As we discussed, you will work in three groups. Please type the names of all members of your group on the top of the first page of the solutions to this exam.

In all problems, you need to follow steps if any are given, and answer all questions asked. Please be very concise and precise in what you write. Please do not include the same information twice- be gentle for the trees! **The total number of pages that will be graded will not exceed 4 pages.** Do all tests of significance on the significance level of 0.05, unless specified otherwise. Each part of every problem is worth 3 points. For all testing hypotheses problems, you must write down the hypotheses you test, the test statistic, the critical number or p-value, the decision you make and the answer to the problem. Write solutions of the problems in the order they were asked. Staple all the pages of your exam. Please be at your best handwriting or type. Remember, what I can not read, I can not grade.
 The exam is due on Monday, November 9 at class time (6pm). No late work will be accepted.

ENJOY!

Problem 1. The data for this problem is in the data set: grainsdata.*. Four types of grain (wheat, barley, maize, and oats) were analyzed for their thiamin content. Six samples of each of four grains were analyzed. Their thiamin content was recorded in mg/g. Please answer the following questions. Remember to justify your answers.

1. Are the assumptions for one-way ANOVA satisfied in this problem? Is it reasonable to assume normality of the error? Is it reasonable to assume that different types of grains have thiamin content with the same variance?
2. Does this data suggest that all grain types have the same mean thiamin content?
3. Which pairs of grain types, if any, have significantly different thiamin content? Perform appropriate comparisons on 95% significance level.

Problem 2. Data in hormonedata.*. Plants were given 5 types of growth hormone. The growth data for 20 plants - four plants per each hormone type- were recorded. Please answer the following questions:

1. Are the assumptions for one-way ANOVA satisfied for this problem? Check normality of the residuals and uniform variance assumptions.
2. Does the data suggest that all hormones have the same effect of plants' growth?
3. I believe that Hormone 2 and Hormone 5 differ significantly. Is my belief justified by the data?
4. Which pairs of hormones have significantly different effect on plant growth?

Problem 3. For some data sets, the *F* statistic will reject the null hypothesis of no difference in mean yields, but the Tukey method will not find any pair of means that can be concluded to differ. For the four sample means $\bar{X}_{1.} = 89.88, \bar{X}_{2.} = 89.51, \bar{X}_{3.} = 86.98,$ and $\bar{X}_{4.} = 85.79,$ and assuming a sample size of 5 for each treatment, find a value of MSE so that the *F* statistic rejects the null hypothesis of no difference at the 5% level, while the Tukey method (for simultaneous comparisons) does not find any pair of means to differ at the 5% level.

Problem 4. The effect of curing pressure on bond strength (in MPa) was tested for two different adhesives. There were three levels of curing pressure. Three replications were performed for each combination of curing pressure and adhesive. The results are presented in the following table.

Adhesive	Curing Pressure	Bond Strength		
A	Low	8.1	8.8	6.3
A	Medium	6.6	6.4	8.1
A	High	3.5	4.1	2.6
B	Low	5.1	6.0	3.7
B	Medium	2.9	5.2	5.6
B	High	4.5	0.8	3.2

a. Construct an ANOVA table.

b. Is the additive model plausible? Provide the value of the test statistic and the P-value.

c. Can the effect of adhesive on the bond strength be described by interpreting the main effects of adhesive? If so, interpret the main effects. If not, explain why not.

d. Can the effect of curing pressure on the bond strength be described by interpreting the main effects of curing pressure? If so, interpret the main effects. If not, explain why not.