1. A manufacturer frequently sends small packages to a customer in another city via air freight, and in many cases it is important for a package to reach the customer as soon as possible. Two different firms offer air freight service, including pickup and delivery, on a 24-hour basis. The head of the manufacturer's shipping department would like to know if the firms differ in speed of service and if time of day makes any difference. An experiment is designed to investigate these issues. Packages are sent at random times (either morning or afternoon), and the air freight firm used (either Speedy Air Freight or ABC Shipping) is also randomly chosen. The customer records the time that each package arrives so that the time elapsed during shipping can be determined. The times are rounded to the nearest hour. The experimental results for a total of 12 packages are shown in the following table.

Time/Firm	**Speedy Air Freight**	**ABC Shipping**
Morning	8, 6, 7	11, 9, 8
Afternoon	7, 8, 9	10, 10, 11

a. Use the Stata `anova` and SPSS ANOVA routines to analyze the data. You can either enter the data by hand OR you can use the files hw07.sav and/or hw07.dta, which are available on the course web page. Confirming the results by hand calculations is OPTIONAL.

b. Briefly explain what hypotheses are being tested by each F value. Be specific as to the substantive meaning of the hypothesis, e.g. "this test examines whether delivery times differ by company." For each F test, indicate whether the null hypothesis should be rejected or not be rejected.

2. A consumer research group is interested in how the price of the leading brand of aspirin varies across different types of retail outlets and across different parts of a metropolitan area. Three types of retail outlets are considered: drugstores, discount stores, and grocery stores. The area is divided into 4 regions: center city, lakefront, west side, and north suburbs. For each type of store and each region, four stores are chosen at random and the price of a large bottle of aspirin is recorded (in dollars). The research group finds that SS Rows = 1.3288, SS Columns = 0.1595, SS Error = 0.2378, and SS Total = 1.8684. (Type of outlet is the Row variable.) Test whether the row effects, the column effects, and the interaction effects significantly differ from zero. Be sure to include the ANOVA table.

3. For each of the following, test whether (1) the row effects (2) the column effects, and (3) the interaction effects significantly differ from 0.

(a) MS Rows = 10, MS Columns = 5, MS Interaction = 4, MS error = 2, J = 2, K = 5, n = 30, $\alpha = .05$

(b) MS Rows = 15, MS Columns = 8, MS Interaction = 5, $s^2 = 4$, J = 3, K = 2, n = 60, $\alpha = .01$. (HINT: What do the sums of squares equal? What does MS Error equal?)

4. Complete the following ANOVA table:

Source	SS	D.F.	Mean Square	F
A + B	56			
A		4		4.0
B		3		
AB				
A + B + AB				
Error	240.0			
Total	499.0		1.0	

Hint: Figure out the d.f. first. Then find MS error and MS Rows. After that, things will fall into place pretty easily.

5. You have been asked to serve as a statistical consultant for several proposed projects. For each of the following, indicate which of the cases we have studied the problem falls under (e.g. one sample tests, case I, σ known; nonparametric tests, case II, tests of association). Briefly explain why. Also go through the first three steps of our hypothesis testing procedure, i.e. state

(i) the null and alternative hypotheses [NOTE: if the problem is an example of 2 Way Anova, just test the hypothesis that all row, column, and interaction effects are zero]

(ii) the appropriate test statistic (Z, T, F, or Chi-Square; giving the formula is optional); if necessary, also indicate what the degrees of freedom are

(iii) the acceptance region. If the significance level is not explicitly stated, use $\alpha = .05$.

a. The President of Notre Dame wants to see whether anything can be done about student drinking. He intends to have a random sample of 25 students fill out a questionnaire reporting on how much alcohol they drank in the last month. The students will then see a film on alcohol abuse. A month later, they will again report on how much alcohol they drank in the last month.

b. An economist wants to test whether the percentage of firms in industry A making a profit differs from the percentage of firms in industry B making a profit. A sample of 200 firms from each industry will be drawn.

c. An office manager wants to test whether productivity per worker (measured on a scale that runs from 0 to 100) is the same regardless of how crowded an office is. She plans to draw independent samples (each of size 6) from Office A (no crowding), Office B (some crowding), and Office C (severe crowding).

d. The Federal Aviation Administration believes that the mean number of takeoffs and landings at American airports last year was at most 50 per day. To test its hypothesis, it plans to draw a sample of $n = 100$ airports, and it will use $\alpha = .01$.

e. An insurance company sells three kinds of life insurance: Whole Life Insurance, Universal Life insurance, and Term Life Insurance. An analyst for the company wants to know whether there is any association between region of the country (North, East, South, and West) and the type of life insurance the company's customers buy. A random sample of 50 customers from the West, 70 customers from the North, 30 customers from the East, and 60 customers from the South will be drawn.

f. A lawyer wants to know whether the educational level of jurors chosen at the county court reflects the makeup of the county population that is eligible for jury duty. She knows that, in the county, 20% of the population has an Elementary School education, 50% has a High school education, 10% has Some college, and 20% has a College degree. She will draw a random sample of 250 jurors and measure their level of education.

g. A researcher believes that racism (measured on a scale that ranges from 0, not racist, to 25, extremely racist) varies by geographic region (North, South, East, or West) and Religion (Catholic or NonCatholic). For each combination of region and religion, 20 individuals are interviewed.