STATISTICS 642 - ASSIGNMENT 2 -Summer 2015

DUE DATE: Noon, Friday, **June 19, 2015**

Name (**Typed**) _____

Email Address (**Typed**) _____

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STATISTICS 642 - ASSIGNMENT #2

- Due NOON **Friday** June 19, 2015

- Read Handout 2 and the following sections from each chapter: (just the parts about design. Skip the discussions about models and analysis.)

  Ch 2 - 2.1, 2.2, 2.3

  Ch 5 - 5.1, 5.9,

  Ch 6 - 6.1, 6.2

  Ch 7 - 7.1, 7.2, 7.3, 7.4

  Ch 8 - 8.1, 8.2, 8.3,

  Ch 9 - 9.1, 9.2, 9.3

  Ch 12 - 12.1, 12.2

  Ch 14 - 14.1, 14.2

  Ch 15 - 15.1

  Ch 16 - 16.1

  Ch 17 - 17.1

- Hand in the following:

Part I - Identifying the Design

- For each of the following four experiments,

A. Identify the following components of the experimental design (some may be absent in a given experiment):

1. Factor(s)	2. Factor Levels	3. Treatments	4. Response
5. Experimental Units	6. Measurement Units	7. Replications	8. Subsampling
9. Covariates	10. Blocking	11. Confounding	

B. Completely describe the following Three Components for each experiment:

C1. Method of Randomization:

C2. Treatment Structure:

C3. Measurement Structure:

1. **(20 points) Experiment 1:** An industrial engineer is studying the hand-insertion of electronic components on printed circuit boards in order to improve the speed of the assembly operation. She has designed three assembly fixtures (F_1,F_2,F_3) and two workplace layouts (L_1,L_2) that seem promising. Operators are required to perform the assembly, and it is decided to randomly select four operators for each fixture-layout combination. However, because the workplaces are in different locations within the plant, it is difficult to use the same operators for each layout.

Therefore, the twelve operators randomly chosen for layout 1 are different individuals from the twelve operators randomly chosen for layout 2. The treatment combinations in this design are run in random order and two replicates are obtained. The 48 assembly times are measured in seconds. The engineer is interested in the effects of Assembly Fixtures (F), Workplace Layout (L), and Operator (O) on the average time required to assemble the circuit boards.

2. **(20 points) Experiment 2:** An experiment studies the effect of insect infestation and weeds on the yield of cotton plants. The experiment will include four levels of infestation, three weed treatments (no additional weeds, addition of weed species 1, addition of weed species 2), and two herbivore treatments (clipping or no clipping). There are eight fields; each field has three plots of land. Each of the plots receive 200 cotton plants to start growth. The eight fields are randomly assigned to the four levels of insect infestation, with two fields to each level. Within each field, the three plots are randomly assigned to the three weed treatments. Each plot is then split into two subplots; with one subplot randomly assigned to be clipped and the other subplot is not clipped. At the end of 18 weeks, the researcher determines the total cotton yield of each subplot of land. The yields are given here with the following notation: Field (F), Infestation (I), weed treatment (W), and clipping (C).

		W1		W2		W3				W1		W2		W3	
F	I	C1	C2	C1	C2	C1	C2	F	I	C1	C2	C1	C2	C1	C2
F1	I1	83.2	81.8	67.4	79.7	75.9	80.6	F5	I1	78.2	80.5	65.1	68.3	65.3	66.6
F2	I2	77.5	78.2	69.2	71.5	75.9	78.2	F6	I2	79.8	85.2	57.6	61.4	58.5	61.6
F3	I3	72.7	69.3	70.1	71.2	75.9	81.3	F7	I3	82.4	83.1	50.5	54.0	51.6	54.7
F4	I4	75.3	78.9	72.7	74.6	75.9	82.8	F8	I4	75.5	78.7	39.0	43.9	41.9	45.1

3. **(20 points) Experiment 3:** A human nutrition researcher conducted an experiment to determine the acceptability of cakes baked with sucrose substitutes as the sweetening agent. Specifically, there were 6 recipes formed by combinations of 3 sweeteners and 2 leavening agents:

S_1 : 100% sucrose S_2 : 75% corn syrup, 25% sucrose S_3 : 75% fructose, 25% sucrose

L_1 : Baking soda L_2 : Baking soda plus "additional acid"

A panel of 6 taste testers were used to evaluate various characteristics of the cakes. On each of three days, cakes were baked from all six recipes. On each day, the six tasters evaluated six cake samples, one from each of the six recipes. The tasters then assigned a taste evaluation score to each of the recipes. The following table provides the tasting regimen for the three days:

	Day 1						Day 2						Day 3					
	Order						Order						Order					
Taster	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
T1	R1	R2	R3	R4	R5	R6	R6	R3	R4	R2	R5	R1	R1	R3	R5	R2	R4	R6
T2	R2	R3	R4	R5	R6	R1	R1	R4	R5	R3	R6	R2	R3	R5	R2	R4	R6	R1
T3	R3	R4	R5	R6	R1	R2	R2	R5	R6	R4	R1	R3	R5	R2	R4	R6	R1	R3
T4	R4	R5	R6	R1	R2	R3	R3	R6	R1	R5	R2	R4	R2	R4	R6	R1	R3	R5
T5	R5	R6	R1	R2	R3	R4	R4	R1	R2	R6	R3	R5	R4	R6	R1	R3	R5	R2
T6	R6	R1	R2	R3	R4	R5	R5	R2	R3	R1	R4	R6	R6	R1	R3	R5	R2	R4

4. **(20 points) Experiment 4:** An experiment was designed to compare three different methods of assessing the knowledge obtained by students in an undergraduate statistics course:

- Method 1: Multiple choice questions
- Method 2: Student provides detailed solutions to problems
- Method 3: Individual oral examinations

To conduct the experiment, four sections of STAT 303 will be randomly selected. The four sections are taught by four different instructors. Six students will be randomly selected from each of four different sections of STAT 303. Each student will take all three exams (a total of 72 observations). The researcher is interested in the difference in average scores on the three exams and whether the size of the differences between average scores is consistent across the various sections of STAT 303. There is concern that there may be an effect based on whether a test is taken during the first, second, or third testing period. Hence, each type of testing appears in each testing period. The 6 orders in which the students take the three types of Test Methods are randomly assigned to the students.

Part II - Selecting the Design

5. **(20 points)** A researcher is developing a commerical shrimp farming operation. She has sought your help in designing and analyzing a study to investigate the influence of three factors on the growth rate of shrimp raised in aquaria. The three factors are:

T = Water Temperature ($25°C$, $35°C$)

S = Water Salinity (10%, 25%, 40%)

D = Density of shrimp in the aquarium (2 shrimp/liter, 4 shrimp/liter)

The response variable is the four week weight gain on a per shrimp basis.

Two possible experimental designs are listed below. For each design, discuss the advantages and disadvantages of the design. In addition, give a brief description of how you would assign the levels of the three factors, or combinations of factor levels to the experimental material. Suppose there are 36 aquaria available for the study. If it helps, you can sketch the experimental layout.

D1. Each aquarium can be partitioned into two sections, but the water in the two sections is common to both sections (i.e., the water in one section circulates through the entire aquarium).

D2. It is not possible to partition the aquaria into sections.