

Name: _____
(Please print)

Exam Instructions

1. Answer ONLY what the question asks! This is not a homework, so there is no need to write a formal conclusion with every answer. If the question asks for a value, just calculate that value and provide it.
2. For multiple choice questions, pick ONE answer and write the letter of the answer choice on the line next to the problem number. If you circle an answer that does not match your written choice, I will grade your written answer choice.
3. For non-MC questions, circle/underline/box your final answer.
4. You are not required to show your work. However, partial credit for non-MC problems can only be given when work is provided. No partial credit will be given for MC problems.

Quantities you may find useful:

$$z_{0.9} = 1.28; \quad z_{0.95} = 1.645; \quad z_{0.975} = 1.96; \quad z_{0.99} = 2.33; \quad z_{0.995} = 2.576$$

Honor Statement. I pledge that I have not used any notes, text, or any other reference materials other than the “Formulas and Tables for Gerstman” (with personal additions) during this examination. I pledge that I have neither given nor received any aid from any other person during this examination, and that the work presented here is entirely my own. I furthermore pledge that I will not reveal any of the material on this examination, either in the form of the exact question or the topics covered, to any person for any reason. I pledge that I will report all Honor Code violations observed by me. I understand that if I have committed any of the above, I have violated the UNC Honor Code.

Signature and date:

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Use the following information to answer questions 1-4.

Consider the population of female diabetics over age 30. A sample of 25 diabetic women is selected, with mean $\bar{x} = 84$ mmHg and standard deviation $s = 12.1$ mmHg. In the general population of women over 30, it is thought that the average DBP is 74.4 mmHg.

1. Construct a 95% confidence interval for the true population mean μ of DBP for female diabetics over 30. (4 pts)

2. List the null and alternative hypotheses for the hypothesis test corresponding to the CI you created in #1. (2 pts)

3. *Without conducting a formal hypothesis test*, what is your decision about this test regarding the null hypothesis? (No interpretation necessary.) (2 pts)

4. How large a sample would be required for the 95% confidence interval to have a margin of error of 3.5 mmHg? (4 pts)

Use the following information to answer questions 5-8.

E. canis infection is a tick-borne disease of dogs that is sometimes contracted by humans. Among infected humans, the distribution of white blood cell counts is approximately Normal and has an unknown mean μ and a standard deviation σ . In the general population, the mean white blood cell count is 7250 mm^3 .

A simple random sample of 15 infected persons is used to test if the average WBC count differs from that of the general population. The sample mean and standard deviation are $\bar{x} = 4767 \text{ mm}^3$ and $s = 3204 \text{ mm}^3$. A 2-sided one sample t -test will be conducted at $\alpha = 0.05$.

_____ 5. What are the appropriate degrees of freedom for this test? (3 pts)

- A) 15
- B) 7249
- C) 14
- D) 4767

_____ 6. What is the p -value for this t test? (3 pts)

- A) $0.0025 < p\text{-value} < 0.005$
- B) $0.005 < p\text{-value} < 0.01$
- C) $0.01 < p\text{-value} < 0.025$
- D) $p\text{-value} > 0.5$

_____ 7. Suppose the mean and standard deviation obtained were based on a sample of size $n = 30$ infected persons rather than 15. What do we know about the value of the p -value? (3 pts)

- A) It would be larger.
- B) It would be smaller.
- C) It would be unchanged, because the detectable difference Δ is unchanged.
- D) It would be unchanged, because the variability measured by the standard deviation s stays the same.

_____ 8. If we decrease α , what happens to the p -value and the power of the test? (3 pts)

- A) p -value will increase and power will increase.
- B) p -value will not change and power will not change.
- C) p -value will decrease and power will decrease.
- D) p -value will not change and power will decrease.
- E) p -value will decrease and power will increase.

Use the following information to answer questions 9-12.

Consider a study comparing the characteristics of tuberculosis meningitis in patients infected with HIV and those who are not infected. We would like to determine whether the two populations have the same mean age.

Group	Mean (\bar{x}_i)	SD (s_i)	n_i
Group 1 (HIV Negative)	38.8	21.7	19
Group 2 (HIV Positive)	27.9	5.6	37

9. Assuming unequal group variances, what is the standard error of the difference between the means? (4 pts)

10. What is the test statistic for the two-sided test of no mean difference ($H_0 : \mu_1 = \mu_2$)? (4 pts)

11. Using the conservative degrees of freedom, what is the corresponding p -value? (4 pts)

- _____ 12. **True/False.** Assume the 95% confidence interval for $\mu_1 - \mu_2$ is given by (0.263, 21.537). Then the true (population) mean difference $\mu_1 - \mu_2$ has a 95% probability of being between 0.263 and 21.537. (2 pts)

Use the following information to answer questions 13-14.

A paired-samples study looked at the number of cavity-free children (per 100) before and after public water fluoridation projects in $n = 16$ U.S. cities. After calculating the differences, we obtain $\bar{x}_d = 12.2$ and $s_d = 13.62$. Based on the data, we decide to reject $H_0 : \mu_d = 0$ in favor of $H_A : \mu_d \neq 0$ at the $\alpha = 0.05$ level of significance.

_____ 13. Suppose the difference worth detecting $\Delta = 10$. What is the power of the test, assuming $\sigma = s_d = 13.62$? (5 pts)

- A) 0.6368
- B) 0.8365
- C) 0.9726
- D) 0.1635

_____ 14. Suppose we want to decrease the difference worth detecting to $\Delta = 5$. What happens to the Type II error rate of the test? (2 pts)

- A) Type II error rate increases.
- B) Type II error rate decreases.
- C) Type II error rate is unchanged.

_____ 15. **True/False.** When the original population is Normal, you can only use t procedures on samples of large size ($n > 40$). (3 pts)

_____ 16. **True/False.** ANOVA tests whether the variances of k groups are the same. (3 pts)

_____ 17. **True/False.** ANOVA requires that individual observations are independent of each other. (3 pts)

_____ 18. **True/False.** ANOVA requires that group samples are independent of each other. (3 pts)

19. Complete the following ANOVA table. Report 5 values in all. (10 pts)

Source	DF	Sum of Squares	Mean Square	F -Value	$\text{Pr} > F$
Model (Between)		3.456			0.0097
Error (Within)	8				
Corrected Total	11	4.656			

Use the following information to answer questions 20-23.

A trial evaluated the fever-reducing effects of three treatment therapies (aspirin, ibuprofen and acetaminophen). Study subjects were 15 adults seen in an emergency room with diagnoses of flu with body temperatures between 100.0°F to 100.9°F and were randomly assigned to one of the treatment groups. The response variable is the resulting decrease in body temperature, two hours post-therapy. The ANOVA table is provided below.

Source	Sum of		Mean	<i>F</i> -Value	Pr > <i>F</i>
	DF	Squares	Square		
Model (Between)	2	3.432	1.716	4.789	0.0296
Error (Within)	12	4.300	0.358		
Corrected Total	14	7.731			

20. Write the null and alternative hypotheses that are tested by the F statistic. (2 pts)

_____ 21. Which distribution was used to find the p -value? (3 pts)

- A) F with 2 and 12 degrees of freedom.
- B) F with 2 and 14 degrees of freedom.
- C) F with 12 and 14 degrees of freedom.
- D) t with 12 degrees of freedom.

_____ 22. What is the value of the estimated pooled standard deviation σ ? (3 pts)

- A) 2.074
- B) 0.358
- C) 1.716
- D) 0.598

_____ 23. At a significance level of $\alpha = 0.05$, what is the appropriate conclusion about mean fever reduction? (3 pts)

- A) The average reduction in fever appears to be the same for all three therapies.
- B) The average reduction in fever appears to be different for each of the three therapies.
- C) It appears that at least one of the three therapies has a different average reduction in fever.
- D) One therapy is significantly better than the other two.

Use the following to answer questions 24-29.

A study was conducted to monitor the emissions (in μm^3) of a noxious substance from a chemical plant and the concentration of the chemical at a location in close proximity to the plant at various times throughout the year. A total of 14 measurements were made. SAS output for the least squares model fit is provided (some entries have been omitted):

Fitted Model: Concentration = 1.543 + 1.825*Emissions

Summary of Fit Table

R-Square	R-Square Adj.	Root MSE	Mean of Response
0.7939	0.7767	1.5140	8.8107

ANOVA Table

Source	DF	Sum of Squares	Mean Square	<i>F</i>	Pr > <i>F</i>
Between (Model)		105.9639		46.2294	< .0001
Within (Error)	12				
Total		133.4695			

Parameter Estimate Table

Variable	Estimate	Std Error	<i>t</i> Value	Prob > <i>t</i>
Intercept	1.543	1.1429		0.2019
Emissions	1.825	0.2684		< .0001

_____ 24. The degrees of freedom for SS_B and SS_W are, respectively (3 pts)

- A) $df_B = 2, df_W = 12$.
- B) $df_B = 2, df_W = 13$.
- C) $df_B = 1, df_W = 12$.
- D) $df_B = 1, df_W = 13$.
- E) $df_B = 1, df_W = 14$.

_____ 25. What is the test statistic and its value to test $H_0 : \beta = 0$ against $H_A : \beta \neq 0$? (3 pts)

- A) $F = 2.292$
- B) $t = 6.80$
- C) $t = 1.35$
- D) $F = 3.8524$

26. Give an interpretation of the estimate of the slope in the context of the problem, in language the investigators can understand. (4 pts)

27. Based on this model, what is the estimated (predicted) Concentration level of the chemical, given an Emissions level of $10 \mu\text{m}^3$? (4 pts)

_____ 28. What is the 95% confidence interval estimate for β ? (4 pts)

- A) (1.24, 2.41)
- B) (-0.49, 3.58)
- C) (1.35, 2.38)
- D) (-0.95, 4.03)
- E) (-1.76, 4.84)

_____ 29. From the SPSS output, the value of R^2 equals 0.7939. Which of the following interpretations of the meaning of this value is correct? (3 pts)

- A) 79.39% of the variation in the predicted values of Emissions can be explained by its linear relationship with Concentration.
- B) 79.39% of the variation in Emissions can be explained by a nonlinear relationship with Concentration.
- C) 79.39% of the variation in the predicted values of Concentration can be explained by its linear relationship with Emissions.
- D) 79.39% of the variation in Concentration can be explained by its linear relationship with Emissions.