

Homework 6

Due 3/20/25

Reminder: Reading Chapter 4 of the textbook will help you answer these questions. In lectures 12 and 13 and some of 14 you will have seen relevant background and examples. *Unless otherwise noted, write out by hand how to calculate the desired values (you can abbreviate but sub in some values). Also please pay attention to sig figs, and remember to sketch out the reference distribution when you do the hypothesis tests – each problem should have a reference distribution sketch.*

- 1) (a) Do problem 4.13 (a) (4.23 in 7th edition) in your book doing the step-by-step hypothesis method by hand (either p-value or critical value is fine). Don't do part b from the book but instead do the following: (b) check your answer in part a in Minitab, print the output and report the p-value you obtained
- 2) You wish to know if changing the catalyst in a process causes the yield to have more variability. Data are collected on the yield for each catalyst:

Cat. 1 Cat. 2

57.9 66.4

66.2 71.7

65.4 70.3

65.4 69.3

65.2 64.8

62.6 69.6

67.6 68.6

63.7 69.4

67.2 65.3

71.0 68.8

- a) Cut and paste this data into Minitab and test the hypothesis that the variances are equal. Assume normality (there is a box to check in this test that assumes normality). Report the output and your conclusions – answer the question of whether you could assume equal variance for these samples if you were to conduct a t-test. Use $\alpha=0.05$
- b) Check the normality assumption using Minitab – does it seem appropriate?

3.) Do problem 4.23 from your book (4.39 in the 7th edition) and use Excel to process the data for parts a-c. Provide the excel sheets and write out the equations used to get your answers. For part b, put the calculated residuals you got from Excel into Minitab to produce your normal probability plot. Use $\alpha=0.05$.

For the final part of this problem (part d) check your answers in Minitab (including the residual plot via the ANOVA function), click assume equal variance box. Report the P-value.

4.) Do problem 4.25 (4.41 in 7th edition) from the book. Use Minitab to conduct the hypothesis testing (assuming equal variances).

a) Conduct the analysis and state your conclusions and sketch out the situation on a reference distribution. Also answer the following questions:

a-1) how many factors are in this experiment?

a-2) how many levels?

a-3) What is the critical value of F if you were to compare the test statistic to it instead of using the P-value?

b) Analyze residuals according to the following directions

b-1) Calculate the residuals in Excel. (Write out the equations needed and report the sheet you used to get your answers).

b-2) Analyze the residuals by plotting them on a normal probability plot in Minitab (cutting and pasting from your table you made in Excel). State if you think normality is an OK assumption.

b-3) Plot the residuals you calculated in Excel, versus the factor levels. (Can use Minitab or Excel) Answer what assumption this graph checks, and comment if the assumption is still valid.

b-4) Plot the residuals vs. the fitted value (\bar{y}_i). Can use Minitab or Excel. Do the residuals depend on the response? State what you would do if they did appear to have a pattern.

C) Do this next extra part (not in the book)

c-1) Conduct the Fisher's LSD post-hoc test using Excel given the MSE = 6.625. Compare: 0.37 vs. 0.51, 0.37 vs. 0.71, and 0.51 vs. 0.71 by hand and conduct the full analysis using Minitab

c-2) Construct a plot that represent your data with an appropriate caption by plotting the average \pm the standard deviation at each treatment mean, and above the bars, listing the letter assignments from the post hoc testing. For the caption, write something like this

example: "All data are represented by the average \pm standard error. ANOVA was performed to confirm statistical significance of (insert what factor you are investigating), followed by the (name here) *post hoc* test to determine differences between treatment means using $\alpha=X$. Bars that do not share a letter within a graph are statistically different."

Of course variations of this can be written, but you should include all of the above information.

Remember for sketching reference distributions for a hypothesis test:

P-value method: Sketch out the reference distribution, labeling the test statistic, and the p-value. In addition, fully define the distribution you are sketching on with the correct shape, any defining characteristics and where 0 is. It is also good to draw in alpha – remembering that alpha is not the same as your p-value.

Fixed Significance Level Testing: Sketch out the reference distribution, labeling the acceptance region, the rejection region, α , the critical value(s) and your test statistic. In addition, fully define the distribution you are sketching on with the correct shape, any defining characteristics and where 0 is.