Name: *Caleb McWhorter — Solutions* **MAT 222**
Quiz 10 **Spring 2017**

Problem 1: Consumer reviewers at a tech magazine are writing an article about battery life of various smartphones. The writers tested three brands of players to determine battery life of the smartphones. Each phone was taken and left running until the device ran out of battery. The battery life time was recorded by number of hours the device lasted. The results are summarized below.

Brand	n_i	$\overline{x}_i$	s_i
A	13	23.45	2.63
B	15	27.71	2.74
C	14	24.87	2.95

(a) Calculate $\overline{x}$.

$$\overline{x} = \frac{13(23.45) + 15(27.71) + 14(24.87)}{13 + 15 + 14} = \frac{1068.68}{42} = 25.4448$$

(b) Calculate s_p.

$$s_p^2 = \frac{(13-1)2.63^2 + (15-1)2.74^2 + (14-1)2.95^2}{(13-1) + (15-1) + (14-1)} = \frac{301.242}{39} = 7.72415 \Rightarrow s_p = \sqrt{7.72415} = 2.77924$$

(c) Calculate SSG, SSE, and SST.

$$\begin{aligned}
SSG &= 13(23.45 - 25.4448)^2 + 15(27.71 - 25.4448)^2 + 14(24.87 - 25.4448)^2 = 133.322 \\
SSE &= (13-1)2.63^2 + (15-1)2.74^2 + (14-1)2.95^2 = 301.242 \\
SST &= SSG + SSE = 434.564
\end{aligned}$$

(d) Calculate R^2.

$$R^2 = \frac{SSG}{SST} = \frac{133.322}{434.564} = 0.306795$$

(e) Calculate MSG and MSE

$$\begin{aligned}
MSG &= \frac{SSG}{DFG} = \frac{133.322}{2} = 66.661 \\
MSE &= \frac{SSE}{DFE} = \frac{301.242}{13 + 15 + 14 - 3} = 7.72415
\end{aligned}$$

(f) Choose the correct F-value and the associated p-value to test $H_0 : \mu_A = \mu_B = \mu_C$.

(i) __✓__ $F(2, 39) = 8.63$, $p < 0.001$
(ii) ______ $F(2, 42) = 8.63$, $p < 0.001$
(iii) ______ $F(3, 39) = 8.63$, $p < 0.001$
(iv) ______ $F(3, 42) = 8.63$, $p < 0.001$

(g) Given your answer from the previous part, what is your conclusion?

(i) ______ There is not enough evidence to suggest that the means are different.
(ii) ______ There is sufficient evidence to conclude that the sample means are not equal.
(iii) __✓__ There is sufficient evidence to conclude that not all the population means are equal.
(iv) ______ There is evidence to support the conclusion that all the population means are all different from each other.

(h) The brand labeled 'B' is known to be the most popular among consumers. Therefore, it was decided before the data was gathered to compare this brand against the other two brands to see if this brand had a longer battery life than the other two. What would be an appropriate null and alternative hypothesis to establish in order to perform such a test?

(a) ______ $H_0 : \mu_A = \mu_B = \mu_C$ and $H_a : \mu_B > \mu_A = \mu_C$.
(b) __✓__ $H_0 : \mu_B = \dfrac{\mu_A + \mu_C}{2}$ and $H_a : \mu_B > \dfrac{\mu_A + \mu_C}{2}$.
(c) ______ $H_0 : \mu_A = \mu_B = \mu_C$ and $H_a : \mu_B > \mu_A$ and $\mu_B > \mu_C$.
(d) ______ H_0 : all means are equal and H_a : all the means are different than μ_B.

(i) Calculate the test statistic to test the contrast in the previous part. Specify its degrees of freedom. Use $\alpha = 0.05$ to draw your conclusions.

We have $\psi = 2\mu_B - \mu_A - \mu_C$. We test

$$\begin{cases} H_0 : \psi = 0 \\ H_a : \psi > 0 \end{cases}$$

$$c = 2(27.71) - 23.45 - 24.87 = 7.1$$
$$SE_c = 2.77924\sqrt{\frac{2^2}{15} + \frac{(-1)^2}{13} + \frac{(-1)^2}{14}} = 1.79044$$
$$t = \frac{7.1}{1.79044} = 3.96551$$

With degrees of freedom $13 + 15 + 14 - 3 = 39$, we find $p < 0.0005$. Because $p < \alpha$, we reject the null hypothesis. There is sufficient evidence to suggest that the average battery life for brand B is longer than either of the other brands.