1. A researcher studied the effects of inbreeding on plant weight in red clover. Given below are plant weights for a group of noninbred (F_1) plants and three groups of inbred plants (F_2, F_3, F_4) arranged in increasing order of inbreeding.

Group	Plant Weights	Mean	Variance
F_1	253, 262, 265, 248, 336, 277, 289, 244, 265	271.0	790.0
F_2	232, 191, 209, 252, 212, 224	220.0	442.0
F_3	257, 192, 141, 160, 229, 221, 150, 215, 232, 234, 193, 188	201.0	1342.0
F_4	176, 165, 184, 139, 146, 125, 177, 198, 171, 177, 172, 198	169.0	498.0

(a) *(7 points)* Fill in the missing entries in the one-way ANOVA table below. (Don't waste your time on complicated calculations. None are necessary.)

Source	Degrees of Freedom	Sum of Squares	Mean Squares
Variety	-----------	-----------	-----------
Error	-----------	-----------	822
Total	-----------	84001	

(b) *(7 points)* Are all the group means the same? Conduct one test to answer this question. Provide a test statistic, a relevant table value (approximate if necessary), and a conclusion.

(c) *(7 points)* Estimate a contrast for comparing the mean for noninbred plants (F_1) to the average of the inbred means (F_2, F_3, F_4).

(d) *(7 points)* Compute the contrast sum of squares for the contrast estimated in part (c).

(e) *(7 points)* Is the contrast estimated in part (c) significantly different from 0? Provide a test statistic, a relevant table value (approximate if necessary), and a conclusion.

(f) *(7 points)* Provide the coefficients of a contrast that is orthogonal to the contrast estimated in part (c).

(g) *(7 points)* The researcher hopes to demonstrate that more inbreeding leads to decreased plant weight. More specifically he hopes to show that

   i. The F_1 mean is significantly greater than each of the other means.

  ii. The F_2 mean is significantly greater than each of the F_3 and F_4 means.

 iii. The F_3 mean is significantly greater than the F_4 mean.

He wants to conduct these analyses so that the experimentwise Type I error rate is no larger than 0.05. Which of the multiple testing methods that we have discussed would be most appropriate for this goal? Circle the best answer from the list below.

Bonferroni   Dunnett   Tukey   Fisher's LSD   Hsu's Test for the Best   Hsu's Test for the Worst

2. A researcher wishes to compare the effect of 4 diet additives (call them A, B, C, and D) on the lifespan of rats. Sixteen cages containing four rats each are available for the experiment. The rats have been randomly assigned to cages. For practical reasons all the rats sharing a cage must receive the same diet additive. The lifespan of each rat will be recorded and analyzed once all the rats have died.

The 16 cages will be kept in fixed positions within one room throughout the entire experiment. The layout of the cages in the room is diagrammed below. Because of the locations of windows in the room, the cages to the far left will get the most sunlight and the cages to the far right will get the least sunlight. Also, temperatures will be most variable to the far left and least variable to the far right. Both amount of sunlight and temperature variation might affect life span.

(a) *(12 points)* Use the random digits below to assign diet additives to cages in a manner that you believe is appropriate in this experiment. Label each cage above with the treatment that you have assigned using the random digits. Explain how you used the random digits if you suspect that it might not be obvious to your instructor.

14979   67281   49874   26421   25443   48250   15627   85412   67329   71950

(b) *(5 points)* What are the experimental units in this experiment?

(c) *(5 points)* What are the observational units in this experiment?

(d) *(5 points)* What is the response variable?

(e) *(5 points)* How many replications are there for each treatment?

(f) *(9 points)* How would you change the design of your experiment if it were possible to assign different diet additives directly to rats rather than to cages? (A one or two sentence answer should be sufficient.)

3. *(10 points)* An experiment with two treatments had the following randomization of treatments to experimental units shown along with the measured response on each unit.

	Unit:	1	2	3	4
	Treatment:	A	B	B	A
	Response:	13	3	5	7

Conduct a randomization test of the null hypothesis, H_0 : no difference in the treatment effects of A and B, versus the alternative, H_A : treatment A tends to produce greater responses that treatment B. Give a p-value for the test.