Challenge Exam Information
Psychology/Social Sciences 300: Statistical Methods

This document is to acquaint you with the material you would need to know to successfully challenge Statistical Methods. This is not meant as a short-cut independent study course, which is challenging enough itself. You need to be able understand the vocabulary, the logic of hypothesis testing, and be able to do the computations with ONLY the provided support materials. It is not possible to pass the test using the support materials if you don't also have the knowledge behind it.

What would a student need to know for this exam?
You need to demonstrate knowledge of, be able to think critically about, and/or do the following.

- Various scales of measurement
- Evaluate frequency distributions
- Calculations, uses, and interpretations of the three measures of central tendency
- Calculations, uses, and interpretations of the measures of variability
- Interpretations of the percentile ranks
- Normal curve model -- including the use of the normal curve table and the basics of probability
- Basic theory of hypothesis testing – including the concept of statistical significance
- Follow the provided steps to carry out different types of t-tests (single sample, independent, dependent) and interpret the results
- Type I and Type II errors
- Understand and interpret correlations -- including the limitations of conclusions
- Follow the provided steps to carry out one-way and two-way chi square analyses and interpretation of results
- Follow the provided steps to carry out one-way ANOVA and interpret the results
- Select the appropriate inferential analysis for various scenarios.

What can a student do to prepare for this exam?
Course Textbook:
To diligently prepare for this exam it would be best to review these learning objectives in a college level statistics textbook written for social sciences. Our recommendation is to use the following text and accompanying handouts for review:

Bartz, A.E. (1999). *Basic statistical concepts* (4th ed.). Upper Saddle River, NJ: Merrill. ISBN: 9780137371808

What is the format of this exam?
There are multiple choice questions (38 at 2 points each for 76 points total), short answer (7 questions with 1 for 4 points and 6 at 2 points each for 16 points total), and scenarios requiring the application of the appropriate inferential analysis (hypotheses, calculations, decisions, and conclusions, a total of 108 points total). You will be provided with copies of the same handouts ("Summary" and "Stats Table") and tables that accompany this

document. You will need to bring a calculator that includes a square root key and is NOT a communications or internet-capable device. You will have 3 hours. You must achieve a total of 70% of the total on the test to pass.

PSYC 300 Statistical Methods Rubric

Assessed Items	Performance Levels (Out of 200 points)	
Multi. Choice - 76 pts **Short Answer - 16 pts** **Scenarios - 108 pts**	**Passing** **140-200**	**Not Passing** **0-139**

What types of question can I expect to see on the exam?
Example Exam Items: See accompanying "Sample Items" document.

Where can I take the exam?
Exam Location

- The exam is on file at the LCSC Testing Center in the Library.

Who should a student contact about a challenge exam for PSYC/SS 300: Statistical Methods?
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REVIEW PROBLEMS

Sample Multiple Choice:

1. Which of the following is true if a distribution is positively skewed?
   a) mode > median > mean
   b) mode < median < mean
   c) median > mode > mean
   d) median = mean = mode

2. Which of the following is NOT a measure of variability?
   a) range
   b) standard deviation
   c) median
   d) All of the above ARE measures of variability.

3. In a normal distribution, approximately what percent of the scores fall below one standard deviation above the mean?
   a) 50%
   b) 68%
   c) 75%
   d) 84%

4. Given a mean of 30 and a standard deviation of 5, what is the z-score for a student who obtains a score of 25?
   a) 84th percentile
   b) 17th percentile
   c) -1.00
   d) +1.00
   e) There is not enough information given.

5. A *one-tailed test* is used when
   a) a particular experimental outcome is certain.
   b) we predict that scores will neither increase or decrease.
   c) it is not certain how scores will change.
   d) we predict the direction in which the scores will change.

6. A Type I error is a decision to
   a) reject the null hypothesis when it is false.
   b) reject the null hypothesis when it is true.
   c) accept the null hypothesis when it is false.
   d) accept the null hypothesis when it is true.

7. A correlation coefficient indicates the _____ and _____ of the relationship between two variables.
   a) nature; shape
   b) direction; strength
   c) scatter; strength
   d) direction; distribution

Sample Short Answer Problems:

1. Michael receives a percentile rank of 44 on a math achievement test. Please interpret what that means.

2. The correlation between age and systolic blood pressure is found to be +.44 for a sample of 22 people.
a) What **DECISION** should the researcher make based on the correlation?

b) What **CONCLUSION** should the researcher draw based on the DECISION?

Sample Analysis Problems:

1. Suppose that a mechanical ventilator is set to deliver a flow of 40 L/min. It is suspected that the ventilator is not operating correctly and is actually delivering less than 40 L/min. Based on a random sample of 36 cycles, you find a sample mean of 39.5 L/min and a standard deviation of 0.9 L/min. Determine if the ventilator is operating correctly or if your concerns are justified.

2. An investigator tested for gender differences in discriminatory attitudes toward women. An attitude scale was administered to five men and five women. Scores could range from 1 to 10, with higher values indicating more discriminatory attitudes. Determine if there were any attitude differences.

Men	Women
7	4
7	3
8	4
7	5
6	4

NOTE: If you need the standard deviations for the two groups, they are $s_M = 0.71$ and $s_W = 0.71$.

3. A common belief is that smoking marijuana affects a person's pupil size. To study this issue, Weil, Zinberg, and Nelson (1968) administered a high dose of marijuana to ten men by having them smoke a potent marijuana cigarette. The men were all 21 to 26 years old and smoked cigarettes but had never tried marijuana. Pupil size was measured under constant illumination before and after smoking the marijuana cigarette. Measurements were taken with a millimeter ruler with the man's eyes focused on an object at a constant distance. Determine if pupil size is different before and after smoking marijuana.

Participant	Before Marijuana	After Marijuana
1	5	7
2	7	5
3	6	8
4	7	5
5	6	6
6	5	7
7	3	9
8	3	5
9	5	9
10	3	9

NOTE: If you need the standard deviations for the two groups, they are $s_B = 1.56$ and $s_A = 1.70$.

4. Visitors in underdeveloped countries frequently experience an acute intestinal reaction, in other words Traveler's Diarrhea. A team of medical researchers recently evaluated the effectiveness of a drug in curbing the incidence of the disorder. A total of 39 Peace Corps volunteers in Kenya participated in the study. Over a three-week period, 18 received the actual drug, while the remaining 21 were given a placebo. Determine if there were any differences.

		Outcome of the Study	
		Contracted Traveler's Diarrhea	Did Not Contract Traveler's Diarrhea
Condition	Drug	1	17
	Placebo	9	12

5. A manufacturer's safety department wishes to determine whether particular days of the week are worse than others as far as accidents frequency is concerned. Listed below is the accident frequencies from a one-year period.

	Monday	Tuesday	Wednesday	Thursday	Friday	
# of Accidents	37	14	18	25	20	114

6. We are interested in determining the effects of various motivational techniques on the acquisition of arithmetic skills. One group is a regular math class (our control group), one group is consistently told they "worked hard" after successful performances, and one group is consistently given candy for successful performances. Following instruction, all children were given the Inventory of Basic Arithmetic. Determine if there is a difference among these teaching/motivational strategies.

Regular Class	"Worked Hard"	Candy
4	12	1
5	8	3
4	10	4
3	5	6
6	7	8
10	9	5
1	14	3
8	9	2
5	4	

REVIEW PROBLEMS

Answers to the sample multiple choice:
1. b
2. c
3. d
4. c
5. d
6. b
7. b

Answers to the sample short answer problems:

1. Michael receives a percentile rank of 44 on a math achievement test. Please interpret what that means.
44% of the students scored at or below Michael's score on the math achievement test.

2. The correlation between age and systolic blood pressure is found to be +.44 for a sample of 22 people.
a) What **DECISION** should the researcher make based on the correlation?
Reject H_o @ .05

b) What **CONCLUSION** should the researcher draw based on the DECISION?
As age increases, systolic blood pressure tends to increase.

Answers to the sample analysis problems:

1. Suppose that a mechanical ventilator is set to deliver a flow of 40 L/min. It is suspected that the ventilator is not operating correctly and is actually delivering less than 40 L/min. Based on a random sample of 36 cycles, you find a sample mean of 39.5 L/min and a standard deviation of 0.9 L/min. Determine if the ventilator is operating correctly or if your concerns are justified.

This is a single-sample t test.

H_o: $\mu = 40.00$
H_1: $\mu < 40.00$

N = 36
$\overline{X} = 39.50$
s = 0.90

$$s_{\bar{X}} = \frac{s}{\sqrt{N}} = \frac{0.90}{\sqrt{36}} = 0.15$$

$$t = \frac{39.50 - 40.00}{.15} = -3.33$$

Critical Values: .05 = -1.697, .01 = 2.457

Decision: Reject H_0 at .01

Conclusion: The ventilator is not operating correctly. It is delivering less flow than the setting indicates.

2. An investigator tested for gender differences in discriminatory attitudes toward women. An attitude scale was administered to five men and five women. Scores could range from 1 to 10, with higher values indicating more discriminatory attitudes. Determine if there were any attitude differences.

Men	Women
7	4
7	3
8	4
7	5
6	4

This is an independent t-test -- 2 tails.

H_o: $\mu_M - \mu_W = 0$
H_1: $\mu_M - \mu_W \neq 0$

calculate mean & standard deviation of samples

$N_M = 5$ $N_W = 5$
$\overline{X}_M = 7$ $\overline{X}_W = 4$
$s_M = .71$ $s_W = .71$

calculate standard error: $s_{diff} = \sqrt{\frac{(5-1)(.71)^2 + (5-1)(.71)^2}{5+5-2}\left[\frac{1}{5}+\frac{1}{5}\right]} = .45$

calculate the test statistic: $t = \frac{7-4}{.45} = 6.67$

df = 5 + 5 - 2= 8; critical values: .05 = ± 2.306, .01 = ± 3.355

DECISION: REJECT H_o @ .01

CONCLUSION: The attitudes of males are significantly more discriminatory towards women than are the attitudes of women towards women.

3. A common belief is that smoking marijuana affects a person's pupil size. To study this issue, Weil, Zinberg, and Nelson (1968) administered a high dose of marijuana to ten men by having them smoke a potent marijuana cigarette. The men were all 21 to 26 years old and smoked cigarettes but had never tried marijuana. Pupil size was measured under constant illumination before and after smoking the marijuana cigarette. Measurements were taken with a millimeter ruler with the man's eyes focused on an object at a constant distance. Determine if pupil size is different before and after smoking marijuana.

Participant	Before Marijuana	After Marijuana
1	5	7
2	7	5
3	6	8
4	7	5
5	6	6
6	5	7
7	3	9
8	3	5
9	5	9
10	3	9

NOTE: If you need the standard deviations for the two groups, they are $s_B = 1.56$ and $s_A = 1.70$.

This is a dependent t-test, repeated measures -- 2 tails

H_o: $\mu_B - \mu_A = 0$

H_1: $\mu_B - \mu_A \neq 0$

$N_B = 10$ $\quad$ $N_A = 10$

$\overline{X}_B = 5.00$ $\quad$ $\overline{X}_A = 7.00$

calculate mean and standard deviation for differences between pairs

$\overline{D} = -2.00$ $\quad$ $s_D = \sqrt{\dfrac{112 - \dfrac{(-20)^2}{10}}{10 - 1}} = 2.83$

calculate standard error: $s_{\overline{D}} = \dfrac{2.83}{\sqrt{10}} = .89$

calculate the test statistic: $t = \dfrac{-2}{.89} = -2.25$

df = 10 - 1 = 9, critical values: .05 = ± 2.262, .01 = ± 3.250

DECISION: ACCEPT H_o

CONCLUSION: There is no difference in pupil size before and after smoking marijuana.

4. Visitors in underdeveloped countries frequently experience an acute intestinal reaction, in other words Traveler's Diarrhea. A team of medical researchers recently evaluated the effectiveness of a drug in curbing the incidence of the disorder. A total of 39 Peace Corps volunteers in Kenya participated in the study. Over a three-week period, 18 received the actual drug, while the remaining 21 were given a placebo. Determine if there were any differences.

This is a 2-way χ^2

H_0: There is no difference in the incidence of Traveler's Diarrhea among those receiving the drug or those receiving the placebo.

H_1: There is a difference in the incidence of Traveler's Diarrhea among those receiving the drug or those receiving the placebo.

		Outcome of the Study		
		Contracted Traveler's Diarrhea	Did Not Contract Traveler's Diarrhea	
Condition	Drug	f_0=1 f_e=4.62	f_0=17 f_e=13.38	18
	Placebo	f_0=9 f_e=5.38	f_0=12 f_e=15.62	21
		10	29	39

$$\chi^2 = \frac{(1-4.62)^2}{4.62} + \frac{(17-13.38)^2}{13.38} + \frac{(9-5.38)^2}{5.38} + \frac{(12-15.62)^2}{15.62}$$

$$\chi^2 = 2.84 + .98 + 2.44 + .84 = 7.10$$

df = (2 - 1) * (2 - 1) =1

Critical values: .05 = 3.84, .01 = 6.64

Decision: Reject H_0 at .01

Conclusion: For those taking the drug, people were more likely NOT to have traveler's diarrhea than to have it. For those not taking the drug, people were more likely TO have traveler's diarrhea than to not have it.

5. A manufacturer's safety department wishes to determine whether particular days of the week are worse than others as far as accidents frequency is concerned. Listed below is the accident frequencies from a one-year period.

This is a 1-way χ^2

H_0: There is no difference in the number of accidents on different days of the week.

H_1: There is a difference in the number of accidents on different days of the week.

	Monday	Tuesday	Wednesday	Thursday	Friday	
# of Accidents	37	14	18	25	20	114
	f_e=22.8	f_e=22.8	f_e=22.8	f_e=22.8	f_e=22.8	

$$\chi^2 = \frac{(37-22.8)^2}{22.8} + \frac{(14-22.8)^2}{22.8} + \frac{(18-22.8)^2}{22.8} + \frac{(25-22.8)^2}{22.8} + \frac{(20-22.8)^2}{22.8}$$

$$\chi^2 = 8.84 + 3.40 + 1.01 + .21 + .34 = 13.8$$

df = 5 – 1 = 4

Critical values: .05 = 9.49, .01 = 13.28

Decision: Reject H_0 at .01

Conclusion: Most accidents occur on Monday and the fewest occur on Tuesday.

6. We are interested in determining the effects of various motivational techniques on the acquisition of arithmetic skills. One group is a regular math class (our control group), one group is consistently told they "worked hard" after successful performances, and one group is consistently given candy for successful performances. Following instruction, all children were given the Inventory of Basic Arithmetic. Determine if there is a difference among these teaching/motivational strategies.

This is an ANOVA.

H_0: $\mu_R = \mu_W = \mu_C$
H_1: $\mu_R \neq \mu_W \neq \mu_C$

Regular Class		"Worked Hard"		Candy	
X	X2	X	X2	X	X2
4	16	12	144	1	1
5	25	8	64	3	9
4	16	10	101	4	16
3	9	5	25	6	36
6	36	7	49	8	84
10	100	9	81	5	25
1	1	14	196	3	9
8	64	9	81	2	4
5	25	4	16		
∑ 46	292	78	756	32	164

$X_R = \frac{46}{9} = 5.11$ $X_W = \frac{78}{9} = 8.67$ $X_C = \frac{32}{8} = 4.00$ $X_{Tot} = \frac{156}{26} = 6.00$

$$SS_{BG} = 9(5.11)^2 + 9(8.67)^2 + 8(4)^2 - 26(6)^2$$
$$235.01 + 676.52 + 128 - 936 = 103.53$$

$$SS_{WG} = (292 - 235.01) + (756 - 676.52) + (164 - 128)$$
$$56.99 + 79.48 + 36 = 172.47$$

$$MS_{BG} = \frac{103.53}{3-1} = 51.77$$

$$MS_{WG} = \frac{172.47}{26-3} = 7.50$$

$$F = \frac{51.77}{7.50} = 6.90$$

df = 2, 23
Critical values: .05 = 3.42, .01 = 5.66

Decision: Reject H_0 at .01

Conclusion: Students who were told they "worked hard" had the highest performances. Those who were given candy had the lowest performances.