ISE 2211 • Exam V • 30 October 2020 NAME SOLUTION

Aircraft electrical wiring often has a conformal coating that makes it more reliable under situations where it may be exposed to fire, seawater, or high-voltage spikes due to lightning and electromagnetic pulses.
A new manufacturing process has been introduced that supposedly reduces the variance in coating thickness; however, it is unknown what effect this has on the mean coating thickness. Population variances are unknown but assumed to be unequal. Samples of each process were analyzed with the following results:
$n_1 = 10$, $\bar{x}_1 = 82$ µm, $s_1 = 6.2$ µm; $n_2 = 8$, $\bar{x}_2 = 80$ µm, $s_2 = 3.8$ µm.
Test the following hypotheses on the difference in means of coating thickness at the $\alpha = 0.05$ level of significance and state whether you would reject or fail to reject $H_0$:
$H_0: \mu_1 = \mu_2$
$H_1: \mu_1 \neq \mu_2$

∴ need $V$

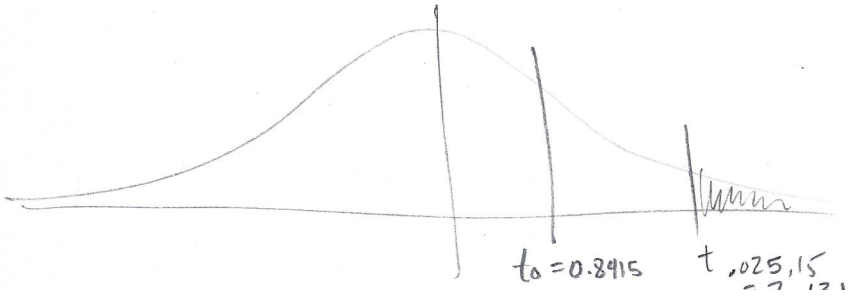
$$\frac{s_1^2}{n_1} = \frac{6.2^2}{10} = 3.844 \qquad \frac{s_2^2}{n_2} = \frac{3.8^2}{8} = 1.805$$

$$V = \frac{(3.844 + 1.805)^2}{\frac{3.844^2}{9} + \frac{1.805^2}{7}} = 15.14 \quad (+2)$$

round down to $V = 15$ (+1)

$$t_0 = \frac{82 - 80}{\sqrt{\frac{6.2^2}{10} + \frac{3.8^2}{8}}} = 0.8415 \quad (+1)$$

$$t_{\alpha/2, V} = t_{.025, 15} = 2.131 \quad (+1)$$




$t_0 \not> t_{.025,15}$

∴ fail to reject $H_0$ (+2)

Now test the following hypotheses on equality of variances of coating thickness using fixed-$\alpha$ @ 0.05:

$H_0: \sigma_1^2 = \sigma_2^2$

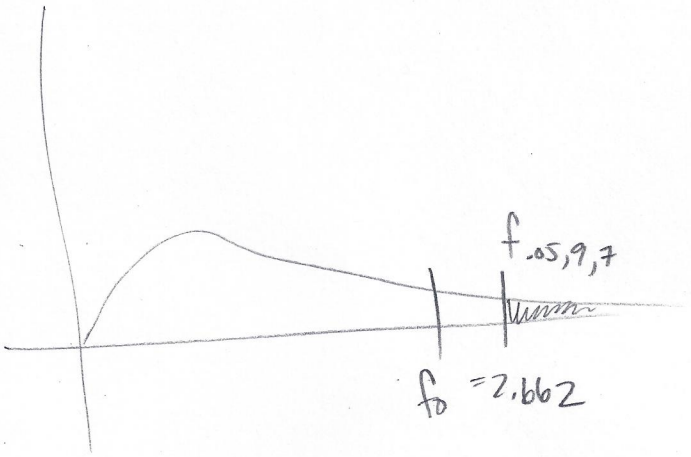
$H_1: \sigma_1^2 > \sigma_2^2$

What does the data suggest about the two processes?

$$f_0 = \frac{S_1^2}{S_2^2} = \frac{6.2^2}{3.8^2} = 2.662 \quad (+1)$$

critical value (upper one-sided):

$$f_{\alpha, n_1-1, n_2-1} = f_{.05,9,7} = 3.68 \quad (+2)$$




$f_0 \neq f_{.05,9,7}$ $\therefore$ fail to reject $H_0$ (+2)

$\therefore$ there is insufficient evidence that the new process reduces variance in coating thickness (+1)

Small voids in the conformal coating are highly undesirable and require that a wire sample be rejected. In this test, four samples of process number one and three samples of process number two were rejected for this reason. Write a 95% confidence interval on the difference in population proportions of rejected wire samples and use it to test the following hypotheses:

$p_1 = p_2$

$p_1 \neq p_2$

$\hat{p}_1 = \frac{4}{10} = 0.4$

$\hat{p}_2 = \frac{3}{8} = 0.375$ } +2

$Z_{\alpha/2} = Z_{.025} = 1.960$ +1

$p_1 - p_2$ : $0.4 - 0.375 \pm 1.960\sqrt{\frac{.4(1-.4)}{10} + \frac{.375(1-.375)}{8}}$

$-0.4275 < p_1 - p_2 < 0.4775$ +2

C.I. does contain zero; ∴ fail to reject $H_0$

+2

Conceptual understanding question: how would a *paired t-test* be implemented in this problem; i.e., what would the test specimens be and what would you do with them and why?

- test specimens would be wire samples +1

- would have to somehow coat same sample w/ both processes, to mitigate confounding effects of variation due to wire, environment, etc.. +2