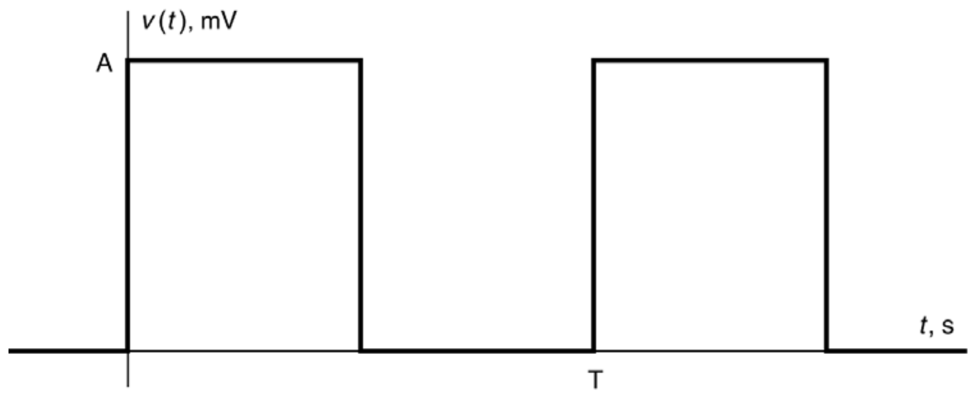
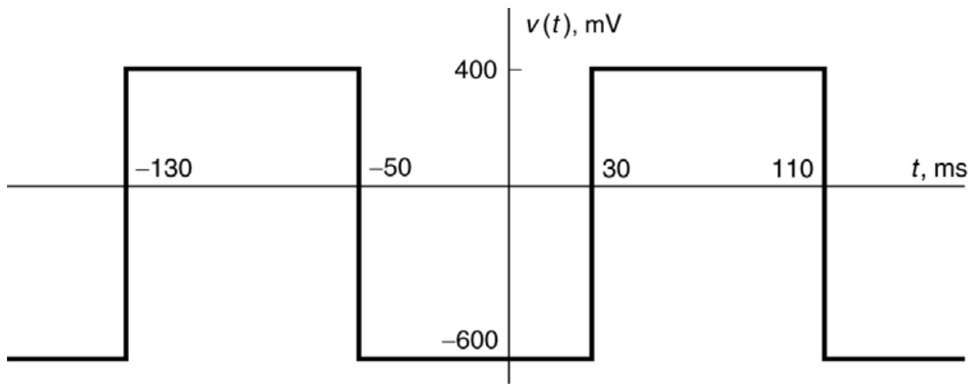


From Table 15.4-1

$$v(t)=\frac{A}{2}+\frac{2A}{\pi}\sum_{n=1}^{\infty}\frac{\sin\left((2n-1)\omega_0 t\right)}{2n-1} \quad \text{where} \quad \omega_0=\frac{2\pi}{T}$$

Consider this square wave:



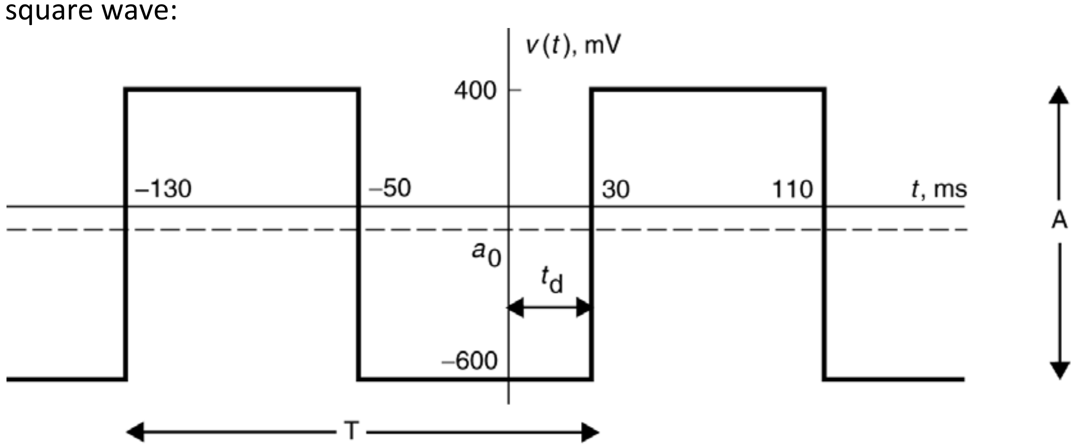
Let's make two changes to the Fourier Series:

1. Change the average value from $\frac{A}{2}$ to a_0.
2. Introduce a delay, t_d.

Now we have

$$v(t)=a_0+\frac{2A}{\pi}\sum_{n=1}^{\infty}\frac{\sin\left((2n-1)\omega_0 (t-t_d)\right)}{2n-1}=a_0+\frac{2A}{\pi}\sum_{n=1}^{\infty}\frac{\sin\left((2n-1)(\omega_0 t-\theta)\right)}{2n-1} \quad \text{where} \quad \omega_0=\frac{2\pi}{T}$$

Let's label the square wave:



$$A=400-(-600)=1000\text{ mV}=1\text{ V},\ a_0=\frac{400+(-600)}{2}=-100\text{ mV},\ t_d=30\text{ ms}$$

$$T = 110 - (-50) = 160 \text{ ms} \quad \Rightarrow \quad \omega_0 = \frac{2\pi}{0.16} = 39.27 \text{ rad/s}$$

$$\theta = \omega_0 t_d = \frac{2\pi}{0.16}(.03) = 0.1875(2\pi) \text{ rad} = 67.5°$$

Let's modify that MATLAB script from Example 15.2-2 to correspond to this square wave:

```
% Ex15_4_1HO.m - square wave Fourier series
% --------------------------------------------------
%        Describe the periodic waveform, v(t)
% --------------------------------------------------
T=0.16; % period
a0=-0.1;  % average value
A=1;    % peak-to-peak amplitude
theta=67.5;          % phase angle in degrees
theta=theta*pi/180; %phase angle in radians
% --------------------------------------------------
%  Obtain a list of equally spaced instants of time
% --------------------------------------------------
w0=2*pi/T;        % fundamental frequency, rad/s
tf=T;          % final time
dt=tf/200;       % time increment
t=-tf:dt:tf;     % time, s
% --------------------------------------------------
%  Approximate v(t) using the trig Fourier series.
% --------------------------------------------------
v = a0*ones(size(t));  % initialize v(t) as vector
for n=1:500
   v = v + (2*A/pi/(2*n-1))*sin((2*n-1)*(w0*t - theta));
end
% --------------------------------------------------
%              Plot the Fourier series
% --------------------------------------------------
plot(t, v)
axis([-tf tf -0.8 0.5])
grid
xlabel('time, s')
ylabel('v(t) V')
title('Square Wave')
```

Running this script produces this plot: