# MIDTERM EXAM (ver 3)

STA 110A
Brani Vidakovic
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Name: ______________________________

1. This is an open book and open notes exam.
2. Your group must show work and explain the answer in order to receive credit.
3. The exam carries 100 points.
4. The points assigned to each problem are indicated at the end of that problem. Use them to plan your time. You have 75 minutes to finish.
5. The exam has 6 problems. Make sure your copy has all of them.

**Two Masked Robbers.** **[15]** Two masked robbers try to rob a crowded bank during the lunch hour but the teller presses a button that sets off an alarm and locks the front door. The robbers realizing they are trapped, throw away their masks and disappear into the chaotic crowd. Confronted with 40 people claiming they are innocent, the police gives everyone a lie detector test. Suppose that guilty people are detected with probability 0.85 and innocent people appear to be guilty with probability 0.08. What is the probability that Mr. Smith was one of the robbers given that the lie detector says he is?

**Multiple Choice and Lazy Student.** **[15]** A professor gives a 100-question multiple-choice final exam. Each question has 4 choices. In order to pass, a student has to obtain at least 30 correct answers. A lazy student decides to guess at random on each question. What is the probability that the student passes the exam? (HINT: USE BINOMIAL DISTRIBUTION).

**About us.[15]** The exam scores for the students in an introductory statistics class are as follows.

| | | | | |
|---|---|---|---|---|
| 88 | 82 | 89 | 70 | 85 |
| 63 | 100 | 86 | 67 | 39 |
| 90 | 96 | 76 | 34 | 81 |
| 64 | 75 | 84 | 89 | 96 |

Find the "5-number summary" for the above data set.

**Aniline.** [20] Organic chemists often purify organic compounds by a method known as *fractional crystallization.* An experimenter wanted to prepare and purify 4.85 grams of aniline. Ten 4.85 quantities of aniline were individually prepared and purified to acetanilide.

(a) Test the hypothesis that the mean dry yield is less than 4 grams if the sample mean yield observed was $\bar{X} = 3.85$. Population variance $\sigma^2 = 0.08$ is assumed known and $\alpha = 0.05$.

(b) Report the $p$-value.

(c) For what values of $\bar{X}$ the null hypothesis will be rejected ($\alpha$ is still 0.05)?

(d) Define and explain the power of a test (No more than 4 sentences). What is the probability of error of second kind $\beta$ of the test under the alternative $H_1 : \mu = 3.6$.

**Growth Hormone.** **[15]** An investigation was undertaken to detrmine how the admnistration of a growth hormone affects the weight gain of pregnant rats. Weight gains during gestation are recorded for 6 control rats and for 6 rats receiving the growth hormone. The summary of the results[1] is given in the table below.

| | Control rats | Hormone rats |
|---|---|---|
| Mean | 41.8 | 60.8 |
| Standard deviation | 7.6 | 10.4 |

(i) State the assumptions about the populations and test to determine if the mean weight gain is significantly higher for the rats receiving the hormone than for the rats in the control group. Suppose the population variances are the same.

[1] Sara at al., *Science* 186 (1974), 446

**The Moon Illusion.**[20] Kaufman and Rock (1962) concluded that the commonly observed fact that the moon near the horizon appears larger than does the moon at its zenith (highest point overhead) could be explained on the basis of the greater *apparent* distance of the moon when it is at the horizon. As part of a very complete series of experiments, the authors initially sought to estimate the moon horizon so as to match the size of a standard "moon" that appeared at its zenith, or vice versa. (In these measurements, they used not the actual moon but an artificial one created with special apparatus.) One of the first questions we might ask is whether there really is a moon illusion - that is, whether a larger setting is required to match a horizon moon or a zenith moon. The following data for 10 subjects are taken from Kaufman and Rock's paper and represent the ratio of the diameter of the variable and standard moons. A ratio of 1.00 would indicate no illusion, whereas a ratio other than 1.00 would represent an illusion. (For example, a ratio of 1.50 would mean that the horizon moon appeared to have a diameter 1.50 times the diameter of the zenith moon.) Evidence in support of an illusion would require that we reject $H_0 : \mu = 1.00$ in favor of $H_1 : \mu \neq 1.00$.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Obtained ratio: | 1.73 | 1.06 | 2.03 | 1.40 | 0.95 | 1.13 | 1.41 | 1.73 | 1.63 | 1.56 |

For these data, $N = 10, \bar{X} = 1.463$, and $s = 0.341$.

Find 95% Confidence Interval for the unknown mean, on basis of data given in the above table.