5. Windmills generate electricity by transferring energy from wind to a turbine. A study was conducted to examine the relationship between wind velocity in miles per hour (mph) and electricity production in amperes for one particular windmill. For the windmill, measurements were taken on twenty-five randomly selected days, and the computer output for the regression analysis for predicting electricity production based on wind velocity is given below. The regression model assumptions were checked and determined to be reasonable over the interval of wind speeds represented in the data, which were from 10 miles per hour to 40 miles per hour.

Predictor	Coef	SE Coef	T	P
Constant	0.137	0.126	1.09	0.289
Wind velocity	0.240	0.019	12.63	0.000

S = 0.237 R-Sq = 0.873 R-Sq (adj) = 0.868

(a) Use the computer output above to determine the equation of the least squares regression line. Identify all variables used in the equation.

(b) How much more electricity would the windmill be expected to produce on a day when the wind velocity is 25 mph than on a day when the wind velocity is 15 mph? Show how you arrived at your answer.

(c) What proportion of the variation in electricity production is explained by its linear relationship with wind velocity?

(d) Is there statistically convincing evidence that electricity production by the windmill is related to wind velocity? Explain.

STATISTICS
SECTION II
Part B
Question 6

Spend about 25 minutes on this part of the exam.

Percent of Section II score—25

Directions: Show all your work. Indicate clearly the methods you use, because you will be scored on the correctness of your methods as well as on the accuracy and completeness of your results and explanations.

6. Every year, each student in a nationally representative sample is given tests in various subjects. Recently, a random sample of 9,600 twelfth-grade students from the United States were administered a multiple-choice United States history exam. One of the multiple-choice questions is below. (The correct answer is C.)

In 1935 and 1936 the Supreme Court declared that important parts of the New Deal were unconstitutional. President Roosevelt responded by threatening to (A) impeach several Supreme Court justices (B) eliminate the Supreme Court (C) appoint additional Supreme Court justices who shared his views (D) override the Supreme Court's decisions by gaining three-fourths majorities in both houses of Congress

Of the 9,600 students, 28 percent answered the multiple-choice question correctly.

(a) Let p be the proportion of all United States twelfth-grade students who would answer the question correctly. Construct and interpret a 99 percent confidence interval for p.

Assume that students who actually know the correct answer have a 100 percent chance of answering the question correctly, and students who do not know the correct answer to the question guess completely at random from among the four options.

Let k represent the proportion of all United States twelfth-grade students who actually know the correct answer to the question.

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Question 5

Intent of Question

The primary goals of this question were to assess students' ability to (1) determine the equation of the least squares regression line from a computer output; (2) use the slope of the least squares line to compare expected values of the response variable for different values of the explanatory variable; (3) recognize how to determine the proportion of variability in the response variable explained by the least squares line; (4) use computer output to determine whether the linear relationship between two quantitative variables is statistically significant.

Solution

Part (a):

The equation of the least squares regression line is

predicted electricity production = 0.137 + 0.240 × wind velocity.

Part (b):

The slope coefficient of 0.240 indicates that for each additional mph of wind speed, the expected electricity production increases by 0.240 amperes. Thus, the expected electricity production is $10 \times 0.240 = 2.40$ amperes higher on a day with 25 mph wind velocity as compared to a day with 15 mph wind velocity.

Part (c):

The proportion of variation in electricity production that is explained by the linear relationship with wind speed is R^2, which the regression output reports to be 0.873.

Part (d):

Yes, there is very strong statistical evidence that the population slope differs from zero, so electricity production is linearly related to wind speed. For testing the hypotheses $H_0 : \beta = 0$ versus $H_a : \beta \neq 0$, where β represents the population slope, the output reveals that the test statistic is $t = 12.63$ and the *p*-value (to three decimal places) is 0.000. Because the *p*-value is so small (much less than both 0.05 and 0.01), the sample data provide very strong statistical evidence that electricity production is linearly related to wind speed.

Scoring

Parts (a), (b), (c) and (d) are scored as essentially correct (E), partially correct (P) or incorrect (I).

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Question 5 (continued)

Part (d) is scored as follows:

Essentially correct (E) if the response includes the following three components:
1. Gives the correct conclusion based on a test for the population slope.
2. Reports the correct *p*-value and/or *t*-statistic.
3. Provides linkage/justification between the *p*-value (or *t*-statistic) and the conclusion.

Partially correct (P) if the response provides exactly two of the three components listed above.

Note: If the wrong *p*-value is chosen, but the conclusion is consistent with that *p*-value and linkage or justification is provided, the response earns a P.

Incorrect (I) if the response fails to meet the criteria for E or P.

Each essentially correct (E) part counts as 1 point. Each partially correct (P) part counts as ½ point.

4 **Complete Response**

3 **Substantial Response**

2 **Developing Response**

1 **Minimal Response**

If a response is between two scores (for example, 2½ points), use a holistic approach to determine whether to score up or down, depending on the overall strength of the response and communication.