Advanced Statistics (DS2003)
BDS-4A, 4B, 4C
Spring 2025

Assignment-2

Instructions:

- This assignment comprises the following questions, and each question carries 20 marks.
- You are required to upload a scanned copy of your assignment, in a single PDF format, over the Google classroom by 11:00 pm on 19-03-2025
- You are also required to submit the hard copy of your assignment completed over A4 or assignment papers ONLY.
  - For sections A and C, a hard copy is due on Wednesday (19-03-2025) during the class.
  - For section B, a hard copy is due on Thursday (20-03-2025) during the class.

Question-1

A soft-drink dispensing machine is said to be out of control if the variance of the contents exceeds 1.15 deciliters. If a random sample of 25 drinks from this machine has a variance of 2.03 deciliters, does this indicate at the 0.05 level of significance that the machine is out of control? Assume that the contents are approximately normally distributed.

Question-2

Two types of instruments for measuring the amount of sulfur monoxide in the atmosphere are being compared in an air-pollution experiment. Researchers wish to determine whether the two types of instruments yield measurements having the same variability. The readings in the following table were recorded for the two instruments. Assuming the populations of measurements to be approximately normally distributed and using $\alpha = 0.1$, test the hypothesis that $\sigma_A^2 = \sigma_B^2$ against the alternative that $\sigma_A^2 \neq \sigma_B^2$

Sulfur Monoxide

Instrument A	Instrument B
0.86	0.87
0.82	0.74
0.75	0.63
0.61	0.55
0.89	0.76
0.64	0.70
0.81	0.69
0.68	0.57
0.65	0.53

Question-3

A study was conducted by the Department of Zoology at Virginia Tech to determine if there is a significant difference in the density of organisms at two different stations located on Cedar Run, a secondary stream in the Roanoke River drainage basin. Sewage from a sewage treatment plant and overflow from the Federal Mogul Corporation settling pond enter the stream near its headwaters. The following data give the density measurements, in number of organisms per square meter, at the two collecting stations:

Number of Organisms per Square Meter			
Station 1		Station 2	
5030	4980	2800	2810
13,700	11,910	4670	1330
10,730	8130	6890	3320
11,400	26,850	7720	1230
860	17,660	7030	2130
2200	22,800	7330	2190
4250	1130		
15,040	1690		

Can we conclude, at the 0.05 level of significance, that the average densities at the two stations are equal? Assume that the observations come from normal populations with different variances.

Question-4

A taxi company manager is trying to decide whether the use of radial tires instead of regular belted tires improves fuel economy. Twelve cars were equipped with radial tires and driven over a prescribed test course. Without changing drivers, the same cars were then equipped with regular belted tires and driven once again over the test course. The gasoline consumption, in kilometers per liter, was recorded as follows:

	Kilometers per Liter	
Car	Radial Tires	Belted Tires
1	4.2	4.1
2	4.7	4.9
3	6.6	6.2
4	7.0	6.9
5	6.7	6.8
6	4.5	4.4
7	5.7	5.7
8	6.0	5.8
9	7.4	6.9
10	4.9	4.7
11	6.1	6.0
12	5.2	4.9

Can we conclude, with level of significance 0.05, that cars equipped with radial tires give better fuel economy than those equipped with belted tires? Assume the populations to be normally distributed.

Question-5

The following histogram was obtained by counting the occurrence of the first digits in telephone numbers in one column of a telephone directory:

digit	0	1	2	3	4	5	6	7	8	9
observed	0	0	24	2	25	3	32	15	2	2

Test the goodness of fit of this data to a random variable that is uniformly distributed in the set$\{0,1,\ldots,9\}$ at a 1% significance level.

Question-6

A criminologist conducted a survey to determine whether the incidence of certain types of crime varied from one part of a large city to another. The particular crimes of interest were assault, burglary, larceny, and homicide. The following table shows the numbers of crimes committed in four areas of the city during the past year:

	Type of Crime			
District	Assault	Burglary	Larceny	Homicide
1	162	118	451	18
2	310	196	996	25
3	258	193	458	10
4	280	175	390	19

Can we conclude from these data at the 0.01 level of significance that the occurrence of these types of crime is dependent on the city district?