Read each question very carefully. You are permitted to use a calculator on all portions of this exam. You are NOT allowed to use any textbook, notes, cellphone, or laptop on either portion of the exam. No part of this exam may be removed from the examination room.

In order to receive full credit for the free response portion of the exam, 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 1 hour 30 minutes to complete the entire exam.

On my honor, I have neither given nor received inappropriate or unauthorized information during this exam.

Student’s Signature: ____________________________
Multiple Choice: (Questions 1 - 17) Answer the following questions on the scantron provided using a #2 pencil. Bubble the response that best answers the question. Each multiple choice correct response is worth 3 points. For your record, also circle your choice on your exam since the scantron will not be returned to you. Only the responses recorded on your scantron will be graded.

1. A researcher has randomly selected 100 students from Clemson University. He asked these students “Are you satisfied with the parking on campus?” He found 11 out of the 100 were satisfied with parking. He calculated his 95% confidence interval to be (0.05, 0.17). What is this interval trying to estimate?
   A) The proportion in his sample of Clemson students that are satisfied with parking
   B) The proportion of all college students that are satisfied with parking
   C) The proportion of all Clemson University students that are satisfied with parking
   D) The population mean number of Clemson University students that are satisfied with parking
   E) The mean number of students from his sample that are satisfied with parking

2. If a test of hypothesis has a Type I error probability (α) of 0.01, it means that
   A) If the null hypothesis is true, you reject it 1% of the time.
   B) If the null hypothesis is false, you reject it 1% of the time.
   C) If the null hypothesis is false, you don’t reject it 1% of the time.
   D) If the null hypothesis is true, you don’t reject it 1% of the time.

3. Suppose you take a random sample from a population known to be normally distributed but the value of population mean and population standard deviation are unknown. Your sample size is \( n = 10 \). Which formula below should be used to find the 90% confidence interval for the mean?
   A) \( \bar{x} \pm 1.645 \frac{s}{\sqrt{10}} \)
   B) \( \bar{x} \pm 1.645 \frac{s}{\sqrt{10}} \)
   C) \( \bar{x} \pm 1.833 \frac{s}{\sqrt{10}} \)
   D) \( \bar{x} \pm 1.812 \frac{s}{\sqrt{10}} \)
   E) \( \bar{x} \pm 1.833 \frac{s}{\sqrt{10}} \)

4. A 95% confidence interval for a population proportion calculated using data from a random sample of size \( n = 500 \) is (0.13, 0.73). Which of the following is the margin of error of this interval?
   A) 0.60
   B) 0.30
   C) 0.15
   D) 0.95
   E) Cannot determine from the information given.
5. Which P-value provides the strongest evidence that the data are consistent with $H_0$?

A) 0.01  
B) 0.50  
C) 0  
D) 0.05  
E) 0.65  

6. Which of the following would tend to decrease the width of a confidence interval?
   I. Increasing the sample size  
   II. Using a higher confidence level  
   III. Using a lower confidence level  

A) I only  
B) II only  
C) III only  
D) I and II only  
E) I and III only  

7. Suppose that a random sample of 100 high school classrooms in the state of California is selected and a 95% confidence interval for the proportion that has Internet access is (0.62, 0.78). Which of the following is a correct interpretation of the confidence level (i.e., what the 95% means)?

A) You can be 95% confident that the sample proportion is between 0.62 and 0.78.  
B) The method used to construct the interval will produce an interval that includes the value of the population proportion about 95% of the time in repeated sampling.  
C) There is a 95% chance that the proportion of all high school classrooms in California that have Internet access is between 0.62 and 0.78.  
D) In repeated sampling of 100 high school classrooms 95% of the sample means created will lie between 0.62 and 0.78.  
E) None of the above is a correct interpretation of the confidence level.  

8. A researcher wants to estimate a population proportion with a margin of error of 0.05. What is the smallest sample size for which the sample proportion would be within 0.05 of the actual population proportion for 95% of all random samples?

A) 30  
B) 100  
C) 193  
D) 385  
E) 1000  

9. In a test of $H_0: p = 0.65$ versus $H_A: p > 0.65$, the value of the z test statistic was calculated to be $z = 2.15$. Which of the following is the p-value for this test?

A) 0.0158  
B) 0.0316  
C) 0.05  
D) 0.9684  
E) 0.9841
10. The manager of a large hotel must decide whether to hire additional front desk staff. He has decided to hire more staff if there is evidence that the average time customers must wait in line before being assisted with check-in is greater than 3 minutes. He decides to test $H_0: \mu = 3$ versus $H_a: \mu > 3$. Which of the following would be a consequence of Type II error?

(A) Decided not to hire additional staff when the wait time really is greater than 3 minutes.
(B) Deciding not to hire additional staff when the waiter time really is not greater than 3 minutes
(C) Deciding to hire additional staff when the wait time really is greater than 3 minutes.
(D) Deciding to hire additional staff when the wait time really is not greater than 3 minutes.
(E) Deciding that a wait time of greater than 3 minutes is acceptable.

11. In conducting a hypothesis test, the procedure always assumes that

(A) The null hypothesis is true
(B) The null hypothesis is false
(C) The alternative hypothesis is true
(D) The alternative hypothesis is false
(E) None of the above

12. Which of the following must be true of a sample in order for it to be appropriate to use a $z$ confidence interval to estimate the population proportion?

(A) The sample size is larger than 30.
(B) The population distribution is approximately normal.
(C) The sampling distribution of $\hat{p}$ is approximately normal.
(D) Both B and C are needed
(E) It is never possible to use a $z$ confidence interval to estimate the population proportion

13. A 90% confidence interval for a population proportion calculated using data from a random sample of size $n = 200$ is (0.38, 0.48). Which of the following is the 99% confidence interval calculated from the same data?

(A) (0.43, 0.53)
(B) (0.40, 0.46)
(C) (0.35, 0.51)
(D) (0.42, 0.54)
(E) (0.35, 0.61)

14. For which of the following $p$-values would the null hypothesis be rejected if $\alpha = 0.05$?

I. 0.002
II. 0.015
III. 0.065

(A) I only
(B) II only
(C) III only
(D) I and II only
(E) I, II and III
15. In order to test a claim that more than half of all calls to the emergency 911 phone number in a particular county are actually not for emergency situations, 100 recordings of 911 calls are selected at random from those received in the past year, and each call is classified as either emergency or non-emergency. Which of the following test statistics is appropriate for testing the hypothesis of interest?

A) \[ z = \frac{\hat{p} - p}{\sqrt{\frac{p(1-p)}{n}}} \]

B) \[ z = \frac{\hat{p} - p}{\sqrt{\frac{p(1-p)}{n}}} \]

C) \[ z = \frac{\bar{x} - \mu}{\frac{s}{\sqrt{n}}} \]

D) \[ t = \frac{\bar{x} - \mu}{\frac{s}{\sqrt{n}}} \]

E) None of the above is appropriate

16. To estimate the proportion of faculty at a state university who own a home, a random sample of faculty is selected. For which of the following combinations of \( n \) and \( \hat{p} \) would it be appropriate to use the confidence interval \( \hat{p} \pm (z \text{ critical value}) \sqrt{\frac{\hat{p}(1-\hat{p})}{n}} \) to estimate the population proportion?

A) \( n = 20 \) and \( \hat{p} = 0.9 \)

B) \( n = 40 \) and \( \hat{p} = 0.1 \)

C) \( n = 100 \) and \( \hat{p} = 0.97 \)

D) \( n = 150 \) and \( \hat{p} = 0.45 \)

E) \( n = 200 \) and \( \hat{p} = 0.02 \)

17. The marketing department of a national department store chain designs its advertising to target 18 to 24 year olds. The marking manager worries that the average age of the chain’s customers is greater than 24, in which case the marketing plan should be reconsidered. He decides to survey a random sample of 100 customers and will use the resulting data to test

\( H_0: \mu = 24 \)
\( H_A: \mu > 24 \)

where \( \mu \) is the mean customer age. Suppose that the p-value from this test was 0.03. Which of the following is a correct interpretation of this p-value?

A) The probability that the null hypothesis is true is 0.03.

B) The probability that the null hypothesis is false is 0.03.

C) When the null hypothesis is true, the probability of seeing results as or more extreme than what was observed in the sample is 0.03.

D) When the null hypothesis is false, the probability of seeing results as extreme as what was observed in the sample is 0.03.

E) Approximately 3% of the chain’s customers are older than 24.
Free Response: The Free Response questions will count 49% of your total grade. Read each question carefully. In order to receive full credit you must show legible and logical (relevant) justification which supports your final answer. You MUST show your work. Answers with no justification will receive no credit.

1. The study “Digital Footprints” reported that 47% of Internet users have searched for information about themselves online. The 47% figure was based on a random sample of 300 Internet users.

A) (4pts) What conditions would need to be met in order to perform an appropriate confidence interval for this study? Are these conditions met? Justify your answers

1. Randomly sample from population – stated in problem
2. \( \hat{p} \) normally distributed – \( n\hat{p} = 300(0.47) = 141 \geq 5; n\hat{q} = 300(0.53) = 159 \geq 5 \)

\( \square \) 1 point for each condition, 1 point for each justification

Grading Notes:
- It is ok if student states “random sample” as condition, however just “random” is not ok
- Must indicate that random sample is stated in the problem either by stating or underlying “random” in problem – some indication that this condition was checked correctly (not just a check mark)
- It is ok if student states \( n\hat{p} \geq 5; n\hat{q} \geq 5 \) as the condition rather than \( \hat{p} \) normally distributed. In other words the statement \( n\hat{p} = 300(0.47) = 141 \geq 5; n\hat{q} = 300(0.53) = 159 \geq 5 \) will receive credit for condition and justification
- Must indicate some comparison to 5 (cannot just calculate 141 and 159 without indicating comparing them to 5)
- If the student leaves off the hats when stating the condition they lose the point for the condition but may get credit for checking condition.
- If an extra condition is stated and checked (such as population normally distributed) subtract 1 point

B) (5 pts) Calculate an appropriate 99% confidence interval for this study. Show notation, formula, and calculations to 2 decimal places. Calculator syntax will not be considered sufficient justification.

\[\hat{p} \pm z_{a/2} \sqrt{\frac{\hat{p}(1-\hat{p})}{n}}\]

\[0.47 \pm (2.575) \sqrt{\frac{(0.47)(0.53)}{300}}\]

\[0.40, 0.54\]

\( \square \) 1 point for correct point estimate (0.47) (notation “\( \hat{p} \)” and value)
\( \square \) 2 points for correct critical value (notation “\( z \)” and value) (it is ok to use 2.576, 2.58, or 2.57)
\( \square \) 2 points for correct standard error notation and value
\( \square \) Subtract 1 point overall for not indicating any notation (i.e., not giving formula notation formula but only giving formula with values plugged into formula)

Grading Notes:
- Must show formula and values plugged into formula
C) (6 pts) Interpret the interval you found in part b.

We are 99% confident that the population proportion of Internet users that have searched online for themselves is captured in the interval 0.40 to 0.54.

- If clearly stating interpretation about sample proportion mark entire part as incorrect.
- Otherwise
  - 2 points for using the word confidence (not probability, likely, chance, etc.) “sure” is ok
  - 2 points for the correct context of the problem
  - 2 points for clearly stating population proportion (“population”, “all”, etc.)
2. An automobile manufacturer decides to carry out a fuel efficiency test to determine if it can advertise that one of its models achieves 30 mpg (miles per gallon). Six randomly selected people each drive a car from Phoenix to Los Angeles. The resulting fuel efficiencies (in miles per gallon) are:

\[
\begin{align*}
27.2 & \quad 29.3 & \quad 31.2 & \quad 28.4 & \quad 30.3 & \quad 29.6 \\
\end{align*}
\]

\( (\bar{x} = 29.33; \ s = 1.41) \)

Assuming that fuel efficiency is normally distributed, do these data provide evidence against the claim that actual mean fuel efficiency for this model is different from 30 mpg? Use \( \alpha = 0.05 \).

A) (4 pts) What are the appropriate hypotheses for this test?

\[
\begin{align*}
H_0: \mu &= 30 \\
H_A: \mu &\neq 30
\end{align*}
\]

Where \( \mu \) is the population mean fuel efficiency for this model (not necessary to receive full credit)

[1 point for population symbol, 2 points for signs, 1 point for value] (if used \( \bar{x} \)-bar minus 2)

B) (4 pts) What conditions are required to perform the appropriate hypothesis test? Are these conditions met and why?

1. Randomly sampled from population
2. \( \bar{x} \)-bar normally distributed – population normally distributed is stated in the problem therefore \( \bar{x} \)-bar is normally distributed

[1 point for each condition, 1 point for each check that condition is met]

C) (4 pts) What is the test statistic for your test? (You MUST show notation, formula and calculations)

\[
\begin{align*}
t &= \frac{\bar{x} - \mu}{s/\sqrt{n}} = \frac{29.33 - 30}{1.41/\sqrt{6}} = -1.16
\end{align*}
\]

[-3 if did not divide by \( \sqrt{6} \), -1/2 for minor arithmetic errors, -1 for switching signs]

D) (4 pts) What is the rejection region for the appropriate hypothesis test? Draw an appropriate picture.

Reject null hypothesis when test statistics is less than -2.57 or greater than 2.57

[-2 for incorrect t-value, -3 for using z instead but have correct direction, -3 for using test statistic]

E) (10 pts) What are your conclusions about the actual mean fuel efficiency for this model being different from 30 mpg? Justify your answer using your responses from parts a – d.

At the 5% significance level, my test statistic does not fall in my rejection region therefore we do not reject the null hypothesis. There is insufficient evidence to suggest the population mean fuel efficiency for this model is different from 30 mpg. [5 points for justifying conclusion using test statistic and rejection region, 5 points for writing conclusion in context about population mean]
3. (4pts) A manufacturer of college textbooks is interested in estimating the strength of the bindings produced by a particular binding machine. Strength can be measured by recording the force required to pull the pages from the binding. If this force is measured in pounds, how many books should be tested to estimate the average force required to break the binding with 90% confidence and a margin of error of 0.1 pound? Assume that an estimate of standard deviation is known to be 0.8 pound. Show calculations and give units.

\[
n = \frac{(1.645)^2 (0.8)^2}{0.1^2} = 173.1856
\]

\[n = 174 \text{ books}\]

- 1 points correct z-value
- 1 point for following formula
- 1 point for rounding up
- 1 point units
- -0.5 for minor arithmetic errors
- -1 for plugging in 0.5 instead of 0.8

4. (3pts) Consider using the results of DNA paternity testing to decide between the following two hypotheses:

\[H_0: \text{a particular man is the father}\]
\[H_A: \text{a particular man is not the father}\]

In the context of this problem describe Type I error (Although these are not hypotheses about a population characteristic, this exercise illustrates the definitions of Type I and Type II errors.)

The test suggest the particular man is not the father when in fact he is the father.

- Subtract 2 points for only defining Type I error without context.

5. (1 pt) If your scantron is correctly bubbled with a #2 pencil, with your correct XID (with a 0 bubbled in as the “C”), your correct test version, AND the front of your test is completed with your signature on the academic integrity statement, you earn 1 point. END OF TEST