Last Name:

First Name:

SCIPER:

Practice Problems: Exercise 7 – Microengineering 110

Spring 2025

Prof. Vivek Subramanian

1. The true average diameter of ball bearings of a certain type is supposed to be .5 in. A one-sample t test will be carried out to see whether this is the case. What conclusion is appropriate in each of the following situations? Assume that 95% confidence is required, unless indicated otherwise.

    a. n = 13, t = 1.6

    The hypotheses are H_0: μ = .5 versus H_a: $\mu \neq$ .5. This is a two-sided test.
    n = 13 $\Rightarrow$ df = 13 – 1 = 12.
    Two-tailed P-value = 0.136. Since .136 > α = .05, we do not reject H_0.

    b. n = 13, t = -1.6

    Same as above, due to symmetry in a 2-tailed test.

    c. n = 25, t = -2.6, 99% percent confidence is required

    df=24, Two-tailed P value = 0.0157, so we do not reject H_0. Note that we would reject H_0 if this were a 95% confidence test.

2. Cube compressive strength (MPa) of concrete specimens is provided below:

    112.3, 97.0, 92.7, 86.0, 102.0, 99.2, 95.8, 103.5, 89.0, 86.7

    Suppose the concrete will be used for a particular application unless there is strong evidence that true average strength is less than 100 MPa. Should the concrete be used? Perform a test of appropriate hypotheses.

    The hypotheses are H_0: μ = 100 versus H_a: μ < 100. Since the data come from a plausibly normal population, we will use the t procedure.

    $$t = \frac{\bar{x} - \mu_0}{s/\sqrt{n}} = \frac{96.42 - 100}{8.26/\sqrt{10}} = -1.37$$

    Since this is a "less than" test, we should use a one-tailed distribution. The corresponding one-tailed P-value, at df = 10 – 1 = 9, is $P(T \leq -1.37) \approx .102$.

    At 95% confidence, the null hypothesis H0: μ = 100 should not be rejected. This concrete may be used.

3. Submerged arc welding (SAW) process is commonly used for joining thick plates and pipes. The heat affected zone (HAZ), a band created within the base metal during welding, was of particular interest to the investigators. Here are observations on depth (mm) of the HAZ both when the current setting was high and when it was lower.

   Non-high 1.04 1.15 1.23 1.69 1.92 1.98 2.36 2.49 2.72 1.37 1.43 1.57 1.71 1.94 2.06 2.55 2.64 2.82
   High 1.55 2.02 2.02 2.05 2.35 2.57 2.93 2.94 2.97

   Does it appear that true average HAZ depth is larger for the higher current condition than for the lower condition? Carry out a test of appropriate hypotheses using a significance level of .01.

   Let μ_1 = the true average depth under the high current setting and let μ_2 = the true average depth under the non-high current setting. We test H_0: $\mu_1 - \mu_2 = 0$ versus H_a: $\mu_1 - \mu_2 > 0$. [The order of the two groups is arbitrary; we just need the direction of the alternative to be consistent with our research question.]

   We can plug the values into the online calculator at socscistatistics, and obtain

   $$t = \frac{(2.378 - 1.926) - 0}{\sqrt{0.507^2/9 + 0.569^2/18}} = 2.$$

   The corresponding one-tailed P-value is .027. Since .025 > .01, at the .01 significance level we fail to reject H_0. At the 1% level, we do not have sufficient evidence to conclude that the true mean HAZ depth is larger when the current setting is higher.

4. Lactation promotes a temporary loss of bone mass to provide adequate amounts of calcium for milk production. The total body bone mineral content (TBBMC) (g) for 10 people both during lactation (L) and in the postweaning period (P) is provided below:

	1	2	3	4	5	6	7	8	9	10
L	1928	2549	2825	1924	1628	2175	2114	2621	1843	2541
P	2126	2885	2895	1942	1750	2184	2164	2626	2006	2627

   a. Does the data suggest that true average total body bone mineral content during postweaning exceeds that during lactation by more than 25 g? State and test the appropriate hypotheses (HINT: Since we are testing for a difference of 25, define the appropriate equation carefully) using a significance level of .05.

   H_0: $\mu_D \leq 25$ v. H_a: $\mu_D > 25$. The test statistic is $t = \dfrac{105.7 - 25}{103.845/\sqrt{10}} = 2.46$

   At DF=8, P=0.018. We therefore reject the null hypothesis and conclude that true average TBBMC during postweaning does exceed the average during lactation by more than 25 grams.

b. Perform a similar test using a 2-sample t-test. Does the (incorrect) use of the two-sample t test to test the hypotheses suggested in (a) lead to the same conclusion?

Using socscistats, we find the t-value and P-value are -0.588 and 0.281, suggesting that the null hypothesis cannot be rejected.   This shows the benefit in confidence of using pairing when possible.

5. Data on cylinder strength (MPa) for various types of columns cured under both moist conditions and laboratory drying conditions is provided below.

<table>
<tr><td></td><td colspan="6">Type</td></tr>
<tr><td></td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr>
<tr><td>M:</td><td>82.6</td><td>87.1</td><td>89.5</td><td>88.8</td><td>94.3</td><td>80.0</td></tr>
<tr><td>LD:</td><td>86.9</td><td>87.3</td><td>92.0</td><td>89.3</td><td>91.4</td><td>85.9</td></tr>
<tr><td></td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td></tr>
<tr><td>M:</td><td>86.7</td><td>92.5</td><td>97.8</td><td>90.4</td><td>94.6</td><td>91.6</td></tr>
<tr><td>LD:</td><td>89.4</td><td>91.8</td><td>94.3</td><td>92.0</td><td>93.1</td><td>91.3</td></tr>
</table>

Does the drying method affect strength, assuming the data is paired?

Using socscistats, we find a t value of 0.9, which gives us a p-value of .38… this indicates that the drying method does not affect strength in a statistically significant way.