

```
SetDirectory[NotebookDirectory[]];
```

## Bset 2 - Nathan Yee

### Question 1 - handel again

d)

```
handel = Transpose[Import["Files/handel.csv", "Data"]][[1]]
```

```
{0, -0.0061568, -0.075036, -0.031169, 0.0061568, 0.038095, 0.018855, -0.025012,
-0.031169, -0.075036, -0.12583, -0.1443, -0.18124, -0.19048, -0.075036,
-0.012698, -0.038095, -0.075036, 0, 0.075036, 0.12583, 0.18124, 0.15046,
... 73 067 ..., -0.095046, -0.081193, -0.018855, 0.081193, 0.11967, 0.12583,
0.15661, 0.095046, 0.012698, 0.13199, 0.018855, -0.081193, -0.1443, -0.19048,
-0.1443, -0.062722, 0.018855, 0.15046, 0.16277, 0.12583, 0.22742, 0.15046, 0}
```

large output

[show less](#)

[show more](#)

[show all](#)

[set size limit...](#)

```
handel3Avg = ListConvolve[Table[\frac{1}{3}, {3}], handel]
```

```
{-0.0270643, -0.0374539, -0.0333494, 0.00436093, 0.0210356,
0.010646, -0.012442, -0.043739, -0.077345, -0.115055, -0.150457,
... 73 089 ..., -0.0688793, -0.138658, -0.159693, -0.132501,
-0.0627223, 0.035531, 0.110695, 0.146353, 0.172007, 0.167903, 0.12596}
```

large output

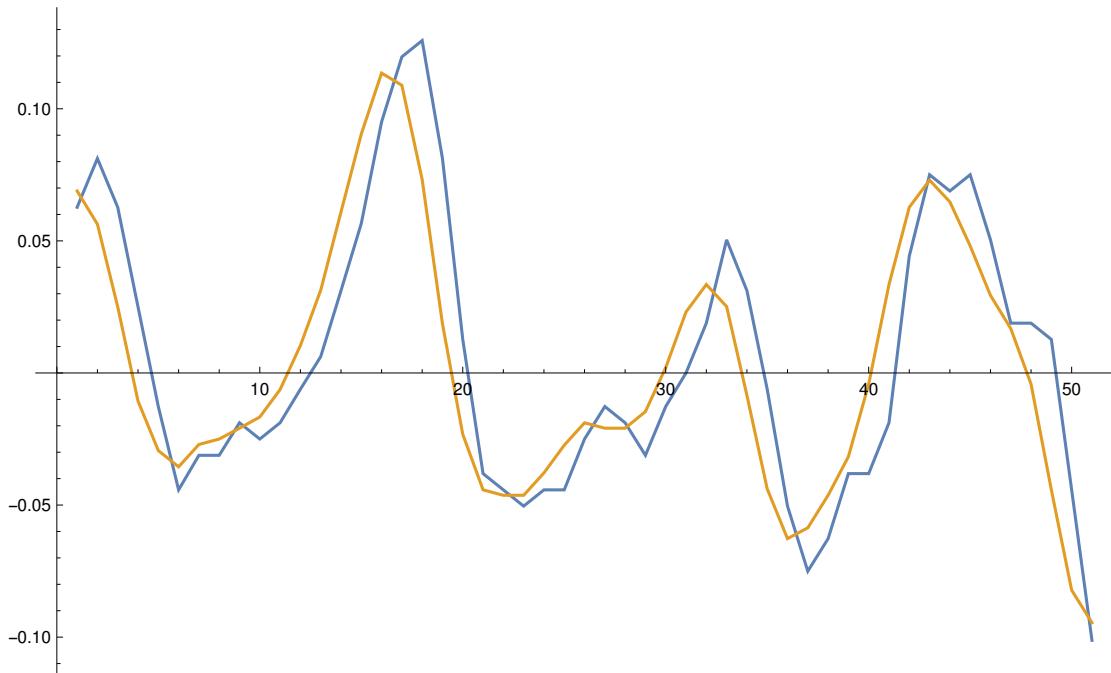
[show less](#)

[show more](#)

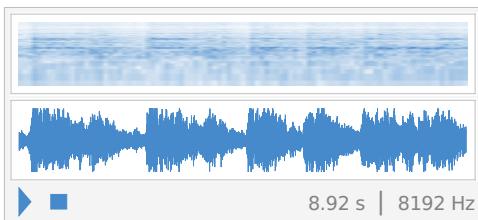
[show all](#)

[set size limit...](#)

```
ListLinePlot[{handel[[1000 ;; 1050]], handel3Avg[[1000 ;; 1050]]}, ImageSize -> Large]
```



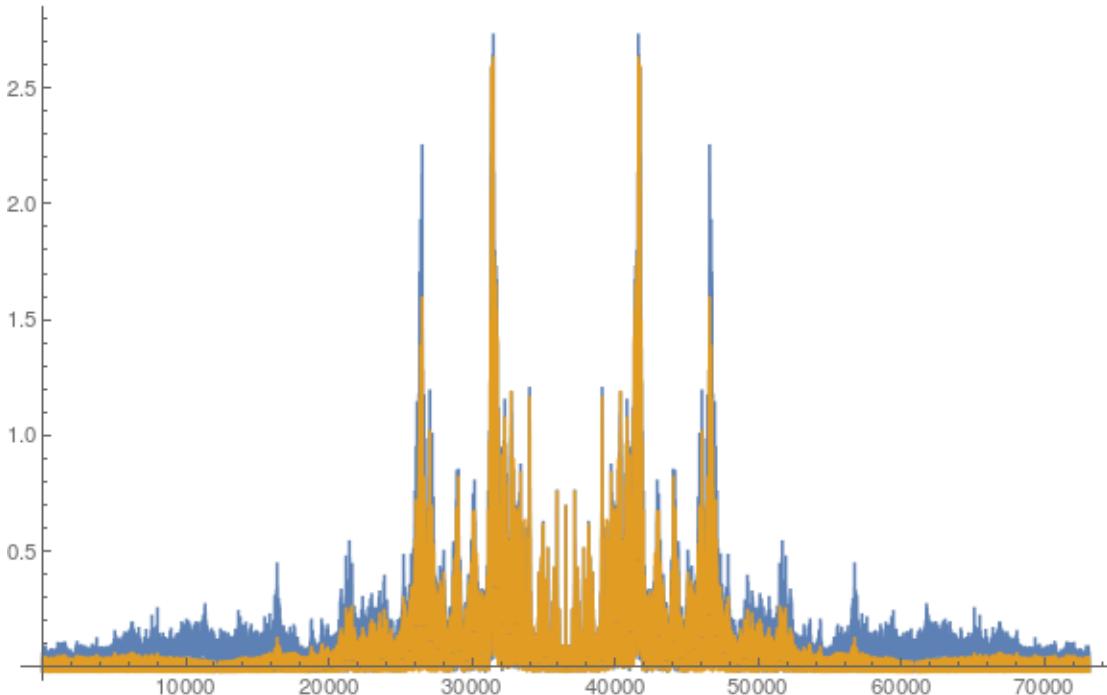
```
ListPlay[handel, SampleRate -> 8192]  
ListPlay[handel3Avg, SampleRate -> 8192]
```



The avg sound sounds much more muffled and smoothed out than the original

e)

```
Rasterize@ListLinePlot[Table[RotateRight[Abs[Fourier[data]], Floor@ $\frac{\text{Length}[\text{data}]}{2}$ ], {data, {handel, handel3Avg}}], PlotRange -> Full, ImageSize -> Large]
```



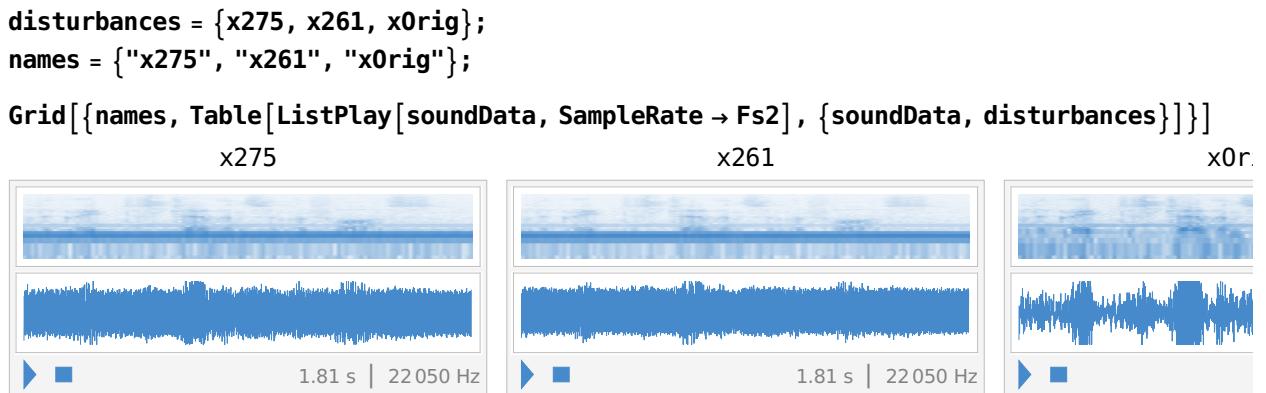
We can see in the above plot

## Question 2 - disturbance in the force

```
indexLargest[soundData_] := (Position[Re[soundData], Max[Re[soundData]]][[1]])
NotchFilter[Ω₀_, q_, Ω_] := 
$$\left( \frac{(1 - e^{-I(\Omega_0 + \Omega)}) (1 - e^{-I(\Omega - \Omega_0)})}{(1 - q * e^{-I(\Omega_0 + \Omega)}) (1 - q * e^{-I(\Omega - \Omega_0)})} \right)$$

```

```
x275 = Import["Files/Disturbance275.wav", "Data"];
x261 = Import["Files/Disturbance261.wav", "Data"];
x0rig = Import["Files/DisturbanceOrig.wav", "Data"];
Fs2 = 22050;
```

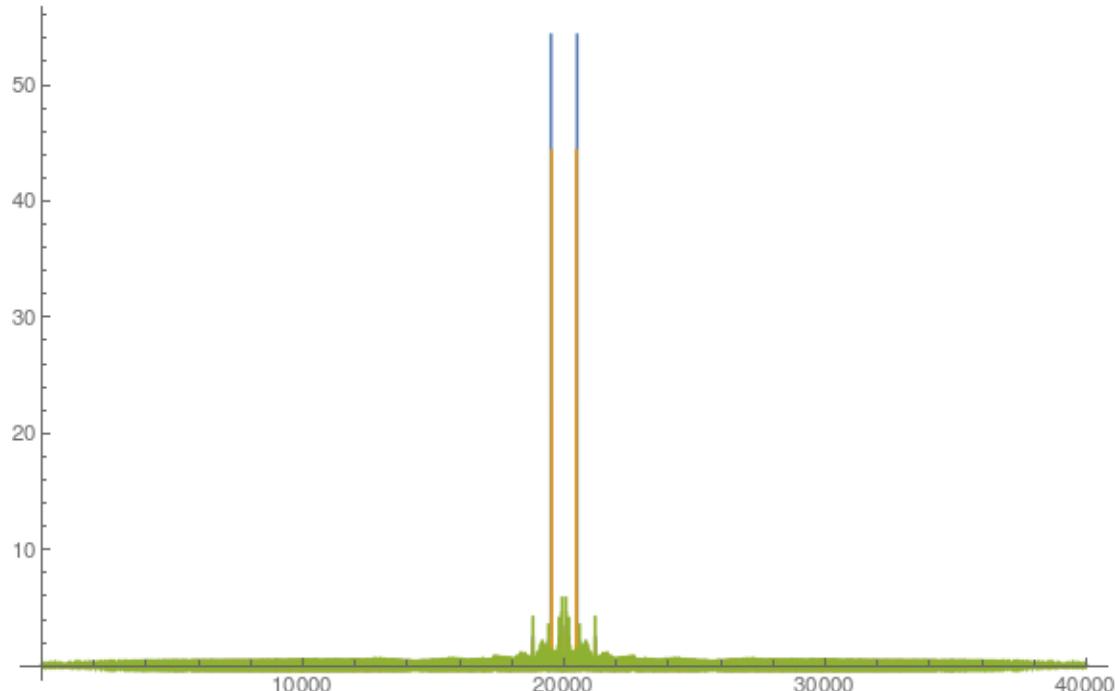


Rasterize@

```

ListLinePlot[Table[RotateRight[Abs[Fourier[soundData]], Floor@ $\frac{\text{Length}[\text{soundData}]}{2}$ ],
{soundData, disturbances}], PlotRange → Full, ImageSize → Large]

```



Two extreme values show in plot below. Set these to zero and get back sound data

```
x275IDFT = RotateRight[Fourier[x275], Floor@ $\frac{\text{Length}[x275]}{2}$ ]
ListPlot[Re[x275IDFT], PlotRange -> All]
```

{0.00409717 - 0.0021909 i, -0.00112833 - 0.001021 i, 0.00182203 - 0.000320854 i,  
0.0000502204 - 0.000396673 i, ... 39.993 ..., 0.0000502204 + 0.000396673 i,  
0.00182203 + 0.000320854 i, -0.00112833 + 0.001021 i, 0.00409717 + 0.0021909 i}

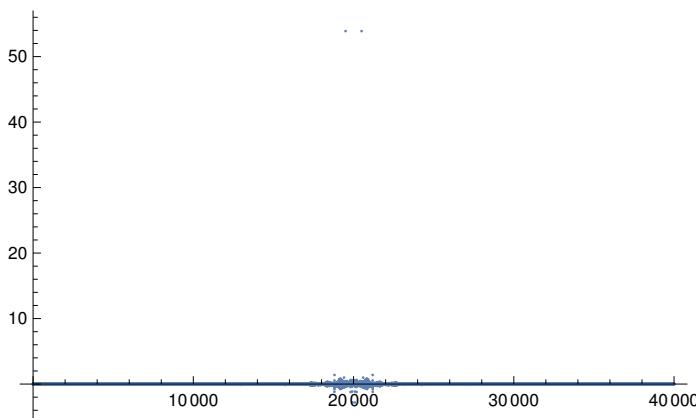
[large output](#)

[show less](#)

[show more](#)

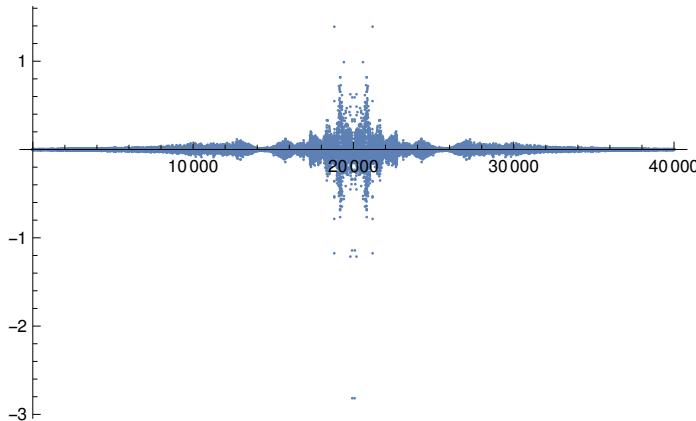
[show all](#)

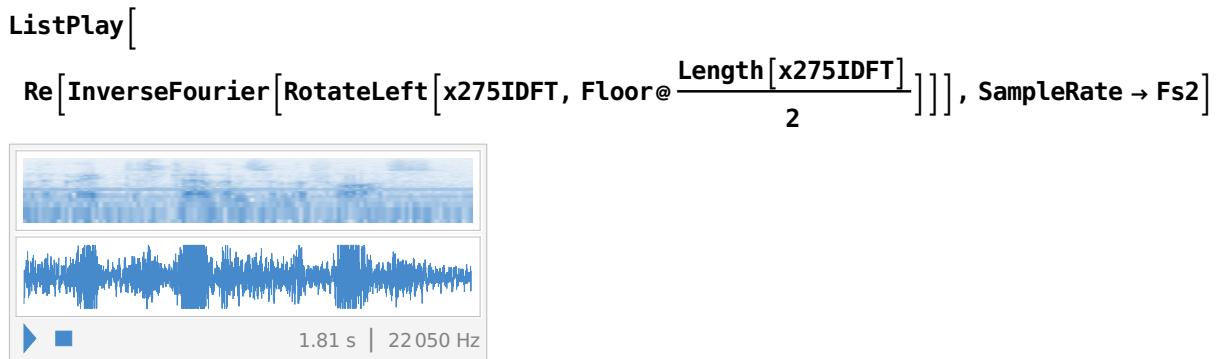
[set size limit...](#)



```
Table[x275IDFT[[indexLargest[x275IDFT]]] = 0, {i, 2}]
ListPlot[Re[x275IDFT], PlotRange -> All]
```

{0, 0}





a) ii - Use notch filter to filter our noise

$$y[n] = Ay[n-1] + By[n-2] + Px[n] + Qx[n-1] + Rx[n-2]$$

$$Ay[-1+n] + By[-2+n] + Px[n] + Qx[-1+n] + Rx[-2+n]$$

x275

```
{0.332102, 0.351176, 0.380779, 0.414045, 0.430219, 0.436323, 0.439344, 0.432447,
 0.415845, 0.396527, 0.381603, ... 39 979 ..., 0.315836, 0.346965, 0.368816,
 0.388134, 0.411664, 0.432386, 0.44322, 0.457869, 0.462477, 0.470748, 0.468825}
```

large output

[show less](#)

[show more](#)

[show all](#)

[set size limit...](#)

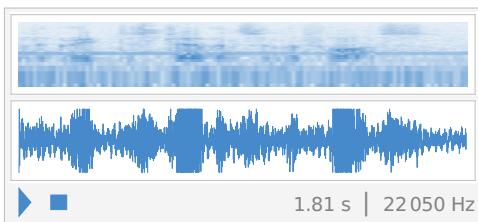
```

 $\Omega = 2 \text{Pi} * 275.6181 / \text{Fs2};$ 
 $q = .95;$ 
 $A = 2 * q * \text{Cos}[\Omega];$ 
 $B = -q^2;$ 
 $P = 1;$ 
 $Q = (-2) \text{Cos}[\Omega];$ 
 $R = 1;$ 
 $\text{smallList} = x275;$ 
 $\text{largeListMutable} = \text{Join}[\{0, 0\}, \text{smallList}, \{0, 0\}];$ 
 $\text{largeListImmutable} = \text{Join}[\{0, 0\}, \text{smallList}, \{0, 0\}];$ 
 $\text{Do}[\text{largeListMutable}[[i + 2]] =$ 
 $A * \text{largeListMutable}[[i + 1]] +$ 
 $B * \text{largeListMutable}[[i]] +$ 
 $P * \text{largeListImmutable}[[i + 2]] +$ 
 $Q * \text{largeListImmutable}[[i + 1]] +$ 
 $R * \text{largeListImmutable}[[i]],$ 
 $\{i, 1, \text{Length}[\text{smallList}]\}]$ 
 $\text{largeListMutable}[[1 ;; 100]]$ 
 $\{0, 0, 0.332102, 0.318069, 0.315439, 0.316439, 0.30016, 0.275541, 0.250627, 0.218838,$ 
 $0.18128, 0.145718, 0.119244, 0.0874293, 0.0580229, 0.0241892, -0.0133914,$ 
 $-0.0610242, -0.0897109, -0.108061, -0.116936, -0.117124, -0.102503, -0.102106,$ 
 $-0.107552, -0.111301, -0.134118, -0.167209, -0.181728, -0.193328, -0.202266,$ 
 $-0.208814, -0.21323, -0.229631, -0.236066, -0.247474, -0.242686, -0.237267,$ 
 $-0.210584, -0.192599, -0.161842, -0.140502, -0.1209, -0.109895, -0.113658,$ 
 $-0.116918, -0.105996, -0.103141, -0.100645, -0.0916823, -0.0838195, -0.0909078,$ 
 $-0.0976517, -0.0833674, -0.0778526, -0.0664521, -0.0567161, -0.048507, -0.0348115,$ 
 $-0.0369449, -0.0394837, -0.0423856, -0.0456063, -0.0559677, -0.045064, -0.0426994,$ 
 $-0.0410473, -0.0400028, -0.0326055, -0.0401498, -0.0404098, -0.034017, -0.0354518,$ 
 $-0.0231048, -0.0121559, -0.00935087, 0.0000141361, 0.00149949, -0.0109635,$ 
 $-0.0151896, -0.018761, -0.0286067, -0.0371656, -0.0374927, -0.0442414, -0.0567292,$ 
 $-0.0673667, -0.0763283, -0.0906717, -0.102867, -0.113173, -0.121735, -0.128716,$ 
 $-0.14128, -0.151956, -0.147103, -0.149074, -0.143492, -0.138074, -0.132832\}$ 

```

I couldn't get this to work. I think I'll move on from this problem because it's taking way too much time.

```
ListPlay[largeListMutable, SampleRate → Fs2]
```



---

## Question 3

$$x[t_-] = E^{\frac{-t}{\tau}}$$

$$e^{-\frac{t}{\tau}}$$

$$\text{Integrate}\left[E^{\frac{-t}{\tau}}, \{t, -\text{Infinity}, \text{Infinity}\}\right]$$

... **Integrate**: Integral of  $e^{-\frac{t}{\tau}}$  does not converge on  $\{-\infty, \infty\}$ .

$$\int_{-\infty}^{\infty} e^{-\frac{t}{\tau}} dt$$