STATISTICS WORKSHEET
STUDENT EXPERIMENT

Fill in your name and other information:

Name: …….

Section: ……..

Instructor: ……..

Date: ……

The experiment you will conduct is to measure your heart rate. You will use the following as guidelines for measuring the data:

> You will only measure your heat rate while resting or doing light physical activity (walking). Do not include data when you are doing "heavy" exercise.
>
> You will measure your rate over at least 30 seconds. If you use an electronic meter, wait long enough for the reading to stabilize. RECORD THE RATE PER MINUTE AS AN EVEN NUMBER – 71 is not allowed and you must decide whether to record it as 70 or as 72 – or take the measurement again!
>
> You will record the date and time when you took the measurement, the rate in beats per minute, and any other pertinent information.
>
> Leave at least 30 minutes between measurements. This is to ensure independence of measurements.

For simple calculations, include everything in this worksheet. For more lengthy calculations use MathCAD and append the data and programs to this worksheet.

OBSERVED DATA

Decide on the size of your small sample.

n_1 =

Measure the data and record it here.

CALCULATIONS

Calculate the mean and standard deviation of your small sample.

$$\bar{x}_1 = \frac{\sum_{i=1}^{n_1} x_i}{n_1} =$$

$$S_1 = \sqrt{\frac{\sum_{i=1}^{n_1} (x_i - \bar{x}_1)^2}{(n_1 - 1)}} =$$

STANDARD ERROR OF THE MEAN

Degrees of freedom, level of significance and Student-t for your sample data.

$dof = (n_1 - 1) =$

Choose a level of significance or confidence interval.

Level of significance = (100% – confidence interval) = %

Look up the Student-t statistic.

t =

Calculate the standard error of your small sample. You will only have one result – the one calculated using the single level of significance you chose above when you looked up the Student-t statistic.

Standard error = $d = \frac{t.S_1}{\sqrt{n}} =$ beats per minute

Mean heart rate is ± beats per minute

REQUIRED SAMPLE SIZE

Calculate the required sample size. Assume the required accuracy is 2.5 beats per minute.

First iteration

t = dof = (n – 1) =

Required sample size = $n \approx \left(\frac{t.S}{d} \right)^2 = \left(\frac{\quad .}{2.5} \right)^2 =$

dof = (n – 1) =

Second iteration

Look up the new Student-t using the dof from the 1st iteration

t =

Required sample size = $n \approx \left(\frac{t.S}{d} \right)^2 = \left(\frac{\quad .}{2.5} \right)^2 =$

dof = (n – 1) =

Have you converged? I.e., is this sample size the same as the one from the 1st iteration?

Third iteration

Look up the new Student-t using the dof from the 2nd iteration

t =

Required sample size = $n \approx \left(\frac{t.S}{d} \right)^2 = \left(\frac{\quad .}{2.5} \right)^2 =$

dof = (n – 1) =

Keep going until convergence. That is, the required number of samples does not change.

Final required sample size = n_{FULL} =

ADDITIONAL SAMPLING

Why can the error of the mean sometimes go up (get worse) as we obtain more data samples?

Acquire the additional data you need to complete your analysis.

Number of additional measurements needed = $\left(n_{FULL} - n_1\right)$ = (-) =

Additional data:

CHECK REQUIRED ACCURACY HAS BEEN ACHIEVED

Calculate the mean and sample standard deviation for your full data set

$$\bar{x}_{FULL} = \frac{\sum_{i=1}^{n_{FULL}} x_i}{n_1} =$$

$$S_{FULL} = \sqrt{\frac{\sum_{i=1}^{n_{FULL}} (x_i - \bar{x}_1)^2}{(n_{FULL} - 1)}} =$$

Calculate the degrees of freedom for your data set

dof = $(n_{FULL} - 1) =$

Re-state the level of significance you are working to:

Level of significance = %

Look up the Student-t statistic

t =

Calculate the error of the mean

$$d = \frac{t.S_{FULL}}{\sqrt{n_{FULL}}} = \frac{(\qquad \times \qquad)}{\sqrt{\qquad}} =$$

Quote your result to full accuracy (i.e., too many significant figures)

Average heart rate = ± beats per minute

Now round off the numbers appropriately

Average heart rate = ± beats per minute

Did you achieve the required accuracy of 2.5 b.p.m.?

Yes / No

If you said "No" you know what to do. Do it!

GOODNESS OF FIT

Goodness of Fit – Uniform Distribution

Make your hypothesis about the Uniform distribution:

Sample statistics for the Uniform distribution: ***(Hint: are there any for a Uniform distribution?)***

Decide on bin limits. Calculate the probability of a sample being less than each bin limit. Fill in the following table:

Bin limit	P(< bin limit) for Uniform distribution

Calculate the expected number of samples in each bin. Modify the bins as necessary to ensure at least 4 samples are expected in each bin.

Bin limits	P_i = P(upper)-P(lower)	Expected Number $= E_i = P_i . n_{FULL}$

Calculate the test statistic.

Bin limits	Expected Number $= E_i = P_i . n_{FULL}$	Observed number, O_i	$\frac{(O_i - E_i)^2}{E_i}$
TOTAL			

Check the test statistic for pass/fail:

Number of bins, k =

Level of significance = %

X^2 statistic (from tables) =

Test statistic from sample data =

Which is bigger? Test statistic / X^2 statistic

Conclusion:

THE WORK AFTER THIS POINT IS FOR EXTRA CREDIT. YOU DO NOT HAVE TO COMPLETE THE REMAINDER OF THIS WORKSHEET.

Goodness of Fit – Normal Distribution.

Make your hypothesis about the Normal distribution:

Sample statistics for the Normal distribution:

Decide on bin limits. Calculate the probability of a sample being less than each bin limit. Fill in the following table:

Bin limit	$z = \frac{(x - \bar{x})}{S}$	P(< bin limit) for Normal distribution

Calculate the expected number of samples in each bin. Modify the bins as necessary to ensure at least 4 samples are expected in each bin.

Bin limits	P_i = P(upper)-P(lower)	Expected Number $= E_i = P_i . n_{FULL}$

Calculate the test statistic.

Bin limits	Expected Number $= E_i = P_i . n_{FULL}$	Observed number, O_i	$\frac{(O_i - E_i)^2}{E_i}$
TOTAL			

Check the test statistic for pass/fail:

Number of bins, k =

Level of significance = %

X^2 statistic (from tables) =

Test statistic from sample data =

Which is bigger? Test statistic / X^2 statistic

Conclusion:

Goodness of Fit – Poisson Distribution.

This time, using the work you have already completed above as examples, check your sample data against the Poisson distribution. Use separate paper and/or MathCAD worksheets (attach copies of all work).

Give your final results here:

Chosen level of significance = %

Degrees of freedom =

X^2 statistic (from tables) =

Test statistic from sample data =

Which is bigger? Test statistic / X^2 statistic

Conclusion: