ME 794 Statistical Design of Experiments

Assignment 3

Due: February 28, 2023

1. Front housings for cell phones are manufactured in an injection molding process. The time the part is allowed to cool in the mold before removal is thought to influence the occurrence of a particularly troublesome cosmetic defect, flow lines, in the finished housing. After manufacturing, the housings are inspected visually and assigned a score between 1 and 10 based on their appearance, with 10 corresponding to a perfect part and 1 corresponding to a completely defective part. An experiment was conducted using two cool-down times, 10 and 20 seconds, and 20 housings were evaluated at each level of cool-down time. All 40 observations in this experiment were run in random order. The data are as follows:

Table 1: Input data

10 seconds	1	2	1	3	5	1	5	2	3	5	3	6	5	3	2	1	6	8	2	3
20 seconds	7	8	5	9	5	8	6	4	6	7	6	9	5	7	4	6	8	5	8	7

Write a script in python to solve the following **[2+2+2 marks]**

a. Is there evidence to support the claim that the longer cool-down time results in fewer appearance defects? Use $\alpha = 0.05$ and two-sample t-test.

b. Find a 95 per cent confidence interval on the difference in means. Comment which sample should be chosen based on the upper bound value.

c. Check the assumption of normality for the data from this experiment.
(There will be two graphs; the x-axis will be time, i.e., '*10 seconds*' in the first graph and '*20 seconds*' in the second graph. The y-axis will be probability in both graphs. The plot colour should be RED for both graphs.)
Note: Data has to be inserted as shown in Table 1, and the final output should be displayed as shown in Table 2.

Table 2: Computer results display format

Two sample T test for *10 seconds* vs *20 seconds*

	N	*Mean*	*Std Dev*
10 seconds	20	_____	_____
20 seconds	20	_____	_____

T-test value:
95% upper bound for difference:
DoF*:*

2. Two machines are used for filling plastic bottles with a net volume of 16.0 ounces. The filling processes can be assumed to be normal, with standard deviations of $\sigma_1 = 0.015$ and $\sigma_2 = 0.018$. The quality engineering department suspects that both machines fill to the same net volume, whether or not this volume is 16.0 ounces. An experiment is performed by taking a random sample from the output of each machine. **[1+2+3 marks]**

Machine 1	16.03	16.04	16.50	16.05	16.02	16.10	15.96	15.98	16.02	15.99
Machine 2	16.02	15.97	15.96	16.01	15.99	16.03	16.04	16.02	16.01	16.00

Write a script in python to solve the following

a. State the hypotheses that should be tested in this experiment.
b. Test these hypotheses using $\alpha = 0.05$ and state whether we accept or reject them?
c. Find a 95 percent confidence interval on the difference in mean fill volume for the two machines.

3. Consider the computer output shown below. **[0.5+0.5+0.5+0.5+1 marks]**

Two-Sample T-Test and CI: Y1, Y2

```
Two-sample T for Y1 vs Y2

        N     Mean     Std. Dev.    SE Mean
Y1     20    50.19         1.71        0.38
Y2     20    52.52         2.48        0.55

Difference = mu (X1) - mu (X2)
Estimate for difference: -2.33341
95% CI for difference: (-3.69547, -0.97135)
T-Test of difference = 0 (vs not =) : T-Value = -3.47
P-Value = 0.001 DF = 38
Both use Pooled Std. Dev. = 2.1277
```

a. Can the null hypothesis be rejected at the 0.05 level? Why?
b. Is this a one-sided or a two-sided test?
c. If the hypotheses had been H_0: $\mu_1 - \mu_2 = 2$ versus H_1: $\mu_1 - \mu_2 \neq 2$, would you reject the null hypothesis at the 0.05 level?
d. If the hypotheses had been H_0: $\mu_1 - \mu_2 = 2$ versus H_1: $\mu_1 - \mu_2 < 2$, would you reject the null hypothesis at the 0.05 level? Can you answer this question without doing any additional calculations? Why?
e. Use the output and the t table to find a 95 percent upper confidence bound on the difference in means. (Note: using same code written for Q.1 (b))

Documents required to be uploaded while submitting the assignment in teams to receive full credit

1. Include the script and results in a single pdf file (Q3 must be handwritten).
2. Separate Jupyter notebook (.ipynb format) for each question (two in this case).