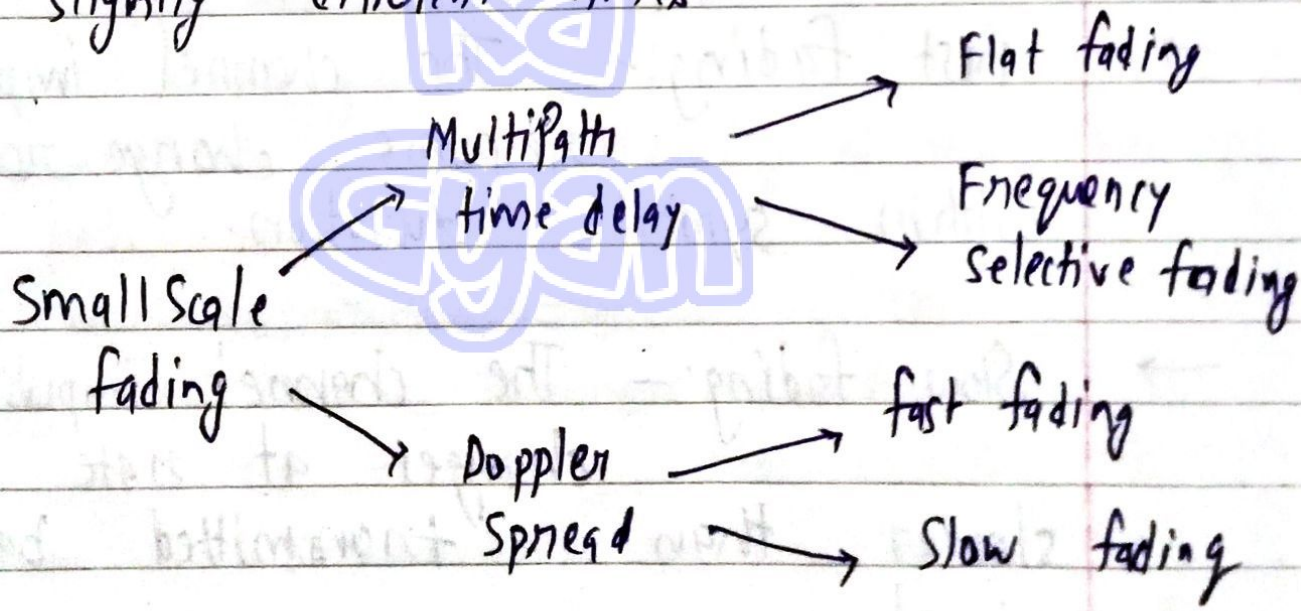
Q.1 Explain Small Scale fading briefly?

Ans - This refers to the fluctuation in signal strength and phase over short distance and small duration of time. It is also called Rayleigh fading. Small fading affects almost all forms of wireless comm and overcoming them is a necessity to increase efficiency & decrease error.

Fading is called by interference b/w 2 or more session of transmitted signal which arrives at receiver at slightly different times.



- Multipath time fading:- It occurs when signal reaches the receiver from various path i.e. when multipath propagation takes place.

→ Flat Fading:- In this all frequency components get affected equally that multipath fading causes the amplitude to fluctuate over a period of time.

→ Selective fading:- It refers to multipath when selected fading components of signal is affected

• Doppler Spread ⇒ Time Varying fading due to motion of scatter or motion of transmitter or receiver or both results in Doppler spread.

→ Fast fading:- The channel impulse response change rapidly within symbol duration.

→ Slow fading:- The channel impulse response changes at rate much slower than transmitted baseband signal.

Q.2 Explain different path loss model free space & two ray models with link budget design.

Ans- The radio propagation channel is main contributon to many impairmence in a wireless system's performance, Suffice it to say that signal attenuation in progration is propagation may be as large as 100–150 dB.

$$P_R = \frac{P_T G_T G_R}{L_T L_R L_P} \quad \text{——— (1)}$$

where P_R & P_T are received and transmitted power resp.

G_R & G_T are receiving & transmitted Antenna gain.

L_R & G_T are receiving & transmitting path loss.

$$L_P = L_o L_S L_L$$

where L_o = Avergge path loss

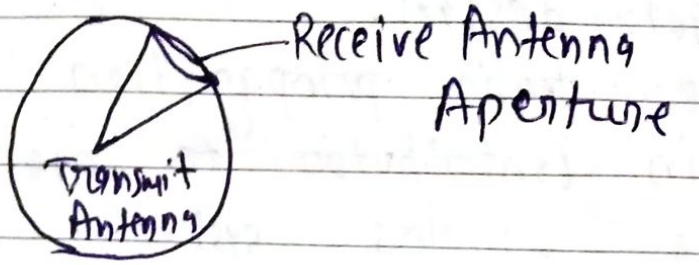
L_L = Long term fading

L_S = Short term fading.

Q.3 Explain free space model with diagram.

Ans - It assumes a transmit antenna and

receive antenna to be located in an otherwise empty environment.



The power density W at distance d from transmitter with power PT & antenna gain G_T is

$$W = P_T G_T / 4\pi d^2$$

The available power P_R at a receive antenna with gain G_R is

$$P_R = \frac{P_T G_T}{4\pi d^2} \cdot A = \frac{\lambda^2}{(4\pi d)^2} G_T P_T G_R$$

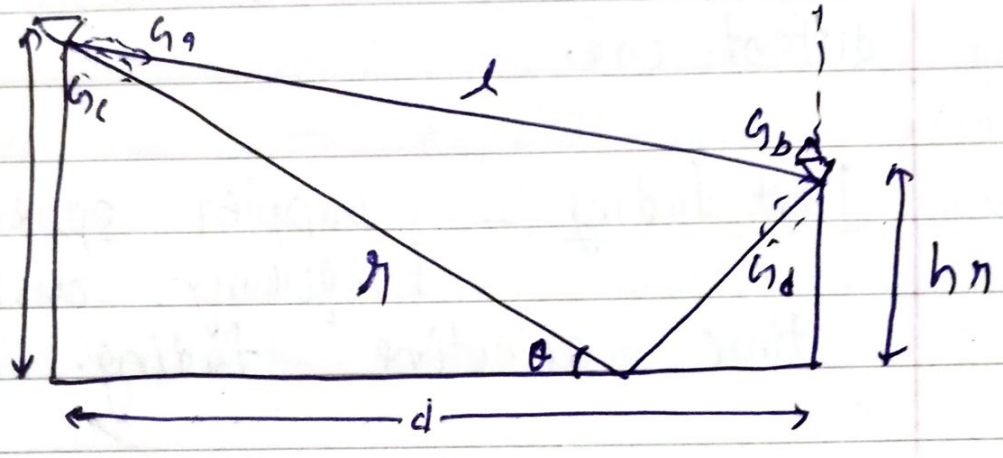
where A = Effective Area on Aperature of antenna

$$G_R = \frac{4\pi A}{\lambda^2}$$

Q.1 Explain two ray model with diagram

Ans - The two rays ground reflection model is radio propagation model which products it path losses b/w its transmitting antenna & a

reducing antenna when they are in line of sight.
The main reasons due to which multipath effect is generated could be reflection, diffraction & scattering.



Power $P_r = P_t \left[\frac{\lambda}{4\pi}\right]^2 \left[\frac{\sqrt{G_R}}{l} + \frac{R\sqrt{G_T e^{j\alpha_q}}}{x+x'}\right]^2$

Q.5 What do you mean by Doppler Spread?

Ans- It is change in frequency of wave in relation to an observer who is moving relative to ~~wave~~ wave source.

The ~~reason~~ reason for doppler Effect is that when the source of wave is moving towards the observer, each successive wave rest is emitted from a position closer to observer than

crest of previous wave.

Fading due to DE:- Fading refers to variation in signal strength w.r.t. time as it is received at antenna from transmitter at distant end.

Fast fading:- Doppler spread leads to frequency dispersion and time selective fading.

Slow Fading:- It results due to following low doppler spread

coherence time >> Symbol Period

Q.1 What do you mean by frequency reuse concept explain.

Ans - **Frequency Reuse:-** Technique for using a specified range of frequencies more than once in same radio system so that total capacity of system is increased without increasing its allocated bandwidth. FR require sufficient isolation among the signals that use some frequency so that mutual interference among them is controlled at an acceptable level.

→ Consider a cellular system which has a total of S duplex channels.

→ Each cell is allocated a group of K channels K<S.

→ The S channels are divided among N cells.

→ The total no. of available radio channels,

$S = KN$.

→ C is used as a measure of capacity.

$C = MK N = MS$

→ The capacity is directly proportional to the no. of replication M.

→ The Hexagonal has exactly six equidistance.

→ The lines pouring the centers of any cell & each of its neighbours are separated by multiples of 60°

→ $N = i^2 + ij + j^2$

Q.2 Explain microcell zone concept with example.

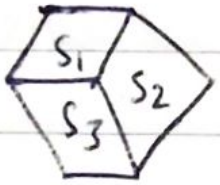
M - A microcell is cell in mobilephone network served by a low power cellular base station, covering a imited area such as a mall or transportation hub. The increased no. of handoffs required when sectoring is employed results in an increased load on the switching and control link elements of mobile system to overcome this problem. A new microcell zone concept has been proposed. This scheme has a cell divided into 3 microcell zones, with each of 3 zones sites connected to base station and sharing the same radio equipment. It is necessary to note that all microcell zones, within a cell use same frequency used by cell, that is no handovers occur b/w microcells.

- Benefits of Microcell zone concept:-

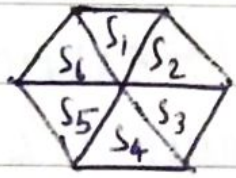
1. Interfence is reduced in this case as compared to scheme in which cell size is reduced.
2. Handoffs are reduced since microcells within the cell operate at same frequency.
3. Size of zone apparatus is small. The zone site equipment being small can be mounted on side of a building or on poles.

Q.3 Discuss sectoring technique.

Ans - A cell has same coverage space but instead of using a single omnidirectional antenna that transmits in all directions either 3 or 6 directional antennas are used such that each of these antennas provides courage to a sector of hexagon.



120° cell sectoring



60° cell sectoring

Advantages:-

(i) Cells are divided into no. of wedge shaped sectors, each with their own set of channels.

(ii) Decrease ECI with adjacent cells.

Disadvantages:-

(i) Each sector is limited to only using 1/3 or 1/6 of available channel. We therefore have a decrease in trunking efficiency and an increase in the no. of required antennas.

Q.4 Discuss Cell capacity.

Ans - Cell splitting is a mean of increasing the capacity of a cellular system by subdividing or splitting cells into two or more smaller cells.

Cell splitting is process of subdividing a congested cell into smaller cells, each with its own base station and a corresponding reduction in antenna height and transmitter power.
If network is already functioning, it may be found that network needs expansion only in specific regions & not network wide expansion.

Advantage:-

- The new small cells are reassigned new frequencies that donot cause CCI with adjacent cells.
- Use "umbrella" cells where fast moving mobiles covered by orginal cell & slower mobiles covered by microcells.

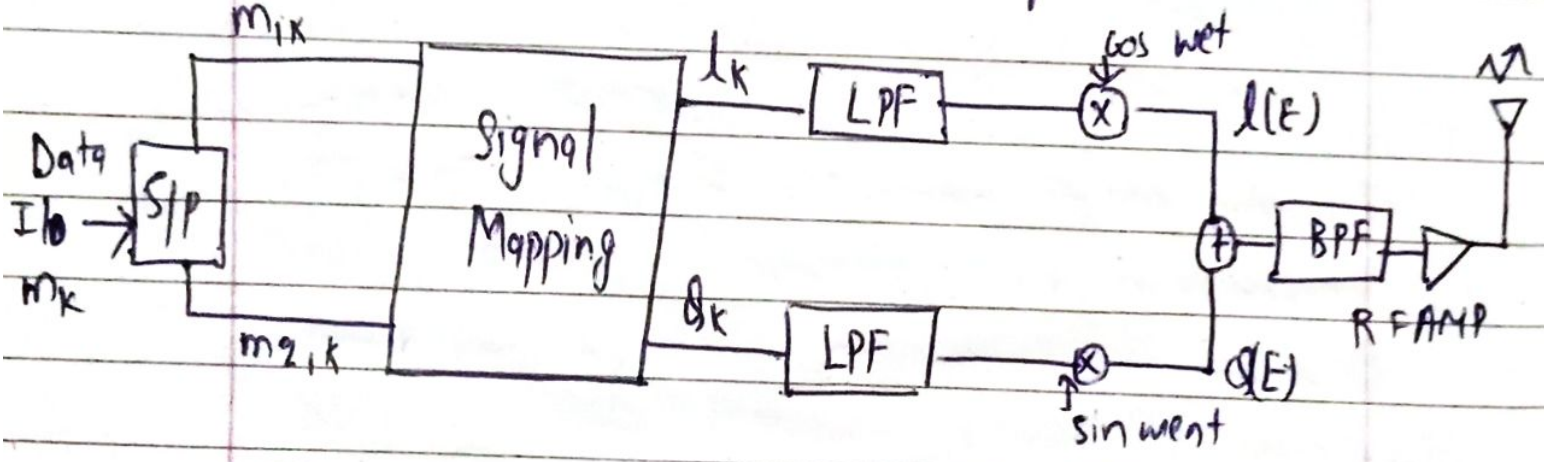
Disadvantage:-

- Cell splitting causes increased handoff.
- It requires the construction of new towers which is very costly.

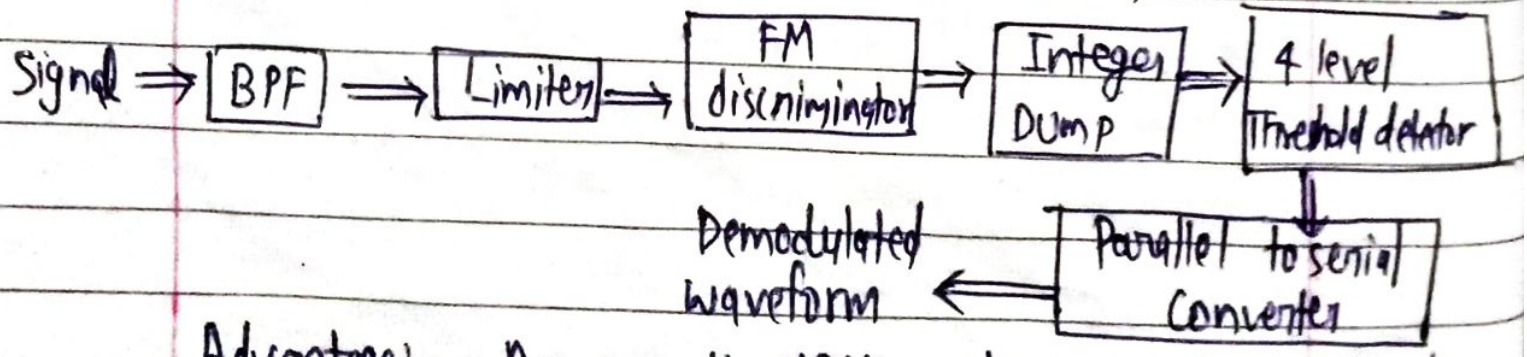
Q.1 Explain π/4 QPSK.

Ans- In π/4 QPSK, the max. phase change is limited to ± 135° as compared to 180° QPSK Hence the signal preserves the constant envelop property better than band limited QPSK. This can be demodulated in a coherent or non-coherent fashion thereby simplifying the receiver design greatly.
In presence of multipath spread and fading, π/4 QPSK is found to perform better.

QPSK transmission technique:



π/4 QPSK discrimination detection:-



Advantage:- Among all MPSK schemes, QPSK is most often used scheme since it doesn't suffer from BER degradation while bandwidth

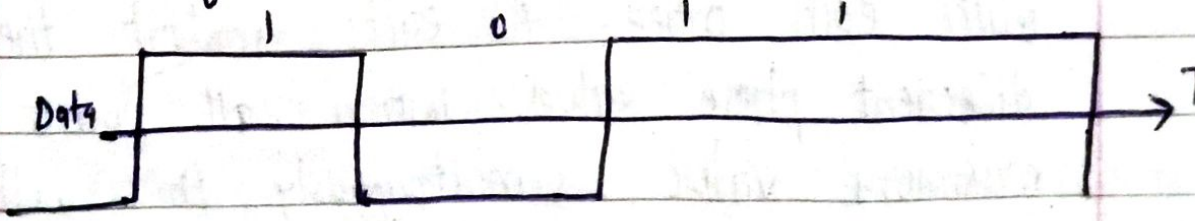
efficiency is increased.

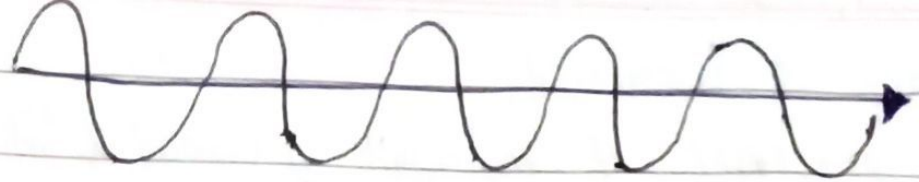
- In presence of multipath, spread & fading condition, Pi/4 QPSK perform the best.
- Signal is demodulated in coherent & non-coherent fashion and hence design of receiver is simple.

Q.2 Explain Gaussian Minimum Shift keying.

Ans- GMSK :- It is form of modulation based on frequency shift keying that has no phase discontinuities and provides efficient use of spectrum as well as enabling high efficiency radio power amplifier.

GMSK modulation is based on MSK which is itself a form of continuous phase frequency shift keying (CPFSK) one of problems with standard forms of PSK is that sidebands extend out form carrier. To overcome this, MSK & its derivated GMSK can be used. MSK and also GMSK modulation are what is known as a cps. Here there are no phase discontinuities because the frequency change occur at carrier zero crossing points. This can be expressed in terms of modulation index, and it is always equal to 0.5.





concept of min. shift keying, MSK signal
A plot of spectrum of a MSK signal shows sidebands extending well beyond a bandwidth equal to data rate. This can be reduced by passing the modulating signal through a low pass filter prior to applying it to carrier.

Q.4 Explain PAPR?

Ay- PAPR (Pack to Average Power ratio) :-
The PAPR is relation b/w maximum power of a sample in a given OFDM transmit symbol divided by average power of that OFDM symbol. In simple terms, PAPR is ratio of peak power to average power of signal. It is expressed in units of dB. PAPR occurs when in a multi carrier system the different subcarriers are out of phase with each other. At each instant they are different phase values. When all points achieve maximum value simultaneously this will cause the output envelope to suddenly shoot up with

causes a 'peak' in output envelope. The ratio of peak to average power value is termed as peak to average power ratio. In LTE system, OFDM signal PAPR is approx 12dB.
PAPR reduction techniques are:
- Chipping
- Partial transmission Sequence
- Selective Mapping (SLM)

Q.5 Explain OFDM?

Ans- Orthogonal Frequency Division Multiplexing :-

→ In telecommunication, it is a type of digital transmission & method of encoding digital data on multiple carrier frequencies. OFDM has developed into a popular scheme for wideband DC, used in application such as digital television and audio networks, powelines n/w & 4G/5G mobile comm^n. OFDM is a FDMS that was introduced by Robert. w chang of Belt labs in 1966. In OFDM, multiple closely spaced orthogonal subcarrier is signals with overlaping spectra are transmitted to carry data in parallel. OFDM is promising technique for achieving high data rate transmission in mobile environment.

Advantage:-

(i) Its ability to cope with reverse channel condition without complex equilication filters.

- Channel Equalization is simplified because OFDM maybe viewed as using many modulated narrowband signal rather than 1 rapidly modulated wideband signal.

DisAdvantage :—

- A no. of independency modulated sub-carrier result in high PAPR.
- High PAPR also increase complexity of ADC & DAC.

Q.1 What do you mean by Adaptive Equalizer

Ans- As a mobile channel fades randomly & varied in time, the equalizer must track that the time varying charac. of mobile channel, & thus are called adaptive equalizer. Its an equalizer that automatically adapts to time varying properties of the mobile comm^n channel.

The followers are the working principles of adaptive equalizers:

- the Output of receiver filter is pictured at symbol rate.
- Sampled signal is applied to adaptive transversal filter equalizer transversal filters are actually FIR discrete time filters.
- The object is to adapt coefficient to minimize the noise & intersymbol interference at output.
- The adaptation of equalizer is driven by an error signal.

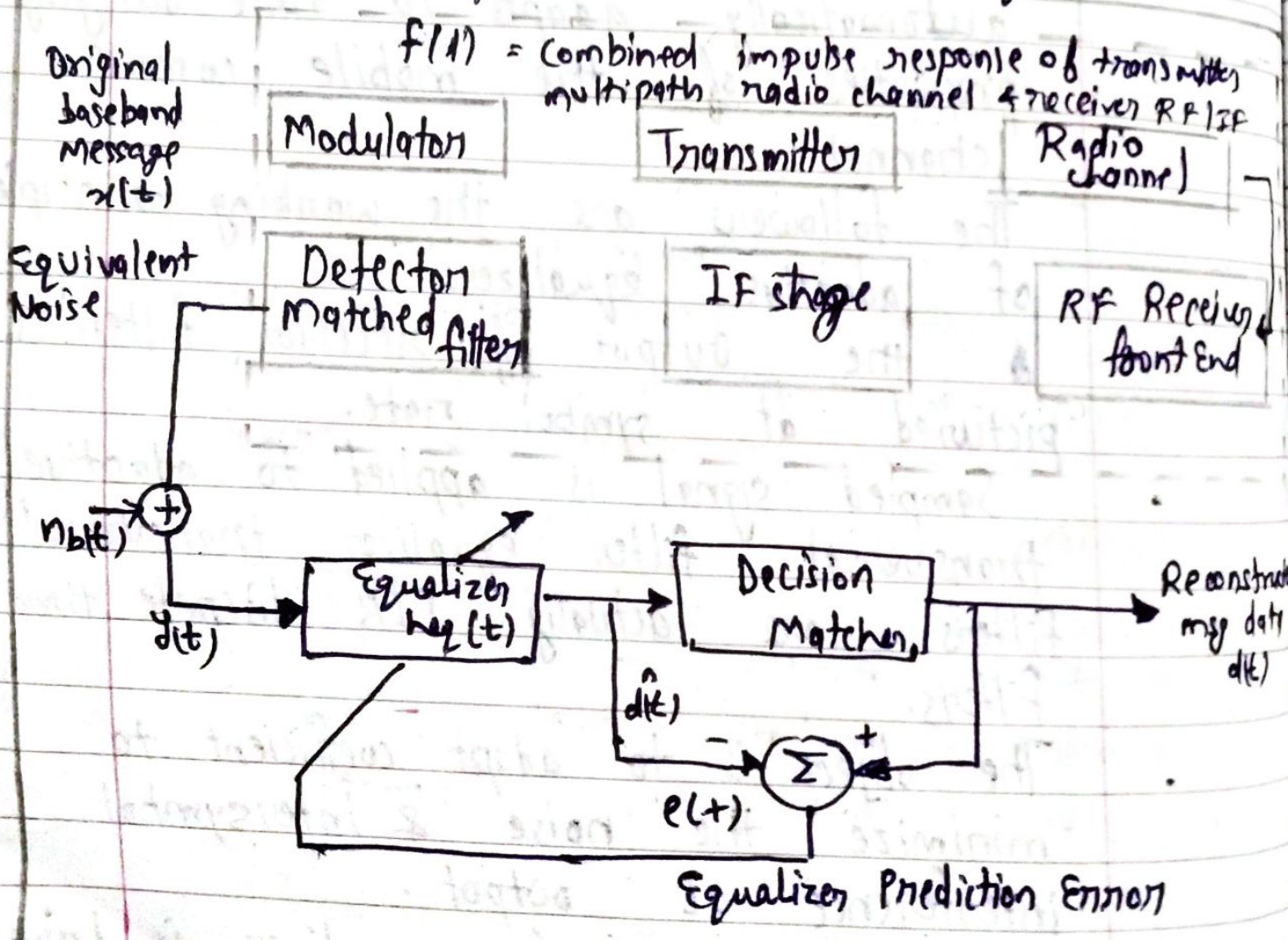
→ Adaptive Equalizer can operate in 2 modes:

- Decision directed mode which indicate that receiver decisions are used to generate

error signal.

- Decision Directed equalizer: This also indicates that adjustment is efficient in tracking slow variation in channel response.

Block diagram of Adaptive Equalizer



Q.2 Explain Linear & non-linear Equalization.

Ans- Linear Equalization :- The output of decision maker is not used in feedback path to adapt the equalizer.

The most simple & common type of channel equalizer used in practice to reduce the ISI is a linear equalizer.

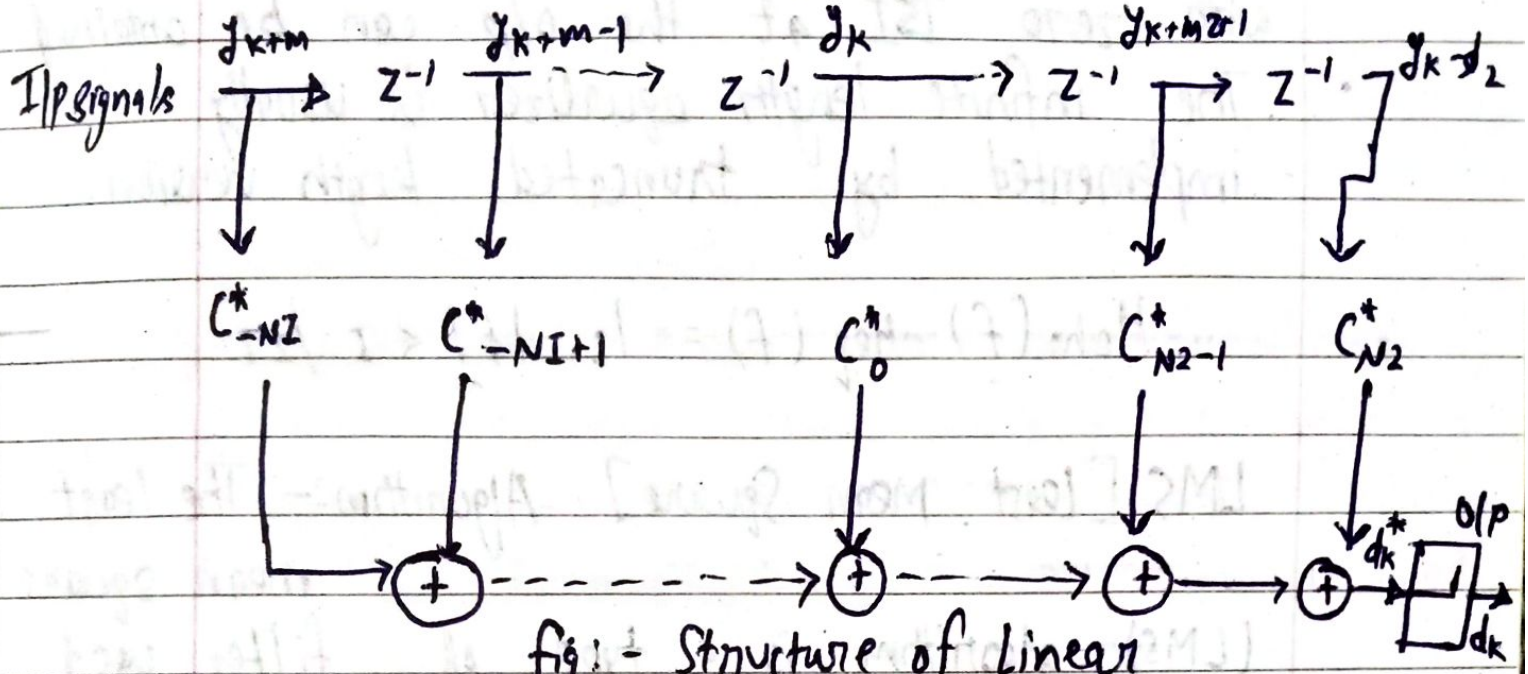


fig:- Structure of linear transversal equalizer

Non-Linear Equalization :- It is used in app. where channel distortion is to severe for linear equalizer to miligate the effect of channel impairments.

3 very effective non linear equalizer are -

- Decicion feedback Equal" (DFE)
- Max. liklihood Symbol detection
- Max. liklihood Sequence estimation (MLSE)

Q.3 Define zero forcing & LMS algorithm.

Ans- Zero forcing equalizer, the equalizer coefficient are chosen to force the samples of combined channel and equalizer impulse response to zero at all but one of NT spaced sample

points in tapped delay line filter.

- By lessing the no. of coefficients increase without bound, an infinite length equalizer with zero ISI at the o/p can be obtained
- The infinite length equalizer is usually implemented by truncated length version.

$$H_{ch}(f)\, H_{eq}(f) = 1_{\epsilon} \quad |f| < 1/2T$$

LMS [least mean Square] Algorithm:- The least mean square (LMS) algorithm is a type of filter used in ML that uses stochastic geradient descent in sophisticated ways. professionals describe it as an adaptive filter that helps to deal with signal processing is various ways.

The least mean square algo. uses a technique called "method of steepest descent" & continously estimates results by updating filter weights.

The LMS algorithm for a p^{th} order filter can be summarized as

Parameters p = filter order

μ = step size

Initialisation: $\hat{h}(0) = \text{zeros}(p)$

Computation: for $n = 0, 1, 2 \ldots$

$x(n) = (x(n), x(n-1), \dots)$

$e(n) = d(n) - \hat{n}(n)x(n)$

$\hat{n}(n+1) = \hat{n}(n) + \mu e^*(n) x(n)$

Q4 Explain Diversity

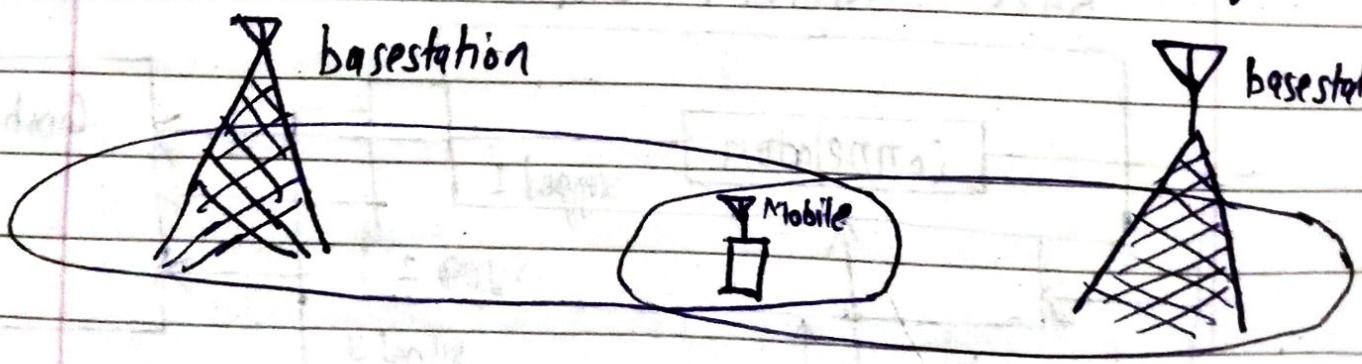
(i) Micro (ii) Macro

(i) Microscopic diversity

(a) Small Scale fades: Deep & rapid amplitude fluctuation over distances of just a few wavelength. It is caused by multiple reflection from surrounding in vicinity at mobile.

Microscopic diversity techniques can exploit the rapidly changing signal.

(ii) → By selecting a basestation which is not shadowed when others are, the mobile can improve avg. signal to noise ratio on forward link. This is Macroscopic diversity. It is used to combat slow fading

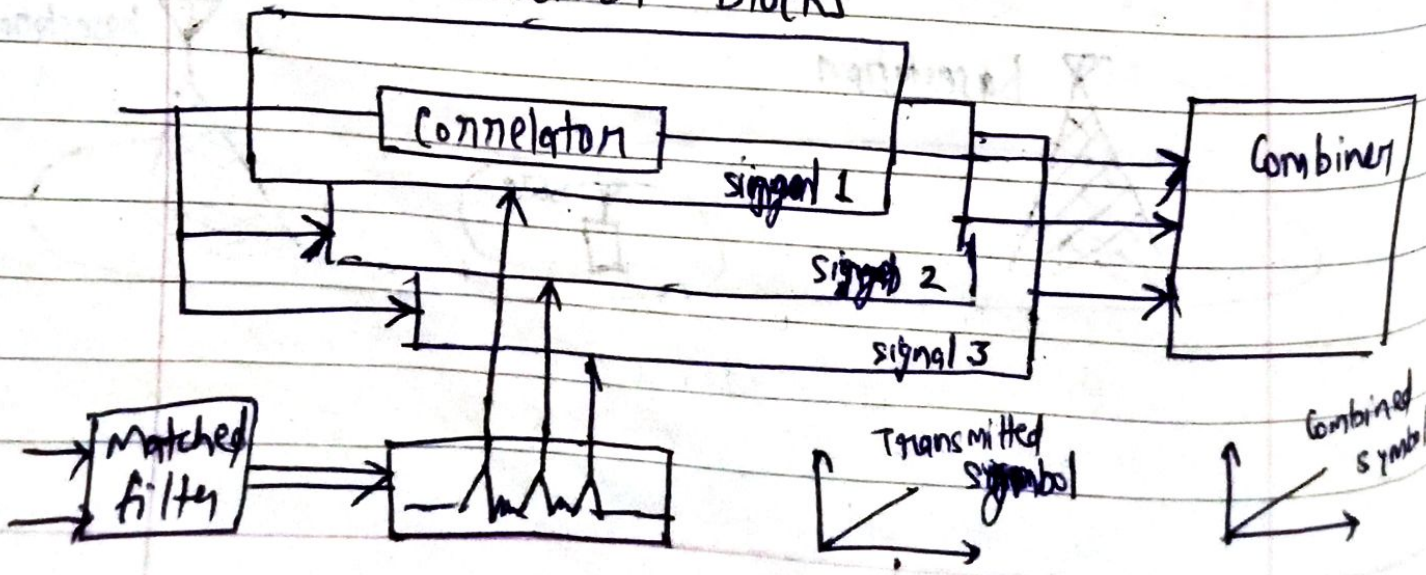


Q.5 Define Rake Receiver

A rake receiver is a radio receiver designed to counter the effects of multipath fading. It does this by using several "sub-receives" called fingers.

- Rake receiver mitigates multipath fading effect.
- Multipath fading is a major cause of unreliable wireless channel characteristics.
- The Rake receiver was designed to equalize the effect of multipath.
- It uses a combination of correlators, lock generator to spread out individual echo signals of multipath.
- Each signal is then delayed according to peaks found is received signal.
- A Rake receiver is a radio designed to counter affect of multipath fading.
- Each component is decoded independently.

Rate Receiver Blocks



Q.1 Define MIMO System

Ans MIMO [Multiple input multiple output]:- It is a technique where multiple antennas are used at both the transmitter & receiver to increase the link reliability, the spectral efficiency or both. The concept has been around for many years but its use in wireless standard is more recent. This is probably due in pont to fact that OFDM, which facilates the implementation of MIMO, is now commonly used in technologies.

MIMO techniques are used today in technologies like wifi & LTE.

MIMO specifically refers to a practical technique for spending & receiving more than one data signal simultaneously over the same radio channel exploiting multiple path propagation.

Advantages:-

(i) Takes advantage of multipath propagation.
(ii) Increase capacity.
(iii) Increased Quality
(iv) Spectral Efficiency.

Q.2 Explain Spatial Multiplexing [SM].

Ans Spatial Multiplexing or Space-division multiplexing is technique in MIMO wireless comm^n, fibre optics comm^n & other comm^n tech. used to transmit independent channels separated in space.

The SM scheme transmit different signals from each transmission antenna, so that the data rate is increased without any change in frequency band or transmission power.

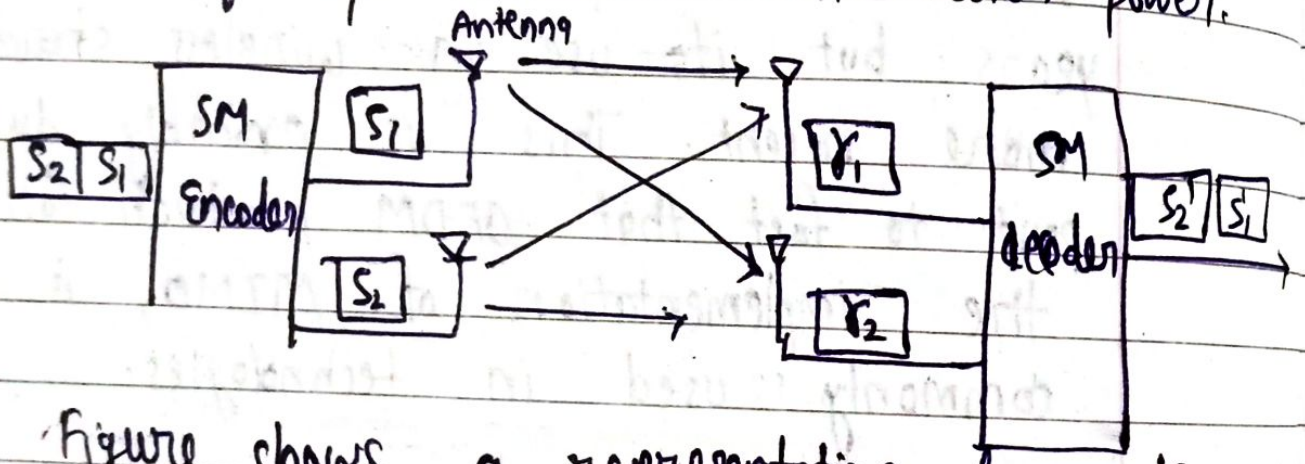


Figure shows a representation of an transcem with 2 transmission antennas and two receiving antennas.

Q.3 What do you mean by beam forming?

Ans - Beamforming is a tech. that focuses a wireless signal towards a specific receiving device, rather than having signal spread in all directions from a broadcast antenna as it normally would. The resulting more direct connection is faster and more reliable than it would be without beamforming.

Beamforming can also be known as spatial. Selectively where with appropriate signal processing technique, an array of antennas can be stored in such a way that interferring signals from a particular direction can be cancelled.

Benefits :- By focusing a signal in a specific direction, beam forming allows you deliver higher signal quality to your receiver.

Limitation :-

→ The limitation is h/w complexity is higher due to use of multiple antennas and other h/w system.

→ Power requirement in beamforming system is higher due to use of more resources Hence Battery in beamforming system drains faster.

Q.4 Explain transmitter & receiver diversity?

Ans - Transmit diversity is radio communication using signals that originates from 2 or more independent sources that have been modulated with identical information bearing

signals that may vary in their transmission characteristics at any given instant.
It can overcome the effect of fading & circuit failure. when using diversity transmission & reception, the amount of received signal improvement depends on the independence of fading characteristic of signal as well as circuit failure.

Receiver Diversity :- It is often used to improve reception of RF signals & diversity receiver utilizes 2 separate independent antenna system. The receiver looks at signal coming from each antenna determines which one is stronger.

Q.5 Define capacity in fading & non-fading channel?

Ans-

Capacity is a channel characteristics no dependent on transmission or reception techniques or limitations.
The fading channel capacity with channel side information at receiver & transmitter is achieved when

transmitter adapt in power, data rate & coding scheme to channel variation.

Channel capacity is the maximum mutual information.

We use Shannon's capacity theorem for calculating the capacity

$$C = W \log_2 \left(1 + \frac{S}{N}\right)$$

W = Bandwidth
S = Avg. signal power
N = Avg. Noise power
channel in non-fading channel.

Capacity for time invarient frequency selective fading channel is hard & it is achieved by watch filling algo.

The channel capacity is approx, obtained by dividing up the bandwidth of sub bands, which is equal to coherence bandwidth.

Capacity of channel = Sum of subchannel

$$C = \sum_{K=1}^{R_n} \log_2 \left[1 + \frac{P_K}{\sigma_n^2} \sigma_K^2 \right]$$

σ_n^2 = noise variance

P_K = Power allocated to K^{th} antenna

R_n = no. of channels

σ_K = signal variance.
