NAME: _____

Math 124 Spring 2005: Section 7 TTh 9:35-10:50 AM
Final Exam Date: May 24, 2005

Instructions: Answer questions 1-8 for full credit. There is a bonus question, but you can get a perfect score without attempting it. Show as much work as you feel reasonable. You have 2 hours 30 minutes. To allow others to fully concentrate at the end please do not leave in the last 5 minutes. You should submit your pages of notes with your test paper.

Question 1. (*25 points*)

Define each of the following and explain why or how it is used (in the context of an experiment)

(a) *Randomization*

(b) *Confounding*

(c) *Block* and *Block Design*

(d) *Single-blind* and *Double-blind*

(e) *Replication*

Question 2. (*25 points*)

An factory manager is interested in the bond strength of a new adhesive product which is being considered for routine use on a production line. The adhesive is used to join together two plastic parts, of which there are unlimited supplies. The adhesive supplier has provided 27 equal sized samples of the adhesive. In the factory the machine which performs the gluing has three different temperature settings (280F, 300F and 320F) and three different pressure settings(100, 150 and 200 psi). A machine which measures the breaking strength is available for use.

(a) Identify the factors, their levels, the treatments and a response variable for this experiment.

(b) Describe and outline an appropriate design for this experiment.

Question 3. (*25 points*)

Imagine that you carry out a random experiment where you first roll a fair 6 sided dice, then you roll a fair 4 sided dice.

(a) Give the sample space for this experiment. Then explain what the probability of each individual outcome will be and why.

(b) Suppose that X is "the square of the larger of the two numbers". Give the probability distribution of this random variable.

(c) What are the mean and standard deviations of X?

Question 4. (*25 points*)

Protein is an important component of both human and animal diets. Although it is well known that grains and legumes contain large amounts of protein, it is not widely recognized that certain grasses can also provide a good source of protein. It is thought that Bermuda grass should contain 20% protein by weight. So one kilogram of Bermuda grass would contain 200g of protein. A scientist wants to verify this claim and so she gathers 75 one-kilogram samples of Bermuda grass and analyzes them for protein content. She finds the mean protein content for her sample is 180g. It is well known that the standard deviation of protein contents from one kilogram samples of grass is 80grams.

(a) Give a 98% confidence interval for the mean protein content of Bermuda grass.

(b) Based upon your confidence interval would it be safe to say that Bermuda grass contains 20% protein by weight? Explain why.

(c) What assumptions are you making when you compute your confidence interval? Which is most important?

Question 5. (*25 points*)

A computer chip manufacturer claims that at most 2% of the chips it produces are defective. An electronics company purchases a large quantity of chips and wants to determine if this claim is plausible. A sample of 400 of these chips is randomly selected and 13 of the 400 are found to be defective when tested. Suppose that p is the proportion of all chips that are defective.

(a) What is the sample estimate of the proportion of defective chips? What is the standard error of this sample proportion?

(b) Carry out a hypothesis test of $H_0 : p \leq .02$ against $H_A : p > .02$. Be sure to state your test statistic and its p-value.

(c) Can the computer chip manufacturers claim be supported by this data?

Question 6. (*25 points*)

A quality inspector at a widget factory measures the diameter of a specific part of the widget. The factory line must be shut down and re-adjusted if the diameter of this part becomes too small. Each hour the inspector takes a simple random sample of 100 widgets and if the mean diameter is below 5mm then the parts being produced are of poor quality. Suppose that for a particular hour the inspector calculates a sample mean of 4.96mm and sample standard deviation 0.2mm for the 100 widgets sampled.

(a) What is $\mathrm{SE}(\bar{x})$?

(b) State appropriate H_0 and H_A (null and alternative hypotheses) to test whether or not acceptable parts are being produced.

(c) Compute the test statistic and its P-value.

(d) Would you recommend that the production line be shut down? Explain your answer.

Question 7. (*25 points*)

Lead is a pollutant that can have harmful effects on humans. One method of measuring exposure to lead is to examine the lead content of human hair. One of the most common sources of lead

exposure is lead-based paint which was widely used up to the 1940's. In 1978, paint containing harmful levels of lead were banned from use on residences, furniture and toys. A research is interested in determining whether or not lead levels have changed from in the past. They gather a dataset which contains hair lead measurements in micrograms for adults who died between 1880 and 1920 and modern adults. The following table summarizes the results

Group	Size	Mean	Standard Deviation
1880-1920	30	48.5	14.5
Modern	100	26.6	12.3

You may assume that μ_1 is the mean lead level for adults in the 1880-1920 period and μ_2 is the mean lead level for modern day adults.

(a) What is the standard error of the difference between the two sample means $\bar{x}_1$ and $\bar{x}_2$?

(b) Do modern adults have lower lead levels? State appropriate H_0 and H_A (null and alternative hypotheses) for answering this question.

(c) Carry out this test. Be sure to state your test statistic value, its degrees of freedom and report your P-value. State in words what you conclude based upon your hypothesis test.

Question 8. (*25 points*)

Two insect sprays are to be compared for effectiveness at killing insects. Two rooms of equal size are sprayed. One with spray 1 and the other with spray 2. Then 100 insects are then released into each room. After 2 hours the number of dead insects are counted. In the room sprayed with spray 1 a total of 64 dead insects were found. In the other room 52 dead insects were found.

(a) Find a 96% confidence interval for the difference in proportion of insects killed be each spray.

(b) Based upon your confidence interval or otherwise determine whether or not the two sprays differ in effectiveness.

Non-compulsory bonus question. (*up to 20 points*)

Describe the uses and features of the two statistical inference techniques, confidence intervals and hypothesis tests, discussed in class. You should be sure to carefully explain the relationship between confidence intervals and hypothesis testing (you may do this in the context of confidence intervals and hypothesis tests for μ).