SECTION I: MULTIPLE-CHOICE

1. When testing for independence in a contingency table with 3 rows and 4 columns, there are _______ degrees of freedom.
   a) 5
   b) 6
   c) 7
   d) 12

2. If we wish to determine whether there is evidence that the proportion of items of interest is the same in group 1 as in group 2, the appropriate test to use is
   a) the \( Z \) test.
   b) the \( \chi^2 \) test.
   c) Both a) and b).
   d) Neither of a) nor b).

3. In testing a hypothesis using the \( \chi^2 \) test, the theoretical frequencies are based on the
   a) null hypothesis.
   b) alternative hypothesis.
   c) normal distribution.
   d) None of the above.

TABLE 11-1

A study published in the American Journal of Public Health was conducted to determine whether the use of seat belts in motor vehicles depends on ethnic status in San Diego County. A sample of 792 children treated for injuries sustained from motor vehicle accidents was obtained, and each child was classified according to (1) ethnic status (Hispanic or non-Hispanic) and (2) seat belt usage (worn or not worn) during the accident. The number of children in each category is given in the table below.
Hispanic Non-Hispanic
Seat belts worn 31 148
Seat belts not worn 283 330

4. Referring to Table 11-1, the calculated test statistic is
   a) -0.9991
   b) -0.1368
   c) \textbf{48.1849}
   d) 72.8063

5. Referring to Table 11-1, at 5% level of significance, the critical value of the test statistic is
   a) \textbf{3.8415}
   b) 5.9914
   c) 9.4877
   d) 13.2767

6. Referring to Table 11-1, at 5% level of significance, there is sufficient evidence to conclude that
   a) use of seat belts in motor vehicles is related to ethnic status in San Diego County.
   b) use of seat belts in motor vehicles depends on ethnic status in San Diego County.
   c) use of seat belts in motor vehicles is associated with ethnic status in San Diego County.
   d) \textbf{All of the above.}

\textbf{TABLE 11-2}

Many companies use well-known celebrities as spokespersons in their TV advertisements. A study was conducted to determine whether brand awareness of female TV viewers and the gender of the spokesperson are independent. Each in a sample of 300 female TV viewers was asked to identify a product advertised by a celebrity spokesperson. The gender of the spokesperson and whether or not the viewer could identify the product was recorded. The numbers in each category are given below.

<table>
<thead>
<tr>
<th></th>
<th>Male Celebrity</th>
<th>Female Celebrity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identified product</td>
<td>41</td>
<td>61</td>
</tr>
<tr>
<td>Could not identify</td>
<td>109</td>
<td>89</td>
</tr>
</tbody>
</table>

7. Referring to Table 11-2, the calculated test statistic is
   a) -0.1006
   b) 0.00
   c) \textbf{5.9418}
   d) 6.1194
8. Referring to Table 11-2, at 5% level of significance, the critical value of the test statistic is
   a) 3.8415
   b) 5.9914
   c) 9.4877
   d) 13.2767

9. Referring to Table 11-2, the degrees of freedom of the test statistic are
   a) 1
   b) 2
   c) 4
   d) 299

10. Referring to Table 11-2, at 5% level of significance, the conclusion is that
    a) brand awareness of female TV viewers and the gender of the spokesperson are independent.
    b) brand awareness of female TV viewers and the gender of the spokesperson are not independent.
    c) brand awareness of female TV viewers and the gender of the spokesperson are related.
    d) Both (b) and (c).

**TABLE 11-3**

A computer used by a 24-hour banking service is supposed to randomly assign each transaction to one of 5 memory locations. A check at the end of a day’s transactions gave the counts shown in the table to each of the 5 memory locations, along with the number of reported errors.

<table>
<thead>
<tr>
<th>Memory Location:</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Trans.:</td>
<td>82</td>
<td>100</td>
<td>74</td>
<td>92</td>
<td>102</td>
</tr>
<tr>
<td>Number of Rep. Errs.</td>
<td>11</td>
<td>12</td>
<td>6</td>
<td>9</td>
<td>10</td>
</tr>
</tbody>
</table>

The bank manager wanted to test whether the proportion of errors in transactions assigned to each of the 5 memory locations differ.

11. Referring to Table 11-3, the degrees of freedom of the test statistic is
    a) 4
    b) 8
    c) 10
    d) 448

12. Referring to Table 11-3, the critical value of the test statistic at 1% level of significance is
    a) 7.7794
    b) 13.2767
    c) 20.0902
13. Referring to Table 11-3, the calculated value of the test statistic is
   a) -0.1777
   b) -0.0185
   c) 1.4999
   d) 1.5190

14. Referring to Table 11-3, at 1% level of significance
   a) there is sufficient evidence to conclude that the proportions of errors in transactions assigned to each of the 5 memory locations are all different.
   b) there is insufficient evidence to conclude that the proportions of errors in transactions assigned to each of the 5 memory locations are all different.
   c) there is sufficient evidence to conclude that the proportion of errors in transactions assigned to each of the 5 memory locations are not all the same.
   d) there is insufficient evidence to conclude that the proportion of errors in transactions assigned to each of the 5 memory locations are not all the same.

15. Referring to Table 11-4, find the rejection region necessary for testing at the 0.05 level of significance whether there is a relationship between defect rate and years of experience.
   a) Reject $H_0$ if $\chi^2 > 16.919$
   b) Reject $H_0$ if $\chi^2 > 15.507$
   c) Reject $H_0$ if $\chi^2 > 11.143$
   d) Reject $H_0$ if $\chi^2 > 9.488$

16. Referring to Table 11-4, what is the expected number of employees with less than 1 year of training time and a high defect rate?
   a) 4.17
   b) 4.60
   c) 5.28
   d) 9.17
17. Referring to Table 11-4, what is the expected number of employees with 1 to 4 years of training time and a high defect rate?
   a) 12.00
   b) 8.64
   c) 6.67
   d) 6.00

18. Referring to Table 11-4, of the cell for 1 to 4 years of training time and a high defect rate, what is the contribution to the overall \( \chi^2 \) statistic for the independence test?
   a) 0.36
   b) 0.1296
   c) 0.015
   d) 0.0144

19. Referring to Table 11-4, a test was conducted to determine if a relationship exists between defect rate and years of experience. Which of the following \( p \)-values would indicate that defect rate and years of experience are dependent? Assume you are testing at \( \alpha = 0.05 \).
   a) 0.045
   b) 0.055
   c) 0.074
   d) 0.080

**TABLE 11-5**

A corporation randomly selects 150 salespeople and finds that 66% who have never taken a self-improvement course would like such a course. The firm did a similar study 10 years ago in which 60% of a random sample of 160 salespeople wanted a self-improvement course. The groups are assumed to be independent random samples. Let \( \pi_1 \) and \( \pi_2 \) represent the true proportion of workers who would like to attend a self-improvement course in the recent study and the past study, respectively.

20. Referring to Table 11-5, if the firm wanted to test whether this proportion has changed from the previous study, which represents the relevant hypotheses?
   a) \( H_0: \pi_1 - \pi_2 = 0 \text{ versus } H_1: \pi_1 - \pi_2 \neq 0 \)
   b) \( H_0: \pi_1 - \pi_2 = 0 \text{ versus } H_1: \pi_1 - \pi_2 > 0 \)
   c) \( H_0: \pi_1 - \pi_2 \leq 0 \text{ versus } H_1: \pi_1 - \pi_2 > 0 \)
   d) \( H_0: \pi_1 - \pi_2 \geq 0 \text{ versus } H_1: \pi_1 - \pi_2 < 0 \)

21. Referring to Table 11-5, what is the critical value when performing a chi-square test on whether population proportions are different if \( \alpha = 0.05 \)?
   a) \( \pm \) 1.645
   b) \( \pm \) 1.96
   c) 3.841
   d) 2.706
22. Referring to Table 11-5, what is the critical value when testing whether population proportions are different if $\alpha = 0.10$?
   a) $\pm 1.645$
   b) $\pm 1.96$
   c) 3.842
   d) 2.706

23. Referring to Table 11-5, what is the value of the test statistic to use in evaluating the alternative hypothesis that there is a difference in the two population proportions using $\alpha = 0.10$?
   a) 4.335
   b) 2.706
   c) 1.194
   d) 0.274

24. Referring to Table 11-5, the company tests to determine at the 0.05 level whether the population proportion has changed from the previous study. Which of the following is most correct?
   a) Reject the null hypothesis and conclude that the proportion of employees who are interested in a self-improvement course has changed over the intervening 10 years.
   b) Do not reject the null hypothesis and conclude that the proportion of employees who are interested in a self-improvement course has not changed over the intervening 10 years.
   c) Reject the null hypothesis and conclude that the proportion of employees who are interested in a self-improvement course has increased over the intervening 10 years.
   d) Do not reject the null hypothesis and conclude that the proportion of employees who are interested in a self-improvement course has increased over the intervening 10 years.
Section II: TRUE Or FALSE

1. In testing the difference between two proportions using the normal distribution, we may use either a one-tailed Chi-square test or two-tailed Z test.

True

2. The squared difference between the observed and theoretical frequencies should be large if there is no significant difference between the proportions.

False

3. A test for the difference between two proportions can be performed using the chi-square distribution.

True

4. A test for whether one proportion is higher than the other can be performed using the chi-square distribution.

False

5. When using the $\chi^2$ tests for independence, one should be aware that expected frequencies that are too small will lead to too big a type I error.

True

6. If we use the chi-square method of analysis to test for the difference between proportions, we must assume that there are at least 5 observed frequencies in each cell of the contingency table.

False
The director of admissions at a state college is interested in seeing if admissions status (admitted, waiting list, denied admission) at his college is independent of the type of community in which an applicant resides. He takes a sample of recent admissions decisions and forms the following table:

<table>
<thead>
<tr>
<th></th>
<th>Admitted</th>
<th>Wait List</th>
<th>Denied</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>45</td>
<td>21</td>
<td>17</td>
<td>83</td>
</tr>
<tr>
<td>Rural</td>
<td>33</td>
<td>13</td>
<td>24</td>
<td>70</td>
</tr>
<tr>
<td>Suburban</td>
<td>34</td>
<td>12</td>
<td>39</td>
<td>85</td>
</tr>
<tr>
<td>Total</td>
<td>112</td>
<td>46</td>
<td>80</td>
<td>238</td>
</tr>
</tbody>
</table>

He will use this table to do a chi-square test of independence with a level of significance of 0.01.

1. Referring to Table 11-6, the test will involve ________ degrees of freedom.
   4

2. Referring to Table 11-6, the critical value of the test is ________.
   13.277

3. Referring to Table 11-6, the expected cell frequency for the Admitted/Urban cell is ________.
   39.06

4. Referring to Table 11-6, the value of the test statistic is ________.
   12.624

5. True or False: Referring to Table 11-6, the null hypothesis will be rejected.
   False

6. True or False: Referring to Table 11-6, the p-value of this test is greater than 0.01.
   True

7. True or False: Referring to Table 11-6, the decision made suggests that admissions status at the college is independent of the type of community in which an applicant resides.
   True

8. True or False: Referring to Table 11-6, the same decision would be made with this test if the level of significance had been 0.005.
   True

9. True or False: Referring to Table 11-6, the same decision would be made with this test if the level of significance had been 0.05.
False

10. True or False: Referring to Table 11-6, the null hypothesis claims that "there is no association between admission status at the college and the type of community in which an applicant resides."

True

11. True or False: Referring to Table 11-6, the alternative hypothesis claims that "there is some connection between admission status at the college and the type of community in which an applicant resides."

True

12. True or False: The chi-square test of independence requires that the number of expected frequency in each cell to be at least 5.

False

13. True or False: The chi-square test of independence requires that the number of expected frequency in each cell to be at least 1.

True