Address each of the following questions by creating a WORD document, cutting and pasting only relevant or requested syntax and output from SPSS. The exam is a “take home” examination, and thus you may utilize any internet resources, the textbook, lecture notes, and so forth. You may not, however, discuss the questions or your responses with anyone except the course instructor. (See syllabus for academic honesty policies). Any questions you have about interpreting questions should be addressed to the instructor. Please make note that APA calls for all text to be DOUBLED SPACED!

1. Consider the two design matrices defined below and address the following questions.

\[ D_1 = \begin{bmatrix} 1 & 12 & 25 \\ 1 & 13 & 20 \\ 1 & 9 & 31 \\ 1 & 10 & 14 \\ 1 & 6 & 39 \\ 1 & 14 & 34 \\ 1 & 8 & 17 \\ 1 & 7 & 19 \end{bmatrix} \quad \text{and} \quad D_2 = \begin{bmatrix} 25 & 12 & 1 \\ 20 & 13 & 1 \\ 31 & 9 & 1 \\ 14 & 10 & 1 \\ 39 & 6 & 1 \\ 34 & 14 & 1 \\ 17 & 8 & 1 \\ 19 & 7 & 1 \end{bmatrix}. \]

(a) Write a sentence or two to give the most common name of the statistical procedure/design represented by both of these designs matrices.

(b) In what way will the parameter vector estimated by the general linear model differ for these two design matrices? *Hint: If you need to think more concretely about it, create an arbitrary DV vector, Y, and estimate the design parameters for each design and compare them.*

2. Consider the following two design matrices and address the questions below.

\[ D_3 = \begin{bmatrix} 1 & 1 \\ 1 & 1 \\ 1 & 1 \\ 1 & 0 \\ 1 & 0 \\ 1 & 0 \end{bmatrix} \quad \text{and} \quad D_4 = \begin{bmatrix} 1 & 1 \\ 1 & 1 \\ 1 & 1 \\ 1 & -1 \\ 1 & -1 \\ 1 & -1 \end{bmatrix}. \]

(a) Write a sentence or two to give the most common name of the statistical procedure/design represented by both of these designs matrices.

(b) In what way will the parameter vector estimated by the general linear model differ for these two design matrices? *Hint: If you need to think more concretely about it, create an arbitrary DV vector, Y, and estimate the design parameters for each design and compare them.*

(c) Which of these two design matrices will generate parameter estimates that are orthogonal?

(d) Create three additional design matrices that could be used for the same design, at least one of which generates orthogonal parameter estimates.
3. Consider the following partial design matrix and address the questions below.

\[
D_1 = \begin{bmatrix}
1 & 12 & 1 \\
1 & 13 & 1 \\
1 & 9 & 1 \\
1 & 10 & 1 \\
1 & 6 & 0 \\
1 & 14 & 0 \\
1 & 8 & 0 \\
1 & 7 & 0
\end{bmatrix}
\]

(a) Find the entries for the fourth column to represent an interaction of the second and third columns. *Hint: You use the same procedure as in multi-way ANOVA design matrices to find interaction columns.*

(b) Write a sentence or two to give the most common name for the statistical procedure represented by this design matrix.

(c) What does each parameter represent.

(d) If the third column of the design matrix had the zeroes replaced by -1 in the dummy coding, what would change and what wouldn’t change?

4. Consider a 3x6 two-way ANOVA (e.g., an ANOVA in which there are three levels of factor A and six levels of factor B. Answer the following questions.

(a) How many parameters total will be estimated for this design?

(b) How many columns will there be in the design matrix?

(c) How many parameters must be estimated to fully characterize the effects of factor A?

(d) How many columns do we need in the design matrix to represent the effects of factor A?

(e) How many parameters must be estimated to fully characterize the effects of factor B?

(f) How many columns do we need in the design matrix to represent the effects of factor B?

(g) How many parameters must be estimated to fully characterize the effects of the AB interaction?

(h) How many columns do we need in the design matrix to represent the effects of the AB interaction?

(i) What other additional parameters need to be estimated and how would they be represented in the typical design matrix?

(j) Assuming only a single observation per cell of this design, create this design matrix.

5. An experiment was performed with a 2x4 design, yielding four observations per cell as given below:

<table>
<thead>
<tr>
<th>Factor</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>73, 80, 76, 82</td>
<td>80, 85, 81, 85</td>
<td>92, 97, 95, 91</td>
<td>75, 74, 79, 73</td>
</tr>
<tr>
<td>A</td>
<td>88, 92, 94, 94</td>
<td>90, 94, 93, 91</td>
<td>76, 81, 82, 81</td>
<td>97, 94, 95, 96</td>
</tr>
</tbody>
</table>
Given these data, address the following questions using SPSS syntax or the GUI as indicated. Present your matrix syntax first, your matrix output second, and then your GUI output (please comment out any PRINT statements in the syntax that do not provide the specific items listed below). Finally, include the text you write for the last two parts of this question.

To make your task easier, I have placed syntax for computing the DV matrix, Y, on the website. You should be sure to create the columns of your design matrix to follow the same order.

(a) Create a design matrix for this analysis.
(b) Estimate the parameters associated with your design.
(c) Compute the SST, SSA, SSB, SSAB, and SSE for this design.
(d) Compute all associated DF.
(e) Compute all associated MS terms.
(f) Compute the F-tests for the main effect of factor A, the main effect of factor B, and the interaction effect.
(g) Repeat this analysis using the GUI to verify the F-ratios computed above.
(h) Creating your own definitions of factor A, factor B, and the DV, write an APA style results paragraph to convey your results, including a table of descriptive statistics.

6. Write a sentence or two to explain why Hotelling’s $T^2$ test statistics utilize an F distribution rather than using the multivariate normal distribution to calculate p-values for multivariate tests.