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% Chapter 3 Fourier series spectra example
% (chap3_fourier_series1_spectra_complex.m)
%
% Computes amplitude and phase spectra for
% complex exponential Fourier series for
% Example 3.2
%
clear;clc;
N = input('Number of harmonics ');
w0 = pi;
for k1 = 1:1:2*N+1,
    ktmp = k1-(N+1);
    if(ktmp == 0),
        ck(k1) = 0.5;
    else
        ck(k1) = (1/ktmp/w0).*sin(0.5*ktmp*w0);
    end
end
k = -N:1:N;
ckmag = abs(ck);
for k2 = 1:1:2*N+1,
    ktmp2 = k2-(N+1);
    if(ktmp2<0),
        ckang(k2) = -angle(ck(k2));
    else
        ckang(k2) = angle(ck(k2));
    end
end
% ck terms related to mag. of voltage so 20log10() appropriate
ckmagdB = 20*log10(ckmag);
ckmagdBnorm = ckmagdB-max(ckmagdB); % normalize to max ampl.
%
stem(k,ckmag,'b.'), axis([-N+1 N+1 0 0.6]),
title(['Fourier series example, N = ',num2str(N)],...
    'fontsize',18,'fontname','times')
xlabel('k','fontsize',16,'fontname','times'),
ylabel('|c_k|','fontsize',16,'fontname','times'),
% Label stems
for n=1:2*N+1, %
    if(ckmag(n)>0.0009),
        text(k(n),ckmag(n)+0.045,[' ' num2str(ckmag(n),3)],...
            'HorizontalAlignment','center','VerticalAlignment','top')
    end
end
figure
stem(k,ckmagdB,'b.'), axis([-N+1 N+1 -50 0]),

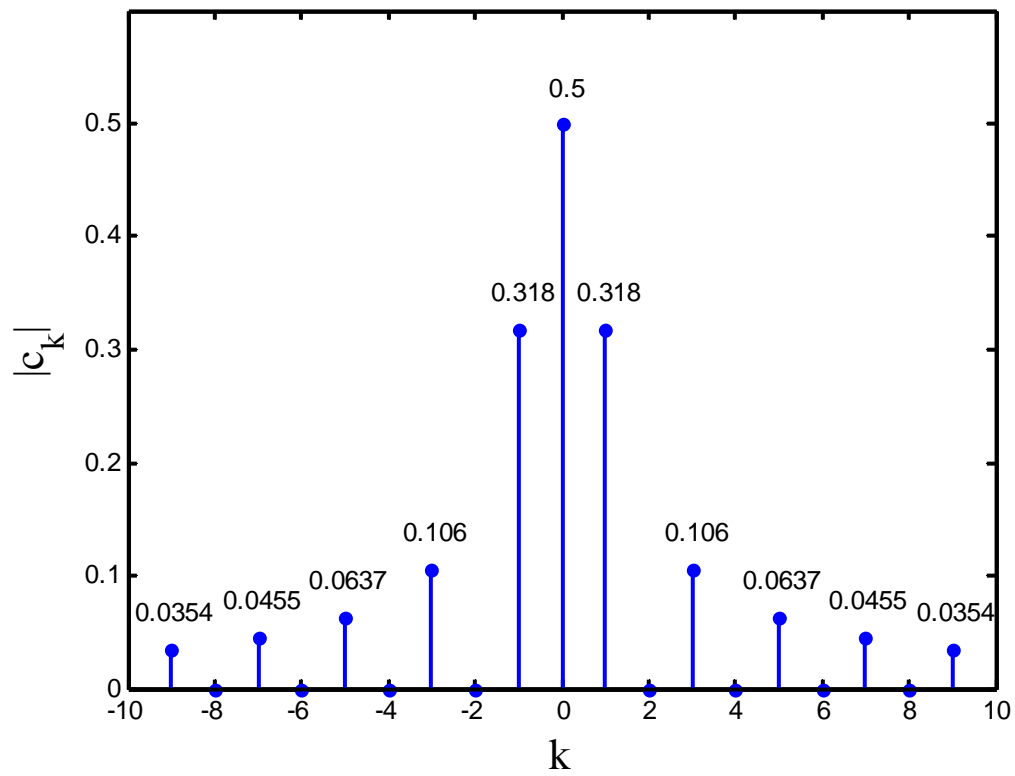
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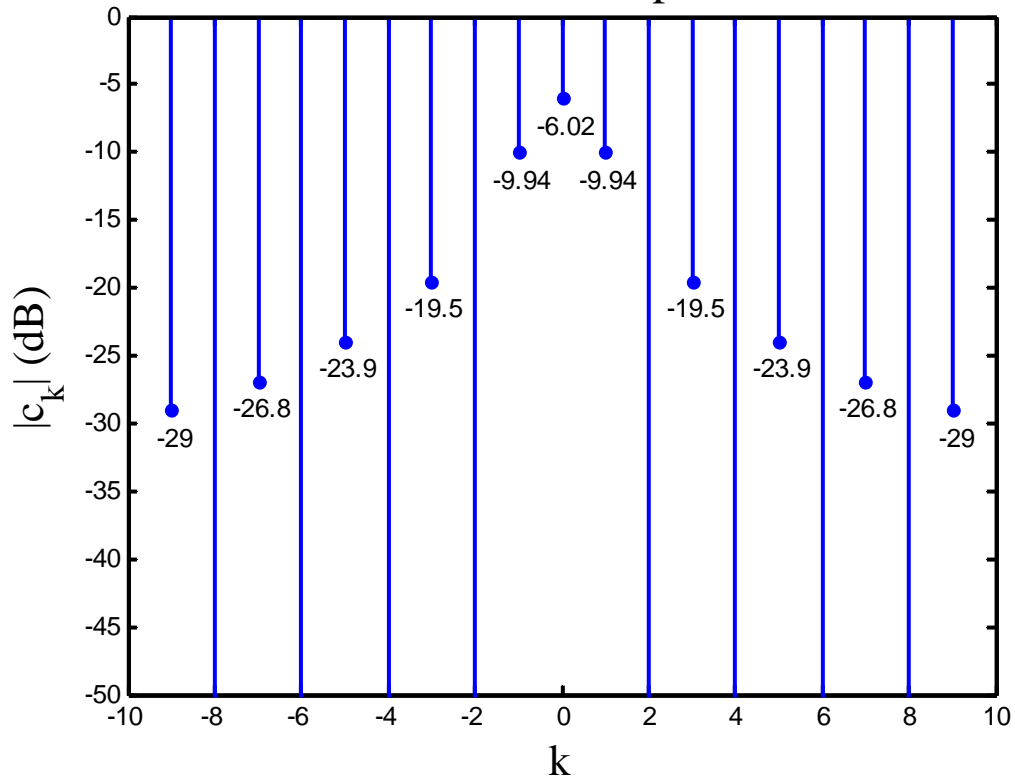
title(['Fourier series example, N = ', num2str(N)], ...
      'fontsize', 18, 'fontname', 'times')
xlabel('k', 'fontsize', 16, 'fontname', 'times'),
ylabel('|c_k| (dB)', 'fontsize', 16, 'fontname', 'times'),
% Label stems
for n=1:2*N+1,
    if(ckang(n)>-50),
        text(k(n),ckmagdB(n)-1,[' ' num2str(ckmagdB(n),3)],...
             'HorizontalAlignment', 'center', 'VerticalAlignment', 'top')
    end
end
figure
stem(k,ckmagdBnorm,'b.'), axis([- (N+1) N+1 -50 0]),
title(['Fourier series example, N = ', num2str(N)];...
      ['max(|c_k|) = ', num2str(max(ckmagdB)), ' dB']],...
      'fontsize', 16, 'fontname', 'times')
xlabel('k', 'fontsize', 16, 'fontname', 'times'),
ylabel('Normalized |c_k| = |c_k| - max(|c_k|) (dB)', ...
      'fontsize', 14, 'fontname', 'times'),
% Label stems
for n=1:2*N+1,
    if(ckang(n)>-50),
        text(k(n),ckmagdBnorm(n)-1,[' ' num2str(ckmagdBnorm(n),3)],...
             'HorizontalAlignment', 'center', 'VerticalAlignment', 'top')
    end
end
figure
stem(k,ckang,'b.'), axis([- (N+1) N+1 -4 4]),
title(['Fourier series example, N = ', num2str(N)], ...
      'fontsize', 18, 'fontname', 'times')
xlabel('k', 'fontsize', 16, 'fontname', 'times'),
ylabel('\angle c_k (rad)', 'fontsize', 16, 'fontname', 'times'),
% Label stems
for n=1:2*N+1, %
    if(ckang(n)>0.1),
        text(k(n),ckang(n)+0.3,[' ' num2str(ckang(n),3)],...
             'HorizontalAlignment', 'center', 'VerticalAlignment', 'top')
    else
        text(k(n),ckang(n)-0.1,[' ' num2str(ckang(n),3)],...
             'HorizontalAlignment', 'center', 'VerticalAlignment', 'top')
    end
end
end
set(findobj('type','line'),'linewidth',1.5)
set(findobj('type','line'),'markersize',14)
set(findobj('type','axes'),'linewidth',2)

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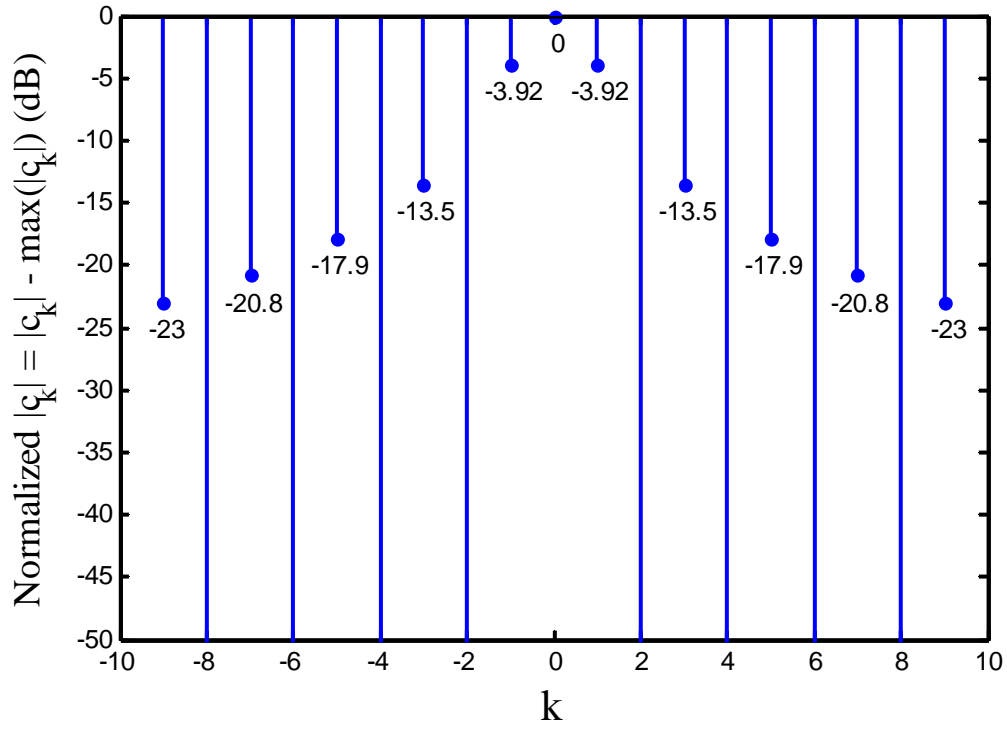
Fourier series example,  $N = 9$



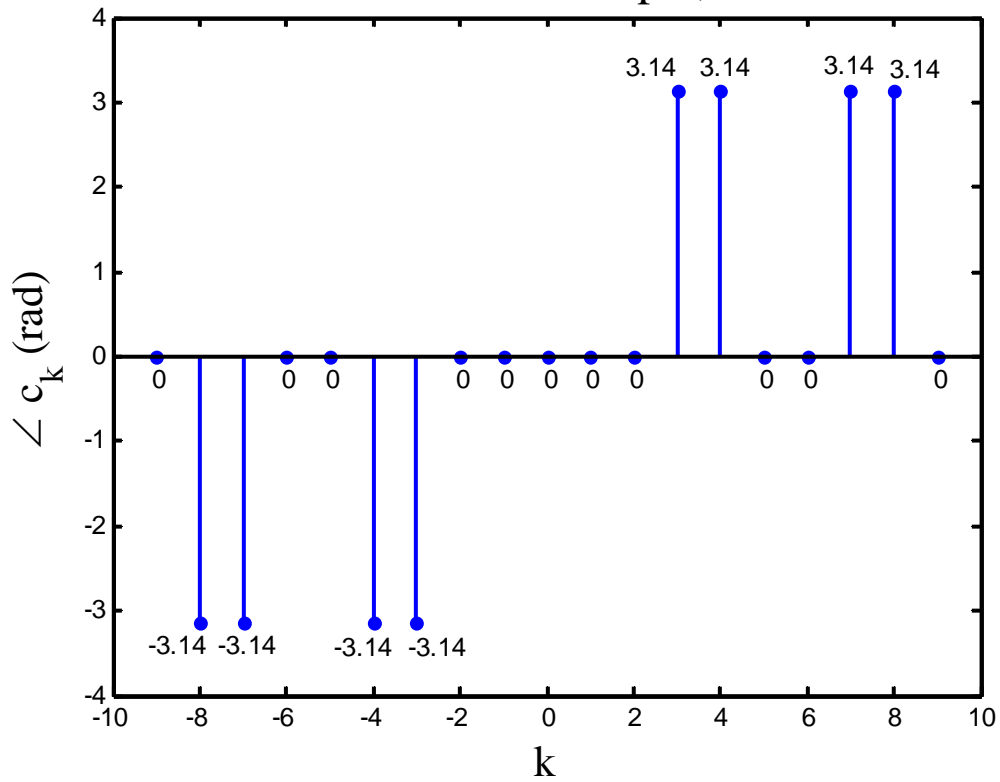
Fourier series example,  $N = 9$



Fourier series example,  $N = 9$   
 $\max(|c_k|) = -6.0206 \text{ dB}$



Fourier series example,  $N = 9$

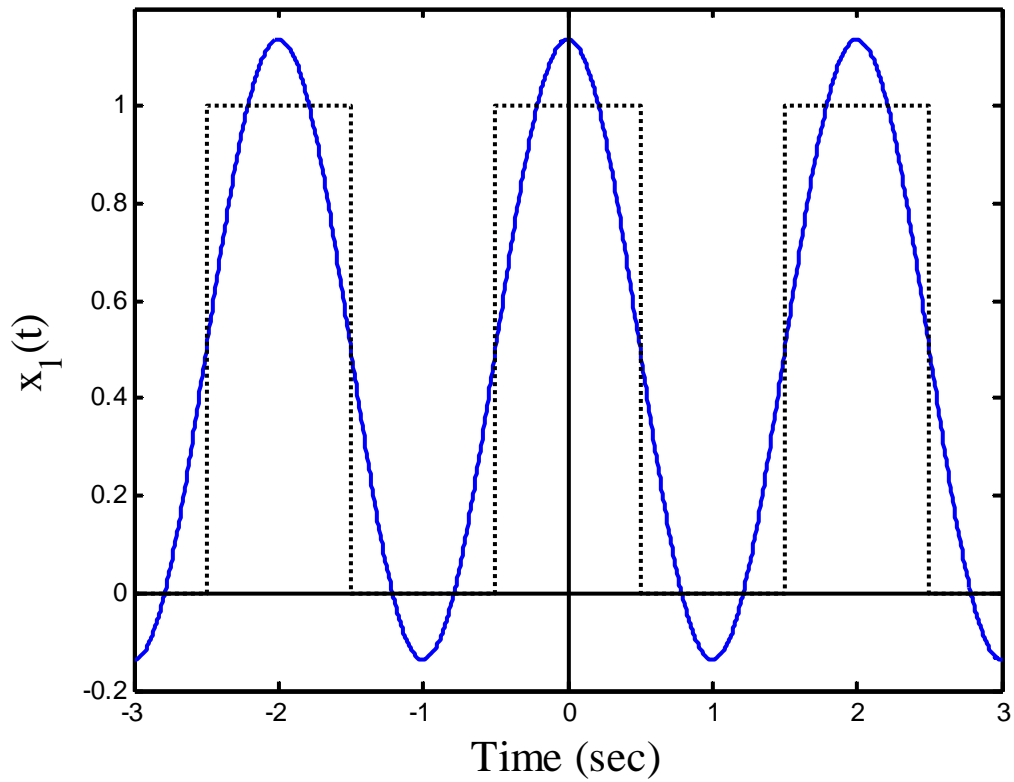


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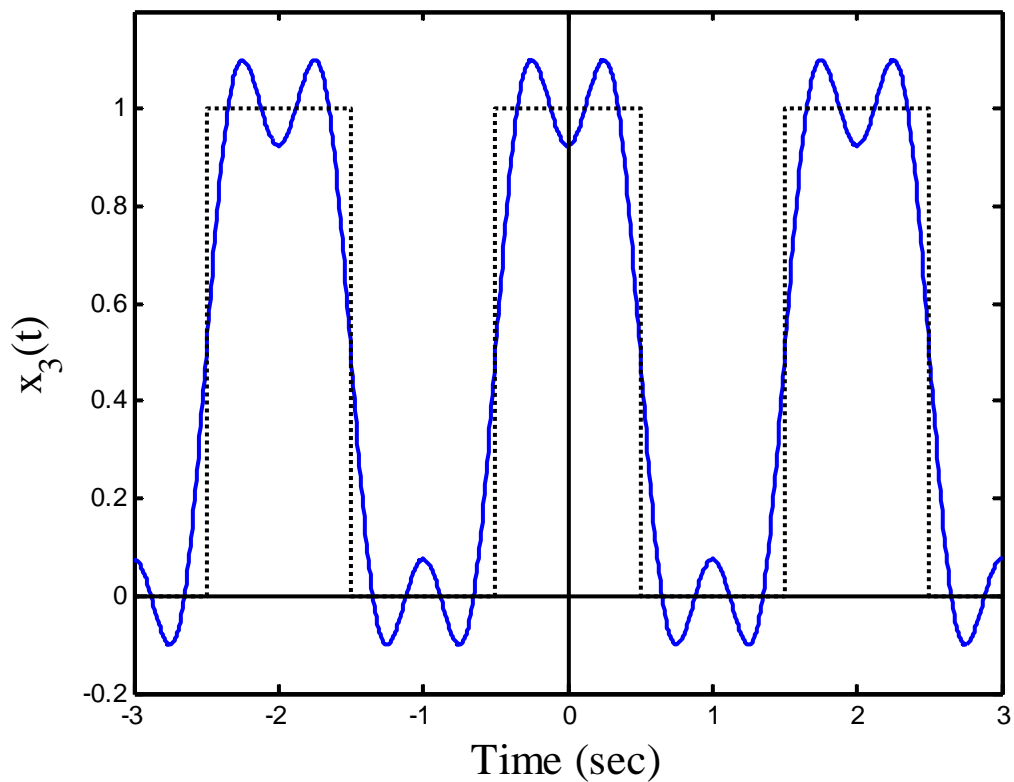
% Chapter 3 Fourier series example
% (chap3_fourier_series1_complex.m)
%
% Computes complex exponential Fourier series
% for Example 3.2
%
clear;clc;
t = -3:6/1000:3;
N = input('Number of harmonics ');
w0 = pi;
xN = zeros(1,length(t));
for k1 = 1:1:2*N+1,
    ktmp = k1-(N+1);
    if(ktmp == 0),
        ck(k1) = 0.5;
    else
        ck(k1) = (1/ktmp/w0).*sin(0.5*ktmp*w0);
    end
    xN = xN + ck(k1)*exp(1j*ktmp*w0*t);
end
xexact = [0 0 1 1 0 0 1 1 0 0 1 1 0 0];
texact = [-3 -2.5 -2.5 -1.5 -1.5 -0.5 -0.5 0.5 0.5 1.5 1.5 2.5 2.5 3];
plot(t,xN,'b-',texact,xexact,'k:',['-3 3],[0,0'],'k-',...
     [0 0],[-0.2,1.2],'k-'),
axis([-3 3 -0.2 1.2]),
title(['Complex Exponential Fourier series example, N = ',...
       num2str(N)],'fontsize',16,'fontname','times')
xlabel('Time (sec)','fontsize',16,'fontname','times')
ylabel(['x_{',num2str(N),'}(t)'],'fontsize',16,'fontname','times')
set(findobj('type','line'),'linewidth',1.5)
set(findobj('type','line'),'markersize',18)
set(findobj('type','axes'),'linewidth',2)

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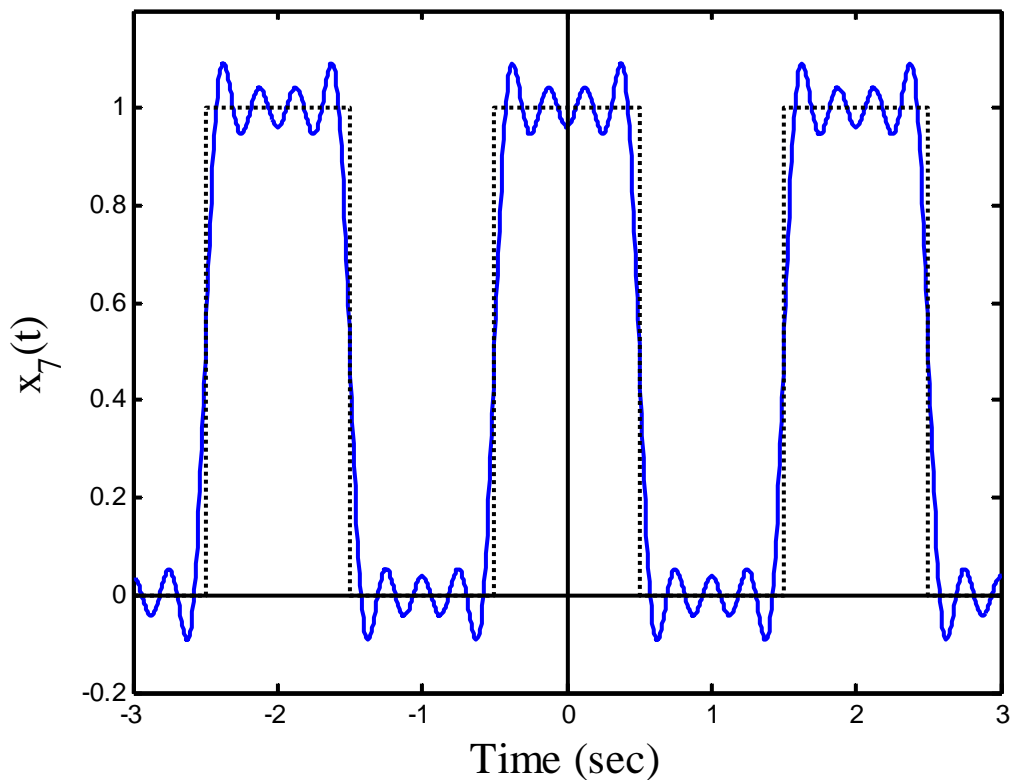
Complex Exponential Fourier series example,  $N = 1$



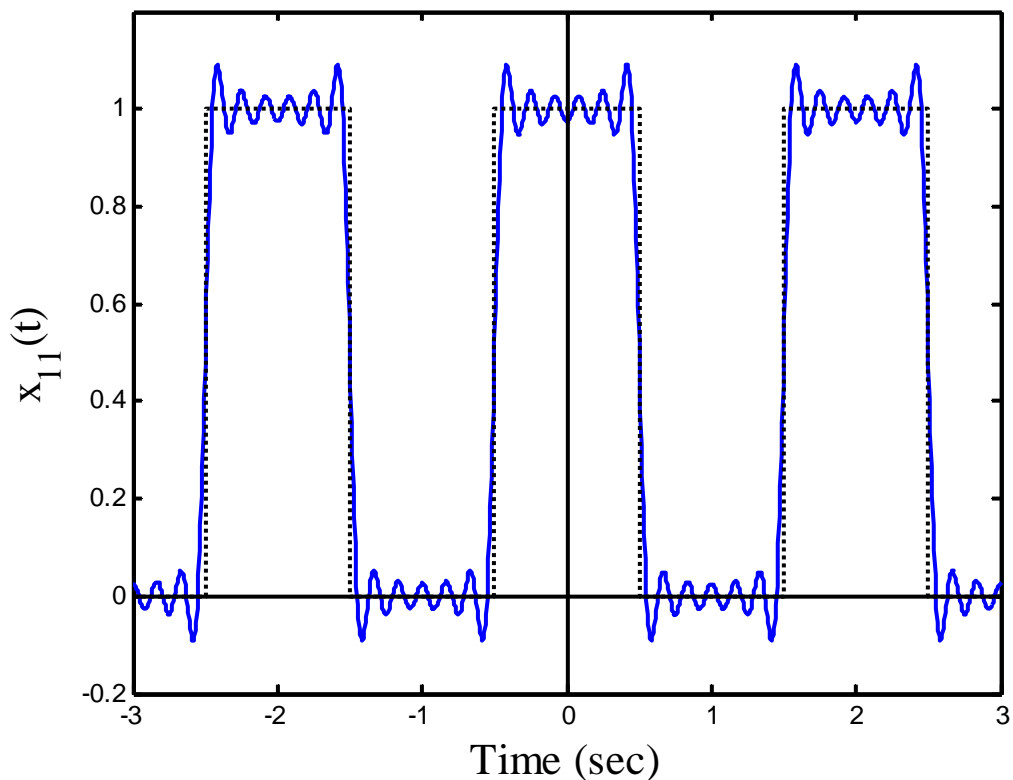
Complex Exponential Fourier series example,  $N = 3$



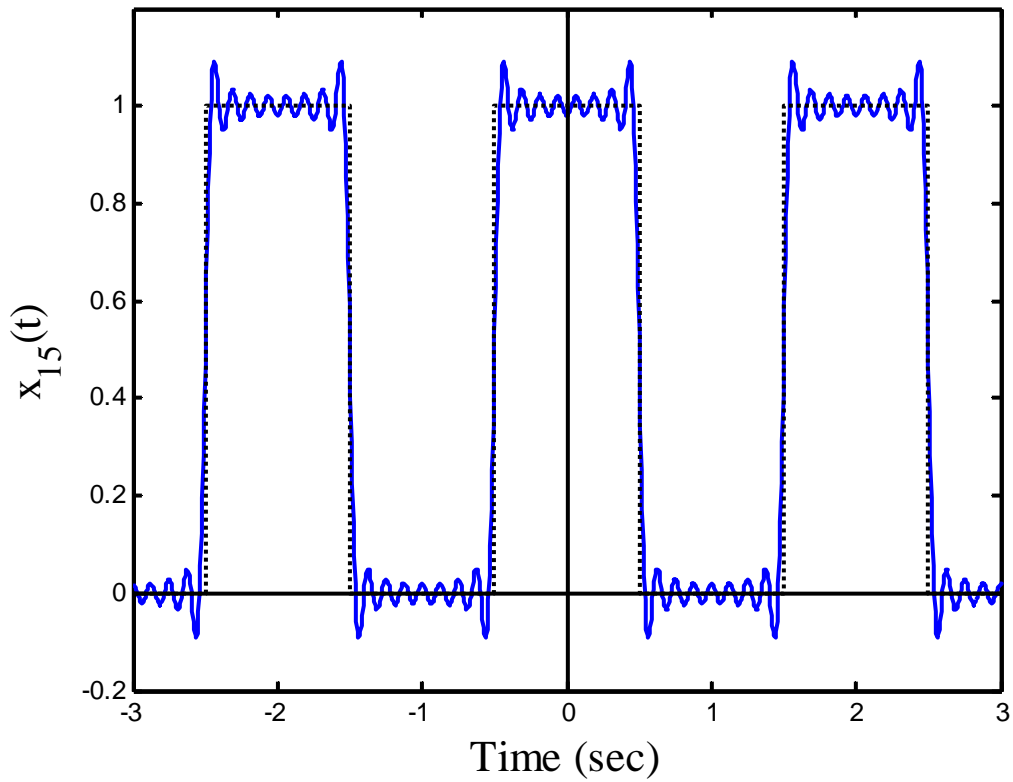
Complex Exponential Fourier series example,  $N = 7$



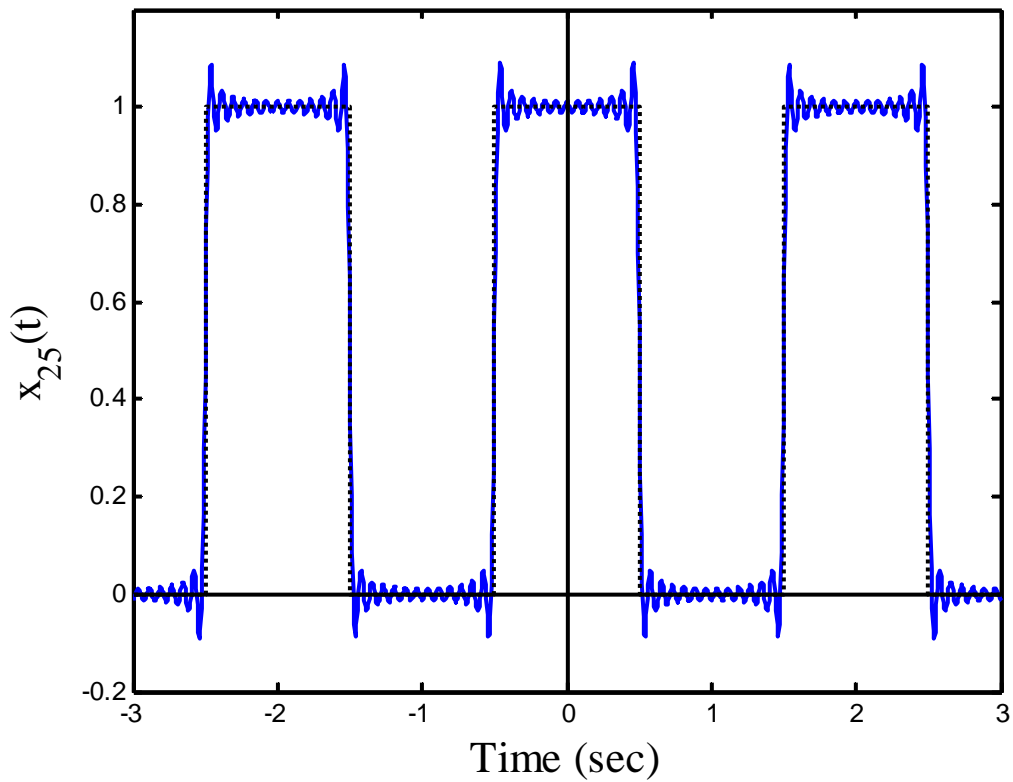
Complex Exponential Fourier series example,  $N = 11$



Complex Exponential Fourier series example,  $N = 15$

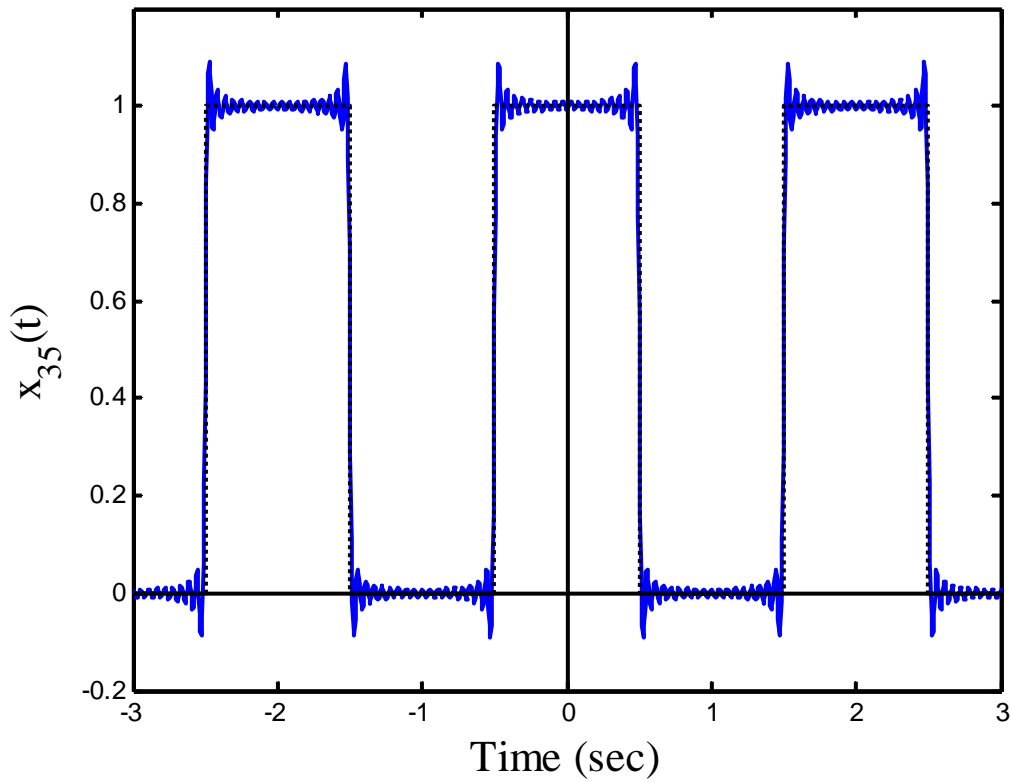


Complex Exponential Fourier series example,  $N = 25$





Complex Exponential Fourier series example,  $N = 35$



Complex Exponential Fourier series example,  $N = 45$

