**STUDY QUESTIONS**

1. A plan for testing hypotheses in which the researcher either controls or manipulates one or more variables is called a(n) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

2. A variable that is either controlled or manipulated is called a(n) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ variable.

3. An independent variable is sometimes referred to as a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ variable, a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ variable, or a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

4. Each independent variable contains two or more \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

5. The response to the different levels of the independent variables is called the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ variable.

6. The experimental design that contains only one independent variable with two or more treatment levels is called a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

7. In chapter 11, the experimental designs are analyzed statistically using \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

8. Suppose we want to analyze the data shown below using analysis of variance.

1 2 3 4

3 5 4 1

2 6 2 2

4 7 2 2

3 6 2 1

2 7 3 1

3 2

The degrees of freedom numerator for this analysis are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The degrees of freedom denominator for this analysis are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

9. Assuming that *α* = .05, for the problem presented in question 8, the critical *F* value is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

10. For the problem presented in question 8, the sum of squares between is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and the sum of squares error is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The mean square between is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and the mean square error is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The observed value of *F* for this problem is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The decision is to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

11. A set of techniques used to make comparisons between groups after an overall significant *F* value has been obtained is called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

12. The two types of multiple comparison techniques presented in chapter 11 are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

13. In conducting multiple comparisons with unequal sample sizes with techniques

presented in chapter 11 of the text, you would use which procedure?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

14. Suppose the following data are taken as samples from three populations and that an ANOVA results in an overall significant *F* value of 404.80. The mean square error for this ANOVA is 1.58.

1 2 3

11 24 27

9 25 30

10 25 29

12 26 28

11 24 31

8 29

10

The Tukey-Kramer significant difference for groups 1 and 2 is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. For groups 1 and 3, it is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. For groups 2 and 3, it is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The following groups are significantly different \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ using *α* = .01.

15. Suppose the following data represent four samples of size five which are taken from four populations. An ANOVA revealed a significant overall *F* value.

1 2 3 4

5 11 12 21

8 9 11 18

7 9 13 20

8 10 14 21

6 11 14 23

The mean square error for this problem is 1.92. The number of populations (*C*) for this problem is \_\_\_\_\_\_\_\_. The degrees of freedom error are \_\_\_\_\_\_\_\_\_\_\_. The value of *q* is \_\_\_\_\_\_\_\_\_\_\_\_. The value of HSD for this problem is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The following pairs of means are significantly different according to Tukey's HSD \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Let *α* = .05

16. A research design that is similar to the completely randomized design except that it includes a second variable referred to as a blocking variable is called a(n) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

17. In the randomized block design, the variable that the researcher desires to control but is not the treatment variable of interest is called the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ variable.

18. Consider the following randomized block design.

Treatment Level

1 2 3

Block

1 2 4 8

2 3 4 9

3 2 5 7

4 4 6 6

5 3 5 9

The degrees of freedom treatment are \_\_\_\_\_\_\_\_. The degrees of freedom blocking are \_\_\_\_\_\_\_\_. The degrees of freedom error are \_\_\_\_\_\_\_\_.

19. For the problem in question 18, the sum of squares treatment is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The sum of squares blocking are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The sum of squares error are \_\_\_\_\_\_\_\_\_\_\_\_.

20. For the problem in question 18, the mean square treatment is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The mean square blocking is \_\_\_\_\_\_\_\_\_\_. The mean square error is \_\_\_\_\_\_\_\_\_\_\_\_\_. The observed *F* value for treatment is \_\_\_\_\_\_\_\_\_\_\_\_\_. The observed *F* value for blocking is \_\_\_\_\_\_\_\_\_\_\_\_\_. Using *α* = .01, the following effects are significant based on these *F* values \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

21. One advantage of a two-way design over the completely randomized design and the

randomized block design is that the researcher can test for

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ if multiple measures are taken under every

combination of treatment levels of the two treatments.

22. The ANOVA table shown below is compiled from the analysis of a two-way factorial design with three rows and four columns. There were a total of 48 values in this design.

Effect SS df MS F

Row 29.3

Column 17.1

Interaction 14.7

Error 55.8

Total

The sum of squares total is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The degrees of freedom for rows are \_\_\_\_\_\_\_\_\_\_\_\_. The degrees of freedom for columns are \_\_\_\_\_\_\_\_\_\_\_. The degrees of freedom for interaction are \_\_\_\_\_\_\_\_\_\_\_. The degrees of freedom for error are \_\_\_\_\_\_\_\_\_\_\_\_. The total degrees of freedom are \_\_\_\_\_\_\_\_\_\_\_\_. The mean square for rows is \_\_\_\_\_\_\_\_\_\_\_\_\_. The mean square for columns is \_\_\_\_\_\_\_\_\_\_\_\_\_. The mean squares for interaction is \_\_\_\_\_\_\_\_\_\_\_. The mean squares for error is \_\_\_\_\_\_\_\_\_\_\_\_. The observed *F* value for rows is \_\_\_\_\_\_\_\_\_\_. The observed *F* value for columns is \_\_\_\_\_\_\_\_\_\_\_\_\_. The observed *F* value for interaction is \_\_\_\_\_\_\_\_\_\_\_\_\_. The following effects are statistically significant using *α* = .05 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

23. Perform a two-way ANOVA on the data given below.

Column Effects

1 2 3

2 5 5

1 3 2 6

Row 2 4 5

Effects 4 8 7

2 6 4 6

6 7 7

The sum of squares rows is \_\_\_\_\_\_\_\_\_\_\_\_\_\_. The sum of squares columns is \_\_\_\_\_\_\_\_\_\_\_\_\_. The sum of squares interaction is \_\_\_\_\_\_\_\_\_\_\_\_\_\_. The sum of squares error is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The degrees of freedom for rows are \_\_\_\_\_\_\_\_\_\_\_\_. The degrees of freedom for columns are \_\_\_\_\_\_\_\_\_\_\_. The degrees of freedom for interaction are \_\_\_\_\_\_\_\_\_\_\_. The degrees of freedom for error are \_\_\_\_\_\_\_\_\_\_\_\_. The mean square for rows is \_\_\_\_\_\_\_\_\_\_\_\_\_. The mean square for columns is \_\_\_\_\_\_\_\_\_\_\_\_\_. The mean squares for interaction is \_\_\_\_\_\_\_\_\_\_\_. The mean squares for error is \_\_\_\_\_\_\_\_\_\_\_\_. The observed *F* value for rows is \_\_\_\_\_\_\_\_\_\_. The observed *F* value for columns is \_\_\_\_\_\_\_\_\_\_\_\_\_. The observed *F* value for interaction is \_\_\_\_\_\_\_\_\_\_\_\_\_. The following effects are statistically significant using *α* = .05 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

**ANSWERS TO STUDY QUESTIONS**

1. Experimental Design 14. 2.514, 2.388, 2.60.

All are significantly different

2. Independent

15. 4, 16, 4.05, 2.51. All are

3. Classification, Treatment, Factor significantly different

4. Levels, Classifications 16. Randomized Block

Design

5. Dependent 17. Blocking

6. Completely Randomized Design 18. 2, 4, 8

7. Analysis of Variance (ANOVA) 19. 63.33, 2.40, 10.00

8. 3, 18 20. 31.67, 0.60, 1.25, 25.34,

0.48, Treatment

9. 3.16

21. Interaction

10. 64.939, 10.333, 21.646, 0.574,

37.71, Reject the Null Hypothesis 22. 116.9, 2, 3, 6, 36, 47,

14.65, 5.70, 2.45, 1.55,

9.45, 3.68, 1.58, Rows

11. Multiple Comparisons and Columns

12. Tukey's Honestly Significant 23. 24.50, 14.11, 2.33, 18.00,

Difference Test (HSD) and 1, 2, 2, 12, 24.50, 7.06,

Tukey-Kramer Procedure 1.17, 1.50, 16.33, 4.71,

0.78, Rows and Columns

13. Tukey-Kramer Procedure