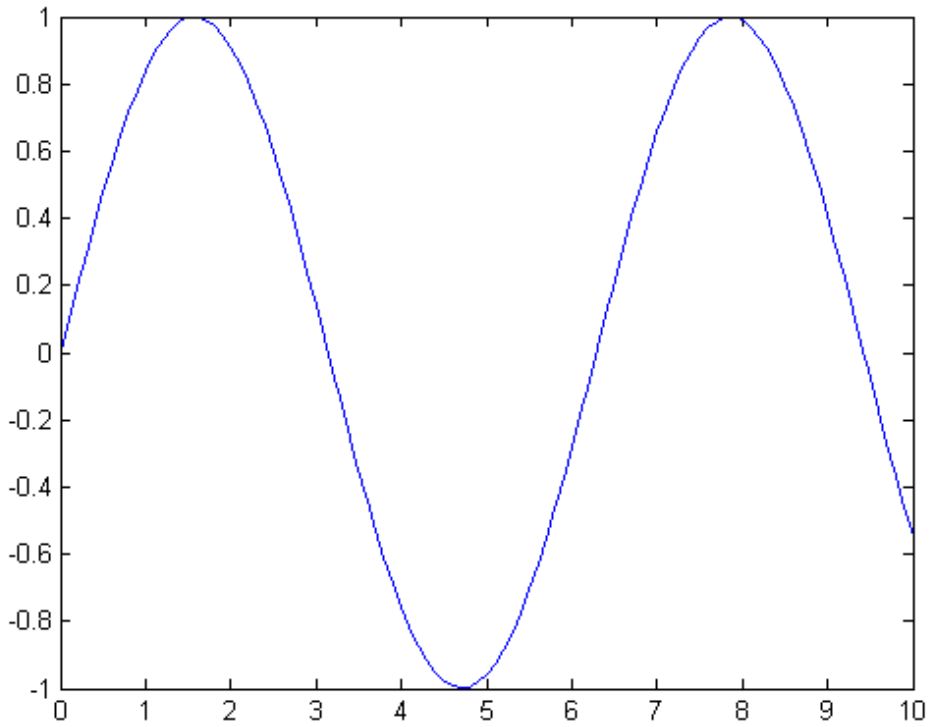
Open xfourier.m in the Editor **Run in the Command Window**

Square Wave from Sine Waves

The Fourier series expansion for a square-wave is made up of a sum of odd harmonics. We show this graphically using MATLAB.

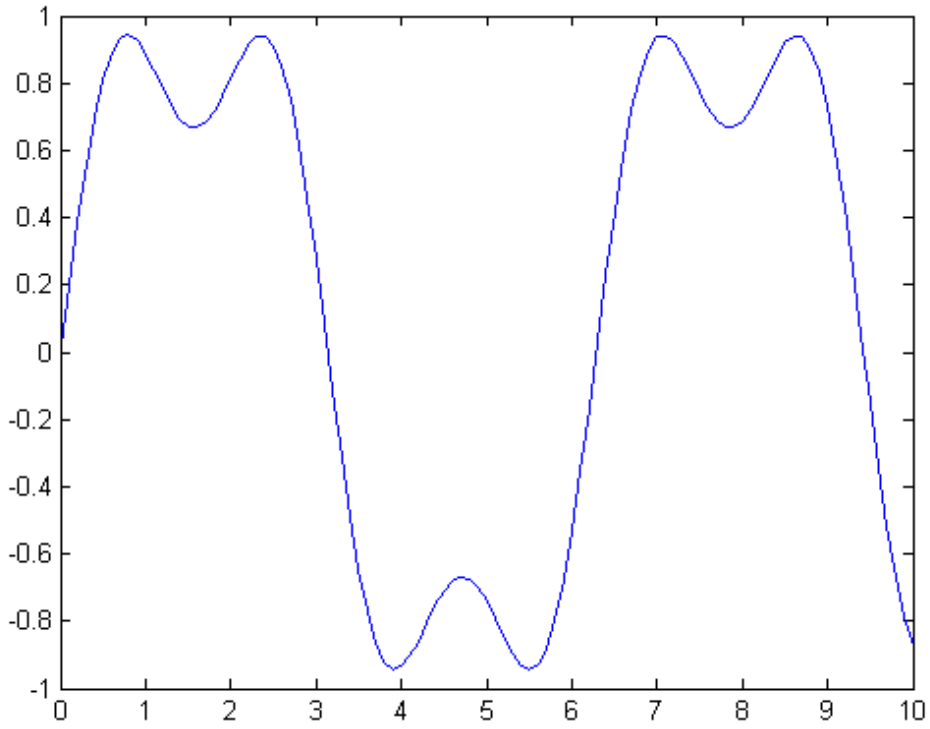
We start by forming a time vector running from 0 to 10 in steps of 0.1, and take the sine of all the points. Let's plot this fundamental frequency.

```
t = 0:.1:10;
y = sin(t);
plot(t,y);
```



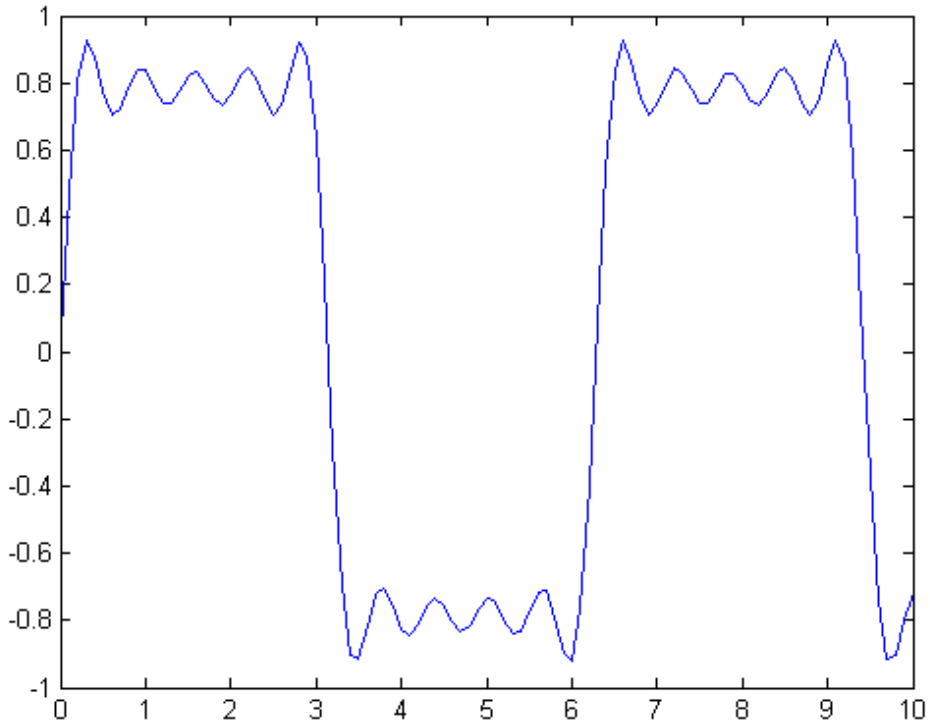
Now add the third harmonic to the fundamental, and plot it.

```
y = sin(t) + sin(3*t)/3;
plot(t,y);
```



Now use the first, third, fifth, seventh, and ninth harmonics.

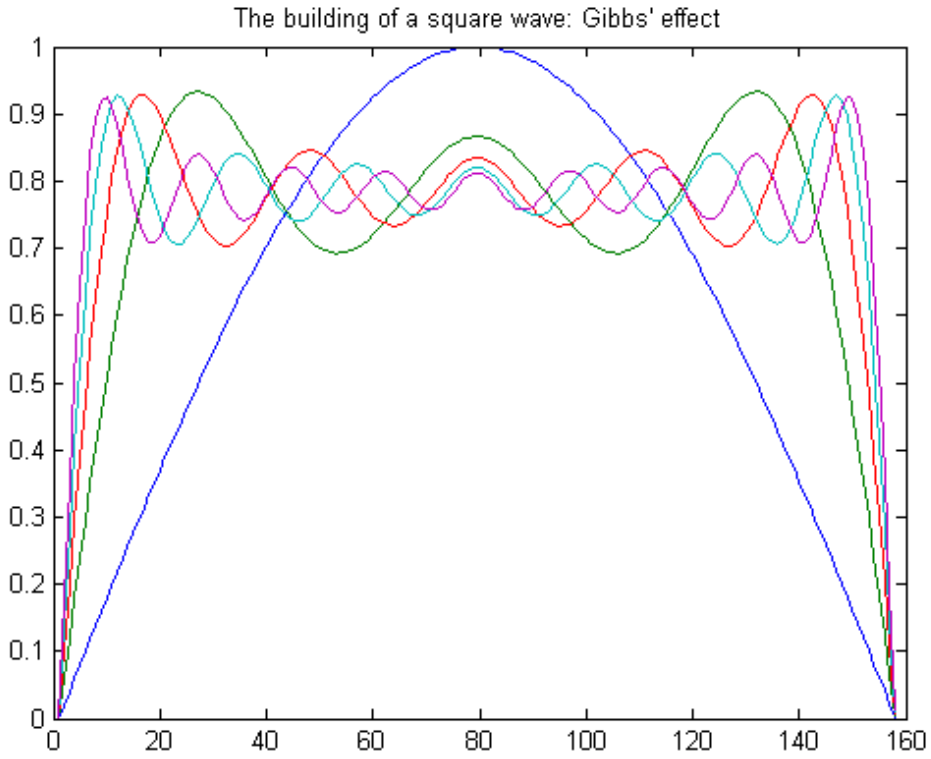
```
y = sin(t) + sin(3*t)/3 + sin(5*t)/5 + sin(7*t)/7 + sin(9*t)/9;
plot(t,y);
```



For a finale, we will go from the fundamental to the 19th harmonic, creating vectors of successively more harmonics, and saving all intermediate steps as the rows of a matrix.

These vectors are plotted on the same figure to show the evolution of the square wave. Note that Gibbs' effect says that it will never really get there.

```
t = 0:.02:3.14;
y = zeros(10,length(t));
x = zeros(size(t));
for k=1:2:19
    x = x + sin(k*t)/k;
    y((k+1)/2,:) = x;
end
plot(y(1:2:9,:)')
title('The building of a square wave: Gibbs'' effect')
```



Here is a 3-D surface representing the gradual transformation of a sine wave into a square wave.

```
surf(y);
shading interp
axis off ij
```