

1. A civil engineer wishes to determine the size needed to estimate the mean maximum stress that can be withstood by a seal used for rigid pavements. Desired precision is ± 100 MPa with reliability 0.95. She has no feel for an assumed population standard deviation; however, the designer believes that it is almost certain that an individual seal will withstand a test stress of 5,000 MPa, whereas it is extremely unlikely that any seals will survive 6,500 MPa.

- (1) What value should the civil engineer use as her assumed standard deviation? (5 points)
- (2) Using your answer to (1), what is the required sample size? (10 points)

Values Provided for Your Calculations

| Student <i>t</i> Distribution | | | | Critical Normal Deviate Values | | | |
|-------------------------------|--------------------------|-------|-------|--------------------------------|------|------|-------|
| Degree of Freedom | Upper-Tail Area α | | | Upper Tail Area α | 1 | 0.05 | 0.025 |
| | 0.1 | 0.05 | 0.025 | Normal Deviate z_α | 1.28 | 1.64 | 1.96 |
| 7 | 1.415 | 1.895 | 2.365 | | | | |
| 8 | 1.397 | 1.860 | 2.306 | | | | |

2. A teacher wants to decide whether or not to include a computer-aided design (CAD) software package in his class on highway geometric design. He is skeptical about the time-savings claims made by the salesperson. A test has been conducted using pairs of nearly equally skillful students who independently design the same project—one using CAD and the other unassisted. For $n = 8$ parts, the following percentage time-savings by CAD over the unassisted design were obtained:

80 10 37 26 45 29 44 5

At the 5% significance level, can the faculty conclude that CAD will indeed yield savings in time over present design methods? (15 points)

3. For statistical process control of a certain variable x , quality control periodically measures a sample of $n=4$ product units. Please answer the following questions using 3-sigma-limit when no specifications are given.

- (1) The sample range R is calculated. For a history of 20 lots, R has fluctuate at random between 1.3 and 6.5, with an average of $\bar{R} = 3.665$. Is the process standard deviation σ_x stable? (10 points)
- (2) The sample average \bar{X} fluctuates at random between 5.82 and 15.42, with an average of $\bar{\bar{X}} = 10.79$. Is the process mean μ_x stable? (10 points)

| n | d_2 | d_3 | c_4 | c_5 |
|-----|-------|-------|-------|-------|
| 4 | 2.059 | 0.88 | 0.921 | 0.389 |

4. Assume $Y_i \sim N.D.(\mu, \sigma^2)$, and consider the following data:

| | | | | | |
|-------|---|---|---|---|---|
| X_i | 1 | 2 | 3 | 4 | 5 |
| Y_i | 2 | 3 | 5 | 5 | 6 |

The least square line for these data is $\hat{Y} = a + bX = 1.2 + 1X$

(1) Please finish the following ANOVA table. (8 points)

| Source | Degree of Freedom (DF) | Sum of Square (SS) | Mean Square (MS) |
|------------|------------------------|--------------------|------------------|
| Regression | | | |
| Error | | | |
| Total | | | |

- (2) Please test the hypothesis: $H_0: a = b = 0$. Note: $F_{0.05} = 10.13$ (2 points)
- (3) If you were free to choose the X_i , how would you choose them when the object was to make the variance of "a" small? (5 points)
- (4) What is the R^2 value? (5 points)
- (5) What is the condition on R^2 under which the adjusted R^2 become negative? (5 points)

(背面仍有題目,請繼續作答)

5. The density of a newly completed highway in Tainan is to be inspected by coring specimens from pavements. Suppose that from past experience, the density of such pavements has a standard deviation of 3%. The mean densities of good and poor quality lots are 96% and 92% respectively. Both consumer's risks (CR) and producer's risks (PR) are taken at 5%. Please use the concepts of the normal distribution to answer the following questions:

- (1) How many samples should you take to reach the balance between PR and CR? (5 points)
- (2) What is the average density to ensure the quality of pavements? (5 points)

6. Please decide the best answer for each question. (15 points)

The answer for following question should include more than one choices except question (5).

(1) Regarding the level of significance in hypothesis testing, please write down the correct choice(s).

- a. is the maximum allowable probability of Type I error
- b. is the maximum allowable probability of Type II error
- c. is the same as p-value
- d. is the probability of accepting a false null hypothesis
- e. is the probability of rejecting a true null hypothesis

(2) Four types of compactors are used to prepare asphalt concrete sample for determining the asphalt content (AC). Based upon the test results, the significant level at which means differ from the AC is presented in the following table. What are the correct statements when we establish the significant level equal to 5%?

| Compactor | A | B | C | D |
|-----------|------|------|------|------|
| A | - | 0.94 | 0.98 | 0.02 |
| B | 0.90 | - | 1 | 0.99 |
| C | 0.98 | 1 | - | 0.01 |
| D | 0.02 | 0.99 | 0.01 | - |

- a. The AC determined by compactor A can be declared to be same as the one from compactor B.
- b. The AC determined by compactor A can be declared to be same as the one from compactor D.
- c. The AC determined by compactor B can be declared to be same as the one from compactor C.
- d. The AC determined by compactor B can be declared to be same as the one from compactor D.
- e. The AC determined by compactor C can be declared to be same as the one from compactor D.

(3) Regarding the multiple regression analysis, please write down the correct choices.

- a. The variance of the error term, ϵ , is assumed to be the same for all values of the dependent variable.
- b. The correlation among the independent variables is termed linearity.
- c. The adjusted multiple coefficient of determination is adjusted for the number of independent variables.
- d. The error term, ϵ , is assumed to be normally distributed with mean of 0 and variance of 1.
- e. For each dependent variable, the collection of all possible independent variable corresponding to that dependent variable has a normal distribution.

(4) Regarding the tests of hypotheses, please write down the correct choices. (a) The null hypothesis (H_0) is a statement asserting no change, or no difference, or no effect. (b) The acceptance of a hypothesis implies that it is true. (c) The rejection of a hypothesis is to conclude that it is false. (d) The rejection of H_0 leads to the acceptance of an alternative hypothesis H_1 . (e) Statistical significance does not necessarily imply practical significance.

(5) Accuracy is the conformity of results, i.e., absence of bias. The reliability of an estimate is the probability that it is correct. Therefore, one can always be improved at the expense of the other. (True or False)