Assignment #5: AxB ANOVA Exercises

1. To study the effects of a cow's age and breed on the percentage of butterfat in milk, ten cows were sampled from each of the six age-breed groups. First, calculate the main effects and the interaction effects. Then, plot the means and predict if you will find significant interaction. Create an ANOVA summary table and run a complete analysis of this data. State your conclusions.

	Guernsey	**Holstein-Fresian**	**Jersey**	
Mature	Mean = 4.85 SD = 0.503 n = 10	Mean = 3.72 SD = 0.329 n = 10	Mean = 5.24 SD = 0.547 n = 10	Mean = 4.603 n = 30
Young	Mean = 5.05 SD = 0.466 n = 10	Mean = 3.62 SD = 0.166 n = 10	Mean = 5.34 SD = 0.674 n = 10	Mean = 4.670 n = 30
	Mean = 4.95 n = 20	Mean = 3.67 n = 20	Mean = 5.29 n = 20	Mean = 4.637 n = 60

2. Do women pay more than men for haircuts? Does the price for a haircut depend on the region in which you live? The following table summarizes statistics about the price paid per haircut for 60 individuals. Run an appropriate analysis and state your conclusion.

	Female	**Male**	
Rural	Mean = 18.8 SD = 6.089 n = 10	Mean = 8.45 SD = 3.467 n = 10	Mean = 13.625 SD = 7.172 n = 20
Urban	Mean = 31.0 SD = 7.348 n = 10	Mean = 12.095 SD = 4.980 n = 10	Mean = 21.5475 SD = 11.462 n = 20
Suburban	Mean = 20.6 SD = 10.167 n = 10	Mean = 9.8 SD = 2.616 n = 10	Mean = 15.2 SD = 9.105 n = 20
	Mean = 23.467 SD = 9.5 n = 30	Mean = 10.115 SD = 3.987 n = 30	Mean = 16.7908 SD = 9.874 n = 60

3. A history professor decides to give an essay final to his class. He randomly gives blue-books to half the class and computers to the other half. In addition, the students were partitioned into three groups according to their typing ability. Answers written in blue-books were later typed and scoring was done blindly. The essays were then graded. The following table summarizes the results of this study. Run an appropriate analysis and state your conclusion.

	Blue-book	**Computer**	
No Typing Ability	Mean = 33.67 SD = 1.5275 n = 3	Mean = 34.0 SD = 2.6458 n = 3	Mean = 33.83 SD = 1.9408 n = 6
Some Typing Ability	Mean = 46.0 SD = 3.0 n = 3	Mean = 32.67 SD = 2.3094 n = 3	Mean = 39.33 SD = 7.6855 n = 6
High Typing Ability	Mean = 22.67 SD = 2.0817 n = 3	Mean = 33.0 SD = 3.0 n = 3	Mean = 27.83 SD = 6.1128 n = 6
	Mean = 34.11 SD = 10.301 n = 9	Mean = 33.22 SD = 2.3863 n = 9	Mean = 33.67 SD = 2.3863 n = 18

An experiment was carried out on the relation between the size and wall color of a room used for job interviews and the measured anxiety levels of the respondents. Thirty-six subjects were randomly assigned to a color-size combination. All the interviews were conducted one-at-a-time, with independent judges rating each interview. The following results were obtained:

	Red	**Yellow**	**Green**	**Blue**	**Total**
Small	$\overline{X} = 161.7$ $s = 7.6$ $n = 3$	$\overline{X} = 139.0$ $s = 5.0$ $n = 3$	$\overline{X} = 125.0$ $s = 43.5$ $n = 3$	$\overline{X} = 89.7$ $s = 20.7$ $n = 3$	$\overline{X} = 128.8$ $s = 34.4$ $n = 12$
Medium	$\overline{X} = 164.7$ $s = 11.7$ $n = 3$	$\overline{X} = 155.0$ $s = 4.6$ $n = 3$	$\overline{X} = 83.7$ $s = 5.0$ $n = 3$	$\overline{X} = 99.0$ $s = 11.5$ $n = 3$	$\overline{X} = 125.6$ $s = 37.2$ $n = 12$
Large	$\overline{X} = 158.3$ $s = 19.9$ $n = 3$	$\overline{X} = 143.7$ $s = 22.9$ $n = 3$	$\overline{X} = 84.3$ $s = 1.5$ $n = 3$	$\overline{X} = 94.3$ $s = 10.1$ $n = 3$	$\overline{X} = 120.2$ $s = 35.6$ $n = 12$
Total	$\overline{X} = 161.6$ $s = 12.4$ $n = 9$	$\overline{X} = 145.9$ $s = 13.9$ $n = 9$	$\overline{X} = 97.7$ $s = 30.0$ $n = 9$	$\overline{X} = 94.3$ $s = 13.5$ $n = 9$	$M = 124.9$ $s = 34.9$ $n = 36$

1. Assume the data are normally distributed. Will we have any problems with the other two assumptions needed to run an AxB ANOVA? You do not need to run any formal analyses to answer this question.

2. The following ANOVA summary table was created from the data. Fill-in the blanks.

Source	Sums of Squares	Degrees of freedom	Mean Square	Mean Square Ratio
Color	31176.8	_____	_____	_____
Size	453.48	_____	_____	_____
Color x Size	3495.87	_____	_____	_____
Error	7486.96	_____	_____	
Total	42613.1	_____	_____	

3. Sketch an interaction plot to see if you should find a significant interaction? Is there significant interaction? Explain what it means in this case.

4. Explain how you would finish your analysis of this data. For example, if you would analyze the simple effects (or main effects), explain how you would do it. Do not actually conduct the analysis.

The effect of three wage plans on the productivity of industrial workers in an assembly plant was studied. In group #1, assemblers were paid on a combination of hourly wages plus an incentive tied to their personal production of error-free units. In group #2, wages were determined on a combination of hourly rates plus an end-of-year bonus on company profits. In group #3, wages were based entirely on hourly rates. Daily production on an 8-hour shift (averaged over several months) was used as the dependent variable. Years of experience in the job were also considered by including two intervals of this variable as a second factor in the experiment. The results were as follows:

	Incentive	**Yearly Bonus**	**Hourly**	**Total**
1-5 Years Exp.	$\overline{X} = 34.79$ $s^2 = 27.63$ $n = 15$	$\overline{X} = 35.6$ $s^2 = 30.17$ $n = 15$	$\overline{X} = 32.6$ $s^2 = 16.3$ $n = 15$	$\overline{X} = 34.33$ $n = 45$
6-10 years exp.	$\overline{X} = 44.5$ $s^2 = 15.14$ $n = 20$	$\overline{X} = 39.5$ $s^2 = 20.28$ $n = 20$	$\overline{X} = 37.5$ $s^2 = 11.78$ $n = 20$	$\overline{X} = 40.5$ $n = 60$
Total	$\overline{X} = 40.34$ $n = 35$	$\overline{X} = 37.83$ $n = 35$	$\overline{X} = 35.40$ $n = 35$	$M = 37.86$ $n = 105$

1. Sketch an interaction plot to see if you should find a significant interaction? Is there significant interaction? Explain what it means in this case.

2. The following ANOVA summary table was created from the data.

Source	Sums of Squares	Degrees of freedom	Mean Square	Mean Square Ratio
Wage Plan	427.10	2	213.55	10.93*
Experience	978.92	1	978.92	50.10*
WP x Exp	82.58	2	82.58	4.23*
Error	1934.20	99	19.54	
Total	3422.80	104		

4. Complete the analysis & state your conclusions.