There are four questions on this exam, A through D, and each question has multiple sub-questions. Unless otherwise indicated, each sub-question is worth 3 points.

Question A

Adrine brought me several papers from clinical psychology. This is a hint for others to bring me papers next semester if you would like exam questions to be based on topics from your discipline.

Whisman & Bruce (1999) examined the relationship between marital dissatisfaction and subsequent depression. I've modified the dependent variable slightly [and there is a question about that modification below] but the following questions are faithful to the original article.

Whisman, M.A., & Bruce, M.L. (1999). Marital dissatisfaction and incidence of major depressive episode in a community sample. *Journal of Abnormal Psychology, 108,* 674-678. [Note: Mark Whisman is a member of the CU Psych Dept.]

Suppose the following variables were available for study:

MARITAL	degree of marital satisfaction
DEPRESS	a score indicating number of depressive symptoms
AGE	age in years
SEX	male or female
HISTORY	number of past depressive episodes

Use the above variables and any you might need to construct to specify the MODEL A/C comparisons you would use to ask the following questions.

1. Is there an association between marital dissatisfaction and depression? [Although one could answer this question in either direction, for purposes of subsequent questions, use depression as the dependent variable.]

2. Is there a significant relationship between marital dissatisfaction and depression when controlling for the effects of the demographics [age and sex] and depression history?

3. Is the relationship between marital dissatisfaction and depression different for males and females? [Use the simplest model comparison you can to answer this question.]

4. Assuming the answer to #3 is yes, is there a difference between the males and females on depression for the average level of marital dissatisfaction?

5. Again assuming that males and females show different relationships between marital dissatisfaction and depression, is marital dissatisfaction significantly related to depression in males?

6. Ignoring other predictors except for marital satisfaction, is the increase in depression for a unit decrease in marital satisfaction constant for each unit change in marital satisfaction? Or does the amount of the increase in depression as a function of marital satisfaction depend on the level of marital satisfaction itself? [This is beyond what we've covered, but the same principles apply.]

7. The original dependent variable used in (Whisman & Bruce, 1999) was whether or not a major depressive episode occurred in the subsequent 12 months. What complication, which was dealt with appropriately in the paper, is caused by using that dependent variable? [Not a MODEL A/C question.]

Question B

The following question is based on an example drawn from Aiken & West, 1991.

A study is conducted examining predictors of the self-assurance of managers in business as a function of the number of years they have been a manager and their ability or competence as managers. Data from 300 managers are gathered. The relevant variables are measured as specified below:

SASSUR	Self-assurance, measured on a scale from –75 to +75, with higher numbers indicating more self assurance
TIME	Amount of time in current managerial position (no. of years).
ABIL	Standardized assessment of managerial ability, assessed on a 0 – 15 scale, with higher numbers indicating more ability

From these variables, the following additional variables are computed:

TIMED	Mean deviated TIME (i.e., TIME – 5.005)
ABILD	Mean deviated ABIL (i.e., ABIL – 9.9723)
TA	TIME * ABIL
TAD	TIME*ABILD
TDAD	TIMED*ABILD

Then the following SAS commands were used to generate the attached output:

```
PROC MEANS;VAR SASSUR TIME ABIL;
PROC REG;
MODEL SASSUR=TIME ABIL/PCORR2 SS2 TOL CLB;
MODEL SASSUR=TIME ABIL TA/PCORR2 SS2 TOL CLB;
MODEL SASSUR=TIME ABILD TAD/PCORR2 SS2 TOL CLB;
MODEL SASSUR=TIMED ABILD TDAD/PCORR2 SS2 TOL CLB;
```

Based on this output, answer the following questions;

1. Assuming a linear additive model (i.e., no interaction), is there a relationship between ABIL and SASSUR controlling for TIME? (Provide PRE, F*, and a one sentence interpretation.)

2. Is there evidence that the relationship between ABIL and SASSUR is different at different levels of TIME? (Provide PRE, F*, and a one sentence interpretation.)

3. Comparing models 2 and 3 (i.e., MODEL SASSUR=TIME ABIL TA and MODEL SASSUR=TIME ABILD TAD), interpret the two TIME slopes and explain why they are different.

4. Assuming the interactive model, calculate the value of the simple slope for the SASSUR : ABIL relationship for managers who have been on the job for 4 years.

5. The tolerance of TIME changes a lot across the four models. Discuss what the tolerance in Model 1 means and then discuss why it varies across the other three models.

6. Given the interactive model (either models 2 or 3 or 4), what is the predicted value of SASSUR for managers who have been on the job four years and whose ability level is 10?

7. How would you test whether the predicted value that you computed in question 6 is different from zero? (Hint: Specify models C and A that you would estimate, defining any variables you need to construct.)

8. (Worth 5 points) Write a summary paragraph that discusses how TIME and ABIL relate to SASSUR.

The MEANS Procedure

Variable	N	Mean	Std Dev	Minimum	Maximum
sassur	300	1.9435164	17.8366625	-63.2012982	49.8974975
time	300	5.0052296	0.9473553	2.1543357	7.4399539
abil	300	9.9723179	1.9021764	4.4627300	14.8624014

The REG Procedure
Model: MODEL1
Dependent Variable: sassur

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	14054	7027.22394	25.74	<.0001
Error	297	81071	272.96756		
Corrected Total	299	95126			

Root MSE	16.52173	R-Square	0.1477
Dependent Mean	1.94352	Adj R-Sq	0.1420
Coeff Var	850.09469		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Type II SS
Intercept	1	-35.60318	7.28234	-4.89	<.0001	6524.49374
time	1	0.31793	1.00902	0.32	0.7529	27.10024
abil	1	3.60552	0.50253	7.17	<.0001	14052

Parameter Estimates

Variable	DF	Squared Partial Corr Type II	Tolerance	95% Confidence Limits	
Intercept	1	.	.	-49.93471	-21.27166
time	1	0.00033416	0.99912	-1.66780	2.30366
abil	1	0.14772	0.99912	2.61655	4.59449

The REG Procedure
Model: MODEL2
Dependent Variable: sassur

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	18588	6195.94247	23.96	<.0001
Error	296	76538	258.57427		
Corrected Total	299	95126			

Root MSE	16.08024	R-Square	0.1954
Dependent Mean	1.94352	Adj R-Sq	0.1872
Coeff Var	827.37890		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Type II SS
Intercept	1	78.27378	28.10518	2.79	0.0057	2005.60442
time	1	-22.20573	5.46814	-4.06	<.0001	4264.17918
abil	1	-7.87559	2.78527	-2.83	0.0050	2067.36661
ta	1	2.27339	0.54295	4.19	<.0001	4533.37952

Parameter Estimates

Variable	DF	Squared Partial Corr Type II	Tolerance	95% Confidence Limits	
Intercept	1	.	.	22.96249	133.58507
time	1	0.05277	0.03223	-32.96709	-11.44436
abil	1	0.02630	0.03081	-13.35702	-2.39415
ta	1	0.05592	0.01648	1.20487	3.34192

The REG Procedure
Model: MODEL3
Dependent Variable: sassur

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	18588	6195.94247	23.96	<.0001
Error	296	76538	258.57427		
Corrected Total	299	95126			

Root MSE	16.08024	R-Square	0.1954
Dependent Mean	1.94352	Adj R-Sq	0.1872
Coeff Var	827.37890		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Type II SS
Intercept	1	-0.26406	5.00448	-0.05	0.9580	0.71990
time	1	0.46527	0.98268	0.47	0.6362	57.96497
abild	1	-7.87559	2.78527	-2.83	0.0050	2067.36661
tad	1	2.27339	0.54295	4.19	<.0001	4533.37952

Parameter Estimates

Variable	DF	Squared Partial Corr Type II	Tolerance	95% Confidence Limits	
Intercept	1	.	.	-10.11293	9.58481
time	1	0.00075676	0.99784	-1.46866	2.39920
abild	1	0.02630	0.03081	-13.35702	-2.39415
tad	1	0.05592	0.03080	1.20487	3.34192

The REG Procedure
Model: MODEL4
Dependent Variable: sassur

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	18588	6195.94247	23.96	<.0001
Error	296	76538	258.57427		
Corrected Total	299	95126			

Root MSE	16.08024	R-Square	0.1954
Dependent Mean	1.94352	Adj R-Sq	0.1872
Coeff Var	827.37890		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Type II SS
Intercept	1	2.06472	0.92884	2.22	0.0270	1277.67801
timed	1	0.46527	0.98268	0.47	0.6362	57.96497
abild	1	3.50327	0.48971	7.15	<.0001	13233
tdad	1	2.27339	0.54295	4.19	<.0001	4533.37952

Parameter Estimates

Variable	DF	Squared Partial Corr Type II	Tolerance	95% Confidence Limits	
Intercept	1	.	.	0.23674	3.89270
timed	1	0.00075676	0.99784	-1.46866	2.39920
abild	1	0.14741	0.99663	2.53952	4.46702
tdad	1	0.05592	0.99613	1.20487	3.34192

Question C

A cognitive psychologist is interested in memory deterioration over time. She asks 48 subjects to memorize a list of 25 words, studying them for 5 minutes. She then asks them to recall as many words as they can, and she varies the delay between list study and recall. Some subjects recall the list after one hour, a second group recalls the list after two hours, a third recalls the list after three hours, and a fourth recalls the list after four hours. Below are the four recalls means for subjects in the four different delay conditions. Assume that there are equal numbers of subjects (i.e., 12) in each of the four conditions.

	Delay (in hours)			
	one	two	three	four
mean	20.2	17.3	15.9	14.8

She conducts a one-way analysis of variance on these data to examine whether mean recall differs across the four delay conditions. Below is the resulting source table:

Source	Sum of Squares	df	Mean Square	F*	PRE
Model	163.05	3	54.35	2.69	.155
Error	887.48	44	20.17		

Unfortunately, her F* just misses the hurdle for significance at the .05 level and so, she fears that she has no story to tell.

1. Based on your expertise with single degree of freedom contrasts, what analysis would you conduct to determine whether recall deteriorates over time? Provide SSR, F*, PRE, critical value (for either F* or PRE), and a short interpretation for your conclusion.

2. Regardless of your answer to the above question, can she conclude that memory is significantly worse at two hours than at one hour? Provide SSR, F*, PRE, critical value (for either F* or PRE), and a short interpretation for your conclusion.

3. Assuming that the means and the mean square error would remain unchanged, what would she have concluded had she used an optimal design as advocated in McClelland (1997) and used only the one and four hour delays with 24 subjects in each of those two groups? Provide SSR, F*, PRE, critical value (for either F* or PRE), and a short interpretation for your conclusion.

4. You decide to replicate this study using only two delay conditions, at one hour and at two hours. Based on the analyses you did in Question 2, what chance would you have of finding a significant difference if you ran 25 subjects in each of the two conditions?

Question D

The graph below depicts the estimated equation

$$\hat{Y} = b_0 + b_1X + b_2Z + b_3XZ$$

1. (Worth 4 points.) Use the values in the graph below to provide the estimates for b_0 through b_3. Note that Δ indicates the slope of the respective lines.

2. (Worth 4 points.)
   If X were replaced by $X^* = X - 2$, what would be the new values of b_0 through b_3?