Assignment 1 – STAT 453/558
Due date: 20 January, 2023

1) Suppose that we are testing H_0: $\mu_1 = \mu_2$ versus H_1: $\mu_1 > \mu_2$ with a sample size of $n_1 = n_2 = 10$. Both sample variances are unknown but assumed equal. **Using R**, find p-values for the following observed values of the test statistics:

(a) $t_0 = 2.45$
(b) $t_0 = -3.60$
(c) $t_0 = 1.96$
(d) $t_0 = -2.19$
(e) Repeat (a)-(d) for the case when the alternative hypothesis is two-sided.

2) The time to repair an electronic instrument is a normally distributed random variable measured in hours. The repair time for 16 such instruments chosen at random are as follows:

Hours			
159	280	101	212
224	379	179	264
222	362	168	250
149	260	485	170

(a) Is the normality assumption appropriated? Justify.
(b) You wish to know if the mean repair time exceeds 225 hours. Set up appropriate hypotheses for investigating this issue.
(c) Using R, test the hypotheses you formulated in part (b). What are your conclusions? Use $\alpha = 0.01$.
(d) By hand, construct a 95 percent confidence interval on mean repair time to test your hypothesis in (b). Show your work.

3) An article in the journal of *Neurology* (1998, Vol. 50, pp.1246-1252) observed that the monozygotic twins share numerous physical, psychological and pathological traits. The investigators measured an intelligence score of 10 pairs of twins. The data are obtained as follows:

Twin pair	Birth Order: 1	Birth Order: 2
1	5.73	6.08
2	5.80	6.22
3	8.42	7.99
4	6.84	7.44
5	6.43	6.48
6	8.76	7.99
7	6.32	6.32
8	7.62	7.60
9	6.59	6.03
10	7.67	7.52

(a) Is the assumption that the difference in score is normally distributed reasonable?
(b) Using R, find a 95% confidence interval on the difference in the mean score. Is there any evidence that mean score depends on birth order?
(c) Test an appropriate set of hypotheses indicating that the mean score does not depend on birth order.

4) The deflection temperature under load for two different formulations of ABS plastic pipe is being studied. Two samples of 12 observations each are prepared using each formulation, and the deflection temperatures (in °F) are reported below:

Formulation 1			Formulation 2		
206	193	192	177	176	198
188	207	210	197	185	188
205	185	194	206	200	189
187	189	178	201	197	203

Do the data support the claim that the mean deflection temperature under load for formulation 2 exceeds that of formulation 1? (a) Use $\alpha = 0.05$ to perform a complete analysis in R, including normality check and the appropriate test. Use the rejection region method to test your hypothesis. (b) Does the confidence interval support your conclusion on part a? Justify.

5) Photoresist is a light-sensitive material applied to semiconductor wafers so that the circuit pattern can be imaged on to the wafer. After application, the coated wafers are baked to remove the solvent in the photoresist mixture and to harden the resist. Here are measurements of photoresist thickness (in kÅ) for eight wafers baked at two different temperatures. Assume that all of the 16 runs were made in random order. Note: a wafer cannot be baked twice.

95 ºC	100 ºC
11.176	5.623
7.089	6.748
8.097	7.461
11.739	7.015
11.291	8.133
10.759	7.418
6.467	3.772
8.315	8.963

(a) Is there evidence to support the claim that the higher baking temperature results in wafers with a lower mean photoresist thickness? Use $\alpha = 0.05$ and justify your answer.
(b)Find a 95% confidence interval on the difference in means. Provide a practical interpretation of this interval.

6) The following are the burning times (in minutes) of chemical flares of two different formulations. The design engineers are interested in both the means and variance of the burning times.

Type 1		Type 2	
65	82	64	56
81	67	71	69
57	59	83	74
66	75	59	82
82	70	65	79

(a) Test the hypotheses that the two variances are equal. Use $\alpha = 0.05$.
(b) Using the results of (a), test the hypotheses that the mean burning times are equal. Use $\alpha = 0.01$. What is the p-value for this test?
(c) Discuss the role of the normality assumption in this problem. Check the assumption of normality for both types of flares.