Physics 3605W Homework 2 (Workshop)

1) Measurements of the frequency of a very slow optical pulsar

```
data = dlmread('PHYS 3605W/Homework/pulsarData.csv',',',1,0)
```

```
data = 8×2
    1.5300    0.0800
    1.6900    0.2500
    1.5000    0.9000
    1.4100    0.1400
    1.6200    0.1300
    1.9400    0.5800
    1.6100    0.1100
    1.2900    0.3200
```

```
freq = data(:,1)
```

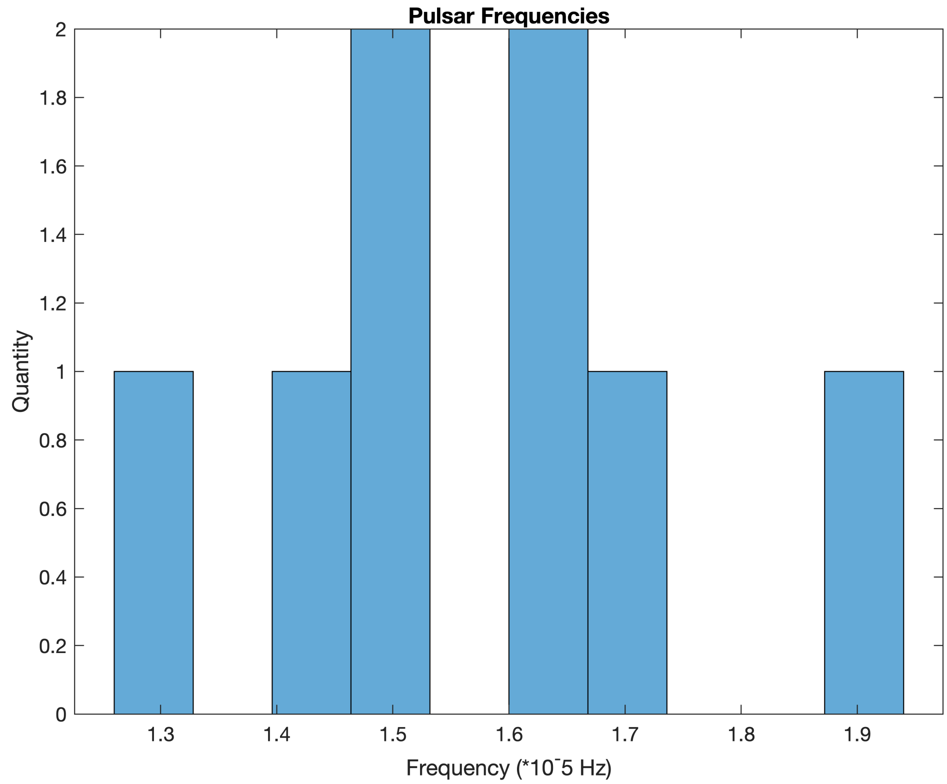
```
freq = 8×1
    1.5300
    1.6900
    1.5000
    1.4100
    1.6200
    1.9400
    1.6100
    1.2900
```

```
freqErr = data(:,2)
```

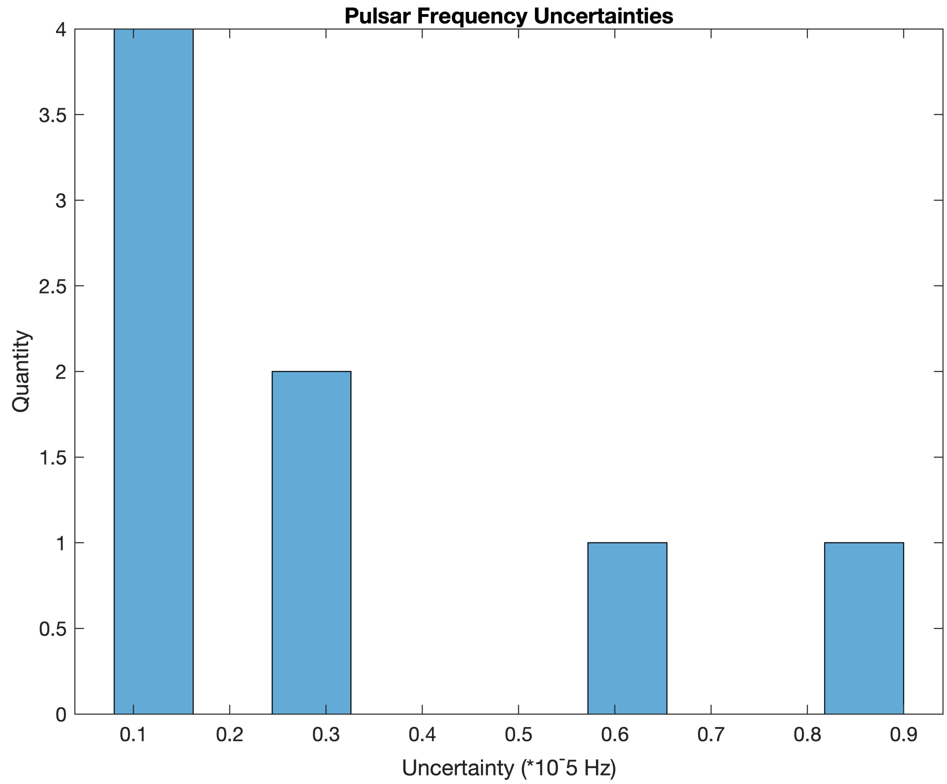
```
freqErr = 8×1
    0.0800
    0.2500
    0.9000
    0.1400
    0.1300
    0.5800
    0.1100
    0.3200
```

a. Histogram of values, histogram of uncertainties

```
histogram(freq, 10)
title('Pulsar Frequencies')
xlabel('Frequency (*10^-5 Hz)')
ylabel('Quantity')
```




```
histogram(freqErr, 10)
title('Pulsar Frequency Uncertainties')
xlabel('Uncertainty (*10^-5 Hz)')
ylabel('Quantity')
```



b. Estimation of true frequency and uncertainty

```
sum1 = sum(freq ./ freqErr.^2)
```

```
sum1 = 587.1736
```

```
sum2 = sum(1 ./ freqErr.^2)
```

```
sum2 = 379.0595
```

```
weightedMeanFreq = sum1/sum2
```

```
weightedMeanFreq = 1.5490
```

```
weightedFreqErr = sqrt(1/sum(1 ./ freqErr.^2))
```

```
weightedFreqErr = 0.0514
```

```
meanFreq = sum(freq)/8
```

```
meanFreq = 1.5738
```

```
meanErr = sqrt(sum(freqErr.^2)/8)
```

```
meanErr = 0.4133
```

So the estimated true value of frequency is (1.55 +/- 0.051) * 10^5 Hz

The straight mean and uncertainty for the frequency is (1.57 +/- 0.41) * 10^5 Hz. We can see that the straight value of uncertainty is larger than the weighted value, since it weighs all values of uncertainty equally.

c. Chi and chi-squared value for each data point

```
chi = (freq - weightedMeanFreq)./freqErr
```

```
chi = 8×1
   -0.2378
    0.5639
   -0.0545
   -0.9931
    0.5459
    0.6741
    0.5543
   -0.8095
```

```
chiSquared = chi.^2
```

```
chiSquared = 8×1
    0.0566
    0.3180
    0.0030
    0.9862
    0.2981
    0.4544
    0.3072
    0.6552
```

d. Histogram of chi values of each data point

```
histogram(chi, 10)
title("Chi values of each data point")
xlabel("Chi values")
ylabel("Quantity")
```

2) Measurement of resonent frequencies of acoustic modes

a. Plot of data with error bars

```
n = [1;2;3;4;5;6]
```

```
n = 6×1
     1
     2
     3
     4
     5
     6
```

```
f = [314;557;870;1134;1289;1674]
```

```
f = 6×1
     314
     557
     870
    1134
    1289
    1674
```

```
s_f = [35;42;51;62;74;86]
```

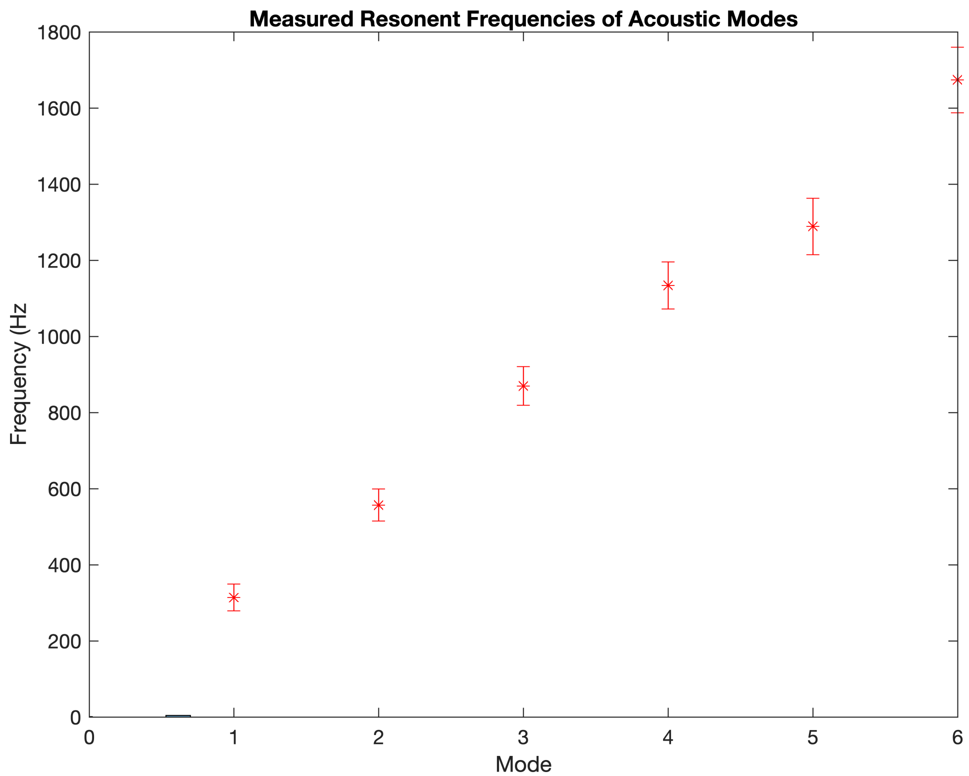
```
s_f = 6×1
    35
    42
    51
    62
    74
    86
```

```
hold on

errorbar(n,f,s_f,'r*','LineStyle','none')

title('Measured Resonent Frequencies of Acoustic Modes')
xlabel('Mode')
ylabel('Frequency (Hz')
xlim([0 6])

hold off
```



b. Linear fit (format y = a +bx)

```
scatter(n,f)
title('Measured Resonent Frequencies of Acoustic Modes')
xlabel('Mode')
ylabel('Frequency (Hz')
hl = lsline
```

```
hl =
  Line (lsline) with properties:

              Color: [0.7500 0.7500 0.7500]
          LineStyle: '-'
          LineWidth: 0.5000
             Marker: 'none'
         MarkerSize: 6
    MarkerFaceColor: 'none'
              XData: [1 6]
              YData: [311.5714 1.6344e+03]
              ZData: [1×0 double]

  Show all properties
```

```
var = [ones(size(hl.XData(:))), hl.XData(:)]\hl.YData(:);
b = var(2)
```

```
b = 264.5714
```

```
a = var(1)
```

```
a = 47.0000
```

```
fo = a
```

```
fo = 47.0000
```

```
L = 0.45
```

```
L = 0.4500
```

```
v = 2*L*b
```

```
v = 238.1143
```

v = 238 m/s , fo = 47 Hz

Getting uncertainty on v and fo

```
s = sum(1./s_f.^2)
```

```
s = 0.0023
```

```
s_y = sum(f./s_f.^2)
```

```
s_y = 1.6633
```

```
s_x = sum(n./s_f.^2)
```

```
s_x = 0.0059
```

```
s_xx = sum((n.^2)./s_f.^2)
```

```
s_xx = 0.0201
```

```
del = s*s_xx - s_x^2
```

```
del = 1.2802e-05
```

```
s_b = s/del
```

```
s_b = 183.2328
```

```
s_a = s_xx/del
```

```
s_a = 1.5732e+03
```

```
s_v = sqrt(2*L*s_b)
```

```
s_v = 12.8417
```

```
s_fo = sqrt(s_a)
```

```
s_fo = 39.6636
```

$\sigma_V = 13$ m/s and $\sigma_{\mathrm{Fo}} = 40.$ Hz

c. Predicted frequency for each mode

```
f_pred = (v.*n)/(2*L) + fo
```

```
f_pred = 6×1
10^3 ×
    0.3116
    0.5761
    0.8407
    1.1053
    1.3699
    1.6344
```

```
hold on

errorbar(n,f,s_f,'r*','LineStyle','none')
```

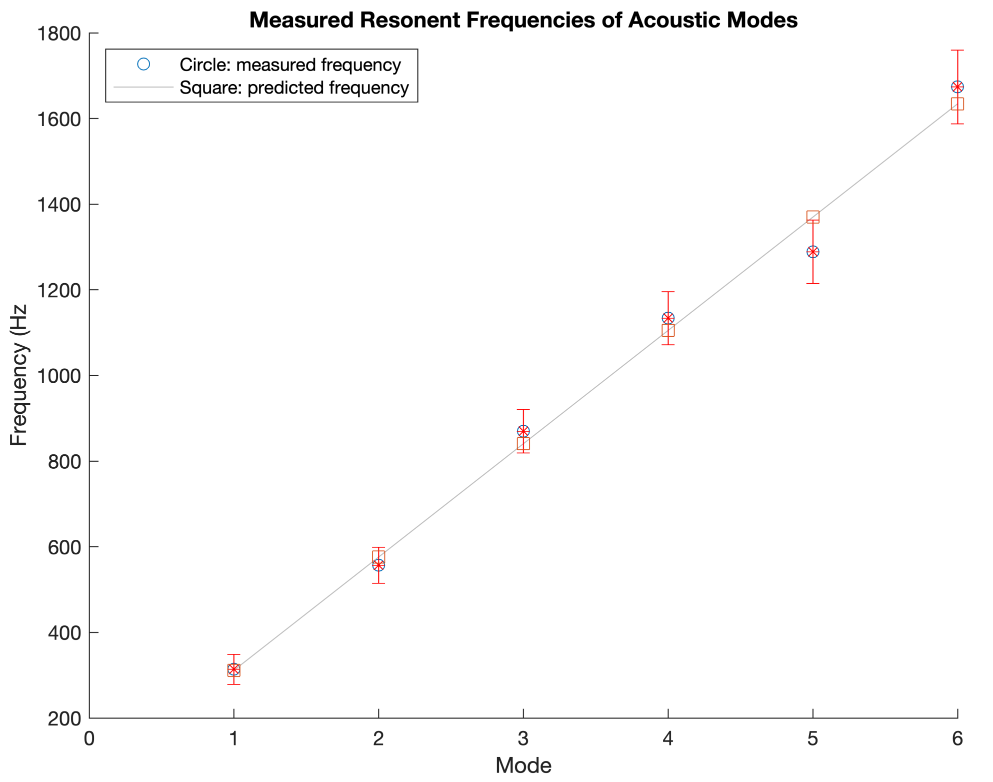
```
title('Measured Resonent Frequencies of Acoustic Modes')
xlabel('Mode')
ylabel('Frequency (Hz')
xlim([0 6])

sz = 60
```

```
sz = 60
```

```
scatter(n,f_pred, sz, 's')
legend({'Circle: measured frequency','Square: predicted frequency'},'Location','northwe

hold off
```



d. Chi-values

```
weightedMean_f = s_y/s
```

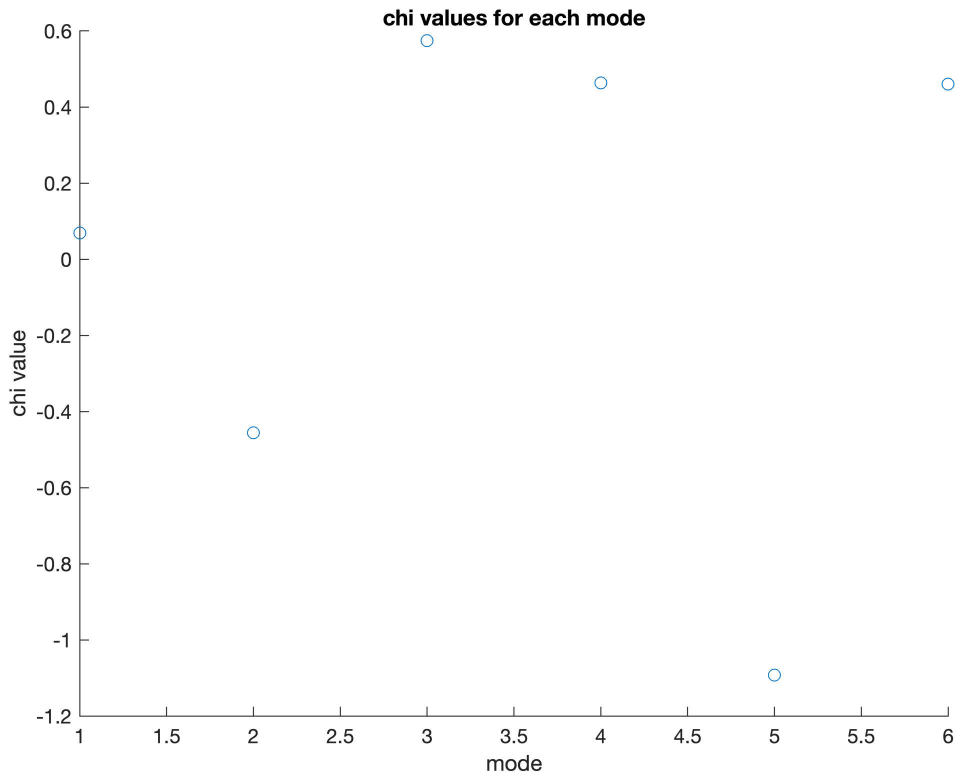
```
weightedMean_f = 709.1011
```

```
chi = (f - f_pred)./s_f
```

```
chi = 6×1
    0.0694
   -0.4558
    0.5742
    0.4631
   -1.0927
```

0.4601

```
scatter(n,chi)
title('chi values for each mode')
xlabel('mode')
ylabel('chi value')
```



There is one frequency with a chi value magnitude of greater than one (-1.09). Since the gaussian distribution tells us we should expect around 1/3 of our values to have a chi magnitude of greater than one, our data appears consistant with that assumption.