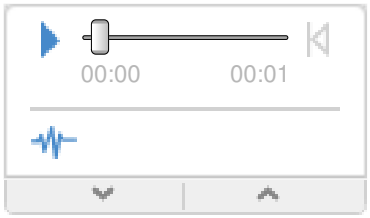
MATH528 Lab10: Sturm-Liouville basketball example

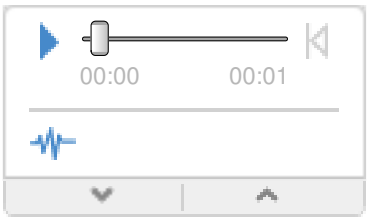
Input sound

This is the ringing sound extracted from classroom measurements of the basketball bounce

In[69]:=
```
m =
```



Out[69]=



These are the properties of the sound sample

In[70]:=
```
props = {AudioLength, Duration, AudioChannels, AudioSampleRate, AudioType};
```

In[71]:=
```
Dataset@AssociationThread[props, Through[props[m]]]
```

Out[71]=

AudioLength	35 280 samples
Duration	0.8 s
AudioChannels	1
AudioSampleRate	44 100 Hz
AudioType	SignedInteger16

Find the sampling frquency

In[72]:=
```
fs = AudioSampleRate[m]
```

Out[72]=
```
44 100 Hz
```

Transform the sound into data

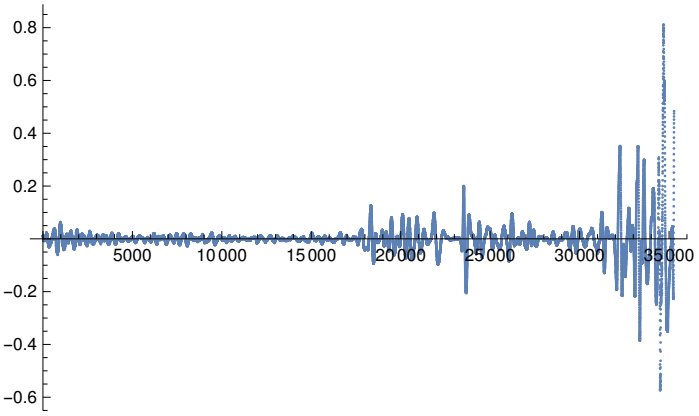
In[73]:=
```
d = AudioData[m];
```

In[74]:=
```
Dimensions[d]
```

Out[74]=
```
{1, 35 280}
```

In[77]:=
```
ListPlot[d, PlotRange → All]
```

Out[77]=



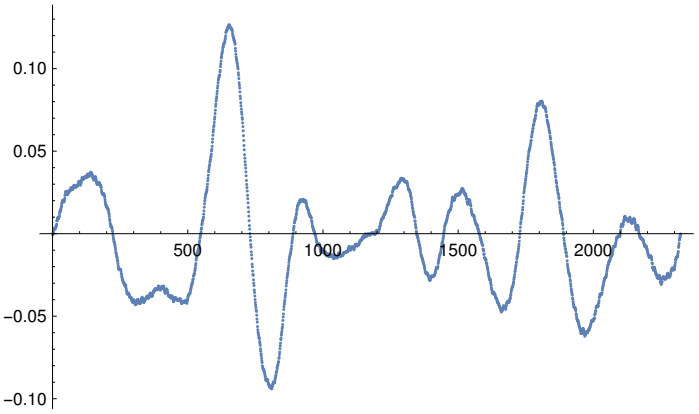
Spherical harmonics representation of sound

Conformant window

Choose one channel and a window that corresponds to a repeating signal

In[98]:=
```
data = d[[1, 17678 ;; 20000]];
ListPlot[data]
```

Out[99]=



In[100]:=
```
nd = Length[data]
```

Out[100]= 2323

Compute the Fourier coefficients

In[•]:=
```
nMax = 100; dj = 2. π / nd;
a = Table[ 1 / 2. / nd Sum[data[[j]] Cos[j n dj], {j, 1, nd}], {n, 1, nMax}];
b = Table[ 1 / 2. / nd Sum[data[[j]] Sin[j n dj], {j, 1, nd}], {n, 1, nMax}];
c2c = Log10[a^2 + b^2];
```

Find index of largest coefficient

```
In[•]:= kmx = Position[c2c, Max[c2c]][[1, 1]]
Out[•]= 4
```

Compute the signal period

```
In[•]:= T = nd / fs
Out[•]= 229/4800 Hz
```

The dominant frequency is

```
In[•]:= fmx = N[(T / kmx)^-1]
Out[•]= 83.8428 Hz
```

The E_2 note should have a frequency of 82.41 Hz, hence the recorded sound is mistuned by

```
In[•]:= fE2 = 82.41; fE2G = 83.8428;
        err = N[(fE2G - fE2) / fE2]
Out[•]= 0.0173862
```

```
In[•]:= ConformantWindowSpectrum = ListPlot[c2c, PlotStyle → Blue]
```

Out[•]=