

INSTRUCTIONS: Answer All the Questions

1. Biodiesel fuel has a cloud point, the temperature at which the fuel becomes cloudy, of approximately  $13^{\circ}\text{C}$ . This clouding can lead to poor engine performance and can even cause an engine to stop completely. An industrial chemical company produces an additive designed to lower the cloud point of this type of fuel. A random sample of six different biodiesel fuels was obtained and the cloud point was measured for each. One gram of the chemical additive was mixed in with every fuel sample and the cloud point was measured again. The resulting data are given in the following table (temperature in  $^{\circ}\text{C}$ ).

Fuel	A	B	C	E	F
Before additive	11.7	12.9	14.2	11.3	12.4
After additive	10.3	10.7	14.1	11.2	12.1

Assume normality, and conduct the appropriate hypothesis test to determine whether the additive lowers the mean cloud point in biodiesel fuel. Use  $\alpha = 0.1$ . [10 Marks]

2. A corporation owns several companies. The strategic planner for the corporation believes amount spent on advertising can to some extent be a predictor of total sales. As an aid in long term planning, she gathers the following sales and advertising information from several of the companies in millions for the year 2019.

Advertising	12.5	3.7	21.6	60.0	37.6	6.1	16.8	41.2
Sales	148	55	338	994	541	89	126	379

- (i) Develop the equation of the simple regression line to predict sales on advertising expenditures using these data. [10 Marks]
- (ii) Find out the sales that are likely to be attained when advertising expenditure is 25 million. [2 Marks]
- (iii) Compute the coefficient of correlation and coefficient of determination and interpret their values. [4 Marks]
- (iv) Test the hypothesis that the population correlation coefficient is zero at 5% level of significance. [4 Marks]
3. The marks of 800 candidates in an examination were normally distributed with a mean of 45 marks and standard deviation of 20 marks.
- (i) If 10% of the candidates obtained a distinction by scoring  $X$  marks or more, estimate the value of  $X$ . [4 Marks]
- (ii) Estimate the interquartile range of the marks. Hint:  $I.Q.R = Q_3 - Q_1$  [6 Marks]
4. The following set of data represents the distribution of annual salaries of a random sample of 100 managers in a large multinational company:

Salary range (£' 000')	Managers
20 but under 25	5
25 but under 30	10
30 but under 35	25
35 but under 40	35
40 but under 45	25
45 but under 50	5

The company chairman claims that the managers in the company earn on average annual salary in excess of £35,500. Using the data given above, test the chairman's claim at 5% level of significance. [10 Marks]

5. The table below contains the widths of a product, showing 10 samples of size 5 measurements

1	2	3	4	5	6	7	8	9	10
40	39	38	48	41	37	43	44	42	39
42	45	44	45	40	39	41	46	44	40
43	41	46	43	44	40	42	48	40	41
41	34	43	43	44	42	43	41	41	42
40	42	48	47	43	44	40	42	42	43

- ( i ) Construct a sample means ( $\bar{X}$ ) and range ( $R$ ) control charts for the above data.
- ( i i ) Identify those subgroup means which are outside the control limits in each case.
- ( i i i ) Comment on the processes.

[16 Marks]