

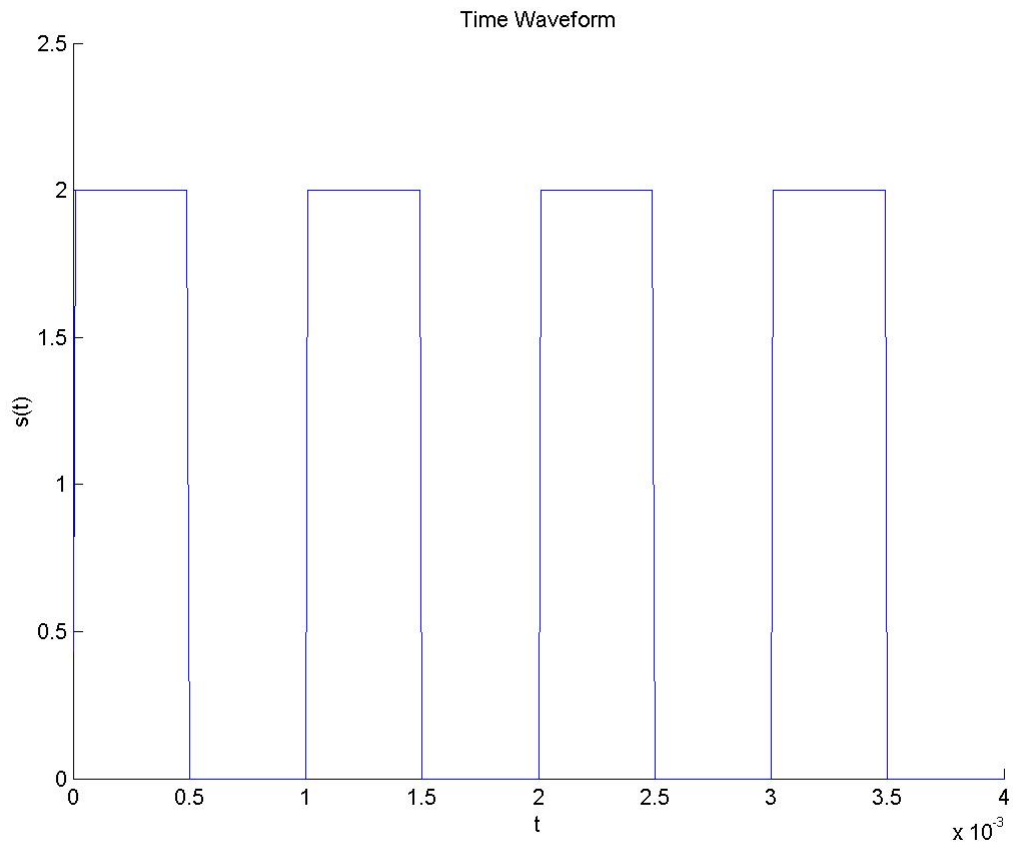
COE 342, Term 012

Data & Computer Communications Programming Assignment #1 Solution

Q1. (ii)

Matlab code for plotting the signal:

```
T=0.001;    % period
A=2;       % signal amplitude
n=4;       % number of times
s=[];
for i=0:0.01*T:T
    if (i>0)&(i<T/2)
        s=[s,A];
    else
        s=[s,0];
    end
end
for j=0:n-1
    k=j*T;
    t=k:0.01*T:k+T;
    hold on;
    plot (t,s);
end
axis([0 n*T 0 A+0.5]);
xlabel('t');
ylabel('s(t)');
title('Time Waveform');
```



Matlab code for plotting the signal and its frequency spectrum using Fourier Transform:

```
% Calculate the FFT for a truncated step
% Let tend be the end of the step.
```

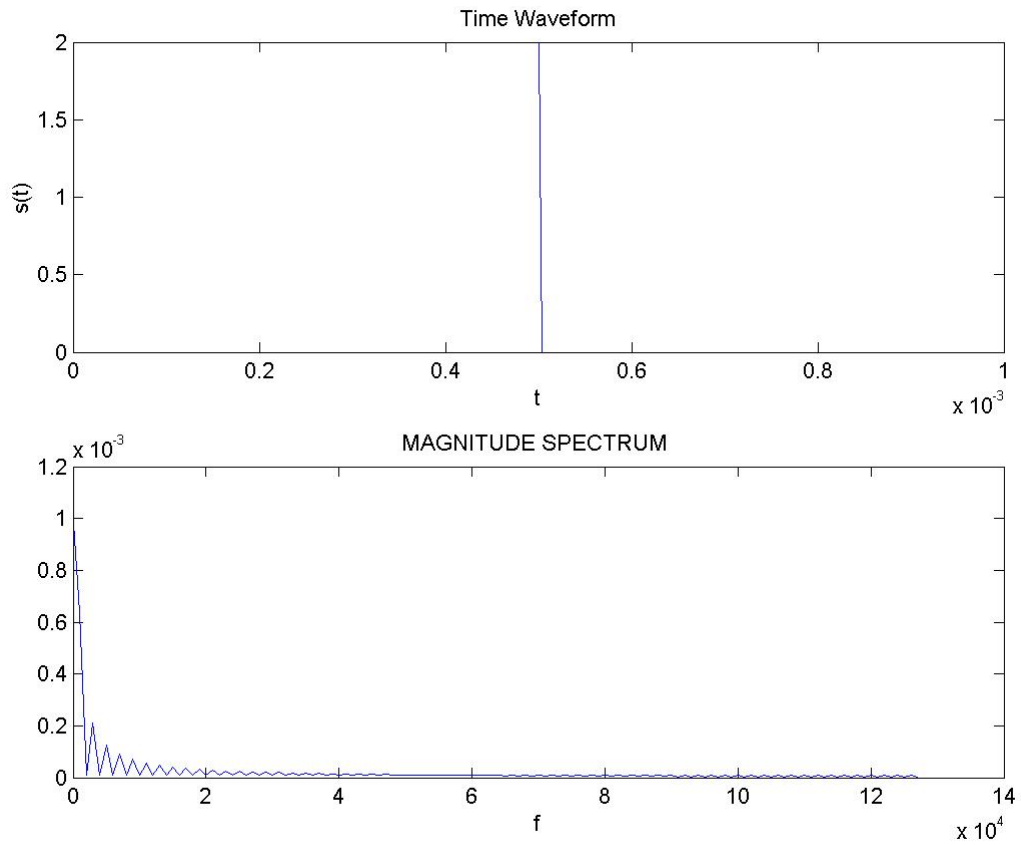
```
M = 8;
N = 2^M;
n = 0:1:N-1;
T = 0.001;
tend = 0.5*T;
dt = T/N;
t = n*dt;
```

```
w = zeros(length(t),1);
for (i = 1:1:length(w))
    if (t(i) <= tend)
        w(i) = 2;
    end;
end;
```

```
% Calculating FFT
W = dt*fft(w);
f = n/T;
```

```
subplot(211);  
plot(t,w);  
xlabel('t');  
ylabel('s(t)');  
title('Time Waveform');
```

```
subplot(212);  
plot(f(1:N/2),abs(W(1:N/2)));  
xlabel('f');  
title('MAGNITUDE SPECTRUM ');
```



Matlab code for plotting the signal and its frequency spectrum using Fourier Series:

```
%setting parameters
M=8;
N=2^M;
n=0:1:N-1;
fo=1000;
T=1/fo;
dt=T/N;
t=n*dt;

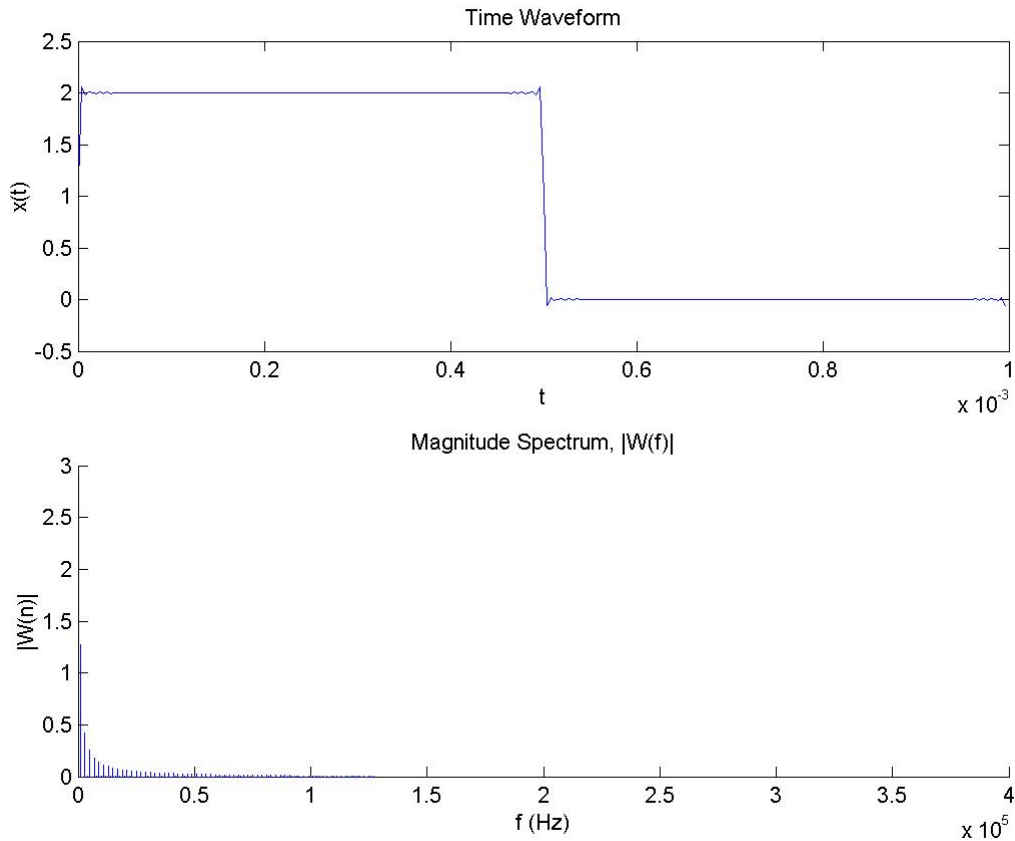
%defining the time waveform
A=1;
x=A;
h=200;
for i=0:1:h
x=x+4/pi*1/(2*i+1)*sin(2*pi*fo*(2*i+1)*t);
end

%ploting time waveform
subplot(211);
plot (t,x);
xlabel('t');
ylabel('x(t)');
title('Time Waveform');

%computing FFT

W=1/N*fft(x);
f=n/T;

%ploting frequency spectrum
subplot(212);
fn=n*fo;
for (i=1:1:N/2)
    if (i>1)
        line([fn(i) fn(i)], [0 2*abs(W(i))]);
    else
        line([fn(i) fn(i)], [0 abs(W(i))]);
    end
end;
xlabel('f (Hz)');
ylabel('|W(n)|');
title('Magnitude Spectrum, |W(f)|');
axis([0 2*(h+1)*fo 0 A+2]);
```



(iii) Effect of transmission media on transmitted signal:

1. BW=20 KHZ

Based on our solution $2\pi f = 2000\pi(2n+1) \Rightarrow f = 1000(2n+1)$

For $f = 20 \text{ KHZ} \Rightarrow 20000 = 1000(2n+1) \Rightarrow 2n+1 = 20 \Rightarrow n = 19/2 = 9.5$

So, only the first ten harmonics will propagate through the media. Thus, we use $h=9$ in the Matlab code.

2. BW=10 KHZ

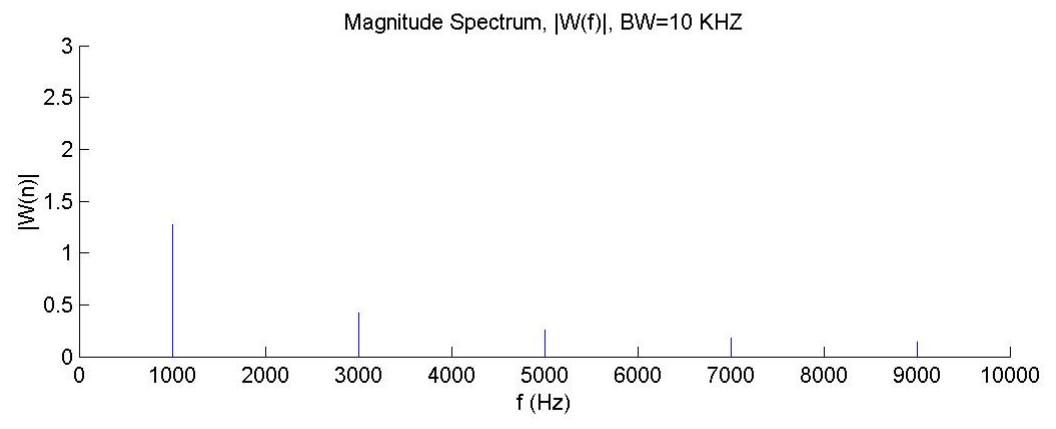
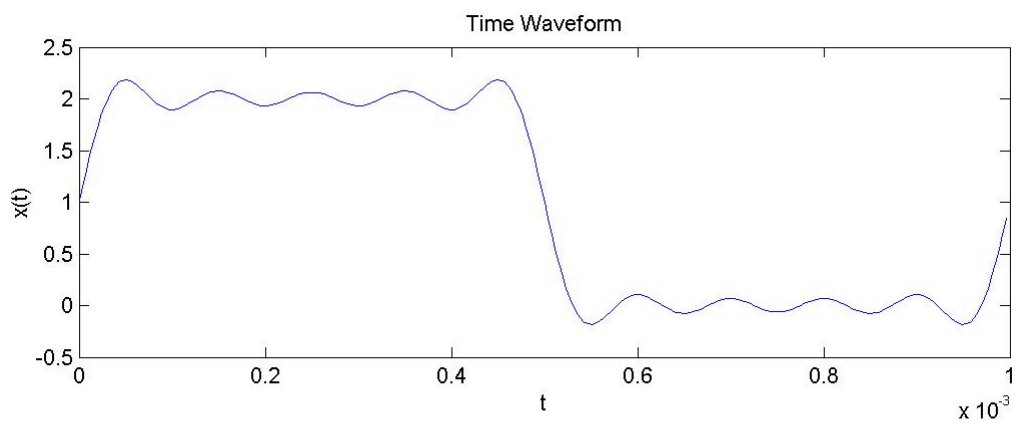
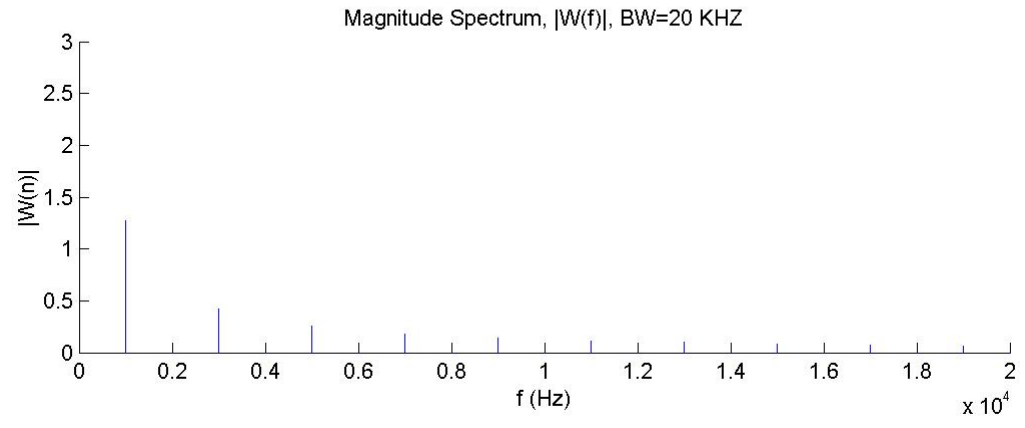
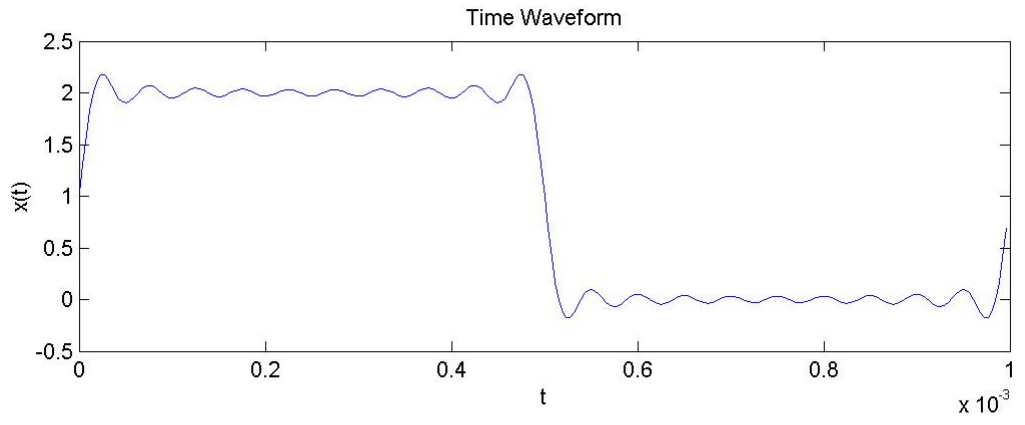
For $f = 10 \text{ KHZ} \Rightarrow 10000 = 1000(2n+1) \Rightarrow 2n+1 = 10 \Rightarrow n = 9/2 = 4.5$

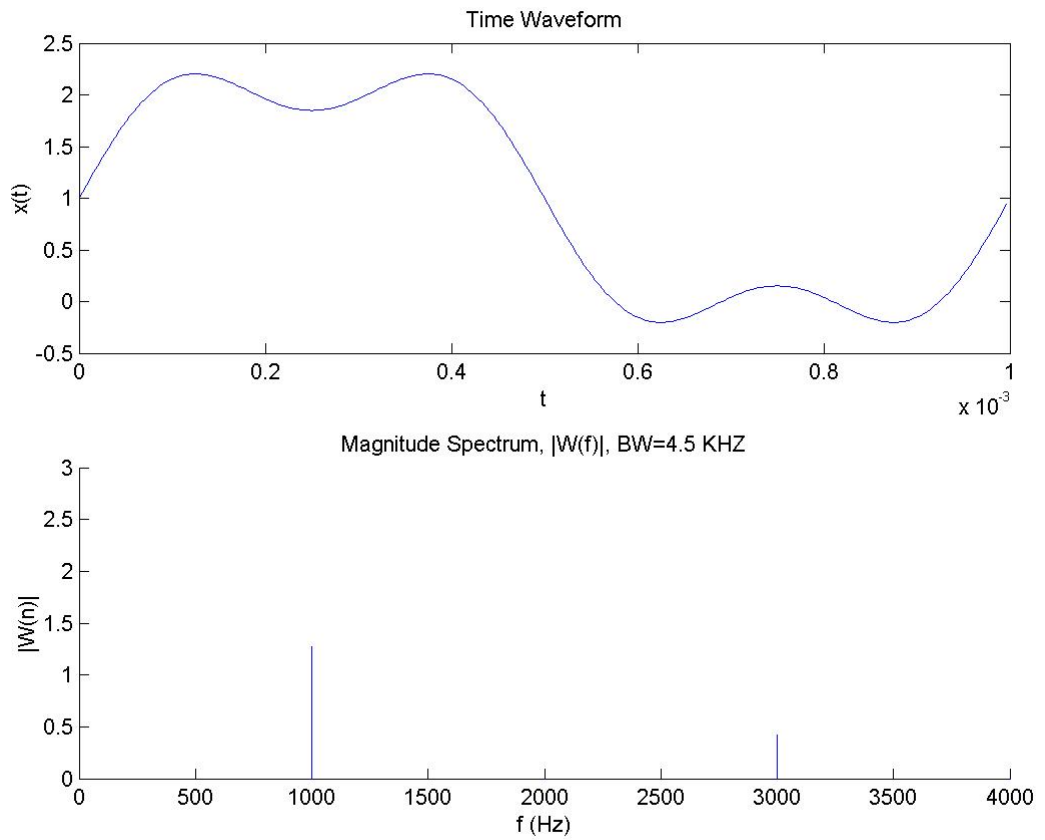
So, only the first five harmonics will propagate through the media. Thus, we use $h=4$ in the Matlab code.

3. BW=4.5 KHZ

For $f = 4.5 \text{ KHZ} \Rightarrow 4500 = 1000(2n+1) \Rightarrow 2n+1 = 4.5 \Rightarrow n = 3.5/2 = 1.75$

So, only the first two harmonics will propagate through the media. Thus, we use $h=1$ in the Matlab code.





As can be seen from the figures, limiting the transmission bandwidth limits the frequency components of the signal that can be transmitted and hence distorts the transmitted signal. The higher the bandwidth, the less distorted the transmitted signal.

Q2.

(ii) In order to determine a sufficient bandwidth for the signal, we need to plot it with several bandwidths and choose the one that produces a reasonable signal. We will plot the signal with several bandwidths namely BW=2 MHZ, 4 MHZ, 6 MHZ, and 8 MHZ.

Matlab code for plotting the signal using Fourier Series:

```
M=8;
N=2^M;
n=0:1:2*(N-1);
fo=1000000;
T=1/fo;
dt=T/N;
t=n*dt;

%defining the time waveform for a BW=2 MHZ
A=0;
x=A;
h=3;
for i=1:2:h
x=x+8/(pi^2)*1/(i^2)* cos(2*pi*fo*i*t);
end
subplot(221);
plot (t,x);
xlabel('t');
ylabel('x(t)');
title('Time Waveform with BW= 2 MHZ');

%defining the time waveform for a BW= 4 MHZ
A=0;
x=A;
h=5;
for i=1:2:h
x=x+8/(pi^2)*1/(i^2)* cos(2*pi*fo*i*t);
end
subplot(222);
plot (t,x);
xlabel('t');
ylabel('x(t)');
title('Time Waveform with BW= 4 MHZ');

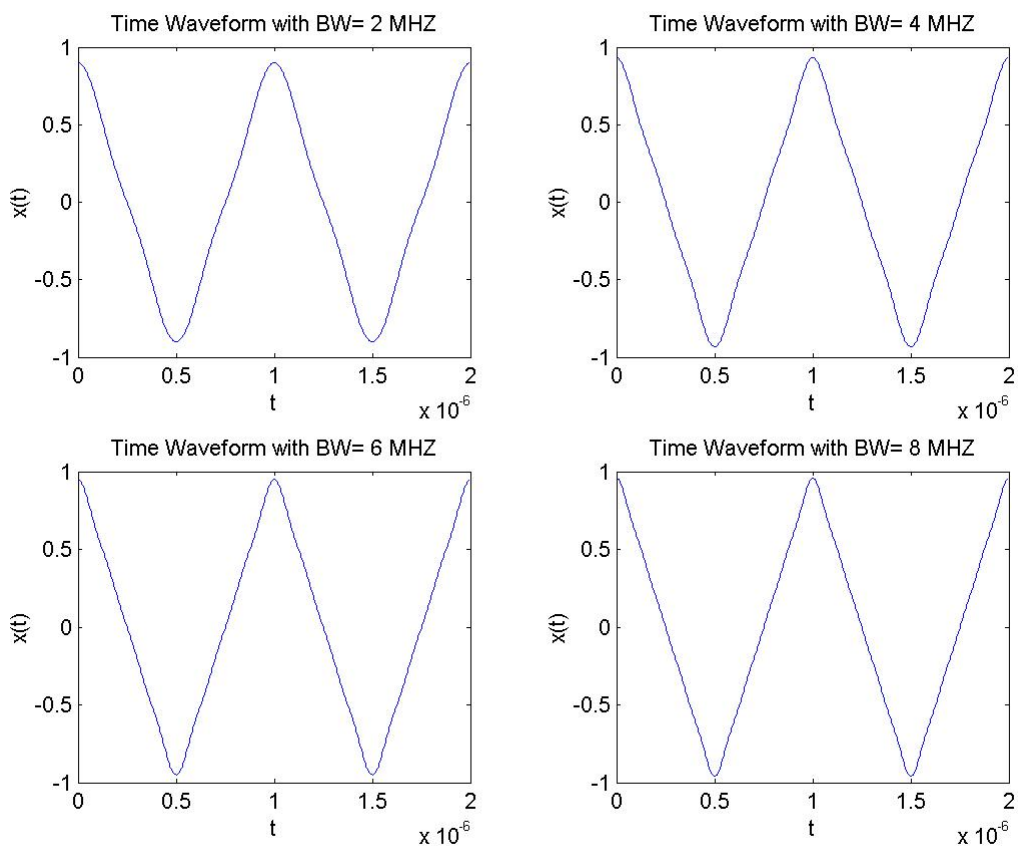
%defining the time waveform for a BW= 6 MHZ
A=0;
x=A;
h=7;
for i=1:2:h
x=x+8/(pi^2)*1/(i^2)* cos(2*pi*fo*i*t);
end
subplot(223);
plot (t,x);
xlabel('t');
```



```

ylabel('x(t)');
title('Time Waveform with BW= 6 MHZ');
%defining the time waveform for a BW= 8 MHZ
A=0;
x=A;
h=9;
for i=1:2:h
x=x+8/(pi^2)*1/(i^2)* cos(2*pi*fo*i*t);
end
subplot(224);
plot (t,x);
xlabel('t');
ylabel('x(t)');
title('Time Waveform with BW= 8 MHZ');

```

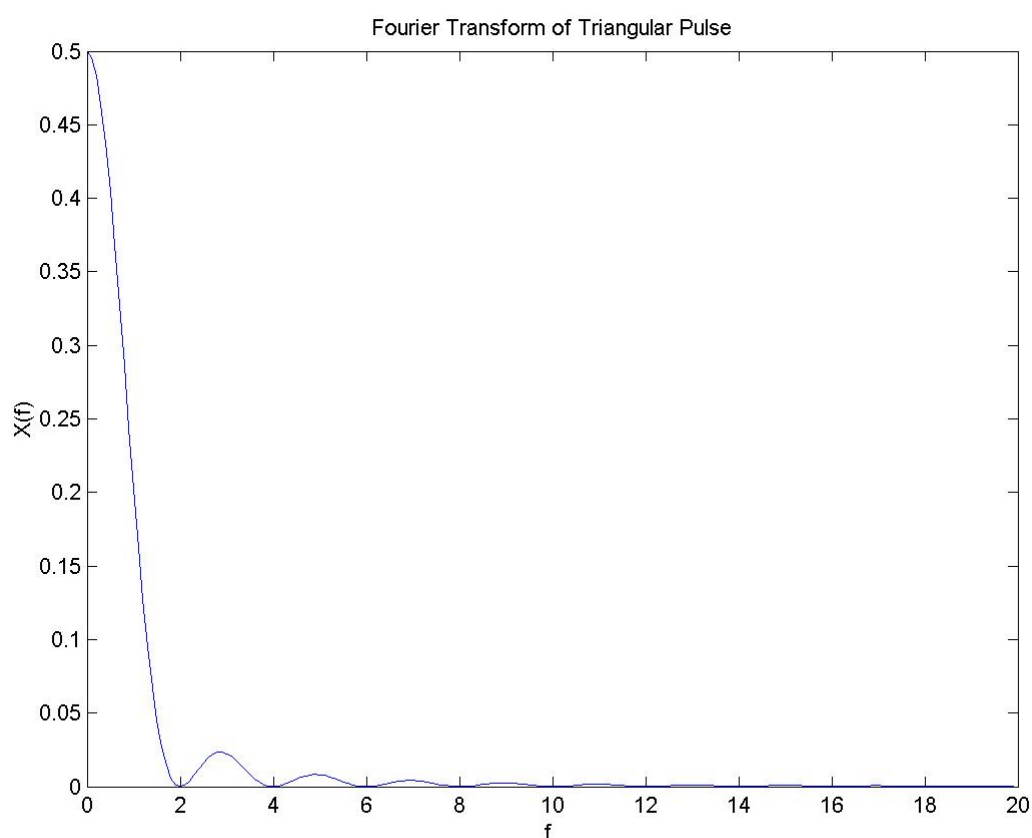


As can be seen from the plots, increasing the bandwidth improves the quality of the signal. A bandwidth of 4 MHz seems sufficient.

Q3.

First, we will plot the Fourier transform of the signal using the derived equation.

```
A=1;
t=0.5;
f=0.001:0.1:20;
x=A*t*(sin(pi*f*t)./(pi*f*t)).^2;
plot (f,x);
xlabel('f ');
ylabel('X(f)');
title('Fourier Transform of Triangular Pulse');
```



Matlab code for plotting the signal and its frequency spectrum using Fourier Transform:

```
M = 8;
N = 2^M;
n = 0:1:N-1;
T = 1;
tbeg=-0.5*T;
tend = 0.5*T;
dt = T/N;
t = tbeg:dt:tend;
```

```

w = zeros(length(t),1);
for (i = 1:length(w))
    if (t(i) <= 0)
        w(i) = 2*t(i)+1;
    else
        w(i) = -2*t(i)+1;
    end;
end;

```

```

% Calculating FFT
W = dt*fft(w);
f = n/T;

```

```

subplot(211);
plot(t,w);
xlabel('t');
ylabel('w(t)');
title('Time Waveform');

```

```

subplot(212);
plot(f(1:20),abs(W(1:20)));
xlabel('f');
title('MAGNITUDE SPECTRUM ');

```

