PLEASE PRINT THE FOLLOWING INFORMATION:

Name: ___________________________    Instructor: ___________________________

Student ID #: _____________________    Section/Time: __________________________

THIS EXAM HAS TWO PARTS.

PART I.
Consists of 30 multiple choice questions (2 points each). Read all questions carefully. You may do calculations on the test paper. Mark the number of the opscan sheet corresponding to the test question number with a Number 2 pencil or a mechanical pencil with HB lead. Mark only one answer; otherwise the answer will be counted as incorrect. In case there is more than one answer; mark the best answer. Please make sure that your name and ID appear on the opscan sheet in the spaces provided.

PART II.
This part consists of 4 problems (a total of 40 points). You must show all works for each question in the space provided to receive full credit for that question. If you write your explanations in another part of the test, please indicate accordingly.

FOR DEPARTMENTAL USE ONLY:
Part II

<table>
<thead>
<tr>
<th>Questions</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<th>Part II</th>
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</table>
The following is used for problems 1 and 2.

The customer service desk at a local bank recorded the following as the length of time (in minutes) that each of a sample of 8 customers had to wait to see a loan officer.

2.6, 3.4, 5.7, 6.2, 6.8, 7.1, 8.2, 10.1

1. The mean \( \bar{x} \) and the median \( M \) of this sample are

(a) \( \bar{x} = 6.5 \) \( M = 6.5 \)  
(b) \( \bar{x} = 6.26 \) \( M = 6.8 \)  
(c) \( \bar{x} = 6.2 \) \( M = 6.26 \)

(d) \( \bar{x} = 6.26 \) \( M = 6.2 \)  
(e) \( \bar{x} = 6.26 \) \( M = 6.5 \)

2. Find the standard deviation of this sample. Round off the answer to two decimal places

(a) 5.83  
(b) 2.62  
(c) 2.43  
(d) 5.08  
(e) 2.25

The following is used for questions 3 and 4.

A survey of 260 UNC Charlotte students showed that the mean sleep time for each student was 405 minutes per night with a standard deviation of 50 minutes. The survey was taken earlier this week. Assume that the histogram of the data is approximately mound shaped.

3. Approximately what percentage of the sleep times fall between 305 and 505 minutes?

(a) 68%  
(b) 95%  
(c) 75%  
(d) 88.9%  
(e) 50%

4. Approximately how many of the 260 student each had sleep time between 355 minutes and 505 minutes per night?

(a) 149 students  
(b) 209 students  
(c) 110 students  
(d) 212 students  
(e) 352 students
The following is for problems 5 and 6.

Consider the discrete probability distribution for the random variable $x$ shown here.

<table>
<thead>
<tr>
<th>$x$</th>
<th>-3</th>
<th>-1</th>
<th>2</th>
<th>4</th>
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<tbody>
<tr>
<td>$p(x)$</td>
<td>.2</td>
<td>3</td>
<td>2</td>
<td>.3</td>
</tr>
</tbody>
</table>

5. The mean $\mu$ and standard deviation $\sigma$ are

(a) $\mu = .70$  $\sigma = 1.73$  
(b) $\mu = .70$  $\sigma = 1.87$  
(c) $\mu = 2.0$  $\sigma = 2.69$  
(d) $\mu = 2.0$  $\sigma = 1.73$  
(e) $\mu = .70$  $\sigma = 2.69$

6. $P \left( (x = -3) \cup (x \text{ is even}) \right) =$

(a) .7  
(b) 0  
(c) .5  
(d) .3  
(e) .2

The following is for problems 7, 8, and 9.

A survey of 2,000 UNC Charlotte students was recently conducted to gather information for the new bus service on the campus. Students were classified as female or male and as living within walking distance of school or not, in which case the student is considered living far from campus. The following table gives the results of the survey.

<table>
<thead>
<tr>
<th></th>
<th>Walking Distance</th>
<th>Far</th>
<th>Total</th>
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<td>Female</td>
<td>800</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>200</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Suppose a student is randomly selected from this survey.

7. Find the probability that the student lives far from the campus or is a male.

(a) .75  
(b) 1.00  
(c) .10  
(d) .60  
(e) .40

8. Find the probability that the student lives within walking distance of the campus and is a female.

(a) .75  
(b) .80  
(c) .10  
(d) .90  
(e) .40
9. Given that the student is a male, the probability the student lives within walking distance of the campus is closest to
   (a) .80    (b) .10    (c) .29    (d) .50    (e) .75

10. Assume events $A$ and $B$ are independent. Which of the following are true?
   
   I. $P(A \cap B) = P(A)P(B)$
   II. $P(A|B) = P(B)$
   III. $P(A|B) = P(A)$

   (a) I only    (b) II only    (c) III only    (d) I, II, and III    (e) I and III only

The following is used for problems 11 and 12.

Cat and mouse is a favorite game our domestic friends play. Suppose that the cat wins 40% of the time.

11. The probability that the cat wins exactly 4 times out of 8 games is closest to
   (a) .400    (b) .093    (c) .232    (d) .007    (e) .003

12. If 440 games of cat and mouse are played, the expected number of cat wins is
    (a) 0.4    (b) $\frac{1}{440}$    (c) 264    (d) 176    (e) None of these

13. Let $z$ be the standard normal random variable. Which of the following best approximates $P(-2.54 \leq z \leq .35)$?
    (a) .3577    (b) .4945 and .1368    (c) .0676    (d) .6313    (e) .3687
14. Again, let $z$ be the standard normal random variable. Find the real number $z_0$ such that $P(z \geq z_0) = .7642$.

(a) $z_0 = -.72$  (b) $z_0 = .72$  (c) $z_0 = .66$  (d) $z_0 = .2764$  (e) $z_0 = -.2764$

15. Perhaps you have noticed the many cats that live in and around the buildings and woods of the UNC Charlotte campus. Suppose that the weights of these Forty-Niner cats are normally distributed with a mean of 9.6 pounds and a standard deviation of 1.3. Find the probability that a randomly selected Forty-Niner cat weighs less than 8.0 pounds.

(a) .1093  (b) .8907  (c) -1.23  (d) .3907  (e) .5721

The following is used for problems 16 and 17.

According to the U.S. Department of Transportation, people in the age group of 15 to 20 spend an average of 25 minutes driving every day. Assume that $\sigma=1.5$ minutes. You randomly select 50 drivers in this age group and find the sample mean $\bar{x}$.

16. Which of the following statements are true about $\bar{x}$, as a random variable?

I. The mean of $\bar{x}$ is equal to the mean of the population.
II. The standard deviation of $\bar{x}$ is equal to the population standard deviation divided by the square root of the sample size.
III. The shape of the sampling distribution of $\bar{x}$ is approximately normal.

(a) I only  (b) II only  (c) III only  (d) I, II, and III  (e) I and III only

17. What is the approximate probability that the mean time they spend driving each day is between 24.7 and 25.5 minutes?

(a) .07  (b) .91  (c) .04  (d) .99  (e) .51
18. A major airline wants to estimate its average number of unoccupied seats per flight over the past year. To accomplish this, the records of 225 flights are randomly selected, and the number of unoccupied seats is noted for each of the sample flights. The results are summarized as \( \bar{x} = 11.6 \) seats and \( s = 4.1 \) seats. Set up a 90% confidence interval for \( \mu \), the mean number of unoccupied seats per flight during the past year.

(a) \( 11.6 - 2.069 \frac{4.1}{15} \leq \mu \leq 11.6 + 2.069 \frac{4.1}{15} \)

(b) \( 11.6 - 1.96 \frac{4.1}{15} \leq \mu \leq 11.6 + 1.96 \frac{4.1}{15} \)

(c) \( 11.6 - 1.645 \frac{4.1}{15} \leq \mu \leq 11.6 + 1.645 \frac{4.1}{15} \)

(d) \( 11.6 - 2.75 \frac{4.1}{15} \leq \mu \leq 11.6 - 2.75 \frac{4.1}{15} \)

(e) \( 11.6 - 1.645 \frac{4.1}{225} \leq \mu \leq 11.6 + 1.645 \frac{4.1}{225} \)

19. Last Wednesday, a random sample of 24 students were surveyed to find out how long it takes to walk from the Fretwell building to the new College of Education building. The survey team found a sample mean of 12.3 minutes with a standard deviation of 3.2 minutes. Assuming walking times from Fretwell to the College of Education are normally distributed for the populations of walkers, which of the following is a 95% confidence interval for the population mean of walking times?

(a) \( 12.3 - 1.645 \frac{3.2}{\sqrt{24}} \leq \mu \leq 12.3 + 1.645 \frac{3.2}{\sqrt{24}} \)

(b) \( 12.3 - 2.069 \frac{3.2}{\sqrt{24}} \leq \mu \leq 12.3 + 2.069 \frac{3.2}{\sqrt{24}} \)

(c) \( 12.3 - 2.500 \frac{3.2}{\sqrt{24}} \leq \mu \leq 12.3 + 2.500 \frac{3.2}{\sqrt{24}} \)

(d) \( 12.3 - 2.064 \frac{3.2}{\sqrt{24}} \leq \mu \leq 12.3 + 2.064 \frac{3.2}{\sqrt{24}} \)

(e) \( 12.3 - 1.96 \frac{3.2}{\sqrt{24}} \leq \mu \leq 12.3 + 1.96 \frac{3.2}{\sqrt{24}} \)

20. A large hog growing company wants to estimate the mean amount (in pounds) of grain feed each hog consumes in its lifetime. How large a sample is required to estimate the mean to within 15 pounds with a confidence level of 95%? Assume previous data have shown that \( \sigma = 125.6 \) pounds.

(a) \( n = 64 \) \hspace{1cm} (b) \( n = 17 \) \hspace{1cm} (c) \( n = 190 \) \hspace{1cm} (d) \( n = 270 \) \hspace{1cm} (e) \( n = 14 \)
21. A campus book store wants to estimate the proportion of the campus population who own an IPOD or a similar device. How large a sample must be collected to estimate the true population proportion to within .02 with a confidence level of 90%?

(a) $n = 1028$  (b) $n = 42$  (c) $n = 4109$  (d) $n = 270$  (e) $n = 1692$

The following is used for problems 22 and 23.

A November issue of the Charlotte Observer reported that nationally 45% of college students do not purchase textbooks for some of their courses. A study of 400 randomly selected students enrolled at UNC Charlotte found that 172 did not purchase the recommended textbooks for some of the courses they were enrolled in.

22. A 95% confidence interval for the proportion of all student enrolled at UNC Charlotte who do not purchase the recommended textbooks for some of their courses is

(a) $45 - 1.96 \sqrt{\frac{45(1-45)}{400}} \leq p \leq 45 + 1.96 \sqrt{\frac{45(1-45)}{400}}$

(b) $\frac{172}{400} - 1.645 \sqrt{\frac{45(1-45)}{400}} \leq p \leq \frac{172}{400} + 1.645 \sqrt{\frac{45(1-45)}{400}}$

(c) $\frac{172}{400} - 1.96 \sqrt{\frac{172(1-\frac{172}{400})}{400}} \leq p \leq \frac{172}{400} + 1.96 \sqrt{\frac{172(1-\frac{172}{400})}{400}}$

(d) $\frac{172}{400} - 1.96 \sqrt{\frac{172(1-\frac{172}{400})}{400}} \leq p \leq \frac{172}{400} + 1.96 \sqrt{\frac{172(1-\frac{172}{400})}{400}}$

(e) Can not be determined because an estimate of the standard deviation was not given.

23. The Student Government Association at UNC Charlotte believes that the proportion of students who do not purchase textbooks for some of their courses is less than the national average of 45%. Set up the appropriate null and alternative hypotheses the Association has to use to test its claim.

(a) $H_0: \mu = 45$
$H_a: \mu < 45$

(b) $H_0: p = .45$
$H_a: p < .45$

(c) $H_0: p = .45$
$H_a: p \neq .45$

(d) $H_0: p = .45$
$H_a: p > .45$

(e) $H_0: \mu = 45$
$H_a: \mu > 45$
24. In the language of hypothesis testing, which of the following is a wrong statement?

(a) Type I error occurs if the null hypothesis is rejected when the null hypothesis is in fact true.

(b) Type II error occurs if the null hypothesis is not rejected when the null hypothesis is in fact false.

(c) The probability of Type I error is equal to \( \alpha \), the significance level of the test.

(d) The null hypothesis is rejected if the \( p \)-value (observed significance level) for the test is greater than \( \alpha \).

25. In testing \( H_0: \mu = 100 \) versus \( H_a: \mu \neq 100 \) using a sample size of 325, the value of the test statistic was found to be 2.16. The \( p \)-value (observed level of significance) is best approximated by

(a) .007  (b) .0308  (c) .0154  (d) .4846  (e) 325

26. In testing \( H_0: p = .50 \) versus \( H_a: p > .50 \) using a sample data of \( n = 400 \) and \( \hat{p} = .54 \), the value of the test statistics is equal to

(a) 1.7  (b) .8  (c) 1.5  (d) 1.6  (e) -2.30
To compare the mean quarterly revenues of Costco with those of Sam’s Club, quarterly sales records of \( n_1 = 250 \) Costco members along with those of \( n_2 = 230 \) Sam’s Club members were examined and the following data were collected. The figures are in thousands of dollars.

\[
\begin{align*}
\text{Costco} & \quad \bar{x}_1 = \$1.25 \quad s_1 = \$.33 \\
\text{Sam’s Club} & \quad \bar{x}_2 = \$1.75 \quad s_2 = \$.35
\end{align*}
\]

Let \( \mu_1 \) denote the mean quarterly revenues for Costco and \( \mu_2 \) the mean quarterly revenues for Sam’s Club.

27. Is there sufficient evidence in the data to conclude that Costco’s revenues are less than those of Sam’s Club? Set up the appropriate null and alternative hypotheses for this purpose.

(a) \( H_0 : \mu_1 - \mu_2 = 0 \)
\( H_a : \mu_1 - \mu_2 \neq 0 \)

(b) \( H_0 : \mu_1 - \mu_2 = 0 \)
\( H_a : \mu_1 - \mu_2 > 0 \)

(c) \( H_0 : \mu_1 - \mu_2 = 0 \)
\( H_a : \mu_1 - \mu_2 \geq 0 \)

(d) \( H_0 : \mu_1 - \mu_2 = 0 \)
\( H_a : \mu_1 - \mu_2 < 0 \)

(e) \( H_0 : x_1 - x_2 = 0 \)
\( H_a : x_1 - x_2 \leq 0 \)

28. The value of the test statistic is given by

(a) \( (1.25 - 1.75) / \sqrt{\frac{(35)^2}{250} + \frac{(35)^2}{230}} \)

(b) \( (1.25 - 1.75) / \sqrt{s_p^2 \left( \frac{1}{250} + \frac{1}{230} \right)} \), where \( s_p^2 = \frac{249 \cdot (.33)^2 + 229 \cdot (.35)^2}{478} \)

(c) \( (1.75 - 1.25) / \sqrt{\frac{(35)^2}{230} + \frac{(33)^2}{2500}} \)

(d) \( (1.75 - 1.25) / \sqrt{s_p^2 \left( \frac{1}{230} + \frac{1}{250} \right)} \), where \( s_p^2 = \frac{229 \cdot (.35)^2 + 249 \cdot (.33)^2}{478} \)

(e) \( (1.25 - 1.75) \sqrt{\frac{(35)^2}{250} + \frac{(35)^2}{230}} \)
29. In a study of gender differences, data was collected on cell phone usage per week from independent random samples of 11 men and 10 women. Label the women as population 1 and the men as population 2. Assume cell phone usage among the population of men and among the population of women are normally distributed and the population variances are equal. At the significance level \( \alpha = .05 \), we want to test the hypothesis that the mean cell phone usage among women is greater than that among men. Which of the following is the correct decision?

(a) Reject \( H_0 \) if \( (\bar{x}_1 - \bar{x}_2)/\sqrt{\frac{s^2}{n_1} + \frac{s^2}{n_2}} < -1.721 \)

(b) Reject \( H_0 \) if \( (\bar{x}_1 - \bar{x}_2)/\sqrt{\frac{s^2}{n_1} + \frac{s^2}{n_2}} > 1.729 \)

(c) Reject \( H_0 \) if \( (\bar{x}_1 - \bar{x}_2)/\sqrt{\frac{s^1}{n_1} + \frac{s^2}{n_2}} > 1.645 \)

(d) Reject \( H_0 \) if \( (\bar{x}_1 - \bar{x}_2)/\sqrt{\frac{s^1}{n_1} + \frac{s^2}{n_2}} < -1.645 \)

(e) None of these.

30. If the equation of regression line between the variables \( x \) and \( y \) is given by \( y = 2 - 3x \), and the correlation coefficient is \( r = -.92 \), consider the following statements:

I. Indications are that the variable \( y \) is strongly positively correlated to the variable \( x \).

II. Indications are that the variable \( y \) is strongly negatively correlated to the variable \( x \).

III. If \( x = 5 \), one would estimate that \( y = 17 \).

(a) If \( x = 5 \), one would estimate that \( y = -13 \).

Now, which of the following is correct?

(a) I only       (b) II only       (c) III only

(d) II and IV only   (e) I and III only
1. (9 points). Thomas Jefferson had a nail manufacturing business at Monticello. In the Spring of 2005, 5 nails were found at the Latta Plantation estate. We do not believe the nails were manufactured at Monticello. A small sample of each nail was tested for iron content. The following data in milligrams was obtained.

   1.0, 3.0 3.0, 3.0, 4.0

(a) Compute the sample mean and sample standard deviation

   \[ \bar{x} = \quad \text{and} \quad s = \]

(b) Find a 95% confidence interval for the mean iron content of the nails.

(c) The nails manufactured by Jefferson at Monticello are known to have a mean iron content of 2.0 milligrams. We want to use the sample data to conduct a test of hypotheses to find out if there is a significant difference from a mean of 2.0. A significant difference from a mean of 2.0 would imply the nails are not from Monticello. Set up the appropriate null and alternative hypotheses and test at level of significance \( \alpha = .10 \).

   Step 1. \( H_0 : \) \quad \text{and} \quad H_a : \)

   Step 2. Write out the formula for the test statistic and find its value.

   Step 3. Find the critical value(s) and identify the rejection region(s).

   Step 4. Draw your conclusion and interpret it in the context of the problem.
2. (8 points). Five randomly chosen users of Facebook and YouTube were asked to document their usage for the first week in December. The five provided the following data. Time is in hours viewed.

<table>
<thead>
<tr>
<th>Person</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facebook</td>
<td>1.3</td>
<td>1.5</td>
<td>3.1</td>
<td>2.1</td>
<td>2.6</td>
</tr>
<tr>
<td>YouTube</td>
<td>1.3</td>
<td>1.8</td>
<td>2.8</td>
<td>2.5</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Test at the level of significance $\alpha = .10$ if there is a difference in user times for Facebook and YouTube. Fill in the blanks to provide a guide as to what you are doing.

(a) Step 1. $H_0$:

Step 2. Write out the formula for the test statistic and find its value.

Step 3. Find the critical value(s) and identify the rejection region(s).

Step 4. Draw your conclusion and interpret it in the context of the problem.
3. (8 points). To study the current mean number of hours students work off campus each week, a random sample of 49 students was selected, and the number hours of work off campus is noted. The collected data yielded a mean of 16.8 hours per week with a standard deviation of 2.51 hours. Do the data provide evidence that the current mean number of hours students work off campus each week exceeds last year's weekly average of 15.8 hours per week? You are to use the $p$-value method.

Step 1. $H_0$:

Step 2. Write the formula for the test statistics and find the value of the test statistics.

Step 3. Determine the $p$-value for the test.

Step 4. Testing at $\alpha = .01$, state your conclusion.
4. (15 points). To study the relationship between the SAT scores in each state and the corresponding percentage of high school seniors who take the test, data were collected from \( n = 26 \) states. We assume that a simple linear regression model \( y = \beta_0 + \beta_1 x + \varepsilon \) is an appropriate model for the study. Here, \( y \) is the independent variable representing the average SAT score by state, \( x \) is the percent of that state's high school seniors taking the test, and \( \varepsilon \) is the error modeled as an independent normal random variable with mean 0 and variance \( \sigma^2 \). The data summary is provided in the table below.

\[
\begin{align*}
\bar{x} &= 39.71 & SS_{xx} &= 44086.6 \\
\bar{y} &= 1072.10 & SS_{yy} &= 226400.5 \\
SS_{xy} &= -87538.7 & n &= 26
\end{align*}
\]

(a) Estimate the model, namely provide estimates of \( \beta_0, \beta_1 \), and \( \sigma \), the standard deviation of the error:

\[
\hat{\beta}_0 = \quad \hat{\beta}_1 = \quad s =
\]

(b) Write out the equation of the regression line

(c) Compute the coefficient of determination

(d) Interpret the meaning of the coefficient of determination obtained above.
(e) Suppose that the state of North Carolina had a 70% participation rate, that is, \( x_p = 70 \). Estimate the North Carolina state average SAT score, using the regression equation.

(f) Find a 95% prediction interval for North Carolina average SAT score if the participation rate was 70% \( (x_p = 70) \).
<table>
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<tr>
<th>z</th>
<th>.00</th>
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<th>.02</th>
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FORMULAS FOR ELEMENTS OF STATISTICS I

DESCRIPTIVE

Sample Standard Deviation \( s = \sqrt{\frac{\sum x^2 - \left(\frac{\sum x}{n}\right)^2}{n - 1}} \)

PROBABILITY

Addition Rule: \( P(A \cup B) = P(A) + P(B) - P(A \cap B) \)

Conditional Probability Rule: \( P(A|B) = \frac{P(A \cap B)}{P(B)} \)

Special Multiplication Rule: \( P(A \cap B) = P(A)P(B) \) when \( A \) and \( B \) are independent

DISCRETE RANDOM VARIABLES

\( E(x) = \mu = \sum xP(x) \quad \sigma = \sqrt{\sum x^2P(x)} - \mu^2 \)

BINOMIAL PROBABILITY

\( P(x) = \frac{n!}{x!(n - x)!}p^xq^{n-x} \quad \mu = np \quad \sigma = \sqrt{npq} \)

SAMPLING DISTRIBUTIONS

\( \mu_\bar{x} = \mu \quad \sigma_\bar{x} = \frac{\sigma}{\sqrt{n}} \)

Inference about a single population mean or proportion

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<th>CONFIDENCE INTERVAL</th>
<th>TEST STATISTIC</th>
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<td>( \sigma ) known, large sample or normal population</td>
<td>( \bar{x} \pm z_{\alpha/2} \frac{\sigma}{\sqrt{n}} )</td>
<td>( z = \frac{\bar{x} - \mu_0}{\frac{\sigma}{\sqrt{n}}} )</td>
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<td>( \sigma ) unknown, large sample</td>
<td>( \bar{x} \pm z_{\alpha/2} \frac{s}{\sqrt{n}} )</td>
<td>( z = \frac{\bar{x} - \mu_0}{\frac{s}{\sqrt{n}}} )</td>
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Inference about a population proportion

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

\( z = \frac{\hat{p} - p_0}{\frac{\hat{p}(1-\hat{p})}{\sqrt{n}}} \)

Sample size formulas

for population mean: \( n = \frac{(z_{\alpha/2})^2 \sigma^2}{(SE)^2} \); for population proportion: \( n = \frac{(z_{\alpha/2})^2 (pq)}{(SE)^2} \) where \( SE \) is a bound of a confidence interval
**CONDITIONS**

large, independent samples

\[ (\bar{x}_1 - \bar{x}_2) \pm z_{\alpha/2} \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}} \]

small, independent samples, \( \sigma_1 \) and \( \sigma_2 \) assumed equal, normal population

\[ (\bar{x}_1 - \bar{x}_2) \pm t_{\alpha/2} \sqrt{s_p^2 \left( \frac{1}{n_1} + \frac{1}{n_2} \right)} \]

with \( df = (n_1 + n_2 - 2) \)

where \( s_p^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2} \)

paired difference, small samples, normal population of differences

\[ \bar{x}_D \pm t_{\alpha/2} \frac{s_D}{\sqrt{n_D}} \]

with \( df = n_D - 1 \)

**CORRELATION AND REGRESSION**

\( \hat{y} = \hat{\beta}_0 + \hat{\beta}_1 x \), where \( \hat{\beta}_1 = \frac{SS_{xy}}{SS_{xx}} \), \( \hat{\beta}_0 = \bar{y} - \hat{\beta}_1 \bar{x} \), and

\[ SS_{xx} = \sum x^2 - \left[ \frac{(\sum x)^2}{n} \right] \]

\[ SS_{xy} = \sum xy - \left[ \frac{(\sum x)(\sum y)}{n} \right] \]

\[ SS_{yy} = \sum y^2 - \left[ \frac{(\sum y)^2}{n} \right] \]

\[ SSE = SS_{yy} - \hat{\beta}_1 SS_{xy} \]

\[ s = \sqrt{\frac{SSE}{n - 2}} \]

\[ s_{\hat{\beta}_1} = \frac{s}{\sqrt{SS_{xx}}} \]

\[ r^2 = \hat{\beta}_1 \frac{SS_{xy}}{SS_{yy}} = 1 - \frac{SSE}{SS_{yy}} \]

\[ r = \frac{SS_{xy}}{\sqrt{SS_{xx} \cdot SS_{yy}}} \]

**CONFIDENCE INTERVAL FOR \( \beta_1 \):**

\[ \hat{\beta}_1 \pm t_{\alpha/2} \frac{s}{\sqrt{SS_{xx}}} \]

with \( df = n - 2 \)

**TEST STATISTIC FOR \( \beta_1 \):**

\[ t = \frac{\hat{\beta}_1}{s/\sqrt{SS_{xx}}} \]

**CONFIDENCE INTERVAL FOR:**

Mean value of \( y \) at \( x = x_p \)

\[ \hat{y} \pm t_{\alpha/2} s \sqrt{\frac{1}{n} + \frac{(x_p - \bar{x})^2}{SS_{xx}}} \]

\( df = n - 2 \)

**PREDICTION INTERVAL FOR:**

Individual new value of \( y \) at \( x = x_p \)

\[ \hat{y} \pm t_{\alpha/2} s \sqrt{1 + \frac{1}{n} + \frac{(x_p - \bar{x})^2}{SS_{xx}}} \]

\( df = n - 2 \)