EXAM III

Name ______________________

<table>
<thead>
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<th>Problem</th>
<th>Points</th>
<th>Score</th>
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<tr>
<td>4</td>
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</tr>
</tbody>
</table>

USE YOUR TIME WISELY

USE CLOSEST DF AVAILABLE IN TABLE

SHOW YOUR WORK TO RECEIVE PARTIAL CREDIT

WRITE LEGIBLY. ANYTHING UNREADABLE WILL NOT BE GRADED

Good Luck!!!!
1. In an dental study, the distance (mm) from the center of the pituitary to the pterygo-maxillary fissure was measured in each of 13 boys and 9 girls at the ages of 8, 10, 12, and 14.

a (4 pts) Explain why this study should be regarded as a repeated measures study?

b (12 pts) Below is partial SAS output analyzing the problem as a split-plot experiment. Complete the output using \( \alpha = .05 \) for all tests. Do not worry about the P-value, simply state if the effect is significant or not using the critical F value. What are your conclusions concerning this distance in relation to AGE and GENDER?

Tests of Hypotheses for Between Subjects Effects

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Type III SS</th>
<th>Mean Square</th>
<th>F Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GENDER</td>
<td></td>
<td>51.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td></td>
<td>234.0</td>
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</tbody>
</table>

Univariate Tests of Hypotheses for Within Subject Effects

Source: AGE

\[
\begin{array}{cccc}
\text{DF} & \text{Type III SS} & \text{Mean Square} & \text{F Value} \\
& 176.7 & & \\
\end{array}
\]

Source: AGE*GENDER

\[
\begin{array}{cccc}
\text{DF} & \text{Type III SS} & \text{Mean Square} & \text{F Value} \\
& 88.2 & & \\
\end{array}
\]

Source: Error(AGE)

\[
\begin{array}{cccc}
\text{DF} & \text{Type III SS} & \text{Mean Square} & \\
& 1176.0 & & \\
\end{array}
\]

Huynh–Feldt Epsilon = 0.67
c. **(6 pts)** Perform the Huynh-Feldt corrected F-tests using the Huynh-Feldt Epsilon. Do your conclusions change? If so, how?

d. **(4 pt)** What are these tests in part c) correcting for and why is the adjustment only necessary when there are more than two time measurements?

e. **(4 pts)** Explain how one could assess whether there is a linear or quadratic trend with AGE.
2. Give a short answer to each of the following

a. (5 pts) Describe what is meant when we say two effects (or factors) are confounded. Also, describe what effects are confounded in a standard RCBD with \( b \) blocks and \( a \) treatments (i.e., no replication).

b. (5 pts) Suppose you have factors \( A \) and \( B \), each with three levels, and you run an experiment such that you have \( n = 4 \) observations at each \( A \times B \) combination (i.e., 36 total observations). Describe the randomization process that would result in you treating this experiment as a) a factorial design and b) a split-plot design.

c. (5 pts) If the results of a \( 2^2 \) factorial (fixed effects) were presented as a table containing the means and std deviations of each combination, explain how one could construct the ANOVA table from this information.
d. (5 pts) In a three factor unrestricted mixed model where $A$ and $C$ are random, there is no simple $F$ test for $A$. Explain how one does Satterthwaite's approximate $F$ test (HINT: If $\sigma_A^2 = 0$, the EMS of $A$ equals $\text{EMS}_{AB} + \text{EMS}_{AC} - \text{EMS}_{ABC}$).

e. (5 pts) Besides analyzing a repeated measures experiment as a split-plot design, describe two other approaches/methods of analysis.
3. (20 pts) Collisions between vehicles and deer are a serious problem in Wisconsin. Suppose a new type of highway reflector has been developed that is supposed to reflect the lights of an oncoming vehicle in such a way as to scare the deer away. You have been asked to design an experiment to study the effectiveness of this new reflector in terms of the distance between reflectors (100 or 200 feet), distance from the road (5 or 10 ft), color of the reflector (white or red), and height of the reflector from the ground (1 or 2 meters). You have been allotted test sections along 6 major interstates/highways but each test section has room to run only eight combinations. Propose a design for this experiment by answering the following questions.

1. What is your response variable $y$ and how is it to be measured?
2. What is the design and how is the randomization associated with your design to be performed?
3. Write out the ANOVA table with degrees of freedom.
4. A drug company is interested in the time it takes their specially coated pain tablet, once swallowed, to completely dissolve relative to two other pain tablets on the market. To study this, the company randomly sampled four batches (i.e., bottles) of each brand and from each batch randomly selected four tablets. These tablets were each placed into one of two solutions and the time to dissolve was recorded. The two solutions were chosen to represent two specific acidity concentrations found in the throat and stomach.

a. *(4 pts)* State the factors in this experiment and explain why you consider each random or fixed.

b. *(6 pts)* Write out the ANOVA table with df
c. (10 pts) Dudley Dowrong treated this as a factorial model (i.e., 3 Companies, 4 Batches, 2 solutions, 2 replicates) and computed the following SS table. Use this table to perform the proper F tests ($\alpha = .05$).

<table>
<thead>
<tr>
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<tr>
<td>(B)atch</td>
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<tr>
<td>C*B</td>
<td>20</td>
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<tr>
<td>(S)olution</td>
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<tr>
<td>C*S</td>
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<tr>
<td>B*S</td>
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<tr>
<td>C<em>B</em>S</td>
<td>30</td>
</tr>
<tr>
<td>Error</td>
<td>180</td>
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</table>

d. (5 pts) Suppose that the two solutions were randomly chosen from a population of stomach acidity levels. How would this change your conclusions in terms of F-tests? Simply state which tests would change, you do not have to perform them.