METHODS QUALIFYING EXAM

AUGUST 2003

INSTRUCTIONS:

1. DO NOT put your NAME on the exam. Place the NUMBER assigned to you on the UPPER LEFT HAND CORNER of EACH PAGE of your exam.
2. Please start your answer to EACH QUESTION on a SEPARATE sheet of paper.
3. Answer all the questions.
4. Be sure to attempt all parts of every question. It may be possible to answer a later part of a question without having solved the earlier parts.
5. Be sure to hand in all of your exam. No additional material will be accepted once the exam has ended and you have left the exam room.

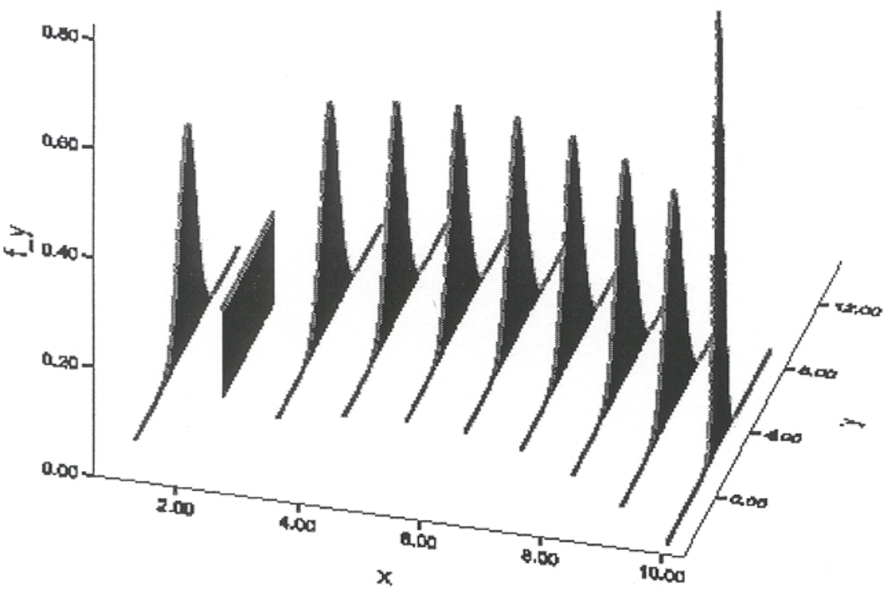
QUESTION #1:

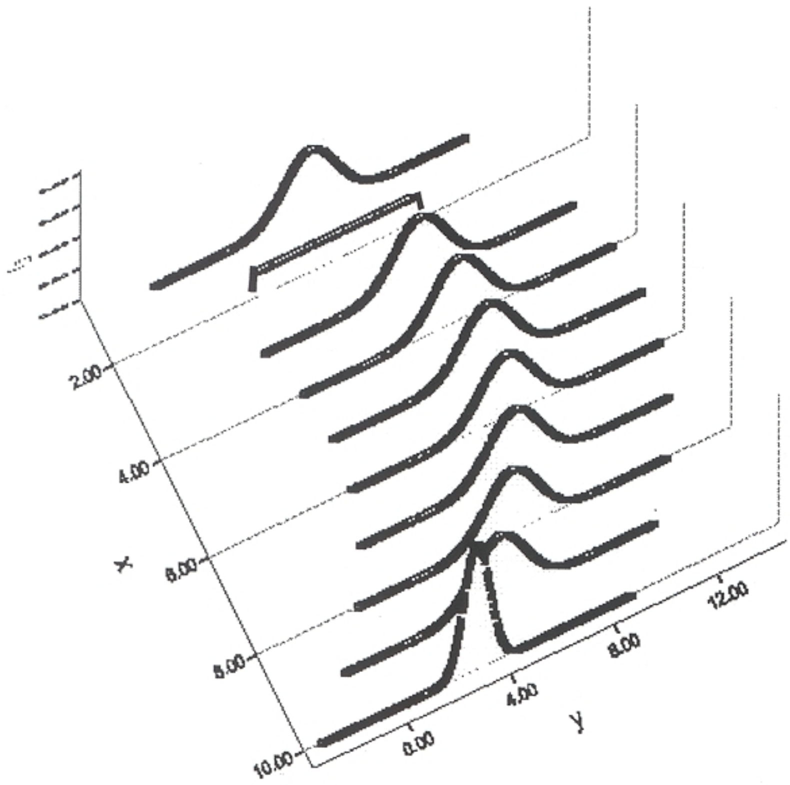
We have observed y = response (change in blood pressure) and x = dosage level of a drug. We assume a polynomial relationship between y and x.

The three graphs are all the same; but have been rotated to give additional views.

1. What is the appropriate model?
2. What are the usual regression assumptions?
3. Answer the following (in detail where appropriate):

    a. Sketch E(y)
    b. Based on the graphs, make comments about the assumptions. Do they appear to be satisfied or violated?
    c. How many populations are represented by the graphs?
    d. For x = 10, sketch the pdf of y. Label the axis, approximate min and max values such that f_y > 0, indicate the mean and standard deviation.
    e. list all of the parameters in the model
    f. What is the effect of non-normal errors on hypothesis testing?
    g. What is the effect of non-constant variance on hypothesis testing?

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y
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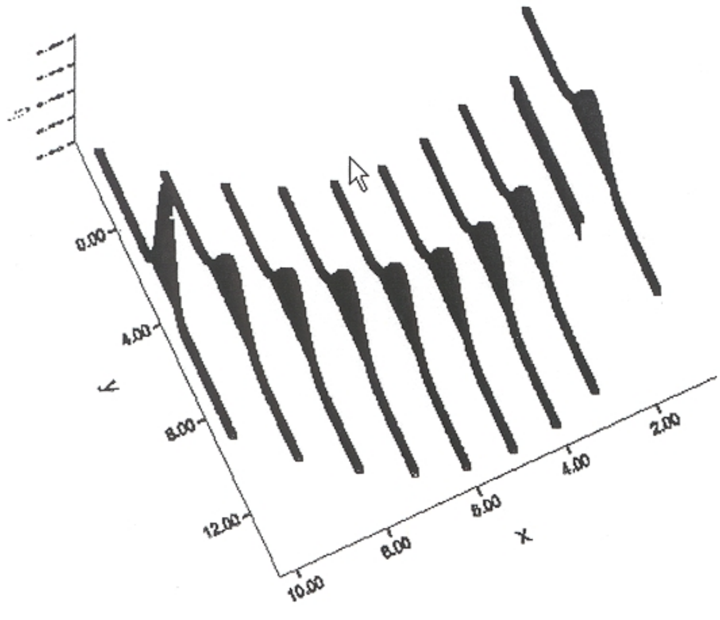
0.00
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x

QUESTION #2:

A company is interested in the ability of a machine to consistently place electrical wire on a coil. There are three varieties of machines available: hand operated(HO), partially computer operated(PCO), and completely automated(CA). Three machines of each type are randomly selected from their suppliers for use in the study. The wire placed on the coils comes in one of three thicknesses: .02mm, .04mm, or .06mm. Each of the machines assembles two coils of each of the three wire thicknesses. Each wound coil is then measured for the uniformity of windings at a middle position on the coil. These measurements are given in the following table.

		VARIETY OF MACHINE								
		HO			PCO			CA		
MACHINE ID		1	2	3	4	5	6	7	8	9
	.02mm	12.30	13.46	12.35	13.01	13.46	13.15	5.47	5.75	6.24
		12.59	14.00	12.06	12.63	13.92	13.20	5.96	5.68	6.15
THICKNESS	.04mm	13.16	13.29	12.50	12.74	13.84	13.46	5.73	5.60	5.92
		13.00	13.62	12.39	12.68	13.75	13.57	5.64	5.65	5.64
	.06mm	12.87	13.46	12.73	12.47	13.62	13.36	5.01	5.80	6.19
		12.92	13.82	12.15	12.15	13.28	13.42	5.62	5.71	6.23

A. Write a linear model for the above experiment. Make sure to identify the terms in your model with respect to distributional properties or restrictions on population parameters.

B. Complete the following AOV table.

SOURCE	DF	MS	EMS
THICKNESS		0.1263	
VARIETY		6.4424	
THICKNESS*VARIETY		0.0594	
MACHINE(VARIETY)		0.6702	
THICKNESS*MACHINE(VARIETY)		0.0919	
ERROR		0.0404	

C. Using the numeric values of the MS's given above and your EMS's, provide the following information:

1. Estimate the variance in the uniformity of windings of a randomly selected coil wound with .04mm wire using a CA winding machine.
2. Proportionally allocate the variance of the uniformity in windings of a randomly selected coil to the various variance components.
3. An estimate of the standard error of the the estimated mean uniformity of windings from a CA winding machine.
4. An estimate of the standard error of the estimated difference in the mean uniformity of windings between HO and CA winding machines.
5. An estimate of the standard error of the estimated difference in the mean uniformity of windings of coils using wire of thickness .02mm and .06mm assembled using a CA winding machine.

QUESTION #3:

The data set consists of the effects of five different drugs on lab rats. A response variable, Y, is measured for each rat. It was believed the response variable for each rat may have a linear relationship with the rat's initial weight, W. The ANOVA tables for five different analyses of these data are shown below and on the next pages. Use them to answer the following questions. For each part, A., B., and C., state the appropriate H_o and H_a, the model used (for example Model I), the value of the test statistic, and your conclusion.

A. It is known there is a linear relationship between the response Y and the initial weight W. Is it reasonable to assume the slope of the response is the same for all five drugs?

B. Perhaps counter to what you found in A., assume a common slope for the five drugs. Is there significant evidence the mean responses for the five drugs, after adjusting for initial weight, are not all equal?

C. The SPSS printout for the least squares means (adjusted means) for Model V are shown. Which pairs of means are significantly different at a 0.05 level of significance?

ANALYSES FOR QUESTION 3

In all five models, the variable DRUG has the "values" 1, 2, 3, 4, and 5. The variable W is a continuous variable. (The analyses for the five models is continued on the next pages.)

DEL I   Y = DRUG

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.733[a]	4	.183	10.657	.000
Intercept	8.567	1	8.567	498.346	.000
DRUG	.733	4	.183	10.657	.000
Error	.258	15	1.719E-02		
Total	9.558	20			
Corrected Total	.991	19			

a. R Squared = .740 (Adjusted R Squared = .670)

DEL II   Y = W

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.461[a]	1	.461	15.662	.001
Intercept	7.894E-02	1	7.894E-02	2.682	.119
W	.461	1	.461	15.662	.001
Error	.530	18	2.943E-02		
Total	9.558	20			
Corrected Total	.991	19			

MODEL III   Y = DRUG   DRUG*W

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.874[a]	9	9.716E-02	8.358	.001
Intercept	8.482E-03	1	8.482E-03	.730	.413
DRUG	5.704E-02	4	1.426E-02	1.227	.359
DRUG * W	1.070E-01	5	2.140E-02	1.840	..193
Error	.116	10	1.163E-02		
Total	9.558	20			
Corrected Total	.991	19			

a. R Squared = .883 (Adjusted R Squared = .777)

MODEL IV   Y = DRUG   W   DRUG*W

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.874[a]	9	9.716E-02	8.358	.001
Intercept	8.482E-03	1	8.482E-03	.730	.413
DRUG	5.704E-02	4	1.426E-02	1.227	.359
W	6.015E-02	1	6.015E-02	5.174	.046
DRUG * W	4.686E-02	4	1.172E-02	1.008	.448
Error	.116	10	1.163E-02		
Total	9.558	20			
Corrected Total	.991	19			

a. R Squared = .883 (Adjusted R Squared = .777)

MODEL V   Y = DRUG   W

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.828[a]	5	.166	14.206	.000
Intercept	7.138E-04	1	7.138E-04	.061	.808
DRUG	.367	4	9.166E-02	7.867	.002
W	9.476E-02	1	9.476E-02	8.133	.013
Error	.163	14	1.165E-02		
Total	9.558	20			
Corrected Total	.991	19			

a. R Squared = .835 (Adjusted R Squared = .777)

Least Square means for Drugs 1-4 using MODEL V

Pairwise Comparisons

Dependent Variable: Y

(I)MEDICINE	(J) MEDICINE	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
1.00	2.00	1.548*	.567	.008	.414	2.682
	3.00	1.868*	.579	.002	.710	3.027
	4.00	2.986*	.576	.000	1.833	4.139
2.00	1.00	-1.548*	.567	.008	-2.682	-.414
	3.00	.320	.575	.579	-.830	1.470
	4.00	1.438*	.573	.015	.292	2.584
3.00	1.00	-1.868*	.579	.002	-3.027	-.710
	2.00	-.320	.575	.579	-1.470	.830
	4.00	1.118	.566	.053	-1.585E-02	2.251
4.00	1.00	-2.986*	.576	.000	-4.139	-1.833
	2.00	-1.438*	.573	.015	-2.584	-.292
	3.00	-1.118	.566	.053	-2.251	1.585E-02

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

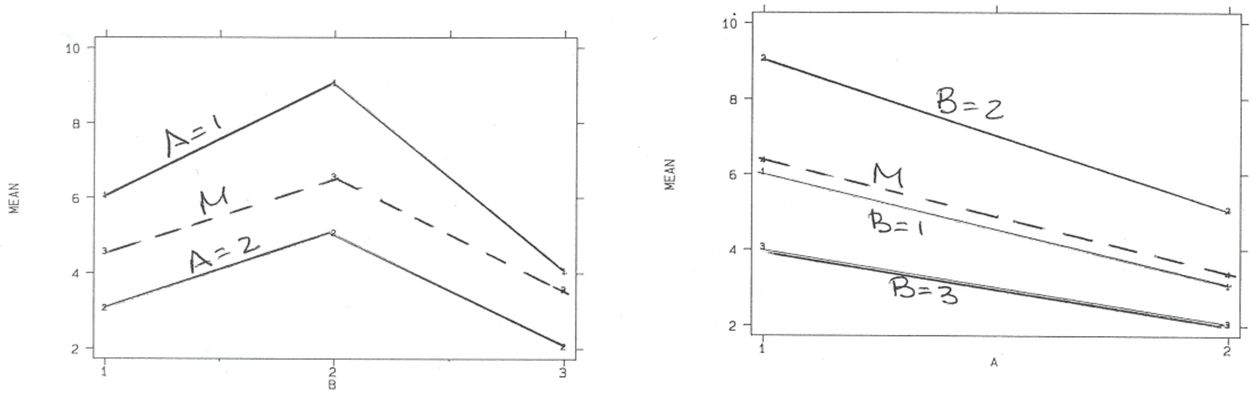
a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

QUESTION #4:

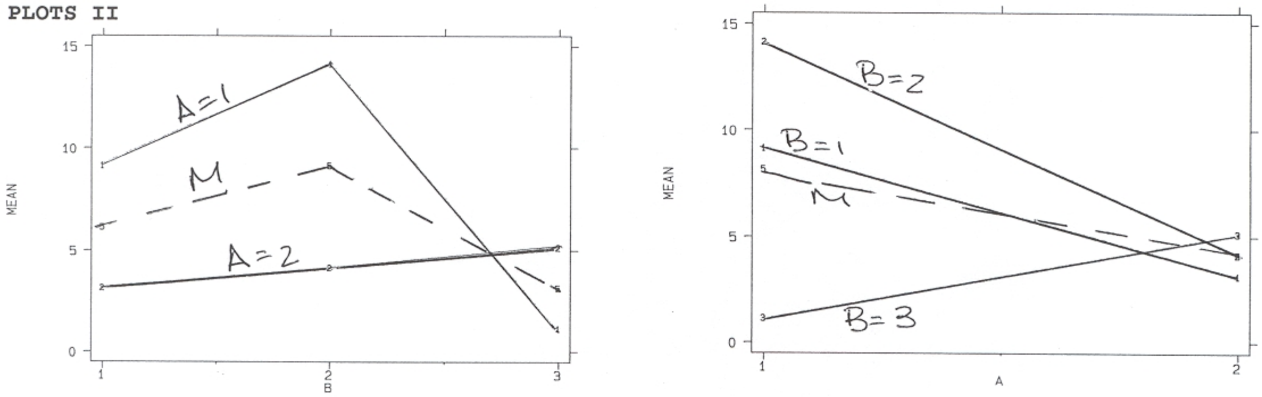
Short discussion questions. Provide short, but sufficient, answers to the following questions.

A. Consider a two factor experiment with the two factors, A at 2 levels and B at 3 levels. Three pairs of plots of simple effects and the main effects (dashed line labeled M) are shown below. For each pair of plots indicate which effects (A main effect, B main effect, AB interaction) you would judge to be significant. Remember, there may be some variation due to random variation.

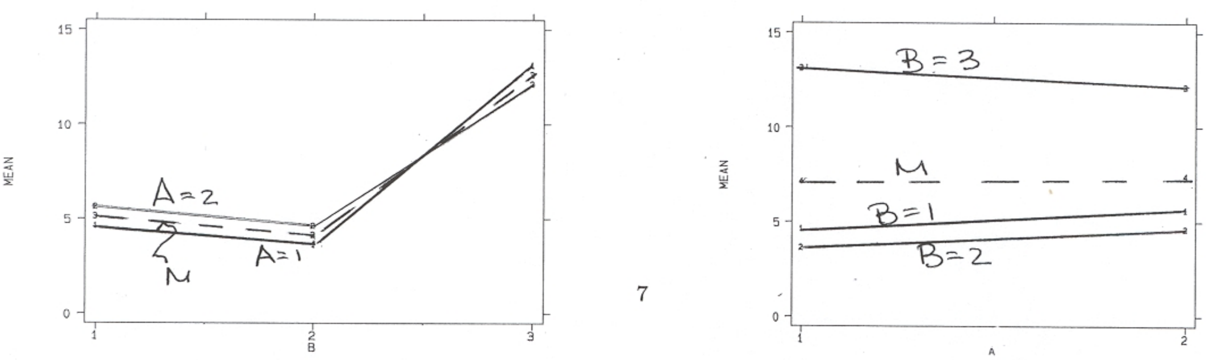
PLOTS I



PLOTS II



PLOTS III



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B. Suppose you have an experiment with six treatment groups. Different descriptions of these treatments groups are described below. The F-ratio for treatments in the ANOVA is significant. For each indicate the type of analysis of means (pairwise comparisons, contrasts, etc.) you believe most appropriate. Give a brief description of the analysis and explain why you choose the analysis.

a. The six groups are different brands of cereal, two made by General Mills and four made by Post.

b. The six groups correspond to two classes taught by Full Professors, two classes taught by Associate Professors, one class taught by an Assistant Professor, and one class taught by a Graduate Assistant.

c. The groups are for a study to determine if there are any differences in the mean moisture content of product from six different production methods for producing the product.

d. The groups are six methods for measuring the amount of protein in samples of breakfast cereals. One of the groups is the current method. The other methods ware proposed methods which are cheaper and easier than the current method, Any of the proposed methods may replace the current method if it is shown that the average response for the samples used in the ANOVA is not significantly different from the mean of the current method

e. The six groups are drugs to treat chronic headaches. The measurement is time to relief. One of the groups is a standard drug and the goal of the study is to determine drugs that give faster relief (shorter time to relief) than the standard.

f. The six groups correspond to pressures of 5, 10, 15, 20, 25, and 30 psi.

C. Research scientists of a paint company studied the weathering ability of two new paints when applied to soft and hard wood boards. Two soft woods (pine and poplar) and two hard woods (oak and maple) were used. Three boards of each type were painted with paint A, three boards of each type were painted with paint B. However, the pine boards for Paint A were lost so only the treatment means shown below were available. MSE and its degrees of freedom are:

Paint	B	A	B	A	B	A	B	
Wood	Pine	Poplar	Poplar	Maple	Maple	Oak	Oak	MSE = 0.30
Mean	7.4	8.6	8.2	9.0	8.4	7.6	7.4	

a. Give the appropriate sources and degrees of freedom for the ANOVA table.

b. The scientists use a contrast with coefficients (-3, 4, -3, 4, -3, 4, -3).

i. What Ho and Ha (in words) is this contrast testing?

ii. Provide the values of the contrast, test statistic, and other quantities necessary for testing the hypotheses.

c. Suggest another appropriate contrast. State (in words) what this contrast is testing and provide the coefficients.