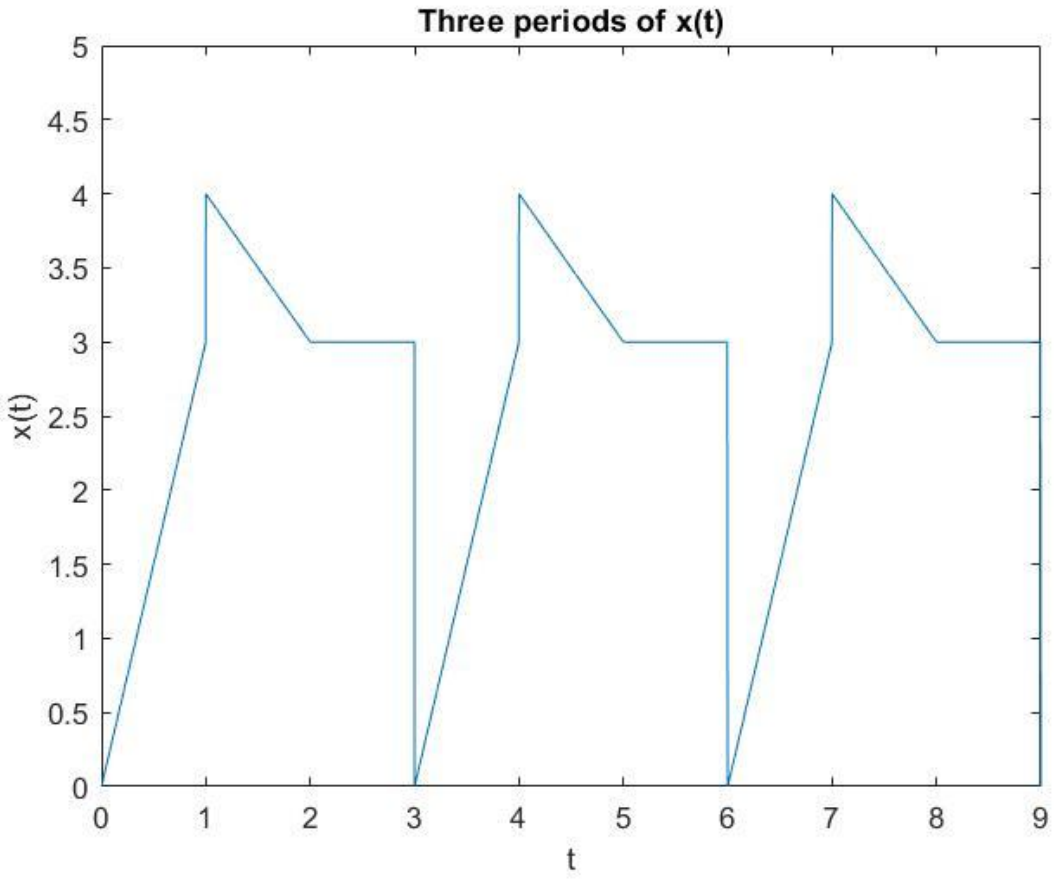
A.2

1)



2)

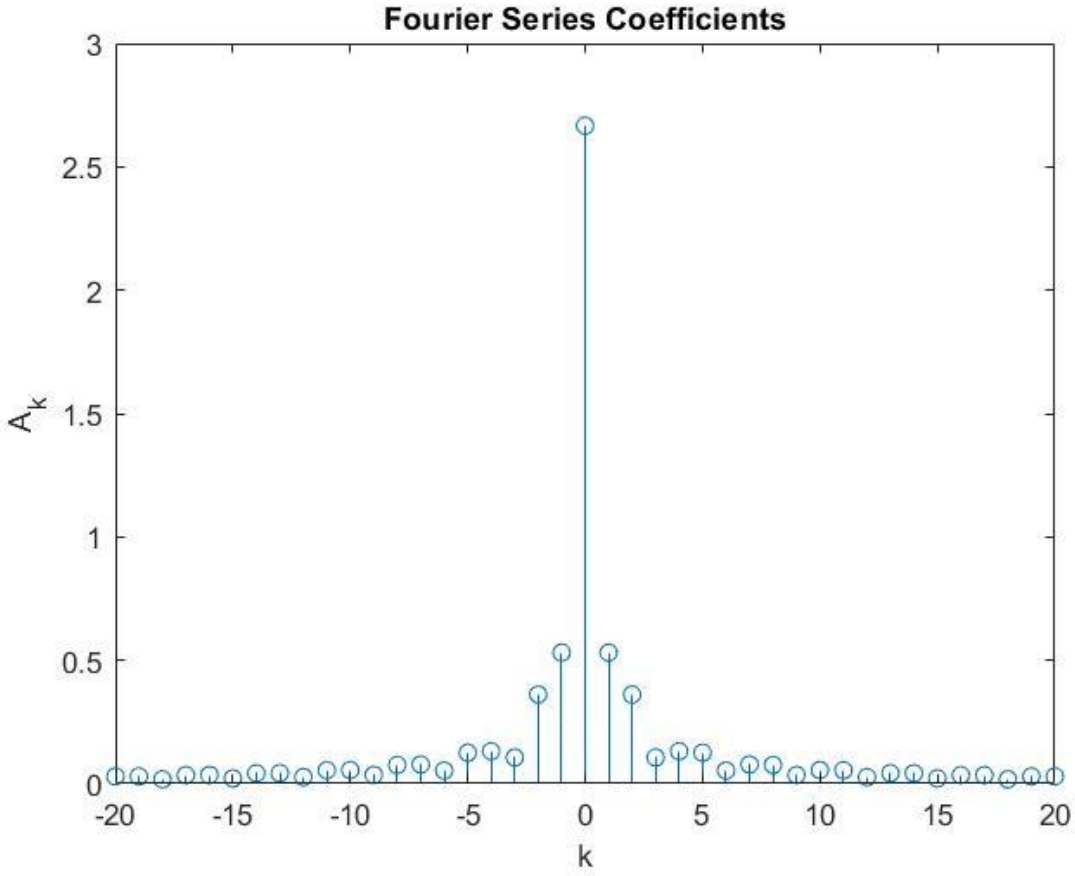
Expanded form

$$\frac{3\,e^{-2/3\,i\pi k}}{\pi^2 k^2} - \frac{3\,e^{-4/3\,i\pi k}}{4\pi^2 k^2} - \frac{9}{4\pi^2 k^2} - \frac{i\,e^{-2/3\,i\pi k}}{2\pi k} + \frac{3\,i\,e^{-2i\pi k}}{2\pi k}$$

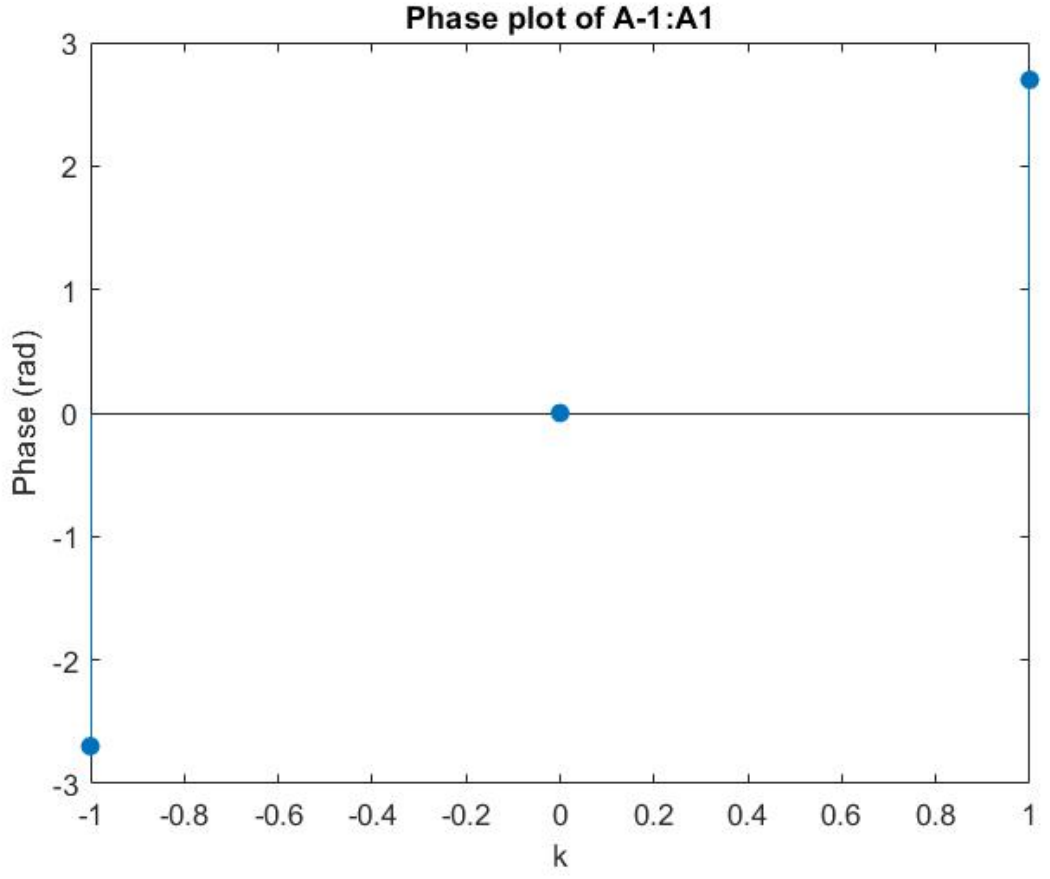
3)

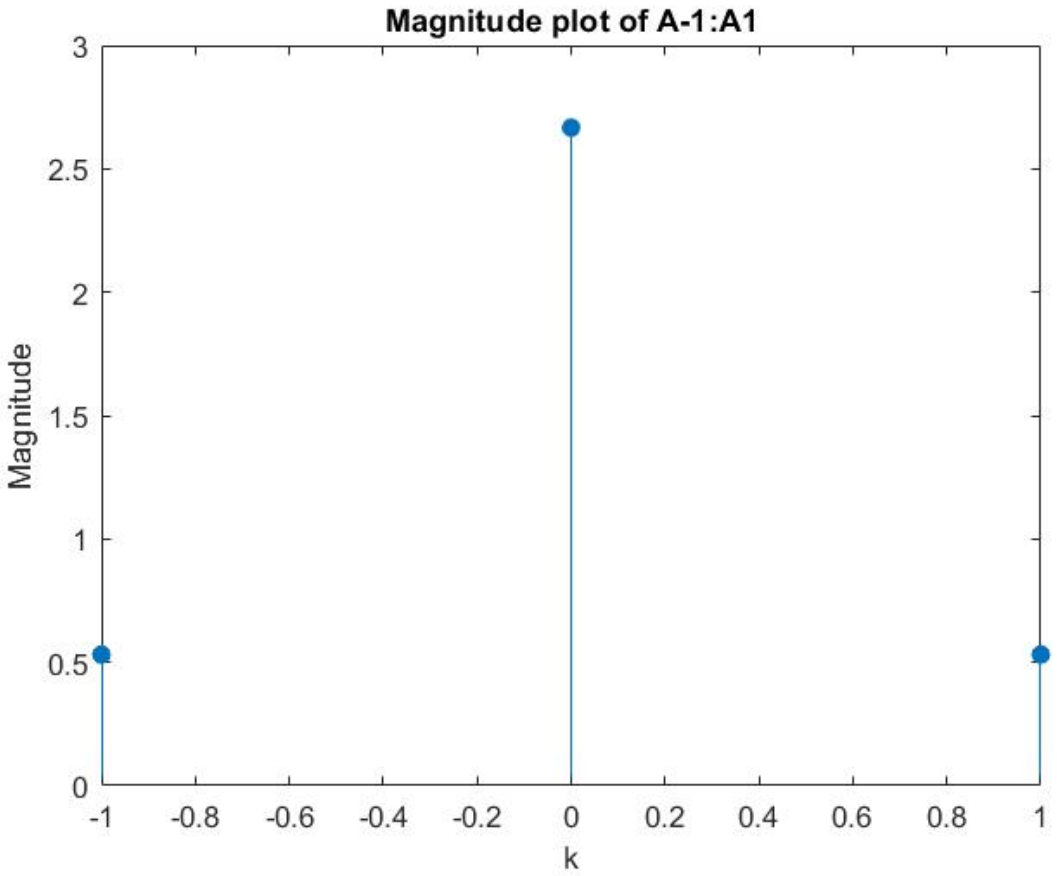
Total energy = 8.0868

For k = [-1:1], we have approximately 95 percent of the energy


Fourier Series Coefficients
A_k
k
3
2.5
2
1.5
1
0.5
0
-20
-15
-10
-5
0
5
10
15
20

4)


Phase plot of A-1:A1
Phase (rad)
k
3
2
1
0
-1
-2
-3
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1



Solution to B-4:

Code will be same with previous parts, only recorded file will change. Different magnitudes should be observed, although we play the same note. Because for different instruments, harmonics are different and this is also what makes them sound different.

Code for A-2

```
%% A.2-1
t = [0:1/8192:9];
x = zeros(size(t));
x(1:8192) = 3*t(1:8192);
x(8193:2*8192) = 5-t(8193:2*8192);
x(2*8192+1:3*8192) = 3;
x(3*8192+1:6*8192) = x(1:8192*3);
x(6*8192+1:9*8192) = x(1:8192*3);
plot(t,x)
ylim([0 5]);
title('Three periods of x(t)')
xlabel('t')
ylabel('x(t)')
%% A.2-3
clear;
syms t
N=20;
```

```
X = zeros(1,41);
X(21) = 1/3*(int(3*t,t,0,1)+int(5-t,t,1,2)+int(3,t,2,3));
for k = -N:N
    if k ~= 0
        X(k+21) = 3*exp(-2/3*j*pi*k)/(pi^2*k^2) - 3*exp(-
4/3*j*pi*k)/(pi^2*4*k^2) -9/(pi^2*4*k^2) -j*exp(-
2/3*j*pi*k)/(2*pi*k)+3*j*exp(-2*pi*j*k)/(2*pi*k);
    end
end
energy = sum(abs(X).^2);
er = 0.95*energy;
e0 = abs(X(21))^2;
stem(-N:N,abs(X))
title('Fourier Series Coefficients')
xlabel('k')
ylabel('A_k')
for k = 1:N
    e0 = e0 + abs(X(21-k))^2+abs(X(21+k))^2;
    if abs(e0-er)<0.01
       break
    end
end
%% A2-4
phase = angle(X(21-k:21+k));
mags = abs(X(21-k:21+k));
figure;
stem(-k:1:k,mags,'filled')
title('Magnitude plot of A-1:A1')
xlabel('k')
ylabel('Magnitude')
figure;
stem(-k:1:k,phase,'filled')
title('Phase plot of A-1:A1')
xlabel('k')
ylabel('Phase (rad)')
```