**Announcements**

- Exam 3 is on Friday, April 5. It will cover Chp 9-11.
- The extended exam period will be on Friday from 4:10-5:30 p.m. in A101 Clark. Sign up for extended exam period before Friday.
- Optional Exam Question Sessions on Thursday, April 4
  - 12:10 – 2:00 p.m. in 005 Statistics Building
  - 7:00 – 9:00 p.m. in A207 Clark
- Note: in chapter 11, the material on page 387-389 and 399-401 will not be on the exam
- See also the “review topics” handout available on the webpage

**P-values**

P-values can be used in two ways:

1. Interpret the strength of evidence against $H_0$: small p-values indicate more evidence against $H_0$.
   - If the p-value is less than
     - .10, we have some evidence that $H_0$ is not true.
     - .05, we have strong evidence that $H_0$ is not true.
     - .01, we have very strong evidence that $H_0$ is not true.
     - .001, we have extremely strong evidence that $H_0$ is not true.

2. Formulate a decision rule: For any hypothesis test, we can state the decision rule in terms of the test statistic or a p-value. To state the decision rule in terms of the p-value, we say:
   - Reject $H_0$ if p-value < $\alpha$

**A guide for selecting the appropriate hypothesis test:**

Is the question about a proportion or a mean?

- Proportion
  - z test for proportions
    - pg 325-328
  - Mean
    - How many means?
    - One mean
      - What is the sample size?
    - Two means
      - What is the sample size?
      - > 2 means
        - ANOVA
          - Chap 11

One mean
- $n > 30$
  - large sample
    - z test for $\mu$
      - pg 305-320
- $n \leq 30$
  - small sample
    - t-test for $\mu$
      - pg 354-359

Two means
- $n_1$ and $n_2 > 30$
  - large sample
    - z test for two $\mu$
      - pg 320-324
- $n_1$ or $n_2 \leq 30$
  - small sample
    - t-test for two $\mu$
      - pg 363-368

1. A computer printer manufacturer claims that a printer cartridge will make more than 20,000 copies on average before it needs to be replaced. To check this claim, the quality control manager tests 50 cartridges. The Minitab output below was obtained. Let $\alpha = .05$.

   Test of $\mu = 20000$ vs $\mu > 20000$
   The assumed sigma = 500

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>StDev</th>
<th>SE Mean</th>
<th>SE Mean</th>
<th>Z</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copies</td>
<td>50</td>
<td>20178</td>
<td>473</td>
<td>66.9</td>
<td>2.52</td>
<td>.006</td>
<td></td>
</tr>
</tbody>
</table>

   Based on the Minitab output, the conclusion should be
2. A vacuum cleaner belt manufacturer needs to develop a claim for the length of time its belt will run before needing a replacement. A production manager suggests that 250 hours is a reasonable claim. To check whether the claim of 250 hours is reasonable, the quality control manager tests 17 belts. The mean number of hours was 242 and the standard deviation was 23. Carry out all 5 steps of a hypothesis test to determine whether or not the number of hours that the belt will last is different from 250 hours. Let \( \alpha = .05 \)

- Step 1:

- Step 2:

- Step 3:

- Step 4:

- Step 5:

- What assumption did you make about the distribution of the data?

3. Greyhound Bus Company will add a new bus route if more than 55% of potential riders indicate they would use the particular route. A sample of 70 riders revealed that 46 would use a proposed route from Fort Collins to Boulder. Carry out all 5 steps of a hypothesis test to determine whether the new route meets Greyhound’s criteria. Use a .05 significance level. Compute and interpret the p-value.

- Step 1:

- Step 2:

- Step 3:

- Step 4:

- Step 5:
4. A random sample of 100 people was taken. Eighty (80) of the people in the sample favored Candidate A. We are interested in determining whether or not the proportion of the population in favor of Candidate A is more than 75% ($H_0: \pi \leq 0.75$ versus $H_1: \pi > 0.75$). The p-value is .0156. At the .05 significance level, it can be concluded that the proportion of the population in favor of Candidate A is
   a. less than .75
   b. not greater than .75
   c. greater than .75
   d. significantly greater than .80

5. Tire wear was compared for three brands of tires, based on simple random samples selected from three populations of tire brands stored in the same warehouse. Each selected tire was driven on a vehicle for 5,000 miles and then the tire wear was measured in inches. The following Minitab output was obtained for testing whether the average tire wear was the same for the three brands with $\alpha = .05$.

   Analyze of Variance
   
<table>
<thead>
<tr>
<th>SOURCE</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>FACTOR</td>
<td>2</td>
<td>259.0</td>
<td>129.5</td>
<td>5.37</td>
<td>0.008</td>
</tr>
<tr>
<td>ERROR</td>
<td>51</td>
<td>1228.9</td>
<td>24.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>53</td>
<td>1487.9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

   Based on this output, the investigators should
   a. reject $H_0$, since the p-value is less than 0.05
   b. reject $H_0$, since 5.37 is greater than 1
   c. reject $H_0$, since the total degrees of freedom exceed 30
   d. fail to reject $H_0$, since the p-value is less than 0.05
   e. fail to reject $H_0$, since the F-value is small

6. Three brands of light bulbs were compared with respect to lifetime of the light bulbs. Investigators planned to use analysis of variance to test whether the average lifetimes are equal for the three brands. What is the appropriate test and what are the null and alternative hypotheses?

7. Suppose a one-tailed t-test is being applied to test $H_0: \mu \leq 52$ versus $H_1: \mu > 52$ at the .05 significance level. Sample size is 25. What is the critical value?

8. The ABC Company claims that the batteries it produces have useful lives of more than 100 hours, with a known population standard deviation, $\sigma$ equal to 20 hours. A test is taken to determine the validity of this claim. The hypotheses to be tested are: $H_0: \mu \leq 100$, $H_1: \mu > 100$. A sample of 64 batteries had an average useful life of 103.8 hours. The p-value for the test is
9. The results of a mathematics placement exam at Mercy College for two campuses is as follows:

<table>
<thead>
<tr>
<th>Campus</th>
<th>Sample Size</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>82</td>
<td>43</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>44</td>
<td>32</td>
<td>7</td>
</tr>
</tbody>
</table>

For testing $H_0: \mu_1 = \mu_2$, what is the computed value of the test statistic?