ECE3051 – Analog and Digital Signal Processing, Fall Semester 2022-2023

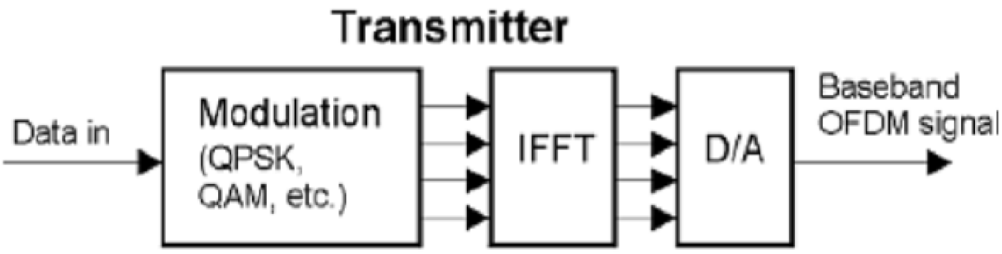
ELA DA – 3, Slot: L25-L26

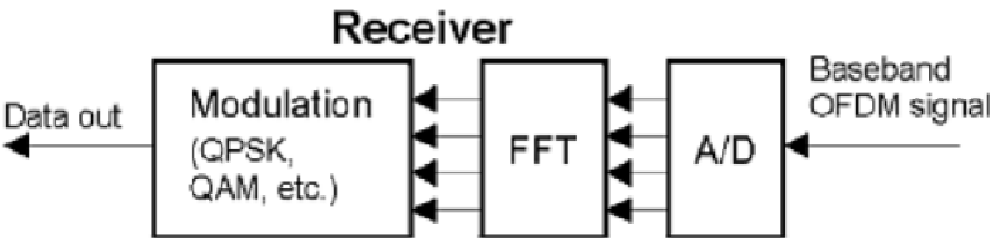
By: Jonathan Rufus Samuel (20BCT0332) Date: 07.10.2022

ELA DA 3 – DOS: 09.10.2022

Task - 3: Realization of OFDM waveforms

Q1) For the given OFDM system generate the waveforms corresponding to each block:





CODE:

```
%Task - 3: Realization of OFDM Waveforms
%Name: Jonathan Rufus Samuel (20BCT0332)
%Course: ECE3051 - ELA

%For the given OFDM system, generate the waveforms corresponding to each
%block.

%-----Transmitter-------
%1) Base Signal (Data in):
syms x(n);
x(n) = 1/pi * (2*sin(9*pi*n/10) - sin(8*pi*n/10));
t = -50:50; %t = -20:20;
subplot(421),plot(t,x(t));
title('Signal x(n) - Data In/Base Signal');
xlabel('time (t)');
```

```
ylabel('Magnitude (x(n))');
grid;

%2) Signal after QPSK/QAM modulation transform (here choose QAM)
fs = 20;
t = -50:50;
x1 = modulate(double(x(t)),5,fs,'amssb');
subplot(422),stem(t,x1);
title('Signal x1(n) - Signal after QAM Modulation');
xlabel('time (t)');
ylabel('Magnitude (x1(n))');
grid;

%3) Signal after Inverse Discrete Fourier Transform (IFFT)
x2 = ifft(x1);
t = -50:50;
subplot(423),stem(t,x2);
title('Signal x2(n) - Signal after Inverse Fourier Transform');
xlabel('time (t)');
ylabel('Magnitude (x2(n))');
grid;

%4) Signal after Digital to Analog Conversion
x3 = x2;
subplot(424),plot(t,x3);
title('Signal x3(n) - Signal after conversion to Analog');
xlabel('time (t)');
ylabel('Magnitude (x3(n))');
grid;
%i.e. Data in ----> Baseband OFDM Signal

%-----Receiver-------
%5) Signal after Analog to Digital Conversion
%i.e. Baseband OFDM Signal ----> Data Out
y = x3;
subplot(425),stem(t,y);
title('Signal y(n) - Signal after conversion to Digital');
xlabel('time (t)');
ylabel('Magnitude (y(n))');
grid;
%6) Signal after Discrete Fourier Transform (FFT)
y1 = fft(y);
t = -50:50;
subplot(426),plot(t,y1);
title('Signal y1(n) - Signal after Fourier Transform');
xlabel('time (t)');
ylabel('Magnitude (y1(n))');
grid;

%7) Signal after QPSK/QAM modulation transform (here choose QPSK)
fs = 20;
t = -50:50;
y2 = modulate(double(y1),5,fs,'amssb');
subplot(427),stem(t,y3);
title('Signal y2(n) - Signal after QAM De-Modulation');
xlabel('time (t)');
ylabel('Magnitude (y2(n))');
grid;
```

```
%8) Final Data Out Signal after various stages of transmission
y3 = y2;
t = -50:50;
subplot(428),plot(t,y3);
title('Signal y3(n) - Data Out Signal');
xlabel('time (t)');
ylabel('Magnitude (y3(n))');
grid;
```

OUTPUT:

```
>> %Task - 3: Realization of OFDM Waveforms

%Name: Jonathan Rufus Samuel (20BCT0332)

%Course: ECE3051 - ELA


%For the given OFDM system, generate the waveforms corresponding to each

%block.


%-----Transmitter-------

%1) Base Signal (Data in):

syms x(n);

x(n) = 1/pi * (2*sin(9*pi*n/10) - sin(8*pi*n/10));

t = -50:50; %t = -20:20;

subplot(421),plot(t,x(t));

title('Signal x(n) - Data In/Base Signal');

xlabel('time (t)');

ylabel('Magnitude (x(n))');

grid;


%2) Signal after QPSK/QAM modulation transform (here choose QAM)

fs = 20;

t = -50:50;

x1 = modulate(double(x(t)),5,fs,'amssb');

subplot(422),stem(t,x1);
```

```
title('Signal x1(n) - Signal after QAM Modulation');

xlabel('time (t)');

ylabel('Magnitude (x1(n))');

grid;


%3) Signal after Inverse Discrete Fourier Transform (IFFT)

x2 = ifft(x1);

t = -50:50;

subplot(423),stem(t,x2);

title('Signal x2(n) - Signal after Inverse Fourier Transform');

xlabel('time (t)');

ylabel('Magnitude (x2(n))');

grid;


%4) Signal after Digital to Analog Conversion

x3 = x2;

subplot(424),plot(t,x3);

title('Signal x3(n) - Signal after conversion to Analog');

xlabel('time (t)');

ylabel('Magnitude (x3(n))');

grid;

%i.e. Data in ----> Baseband OFDM Signal


%-----Receiver-------

%5) Signal after Analog to Digital Conversion

%i.e. Baseband OFDM Signal ----> Data Out

y = x3;

subplot(425),stem(t,y);

title('Signal y(n) - Signal after conversion to Digital');

xlabel('time (t)');

ylabel('Magnitude (y(n))');
```

```
grid;
%6) Signal after Discrete Fourier Transform (FFT)
y1 = fft(y);
t = -50:50;
subplot(426),plot(t,y1);
title('Signal y1(n) - Signal after Fourier Transform');
xlabel('time (t)');
ylabel('Magnitude (y1(n))');
grid;

%7) Signal after QPSK/QAM modulation transform (here choose QPSK)
fs = 20;
t = -50:50;
y2 = modulate(double(y1),5,fs,'amssb');
subplot(427),stem(t,y3);
title('Signal y2(n) - Signal after QAM De-Modulation');
xlabel('time (t)');
ylabel('Magnitude (y2(n))');
grid;

%8) Final Data Out Signal after various stages of transmission
y3 = y2;
t = -50:50;
subplot(428),plot(t,y3);
title('Signal y3(n) - Data Out Signal');
xlabel('time (t)');
ylabel('Magnitude (y3(n))');
grid;
Warning: Using only the real component of complex data.
> In matlab.graphics.chart.internal.getRealData (line 52)
In stem (line 40)
```

Warning: Imaginary parts of complex X and/or Y arguments ignored.

Warning: Using only the real component of complex data.

> In matlab.graphics.chart.internal.getRealData (line 52)

In stem (line 40)

Warning: Imaginary parts of complex X and/or Y arguments ignored.

Warning: HILBERT ignores imaginary part of input.

> In hilbert>hilbert_ml (line 58)

In hilbert (line 40)

In modulate (line 125)

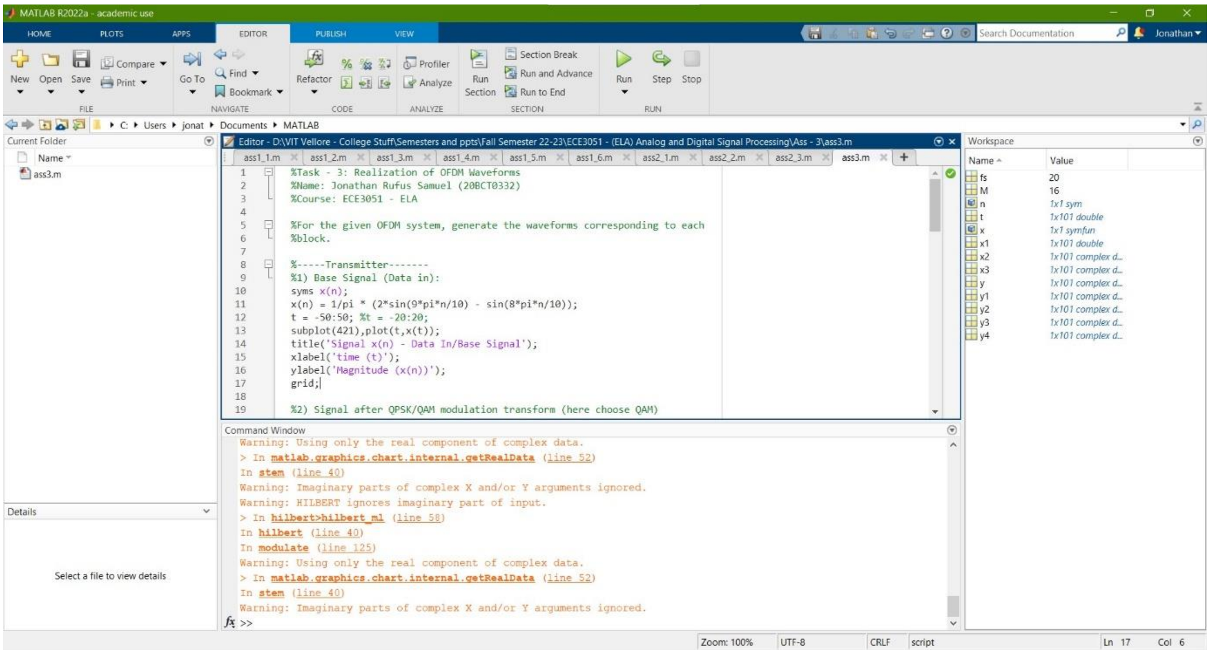
Warning: Using only the real component of complex data.

> In matlab.graphics.chart.internal.getRealData (line 52)

In stem (line 40)

Warning: Imaginary parts of complex X and/or Y arguments ignored.

>>



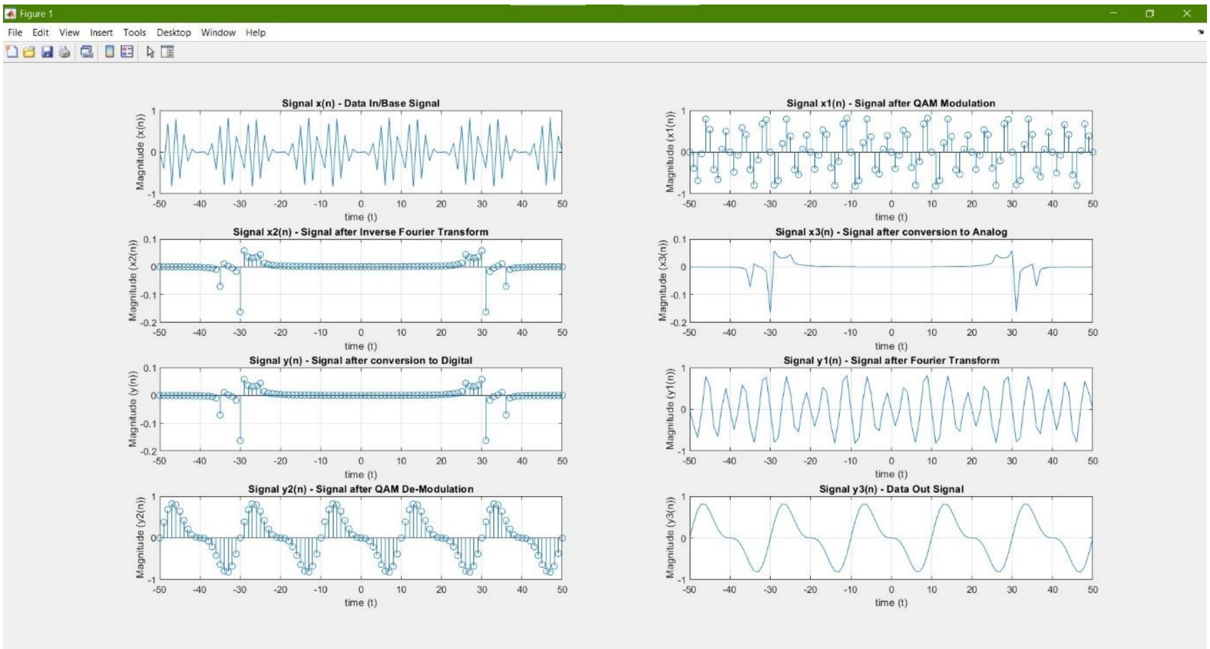


Figure 1
File Edit View Insert Tools Desktop Window Help
Signal x(n) - Data In/Base Signal
Signal x1(n) - Signal after QAM Modulation
Signal x2(n) - Signal after Inverse Fourier Transform
Signal x3(n) - Signal after conversion to Analog
Signal y(n) - Signal after conversion to Digital
Signal y1(n) - Signal after Fourier Transform
Signal y2(n) - Signal after QAM De-Modulation
Signal y3(n) - Data Out Signal
Magnitude (x(n))
Magnitude (x1(n))
Magnitude (x2(n))
Magnitude (x3(n))
Magnitude (y(n))
Magnitude (y1(n))
Magnitude (y2(n))
Magnitude (y3(n))
time (t)

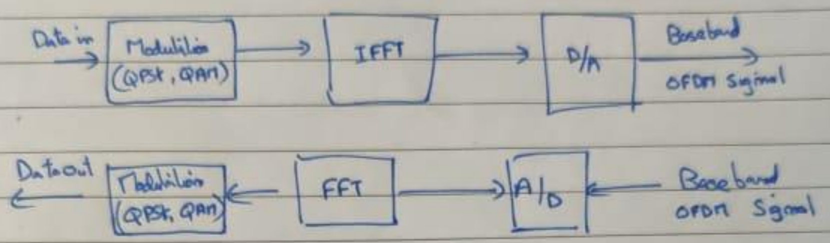
WORKING OUT:

07.10.22

ECE3051 - ELA Task 3

By: JONATHAN RUFUS SAMUEL (20BCT0332) DOS: 09.10.2022

Q: Derive Signals for each block of OFDM System



Some Key Points:

1) Signal Chosen (Discrete Signal called Data in)

$\Rightarrow x(m) = \frac{1}{4\pi}\left(2\sin(9\pi m/10) - \sin(8\pi m/10)\right)$

{ Over a time period frame of reference t: -50:50.

2) QPSK - Form of Phase Shift Keying in which two bits are modulated at once (QPSK - Quadratic Phase Shift Keying)

QAM - Quadratic Amplitude Modulation

↳ Method of Combining two Amplitude Modulation Signals into a single channel.

3) IFFT & FFT - Compute Inverse Discrete Fourier Transform as well as Discrete Fourier Transform of the i/p.

4) D/A & A/D Converters - Converts Digital to Analog & vice versa from the given i/p signal.