Bset 3: The power of LTI

In[1]:=
```
SetDirectory@NotebookDirectory[];
<< "../MMA library.m"
```

Guitar Stairwell

In[21]:=
```
With[{context = "p4`"}, If[Context[] ≠ context, Begin[context]]];
Dynamic[Refresh[Context[], UpdateInterval → 1]]
```

Out[21]= Global`

In[85]:=
```
With[{data = Import["provided files/guitar_stairwell.mat", "LabeledData"]},
 fs = ("Fs" /. data)[[1, 1]];
 hstairwell = ("h_stairwell" /. data)[[All, 1]];
 x = ("x" /. data)[[All, 1]];
]
```

In[97]:=
```
playSound[x, fs]
```

In[98]:=
```
playSound[hstairwell, fs]
```

In[94]:=
```
mutated = ListConvolve[hstairwell, x, {1, -1}, 0];
mutated /= Max@Abs@mutated;
```

In[96]:=
```
playSound[mutated, fs]
```

In[102]:=
```
With[{context = "p4`"}, If[Context[] == context, End[], "Not in context"]]
```

Out[102]= p4`

5. Convolution Filtering

In[104]:=
```
With[{context = "p5`"}, If[Context[] ≠ context, Begin[context]]];
Dynamic[Refresh[Context[], UpdateInterval → 1]]
```

Out[104]= Global`

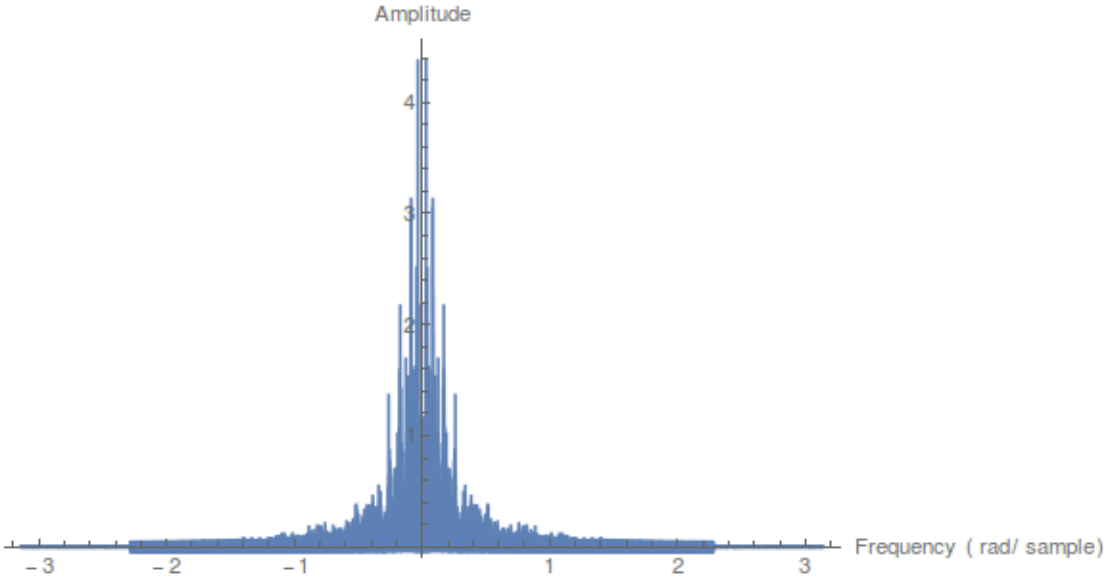
In[116]:=
```
fs = Import["provided files/hallelujah.wav", "SampleRate"]
handel = Import["provided files/hallelujah.wav", "Data"][[1]];
```

Out[116]= 44 100

In[188]:=
```
playSound[handel, fs]
```

In[118]:=
```
plotFFT[handel]
```

Out[118]=

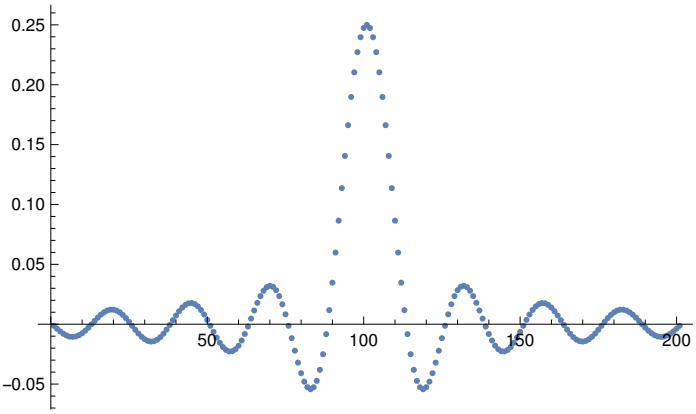


Cutoff frequency is in radians/sample

In[121]:=
```
cutoff = Pi / 4;
```

In[152]:=
```
sinc = N@cutoff / Pi * Sinc[cutoff * Range[-100, 100] / Pi];
ListPlot[sinc, PlotRange → Full]
```

Out[153]=



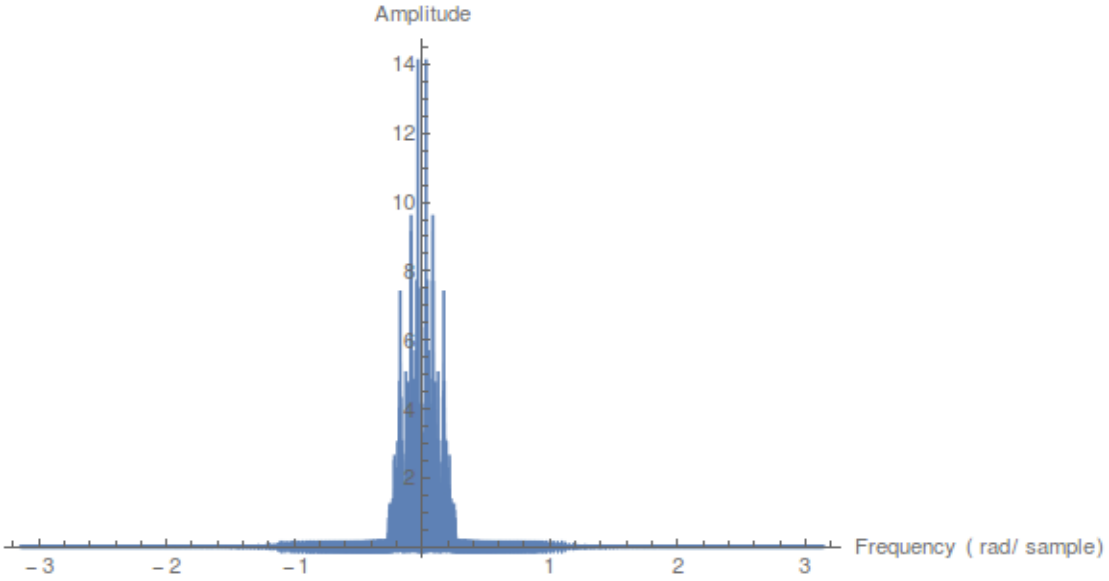
Convolve the input signal with the generated sinc function

In[163]:=
```
lowpass = ListConvolve[sinc, handel];
```

In[174]:=
```
playSound[lowpass, fs]
```

```
plotFFT[lowpass]
```

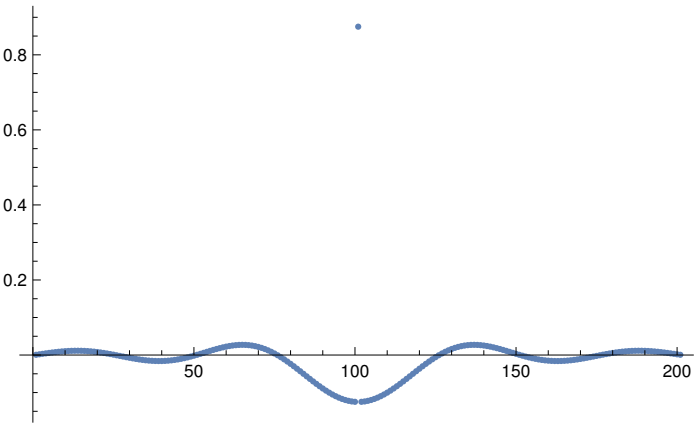
Out[155]=



In[177]:=
```
cutoff = Pi / 8;
sinc = N@cutoff / Pi * Sinc[cutoff * Range[-100, 100] / Pi];
```

In[191]:=
```
highpassKernel = Join[ConstantArray[0, 100], {1}, ConstantArray[0, 100]] - sinc;
ListPlot[highpassKernel, PlotRange → Full]
```

Out[192]=

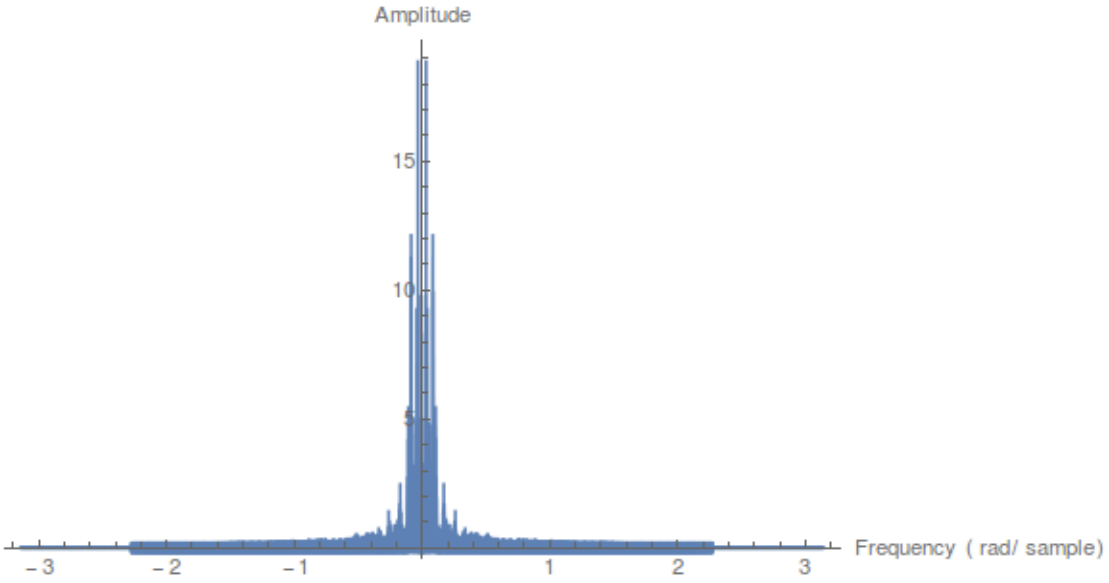


In[193]:=
```
highpass = ListConvolve[highpassKernel, handel];
```

In[194]:=
```
playSound[highpass, fs]
```

In[190]:=
```
plotFFT@highpass
```

Out[190]=



In[195]:=
```
With[{context = "p5`"}, If[Context[] == context, End[], "Not in context"]]
```

Out[195]=
```
p5`
```

6. Radio decode

In[72]:=
```
With[{context = "p6`"}, If[Context[] ≠ context, Begin[context]]];
Dynamic[Refresh[Context[], UpdateInterval → 1]]
```

Out[72]=
```
Global`
```

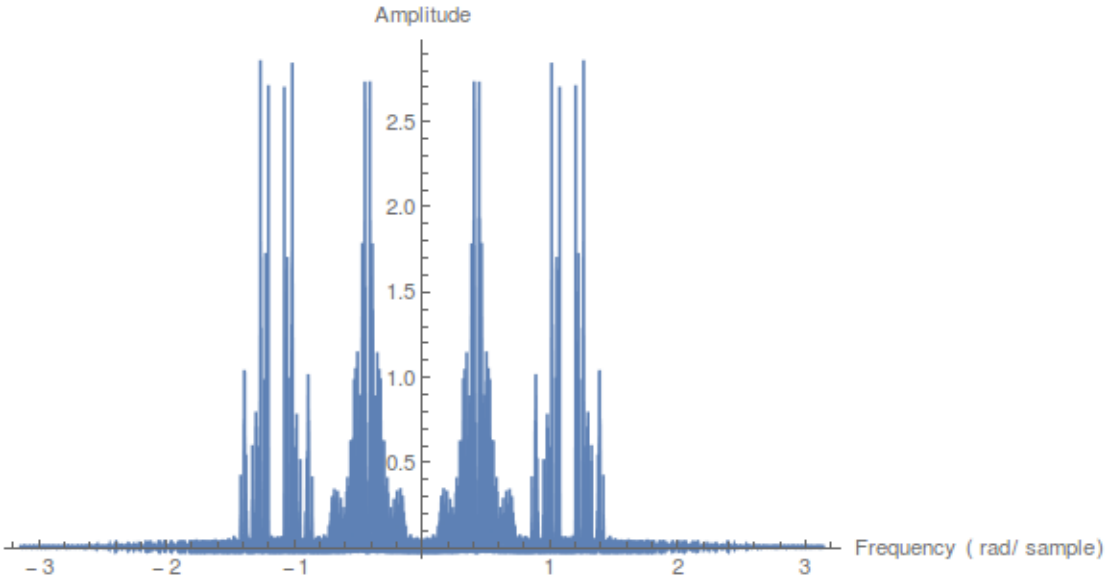
In[19]:=
```
lowpass[signal_, freq_] :=
 Module[{sinc},
  sinc = N@freq / Pi * Sinc[freq * Range[-60, 60] / Pi];
  (*ListPlot[sinc,PlotRange→Full];*)
  ListConvolve[sinc, signal]
 ]
```

In[15]:=
```
fs = Import["provided files/TwoAM.wav", "SampleRate"]
encodedSignals = Import["provided files/TwoAM.wav", "Data"];
```

Out[15]=
```
44 100
```

In[18]:=
```
plotFFT@encodedSignals
```

Out[18]=



In[60]:=
```
recoverSignal[data_, freq_] :=
 Module[{shifted, filtered},
  shifted = data * Cos[Pi freq * Range@Length@data];
  filtered = lowpass[shifted, 0.3 Pi];
  filtered
 ]
```

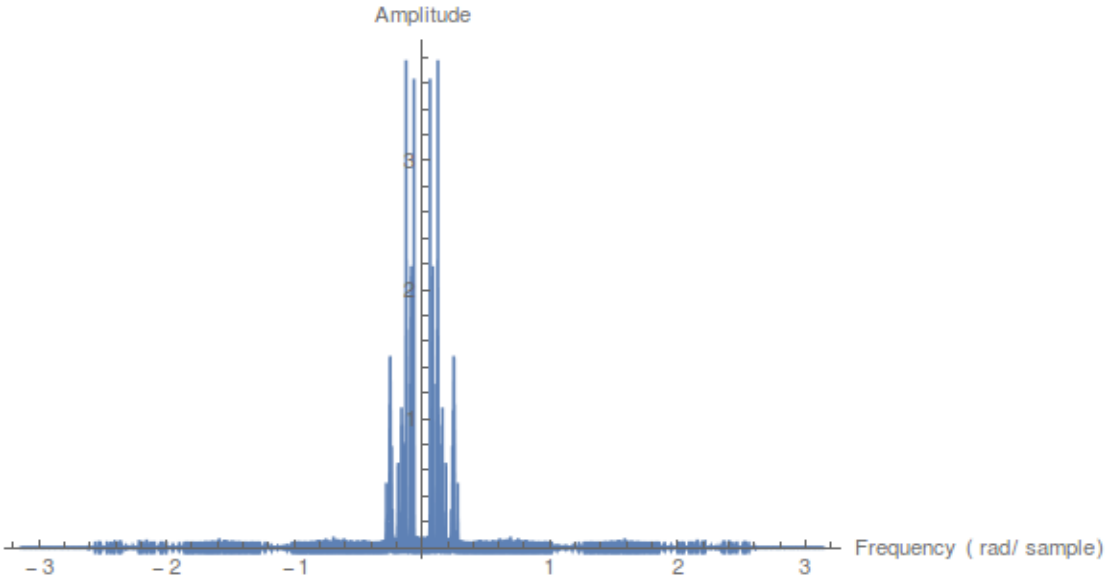
Recover x[n]

In[73]:=
```
freq = 16 000 / fs;
x = recoverSignal[encodedSignals, freq];
```

In[84]:=
```
playSound[x, fs];
```

In[76]:=
```
plotFFT@x
```

Out[76]=



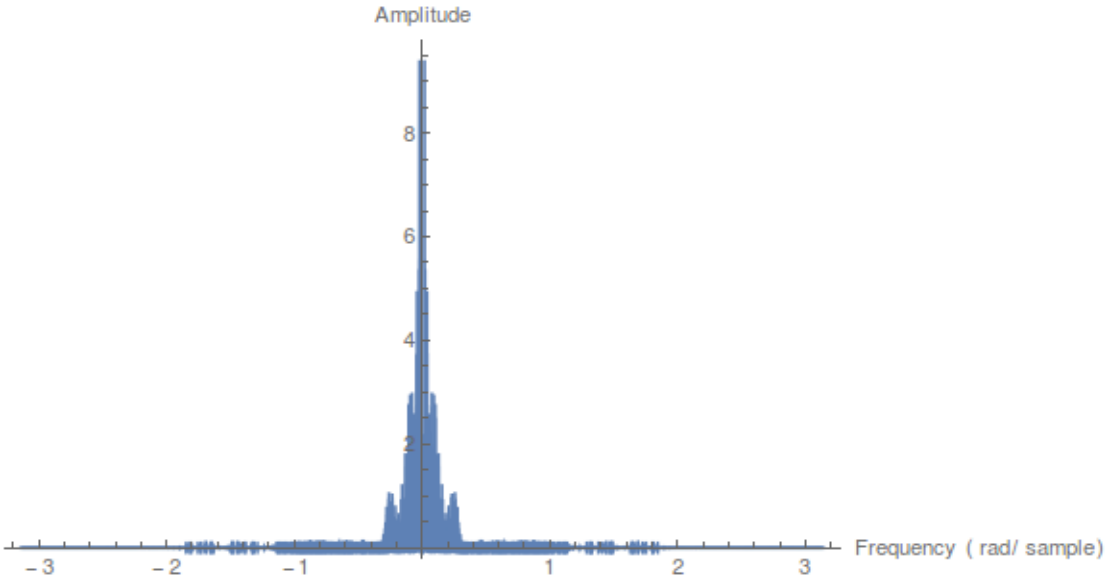
Recover w[n]

In[77]:=
```
freq = 6000 / fs;
w = recoverSignal[encodedSignals, freq];
```

In[88]:=
```
playSound[w, fs]
```

In[80]:=
```
plotFFT@w
```

Out[80]=



In[89]:=
```
With[{context = "p6`"}, If[Context[] == context, End[], "Not in context"]]
```

Out[89]= p6`

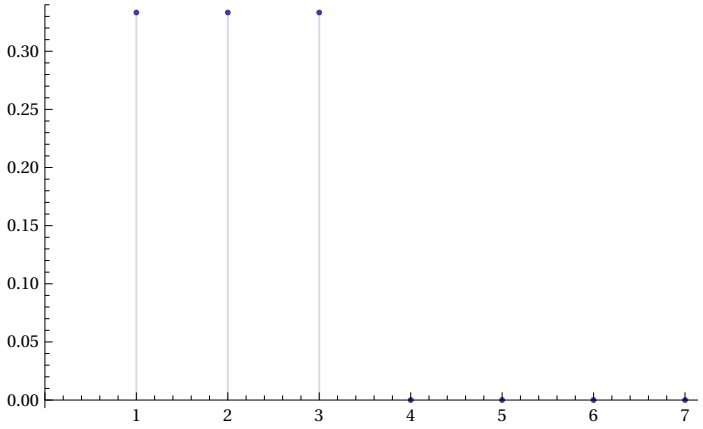
Scratch work

In[91]:=
```
exportNotebookPDF[]
```

Out[90]=
```
/home/eric/Documents/School/QEA2/Acoustic Modem/Bset 3/Mathematica scratch.pdf
```

In[17]:=
```
DiscretePlot[1/3 {1, 1, 1, 0, 0, 0, 0}[[i]], {i, 7},
 PlotTheme → "Classic", PlotRange → {{0, Automatic}, Automatic}]
```

Out[17]=



In[101]:=
```
Plot[Sinc@x, {x, -5 Pi, 5 Pi}, PlotRange → All]
```

Out[101]=