ISE 2211 Exam IV Solution
27 March 2020

1) Manufacturing flaws are inevitable in the manufacture of vacuum tubes for high-end audio applications. Of the potential consequences of these flaws, noise is often the end result in small-signal tubes. Joe Tritschler purchased a batch of 100 tubes in 2013 and seven of these were noisy and had to be excluded in the preamp he manufactures on joetritschler.com. Last year, he bought a smaller batch of fifty tubes and only two of these were noisy. Test the following hypotheses on the difference in proportions of noisy tubes using the *p*-value approach. In the space provided, show your sample proportions, test statistic, *p*-value, final conclusions with respect to $\alpha = 0.05$, and any necessary supporting work.

H_0: $p_1 = p_2$
H_1: $p_1 \neq p_2$

Solution:

$\hat{p}_1 = .07$ (+1)

$\hat{p}_2 = .04$ (+1)

$\hat{p} = .06$ (+1)

$Z_0 = 0.7293$ (+1)

p-value/2 ≈ $P(Z > 0.73) = P(Z < -0.73)$ (+1)

= 0.235762 (table) (+1)

p-value = 0.471524 (+1)

p-value >>> 0.05 (+1)

fail to reject H_0 (+1)

2) Joe Tritschler randomly spot-checked the transconductance of a few tubes in each batch and got the following values:

$n_1 = 10$ tubes, $\bar{x}_1 = 10{,}820$ µmhos, $s_1 = 1622$ µmhos
$n_2 = 8$ tubes, $\bar{x}_2 = 11{,}730$ µmhos, and $s_2 = 848$ µmhos.

Write a 95% C.I. on the ratio of population standard deviations and use it to test the following hypotheses:
H_0: $\sigma_1 = \sigma_2$
H_1: $\sigma_1 \neq \sigma_2$
Include a unit with the C.I. Show critical values and any other necessary information in the space provided. Don't get too hung up on perfect mathematical notation; it's awkward to input electronically.

Solution:

$s_1^2 / s_2^2 = 1622^2 / 848^2 = 3.659$ (+1)

$f_{\alpha/2, n2-1, n1-1} = f_{0.025, 7, 9} = 4.20$ (+2)

$f_{1-\alpha/2, n2-1, n1-1} = 1/f_{\alpha/2, n1-1, n2-1} = 1/f_{0.025, 9, 7} = 1/4.82 = 0.2075$ (+2)

$0.7592 < \sigma_1^2/\sigma_2^2 < 15.37$ (+1)

$\underline{0.8713 < \sigma_1/\sigma_2 < 3.920}$ (+1)

C.I. contains unity; therefore, fail to reject H_0. (+2)

3) Using data from problem #2, test the following hypotheses regarding the mean values of transconductance between the two batches of vacuum tubes using the fixed-significance-level approach at $\alpha = 0.05$. Population variances are unknown and assumed <u>unequal</u>. Show the test statistic, critical value, and any other supporting information in the spaced provided, along with your final conclusion.
H_0: $\mu_1 - \mu_2 = 0$
H_1: $\mu_1 - \mu_2 < 0$

Solution:

$v = 14.09$ (+2)

Round down to $v = 14$ (+1)

critical value: $-t_{\alpha, v} = -t_{0.05, 14} = -1.761$ (+2)

$t_0 = -1.531$ (+1)

t_0 is not in critical region; fail to reject H_0 (+2)