B6014 MANAGERIAL STATISTICS

Course Description:

This course introduces students to basic concepts in probability and statistics of relevance to managerial decision making. Topics include basic data analysis, random variables and probability distributions, sampling distributions, interval estimation, hypothesis testing and regression. Numerous examples are chosen from quality-control applications, finance, marketing and management.

Type and Length of Exam:

Open book, 3 hours, calculator such as HP-12C or HP-21S required. Laptop not allowed.

Specific Topics Covered:

Descriptive statistics, including mean, median, mode, standard deviation and variance, and the ability to calculate and interpret these. Elementary probability theory, understanding basics including the ability to calculate the probabilities of unions and intersections of simple events.
Understand the idea of independence of events. Conditional probabilities, Bayes rule.

Distributions, including the binomial and the normal distribution.

Sampling and sampling distributions. Understand the concept of the standard error. Be able to build confidence intervals on the means or proportions or the difference in means or proportions based on sample data. Understand the testing of hypotheses for means, proportions, and the difference of means and proportions.

Linear regression analysis. This includes understanding the idea of the regression equation, the correlation coefficient and coefficient of determination. Being able to test hypotheses on the slope (coefficients), build confidence intervals on the coefficients. Build confidence intervals on predictions.

Recommended Reading for Review:

Spiegel, Murray. Statistics. Schaum Outline Series, McGraw-Hill.
Newbold, Paul. Statistics for Business and Economics. Prentice-Hall.
Berenson, Levine and Stephan. Statistics for Managers Using Microsoft Excel. Prentice-Hall.

Sample Exam:

See attached.

B6014 MANAGERIAL STATISTICS
Sample Exemption Exam

(3 hours, open book, calculator allowed)

1. Individuals who want to pursue a career in investment analysis are often encouraged to obtain the professional designation of Chartered Financial Analyst (CFA). A candidate must pass three exams to obtain this designation and can take only one exam in a given year. The results of the exams held in 1994, reported by the Institute of Chartered Financial Analysis are summarized in the accompanying table. One candidate is selected at random from those who took a CFA exam in 1994.

Exam	Number of Candidates	Percentage Who Passed
I	4,149	54%
II	2,484	64%
III	1,431	79%

a. What is the probability that the selected candidate passed?
b. What is the probability that the selected candidate took Exam I and passed it?
c. If the selected candidate passed, what is the probability that the candidate took Exam III?

2. A fast-food chain tests each day that the number of calories in their "Diet-Burger" is no more than 400. Due to imperfections in the cooking processes, the number of calories in their Diet-Burger is normally distributed with standard deviation 30 calories. The decision rule adopted by the fast-food chain is to reject the null hypothesis (that the mean calories is 400) if the sample mean number of calories is more than 410.

a. If a random sample of size 40 burgers is selected, what is the probability of a Type I error, using this decision rule?

b. If a random sample of size 10 burgers is selected and the same decision rule is applied, do you think the probability of a Type I error will be (check one):

_____ lower than the one in part a).
_____ the same as the one in part a).
_____ higher than the one in part a).

c. Suppose that the true mean number of calories is 422 (and the standard deviation is 30). If a random sample of 40 burgers is selected, what is the probability of a Type II error, using this decision rule?

3. Due to turnover and absenteeism at an assembly plant, 20% of the items are assembled by inexperienced employees. Management has determined that customers return 15% of the items assembled by inexperienced employees, whereas only 3% of the items assembled by experienced employees are returned. Given that an item has been returned, what is the probability that it was assembled by an experienced employee?

4. A large university wants to determine the average income their students earn during the summer. A random sample of 45 first-year business students produced the following statistics measured in hundreds of dollars: $\overline{X} = 33.1$ and $s = 5.0$.

a. Estimate the mean summer employment income for all first-year business students, with 99% confidence.

b. A statistician provides a confidence interval that runs from 31.5 to 33.8. Assuming he/she used the same sample data, what is the probability content of this interval?

5. A major beverage manufacturer sells one liter bottles of *Fruit Punch* which are labeled "contains a minimum of 10% real fruit juice". A liter is 100 centiliters (cl), so the label implies that there are least 10 cl of fruit juice in a one liter bottle. Since the main ingredient is water, the manufacturer is tempted to put more water and less fruit juice. However, federal regulations require that 97% of bottles on the shelf meet the labeling specifications (i.e., have at least 10 cl of fruit juice). In the bottling process, the machine that dispenses the fruit juice is not perfect. Sometimes it puts too much fruit juice and sometimes not enough. Assume the amount of fruit juice put in a one-liter bottle is normally distributed with a standard deviation of 1.4 cl.

a. Assuming the bottling company can accurately set the mean amount dispensed. What is the minimum the mean can be set to so that the federal regulations are met?

b. If 60 bottles (of one liter each) are sent to a supermarket, what is the probability that 2 or more of the bottles sent do not have enough fruit juice to meet the specifications?

6. A large consumer products company wants to measure the effect of different local advertising media on the sales of its products. Specifically, they considered TV and newspaper advertising, and also considered providing cents-off coupons in newspapers. Over a period of three months, these variables were measured in 22 cities of roughly equal population and demographics, and the results were analyzed using multiple regression. The variables were:

SALES = sales in 1,000,000 dollar units.
TVAD = TV ad budget, in 10,000 dollar units.
NEWSAD = Newspaper ad budget, in 1,000 dollar units.
COUPON = 1 if coupons were given out in local newspapers, and 0 otherwise.

A part of the output of the regression is given below:

Regression Statistics	
R Squared	(D)
Standard Error	(C)

ANOVA

	Df	*SS*
Regression		1.971
Residual	(E)	0.447
Total		

	Coefficients	*Standard Error*	*t-Stat*	*p-value*
Intercept	0.376	0.130		
TVAD	0.127	0.017	(A)	(B)
NEWSAD	0.016	0.003		
COUPON	0.100	0.075		

a. Fill in the blank spaces above in the regression output:
(A) *t*-stat for *TVAD* = _____
(B) *p*-value for *TVAD*=_____
(C) R-squared= _____
(D) Standard Error of Estimate s_e= _____
(E) Degrees of Freedom, Error= _____

b. Interpret the coefficient for *COUPON* in words. Develop a 95% confidence interval for this number and interpret this confidence interval in words.

c. For Pittsburgh, a city typical of those studied, the proposed local advertising budgets were $47,000 for TV ads and $25,000 for newspaper ads. No coupons were distributed in this area. What is the predicted level of sales in Pittsburgh in dollars?

d. The total effective cost of distributing cents-off coupons in this city is $20,000. Of the three advertising-promotional media considered here, which is the most cost-effective way of increasing sales in Pittsburgh?

e. Which of the three advertising and promotional media (if any) may not be having a significant effect on sales?

f. Let b_2 denote the coefficient for *NEWSAD* in this regression. Test the hypothesis (using α=5%):

$$H_0: b_2 \leq 0.01 \text{ and } H_A: b_2 > 0.01.$$

Interpret your results in words suitable for a person who has little appreciation for statistics.

g. Is this regression likely to be useful? Explain.