ECE 311 - Solution to Homework #28

Fourier Transform

note: What to take from this assignment is that

- *If you have a periodic waveform,*
- *You can express it as a sum of sine waves*

1) $$x(t) = \begin{cases} 1 & \sin(5t) > 0.5 \\ 0 & otherwise \end{cases}$$

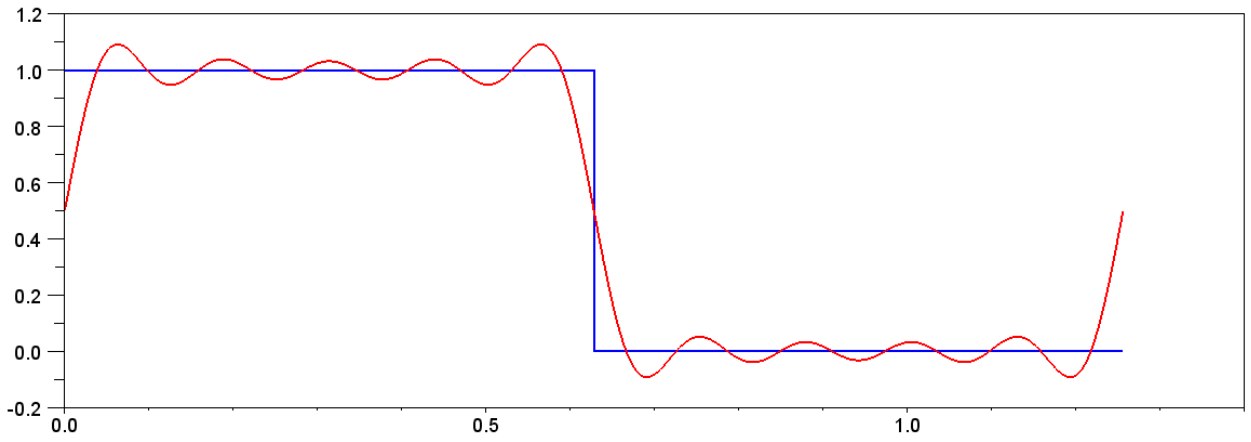
a) Find the Fourier transform for the following waveforms as

```
t = [1:10000]'/10000 * 2*pi/5;
w0 = 5;
x = 1 * (sin(5*t) > 0);
a0 = mean(x)

a = zeros(10,1);
b = zeros(10,1);

for n=1:10
   a(n) = 2*mean(x .* cos(5*n*t));
   b(n) = 2*mean(x .* sin(5*n*t));
   end
```

n	0	1	2	3	4	5	6	7	8	9	10
a(n)	0.5	0	0	0	0	0	0	0	0	0	0
b(n)	0	0.637	0	0.212	0	0.127	0	0.091	0	0.071	0

b) Plot x(t) vs time along with it's Fourier transform approximation taken out to 10 terms

```
x10 = 0*t + a0;
for n=1:10
   x10 = x10 + a(n)*cos(5*n*t) + b(n)*sin(5*n*t);
   end
plot(t,x,t,x10);
```



x(t) (blue) and it's Fourier Series approximation taken out to the 10th harmonic (red)

2) $$x(t) = \begin{cases} \sin(5t) & \sin(5t) > 0 \\ 0 & otherwise \end{cases}$$

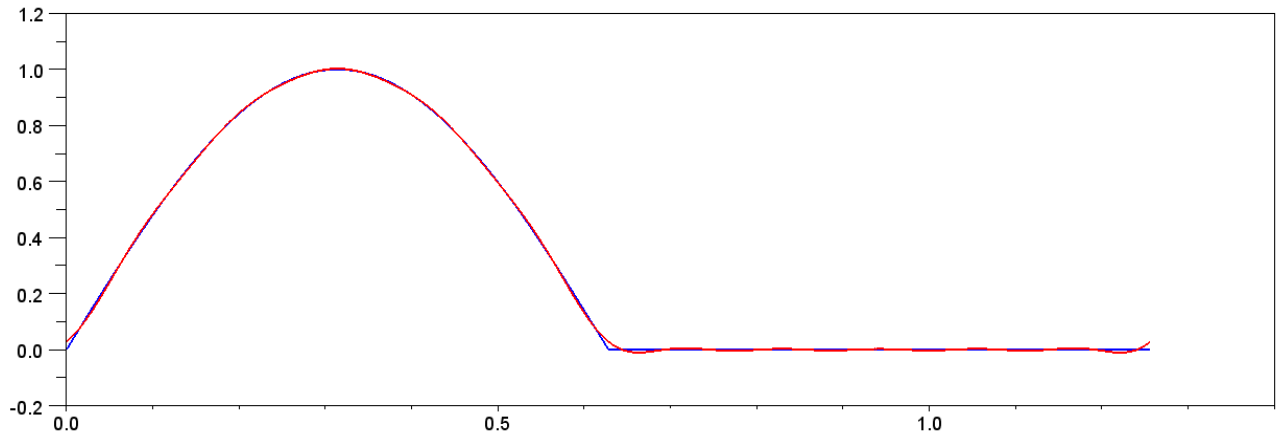
a) Find the Fourier transform for the following waveforms as

```
t = [1:10000]'/10000 * 2*pi/5;
w0 = 5;
x = max(0, sin(5*t));
a0 = mean(x)

a = zeros(10,1);
b = zeros(10,1);

for n=1:10
   a(n) = 2*mean(x .* cos(5*n*t));
   b(n) = 2*mean(x .* sin(5*n*t));
   end
```

n	0	1	2	3	4	5	6	7	8	9	10
a(n)	0.318	0	-0.212	0	-0.042	0	-0.018	0	-0.010	0	-0.006
b(n)	0	0.5	0	0	0	0	0	0	0	0	0

b) Plot x(t) vs time along with it's Fourier transform approximation taken out to 10 terms

```
x10 = 0*t + a0;
for n=1:10
   x10 = x10 + a(n)*cos(5*n*t) + b(n)*sin(5*n*t);
   end
plot(t,x,t,x10);
```



x(t) (blue) and it's Fourier Series approximation taken out to the 10th harmonic (red)

3) $$x(t) = \begin{cases} \sin(5t) & \sin(5t) < 0.8 \\ 0.8 & otherwise \end{cases}$$

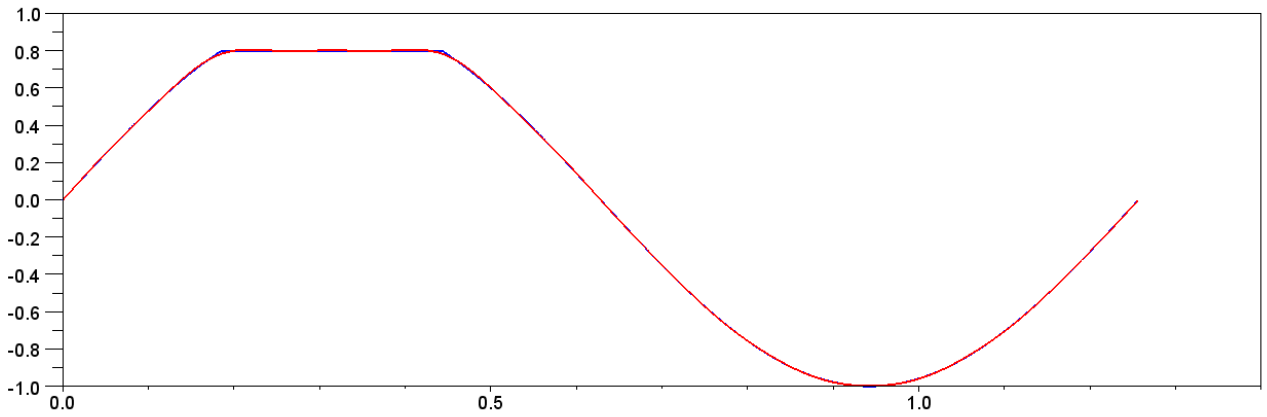
a) Find the Fourier transform for the following waveforms as

```
t = [1:10000]'/10000 * 2*pi/5;
w0 = 5;
x = min(0.8, sin(5*t));
a0 = mean(x)

a = zeros(10,1);
b = zeros(10,1);

for n=1:10
   a(n) = 2*mean(x .* cos(5*n*t));
   b(n) = 2*mean(x .* sin(5*n*t));
   end
```

n	0	1	2	3	4	5	6	7	8	9	10
a(n)	-0.027	0	0.046	0	-0.026	0	0.007	0	0.003	0	-0.004
b(n)	0	0.949	0	0.037	0	-0.016	0	0	0	0.005	0

b) Plot x(t) vs time along with it's Fourier transform approximation taken out to 10 terms

```
x10 = 0*t + a0;
for n=1:10
   x10 = x10 + a(n)*cos(5*n*t) + b(n)*sin(5*n*t);
   end
plot(t,x,t,x10);
```



x(t) (blue) and it's Fourier Series approximation taken out to the 10th harmonic (red)