ASSIGNMENT 7.1

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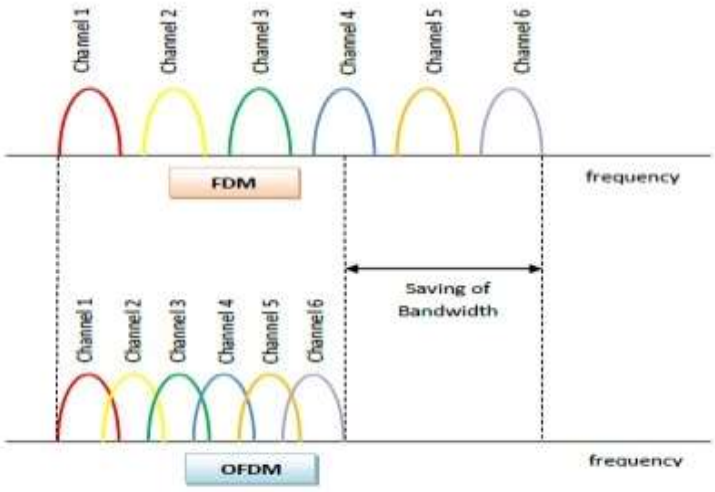
1. INTRODUCTION

OFDM is abbreviated as Orthogonal Frequency Division Multiplexing, which is a digital multi carrier modulation technique. Multiplexing generally refers to transmitting multiple or more than one signal over the channel/medium. This OFDM modulation technique can be understood as an improved version of FDM (Frequency Division multiplexing) although they differ by implementation.

In FDM, the total bandwidth is split into different frequency bands i.e, each message signal information is transmitted over a different frequency band, such that they don't overlap. The frequency bands are separated by guard bands to avoid loss of information in the message signal at the receiver due to inter symbol interference or overlaping/aliasing.

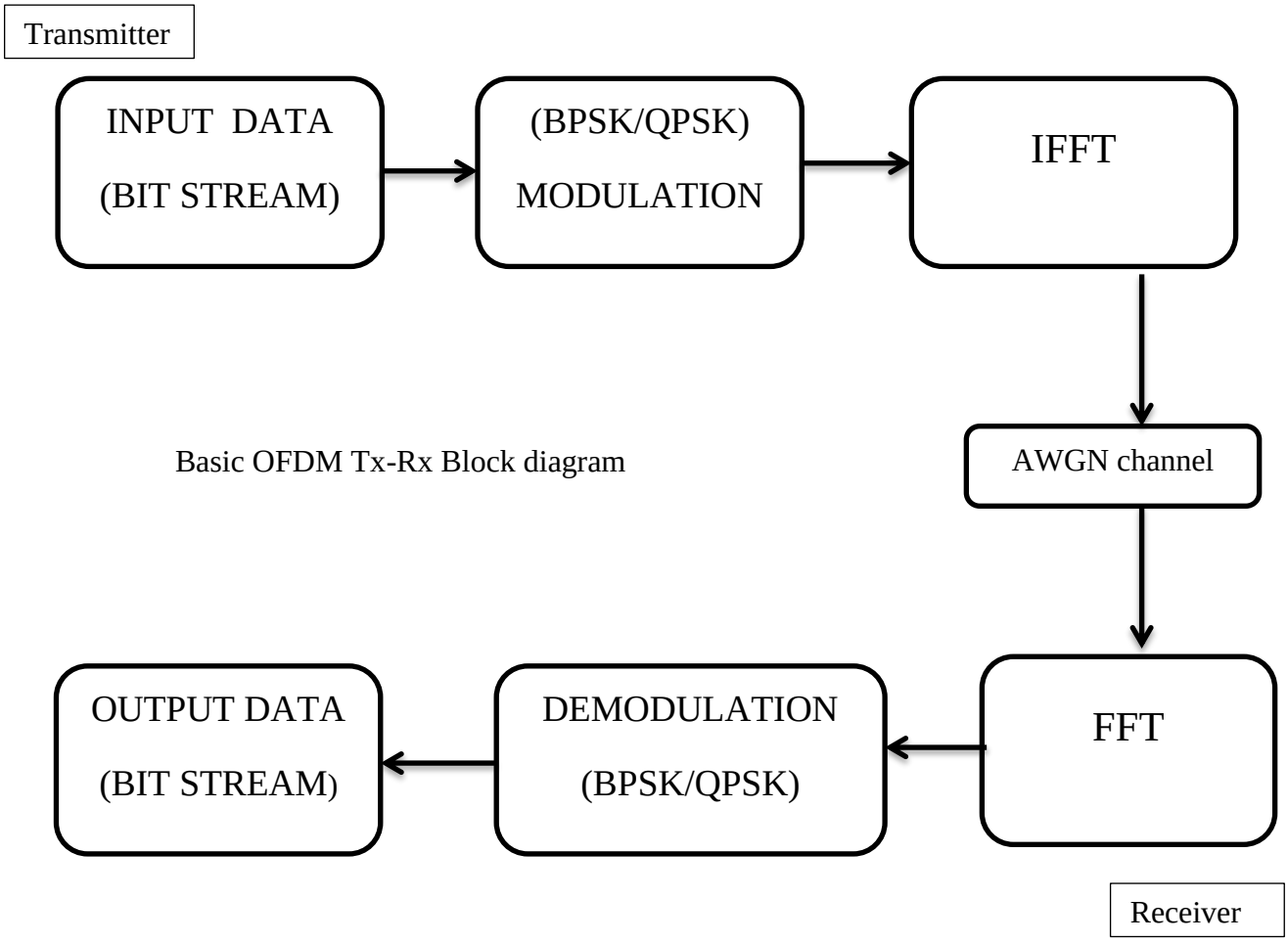


The above diagram shows the basic difference between FDM and OFDM

Whereas OFDM is a modulation scheme which splits the channel bandwidth into multiple sub-carriers, each of which carries the message signal information independently using modulation techniques like BPSK/QPSK/QAM etc. These sub-carriers are orthogonal to each other and so there won't be any loss of information occurring at the receiver, as they don't interference would occur and hence the use of guard bands is also not required in case of OFDM.

2. BLOCK DIAGRAM OFDM

The basic block diagram of OFDM Transmitter and receiver is show below



Basic OFDM Tx-Rx Block diagram

Block diagram description:

The input data is initially encoded into bit stream and then modulated using BPSK/QPSK/QAM and to this modulated output IFFT is applied to generate OFDM signals which are then transmitted through channel.

At the receiver, it receives the transmitted data with the AWGN noise added to it. The received data is passed through FFT and then demodulated to get the output data. Detailed explaination of each block of OFDM will be discussed in the next document.

3. IMPORTANCE OF ORTHOGONAL SIGNALS IN OFDM

Orthogonal signals are those signals whose inner product over a time period is zero. In other words the signals are perpendicular to each other. This property of the signals helps in no interference with other signals and hence the retrieving of the transmitted information can be done with out much loss. Due to this orthogonality of signals, even if their side bands overlap no interference occurs in OFDM but this is not the case in FDM and hence guard bands are not required here which results in better utilization of bandwidth.

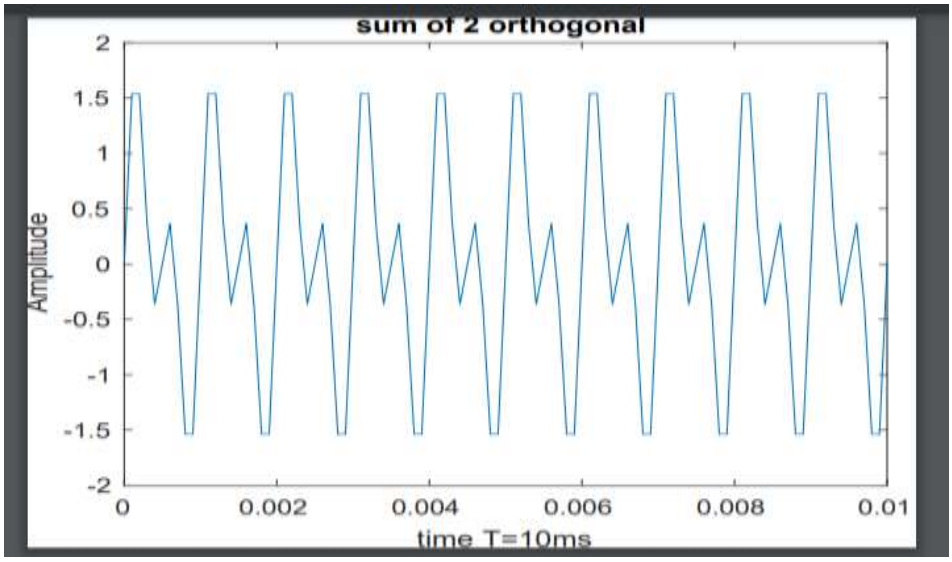
The below is the matlab code to generate and plot the orthogonal and non orthogonal signals

3.1 MATLAB CODE FOR 2 ORTHOGONAL SIGNALS

```
% proving two signals are orthogonal
output1=0;
t=0:0.0001:0.01;
f1=1000;
w1=2*pi*f1;
x1=sin(w1*t);
x2=sin(2*w1*t);
x3=x1.*x2;          % product of 2 signals
output1=sum(x3);    % finding total sum over time period T
k1=round(output1,1);
if (k1==0)
   fprintf("x1 and x2 are orthogonal sig\n");
else
   fprintf("x1 and x2 are non orthogonal sig\n");
end
```

```
% plot of addition of 2 orthogonal signals
x4=x1+x2;  % sum of 2 signals
figure;
plot(t,x4);
xlabel('time T=10ms')
ylabel('Amplitude')
title('sum of 2 orthogonal')
```

PLOT OF SUM OF TWO ORTHOGONAL SIGNALS

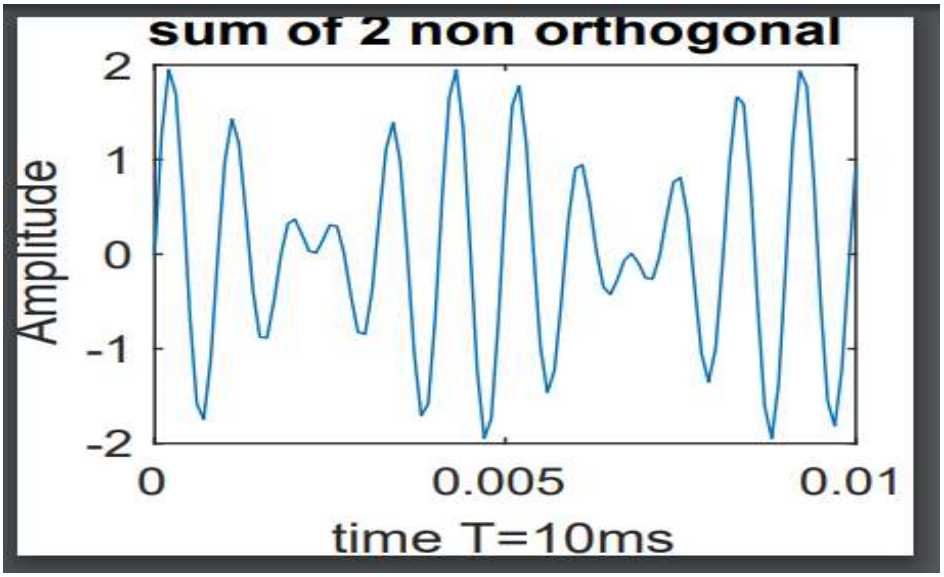


3.2 MATLAB CODE FOR 2 NON ORTHOGONAL SIGNALS

```
% proving two signals are non orthogonal
output2=0;
t=0:0.0001:0.01;
f1=1000;
w1=2*pi*f1;
y1=sin(w1*t);
y2=sin(1.22*w1*t);
y3=y1.*y2;              % product of 2 signals
output2=sum(y3);        % finding total sum over time period T
```

```
k2=round(output2,1);
if (k2==0)
   fprintf("y1 and y2 are orthogonal sig\n");
else
   fprintf("y1 and y2 are non orthogonal sig\n");
end
% plot of addition of 2 non orthogonal signals
y4=y1+y2;            % sum of 2 signals
plot(t,y4);
xlabel('time T=10ms');
ylabel('Amplitude');
title('sum of 2 non orthogonal');
```

PLOT OF SUM OF TWO NON ORTHOGONAL SIGNALS



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