1. Circle a response of True (T) or False (F) for EACH statement:

   T   F   Power is higher for a two-tailed test than a one-tailed test.

   T   F   A statistical test with low power means low probability of not detecting a difference when there really is a difference.

   T   F   Performing separate pairwise t-tests to look at differences between three or more groups without using a multiple comparisons procedure will result in a decreased probability of a Type I error.

   T   F   A statistically significant p-value is always less than or equal to the significance level, α, chosen for the test.

   T   F   The kappa statistic provides a measure of association between two continuous variables.

   T   F   Fitted straight lines with different slopes may have the same value for the sample correlation coefficient.

   T   F   If the sample correlation coefficient = 0, then the slope = 0.

   T   F   The assumption of constant variance is required for both an ANOVA and a simple linear regression analysis.
2. Match the following uses with an appropriate procedure:

   1. Maintaining overall significance level
   a. Spearman rank
   b. HSD
   2. Measure of agreement between two raters
   c. Chi-square
   3. Global test of differences in mean levels among 3 groups
   d. Pearson correlation
   e. Kappa
   4. Linear correlation between two continuous variables
   f. ANOVA
   5. Test of association between two categorical variables
   6. Measure of association between two ordinal variables

3. A double-blind experiment was carried out to investigate the effect of caffeine on performance (number of finger taps per minute).

<table>
<thead>
<tr>
<th>Caffeine Groups</th>
<th>n</th>
<th>Mean Performance ($\bar{Y}_i$)</th>
<th>SD (s_i)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 ml</td>
<td>10</td>
<td>244.8</td>
<td>2.39</td>
</tr>
<tr>
<td>100 ml</td>
<td>10</td>
<td>246.4</td>
<td>2.07</td>
</tr>
<tr>
<td>200 ml</td>
<td>10</td>
<td>248.3</td>
<td>2.21</td>
</tr>
</tbody>
</table>

3a. Complete the following ANOVA table:

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Among groups</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within groups</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>195.5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3b. In this problem, the null hypothesis can be written: (Check ALL responses that are true.)

( )  a. $H_0$: $u_1 = u_2 = u_3$
( )  b. $H_0$: $\tau_1 = \tau_2 = \tau_3 = 0$
( )  c. $H_0$: $\bar{X}_1 = \bar{X}_2 = \bar{X}_3$
( )  d. $H_0$: $\tau_1 = \tau_2 = \tau_3 = \tau$
3c. In this problem, as a result of the F test, is the mean performance (mean number of finger taps per minute) different among the caffeine groups? (Check only one response.)

( ) a. Yes, all means are different
( ) b. Yes, at least one mean is different
( ) c. No, all means appear to be the same
( ) d. No, at least two means are different
( ) e. Not enough information to tell

3d. In this problem, the best estimate of the population variance, $\sigma^2$ is __________ (FILL IN THE BLANK) and is provided by: (Check only one response.)

( ) a. the MSB
( ) b. the MSW
( ) c. either the MSB or the MSW
( ) d. the sample variance
( ) e. none of the above

The following STATA output is available for this problem:

```
Bartlett's test for equal variances: chi2(2) = 0.1877  Prob>chi2 = 0.910

Comparison of taps by caff_grp
(Bonferroni)

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>2</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.360</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3.5</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td>0.005</td>
<td>0.202</td>
</tr>
</tbody>
</table>
```
3e. Based on Bartlett's test for equal variances, one would conclude that: (Check only one response.)

( ) a. the assumption of equal means across the three caffeine groups is reasonable
( ) b. the assumption of equal means across the three caffeine groups is not reasonable
( ) c. the assumption of equal variances across the three caffeine groups is reasonable
( ) d. the assumption of equal variances across the three caffeine groups is not reasonable

3f. Based on the Bonferroni tests, one would conclude that: (Check only one response.)

( ) a. the mean performances are all statistically significantly different among the three groups
( ) b. there are no differences in mean performance among the groups
( ) c. there is a statistically significant increase in performance with increased caffeine level
( ) d. there is an increased performance in the 200 ml caffeine group as compared with the no caffeine group
( ) e. there is a decreased performance in the no caffeine group as compared with both the 100 ml and the 200 ml caffeine groups

3g. What assumptions are required for performing an ANOVA?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

3h. Was ANOVA an appropriate statistical technique for this problem? Why or why not?

________________________________________________________________________
4. The following table is from a study investigating methods for reducing adverse psychological consequences of teaching cardiopulmonary resuscitation (CPR) to family members of patients at risk for sudden death. (Am J Pub Health 1997;87:1434). Participants were randomized to one of 3 intervention groups or a control group.

4a. With respect to anxiety at 6 months following CPR training, the authors concluded: (Check only one response.)

( ) a. There are significant differences in anxiety level among all four groups.

( ) b. Patients in the CPR-social support group had less anxiety than patients in the control group.

( ) c. Patients in the CPR-only group had more anxiety than patients in the control group or CPR-social support group.

( ) d. Patients in the CPR-only group had less anxiety than patients in the CPR-education group.

| TABLE 2—Comparison of Emotional States and Psychosocial Adjustment among Patients in Cardiopulmonary Resuscitation (CPR) Treatment Groups and Control Group across Time (Mean Scores ± SD) |
|-------------------------------------------------|-----------------|-----------------|-----------------|-----------------|
| | CPR-Control Group | CPR-Social Support Group | CPR-Education Group | CPR-Only Group |
| | (n = 99) | (n = 74) | (n = 74) | (n = 90) |
| Anxiety (range, 0–21) | | | | |
| Baseline | 6.3 ± 4.7 | 6.1 ± 4.7 | 7.3 ± 4.6 | 6.6 ± 4.6 |
| 2 wk | 6.9 ± 4.6 | 5.8 ± 4.6 | 7.1 ± 4.7 | 7.0 ± 4.9 |
| 3 mo* | 5.8 ± 4.2 | 5.6 ± 4.3 | 7.2 ± 4.7 | 7.3 ± 4.6 |
| 6 mo* | 5.6 ± 4.1 | 5.2 ± 4.6 | 7.2 ± 4.8 | 7.4 ± 4.9 |
| Depression (range, 0–40) | | | | |
| Baseline | 11.8 ± 7.0 | 12.4 ± 6.4 | 11.8 ± 5.5 | 12.9 ± 7.1 |
| 2 wk | 12.5 ± 7.8 | 11.3 ± 7.4 | 11.8 ± 6.2 | 13.2 ± 7.9 |
| 3 mo | 11.4 ± 6.5 | 11.8 ± 7.3 | 12.1 ± 5.6 | 13.3 ± 7.1 |
| 6 mo | 11.0 ± 6.4 | 11.3 ± 7.2 | 12.2 ± 5.9 | 13.5 ± 8.0 |
| Hostility (range, 0–30) | | | | |
| Baseline | 7.4 ± 4.3 | 8.1 ± 4.5 | 8.4 ± 4.2 | 8.7 ± 4.8 |
| 2 wk | 8.2 ± 4.4 | 7.6 ± 4.4 | 8.3 ± 4.0 | 8.7 ± 5.0 |
| 3 mo | 7.5 ± 4.5 | 7.6 ± 4.2 | 8.6 ± 3.9 | 8.6 ± 5.2 |
| 6 mo* | 7.2 ± 4.4 | 7.0 ± 4.4 | 8.4 ± 4.1 | 9.3 ± 5.8 |
| Psychosocial adjustment to illness (range, 0–100)* | | | | |
| Baseline | 42.6 ± 10.0 | 40.0 ± 9.4 | 42.8 ± 1.9 | 45.4 ± 12.5 |
| 3 mo* | 41.6 ± 10.5 | 39.0 ± 9.9 | 41.5 ± 10.2 | 45.2 ± 12.9 |
| 6 mo* | 41.3 ± 9.2 | 38.2 ± 9.0 | 40.6 ± 9.5 | 45.4 ± 13.3 |

Note: Data were collected before family members attended CPR training; men 2 weeks, 3 months, and 6 months following CPR training. Family members in the control group did not attend CPR training.

aP = .004 for univariate analysis of variance (ANOVA); for post hoc comparisons, P = .03 for CPR-only group vs CPR-social support group, P = .04 for CPR-only group vs control group.

bP = .007 for univariate ANOVA. P = .02 for CPR-only group vs CPR-social support group, P = .02 for CPR-only group vs control group.

cHigher scores indicate poorer adjustment.

*P = .02 for univariate ANOVA. P = .005 for CPR-only group vs CPR-social support group, no significant differences for other group comparisons.

P = .03 for CPR-only group vs CPR-social support group. P = .03 for CPR-only group vs control group.
4b. If you wanted to confirm or disprove the authors' findings of pairwise differences between groups, what other summary information would you need in order to perform either the Bonferroni or HSD tests? (Check only one response.)

( ) a. F ratio
( ) b. MS
( ) c. MSW
( ) d. s^2
( ) e. SST

4c. What value of q, the studentized range, would you use for an HSD test in this example? (Check only one response.)

( ) a. 3.40
( ) b. 3.73
( ) c. 3.31
( ) d. 3.63
( ) e. Insufficient information given in the table

5. The following plot shows the relationship between height (cm) and weight (kg) for 30 eleven-year-old girls. It is known that the mean height is 144.8 cm and the mean weight is 36.18 kg. It is also known that \( \Sigma y_i^2 = 630,728.10. \)

1. plot height weight
5a. Complete the ANOVA table for a regression of height on weight:

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residual</td>
<td></td>
<td>770.66</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5b. The least squares estimate of the y-intercept is 117.96. The form of the regression line is: (Fill in the blanks.)

\[ y = b_0 + b_1 x \]

where \( b_0 = \) ____ and \( b_1 = \) ____.

5c. From the information provided: (Check only one response.)

- ( ) a. there appears to be a negative linear association between height and weight
- ( ) b. there appears to be a positive linear association between height and weight
- ( ) c. a lower height causes a lower weight
- ( ) d. a lower weight causes a lower height
- ( ) e. there is no association between height and weight

5d. For this problem, the coefficient of determination, \( r^2 \), is: (Check only one response.)

- ( ) a. 0.55
- ( ) b. 0.30
- ( ) c. 0.45
- ( ) d. 0.70
- ( ) e. 0.74

5e. The value of the correlation coefficient is: (Check only one response.)

- ( ) a. 0.55
- ( ) b. 0.30
- ( ) c. 0.45
- ( ) d. 0.70
- ( ) e. 0.74
5f. A test for whether there is a significant linear relationship can be performed by: (Check ALL responses that are true.)

( ) a. An F test
( ) b. A t-test on the value of the intercept
( ) c. Inspection of the confidence interval for \( \beta_1 \) to see if it contains zero
( ) d. Inspection of the confidence interval for \( \beta_0 \) to see if it contains zero
( ) e. A t-test on the value of the slope

5g. What is your conclusion regarding \( H_0: \beta_1 = 0 \) based on the F test? (Check only one response.)
( ) a. \( p > 0.05 \), significant linear relationship between height and weight
( ) b. \( p < 0.05 \), no significant linear relationship between height and weight
( ) c. \( p < 0.001 \), no significant linear relationship between height and weight
( ) d. \( p < 0.001 \), significant linear relationship between height and weight

5h. When a girl’s weight is 25 kg, what is her predicted height? (Check only one response.)

( ) a. 144.8
( ) b. 91.3
( ) c. 99.5
( ) d. 136.5

5i. What assumptions are required for performing a simple linear regression analysis?

5j. One way to check some of these assumptions is:
6. Suppose an investigator is interested in determining whether the mean birth weight of infants of mothers in an impoverished area may be improved by a maternal dietary intervention during pregnancy. The aim of the study is to detect an improvement in mean birth weight from 3000 g to 3500 g. (FILL IN THE BLANK for each statement.)

a. If a significance level of 0.05 and a power of 0.90 are desired, and the standard deviation of birth weight is assumed to be 1500 g, how large must the sample size be for each group in order to detect this difference in mean birth weight? ________

b. If a significance level of 0.05 and a power of 0.80 are desired, how large must the sample size be for each group? ________

c. If the standard deviation was 1000 g, with a significance level of 0.05 and a power of 0.80, how large must the sample size be for each group? ________

d. If the standard deviation was 1000 g, with a significance level of 0.05 and a power of 0.80, how large must the sample size be for each group in order to detect a difference of 250 g in mean birth weight? ________

e. If only 85 patients per group were obtained and the significance level is 0.05 (two-sided) and standard deviation is 1000 g, what is the power to detect a difference of 500 g? ________
Assumptions:

Test Ho: μ1 = μ2, where μ1 is the mean in population 1 and μ2 is the mean in population 2.

Estimated sample size for two-sample comparison of means:

\[
\begin{align*}
\text{Sample 1:} & \quad 3000, \quad \text{Sample 2:} \quad 3000, \quad \text{P} = \rho + \delta = 0.99 (\text{df} = 1200) \\
& \quad z = 1.96, \quad n = 196
\end{align*}
\]

Estimated required sample sizes:

\[
\begin{align*}
\alpha = 0.025, \quad \beta = 0.2, \quad \rho = 0.5, \quad \delta = 0.1, \quad \text{df} = 1200, \quad \text{two-sided}
\end{align*}
\]

Assumptions:

Test Ho: μ1 = μ2, where μ1 is the mean in population 1 and μ2 is the mean in population 2.

Estimated sample size for two-sample comparison of means:

\[
\begin{align*}
\text{Sample 1:} & \quad 3000, \quad \text{Sample 2:} \quad 3000, \quad \text{P} = \rho + \delta = 0.99 (\text{df} = 1200) \\
& \quad z = 1.96, \quad n = 196
\end{align*}
\]

Estimated required sample sizes:

\[
\begin{align*}
\alpha = 0.025, \quad \beta = 0.2, \quad \rho = 0.5, \quad \delta = 0.1, \quad \text{df} = 1200, \quad \text{two-sided}
\end{align*}
\]
m2 = 3500
sd1 = 1000
sd2 = 1000
n2/n1 = 1.00

Estimated required sample sizes:

n1 = 85
n2 = 85

3. sampsi 3000 3500, p(0.8) sd1(1000) sd2(1000)

Estimated sample size for two-sample comparison of means

Test Ho: m1 = m2, where m1 is the mean in population 1
and m2 is the mean in population 2

Assumptions:

alpha = 0.0500 (two-sided)
power = 0.8000
m1 = 3000
m2 = 3500
sd1 = 1000
sd2 = 1000
n2/n1 = 1.00

Estimated required sample sizes:

n1 = 63
n2 = 63

4. sampsi 3000 3250, p(0.8) sd1(1500) sd2(1500)

Estimated sample size for two-sample comparison of means

Test Ho: m1 = m2, where m1 is the mean in population 1
and m2 is the mean in population 2

Assumptions:

alpha = 0.0500 (two-sided)
power = 0.8000
m1 = 3000
m2 = 3250
sd1 = 1500
sd2 = 1500
n2/n1 = 1.00

Estimated required sample sizes:

n1 = 566
n2 = 566

Stata Corporation
702 University Drive East
College Station, Texas 77840
409-696-4600, fax 409-696-4601
7. The following page shows a STATA log of the regression of the under 5-year mortality rate per 100 live births on adult female literacy rate for 31 developing countries.

7a. The form of the fitted regression line is: (Fill in the blanks.)

\[ y = b_0 + b_1 x \]

where \( b_0 = \) ____ and \( b_1 = \) ____.

7b. Based on the result of the F test, it appears that: (Check only one response.)

( ) a. The under 5 mortality rate decreases with decreased adult female literacy rate.

( ) b. The under 5 mortality rate increases with increased adult female literacy rate.

( ) c. The under 5 mortality rate decreases with increased adult female literacy rate.

( ) d. There is no association between the under 5 mortality rate and the adult female literacy rate.

7c. Are there any potential problems with this analysis? Explain.
regress u\textsuperscript{1}smort literacy

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>Number of obs = 11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>48011.5343</td>
<td>19</td>
<td>4001.1123</td>
<td>F: 19, Prob &gt; F: .10</td>
</tr>
<tr>
<td>Residual</td>
<td>50013.6593</td>
<td>28</td>
<td>1724.60894</td>
<td>R-squared = 0.479</td>
</tr>
<tr>
<td>Total</td>
<td>98024.1935</td>
<td>30</td>
<td>3267.47312</td>
<td>Root MSE = 47.14</td>
</tr>
</tbody>
</table>

| u\textsuperscript{1}smort | Coef. | Std. Err. | t | P>|t| | 95\% Conf. Interval |
|---------------------------|-------|-----------|---|-----|---------------------|
| literacy                  | -1.65644 | 0.3143247 | -5.276  | 0.000  | (-3.01313, -1.2998) |
| cons                      | 191.3143 | 22.16962  | 8.630  | 0.000  | (145.923, 236.696) |

1. plot u\textsuperscript{1}smort literacy

2. predict u\textsuperscript{1}smort

3. gen res=u\textsuperscript{1}smort-p\textsuperscript{1}smort

4. plot res p\textsuperscript{1}smort

94.4885

res

-96.2933

32.1034  p\textsuperscript{1}smort  171.413
8. Suppose the following is the ANOVA table computed from a study of the effect of two different treatments on mean hemoglobin level for 48 patients with cancer.

8a. Complete the ANOVA table:

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment group</td>
<td></td>
<td>5.27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>69.18</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8b. An appropriate test of the hypothesis of no difference in mean hemoglobin levels between treatment groups is given by the comparison of the calculated F statistic equal to _________ with _________ and _________ degrees of freedom with a tabled F value equal to _________ with _________ and _________ degrees of freedom (Fill in the blanks.)

8c. From the F test, one would conclude: (Check only one response.)

( ) a. there are differences in mean hemoglobin levels by treatment group

( ) b. there are no differences in mean hemoglobin levels by treatment group

( ) c. there are differences in mean treatment response by hemoglobin level

( ) d. there are no differences in mean treatment response by hemoglobin level
9. Nonparametric tests rather than parametric statistical tests: (Check ALL responses that are true.)

( ) a. require that the sample sizes are large
( ) b. require that the data are normally distributed
( ) c. are performed in order to be more conservative in testing a hypothesis
( ) d. often use ranks rather than actual measurements
( ) e. are based on hypothesized values of population parameters

/\.

Circle a response of True (T) or False (F) for EACH statement:

T  F  Multiple comparisons testing is performed in order to decrease the probability of a Type I error.

T  F  A statistical test with high power means high probability of not detecting a difference when there really is none.

T  F  A statistically significant finding may be the result of large sample size.

T  F  An Analysis of Variance is used to test a hypothesis regarding equal variances among groups.

T  F  The kappa statistic provides a measure of agreement between graders which is expected due to chance alone.

T  F  A test for whether there is a significant linear relationship can be performed by calculating a confidence interval for the intercept.

T  F  If the sample correlation coefficient = 1, then the slope = 1.
11. Circle a response of True (T) or False (F) for EACH statement:

T F The best estimate of population variance from an ANOVA is always the MSβ.

T F In performing an ANOVA, it is assumed that population variances are the same across groups.

T F A larger sample size is needed for a two-tailed test than a one-tailed test.

T F The proportion of variability in the y’s which is explained by the relationship between x and y is $r^2$.

T F The chi-square statistic provides a test of association between two continuous variables.

T F The y intercept, $b_0$, is the value of x when $y = 0$.

T F If the sample correlation coefficient = 1, then the slope = 1.

T F If the sample correlation coefficient = 0, then the slope = 0.
12. A study evaluated the association between intervention group and age (months) at which an infant first walked. Infants in four groups were evaluated: (1) active exercise, (2) passive exercise, (3) no exercise, and (4) control group.

The following STATA log may be interpreted to test

\[ H_0: u_1 = u_2 = u_3 = u_4. \]

```
oneway age group, tabulate bonferroni
```

<table>
<thead>
<tr>
<th>group</th>
<th>Summary of age</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. Dev.</td>
<td>Freq.</td>
</tr>
<tr>
<td>1</td>
<td>10.125</td>
<td>1.4469796</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>11.375</td>
<td>1.8957189</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>11.708333</td>
<td>1.5200055</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>12.35</td>
<td>0.86023253</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>11.389583</td>
<td>1.6074541</td>
<td>24</td>
</tr>
</tbody>
</table>

```
Analysis of Variance
```

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Prob &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>15.7403132</td>
<td>3</td>
<td>5.24677108</td>
<td>2.40</td>
<td>0.0979</td>
</tr>
<tr>
<td>Within groups</td>
<td>43.6895833</td>
<td>20</td>
<td>2.18447917</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>59.4298966</td>
<td>23</td>
<td>2.58390855</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Bartlett's test for equal variances: \( \chi^2(3) = 2.6355 \) \( \text{Prob}>\chi^2 = 0.451 \)

Comparison of age by group (Bonferroni)

```
Row Mean- Col Mean
```

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.951</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1.58333</td>
<td>.333333</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.470</td>
<td>1.000</td>
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</tr>
<tr>
<td>4</td>
<td>2.225</td>
<td>.975</td>
<td>.641667</td>
</tr>
<tr>
<td></td>
<td>0.101</td>
<td>1.000</td>
<td>1.000</td>
</tr>
</tbody>
</table>

12a. In this problem, the alternative hypothesis can be written: (Check ALL responses that are true.)

( ) a. \( H_1: u_1 = u_2 = u_3 \)
( ) b. \( H_1: \) at least one \( u_i \) is different
( ) c. \( H_1: \) at least one \( \tau_j \) is different from 0
( ) d. \( H_1: \tau_1 = \tau_2 = \tau_3 = 0 \)
12b. In this problem, as a result of the F test, do the mean ages at which infants first walked vary among the intervention groups? (Check only one response.)

( ) a. Yes, all means are different
( ) b. Yes, at least one mean is different
( ) c. No, all means appear to be the same
( ) d. No, at least one mean is different
( ) e. Not enough information to tell

12c. In this problem, is it reasonable to assume equal variances across treatment groups? (Check only one response.)

( ) a. Yes, p = 0.0979
( ) b. No, p = 0.0979
( ) c. Yes, p = 0.451
( ) d. No, p = 0.451
( ) e. Not enough information to tell

12d. Compute the differences between means. What are the conclusions of either a Bonferroni adjustment or Tukey's HSD testing?

<table>
<thead>
<tr>
<th>Hypothesis: $\bar{x}_i - \bar{x}_j$</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_0$: $u_1 = u_2$</td>
<td></td>
</tr>
<tr>
<td>$H_0$: $u_1 = u_3$</td>
<td></td>
</tr>
<tr>
<td>$H_0$: $u_1 = u_4$</td>
<td></td>
</tr>
<tr>
<td>$H_0$: $u_2 = u_3$</td>
<td></td>
</tr>
<tr>
<td>$H_0$: $u_2 = u_4$</td>
<td></td>
</tr>
<tr>
<td>$H_0$: $u_3 = u_4$</td>
<td></td>
</tr>
</tbody>
</table>

12e. In this problem, is it necessary to use a multiple comparisons procedure? (Check only one response.)

( ) a. Yes, because the F test indicates a difference in at least one mean.
( ) b. No, because the F test indicates no differences in means.
( ) c. No, because the F test indicates a difference in at least one mean.
( ) d. Yes, because the F test indicates no differences in means.
42f. In this problem, one would conclude that: (Check only one response.)

( ) a. the mean ages at which infants first walked are statistically significantly different among the four intervention groups.
( ) b. there are no differences among the intervention groups in mean age at which infants first walked.
( ) c. there is a statistically younger mean age at which infants first walked in the exercise group.
( ) d. there is a statistically older mean age at which infants first walked in the control group.

42g. Suppose that the study was designed to also control or adjust for gender differences with the resulting table. See the STATA log below. An appropriate test of the hypothesis that there are no differences in mean ages across intervention groups after adjusting for gender differences is: Check only one response.)

( ) a. F = 3.06 with 3, 19 df
( ) b. F = 6.5 with 1, 19 df
( ) c. F = 3.06 with 1, 19 df
( ) d. F = 3.06 with 1, 3 df

42h. Given this new information and ANOVA, in this problem, would your answer to problem 2f change? (Check only one response.)

( ) a. Yes, since p = 0.0196, there appear to be differences in mean age at which infants first walked among the intervention groups after adjusting for gender.
( ) b. No, since p = 0.0196 there do not appear to be differences in mean age at which infants first walked among the intervention groups after adjusting for gender.
( ) c. Yes, since p = 0.0531, there are possibly borderline statistically significant differences in mean age at which infants first walked among intervention groups after adjusting for gender.
( ) d. No, since p = 0.0531, there do not appear to be differences in mean age at which infants first walked among the intervention groups after adjusting for gender.

<table>
<thead>
<tr>
<th>Source</th>
<th>Partial SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Prob &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>group</td>
<td>15.7403132</td>
<td>3</td>
<td>5.24677108</td>
<td>3.06</td>
<td>0.0531</td>
</tr>
<tr>
<td>gender</td>
<td>11.138438</td>
<td>1</td>
<td>11.138438</td>
<td>6.50</td>
<td>0.0196</td>
</tr>
<tr>
<td>Residual</td>
<td>32.5511453</td>
<td>19</td>
<td>1.71321817</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>59.4298966</td>
<td>23</td>
<td>2.58390855</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
13. Between 1958 and 1964, middle-aged men were enrolled in a follow-up study, the Seven Countries Study, of 16 cohorts across the world (Int J Epid 25: 753-759, 1996). The authors investigated the relationship between alcohol intake and 25-year mortality from coronary heart disease (CHD). The following Figure 1 shows each country represented by a letter (for example, E = East Finland and D = Dalmatia, Croatia).

![Figure 1](Relation between alcohol (100%) intake at baseline and 25-year mortality from coronary heart disease)

13a. From the information provided, it can be seen that: (Check only one response.)

( ) a. The risk of 25-year CHD mortality increases with increasing alcohol intake.

( ) b. The risk of 25-year CHD mortality decreases with decreasing alcohol intake.

( ) c. The risk of 25-year CHD mortality decreases with increasing alcohol intake.

( ) d. The risk of 25-year CHD mortality does not vary with alcohol intake.
13b. From the above information and what is provided below, complete the following ANOVA table for regression:

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residual</td>
<td></td>
<td>414.69</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \sum y_i^2 = 3287, \quad \sum y_i = 205, \quad \sum x_i = 35.2 \quad b_1 = -3.44 \]

13c. In this problem, what is least squares regression line? (Please complete.)

13d. What methods are available to test whether there is a statistically significant linear relationship between \( x \) and \( y \)? (Check ALL responses that apply.)

( ) a. 95\% confidence interval for \( B_o \)

( ) b. \( t \) test or \( F \) test of \( H_0: B_1 = 0 \)

( ) d. \( t \) test or \( F \) test of \( H_0: B_o = 0 \)

( ) e. 95 \% confidence interval for \( B_1 \)

13e. The proportion of variability in 25-year CHD mortality that can be explained by its relationship with alcohol intake: (Check only one response.)

( ) a. -3.44

( ) b. -0.61

( ) c. +0.61

( ) d. 0.37

( ) e. 24.65
13f. If a particular country's alcohol intake is $2 \log g / \text{day}$. What is this country's predicted 25-year CHD mortality? (Check only one response.)

( ) a. -3.44
( ) b. 13.50
( ) c. -6.64
( ) d. 20.38
( ) e. 27.26

14a. Suppose it is assumed that the standard deviation of GRE scores in a population of students is 200 points. The sample size required in a class in order to obtain a 95% confidence interval for the mean GRE score which is of width 50 points ($+/- 25$ points) is: (Check only one response.)

( ) a. 492
( ) b. 246
( ) c. 125
( ) d. 30

14b. Suppose that a cut-off level for GRE scores is desired for admission into a certain academic program. What sample size is necessary in order to estimate to within $+/- 5\%$ (with 95% confidence) the percent of students scoring above 1400? (Check only one response.)

( ) a. 768
( ) b. 35
( ) c. 384
( ) d. 196
15. If a statistical test finds a difference in outcome between two treatments with a significance level of 0.05, one can conclude that: (Check only one response.)

( ) a. there is a 5% chance that there really is no difference
( ) b. there really is a difference
( ) c. the sample sizes are large enough for sufficient power to detect a difference
( ) d. the probability of a Type I error may be low
( ) e. the probability of a Type II error may be high

16. Fill in the blank for each sentence:

If alpha and beta are fixed, a __________ total sample size is needed in order to detect a larger difference of interest between groups.

If alpha and sample size are fixed, there is __________ power to detect a smaller difference of interest between groups.

Journal articles often publish only positive (statistically significant) findings. Negative findings are usually the result of __________ power.

17. The maximum sample size required in a survey in order to obtain a confidence interval of width 6% (+/- 3%) for a single population proportion is: (Check only one response.)

( ) a. 16
( ) b. 124
( ) c. 240
( ) d. 1067
18. A study evaluated the efficacy of three aerobic exercise programs for weight loss. Weight change (before - after) in pounds was calculated.

<table>
<thead>
<tr>
<th>Exercise Program</th>
<th>( n_i )</th>
<th>Mean Weight Change ( \bar{y}_{ij} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking</td>
<td>11</td>
<td>17.1</td>
</tr>
<tr>
<td>Cycling</td>
<td>10</td>
<td>18.6</td>
</tr>
<tr>
<td>Swimming</td>
<td>8</td>
<td>-4.0</td>
</tr>
</tbody>
</table>

Also given is \( \sum y_{ij}^2 = 7485 \).

18a. Complete the following ANOVA table:

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Among groups</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within groups</td>
<td>6</td>
<td>679.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

18b. In this problem, the null hypothesis can be written: (Check ALL responses that are true.)

( ) a. \( H_0: \mu_1 = \mu_2 = \mu_3 \)

( ) b. \( H_0: \tau_1 = \tau_2 = \tau_3 = 0 \)

( ) c. \( H_0: \bar{x}_1 = \bar{x}_2 = \bar{x}_3 \)

( ) d. \( H_0: \tau_1 = \tau_2 = \tau_3 = \tau \)

18c. In this problem, as a result of the F test, are the mean weight changes different among the exercise groups? (Check only one response.)

( ) a. Yes, all means are different

( ) b. Yes, at least one mean is different

( ) c. No, all means are the same

( ) d. No, at least two means are the same

( ) e. Not enough information to tell
18d. In this problem, the best estimate of the population variance, $\sigma^2$, is provided by: (Check only one response.)

( ) a. the MSB
( ) b. the MSW
( ) c. either the MSB or the MSW
( ) d. the sample variance
( ) e. none of the above

18e. Compute the differences between means and the associated HSD values and test the hypotheses:

Hypothesis: $\bar{Y}_i - \bar{Y}_j$ HSD Conclusion

$H_0: \mu_i = \mu_j$
$H_0: \mu_i = \mu_j$
$H_0: \mu_i = \mu_j$

18f. In this problem, one would conclude that: (Check only one response.)

( ) a. the mean weight changes are statistically significantly different among the three exercise programs

( ) b. there are no differences in mean weight change among the exercise programs

( ) c. there is a larger mean weight loss with swimming than with walking or cycling

( ) d. there is a larger mean weight loss with either walking or cycling than with swimming

( ) e. there is a larger mean weight loss with cycling than with either of the other two exercise programs
49. The linear correlation between a student's current medical examination score \( (y_i = \text{MCAT}) \) and previous academic examination score \( (x_i = \text{ACT}) \) were examined for a group of medical school applicants. The results were:

\[
b_i = 0.406
\]

\[
\sum x_i = 1036
\]

\[
\sum y_i = 353
\]

49a. Complete the ANOVA table for the regression:

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td></td>
<td>80.18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residual</td>
<td>40</td>
<td></td>
<td>2.0045</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>212.12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

49b. The form of the regression line is: (Fill in the blank.)

\[
y = b_i x_i + b_0
\]

49c. In this problem, the slope indicates: (Check only one response.)

( ) a. for every 1.62 point increase in ACT score there is a 0.4 point increase in MCAT score

( ) b. for every 1 point increase in ACT score there is a 0.4 point increase in MCAT score

( ) c. for every 0.4 point increase in ACT score there is a 1 point increase in MCAT score

( ) d. for every 0.4 point increase in ACT score there is a 1.62 point decrease in MCAT score

( ) e. for every 1 point increase in ACT score there is a 1.62 point decrease in MCAT score
j9d. For this problem, is there a significant linear relationship between MCAT and ACT scores? (Check only one response.)

( ) a. Yes, $F > 4.08$
( ) b. No, since $F < 4.08$
( ) c. Yes, since $F > 254.3$
( ) d. No, since $F < 254.3$

j9e. The proportion of variability in MCAT scores which is explained by its relationship with ACT score is: (Check only one response.)

( ) a. 62%  
( ) b. 38%  
( ) c. 100%  
( ) d. 5%

j9f. What can one interpret from these results? (Check only one response.)

( ) a. there is a positive linear relationship between the two scores and there is no unexplained variability
( ) b. there is a positive linear relationship between the two scores but there is still unexplained variability
( ) c. there is a negative linear relationship between the two scores and there is no unexplained variability
( ) d. there is a negative linear relationship between the two scores but there is still unexplained variability
90. Circle a response of True (T) or False (F) for EACH statement:

T  F  Nonparametric tests are usually less conservative than parametric tests.

T  F  An ANOVA is used to test a hypothesis of equal population proportions.

T  F  The proper use of parametric statistics involves assumptions about population distributions.

T  F  The value of the sample correlation coefficient is not influenced by outliers.

T  F  Scatterplots of the residuals provide checks on assumptions used in simple linear regression.

T  F  A test for whether there is a significant linear relationship can be performed by calculating a confidence interval for the intercept.

T  F  If the sample correlation coefficient = 1, then the slope = 1.

91. Match the following:

_____ residual 

_____ MSE 

_____ SST/(n-1) 

_____ fitted value 

best estimate of $\sigma^2$

$\hat{\sigma}^2$

$\bar{y}$

$\hat{y}$

$y - \hat{y}$

$s^2$

94. Suppose it is assumed that standard deviation of babies' birth weights is 1500 grams. The sample size required in a survey of babies' birth weights in order to obtain a 95% confidence interval of width 500 grams (+/- 250 grams) for: (Check only one response.)

( ) a. 12
( ) b. 200
( ) c. 500
( ) d. 138
The following plot shows two separate regression equations for predicting birthweight from length of gestation for smoking as well as non-smoking mothers.

(a) The plot suggests:

( ) a. Babies born to smoking mothers weigh less than babies born to non-smoking mothers when length of gestation is taken into account
( ) b. Babies born to smoking mothers weigh more than babies born to non-smoking mothers when length of gestation is taken into account
( ) c. Babies of smoking and non-smoking mothers weigh the same
( ) d. A relationship cannot be determined from this plot.

(b) In this problem, one could conclude that the slope of the linear relationship between length of gestation and birthweight is:

( ) a. Greater for births of smoking mothers
( ) b. Less for births of non-smoking mothers
( ) c. The same for all births
( ) d. Equal to zero, indicating no correlation.
A pilot study was performed to assess chromium concentrations in body fluid levels of nine exposed workers. (Occup Environ Med 1994;51:663-668). The following figure show the relationship between chromium (Cr) concentration in whole blood (x) and the chromium concentration in urine (y). The authors reported that r = 0.64 and x = 5.5 and y = 5.9.

It was reported that the slope of this line is 0.6. The form of the regression line is: (Fill in the blanks.)

\[ y = b_0 + b_1 x \]

where \( b_0 = \) ___ and \( b_1 = \) ___.

From the information provided: (Check only one response.)

( ) a. there appears to be a negative linear association between Cr concentration in whole blood and Cr concentration in urine

( ) b. there appears to be a positive linear association between Cr concentration in whole blood and Cr concentration in urine

( ) c. a higher Cr concentration in whole blood causes a higher Cr concentration in urine

( ) d. a lower Cr concentration in whole blood causes a lower Cr concentration in urine

( ) e. there is no association between Cr concentration in whole blood and Cr concentration in urine
23c. **In this problem, the slope indicates:** (Check ALL responses that are true.)

( ) a. for every 1 ug/l increase in Cr concentration in urine there is a 0.6 ug/g increase in Cr concentration in blood

( ) b. for every 0.6 ug/l increase in Cr concentration in blood there is a 1 ug/g increase in Cr concentration in urine

( ) c. for every 1 ug/l increase in Cr concentration in blood there is a 0.6 ug/g increase in Cr concentration in urine

( ) d. for every 6 ug/l increase in Cr concentration in blood there is a 10 ug/g increase in Cr concentration in urine

( ) e. for every 10 ug/l increase in Cr concentration in blood there is a 6 ug/g increase in Cr concentration in urine

( ) f. for every 10 ug/l increase in Cr concentration in urine there is a 6 ug/g increase in Cr concentration in blood

23d. **For this problem, the coefficient of determination, r^2, is:** (Check only one response.)

( ) a. 0.60
( ) b. 0.36
( ) c. 0.64
( ) d. 0.41
( ) e. 0.59

23e. **The proportion of variability in Cr concentration in urine which is not explained by its relationship with Cr concentration in whole blood is:** (Check only one response.)

( ) a. 60%
( ) b. 36%
( ) c. 64%
( ) d. 41%
( ) e. 59%
The F test for the ANOVA for regression would be based on df1 = ____ and df2 = ____ degrees of freedom.

When the Cr concentration in blood is 12 ug/l, what is the predicted Cr concentration in urine? (Check only one response.)

( ) a. 2.6
( ) b. 14.6
( ) c. 3.2
( ) d. 32.8
( ) e. 9.8

Potential problems with this analysis are: (Check ALL responses that are true.)

( ) a. the small sample size
( ) b. the assumption of equal variances
( ) c. the assumptions of normally distributed observations
( ) d. the assumption of a linear relationship between the two concentrations

Suppose it is assumed that standard deviation of babies' birth weights is 1500 grams. The sample size required in a survey of babies' birth weights in order to obtain a 95% confidence interval of width 500 grams (+/- 250 grams) for: (Check only one response.)

( ) a. 12
( ) b. 200
( ) c. 500
( ) d. 138
A cohort analysis was conducted to determine whether the postnatal age of death or postconceptional age of death of SIDS (sudden infant death syndrome) deaths varies by gestational age at birth (Pediatrics 1995;96:464-471). Infants with gestational age < 37 weeks are considered preterm; 37 + weeks are term infants. The following table shows their analysis.

<table>
<thead>
<tr>
<th>Gestational Age</th>
<th>N</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Median</th>
<th>Range</th>
<th>Pairwise Comparisons</th>
</tr>
</thead>
<tbody>
<tr>
<td>24-28 wks</td>
<td>79</td>
<td>17.9</td>
<td>8.5</td>
<td>17</td>
<td>4-46</td>
<td>3.4</td>
</tr>
<tr>
<td>29-32 wks</td>
<td>162</td>
<td>16.1</td>
<td>6.7</td>
<td>15</td>
<td>3-49</td>
<td>3.4</td>
</tr>
<tr>
<td>33-36 wks</td>
<td>604</td>
<td>12.8</td>
<td>8.2</td>
<td>11</td>
<td>0-51</td>
<td></td>
</tr>
<tr>
<td>≥37 wks</td>
<td>3326</td>
<td>12.8</td>
<td>8.4</td>
<td>11</td>
<td>0-52</td>
<td></td>
</tr>
</tbody>
</table>

25a. It can be concluded that: (Check ALL responses that are true.)

( ) a. There was no difference in the postnatal age of death between preterm infants 33 to 36 weeks and term infants.

( ) b. There were no differences in the postnatal age of death between infants.

( ) c. There was no difference in the postnatal age of death between preterm and term infants.

( ) d. There were differences in the postnatal age of death between preterm infants 24 to 28 weeks and preterm infants 29 to 32 weeks.

( ) e. There were differences in postnatal age of death between infants with gestational age < 33 weeks and those > 33 weeks.

25b. The total number of pairwise comparisons in testing differences in postnatal age of death is: (Check only one response.)

( ) a. 4

( ) b. 6

( ) c. 8

( ) d. 16

( ) e. none of the above
27. A statistical test with low power means that there is:

( ) a. Low probability of not detecting a difference when there really is a difference
( ) b. Low probability of rejecting $H_0$ when $H_0$ is true
( ) c. Low probability of detecting a difference when there really is a difference
( ) d. Low probability of a Type II error.

28. The employees of a manufacturing firm that is suspected of producing a product associated with respiratory disorders are cross-classified by level of exposure and symptoms:

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Level of Exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High</td>
</tr>
<tr>
<td>Yes</td>
<td>185</td>
</tr>
<tr>
<td>No</td>
<td>120</td>
</tr>
<tr>
<td>Total</td>
<td>305</td>
</tr>
</tbody>
</table>

An appropriate test for investigating the association between $x$ and $y$ is:

( ) a. One-way ANOVA
( ) b. Kappa
( ) c. Chi-Square
( ) d. Two-way ANOVA
( ) e. Simple linear regression

29. Suppose you are interested in carrying out a study to determine whether bottle-fed infants are at the same risk of death from acute respiratory infection (ARI) as are breast-fed infants. It is expected that 10% of breast-fed infants die from ARI. Supposing $\alpha = 0.05$, $\beta = 0.20$ and equal sample sizes, how many babies in each group are needed to be able to detect at least a 10% increase in death from ARI in the bottle-fed group?

( ) a. 348
( ) b. 219
( ) c. 133
( ) d. 483
( ) e. 725
( ) f. 190
The following problems concern results of a simple linear regression investigating the linear relationship between two different methods of reading blood pressure (in mm Hg) on 25 patients with essential hypertension.

30a. Complete the ANOVA table for regression:

<table>
<thead>
<tr>
<th>Source</th>
<th>Sums of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residual</td>
<td>1.306.85</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[
\sum x_i = 4440 \quad \sum y_i = 4172 \quad \sum y_i^2 = 710.952
\]

\[
b_0 = 20.89 \quad b_1 = 0.82
\]

30b. In this problem, the coefficient of determination, \( r^2 \), is:

( ) a. 0.95  
( ) b. 0.91  
( ) c. 0.05  
( ) d. 0.09

30c. In this problem, the value of \( r^2 \) indicates that:

( ) a. 95% of the variation in the \( x \)'s is explained by the relationship between \( x \) and \( y \)  
( ) b. 91% of the variation in the \( x \)'s is explained by the relationship between \( x \) and \( y \)  
( ) c. 9% of the variation in the \( y \)'s is not explained by the relationship between \( x \) and \( y \)  
( ) d. 5% of the variation in the \( y \)'s is not explained by the relationship between \( x \) and \( y \)

30d. In this problem, a test of \( H_0 \beta_1 = 0 \) results in:

( ) a. Rejecting \( H_0 \) since \( F < 249.1 \)  
( ) b. Failing to reject \( H_0 \) since \( F < 4.28 \)  
( ) c. Concluding that the slope equals 0 since \( F < 4.28 \)  
( ) d. Concluding that there is a significant linear relationship between the two methods.
30e. In this problem, if Method 2 is regressed on Method 1, the regression line indicates:

( ) a. A change of 0.82 mm Hg in Method 2 for every mm Hg change in Method 1
( ) b. A change of 0.82 mm Hg in Method 1 for every mm Hg change in Method 2
( ) c. A change of 20.89 mm Hg in Method 2 for every mm Hg change in Method 1
( ) d. A change of 20.89 mm Hg in Method 1 for every mm Hg change in Method 2

30f. In this problem, the best estimate of $\sigma^2$ is:

( ) a. 1306.85
( ) b. SSE/24
( ) c. 56.82
( ) d. all of the above

30g. In this problem, if blood pressure is 185 mm Hg by Method 1, it can be predicted that the reading by Method 2 is:

( ) a. 185
( ) b. 172.6
( ) c. 3852.5
( ) d. 168
31. Suppose the following is an ANOVA table for differences in hemoglobin levels between patients with different types of sickle cell disease.

31a. Complete the table.

<table>
<thead>
<tr>
<th>Source</th>
<th>Sums of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between</td>
<td>99.89</td>
<td>2</td>
<td>49.94</td>
<td></td>
</tr>
<tr>
<td>Within</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>137.85</td>
<td>40</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Also given is the following information:

<table>
<thead>
<tr>
<th>Type of sickle cell disease</th>
<th>Number of observations</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hb SS</td>
<td>16</td>
<td>8.7</td>
</tr>
<tr>
<td>Hb S/B thalassaemia</td>
<td>10</td>
<td>10.6</td>
</tr>
<tr>
<td>Hb Sc</td>
<td>15</td>
<td>12.3</td>
</tr>
</tbody>
</table>

31b. In this problem, the null hypothesis can be written:

( ) a. H₀: μ₁ = μ₂ = μ₃
( ) b. H₀: x₁ = x₂ = x₃
( ) c. H₀: τ₁ = τ₂ = τ₃
( ) d. a and c
( ) e. b and c

31c. In this problem, are mean hemoglobin levels different among groups?

( ) a. Yes, all means are different. F > 3.23
( ) b. Yes, at least one mean is different. F > 3.23
( ) c. No, all means are the same. F < 3.23
( ) d. No, at least two means are the same. F > 19.47
31d. For this problem, compute the differences between means and the associated HSD values:

| Hypothesis | \( |\bar{y}_a - \bar{y}_b| \) | HSD |
|------------|-----------------|-----|
| \( H_0: \mu_1 = \mu_2 \) |                 |     |
| \( H_0: \mu_1 = \mu_3 \) |                 |     |
| \( H_0: \mu_2 = \mu_3 \) |                 |     |

31e. For this problem, using Tukey's HSD test, one would conclude that:

( ) a. Each pairwise difference is significant with individual significance levels of \( \alpha = 0.05 \)
( ) b. All pairwise differences are significant differences with an overall significance level of \( \alpha = 0.05 \)
( ) c. Only Group 1 and 3 means are different
( ) d. Only Group 2 and 3 means are different.

32. Suppose that a continuous behavioral measure is taken on individuals classified by both coffee consumption groups (none, low, high) and smoking status. A two-way ANOVA allows one to:

( ) a. Investigate the effect of behavior after controlling for smoking status
( ) b. Investigate the correlation between coffee consumption and smoking status
( ) c. Investigate differences in behavior among coffee consumption groups after controlling for smoking status
( ) d. Investigate the effect of smoking status after controlling for behavior.

33. When the fit of the regression line is poor:

( ) a. The value of \( r^2 \) is near one
( ) b. The regression line and the line \( y = \bar{y} \) may be the same
( ) c. The regression line will provide good predictions of \( y \)
( ) d. The value of MSR > the value of MSE.
34. Multiple comparison testing is performed in order to:

( ) a. Prevent finding significant differences when they really don't exist
( ) b. Increase the probability of a Type I error
( ) c. Decrease the probability of a Type II error
( ) d. a and b
( ) e. a and c

35. It is desired to draw a simple random sample of hospital admissions for injuries received in motorcycle accidents in order to determine the relative frequency with which alcohol is mentioned on the hospital record. It is guessed that the frequency may be about 10%. How large a sample should be drawn if the desired 95% confidence interval estimate is to be ± 2%?

( ) a. 459
( ) b. 35
( ) c. 216
( ) d. 864
( ) e. 17

36. Sample size requirements for investigating the difference in proportions between two groups does not depend on:

( ) a. The assumed α and β
( ) b. The maximum difference in proportions that one is interested in detecting
( ) c. The proportion expected in one group
( ) d. None of the above.
The following problem investigates the relationship between age and percent body fat for a group of 18 individuals. It is also of interest to investigate whether this relationship differs by gender.

1. regress perc_fat age

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>Number of obs = 18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>891.873652</td>
<td>1</td>
<td>891.873652</td>
<td>F( 1, 16) = 26.94</td>
</tr>
<tr>
<td>Residual</td>
<td>529.664093</td>
<td>16</td>
<td>33.1040058</td>
<td>Prob &gt; F = 0.0001</td>
</tr>
<tr>
<td>Total</td>
<td>1421.53775</td>
<td>17</td>
<td>83.6196674</td>
<td>R-squared = 0.6274</td>
</tr>
</tbody>
</table>

| perc_fat     | Coef.     | Std. Err. | t     | P>|t|   | [95% Conf. Interval] |
|--------------|-----------|-----------|-------|-------|---------------------|
| age          | .547991   | .1055752  | 5.191 | 0.000 | .3241815  .7718005  |
| cons         | 3.22086   | 5.076158  | 0.635 | 0.535 | -7.540113  13.98183  |

37a. The STATA log above indicates: (Check only one response.)

( ) a. There appears to be a positive linear relationship between percent body fat and age.

( ) b. There appears to be a negative linear relationship between percent body fat and age.

( ) c. There appears to be no correlation between percent body fat and age.

37b. What evidence is there for your response in 7a? (Give brief rationale.)
The STATA log below provides separate linear regressions by gender. One would conclude that: (Check only one response.)

( ) a. There appears to be a linear relationship between percent body fat and age for both males and females.
( ) b. There appears to be a linear relationship between percent body fat and age for males only.
( ) b. There appears to be a linear relationship between percent body fat and age for females only.
( ) c. There appears to be no correlation between percent body fat and age for either gender.

2. `sort gender`

3. by gender: `regress perc_fat age`

```
-> `gender'= 1 Male
Source | SS df MS
-------+------------------------------------------
Model  | 149.091885  1 149.091885
Residual | 293.536678  5 58.7073355
        |------------------------------------------
Total  | 442.628562  6 73.7714271

        | Coef. Std. Err.    t    P>|t|    [95% Conf. Interval]
perc_fat | age  | .4507788   .2828673  1.594  0.172   -2.783546 1.177912
          | _cons| 5.080996   9.928025  0.512  0.631  -20.43988 30.6018

-> `gender'= 2 Female
Source | SS df MS
-------+------------------------------------------
Model  | 12.9644342  1 12.9644342
Residual | 158.32282  9 17.5914244
        |------------------------------------------
Total  | 171.287254 10 17.1287254

        | Coef. Std. Err.    t    P>|t|    [95% Conf. Interval]
perc_fat | age  | .1670034   .2176328  0.788  0.413   -.3057686  .6797754
          | _cons| 23.77136   11.9292  1.993  0.077  -3.214375 50.75709
```
38. The result of an F test for a one-way ANOVA for two groups is equivalent to:

( ) a. Chi-square test
( ) b. z test for proportions
( ) c. t-test
( ) d. Fishers's exact test
( ) e. none of the above

39. Match the following data with the appropriate method for investigating association between two variables:

___1. Two continuous variables  a. Kappa
___2. Categorical classifications by multiple raters  b. Pearson sample correlation coefficient
___3. Two categorical variables  c. Spearman rank correlation coefficient
___4. Two ordinal variables  d. Chi-square

40. Nonparametric tests such as the rank-sum test or Kruskal-Wallis test:

( ) a. Require that the underlying population forms are normal
( ) b. Are based on the actual values of the measurements in the samples
( ) c. Do not depend on knowing or assuming the distributional forms of the sampled populations
( ) d. Are not necessary when the sample sizes are small.
1. FFETFTT
2. bef|dca
3a.  2 61.57 30.79 6.21 = F
     \[\frac{27}{29} \times 133.93 = 4.96\]
3b. a, b
3c. b
3d. 4.96 b
3e. c
3f. d
3g. independent Y's, normally distributed, constant variance
3h. Not known if Y's are normally distributed. Small sample size, CLT will not hold
4a. c  4b. c  4c. d
5a.  946.24 / 946.24 34.38 = F
     \[\frac{770.66}{20} \times 27.52\]
5b. b_o = 117.96  b_1 = 0.74  5c. b, 5d. a  5e.e. 5f. a,c,e  5g. d  5h. d
6a. 190 b.142 c.6 3 d.252 e.090
7a. b_o = 191.3  b_1 = -1.658
7b. c
8.  1 5.27 5.27 3.79 = F
     \[\frac{46}{63.91} \times 1.39\]
     \[\frac{47}{69.18}\]
8b. 3.79 1.46 4.08,1.46
8c. b
9. c,d  10. TFFFFF  11. FTTT FFFFT
12a. b,c  12b. c  12c. c  12d. 1.25 1.58 2.225 0.33 0.975 0.642
13a. c  13b. \[\frac{46.75}{245.75} = \frac{245.75}{8.30} = F\]
13c. \[\frac{y}{b_0 + b_1 x}\]
13d. b,e  13e. d  13f. b  14a. b  14b. c  15. a
16. Smaller, lower, low 17. d
18a. 2 2767 1383.7 539 = F
     \[\frac{26}{88} \times 179.3 = 26.1\]
18e. 1.5, 21.1, 22.6 Fail to reject Ho, reject Ho, reject Ho
18f. d
|   | 1  &  80.18 &  80.18 &  24.3  =  F |
|---|--------|--------|--------|
|   | 40  &  131.94 &  3.30  |
|---|--------|--------|--------|
| 41 | 812.12 |

19b. \( q = -1.62 + 0.406x \)
19c. b. 19d. a 19e. b 19f. b

20. FFTFTFF
21. \( y - \hat{y}, \hat{\sigma}^2, S^2, \hat{y} \)

a. a  a  a  a  b. b  c

23a. \( b_0 = 2.6 \) \( b_1 = 0.6 \)
23b. b. 23c. core(some) 23d. d 23e. e

23f. 1 and 7 23g. e 23h. q 5 24. d

25a. a, e 25b. b 27. c 28. c 29. f

30a. 13.421.79  1 13.421.79  a 36.22 = F

\[ \begin{array}{ll}
1,306.58 & 33 \\
56.52 & \\
14,788.64 & 34 \\
\end{array} \]

30b. b 30c. c 30d. d. 30e. a 30f. c 30g. b

31a. 99.49  2 49.94 49.94 = F

\[ \begin{array}{ll}
37.96 & 38 \\
1.00 & \\
137.85 & 40 \\
\end{array} \]

31b. a, c, d 31c. b 31d. 1.9, 3.6, 1.7 31e. b 32. c 33. b

34. a 35. d 36. b

37a. a 37b. t-test of \( H_0: \beta_1 = 0 \), F test, 95% CI for \( \beta \),

37c. c

38. c

39. badc 40. c