STAT nnn EXAM II.1

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Name:

Show all work on these pages.

(25) 1. (a) Assume a one-way anova with the same number of observations for each treatment. Suppose the degrees of freedom for treatments is 4 and the degrees of freedom for error is 45. Find (i) the number of treatments, and (ii) the number of observations for each treatment.

(b) Give the degrees of freedom for the three–way interaction in a $2 \times 3 \times 4$ three-way anova.

(c) For a one–way anova with three groups, the sample sizes are 10, 10, and 20; and the corresponding variances are 50, 70, and 40. Find the MSE.

(d) In a one–way anova with three groups, you are interested in the difference between the mean of the first group and the average of the means of the other groups. If the MSE is 60 and the sample sizes are 10, 6, and 12, find the standard error for this difference.

(e) For a one-way anova with 3 treatments and 5 subjects per treatment, the sum of squares total is 450 and the sum of squares for treatments is 150. Find (i) the F statistic for testing no treatment differences, (ii) the degrees of freedom for the null distribution of this statistic.

(25) 2. (a) You are using SAS to analyze a 4×2 anova using the statements CLASS A B; MODEL Y=A B A*B;. Write a contrast statement for the difference between μ_{11} and μ_{32}.

(b) In a 2×2 anova the population means are $\mu_{11} = 20$, $\mu_{21} = 25$, $\mu_{12} = 31$, and $\mu_{22} = 36$. Is there an interaction in this model? Explain why or why not.

(c) In a 4–way anova with 5 observations per cell, give the total number of main effects and interactions in the anova table.

(d) An analysis of covariance is used to analyze data from an experiment with five treatments and two covariates. There are ten subjects in each treatment group. Find the degrees of freedom for error.

(e) You ran a one–way anova with three groups and calculated an F-statistic, say F_{1-2}, for comparing the means of groups 1 and 2. An examination of the residuals revealed a very large outlier in group 3. If you rerun the analysis without the outlier, what change in F_{1-2} and its P-value do you expect. Explain why you expect this change.

(25) 3. For this question refer to the output for PROC GLM given as OUTPUT FOR PROBLEM 3.

(a) Write the anova model for this analysis using the cell means model. (Give explicit numerical values for number of groups being compared and the numbers of observations per group.)

(b) State the usual null hypothesis for this model, give the test statistic with degrees of freedom, the P-value and write one sentence describing the conclusion in words.

(c) Which pairs of means differ significantly according to the Tukey HSD procedure given in the output?

(d) What is the standard error for the estimate of the mean of the first group?

(e) Give the estimate for the parameter σ^2 of your model.

(25) 4. For this question refer to the output for PROC GLM given as OUTPUT FOR PROBLEM 4.

(a) Write the anova model for the analysis marked **PART A** using the cell means model. (Give explicit numerical values for number of groups being compared and the numbers of observations per group.)

(b) Summarize the results of the hypothesis tests for the **PART A** analysis.

(c) The **PART B** analysis consists of two runs, one for each level of the factor A. Summarize the results for A at level 1.

(d) Summarize the results for A at level 2.

(e) Do you have reason to doubt the assumption of equal variances for the analyses done at the two different levels of A. Explain why or why not.

OUTPUT FOR PROBLEM 3

General Linear Models Procedure
Class Level Information

Class	Levels	Values
TREAT	4	1 2 3 4

Dependent Variable: Y

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	162.34873	54.11624	48.20	0.0001
Error	16	17.96290	1.12268		
Corrected Total	19	180.31164			

R-Square	C.V.	Root MSE	Y Mean
0.900379	8.485962	1.0596	12.486

Source	DF	Type I SS	Mean Square	F Value	Pr > F
TREAT	3	162.34873	54.11624	48.20	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
TREAT	3	162.34873	54.11624	48.20	0.0001

Tukey's Studentized Range (HSD) Test for variable: Y
NOTE: This test controls the type I experimentwise error rate,
but generally has a higher type II error rate than REGWQ.
Alpha= 0.05 df= 16 MSE= 1.122682
Critical Value of Studentized Range= 4.046
Minimum Significant Difference= 1.9173
Means with the same letter are not significantly different.

Tukey Grouping	Mean	N	TREAT
A	16.1123	5	2
A			
A	14.4331	5	3
B	9.7088	5	4
B			
B	9.6903	5	1

OUTPUT FOR PROBLEM 4 PART A

General Linear Models Procedure

Class	Levels	Values
A	2	1 2
B	2	1 2
C	2	1 2

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	1248.7585	178.3941	249.53	0.0001
Error	32	22.8776	0.7149		
Corrected Total	39	1271.6361			

R-Square	C.V.	Root MSE	Y Mean
0.982009	4.940219	0.8455	17.115

Source	DF	Type I SS	Mean Square	F Value	Pr > F
A	1	204.87008	204.87008	286.56	0.0001
B	1	228.01166	228.01166	318.93	0.0001
A*B	1	304.29516	304.29516	425.63	0.0001
C	1	247.45368	247.45368	346.13	0.0001
A*C	1	262.61920	262.61920	367.34	0.0001
B*C	1	1.13658	1.13658	1.59	0.2165
A*B*C	1	0.37209	0.37209	0.52	0.4759

Source	DF	Type III SS	Mean Square	F Value	Pr > F
A	1	204.87008	204.87008	286.56	0.0001
B	1	228.01166	228.01166	318.93	0.0001
A*B	1	304.29516	304.29516	425.63	0.0001
C	1	247.45368	247.45368	346.13	0.0001
A*C	1	262.61920	262.61920	367.34	0.0001
B*C	1	1.13658	1.13658	1.59	0.2165
A*B*C	1	0.37209	0.37209	0.52	0.4759

Level of A	Level of B	Level of C	N	Y Mean	Y SD
1	1	1	5	9.5165503	0.83816315
1	1	2	5	9.8964121	0.47185939
1	2	1	5	20.3379312	1.12949695
1	2	2	5	19.6577356	0.77139135
2	1	1	5	14.6273616	1.38903905
2	1	2	5	24.8707070	0.31058412
2	2	1	5	14.0303581	0.66948191
2	2	2	5	23.9852330	0.67032037

OUTPUT FOR PROBLEM 4 PART B

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---------------------------------- A=1 ----------------------------------
                    General Linear Models Procedure
                        Class Level Information

                       Class    Levels    Values
                       B             2    1 2
                       C             2    1 2
Dependent Variable: Y
                                     Sum of         Mean
Source                     DF       Squares       Square  F Value    Pr > F
Model                       3     531.07705    177.02568   253.26    0.0001
Error                      16      11.18391      0.69899
Corrected Total            19     542.26096

                  R-Square          C.V.     Root MSE             Y Mean
                  0.979375      5.629207       0.8361             14.852

Source                     DF     Type I SS  Mean Square  F Value    Pr > F
B                           1     529.55965    529.55965   757.60    0.0001
C                           1       0.11275      0.11275     0.16    0.6933
B*C                         1       1.40465      1.40465     2.01    0.1755

Source                     DF   Type III SS  Mean Square  F Value    Pr > F
B                           1     529.55965    529.55965   757.60    0.0001
C                           1       0.11275      0.11275     0.16    0.6933
B*C                         1       1.40465      1.40465     2.01    0.1755

        Level of   Level of       --------------Y--------------
        B          C          N       Mean              SD

        1          1          5      9.5165503       0.83816315
        1          2          5      9.8964121       0.47185939
        2          1          5     20.3379312       1.12949695
        2          2          5     19.6577356       0.77139135
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---------- A=2 ----------

General Linear Models Procedure

Class Level Information

Class	Levels	Values
B	2	1 2
C	2	1 2

Dependent Variable: Y

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	512.81132	170.93711	233.89	0.0001
Error	16	11.69371	0.73086		
Corrected Total	19	524.50503			

R-Square	C.V.	Root MSE	Y Mean
0.977705	4.411618	0.8549	19.378

Source	DF	Type I SS	Mean Square	F Value	Pr > F
B	1	2.74717	2.74717	3.76	0.0704
C	1	509.96013	509.96013	697.76	0.0001
B*C	1	0.10402	0.10402	0.14	0.7109

Source	DF	Type III SS	Mean Square	F Value	Pr > F
B	1	2.74717	2.74717	3.76	0.0704
C	1	509.96013	509.96013	697.76	0.0001
B*C	1	0.10402	0.10402	0.14	0.7109

Level of B	Level of C	N	Y Mean	Y SD
1	1	5	14.6273616	1.38903905
1	2	5	24.8707070	0.31058412
2	1	5	14.0303581	0.66948191
2	2	5	23.9852330	0.67032037