

---

# Square Waves from Sine Waves

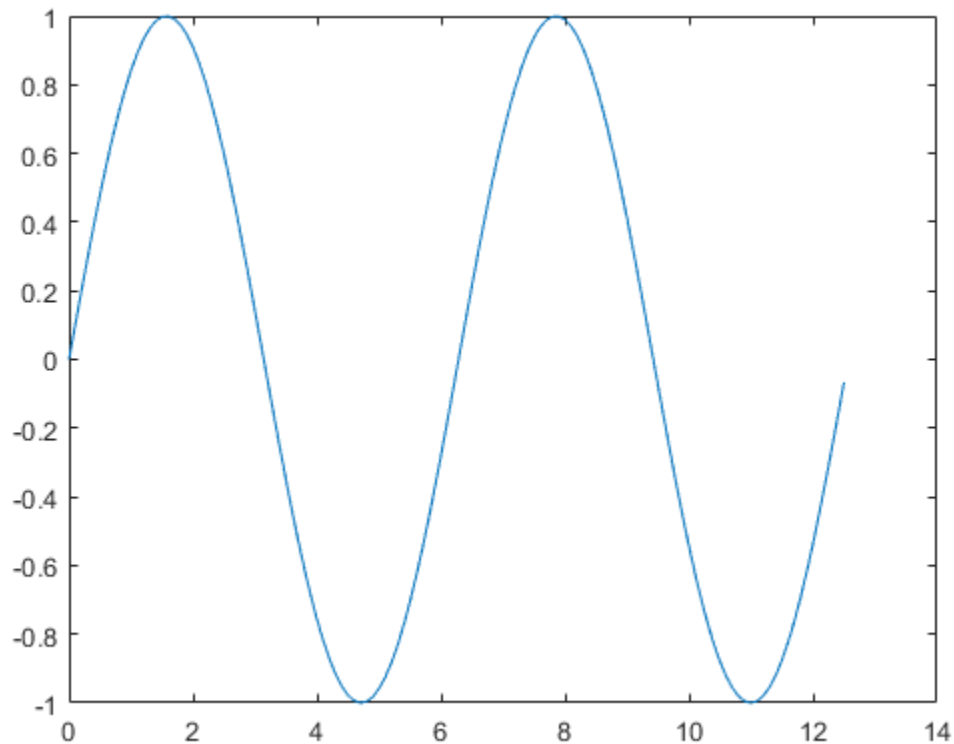
## Table of Contents

|                                       |   |
|---------------------------------------|---|
| Add an Odd Harmonic and Plot It ..... | 1 |
| Note About Gibbs Phenomenon .....     | 3 |

The Fourier series expansion for a square-wave is made up of a sum of odd harmonics, as shown here using MATLAB®.

## Add an Odd Harmonic and Plot It

```
t = 0:.1:pi*4;  
y = sin(t);  
plot(t,y);
```



In each iteration of the for loop add an odd harmonic to y. As  $k$  increases, the output approximates a square wave with increasing accuracy.

```
for k = 3:2:9
```

Perform the following mathematical operation at each iteration:

$$y = y + \frac{\sin kt}{k}$$

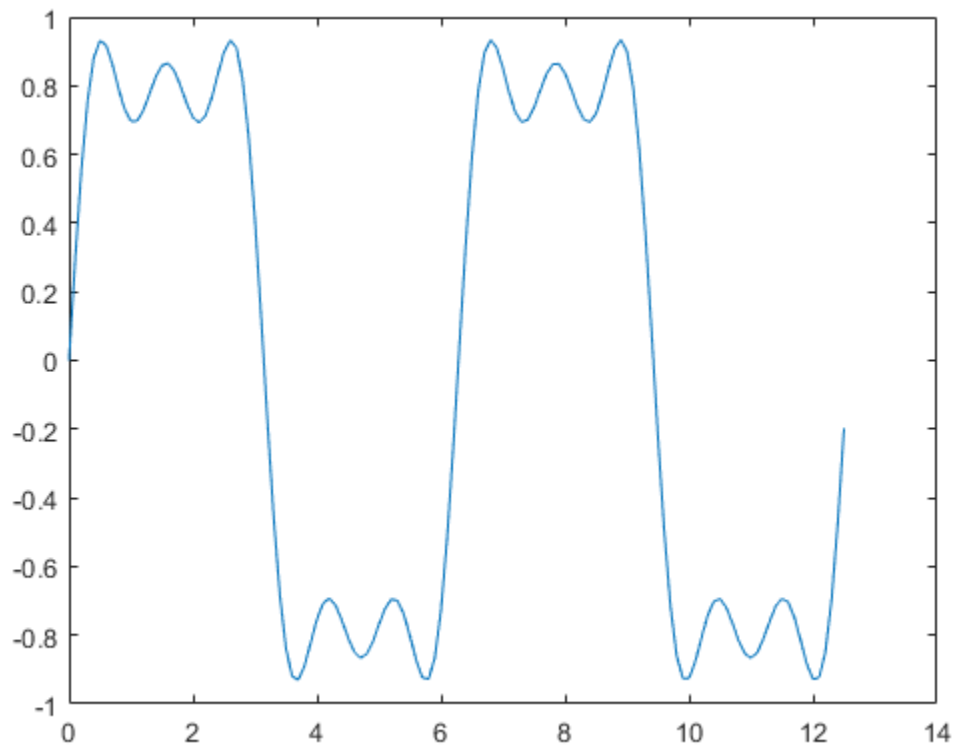
Display every other plot:

```

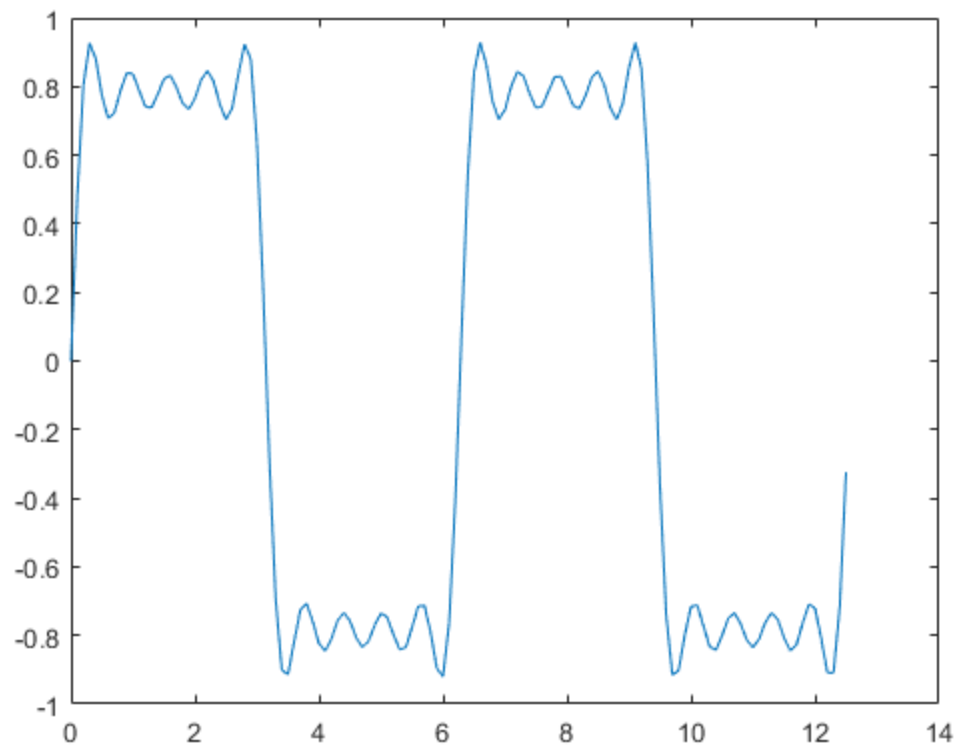
y = y + sin(k*t)/k;
if mod(k,4)==1
    display(sprintf('When k = %.1f',k));
    display('Then the plot is:');
    cla
    plot(t,y)
end

```

When  $k = 5.0$   
Then the plot is:



When  $k = 9.0$   
Then the plot is:



end

## Note About Gibbs Phenomenon

Even though the approximations are constantly improving, they will never be exact because of the Gibbs phenomenon, or ringing.

*Published with MATLAB® R2016b*