# FUNDAMENTALS OF ENGINEERING STATISTICAL ANALYSIS

ISE/DSA 5013

Assignment 6

Show your work for calculation problems. You will receive no credit if you only provide the answer. *As with all homework this semester, spend time to be neat and organized. Any disorganized submissions are subject to a zero grade.*

**Problem 1**

Let $\mu$ denote the mean reaction time of drivers to brake lights in front of them. A test of $H_0: \mu \leq 5, H_1: \mu > 5$ was performed for several experiments, whose attributes and results are below. Find the $p$-value, or bound the $p$-value, associated with each of the following.

a. $n$ = 7, $t_0$ = 0.94, MUST USE TABLE IN BOOK
b. $n$ = 12, $t_0$ = 2.41, MUST USE TABLE IN BOOK
c. $n$ = 41, $t_0$ = 3.49, MUST USE EXCEL FUNCTION
d. $n$ = 13, $t_0$ = 0.52, MUST USE EXCEL FUNCTION

**Problem 2**

A valve manufacturer produces a butterfly valve composed of two semicircular plates on a common spindle that is used to permit flow in one direction only (seen here: http://en.wikipedia.org/wiki/Butterfly_valve). The semicircular plates are supplied by a vendor with specifications that the plates be 2.37 millimeters thick and have a tensile strength of five pounds per millimeter. A random sample of 20 such plates is taken. Electronic calipers are used to measure the thickness of each plate. A universal testing machine was used to test the tensile strength. The sample data are found in the Assignment 6 spreadsheet.

a. Determine, with 95% confidence, if mean tensile strength is less than five pounds per millimeter. Use the critical value approach.
b. Are more than half of plates thicker than 2.37? Use the *p*-value approach with 95% confidence.

**Problem 3**

You're looking into the voltage outputted by a power supply. You collected outputs from 16 different power supplies that are supposed to produce 13.5 volts. What do you conclude about the mean output being 13.5 volts with 95% confidence using the *p*-value approach?

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 13.76 | 13.97 | 13.94 | 13.81 | 14.92 | 13.77 | 12.64 | 13.52 |
| 13.27 | 13.83 | 12.68 | 14.33 | 12.81 | 12.63 | 12.46 | 13.98 |

**Problem 4**

A grinding process will be qualified for use in a particular task if it can be shown to produce less than 8% defective parts. In a random sample of 300 parts, 12 were defective. On the basis of these data, can the machine be qualified? Use the critical value approach with 99% confidence.

**Problem 5**

You're an industrial engineer working in a large warehouse. The average time to pick items off the warehouse shelves was 8.73 minutes. You've made some layout changes, and you've collected picking times for 25 different randomly chosen items, provided in the Assignment 6 spreadsheet. With 95% confidence, did you changes make a positive statistical difference?

a. What do you conclude using the critical value approach?
b. Go ahead and use the *p*-value approach also.

**Problem 6**

An aircraft manufacturer needs to buy aluminum sheets with an average thickness of 0.05 inch. Due to the manufacturer's production philosophy, it requires a particular quantity of aluminum sheets to be delivered on time with a short lead time of no more than four days (time between when the manufacturer places the order for aluminum and when that order arrives from the supplier). The manufacturer is considering an aluminum supplier but is concerned with the supplier's ability to meet lead time. The supplier provided a sample of lead times required to fill order sizes similar to what the manufacturer expects, provided in hours below.

88 97 104 98 88 103 104 92 95 102

a. Use the *p*-value approach to determine if the aircraft manufacturer should buy aluminum sheets from the supplier based on average lead time. Assume 90% confidence to draw a conclusion.
b. For which values of the sample mean would the aircraft manufacturer decide to buy sheets from this supplier, assuming $\alpha = 0.05$?

**Problem 7**

You're developing a foam insulation product that expands after application. You want the final (after expansion) height of the insulation to be more than 175 mm. You performed an experiment of spraying the insulation on 10 different surfaces (in a similar manner on similar surfaces), and you recorded the following insulation heights.

171.9 186.2 195.6 164.6 147.8 155.4 191.5 201.2 171.4 201.1

a. Is there sufficient evidence to conclude that your condition is met? Use the critical value approach with significance of 0.1.
b. Find the probability of type II error if the true mean height is 185 mm.
c. Find the probability of type II error if the true mean height is 195 mm.
d. Discuss how and why the probability of type II error changes.

**Problem 8**

As a quality control engineer, you're examining the surface roughness of ball bearings produced by Kruger Industrial Smoothing. You collected surface roughness measurements of 85 ball bearings. You do not want surface roughness to exceed 6.3 microns. Use the data in the Assignment 6 spreadsheet to test whether the percentage of ball bearings with excess surface roughness is more than 10%. Testing with 95% confidence using the p-value approach.

**Problem 9**


A machine that fills cans of Mountain Shoutin' is supposed to put 12 ounces of beverage in each can. The variance of the amount in each can is 0.01. The machine is moved to a new location, which has previously been shown to alter the machine settings. Determine whether the variance has changed following the move based on the following sample of the fills of 10 Mountain Lightning cans.

12.18 11.77 12.09 12.03 11.87 11.96 12.03 12.36 12.28 11.85

**Problem 10**

You're a healthcare engineering consultant and you're analyzing the emergency room design at Pawhuska Hospital, Inc. In the Assignment 6 spreadsheet, you'll find sample data for the waiting time of non-critical patients entering the emergency room. You realize that there's going to be some variability in the waiting time of patients given how different their circumstances are (even if all are non-critical), but you'd like for the standard deviation of waiting times to be less than 35 minutes. What do you conclude using the *p*-value approach and 99% confidence?