

**BIOSTATS 540 - Introductory Biostatistics
Fall 2022**

Exam 3

Unit 8 – Introduction to Statistical Literacy

Unit 9 – One Sample Inference

Unit 10 – Two Sample Inference

Due: Monday December 19, 2022

Last Date for Submission with -10 points: Wednesday December 21, 2022

Last Date for Submission with Credit (-10 points): Wednesday December 21, 2022

This is an “open book” “take-home” exam. You are welcome to use any reference materials you wish. You are welcome to use the computer as you wish, too. However, you **MUST** work this exam **by yourself** and you may **not** consult with anyone (except me!).

How to Submit Your Exam

Please upload a ***SINGLE PDF***
of your completed exam to the Blackboard Learn ASSIGNMENT tab
no later than **Monday December 19, 2022 (11:59 pm)**.

... unless you are opting to submit your exam late per the late submissions policy above.

**BIOSTATS 540 - Introductory Biostatistics
Fall 2022**

Exam 3

Unit 8 – Introduction to Statistical Literacy

Unit 9 – One Sample Inference

Unit 10 – Two Sample Inference

Due: Monday December 19, 2022

Last Date for Submission with -10 points: Wednesday December 21, 2022

Last Date for Submission with Credit (-10 points): Wednesday December 21, 2022

Signature

This is to confirm that in completing this exam, I worked independently and did not consult with anyone.

Signature: _____

Printed Name: _____

Date: _____

11/28/2022

Dear BIOSTATS 540 Fall 2022

As with exams 1 and 2, the points on this exam total 105

Thus, you can lose 5 points in your work and still score 100 on this test.

Please note, however: The maximum score you can earn is 100.

1. (20 points total)

1a. (2 points)

True or False. For each positive integer degrees of freedom, there is a different Student t-distribution.

1b. (2 points)

True or False. When the population variance of a normal probability distribution is known, a Student t-distribution should not be used in hypothesis testing.

1c. (2 points)

True or False. For a one-sample t-test, the rejection region is uniquely determined by the alternative hypothesis and the sample size.

1d. (2 points)

True or False. For a test of a hypothesis about a population mean μ , the student t-distribution is used in place of the standard normal distribution when the population variance σ^2 is unknown and the sample size is small.

1e. (2 points)

True or False. Whether a hypothesis test is one-sided or two-sided depends on the question being asked by the investigator.

1f. (2 points)

True or False. In a paired t-test of data on 20 pairs of twins, there are 38 degrees of freedom.

1g. (2 points)

True or False. Even when $\mu_1 = \mu_2$, due to random sampling, the calculated value of the t-statistic may be large enough to cause a Type I error.

1h. (2 points)

True or False. If, in a two-sample test, it is true that $\mu_1 = \mu_2$, then the computed value of the t-statistic will be exactly zero.

1i. (2 points)

True or False. If the investigator is unsure that $\sigma_1 = \sigma_2$, this hypothesis can be tested prior to performing a two sample t-test equality of means.

1j. (2 points)

True or False. If $\sigma_1 = \sigma_2$, then the F test for equality of variances should be close to zero.

2. (10 points total)

In the movie “*When Harry Met Sally*”, there is a scene where Meg Ryan is shopping for a Christmas tree. The film shows a beautiful snowy night in New York city and Meg Ryan dragging her tree back to her apartment. Suppose the mean height of a sample of $n=15$ christmas trees was $\bar{X} = 143$ cm.

Assume that the population of tree heights is normal with known population standard deviation $\sigma = 18$ cm.

2a. (5 points)

Construct a 90% confidence interval estimate of the unknown mean μ .

2b. (5 points)

Have a look at the CI that you constructed in answering question #2a. On the basis of its lower bound, is it reasonable to say that the population mean tree height in the population is at least 130 cm? Explain.

3. (20 points total)

Sometimes drugs are recalled because of failure to meet “content uniformity” requirements. Suppose that “content uniformity” is expressed in terms of variance. For example, suppose a “content uniformity” requirement specifies that the variance in the amount of Phenobarbital in tablets must be less than or equal to 0.015 grams². (to be clear: the hypothesized variance here is = 0.015)

The satisfaction of this requirement is being evaluated in a simple random sample of 30 tablets. For this sample, the sample standard deviation was found to be $s=0.14$ grams. Carry out the appropriate statistical hypothesis test to assess compliance with the content uniformity specification of variance less than or equal to 0.015 grams². In developing your answer, address the following:

3a (4 points)

What is the null hypothesis?

3b (4 points)

What is the alternative hypothesis?

3c (4 points)

What is the appropriate test statistic and what is its value for these data?

3d (4 points)

What is the p-value?

3e (4 points)

In 1-2 sentences, what is your interpretation and conclusion?

4. (10 points total)

My house is in the woods. And, not surprisingly, there are lots of woods in my neighborhood as well! These neighboring woods are preferred areas for local hunters. December is hunting season in New England (what's more - each week has its own designated gun type). During these weeks, joggers are advised to wear the same "hunting" orange, even if they are careful and jog only on the roads.

A study of hunting injuries and the wearing of "hunting" orange found that, among 123 actual injured hunters who were mistaken for game, 6 were wearing "hunting" orange at the time.

Construct a 95% confidence interval for the population proportion π of injured hunters who are wearing "hunting" orange.

5. (10 points)

Consider testing the null hypothesis that the mean of a normal probability distribution is $\mu = 98.6$. The population standard deviation is known and is equal to $\sigma = 1.5$. You draw a sample of size 25 from this distribution and calculate a sample mean.

Suppose it is of interest to perform a two-sided test of the null hypothesis with a pre-specified type I error equal to 0.02.

What values must the sample mean lie between in order for the null hypothesis to be **not** rejected?

6. (20 points total)

A health management firm wants to know which of two hospitals (A or B) has the higher rating among former maternity patients with respect to such things as: service, food, cleanliness, staff friendliness, and the quality of the doctors. A questionnaire is devised and the responses for each former patient are summarized to form a single rating. The following are the ratings data.

Hospital A			Hospital B		
81	86	73	89	55	59
77	90	91	64	37	58
75	62	98	35	57	65
74			68	42	71
			69	49	67

6a (15 points)

Under the assumption that the data are simple random samples from two independent normal distributions with unknown variances, and under the assumption that the two unknown variances are equal, calculate a 95% confidence interval estimate of the difference in mean rating, where difference is defined as (Hospital A – Hospital B)

6b. (5 points)

In 1 sentence, interpret the confidence interval you obtained in #6a.

7. (15 points total)

A 95% confidence interval for the mean μ of a Normal distribution, in the setting of *known population variance*, was calculated using the usual formula $\bar{x} \pm [z_{1-\alpha/2}] \left(\frac{\sigma}{\sqrt{n}} \right)$. The resulting confidence interval was 5.7 to 6.5.

7a. (5 points)

What is the value of the sample mean used to calculate the confidence interval?

7b. (5 points)

What is the value of the standard error of the estimate?

7c. (5 points)

Using your answers to questions #7a and #7b, calculate a 99% confidence interval for μ .