.
7.	Efficient use of transmission lines is done in synchronous transmission.	While in Asynchronous transmission, the transmission line remains empty during a gap in character transmission.
8.	The start and stop bits are not used in transmitting data.	The start and stop bits are used in transmitting data that imposes extra overhead.
9.	Synchronous transmission needs precisely	Asynchronous transmission does not

III. 4

Any 7 points
1 mark each

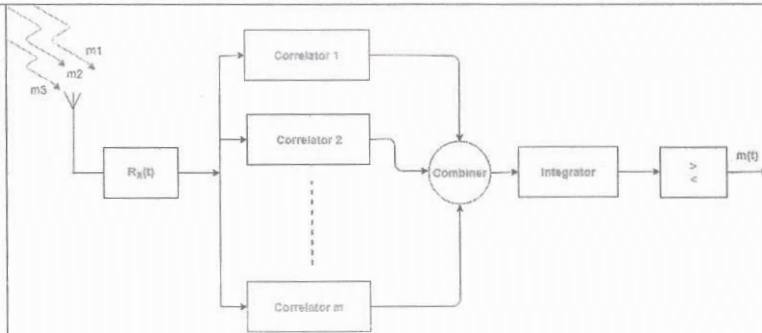
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		synchronized clocks for the information of new bytes.	need synchronized clocks as parity bit is used in this transmission for information of new bytes.			
	10.	Errors are detected and corrected in real time.	Errors are detected and corrected when the data is received.			
	11.	Low latency due to real-time communication.	High latency due to processing time and waiting for data to become available.			
	12.	Examples: Telephonic conversations, Video conferencing, Online gaming.	Examples: Email, File transfer, Online forms.			
III. 5	ASK	FSK	PSK		Any 7 points 1 mark each	7
	1] Information is in amplitude variations.	Information is in frequency variations.	Information is in phase variations.			
	2] Less Bandwidth as compared.	More Bandwidth as compared.	Less to moderate Bandwidth.			
	3] Poor Noise immunity.	Better Noise immunity.	Better Noise immunity.			
	4] Synchronization is not required.	Synchronization is not required.	Synchronization is essential.			
	5] Effect of DC is more.	Effect of DC component is less.	Effect of DC component is less.			
	6] More power required.	Moderate power required.	Less-moderate power required.			
	7] Low bit rate application	Moderate bit rate application.	High bit rate application.			
	8] Simple Implementation.	Moderately complex Implementation.	Very complex Implementation.			
III. 6	<p style="text-align: center;">Multiplexing and Demultiplexing in Synchronous TDM</p>				4 fig, 3 explanation	7
<p>The Time Division Multiplexing (TDM) is a digital procedure. Here, each sender is given the entire possession of the whole bandwidth of the channel for a fixed duration of time. After this, the control is moved to the next sender, and the process continues on a round-robin</p>						

	basis.			
III. 7	<p>Step 1: Write the data bits in their respective positions, leaving the parity bit positions blank:</p> <p style="text-align: center;">_ _ 1 _ 1 0 0 1 P4 P3 1 P2 1 0 0 1</p> <p>Step 2: Calculate the value of each parity bit:</p> <ul style="list-style-type: none"> - P1: Check positions 1, 3, 5, 7. - `1 + 1 + 0 + 0 = 2` (even number), so P1 = 0. - P2: Check positions 2, 3, 6, 7. - `1 + 1 + 0 + 0 = 2` (even number), so P2 = 0. - P4: Check positions 4, 5, 6, 7. - `0 + 1 + 0 + 0 = 1` (odd number), so P4 = 1. <p>Step 3: Fill in the parity bit positions with their calculated values:</p> <p style="text-align: center;">0 0 1 1 1 0 0 1 P4 P3 1 P2 1 0 0 1</p> <p>Therefore, the even parity Hamming code for the data word `11001` is `00111101`.</p>	2 for step 1, Each parity bit 1 mark, final answer 2 mark	7	
III. 8	<p>$C = 4000 \log_2(1 + 100) = 4000 \log_2(101) = 26.63 \text{ kbit/s.}$</p> <p>Note that the value of $S/N = 100$ is equivalent to the SNR of 20 dB.</p>	3 for equation, full mark for correct answer	7	
III. 9	<p>OR</p>  <p>Input stream: 1011</p> <p>3 bit Shift register (right shift) present to 0</p> <p>The orange cells represent the state of the encoder.</p> <p>Boolean functions XOR operation of corresponding bit positions in the shift register</p> <p>Encoded outputs: c1, c0</p>	4 for explanation with example, 3 for figure	7	
	 <p>Input: m, p1, p2</p> <p>Output: $X_1 = m \oplus p_1 \oplus p_2$, $X_2 = m \oplus p_2$</p>			

III. 10	<p>Error Detection and Correction: Hamming code is designed to detect and correct single-bit errors that may occur during the transmission of data. This ensures that the recipient receives the same data that was transmitted by the sender.</p> <p>Redundancy: Hamming code uses redundant bits to add additional information to the data being transmitted. This redundancy allows the recipient to detect and correct errors that may have occurred during transmission.</p> <p>Efficiency: Hamming code is a relatively simple and efficient error-correction technique that does not require a lot of computational resources. This makes it ideal for use in low-power and low-bandwidth communication networks.</p> <p>Widely Used: Hamming code is a widely used error-correction technique and is used in a variety of applications, including telecommunications, computer networks, and data storage systems.</p> <p>Single Error Correction: Hamming code is capable of correcting a single-bit error, which makes it ideal for use in applications where errors are likely to occur due to external factors such as electromagnetic interference.</p> <p>Limited Multiple Error Correction: Hamming code can only correct a limited number of multiple errors. In applications where multiple errors are likely to occur, more advanced error-correction techniques may be required.</p>			Any five feature for full mark	7	
III. 11	<p>Parameters</p>	<p>FDMA</p>	<p>TDMA</p>	Any 7 Points 1x7	7	
Full Form	The term FDMA is an acronym for Frequency Division Multiple Access.	The term TDMA is an acronym for Time Division Multiple Access.				
Mode of Operation	FDMA shares one single bandwidth among various stations by splitting it into sub-channels.	TDMA only shares the time of transmission via the satellite and not the channel.				

Idea of Transmission	It segments a single band of frequency into various disjoint sub-bands.	It segments the sending time of data into disjoint time slots- in a fixed or demand-driven pattern.			
Synchronization	FDMA does not require any synchronization.	TDMA requires synchronization.			
Data Transmission Mode	Transmission occurs via a continuous signal in FDMA.	Transmission occurs via signals in bursts.			
Rate of Data	FDMA supports a low rate of data.	TDMA supports a medium rate of data.			
Flexibility	FDMA is a little flexible.	Flexibility is moderate in TDMA.			
Terminals	Every terminal possesses its own uninterrupted frequency.	Every terminal on the same frequency stays active for a very short time.			
Separation of Signals	It occurs by the process of filtration in the frequency domain.	It occurs by synchronizing the time domain.			
Scheme of Transmission	It is continuous for FDMA.	It is discontinuous for TDMA.			
Capacity of Cells	FDMA has a very limited cell capacity.	TDMA also has a very limited cell capacity.			
Advantages	FDMA is robust, established, and very simple.	TDMA is very flexible, fully digital, and established.			
Disadvantages	FDMA is not very flexible, and the frequencies it possesses are a scarce resource.	TDMA needs guard space (for multipath propagation).			



III. 12

Rake Receiver is used to oppose the characteristics of multipath fading. Multipath fading occurs due to scattering, reflection, and difference of the signals when it comes across any obstacles. Due to this fading, the incoming radio signal will be very weak and can increase its characteristics by using the correlators of the rake receiver.

The Basic idea of this receiver follows multipath diversity. The Multipath diversity means the radio signal from the sender is transmitted to the receiver side in a different path which may have variant delay and attenuation values.

The Performance of the Rake Receiver is that it collects all the time-shifted delays of the transmitted signal and a correlation is provided for each of the multipath signals. The time delays can be seen in each correlator called the search window.

3 fig+ 4 exp

7