THE UNIVERSITY OF THE WEST INDIES

EXAMINATIONS OF: APRIL/MAY 2012....

CODE AND NAME OF COURSE: – ECON 1005 – INTRODUCTION TO STATISTICS

DATE AND TIME: (do not write in this space) DURATION: 2 Hours

INSTRUCTIONS TO CANDIDATES: This paper has 12 Pages and 21 Questions.

ANSWER ALL THE QUESTIONS FROM SECTION A AND THREE (3) QUESTIONS FROM SECTION B.

IN SECTION B ALL WORKING MUST BE CLEARLY SHOWN.

FORMULA SHEETS AND STATISTICAL TABLES ARE PROVIDED.

SILENT NON-PROGRAMMABLE SCIENTIFIC CALCULATORS MAY BE USED.

PLEASE WRITE YOUR CRN NUMBER ON THE TOP RIGHT HAND CORNER OF YOUR ANSWER BOOKLET.

PLEASE TURN OVER
SECTION A

There are fifteen (15) questions in this section. This section is worth 15 marks.

ANSWER ALL QUESTIONS IN THIS SECTION on the Multiple Choice answer sheet provided.

Select the best answer from each of the following, and on the answer sheet provided, fill in the space corresponding to the letter you have chosen as your answer.

1. When the discrete variable $X$ is changed to a continuous variable,
   then the $P(34 < X \leq 43)$ becomes

   A. $P(34.5 < X < 43.5)$
   B. $P(33.5 < X < 43.5)$
   C. $P(34.5 < X < 42.5)$
   D. $P(33.5 < X < 42.5)$

2. A normal distribution is such that the mean is 32 and the standard deviation is 7.
   Given that $P(X > m) = 0.3264$, the value of $m$ is

   A. 35.15
   B. 38.58
   C. 28.85
   D. 25.42

3. In a test of hypothesis, at the 5 % level of significance, the null hypothesis is that the population mean is equal to 45 and the alternative hypothesis is that the population mean is greater than 45. The critical value of $z$ is

   A. $-1.96$
   B. $-1.64$
   C. 1.64
   D. 1.96

PLEASE TURN OVER
4. In hypothesis testing, a type I error occurs when the null hypothesis is
   
   A. accepted and it is true.
   B. accepted when it is in fact false.
   C. rejected and it is false.
   D. rejected when it is in fact true.

5. The distribution of the mass of a particular type of dumb bell has a mean of 2 kg and a variance of 0.25 kg. The distribution of the mass of a dumb bell 4 times as heavy will have a mean of 8 kg and a variance of
   
   A. 0.25 kg.
   B. 1 kg.
   C. 2 kg.
   D. 4 kg.

6. A two tail test of hypothesis is made at the 5% level of significance. Which of the following p-values will lead to rejection of the null hypothesis?
   
   A. 0.072
   B. 0.035
   C. 0.029
   D. 0.013

7. For which of the following will a t-test be appropriate?
   
   A. A sample of size 15 from a normal population with a standard deviation of 6.
   B. A sample of size 15 from a non-normal population with a standard deviation of 6.
   C. A sample of size 15, with a standard deviation of 6, from a normal population.
   D. A sample of size 15, with a standard deviation of 6, from a non-normal population.
8. For which of the following would a hypothesis involving paired means be appropriate?

I to find out if fluoride treatment was effective in reducing cavities, 15 children who had fluoride treatment were compared with 15 who did not have the treatment.

II to test whether the Looze-a-Pound weight reduction program was effective, the weights of 10 adults were recorded before they started the programme and at the end of the programme.

A. I only
B. II only
C. Both I and II
D. Neither I nor II

9. A chi-square test of independence is about the independence of

A. two means.
B. two proportions.
C. two characteristics presented in a contingency table.
D. means of several populations

10. Given two samples $x$ and $y$ such that $n_x = 30$, $n_y = 50$, $s_x = 2.5$, $s_y = 2.8$, a pooled estimate of the variance of the population is calculated from

A. $\frac{29(2.5) + 49(2.8)}{78}$
B. $\frac{(2.5)^2 + (2.8)^2}{30 + 50}$
C. $\frac{(2.5)^2}{30} + \frac{(2.8)^2}{50}$
D. $\frac{29(2.5)^2 + 49(2.8)^2}{78}$
11. To estimate the population mean to be within 4 cm. of the sample mean from a population with a standard deviation of 7 cm, at a 98\% level of confidence, the sample size, n, will be

A.  4
B.  7
C.  17
D.  67

12. In a regression equation, \( y = a + bx \), the value of \( b \) represents

A. the point where the \( y \)-axis intersects the \( x \)-axis.
B. the change of \( y \) due to a one-unit change in \( x \).
C. the point where the \( x \)-axis intersects the \( y \)-axis.
D. the change of \( x \) due to a one-unit change in \( y \).

13. If the correlation coefficient, \( r \), is 0.8, the proportion of variation explained by the independent variable is

A.  0.08
B.  0.064
C.  0.64
D.  0.8

14. A time series equation is given as \( y = 9.29 + 0.72 \times \) for the years 2004 to 2010, with 2008 as the base year. Use the equation to forecast the value of \( y \) in 2012.

A.  10.73
B.  12.17
C.  13.61
D.  15.05

PLEASE TURN OVER
15. A price index of 115 in 2010 using 2005 as base year means the prices of commodities in the year

A. 2005 were 15% higher than in 2010.
B. 2010 were 15% higher than in 2005.
C. 2005 were 115% higher than in 2010.
D. 2010 were 115% higher than in 2005.

END OF SECTION A
SECTION B

ANSWER THREE (3) QUESTIONS FROM THIS SECTION. EACH QUESTION IS WORTH 15 MARKS.

QUESTION 1

a) The masses of cabbages produced on a certain farm are normally distributed with a mean mass of 600g and a standard deviation of 20 g. A cabbage is chosen at random from a particular crop, what is the probability that

(i) it will have a mass greater than 625 g?  [3]

(ii) it will have a mass between 570g and 645g?  [4]

b) State the conditions under which a binomial probability model can be approximated by the normal distribution.  [2]

c) Market research has shown that 60% of persons who are introduced to a particular product actually buy the product. A random sample of 80 persons was introduced to the product.

(i) Calculate the mean and the standard deviation of the number of the persons in the sample who are expected to buy the product.  [2]

(ii) Calculate the probability that between 54 and 60 persons (inclusive) in the sample bought the product.  [4]

QUESTION 2

a) A random sample of 84 oranges from a particular crop was found to have a mean Vitamin C content of 64.5 mg, with a standard deviation of 3.14 mg. Construct a 95% confidence interval for the mean Vitamin C content of that crop of oranges.  [3]

PLEASE TURN OVER
b) The length of steel rods used to reinforce concrete is known to have a normal distribution with mean of 600 centimetres and a standard deviation of 8 centimetres. A random sample of 40 steel rods was measured. What is the probability that the mean length of the sample is less than 598 cm? [4]

c) (i) Explain the Central Limit Theorem. [2]
(ii) Explain what is meant by the significance level of a test. [1]
(iii) The mean length of time for a company's computer system to perform a daily general ledger update has been found to be 174 minutes with a standard deviation of 36 minutes. A new accounting package is being considered and is given a 45-day trial. For these 45 days, which may be considered to be a random sample, the general ledger updating times had a mean of 163 minutes. The standard deviation is assumed to have remained unchanged.

A hypothesis test is carried out to determine whether the new package is more efficient than the previous system.

a. State the null and alternative hypotheses which may be used for this test.
b. Calculate the appropriate test statistic.
c. Determine the critical value of the test. Use \( \alpha = 0.01 \).
d. State clearly a valid conclusion for this test [5]

QUESTION 3

a) In hypothesis testing, state the conditions that are necessary to use a t-test. [2]

b) The manager of a large shipping company, from past experience, believes that the mean number of packages processed for shipping per day is 450. A new method of processing was introduced, and in a random sample of 20 days, the mean number of packages processed was found to be 460, with a standard deviation of 40. Assuming that the distribution is normal, test at the 5% level of significance, the null hypothesis \( H_0: \mu = 450 \) against the alternative hypothesis \( H_1: \mu > 450 \). Is this enough evidence, to conclude that the mean number has increased? [5]
c) The blood pressure of 13 men and 9 women, all of whom are suffering from some degree of hypertension, are measured while the subjects are in a relaxed condition. They are then given a special medication to improve their condition. The reductions in their blood pressures are summarized below:

<table>
<thead>
<tr>
<th>Sex</th>
<th>Sample size</th>
<th>Mean</th>
<th>Std Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>13</td>
<td>8.9</td>
<td>6.2</td>
</tr>
<tr>
<td>Female</td>
<td>9</td>
<td>5.0</td>
<td>6.0</td>
</tr>
</tbody>
</table>

(i) Calculate the pooled variance for the distribution. [3]

(ii) Assuming that the male and female populations have normal distributions with the same variances, test, at the 5% level of significance, the hypothesis that men and women derive equal reduction in blood pressure through the use of this medication. [5]

QUESTION 4

(a) The table below shows the lunch sales that a food vendor made in a given week outside a certain establishment.

<table>
<thead>
<tr>
<th>Day of the week</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of lunch sales</td>
<td>58</td>
<td>65</td>
<td>90</td>
<td>75</td>
<td>62</td>
</tr>
</tbody>
</table>

A chi squared test, at the 5% level of significance, is carried out to test whether these data suggest support the claim that sales are the same each day.

(i) State clearly the null and alternative hypotheses for this test.
(ii) Calculate the expected number of lunch sales for each day.
(iii) Determine the critical value of the test.
(iv) Calculate the test statistic.
(v) State a valid conclusion of the test. [7]
(b) A sample of 100 persons was asked their opinion on the decision not to have drums at interschool sports over the last years. The results of the survey are given in the following table.

<table>
<thead>
<tr>
<th>Opinion</th>
<th>Gender of respondent</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>male</td>
<td>female</td>
</tr>
<tr>
<td>Should have drum music</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>It does not matter</td>
<td>26</td>
<td>24</td>
</tr>
<tr>
<td>Should not have drum music</td>
<td>7</td>
<td>28</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>41</td>
<td>59</td>
</tr>
</tbody>
</table>

Using a 5% level of significance does this sample present sufficient evidence to reject the hypothesis that gender is independent of opinion.

Show full details of your method and state your conclusion clearly. [8]

**QUESTION 5**

It is claimed in University circles that the more credits a student takes during a semester the lower his or her grade point average is for that semester.

The number of credits and the GPA’s of a random sample of eight students in a certain programme were recorded at the end of their first year. The information is shown in the following table.

<table>
<thead>
<tr>
<th>Student</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of credits (x)</td>
<td>10</td>
<td>18</td>
<td>12</td>
<td>15</td>
<td>16</td>
<td>16</td>
<td>22</td>
<td>9</td>
</tr>
<tr>
<td>GPA</td>
<td>3.5</td>
<td>2.8</td>
<td>3.3</td>
<td>3.7</td>
<td>2.9</td>
<td>3.0</td>
<td>2.4</td>
<td>3.1</td>
</tr>
</tbody>
</table>

Summary: $\sum x = 118$, $\sum y = 24.7$, $\sum x^2 = 1870$, $\sum y^2 = 77.45$, $\sum xy = 355.6$
a) Determine the least squares regression line, in the form $y = a + bx$ to represent this information. [4]

b) Without carrying out any statistical test, does your regression line support this claim? Justify your answer. [3]

c) Use your regression line to estimate the GPA for a student with 14 credits. [2]

d) Determine the error generated when the regression line is used to estimate the GPA for the student with 12 credits. [3]

e) Calculate the correlation coefficient and interpret this value. [3]

QUESTION 6

a) The sales (in $000s) for each quarter of 2010 for a certain retail company and the seasonal indexes for each quarter are given below.

<table>
<thead>
<tr>
<th>Quarter</th>
<th>Sales, $ (x 1000)</th>
<th>Seasonal index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>76</td>
<td>96.48</td>
</tr>
<tr>
<td>2</td>
<td>84</td>
<td>98.52</td>
</tr>
<tr>
<td>3</td>
<td>98</td>
<td>99.30</td>
</tr>
<tr>
<td>4</td>
<td>112</td>
<td>104.80</td>
</tr>
</tbody>
</table>

(i) Calculate the adjusted seasonal index for each quarter. [6]
(ii) Calculate the deseasonalized value for the third quarter. [2]

b) The following table shows the performances of three major shares in the junk market.

<table>
<thead>
<tr>
<th>Shares</th>
<th>2008</th>
<th></th>
<th>2011</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Price</td>
<td>Quantity</td>
<td>Price</td>
<td>Quantity</td>
</tr>
<tr>
<td>A</td>
<td>85</td>
<td>480</td>
<td>210</td>
<td>200</td>
</tr>
<tr>
<td>B</td>
<td>84</td>
<td>250</td>
<td>88</td>
<td>450</td>
</tr>
<tr>
<td>C</td>
<td>285</td>
<td>350</td>
<td>435</td>
<td>550</td>
</tr>
</tbody>
</table>

PLEASE TURN OVER
(i) Calculate the simple aggregate index using 2008 as the base year. [2]

(ii) Determine the Laspeyres price index (to two decimal places) for the increase in prices associated with these shares using 2008 as base year. [4]

(iii) State the percentage change in prices according to this index. [1]

END OF EXAMINATION
**Descriptive Statistics**

Notation: \( N \) = population size; \( n \) = sample size

Population proportion \( p = \frac{x}{N} \)

Sample proportion \( \hat{p} = \frac{x}{n} \)

Population mean \( \mu = \frac{\sum x}{N} \)

Sample mean \( \bar{x} = \frac{\sum x}{n} \)

Frequency distribution \( \mu = \frac{\sum fx}{\sum f} \)

\( \bar{x} = \frac{\sum fx}{\sum f} \)

Population variance \( \sigma^2 = \frac{\sum(x - \mu)^2}{N} \)

Sample variance \( s^2 = \frac{\sum(x - \bar{x})^2}{n-1} \) or \( \frac{n\sum x^2 - (\sum x)^2}{n(n-1)} \)

Frequency distribution \( \sigma^2 = \frac{\sum f(x - \mu)^2}{\sum f} \)

\( s^2 = \frac{\sum f(x - \bar{x})^2}{\sum f - 1} \)

\( \sigma^2 = \frac{\sum fx^2}{\sum f} - \mu^2 \)

\( s^2 = \frac{\sum fx^2 - (\sum fx)^2}{\sum f} \)

Standard deviation \( \sigma = \sqrt{\sigma^2} \)

\( s = \sqrt{s^2} \)

Geometric mean \( GM = \sqrt[n]{x_1 \cdot x_2 \cdot x_3 \ldots x_n} - 1 \)

Coefficient of variation \( CV = \frac{\sigma}{\mu} \)
**Probability**

Number of arrangements of \( n \) distinct objects
\[
n! = n(n-1)(n-2) \ldots (3)(2)(1)
\]

Number of arrangements of \( r \) objects from \( n \) objects
\[
^nP_r = \frac{r!}{(n-r)!}
\]

Number of combinations of \( r \) objects from \( n \) objects
\[
^nC_r = \frac{n!}{r!(n-r)!}
\]

Probability of an event \( A \) occurring
\[
P(A) = \frac{n(A)}{n(S)} = \frac{\text{number of outcomes in } A}{\text{total number of outcomes}}
\]

Probability rule for complements
\[
P(\overline{A}) = 1 - P(A) \quad \text{or} \quad P(A^\complement) = 1 - P(A)
\]

General rule for addition
\[
P(A \cup B) = P(A) + P(B) - P(A \cap B)
\]

General rule for multiplication
\[
P(A \cap B) = P(A)P(B \mid A) = P(B)P(A \mid B)
\]

Conditional probability of \( A \) given \( B \)
\[
P(A \mid B) = \frac{P(A \cap B)}{P(B)}
\]

Expected value of \( X \)
\[
\mu = E(X) = \sum xP(x)
\]

Variance of \( X \)
\[
\sigma^2 = \text{Var}(X) = E(X^2) - (E(X))^2
\]

Binomial formula

probability of \( x \) success in \( n \) trials
\[
P(X = x) = ^nC_x p^x (1 - p)^{n-x}
\]

where \( x = 0, 1, 2, \ldots, n \) and \( 0 < p < 1 \).
\[
E[X] = np \quad \text{Var}[X] = np(1 - p)
\]

Standardized normal random variable
\[
z = \frac{x - \mu}{\sigma}
\]

Normal approximation to the binomial
\[
z = \frac{x \pm 0.5 - np}{\sqrt{np(1 - p)}}
\]
**Estimation**

Unbiased estimate for

\[ \bar{x} = \frac{\sum x}{n} \]

Unbiased estimate for

\[ s^2 = \frac{\sum x^2 - (\sum x)^2}{n - 1} \quad \text{or} \quad \frac{n \sum x^2 - (\sum x)^2}{n(n - 1)} \]

Standardization of \( \bar{x} \)

\[ z = \frac{\bar{x} - \mu}{\sigma / \sqrt{n}} \]

Approximate normal standardized variable for

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

**Confidence Intervals**

100(1 - \( \alpha \))% confidence interval for \( p \)

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

100(1 - \( \alpha \))% confidence interval for \( \bar{x} \)

Where \( \sigma \) is known and the parent population is normal

\[ \bar{x} \pm z_{\alpha/2} \frac{\sigma}{\sqrt{n}} \]

Where \( \sigma \) is unknown and the sample size is large.

\[ \bar{x} \pm t_{\alpha/2} \frac{s}{\sqrt{n}} \]

Where \( \sigma \) is unknown and the sample size is small; \( n - 1 = \) degrees of freedom.

Minimum required sample size in estimating the mean

\[ n = \left( \frac{z_{\alpha/2} \sigma}{E} \right)^2 \]

\( E \) is the error factor.
Hypothesis testing

Computed z value

\[ z_{test} = \frac{\bar{x} - \mu}{\sigma / \sqrt{n}} \]

Computed t value (with \( n - 1 \) degrees of freedom)

\[ t_{test} = \frac{\bar{x} - \mu}{s / \sqrt{n}} \]

where \( n \) is small and \( \sigma \) is unknown.

Testing population proportion \( p \)

\[ Z_{test} = \frac{\hat{p} - p}{\sqrt{\frac{p(1-p)}{n}}} \]

The chi-squared test

\[ \chi^2 = \sum \frac{(O - E)^2}{E} \]

with \( n - 1 \) degrees of freedom

For contingency table

\[ E = \frac{\text{row total} \times \text{column total}}{\text{grand total}} \]

\[ \chi^2 = \sum \frac{(O - E)^2}{E} \]

with \((r - 1)(c - 1)\) degrees of freedom, where \( r \) is the number of rows and \( c \) is the number of columns

Differences of means and proportions

Confidence Intervals

100(1 - \( \alpha \))% confidence interval for \( \mu_1 - \mu_2 \)

large samples

\[ (\bar{x}_1 - \bar{x}_2) \pm z_{\alpha/2} \sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}} \]  

where \( \sigma_1^2 \neq \sigma_2^2 \)

\[ (\bar{x}_1 - \bar{x}_2) \pm z_{\alpha/2} \sqrt{\frac{1}{n_1} + \frac{1}{n_2}} \]  

where \( \sigma_1 = \sigma_2 \)
small sample: \( (\bar{x}_1 - \bar{x}_2) \pm t_{\alpha/2} \sqrt{\frac{1 + \frac{1}{n_1} + \frac{1}{n_2}}{n_1 n_2}} \)

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

and \( t \) has \( n_1 + n_2 - 2 \) degrees of freedom.

\[ 100(1 - \alpha) \% \text{ confidence interval for } p_1 - p_2 \]

\[ (\hat{p}_1 - \hat{p}_2) \pm z_{\alpha/2} \sqrt{\frac{\hat{p}_1(1 - \hat{p}_1)}{n_1} + \frac{\hat{p}_2(1 - \hat{p}_2)}{n_2}} \]

**Hypothesis testing for the differences of means and proportions:**

**z-test statistic for testing } \mu_1 - \mu_2\)

for normal populations with a common known variance \( \sigma \)

\[ z_{\text{test}} = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sigma \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \]

for normal populations with known but unequal variances

\[ z_{\text{test}} = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \]

for large samples with unknown variances

\[ z_{\text{test}} = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \]

**two sample t-test with } n_1 + n_2 - 2 \text{ degrees of freedom, assuming equal variances in the parent population: } t_{\text{test}} = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu)}{s \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \]

where \( s = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}} \)
\[
z_{test} = \frac{(\hat{p}_1 - \hat{p}_2) - (p_1 - p_2)}{\sqrt{\frac{\hat{p}_1(1 - \hat{p}_1)}{n_1} + \frac{\hat{p}_2(1 - \hat{p}_2)}{n_2}}}
\]

Regression and Correlation

Sample regression line
\[
\hat{y} = a + bx
\]

\[b = \frac{SC_{xy}}{SS_x} = \frac{\Sigma xy - \Sigma x \Sigma y}{\Sigma x^2 - \left(\Sigma x\right)^2/n}
\]
or
\[b = \frac{n\Sigma xy - \Sigma x \Sigma y}{n \Sigma x^2 - \left(\Sigma x\right)^2}
\]

\[b = \frac{SC_{xy}}{SS_x} = \frac{\Sigma (x - \bar{x})(y - \bar{y})}{\Sigma (x - \bar{x})^2}
\]

\[a = \bar{y} - b\bar{x} = \frac{\Sigma y}{n} - b \frac{\Sigma x}{n}
\]

Standard error of estimate
\[s_e = \sqrt{\frac{1}{n-2} \Sigma (y - \hat{y})^2}
\]

Total variation = Unexplained variation + Explained variation
\[
SST = SSE + SSR
\]
\[
\Sigma (y - \bar{y})^2 = \Sigma (y - \hat{y})^2 + \Sigma (\hat{y} - \bar{y})^2
\]
Sample correlation coefficient
\[ r = \frac{SC_{xy}}{\sqrt{(SS_x)(SS_y)}} = \frac{\sum xy - \frac{\sum x \sum y}{n}}{\sqrt{\frac{\sum x^2 - (\sum x)^2}{n}} \sqrt{\frac{\sum y^2 - (\sum y)^2}{n}}} \]

or
\[ r = \frac{n\sum xy - \sum x \sum y}{\sqrt{n\sum x^2 - (\sum x)^2} \sqrt{n\sum y^2 - (\sum y)^2}} \]

Coefficient of determination
\[ r^2 = \frac{SSR}{SST} = \frac{\sum (\hat{y} - \bar{y})^2}{\sum (y - \bar{y})^2} \]

Estimated standard error of regression coefficient \( b \)
\[ s_b = \frac{s_e}{\sqrt{SS_x}} = s_e \sqrt{\frac{1}{n\sum x^2 - (\sum x)^2}} \]

Confidence interval for the regression slope
\[ b \pm t_{(\alpha/2, n-2)} s_b \]

Test statistic for inference on the regression slope
\[ t_{(n-2)} = \frac{b - \beta_0}{s_b} \]

Test statistic on the correlation coefficient \( \rho \)
\[ t_{(n-2)} = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}} \]

**Time series and Index numbers**

Deseasonalized time series: seasonally adjusted value = \( \frac{\text{original value} \times 100}{\text{seasonal index}} \)

Index number = \( \frac{\text{value in period} \times 100}{\text{value in base period}} \)

Real value = \( \frac{\text{nominal value} \times 100}{\text{index number}} \)

Simple aggregate price index:
\[ p = \frac{\sum p \nu}{\sum p_0} \times 100 \]
Simple aggregate price index: 
\[ p = \frac{\sum p_n}{\sum p_0} \times 100 \]

Simple average of price relatives: 
\[ p = \frac{\sum p_n}{N} \times 100 \]

Weighted average of price relatives: - base year weights: 
\[ p = \frac{\sum p_nq_o}{\sum p_oq_o} \times 100 \]

Weighted average of price relative: - given year weights: 
\[ p = \frac{\sum p_nq_n}{\sum p_nq_n} \times 100 \]

Laspeyre's Index (base year method) 
\[ LP = \frac{\sum p_nq_o}{\sum p_oq_o} \times 100 \]

Paasche price index (given year method) 
\[ PP = \frac{\sum p_nq_n}{\sum p_oq_n} \times 100 \]

Fisher's ideal index 
\[ = \sqrt{\left(\frac{\sum p_oq_o}{\sum p_oq_o}\right)\left(\frac{\sum p_nq_n}{\sum p_nq_n}\right)} \]

For use with ECON 1005.
## TABLE VII  STANDARD NORMAL DISTRIBUTION TABLE

The entries in this table give the areas under the standard normal curve from 0 to \( z \).

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## TABLE IX  CHI-SQUARE DISTRIBUTION TABLE

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