King Fahd University of Petroleum and Minerals Department of Mathematics Stat 319 Final Exam 241 December 22, 2024 Net Time Allowed: 120 Minutes

MASTER VERSION

- 1. The probability is 1% that an electrical connector that is kept dry fails during the warranty period of a portable computer. If the connector is ever wet, the probability of a failure during the warranty period is 6%. If 90% of the connectors are kept dry and 10% are wet, what proportion of connectors fail during the warranty period?
 - (a) 0.015 _____(correct)
 - (b) 0.009
 - (c) 0.006
 - (d) 0.070
 - (e) 0.059

- 2. Trees are subjected to different levels of carbon dioxide atmosphere with 6% of them in a minimal growth condition at 350 parts per million (ppm), 10% at 450 ppm (slow growth), 47% at 550 ppm (moderate growth), and 37% at 650 ppm (rapid growth). What is the standard deviation of the carbon dioxide atmosphere (in ppm) for these trees in ppm?
 - (a) 82.92 ppm _____(correct)
 - (b) 95.6 ppm
 - (c) 120.3 ppm
 - (d) 85.7 ppm
 - (e) 110.2 ppm

- 3. The time to failure (in hours) for a laser in a cytometry machine is modeled by an exponential distribution with $\lambda = 0.005$. What is the probability that the time until failure is between 120 and 150 hours?
 - (a) 0.0764 _____(correct)
 - (b) 0.4512
 - (c) 0.5276
 - (d) 0.9788
 - (e) 0.0019

4. A random sample of 60 suspension helmets used by motorcycle riders and automobile race-car drivers was subjected to an impact test, and some damage was observed on 18 of these helmets. Find a 76.2% two-sided confidence interval on the true proportion of helmets that would show damage from this test. The upper limit of interval is:

(a)	0.3698	(correct)
(b	0.3422	

- (c) 0.3179
- (d) 0.2302
- (e) 0.3041

- 5. A semiconductor manufacturer collects data from a new tool and conducts a hypothesis test with the null hypothesis that a critical dimension mean width equals 100 nm. Based on sample data, the decision is to not reject the null hypothesis. What is the correct conclusion?
 - (a) The critical dimension mean is not significantly different from 100 nm. _____(correct)
 - (b) The critical dimension mean is significantly higher than 100 nm.
 - (c) The critical dimension mean is significantly different from 100 nm.
 - (d) The critical dimension mean is not close to 100 nm.
 - (e) The critical dimension mean is significantly less than 100 nm.

6. Output from a software package follows:

One-Sample Z:

Test of $\mu = 20$ vs > 20

The assumed standard deviation = 0.75

Variable	n	Mean	Ζ	<i>p</i> -value
X	20	20.218	??	??

Find the missing p-value.

(a) 0.0968

(correct)

- (b) 0.1936(c) 0.9036
- (d) 0.8064
- (e) 0.0823

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(correct)

- 7. An engineer who is studying the tensile strength of a steel alloy intended for use in golf club shafts knows that tensile strength is approximately normally distributed with $\sigma = 415 \text{ kN/m}^2$. A random sample of 12 specimens has a mean tensile strength of $\bar{x} = 23800 \text{ kN/m}^2$. Test the hypothesis that mean strength is 24150 kN/m². Use $\alpha = 0.05$ and find which one of the following statements is **not** true.
 - (a) We reject the null hypothesis if $z_0 > 1.96$. _____(correct)
 - (b) We reject the null hypothesis if $|z_0| > 1.96$.
 - (c) The p-value of this test is approximately equal to 0.0035.
 - (d) We reject the null hypothesis if $z_0 > 1.96$ or if $z_0 < -1.96$.
 - (e) Rounded to 2 decimal points, the computed value of Z is -2.92.

8. Output from a software package follows:

One-Sample T:

Test of $\mu = 12$ vs not = 12

Variable	n	Mean	StDev	Т	<i>p</i> -value
X	10	12.564	1.1859	1.504	??

Find the missing p-value.

- (a) 0.1 < p-value < 0.2
- (b) 0.05 < p-value < 0.1
- (c) 0.01 < p-value < 0.05
- (d) 0.02 < p-value < 0.05
- (e) 0.01 < p-value < 0.02

- 9. The United States Golf Association tests golf balls to ensure that they conform to the rules of golf. Balls are tested for weight, diameter, roundness, and overall distance. The overall distance test is conducted by hitting balls with a driver swung by a mechanical device. Using a random sample of 277 distances (in yards) achieved by a particular brand of golf ball in the overall distance test, the mean distance came out to be 282 with a standard deviation of 12.06. Can you support a claim that mean distance achieved by this particular golf ball exceeds 280 yards? Find the *p*-value.
 - (a) 0.00289 _____(correct)
 - (b) 0.00578
 - (c) 0.00500
 - (d) 0.99711
 - (e) 0.99422

- 10. A researcher claims that at least 10% of all football helmets have manufacturing flaws that could potentially cause injury to the wearer i.e. $H_0: p \ge 0.1$ against $H_1: p < 0.1$. A sample of 200 helmets revealed that 16 helmets contained such defects. Does this finding support the researcher's claim? Using the critical value of 2.62, which of the following statements correctly applies the decision rule and conclusion?
 - (a) Since $z_0 = -0.94$ and it is not less than -2.62, we fail to reject the null hypothesis and conclude that the researcher's claim is valid. _____(correct)
 - (b) Since $z_0 = -0.94$ and it is not less than -2.62, we reject the null hypothesis and conclude that the researcher's claim is not supported.
 - (c) Since $z_0 = -0.94$ and its absolute value is less than 2.62, we accept the null hypothesis and conclude that the researcher's claim is false.
 - (d) Since $z_0 = -1.04$ and it is less than 2.62, we accept the null hypothesis and conclude that the researcher's claim is correct.
 - (e) Since $z_0 = -1.04$ and it falls above -2.62, we reject the null hypothesis and determine that the researcher's claim is not true.

(correct)

(correct)

- 11. Regression methods were used to analyze the data from a study investigating the relationship between roadway surface temperature (x) and pavement deflection (y). Summary quantities were n = 20, $\sum y_i = 12.75$, $\sum y_i^2 = 8.86$, $\sum x_i = 1478$, $\sum x_i^2 = 143, 215.8$, and $\sum x_i y_i = 1083.67$. Predict what pavement deflection would be observed when the surface temperature is 90°F? **Note:** For this question, round your calculations to 5 decimal places.
 - (a) 0.70448
 - (b) 141.445
 - (c) 0.33008
 - (d) 0.00797
 - (e) 0.00416

- 12. Regression methods were used to analyze the data from a study investigating the relationship between roadway surface temperature (x) and pavement deflection (y). Summary quantities were n = 20, $\sum y_i = 12.75$, $\sum y_i^2 = 8.86$, $\sum x_i = 1478$, $\sum x_i^2 = 143,215.8$, and $\sum x_i y_i = 1083.67$. What is the mean pavement deflection when the surface temperature is 90°F? Note: For this question, round your calculations to 5 decimal places.
 - (a) 0.70448 .
 - (b) 141.445
 - (c) 0.33008
 - (d) 0.00797
 - (e) 0.00416

(correct)

13. Consider the regression equation $\hat{y} = 38.02 + 0.774x$ and the following output generated from a dataset with n = 16:

Predictor	Coef	SE Coef	Т	Р
Constant	38.02	7.83	4.856	0.0003
X	0.774	0.5116	a_1	a_2

Find the value of a_2 i.e. the *p*-value for testing the significance of X.

(a) $0.10 < a_2 < 0.20$ ______(correct) (b) $0.05 < a_2 < 0.10$ (c) $0.20 < a_2 < 0.50$ (d) $0.01 < a_2 < 0.02$ (e) $0.02 < a_2 < 0.05$

14. Consider the regression equation $\hat{y} = 38.02 + 0.774x$ and the following output generated from a dataset with n = 16:

Source	DF	SS	MS	F	Р
Regression	1	b_1	b_2	b_3	b_4
Residual error	14	321.54	22.97		
Total	15	374.13			

Find the value of b_3 i.e. the *F*-statistic for testing the significance of regression model.

- (a) $b_3 = 2.2895$ _
- (b) $b_3 = 0.4368$
- (c) $b_3 = 52.59$
- (d) $b_3 = 3.7564$
- (e) $b_3 = 0.774$

(correct)

15. Consider the regression equation $\hat{y} = 38.02 + 0.774x$ and the following output generated from a dataset with n = 16:

Source	DF	\mathbf{SS}	\mathbf{MS}	\mathbf{F}	Р
Regression	1	b_1	b_2	b_3	b_4
Residual error	14	321.54	22.97		
Total	15	374.13			

Find the value of b_4 i.e. the *p*-value for testing the significance of regression model.

- (a) $0.1 < b_4 < 0.25$ _
- (b) $0.05 < b_4 < 0.1$
- (c) $0.025 < b_4 < 0.05$
- (d) $0.01 < b_4 < 0.025$
- (e) $0.005 < b_4 < 0.01$

16. Data are available on the highway gasoline mileage performance and engine displacement for DaimlerChrysler vehicles for model year 2005. A simple linear model relating highway miles per gallon (y) to engine displacement (x) in cm³ was fitted using least squares. Following results are obtained:

 $\sum y_i = 620.5, \ \sum y_i^2 = 18985.71, \ \sum x_i = 5017, \ \sum x_i^2 = 1436737, \ \sum x_i y_i = 138662.8, \\ n = 21, \ S_{xx} = 238151.8095, \ S_{xy} = -9577.6048, \ \hat{\beta}_1 = -0.0402, \ \hat{\beta}_0 = 39.1516, \\ SST = 651.4124, \ SSR = 385.0197 \text{ and } SSE = 266.3927.$

Construct a 99% prediction interval on highway gasoline mileage when the engine displacement is $x = 158 \text{ cm}^3$. Use $t_{\alpha/2,19} = 2.861$ and report the upper limit.

(a) 43.9 miles per gallon

(correct)

- (b) 74.4 miles per gallon
- (c) 35.7 miles per gallon
- (d) 44.3 miles per gallon(e) 81.2 miles per gallon

17. An engineer at a semiconductor assembly plant is investigating the relationship between pull strength of a wire bond and the wire length. A random sample of 25 units is selected and tested, and the wire bond pull strength and wire length are observed for each unit. We assume that pull strength and wire length are jointly normally distributed. For fitting a simple linear regression of wire pull strength (y) on wire length (x), we have the following results:

 $S_{xx} = 698.56, S_{xy} = 2027.7132$ and $S_{yy} = 6105.9$.

What percent of variability in pull strength is explained by the linear relationship to wire length i.e. Coefficient of determination R^2 ?

- (a) 96.4% _____(correct)
- (b) 95.0%
- (c) 98.2%
- (d) 99.4%
- (e) 20.3%

- 18. A study was performed to investigate the shear strength of soil (y) as it related to depth in feet (x_1) and percent of moisture content (x_2) . Ten observations were collected, and the fitted linear regression model is given as: $\hat{y} = 171.055 + 3.714x_1 1.126x_2$. Using this model, the predicted shear strength for a soil sample with a depth of 18 feet (i.e. $x_1 = 18$) and a moisture content of 43% (i.e. $x_2 = 43$) was calculated. Afterwards, the actual shear strength for this specific sample was measured to be 191.2. What is the residual value for this observation?
 - (a) 1.711 _____(correct)
 - (b) 189.489
 - (c) 3.714
 - (d) -1.126
 - (e) 171.055

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_(correct)

- 19. You have fit a regression model with two regressors to a data set that has 20 observations. The total sum of squares (SST) is 1200 and the model sum of squares (SSR) is 1000. Suppose that you add a third regressor to the model and as a result, the model sum of squares is now 1100. For testing the hypothesis that adding this regressor has improved the model significantly, what is the value of partial *F*-statistic?
 - (a) 16 _____(correct)
 - (b) 6.25
 - (c) 17
 - (d) 20
 - (e) 5.88

20. A multiple linear regression model produced the following summary and ANOVA table:

S = 3.0(82) $R-sq = 93.(%)$	S = 3.07827	R-sq = 93.7%
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Source	DF	SS	MS	\mathbf{F}	Р
Regression	2	842.37	421.18	44.45	0.000
Residual error	6	56.85	9.48		
Total	8	899.22			

R-sq(adj) = ??

Find the adjusted R-square.

(a) 91.6% _

- (b) 94.8%
- (c) 93.7%
- (d) 92.3%
- (e) 88.1%