Queen's University
Faculty of Arts and Sciences
Department of Mathematics and Statistics
STAT 261 Winter 2006, Final Exam
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Wednesday, April 26, 2006

PRINT YOUR NAME:

You will have 3 hours for this exam. You may use one double-sided pages of notes and a calculator. Write your answers in the space provided. Except where otherwise indicated, you are expected to explain your answers. Correct answers without adequate explanation will not receive full credit. Incorrect answers without substantially correct explanation will receive no credit.

Tables of normal, t, and χ^2 distributions are provided at the end.

Put your answers in the spaces provided. The point value is given for each problem. The total number of points is 100.

PLEASE NOTE: "Proctors are unable to respond to queries about the interpretation of exam questions. Do your best to answer exam questions as written." If you are uncertain about the interpretation of a question, state explicitly the assumptions you are making.

1) (4 pts) An ESP experiment is done, in which a participant guesses which of 5 cards the researcher has randomly picked. This is repeated for 200 trials. The null hypothesis is that the subject is guessing and has a 1/5 probability of being correct on each guess, while the alternative is that the subject has ESP and can have a better chance than 1/5 of guessing right. The subject actually gets 50 correct answers. We perform a hypothesis test on this result. Which of the following describes the probability represented by the p-value for this test? (No explanation required.)

A. The probability that the subject has ESP.
B. The probability that the subject is just guessing.
C. The probability of 50 or more correct guesses if the subject has ESP.
D. The probability of 50 or more correct guesses if the subject is just guessing at the chance rate.
E. The probability that the subject is just guessing and would get 50 or more correct guesses.

2) (4 pts) A study is done to determine whether men and women have the same mean blood pressure. Random samples of men and women have their blood pressure measured. A statistical test is done at the 0.05 significance level: The null hypothesis is that the mean blood pressure of men and women are the same. The alternative hypothesis is that men have higher mean blood pressure than women. The p-value is computed to be 0.127. What is an appropriate conclusion? (No explanation required.)

A. Men and women have the same mean blood pressure.
B. Men have higher mean blood pressure than women.
C. There is not enough evidence to say that men and women have different mean blood pressure.
D. There is a probability 0.127 that men and women have the same mean blood pressure.
E. Men's mean blood pressure is about 12.7% higher than women's mean blood pressure.

3) (4 pts) In a criminal trial, the null hypothesis is that the defendant is innocent. In this context, a type II error would be (pick one, with no explanation)

A. a "guilty" verdict for an innocent defendant.
B. a "not guilty" verdict for a guilty defendant.
C. a "hung jury" that can't come to a verdict.
D. a "mistrial", a procedural error requiring that the trial be rerun from the start, with a new judge and jury.

4) (4 pts) Suppose we have a large population, in which 20% of the individuals are over age 65. We take 400 independent random samples from our census lists, of size 100 each, and find the proportion of individuals in each sample who are over age 65. We plot a histogram of these proportions. Fill in the blanks: We would expect about 68% of the values in the histogram to lie in the interval _____ ± _____.

5) (9 pts) Describe the following in your own words:

a) Double-blind experiment

b) Neyman-Pearson Lemma

c) Cramer-Rao Inequality

6) (16 pts) An experiment is planned to compare the mean μ_X of a control group against the mean μ_Y of an independent sample of a group given a treatment. There are to be 25 samples from each group. Suppose that the observations are approximately normally distributed, and that the standard deviation of a single measurement in either group is about $\sigma = 10$. We denote the control-group measurements by X_i, and the treatment-group measurements by Y_i.

a) What is the standard error of $\bar{Y} - \bar{X}$?

b) What is the rejection region for testing the null hypothesis $H_0 : \mu_X = \mu_Y$ against the alternative $H_0 : \mu_X > \mu_Y$, at significance level $\alpha = 0.05$?

c) What is the power of the test if $\mu_Y = \mu_X + 10$?

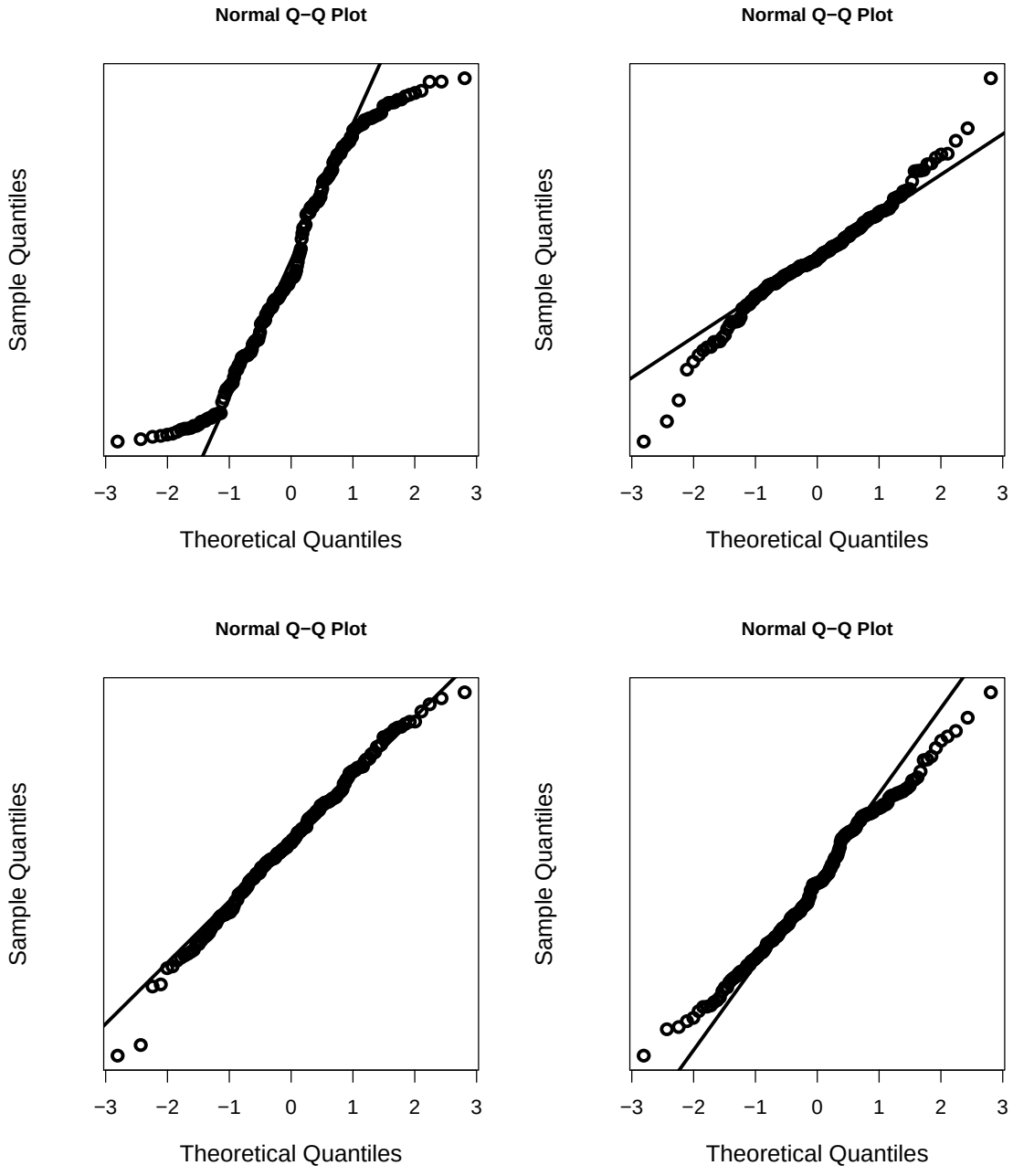
d) Suppose the p-value of the test is 0.07. If we are doing a test at significance level $\alpha = 0.10$, would the test reject?

7) (10 pts) A spectrophotometer is used to measure the concentration of carbon monoxide (CO) in air. The measurement errors are normally distributed, but the magnitude of measurement errors changes, and the average may also drift. Each day, the machine needs to be recalibrated: we need to check whether the average error, the bias, is about 0. To do this, it is used to measure a sample of gas (called "span gas") of known CO concentration 72 ppm (parts per million). Suppose we take 5 independent measurements of the span gas, and obtain measures 78, 69, 82, 74, 85 ppm.
a) Test the hypothesis that the average error is 0, at the 0.05 significance level.

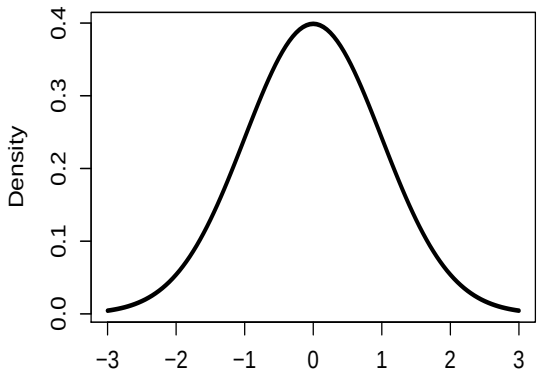
b) Construct a 90% confidence interval for the standard deviation of the measurements.

8) (12 pts) Two hundred samples were drawn from each of 4 probability distributions, and normal Q-Q plots were made of these data. Six probability distributions are sketched on the next page. For each Q-Q plot, identify the probability plot that is most likely to have yielded those data. (Note that each distribution has expectation 0 and variance 1.)

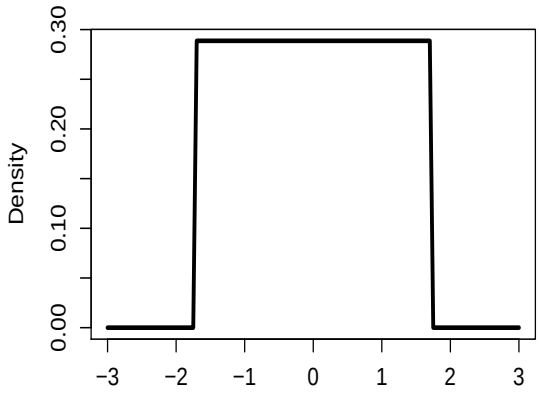
For each plot, explain why it is most likely to have come from the indicated distribution, and label the vertical axis to show the appropriate scale.



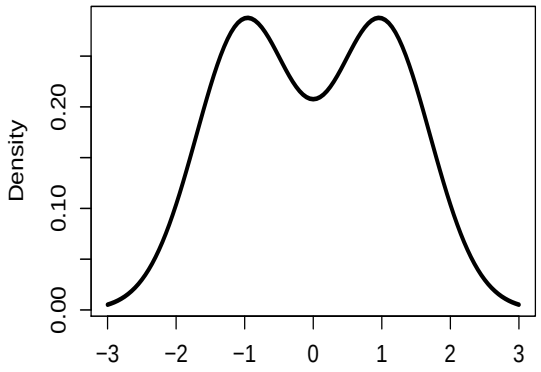
Plot A



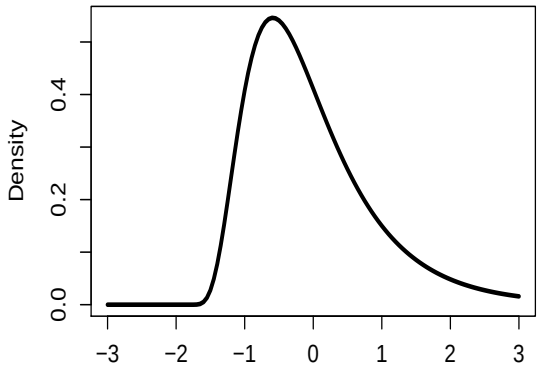
Plot B



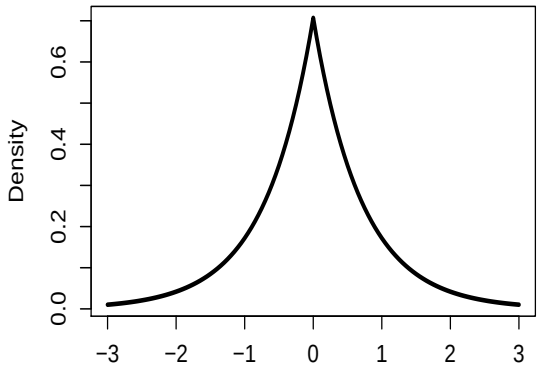
Plot C



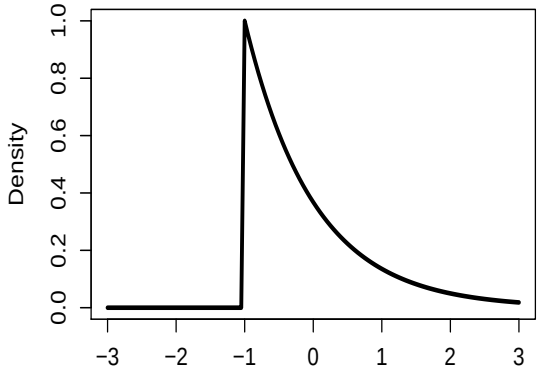
Plot D



Plot E



Plot F



9) (15 pts) It is found that the correlation in height between husbands and wives is about 0.3. The mean height of the husbands is 69 inches, the mean height of the wives is 65 inches. The husbands have SD 2.8 inches, and the wives have SD 2.5 inches. The distributions are normal, and the scatterplot is homoscedastic.

a) We are told a husband's height, and we use that to predict the wife's height. How much would we expect our prediction to be off by?

b) Write the regression equation for predicting the wife's height from the husband's height.

c) If we pick a random husband whose height is 72 inches, what is the probability that the wife is under 68 inches?

10) (10 points) Four hundred cardiac patients are randomly divided into two groups of two hundred each, one of which is given treatment A, the other treatment B. Neither the physicians nor the patients know which treatment any given patient has received. Five years later, 180 of the group A patients are still alive, but only 160 from group B.
(a) TRUE or FALSE, and explain: This result is good evidence for believing that treatment A saved some lives that would have been lost if treatment B had been given to everyone.

(b) Fill in the blank: *We can be about* _____*% sure that treatment A is more effective in the general population.* If you don't have enough information to fill in the blank, explain why not.

11) (12 points) It is hypothesized that when homing pigeons are disoriented in a certain manner, they will fly off in a completely random direction. To test this, 116 pigeons are disoriented, let loose, and the direction of flight of each is recorded. The following are the resulting data:

Direction	# Pigeons	Direction	# Pigeons
0–45°	12	180–225°	13
45–90°	12	225–270°	20
90–135°	17	270–315°	17
135–180°	15	315–360°	10

a) Formulate explicitly the null hypothesis.

b) What do the data tell us about the truth of the hypothesis?

Scores:

1:_____ 8:_____

2:_____ 9:_____

3:_____ 10:_____

4:_____ 11:_____

5:_____

6:_____ 7:_____

Total:_____