Ans 1. Standard QPSK guarantees that high slope symbol - to - symbol transitions will occur; because the phase jumps can be ±90°, we can't use the approach described for the 180° phase jumps produced by BPSK modulation. This problem can be mitigated by using one of two QPSK variants. Offset QPSK, which involves adding a delay to one of two digital data streams used in the modulation process, reduces the maximum phase jump to 90°. Another option is π/4 - QPSK, which reduces the maximum phase jump to 135°. Offset QPSK is thus superior with respect to reducing phase discontinuities, but π/4 - QPSK is advantageous because it is compatible with differential encoding.

Another way to deal with symbol - to - symbol discontinuities is to implement additional signal processing that creates smoother transitions between symbols. This approach is incorporated into a modulation scheme called minimum shift Keying (MSK), and there is also an improvement on MSK known as Gaussian MSK.

Ans. Beamforming antennas (also known as phased-array or beamsteering antennas) utilize a series of antenna bundle to be controlled electronically instead of mechanically. This allows signals to be emitted in or received from the correct direction. This is an important advantage for non-fixed systems such as aircraft and satellites. In addition, the radiation diagram can be adjusted so that the antenna sends or receives in one or more directions or that it receives more information or emits more energy in one specific direction than another. Because they are controlled electronically, beam-forming antennas are less vulnerable and do not require mechanical maintenance. NLR specializes in developing phased-array antennas, their individual antennas, their individual antenna elements and the beam former that controls the array. For various aerospace applications, NLR develops the antennas or the antenna system and the system architecture. "In addition, we have drawn up requirements for the antenna," says Jaco Verpoorte, a senior engineer at Royal NLR. "For the technology in specific applications such as satellites are aircraft, and for the environment that the system is used in. In these jobs, NLR looks at aspect such as environmental factors like the vibrations, pressure and temperature levels that a satellite or aircraft has to cope with, as well as the propagation of signals - how they progress and move. Atmospheric damping or reflection by buildings can then occur. NLR can run through the entire process, from design to field testing and qualification - and that's pretty unique!"

Ans 3. Channel State Information :- There are basically two levels of CSI, namely instantaneous CSI and statistical CSI.

(i) Instantaneous CSI :- Instantaneous CSI (or short - term CSI) means that the current channel conditions are known, which can be viewed as knowing the impulse response of a digital filter. This gives an opportunity to adapt the transmitted signal to the impulse response and thereby optimize the received signal for spatial multiplexing or to achieve low bit error rates.

(ii) Statistical CSI :- Statistical CSI (or long - term CSI) means that a statistical characterization of the channel is known. This description can include, for example, the type of fading distribution, the average channel gain, the line - of - sight component, and the spatial correlation. As with instantaneous CSI, this information can be used for transmission optimization.

The CSI acquistion is practically limited by how fast the channel conditions are changing. In fast fading systems where channel conditions vary rapidly under the transmission of a single information

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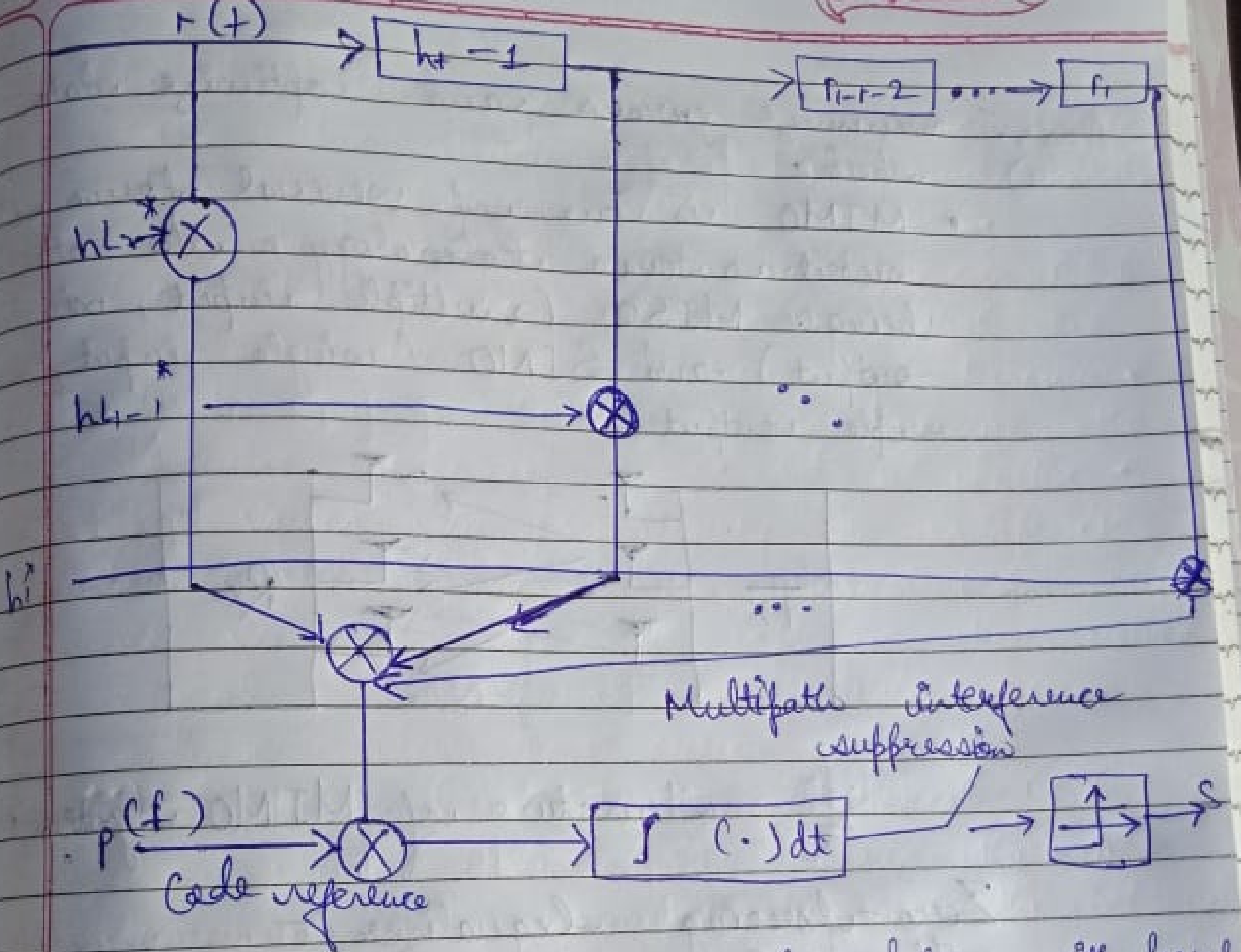
symbol, only statistical CSI is reasonable.
On the other hand, in slow fading systems instantaneous CSI can be estimated with reasonable accuracy and used for transmission adaptation for some time before being outdated.

In practical systems, the available CSI often lies in between these two levels; instantaneous CSI with some estimation / quantization error is combined with statistical information.

Ans 4. (a) Rake Receiver :-

- Rake receiver is a tapped delay line, whose outputs are weighted and added up.
- The tap delays, as well as the tap weights, are adjustable, and matched to the channel.
- Note that the taps are usually spaced at least one chip duration apart, but there is no requirement for the taps to be spaced at regular intervals



Spread spectrum correlator with hard decision

fig. Rack receiver

4. (b) MIMO system :-

• MIMO (multiple input, multiple output) is an antenna technology for wireless communication in which antennas are used at both the source (transmitter) and the destination (receiver).

• The antennas at each end of the communication circuit are combined to minimize errors and optimize data speed.

- MIMO is one of several forms of smart antenna technology, the others being MISO (multiple input, single output) and SIMO (single input, multi-ple output.)

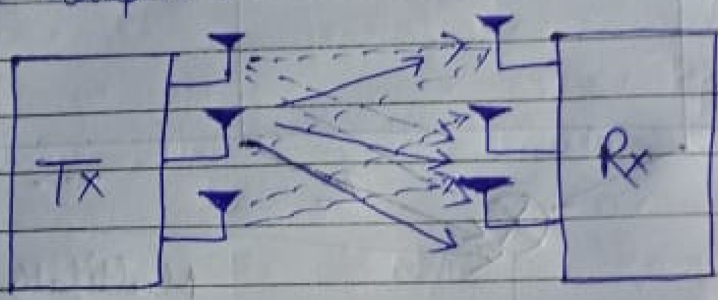
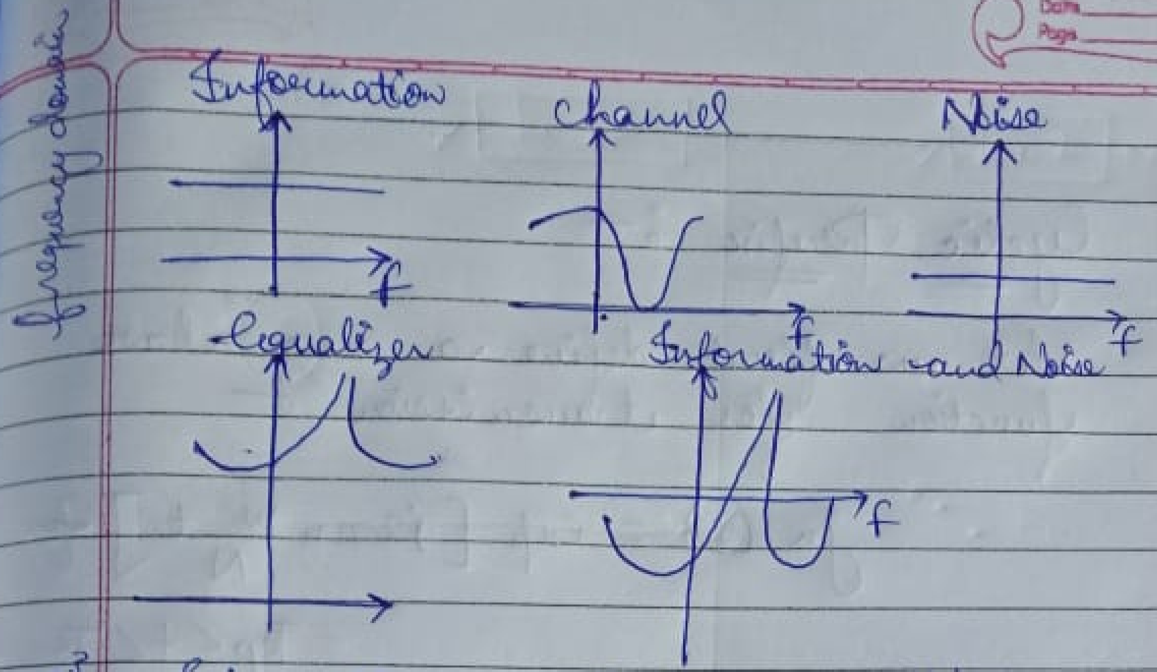


fig. structure of MIMO system Model

Zero-forcing equalizer :-

- The ZF equalizer can be interpreted in the freq. domain as enforcing a completely flat (Constant) transfer function of the combination of channel and equalizer by choosing the equalizer transfer function as $E(z) = 1\ F(z)$.
- In the time domain, this can be interpreted as minimizing the maximum ISI (peak distortion criterian).
- The ZF equalizer is optimum for elimination of ISI.



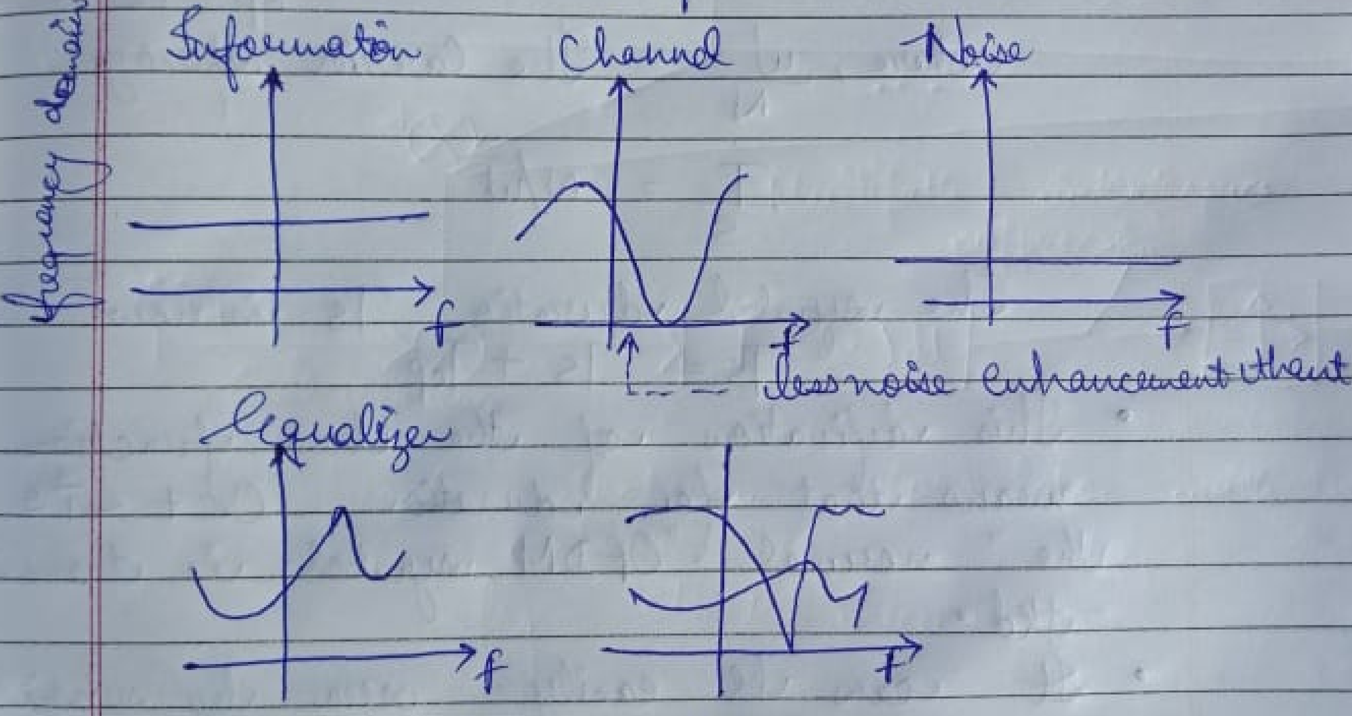


fig (a.) Illustration of noise enhancement in zero forcing

(b.) which is mitigated in an MMSE linear equilizer.

Ans 5. (a)

Cyclic Prefix :-

Let us first define a new base function for transmission :-

$$g_n(t) = \exp\left[j2\pi n \frac{W}{N} t \right] \text{ for } -T_{cp} < t < T_s$$

where, $\frac{W}{N}$ = The Carrier spacing

$$\hat{T}_s = N/W$$

The symbol duration T_s is now

$$T_s = \hat{T}_s + T_{cp}$$

- This defination of the base function means that for duration $0 < t < \hat{T}_s$ the "normal" OFDM symbol is transmitted.
- It can be easily seen by substituting in eq. that $g_n(t) = g_n(t + N/W)$.
- This "regular" ISI is eliminated by discarding the received signal during this time interval.

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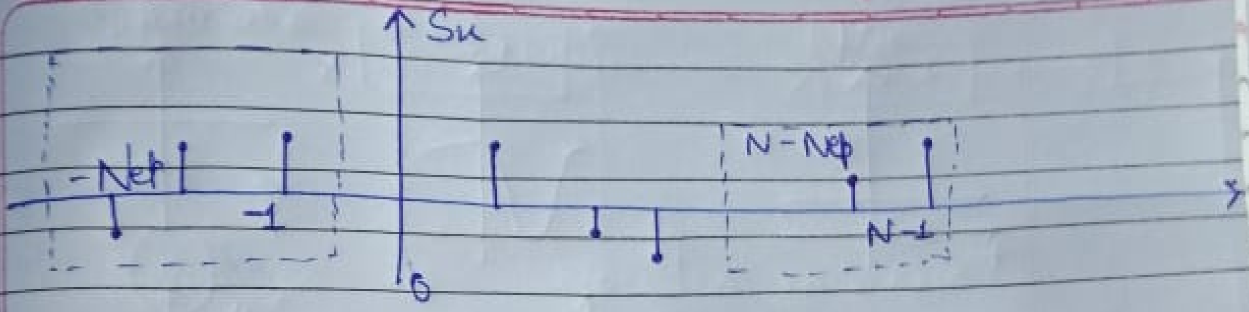

fig. Principle of the cyclic prefix. Ncp = NTcp (N/W)

Ans. (b) PAPR (Peak to Average Power Ratio) :-

- The PAPR is the relation between the max. power of a sample in a give OFDM transmit symbol divided by the average power of that OFDM symbol.

- In simple terms, PAPR is the ratio of peak power to the average power of a signal.

- PAPR occurs when in a multicarrier system the different sub - carrier are out of phase with each other.

- At each instant they are different with respect to each other at different phase values.