```
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}
```

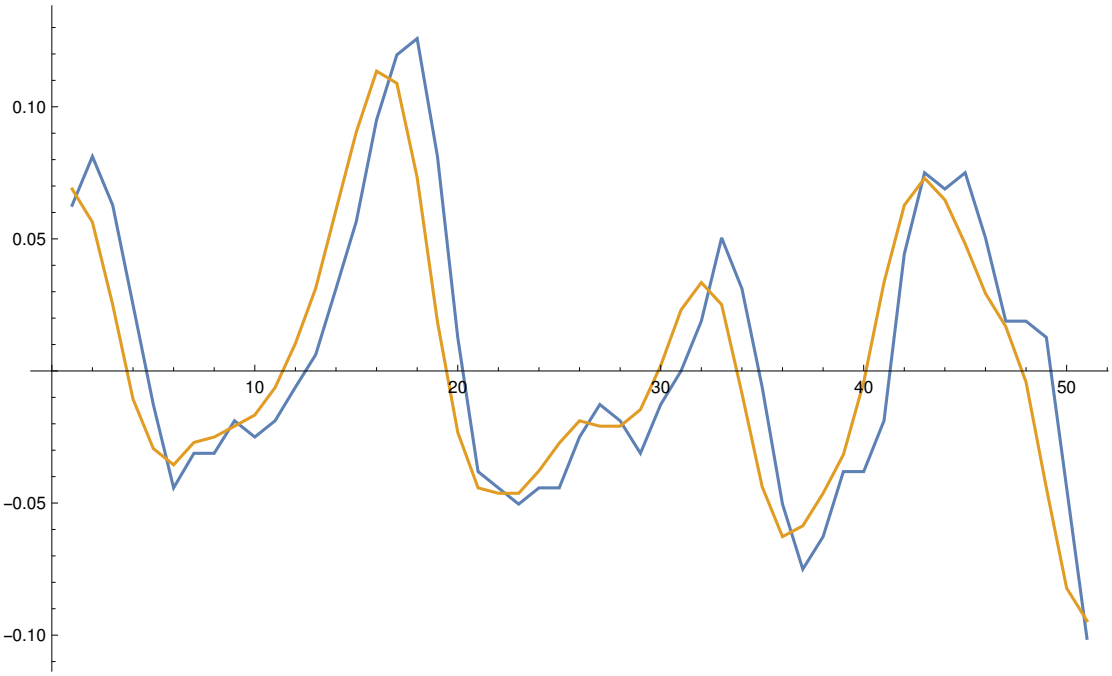
large output | show less | show more | show all | set size limit...

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

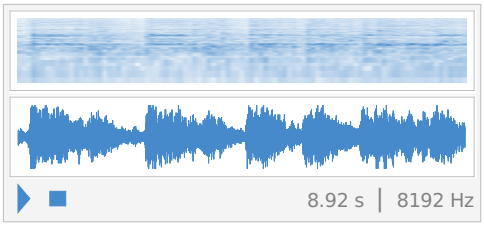
```
{-0.0270643, -0.0374539, -0.0333494, 0.00436093, 0.0210356,
 0.010646, -0.012442, -0.043739, -0.077345, -0.115055, -0.150457,
 ··· 73 089 ···, -0.0688793, -0.138658, -0.159693, -0.132501,
 -0.0627223, 0.035531, 0.110695, 0.146353, 0.172007, 0.167903, 0.12596}
```

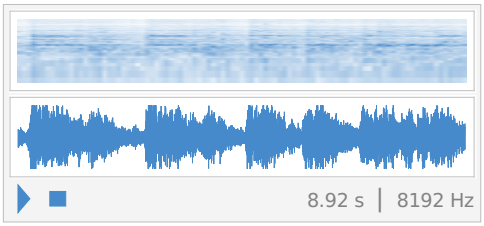
large output | show less | show more | show all | set size limit...

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




```
ListPlay[handel, SampleRate → 8192]
ListPlay[handel3Avg, SampleRate → 8192]
```

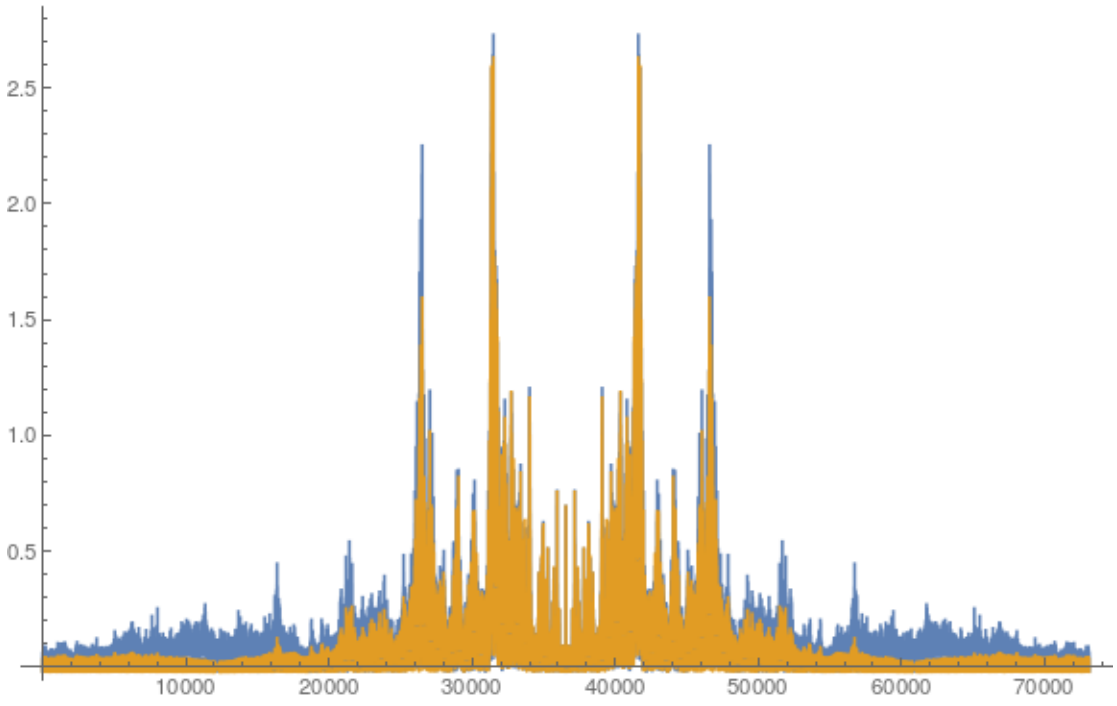




The avg sound sounds much more muffled and smoothed out than the original

e)

```
Rasterize@ListLinePlot[Table[RotateRight[Abs[Fourier[data]], Floor@ Length[data]/2],
  {data, {handel, handel3Avg}}], PlotRange → Full, ImageSize → Large]
```



We can see in the above plot

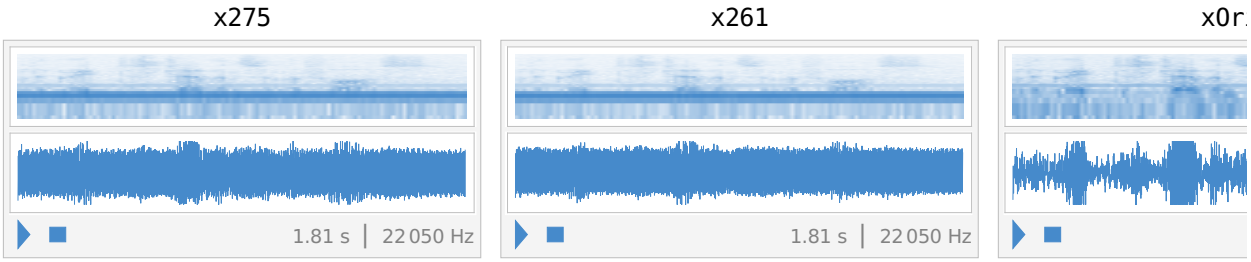
Question 2 - disturbance in the force

```
indexLargest[soundData_] := (Position[Re[soundData], Max[Re[soundData]]][[1]])
NotchFilter[Ω0_, q_, Ω_] := ((1 - E^-I (Ω0+Ω)) (1 - E^-I (Ω-Ω0)))/((1 - q * E^-I (Ω0+Ω)) (1 - q * E^-I (Ω-Ω0)))
```

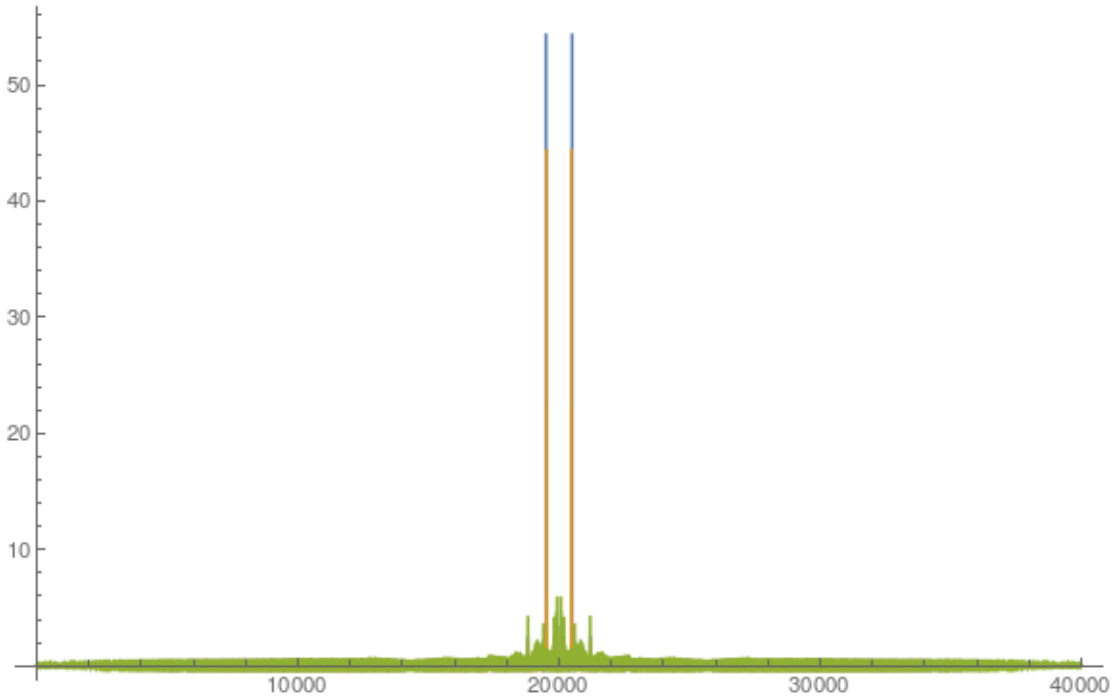
```
x275 = Import["Files/Disturbance275.wav", "Data"];
x261 = Import["Files/Disturbance261.wav", "Data"];
xOrig = Import["Files/DisturbanceOrig.wav", "Data"];
Fs2 = 22 050;
```

```
disturbances = {x275, x261, xOrig};
names = {"x275", "x261", "xOrig"};
```

```
Grid[{names, Table[ListPlay[soundData, SampleRate → Fs2], {soundData, disturbances}]}]
```




```
Rasterize@
 ListLinePlot[Table[RotateRight[Abs[Fourier[soundData]], Floor@ Length[soundData]/2],
   {soundData, disturbances}], PlotRange → Full, ImageSize → Large]
```

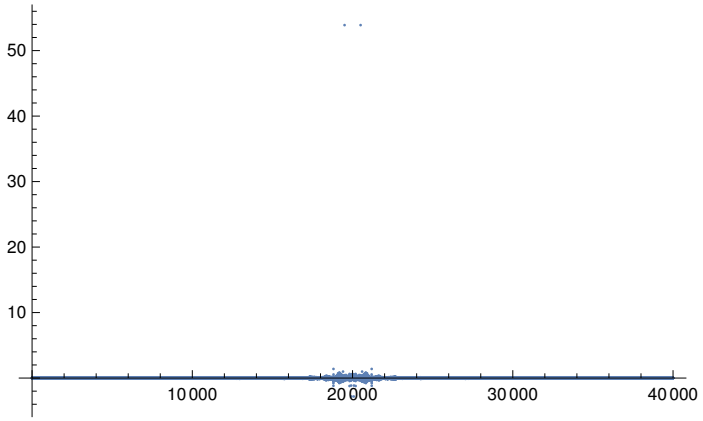


Two extreme values show in plot below. Set these to zero and get back sound data

```
x275IDFT = RotateRight[Fourier[x275], Floor@ Length[x275]/2]
ListPlot[Re[x275IDFT], PlotRange → All]
```

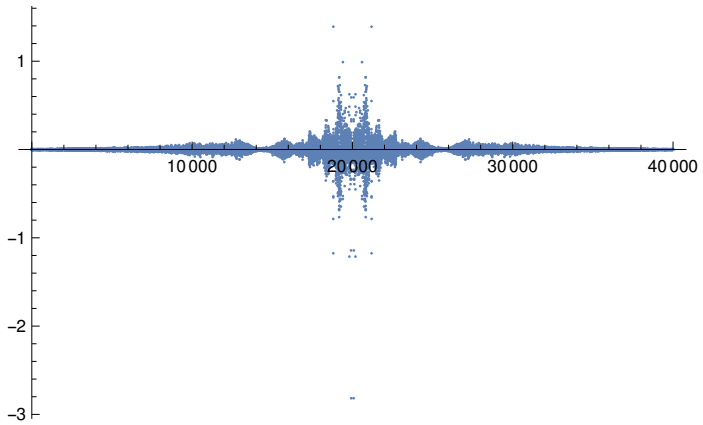
```
{0.00409717 - 0.0021909 i, -0.00112833 - 0.001021 i, 0.00182203 - 0.000320854 i,
 0.0000502204 - 0.000396673 i, ··· 39 993 ···, 0.0000502204 + 0.000396673 i,
 0.00182203 + 0.000320854 i, -0.00112833 + 0.001021 i, 0.00409717 + 0.0021909 i}
```

large output | show less | show more | show all | set size limit...

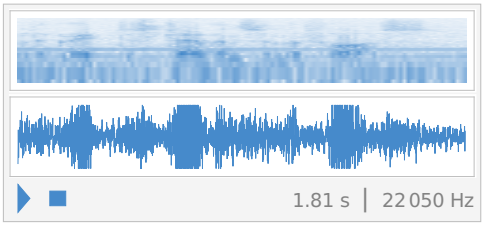



```
Table[x275IDFT[[indexLargest[x275IDFT]]] = 0, {i, 2}]
ListPlot[Re[x275IDFT], PlotRange → All]
```

```
{0, 0}
```



```
ListPlay[
 Re[InverseFourier[RotateLeft[x275IDFT, Floor@ Length[x275IDFT]/2]]], SampleRate → Fs2]
```



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}
```

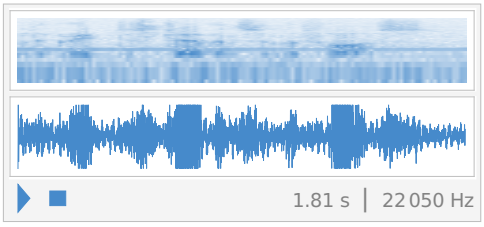
large output | show less | show more | show all | set size limit...

```
ω = 2 Pi * 275.6181 / Fs2;
q = .95;
A = 2 * q * Cos[ω];
B = -q^2;
P = 1;
Q = (-2) Cos[ω];
R = 1;
smallList = x275;
largeListMutable = Join[{0, 0}, smallList, {0, 0}];
largeListImmutable = Join[{0, 0}, smallList, {0, 0}];
Do[largeListMutable[[i + 2]] =
  A * largeListMutable[[i + 1]] +
   B * largeListMutable[[i]] +
   P * largeListImmutable[[i + 2]] +
   Q * largeListImmutable[[i + 1]] +
   R * largeListImmutable[[i]],
 {i, 1, Length[smallList]}]
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^(-t/T)
```

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

```
Integrate[E^(-t/T), {t, -Infinity, Infinity}]
```

... Integrate: Integral of $e^{-\frac{t}{T}}$ does not converge on {−∞, ∞}.

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

(2) Notch filter

$$H(\Omega) = \frac{(1 - e^{-j(\Omega_0 + \Omega)})(1 - e^{-j(\Omega - \Omega_0)})}{(1 - q e^{-j(\Omega_0 + \Omega)})(1 - q e^{-j(\Omega - \Omega_0)})}$$

$$Y(\Omega) = H(\Omega)X(\Omega), \quad \Omega_0 = \frac{2 \cdot 275.6181\pi}{22050}$$

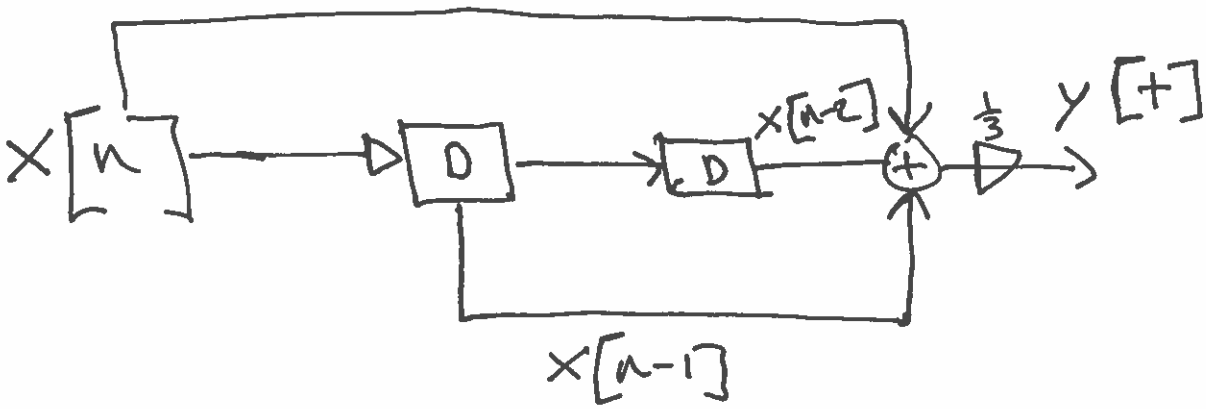
$$\Omega_0 =$$

③

$x(t) = e^{-\frac{t}{\tau}} u(t)$ $\quad \tau > 0$

$u(t) = \begin{cases} 1 & \text{if } t \geq 0 \\ 0 & \text{otherwise} \end{cases}$

(5)



(4)