You are permitted to use a calculator on all portions of this test. You are not allowed to use any textbook, notes, cell phone, or laptop on any portion of this test. All devices must be turned off while you are in the testing room.

During this test, any communication with any person (other than the instructor or test proctor) in any form, including written, signed, verbal, or digital, is understood to be a violation of academic integrity.

No part of this test may be removed from the testing room.

Read each question very carefully. In order to receive full credit for the free response portion of the test, you must:

1. Show legible and logical (relevant) justification which supports your final answer.
2. Use complete and correct mathematical notation.
3. Include proper units, if necessary.

You have 90 minutes to complete the entire test.

On my honor, I have neither given nor received inappropriate or unauthorized information at any time before or during this test.

Student’s Signature: ____________________________________

Do not write below this line.

<table>
<thead>
<tr>
<th>Free Response Problem</th>
<th>Points Possible</th>
<th>Points Earned</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>4</td>
<td></td>
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<tr>
<td>1b</td>
<td>4</td>
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<td>2</td>
<td>11</td>
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<td>3</td>
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<td>4a</td>
<td>5</td>
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<tr>
<td>4b</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td><strong>Free Response Total</strong></td>
<td><strong>39</strong></td>
<td></td>
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<tr>
<td><strong>Multiple Choice</strong></td>
<td><strong>60</strong></td>
<td></td>
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<tr>
<td><strong>Correct Scantron</strong></td>
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<tr>
<td><strong>Test Total</strong></td>
<td><strong>100</strong></td>
<td></td>
</tr>
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</table>
Part I: Multiple Choice. There are 20 multiple choices questions. Solve each question using the available space for scratch work. Decide which is the best of the choices given and fill in the corresponding oval on the provided scantron using a #2 pencil. For your own record, also circle your choice on your test since the scantron will not be returned to you. Only the responses recorded on your scantron sheet will be graded. Each multiple choice question is worth 3 points.

1. Which of the following statements about hypothesis testing is correct?
   (A) In hypothesis testing, sample data are used to test claims about the value of population parameters.
   (B) In hypothesis testing, population data are used to test claims about the value of sample statistics.
   (C) The purpose of hypothesis testing is to understand and describe the sample data.
   (D) None of the above is a true statement.

2. The null hypothesis of a test is \( H_0: p = 0.8 \) and the alternative hypothesis is \( H_a: p > 0.8 \). The test is being conducted with a level of significance \( \alpha = 0.01 \). Which of the following is the best explanation of the meaning of this significance level?
   (A) There is a 1% chance of observing a sample proportion greater than 0.8.
   (B) There is a 1% chance of rejecting the null hypothesis when the true proportion is actually equal to 0.8.
   (C) There is a 1% chance of not rejecting the null hypothesis when the true proportion is actually greater than 0.8.
   (D) There is a 1% chance of rejecting the null hypothesis under any circumstances.

3. A large tax preparation company claims that 75% of its prepared federal tax returns result in a refund. To determine the validity of this claim, a consumer advocacy group takes a random sample of 225 federal tax returns prepared by this company, and finds that 144 of them resulted in a refund. The resulting 95% confidence interval is (0.58, 0.70). What parameter is the consumer advocacy group interested in estimating?
   (A) The parameter of interest is 0.75.
   (B) The parameter of interest is 0.64.
   (C) The parameter of interest is the true proportion of federal tax returns prepared by this company that result in a refund.
   (D) The parameter of interest is the true mean refund amount of federal tax returns prepared by this company.
Use the following information to answer questions 4 – 5.

In a random sample of 300 Clemson football fans, 252 believe that the Tigers will win the ACC football championship in the 2015 season. We would like to conduct a hypothesis test at the 10% significance level to determine if more than 80% of all Clemson football fans believe that the Tigers will be ACC champions next season.

4. State the alternative hypothesis for this hypothesis test.
   (A) $H_a: p > 0.80$
   (B) $H_a: p < 0.80$
   (C) $H_a: p \neq 0.80$
   (D) None of the above

5. Which of the following expressions gives the test statistic for this hypothesis test?
   (A) 0.80
   (B) 0.84
   (C) $\frac{0.80 - 0.84}{0.84(0.16)\sqrt{300}}$
   (D) $\frac{0.84 - 0.80}{0.80(0.20)\sqrt{300}}$

6. Find the critical value $Z_{a/2}$ for a 98% confidence interval for a population proportion $p$.
   (A) 1.645
   (B) 1.96
   (C) 2.33
   (D) 2.575
7. The president of a large company believes that a majority of the employees at her company are satisfied with their jobs. To test her belief, she surveys 100 randomly selected employees and asks if they are satisfied with their jobs. The results of the subsequent hypothesis test are shown below.

Which of the following statements is the best interpretation of this p-value?

(A) There is a 0.2119 probability that the true proportion of satisfied employees equals 0.50.

(B) There is a 0.2119 probability that the true proportion of satisfied employees is more than 0.50.

(C) If the true proportion of satisfied employees is equal to 0.50, the probability of obtaining 54 or more satisfied employees in a sample of 100 is equal to 0.2119.

(D) If the true proportion of satisfied employees is more than 0.50, the probability of obtaining 54 or more satisfied employees in a sample of 100 is equal to 0.2119.

8. When using sample statistics to estimate population parameters, it is often better to have a larger sample size because estimation improves due to

(A) a larger standard error of the sampling distribution.

(B) a larger standard deviation of the population distribution.

(C) a smaller standard error of the sampling distribution.

(D) a smaller standard deviation of the population distribution.
Use the following information to answer questions 9 – 10.
During the first week of February 2015, 46% of the males that the Gallup polling organization surveyed approved of President Obama’s job performance, compared to 45% of females polled. A 95% confidence interval for the difference in approval of the president for all Americans, males versus females, can be found in the JMP output below.

<table>
<thead>
<tr>
<th>Description</th>
<th>Proportion Difference</th>
<th>Lower 95%</th>
<th>Upper 95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P(\text{Approve}</td>
<td>\text{Male}) - P(\text{Approve}</td>
<td>\text{Female})$</td>
<td>0.01</td>
</tr>
</tbody>
</table>

9. Which of the following conclusions is supported by this information?
   (A) The proportion of male Americans who approve of the president is higher than the proportion of females who approve of the president.
   (B) The proportion of female Americans who approve of the president is higher than the proportion of males who approve of the president.
   (C) Approximately 95% of the time, more males approve of the president than females.
   (D) None of the above.

10. What is the margin of error for the confidence interval given?
   (A) 0.01
   (B) 0.035
   (C) 0.07
   (D) 0.95

11. The p-value for a hypothesis test is 0.0002. Which of the following is a correct statement?
   (A) There is strong evidence against the null hypothesis.
   (B) There is weak evidence against the null hypothesis.
   (C) There is little to no evidence against the null hypothesis.
   (D) The strength of the evidence against the null hypothesis cannot be assessed without knowing the chosen value of $\alpha$. 
12. The output below gives a 95% confidence interval for the true proportion of adults who believe that economic conditions are getting better based upon the results of a recent Gallup poll.

Which of the following statements is the best interpretation of the 95% confidence level?

(A) About 95% of the possible samples that could be taken from the population will result in a sample proportion between 0.30 and 0.36.

(B) About 95% of the possible samples that could be taken from the population will result in a confidence interval that contains the true proportion of adults who believe that economic conditions are getting better.

(C) There is a 95% chance that the sample proportion of adults who believe economic conditions are getting better is between 0.30 and 0.36.

(D) There is a 95% chance that the true proportion of adults who believe economic conditions are getting better is between 0.30 and 0.36.
13. A researcher tested the hypotheses $H_0: p_1 - p_2 = 0$ versus $H_a: p_1 - p_2 \neq 0$, and obtained a test statistic value of 2.05. Find the p-value for this test.

(A) 0.0202
(B) 0.0404
(C) 0.4798
(D) 0.9596

14. From the results of a student survey, a 95% confidence interval for the proportion of Clemson students that live off-campus is (0.55, 0.63). If a 99% confidence interval is calculated using the same survey results, which of the following statements is correct?

(A) The 99% confidence interval will be narrower.
(B) The 99% confidence interval will be wider.
(C) The 99% confidence interval will be the same width.
(D) There is not enough information given to determine how the width of the confidence interval would be affected.

15. In 2005, the Centers for Disease Control reported that 21% of adult Americans smoke cigarettes. A researcher suspects that the percentage of adult Americans that smoke has decreased in the last 10 years. To test this belief, the researcher plans to take a random sample of 1,000 American adults and use the sample proportion of smokers to test the hypotheses:

$H_0: p = 0.21$
$H_a: p < 0.21$

In these hypotheses, what does $p$ represent?

(A) The sample proportion of adult Americans that smoked in 2005.
(B) The population proportion of adult Americans that smoked in 2005.
(C) The proportion of the 1,000 American adults randomly selected by this researcher that smoke.
(D) The population proportion of adult Americans that currently smoke.
Use the following information to answer questions 16 – 17.
Recently, Wendy’s conducted a national customer satisfaction survey. Out of 2000 respondents, 1850 indicated that they were satisfied with the customer service that they received when placing their order.

16. Determine the point estimate that would be used to construct a 95% confidence interval for the proportion of all Wendy’s customers who are satisfied with the customer service they received.

(A) \( \hat{p} = 0.925 \)
(B) \( \hat{p} = 0.075 \)
(C) \( \bar{x} = 0.925 \)
(D) \( \bar{x} = 0.075 \)

17. Which of the following expressions gives the margin of error for a 95% confidence interval for the proportion of all Wendy’s customers who are satisfied with the customer service at their local fast-food restaurant?

(A) \( 1.645 \sqrt{\frac{(0.925)(0.075)}{1850}} \)
(B) \( 1.645 \sqrt{\frac{(0.925)(0.075)}{2000}} \)
(C) \( 1.96 \sqrt{\frac{(0.925)(0.075)}{1850}} \)
(D) \( 1.96 \sqrt{\frac{(0.925)(0.075)}{2000}} \)

18. Which of the following best describes the result of increasing the sample size on the sampling distribution of the sample proportion?

(A) As the sample size increases, the distribution of the population approaches a normal distribution.
(B) As the sample size increases, the sampling distribution of \( \bar{x} \) approaches the distribution of the population.
(C) As the sample size increases, the sampling distribution of \( \hat{p} \) does not change.
(D) As the sample size increases, the sampling distribution of \( \hat{p} \) approaches a normal distribution.
19. For patients with coronary artery disease, wire mesh tubes called stents are commonly inserted into blocked coronary arteries to keep the arteries open and prevent heart attacks. In a study reported in the *Canadian Medical Association Journal*, bare metal stents were compared with stents coated with a drug that prohibits the growth of scar tissue which can reblock the artery. Of 5320 patients who received bare metal stents, 798 needed treatment for reblocking within a year. Of 1150 patients receiving drug-coated stents, 138 needed treatment within a year. Is the drug-coated stent effective at reducing the need for retreatment compared to the bare metal stent? Give the test statistic for this comparison.

(A) \[ \frac{0.15 - 0.12}{\sqrt{\frac{0.15(0.85)}{5320} + \frac{0.12(0.88)}{1150}}} \]

(B) \[ \frac{0.15 - 0.12}{\sqrt{\frac{936}{6470} \left( 1 - \frac{936}{6470} \right) \left( \frac{1}{5320} + \frac{1}{1150} \right)}} \]

(C) \[ \frac{(0.15 - 0.12) - 0.01}{\sqrt{\frac{0.15(0.85)}{5320} + \frac{0.12(0.88)}{1150}}} \]

(D) \[ \frac{(0.15 - 0.12) - 0.01}{\sqrt{\frac{936}{6470} \left( 1 - \frac{936}{6470} \right) \left( \frac{1}{5320} + \frac{1}{1150} \right)}} \]

20. Two competitive investment fund managers devised a plan to determine which one is better at picking stocks. They hired a statistician to randomly select some stocks from each manager’s portfolio and to compare the proportions of these stocks that are valued higher than they were 6 months earlier. Her analysis revealed that 66% of the stocks picked by manager #1 had increased in value while 60% of the stocks picked by manager #2 had increased in value. Her p-value for a two-tailed test was .3500. At a significance level of 0.05, what should she conclude?

(A) Fund manager #1 is better at picking stocks than fund manager #2.

(B) Fund manager #2 is better at picking stocks than fund manager #1.

(C) There is insufficient evidence to conclude that the two fund managers differ in their ability to pick stocks.

(D) There is sufficient evidence to conclude that the two fund managers differ in their ability to pick stocks.
Part II: Free Response. Show all your work. Indicate clearly the methods you use, because you will be graded on the correctness of your methods as well as on the accuracy and completeness of your results and explanations. Answers with no justification will receive no credit.

1. Heights of adult females follow a normal distribution with a mean of 65 inches and a standard deviation of 3.5 inches. According to models.com, female fashion models need to be at least 5 feet and 8 inches tall (i.e., 68 inches tall).

(a) What is the probability of randomly selecting an adult female who is tall enough to be a fashion model? (4 pts)

Let $X =$ height of an adult female. Then $X \sim \text{N}(65, 3.5)$.

$$Z = \frac{x - \mu}{\sigma} = \frac{68 - 65}{3.5} = 0.86$$

$$P(X > 68) = P(Z > 0.86) = 0.5 - 0.3051 = 0.1949$$

1 pt for correctly substituting values into Z-score formula
1 pt for correct final Z value
1 pt for finding probability for Z in table
1 pt for correct answer (i.e., subtracting from 0.5)

(b) What is the probability that a random sample of 10 adult females have an average height that is greater than the 68 inch requirement for fashion models? (4 pts)

Let $\bar{X} =$ average height of 10 randomly selected adult females.

Because $X$ is normally distributed, $\bar{X}$ is approximately normal with $\bar{X} \sim \text{N}(65, \frac{3.5}{\sqrt{10}})$.

$$Z = \frac{\bar{x} - \mu}{\sigma/\sqrt{n}} = \frac{68 - 65}{\frac{3.5}{\sqrt{10}}} \approx 2.71$$

$$P(\bar{X} > 68) = P(Z > 2.71) = 0.5 - 0.4966 = 0.0034$$

1 pt for correctly substituting values into Z-score formula
1 pt for correct final Z value (must round correctly)
1 pt for finding area for Z value in table
1 pt for correct final answer

Note: If a response does not recognize that the probability is obtained from the sampling distribution of $\bar{X}$, at most 1 point will be awarded.
2. The EPA sets an airborne limit of 5 parts per million (ppm) on vinyl chloride, a colorless gas used to make plastics, adhesives, and other chemicals. A major plastics manufacturer, attempting to control the amount of vinyl chloride its workers are exposed to, has given instructions to halt production if the mean amount of vinyl chloride in the air at its manufacturing plant exceeds 3.0 ppm.

(a) Define the parameter of interest and state the null and alternative hypotheses of a test to determine if the production process should be halted. (3 pts)

Let $\mu =$ true mean amount of vinyl chloride in the air at this manufacturing plant.

- $H_0: \mu = 3 \text{ ppm}$
- $H_a: \mu > 3 \text{ ppm}$

1 pt for correctly defining the parameter of interest
1 pt for using the correct signs in both $H_0$ and $H_a$
1 pt for using the correct value in the hypotheses

Note: In order to earn the point for correctly defining the parameter, the correct symbol must be used and the definition must reference the population.

(b) Describe a Type I error in the context of this situation. (2 pts)

Concluding that the mean amount of vinyl chloride in the air exceeds 3 ppm when it does not.

1 pt for stating the conclusion made
1 pt for stating how the conclusion is incorrect
Subtract 1 pt for no context

(c) What are the consequences of making a Type I error in the context of this situation? (2 pts)

The production process will needlessly be halted at great expense to the company.

(d) Describe a Type II error in the context of this situation. (2 pts)

Failing to conclude that the mean amount of vinyl chloride in the air exceeds 3 ppm when it actually does.

1 pt for stating the conclusion made
1 pt for stating how the conclusion is incorrect
Subtract 1 pt for no context
Subtract 1 pt for stating the conclusion is to Accept $H_0$

(e) What are the consequences of making a Type II error in the context of this situation? (2 pts)

Production will continue when it should be halted, potentially exposing workers to unsafe conditions.

For parts (b) – (e), if a response reverses Type I and Type II errors, subtract 4 pts
3. The math department recently adopted a new textbook for its business statistics course. At the completion of the course, 180 randomly selected students were asked to assess the book. The results of this survey are given in the table below.

<table>
<thead>
<tr>
<th>Rating</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>99</td>
</tr>
<tr>
<td>Good</td>
<td>56</td>
</tr>
<tr>
<td>Adequate</td>
<td>16</td>
</tr>
<tr>
<td>Poor</td>
<td>9</td>
</tr>
</tbody>
</table>

\[ \hat{p} = \frac{99}{180} = 0.55 \]

Can we conclude at the 10% significance level that more than 50% of all students who took this course would rate the newly adopted textbook as excellent?

(a) Define the parameter of interest and state the null and alternative hypotheses. (3 pts)

Let \( p \) = proportion of all students who took this course that would rate the book as excellent.

- \( H_0: p = 0.50 \)
- \( H_a: p > 0.50 \)

1 pt for correctly defining the parameter of interest
1 pt for using the correct signs in both \( H_0 \) and \( H_a \)
1 pt for using the correct value in the hypotheses

*Note:* In order to earn the point for correctly defining the parameter, the correct symbol must be used and the definition must reference the population.

(b) Calculate the test statistic. (2 pts)

\[ Z_{obs} = \frac{\hat{p} - p_0}{\sqrt{\frac{p_0(1 - p_0)}{n}}} = \frac{0.55 - 0.50}{\sqrt{\frac{(0.50)(0.50)}{180}}} \approx 1.34 \]

1 pt for correctly filling in formula
1 pt for correct final answer

(c) Determine the p-value. (2 pts)

\[ p-value = P(\hat{p} > 0.50) \]
\[ = P(Z > 1.34) \]
\[ = 0.5 - 0.4099 \]
\[ = 0.0901 \]

1 pt for finding area for \( Z_{obs} \) in \( Z \) table
1 pt for correct p-value given \( H_a \) and \( Z_{obs} \)

(d) What is the decision? Why? (2 pts)

Reject \( H_0 \) because the p-value of 0.0901 is less than \( \alpha = 0.10 \).

1 pt for correct decision for p-value in (c)
1 pt for correct justification

(e) What is the conclusion? (3 pts)

There is sufficient evidence to conclude that more than 50% of all students who took this course would rate the newly adopted textbook as excellent.

1 pt for stating conclusion in terms of \( H_a \)
1 pt for putting in context of problem
1 pt for stating (in)sufficient evidence (must be consistent with decision in part d)
4. During January 2015, the Gallup polling organization asked 3500 Americans “Are you feeling pretty good these days about the amount of money you have to spend, or not?” Yes responses were received from 1715 of these individuals. When the same question was asked of 3260 Americans in January of 2014, yes responses were received from 1467 of these individuals.

(a) Construct a 90% confidence for the change in the positive feelings about personal finances in the U.S. from last year to this year. Round your final answer to two decimal places. (5 pts)

Let \( p_{2015} \) = the true proportion of Americans with positive feelings about their finances in 2015 & \( p_{2014} \) = the true proportion of Americans with positive feelings about their finances in 2014.

\[
\hat{p}_{2015} = \frac{1715}{3500} = .49, \quad \hat{p}_{2014} = \frac{1467}{3260} = .45
\]

90% CI for \( p_{2015} - p_{2014} \):

\[
(\hat{p}_{2015} - \hat{p}_{2014}) \pm z_{\alpha/2} \sqrt{\frac{\hat{p}_{2015}(1 - \hat{p}_{2015})}{n_{2015}} + \frac{\hat{p}_{2014}(1 - \hat{p}_{2014})}{n_{2014}}}
\]

\[
= (.49 - .45) \pm 1.645 \sqrt{\frac{.49(.51)}{3500} + \frac{.45(.55)}{3260}}
\]

\[
\approx .04 \pm .01997
\]

\[
\approx (.02, .06)
\]

Note: The 90% CI for \( p_{2014} - p_{2015} \) is \((-0.06, -0.02)\).

(b) Has the proportion of people that feel pretty good about their personal finances changed since last year? Explain how you can tell. (3 pts)

Yes, because 0 is not in the interval we can infer that there is a difference between the proportion of people that feel pretty good about their personal finances in 2014 and in 2015.

1 pt for correct decision based on CI from part (a)
2 pts for correct justification consistent with decision made

Did you correctly fill in your scantron? (1 pt)
- Did you write your name, lecture section #, and lecture instructor at the top of the form?
- Did you fill in your CUID with the C bubbled as a 0?
- Did you bubble in your Test Version?
- Are your bubbles filled in dark enough so that the form can be machine read?