CLASS TEST-2

Answer key

1. Give the function of Gaussian filter in GMSK. [K1]

Gaussian Minimum Shift Keying, or to give it its full title Gaussian filtered Minimum Shift Keying, GMSK, is a form of modulation used in a variety of digital radio communications systems. It has advantages of being able to carry digital modulation while still using the spectrum efficiently. One of the problems with other forms of phase shift keying is that the sidebands extend outwards from the main carrier and these can cause interference to other radio communications systems using nearby channels.

2.What is cyclic prefix

In delay dispersive channel, inter carrier interference occur. To overcome the effect of inter carrier interference and ISI, cyclic prefix is introduced. It is a cyclically extended guard interval whereby each symbol sequence is preceded by a periodic extension of the sequence itself.

3.Define the term Bandwidth efficiency

Spectrum **efficiency**. The amount of useful information that can be transmitted over a given spectrum (**bandwidth**) over a given period of time. For modem designers, spectrum **efficiency** is **defined** as the amount of bits per second per **bandwidth**.

4.How would you explain non coherent detection? [K1]

The requirement of estimating the carrier phase for the M signals makes coherent demodulation of MFSK signals very complex.
For FSK, a non–coherent demodulator is preferred, which does not require the estimation of the carrier phase

5. Interpret the term PAPR with necessary equations [K2]

PAPR as a function of bandwidth efficiency for OFDM and SC modulation techniques is considered. It is shown that high PAPR for both types of modulation technique appears as a result of high bandwidth efficiency demand, regardless of the modulation technique used. This property is not unique to OFDM.

6. (a) Explain with neat diagram and the modulation technique of QPSK. [K2] (15)

In the world of wired electronics, analog signals exhibit continuous variations whereas digital signals assume (ideally) one of two discrete states. This distinction can be extended to systems that transmit data via electromagnetic radiation instead of electric current traveling through wires.

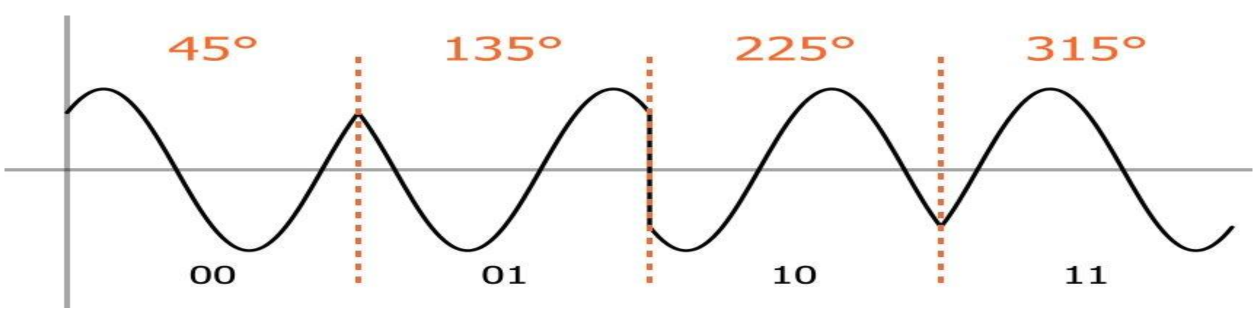
When used for analog signals, frequency modulation and amplitude modulation lead to continuous variations in the frequency or amplitude of a carrier wave. When modulation techniques are used for digital communication, the variations applied to the carrier are restricted according to the discrete information being transmitted.

Examples of common digital modulation types are OOK (on/off keying), ASK (amplitude shift keying), and FSK (frequency shift keying). These schemes cause the carrier to assume one of two possible states depending on whether the system must transmit a binary 1 or a binary 0; each discrete carrier state is referred to as a symbol.

Quadrature phase shift keying (QPSK) is another modulation technique, and it's a particularly interesting one because it actually transmits two bits per symbol. In other words, a QPSK symbol doesn't represent 0 or 1—it represents 00, 01, 10, or 11.

This two-bits-per-symbol performance is possible because the carrier variations are not limited to two states. In ASK, for example, the carrier amplitude is either amplitude option A (representing a 1) or amplitude option B (representing a 0). In QPSK, the carrier varies in terms of phase, not frequency, and there are *four* possible phase shifts.

We can intuitively determine what these four possible phase shifts should be: First we recall that modulation is only the beginning of the communication process; the receiver needs to be able to extract the original information from the modulated signal. Next, it makes sense to seek maximum separation between the four phase options, so that the receiver has less difficulty distinguishing one state from another. We have 360° of phase to work with and four phase states, and thus the separation should be 360°/4 = 90°. So our four QPSK phase shifts are 45°, 135°, 225°, and 315°.



(b) Illustrate the expression for MSK signal as a special type of continuous phase FSK signal. [K2] (15)

Minimum shift keying, MSK, is a form of is a type of continuous-phase frequency-shift keying, that is used in a number of applications. A variant of MSK modulation, known as Gaussian filtered Minimum Shift Keying, GMSK, is used for a number of radio communications applications including being used in the GSM cellular telecommunications system. In addition to this MSK has advantages over other forms of PSK and as a result it is used in a number of radio communications systems.

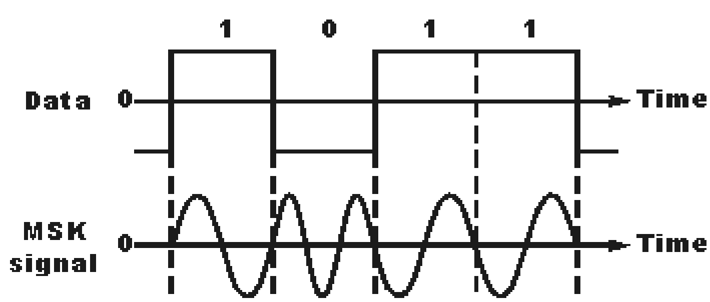
Reason for Minimum Shift Keying, MSK

It is found that binary data consisting of sharp transitions between "one" and "zero" states and vice versa potentially creates signals that have sidebands extending out a long way from the carrier, and this creates problems for many radio communications systems, as any sidebands outside the allowed bandwidth cause interference to adjacent channels and any radio communications links that may be using them.

Minimum Shift Keying, MSK basics

The problem can be overcome in part by filtering the signal, but is found that the transitions in the data become progressively less sharp as the level of filtering is increased and the bandwidth reduced. To overcome this problem GMSK is often used and this is based on Minimum Shift Keying, MSK modulation. The advantage of which is what is known as a continuous phase scheme. Here there are no phase discontinuities because the frequency changes occur at the carrier zero crossing points.

When looking at a plot of a signal using MSK modulation, it can be seen that the modulating data signal changes the frequency of the signal and there are no phase discontinuities. This arises as a result of the unique factor of MSK that the frequency difference between the logical one and logical zero states is always equal to half the data rate. This can be expressed in terms of the modulation index, and it is always equal to 0.5.



Signal using MSK modulation