

STATISTICS 402 - Assignment 8
Due April 3, 2009

1. For each of the following problem statements, identify the response, conditions and experimental material. Indicate the design (completely randomized, randomized complete block, Latin square) that is used to collect the data and indicate if factorial crossing is used. Construct a partial ANOVA table by identifying all sources of variability and associated degrees of freedom.
 - a. Industrial psychologists wish to investigate the effect of music in the factory on the productivity of workers. Four distinct music programs (Country, Soft Rock, Hard Rock, and Classical) and no music make up the five treatments. In order to account for variability from day to day and week to week, a different program is used on each day (M, T, W, R, F). The programs are rotated from week to week, so that over 5 randomly chosen weeks each program appears once on any specific working day of the week.
 - b. An experiment is conducted to compare the energy requirements of three physical activities: running, walking, and bicycle riding. Eight subjects are asked to run, walk and bicycle a measured distance, and the number of kilocalories expended per kilometer is measured for each subject during each activity. The order of the activities is randomized for each individual with time for recovery between activities.
 - c. An experiment is performed to see whether different operators obtain different results in the routine analysis to determine the amount of nitrogen in soil. 50 soil samples are chosen at random and divided at random into 5 groups of 10. Each operator is assigned a group of 10 soil samples at random and asked to determine the amount of nitrogen in each sample.
 - d. A sports physiologist is conducting an experiment on eye focus time. She is interested in the distance of the object from the eye on the focus time. Four different distances are of interest. She chooses 10 players at random from a college softball team. Each player will have her focus time measured at each of the four distances. The order of the distances will be randomized for each player.
 - e. A mechanical engineer is studying the thrust force developed by a drill press. She is interested in the effects if drill speed and drill size. She has five drill speeds and two different drill sizes. A single operator drills 4 holes using each of the speed and size combinations in pieces of aluminum. The order in which the 40 pieces of aluminum are chosen and holes are drilled is randomized.

2. The following is adapted from a problem that appears on page 173 of *Design and Analysis of Experiments*, 3rd edition by Douglas Montgomery.

The effect of five different ingredients (A, B, C, D, and E) on the reaction time of a chemical process is being studied. Each batch of new material is only large enough to permit five runs to be made. Furthermore, each run requires approximately 1½ hours, so only five runs can be made in one day. The experimenter decides to run the experiment as a Latin square so that day and batch may be accounted for in the analysis. Be sure to turn in appropriate JMP output with your assignment.

	Day				
Batch	1	2	3	4	5
1	A=9	B=7	D=2	C=8	E=2
2	C=12	E=2	A=8	D=3	B=8
3	B=5	A=10	C=11	E=1	D=4
4	D=3	C=9	E=3	B=6	A=11
5	E=4	D=2	B=6	A=9	C=8

- Compute an overall grand sample mean, as well as ingredient, batch and day sample means.
- Compute the estimated effect for each ingredient. Which ingredients appear to shorten the reaction time?
- Construct an ANOVA table including all appropriate sources of variation.
- Are there statistically significant differences among the five ingredients in terms of average reaction time? Report the appropriate F- and P-values and explain why these support your answer.
- If there are statistically significant differences among the ingredients, indicate where those differences lie. Give the value of HSD. Clearly state which ingredients have statistically significant differences in sample means and which do not.
- If one wishes to reduce reaction time, what statistically valid recommendations can you make for the choice of ingredient? Explain your reasoning.
- Look at the residuals and comment on whether the equal standard deviation condition and the normally distributed errors condition are satisfied.
- If these data were analyzed as if they came from a completely randomized design, give the ANOVA table with sources of variation, degrees of freedom, sums of squares, mean squares and F-ratio. **Do not use JMP or another computer program to do this part. You should be able to do this from the information in c.**