# Scenario Based problems

1) You work in a quality control department for a manufacturing company. You are given a dataset representing the thickness of a certain component produced by a machine. The thickness values (in millimetres) for a sample are: [8.2, 8.5, 8.0, 8.3, 8.6, 8.1, 8.4, 8.2, 8.5, 8.3].
   a) Calculate the first four sample raw moments based on thickness values.
   b) Use the methods of moments to estimate the skewness and kurtosis for the thickness distribution.
   c) Interpret the skewness and kurtosis values in the context of the manufacturing process. Consider whether the thickness distribution is symmetric or skewness and whether it has tails or more peaked compared to a normal distribution.

   **Ans: 8.31, 68.33, 560.94, 4661.678**

2) A high school teacher is curious about the potential link between the daily hour's students spend on their smartphones and their academic performance. To investigate, the teacher collects data on the daily smartphone usage (in hours) and the corresponding final exam scores of a sample of students.

| Student | A | B | C | D | E |
|---|---|---|---|---|---|
| Smartphone use (in hr) | 4 | 2 | 6 | 3 | 1 |
| Exam Score | 85 | 92 | 78 | 94 | 97 |

   Calculate the correlation coefficient between the daily hours of smartphone usage and the final exam scores of the students. Interpret the result and provide insights into the potential relationship between smartphone usage and academic performance in this sample.

3) In sampling a large number of parts manufactured by a machine, the mean number of defectives in a sample of 20 is 2. Out of 1,000 such samples, how many would be expected to contain
   i) At least 3 defective parts?
   ii) None defective?

   **Ans: 323, 122**

4) Suppose that a book of 600 pages contains printing mistakes. Assume that these errors are randomly distributed throughout the book and x, the number of errors per page has a Poisson distribution. What is the probability that 10 pages selected at random will be free of errors?

**Ans: P(0)= 0.51**

5) A human resources manager is interested in understanding the potential relationship between the average nightly sleep duration of employees and their work performance. The manager believes that employees who get sufficient sleep may exhibit better job performance. To investigate, the HR manager collects data on the average nightly sleep duration (in hours) and the corresponding work performance scores of a sample of employees over a month.

| Employee | A | B | C | D | E |
|---|---|---|---|---|---|
| Sleep (In Hr) | 6 | 8 | 7 | 5 | 9 |
| Work Performance Score | 78 | 92 | 85 | 68 | 95 |

**Ans: 0.82**

6) In a multiple-choice exam with 20 questions, each question has 4 answer choices. A student guesses the answer to each question. Find the probability of the student getting exactly 5 correct answers.

**Ans: 0.202**

7) A quality control inspector examines a sample of 10 products, checking whether each meets a certain standard. Find the probability that exactly 2 products pass the quality check.

**Ans: 0.301**

8) A diagnostic test for a certain disease has a sensitivity of 90%. If the test is performed on 8 patients with the disease, find the probability that exactly 7 of them test positive.

**Ans: 0.057 or 5.7%**

9) In the following table are recorded data showing the test scores made by 10 salesman on an intelligence test and their weekly sales:

| Test scores | 40 | 70 | 50 | 60 | 80 | 50 | 90 | 40 | 60 | 60 |
|---|---|---|---|---|---|---|---|---|---|---|
| Sales | 2.5 | 6.0 | 4.5 | 5.0 | 4.5 | 2.0 | 5.5 | 3.0 | 4.5 | 3.0 |

Calculate the regression lines of sale on rest score, and estimate the probable weekly sales volume if the salesman makes a score of 70.

**Ans: y=0.0583x+.5070; 4.5880**

10) The following table gives the number of aircraft accidents that occurred during various days of the week. Find whether the accidents are uniformly distributed over the week. ($x^2_{6,0.05}$=12.59)

| Days | Sun. | Mon. | Tue. | Wed. | Thus. | Fri. | Sat. |
|---|---|---|---|---|---|---|---|
| No. of students | 14 | 15 | 8 | 20 | 11 | 9 | 14 |

**Ans: Yes**

11) A Book has 700 pages. The number of pages with various numbers of misprints is recorded below:

| No. of misprints | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| No. of pages with misprints | 616 | 70 | 10 | 2 | 1 | 1 |

Can a poission distributions be fitted to this set of data?

**Ans: No**

12) The coefficient of rank correlation of the marks obtained by 10 students in Math's and Statistics was found to be 0.5. It was later discovered that the differences in ranks in two subjects obtained by one of the students was wrongly taken as 3 instead of 7. Find the correct coefficient of rank correlation.

**Ans: 0.2576**

13) A basketball player has a free throw success rate of 80%. If the player takes 10 free throws, what is the probability that they make at least 8 of them?
**Ans: 0.3752**

14) A teacher is interested in studying the relationship between the performance in Statistics and Economics of a class of 20 students. For this he compiles the scores on these subjects of the students in the last semester examination. Some data of this type are presented in Table. Calculate correlation coefficient for the data:

| Score in Statistics | 82 | 70 | 34 | 80 | 66 | 84 | 74 | 84 | 60 | 86 | 76 | 76 | 92 | 72 | 64 | 86 | 84 | 60 | 82 | 90 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Score in Economics | 64 | 40 | 35 | 48 | 54 | 56 | 62 | 66 | 52 | 82 | 58 | 66 | 72 | 46 | 44 | 76 | 52 | 40 | 60 | 60 |

15) Salesmen employed by a company were given one month training. At the end of the training, they conducted a test on 10 salesmen on a sample basis who were ranked on the basis of their performance in the test. They were then posted to their respective areas. After six months,

they were rated in terms of their sales performance. Find the degree of association between them.

| Salesman | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Ranks in training | 7 | 1 | 10 | 5 | 6 | 8 | 9 | 2 | 3 | 4 |
| Ranks on sales | 6 | 3 | 9 | 4 | 8 | 10 | 7 | 2 | 1 | 5 |

16) Ten competitors in a musical contest were ranked by 3 judges, A, B and C in the following order

| Competitors | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Rank by A | 1 | 6 | 5 | 10 | 3 | 2 | 4 | 9 | 7 | 8 |
| Rank by B | 3 | 5 | 8 | 4 | 7 | 10 | 2 | 1 | 6 | 9 |
| Rank by C | 6 | 4 | 9 | 8 | 1 | 2 | 3 | 10 | 5 | 7 |

Using rank correlation method, discuss which pair of judges has the nearest approach to common liking in music.

17) The number of yiest cells counted in a haemocytometer is compared to the theoretical value is given below. Does the experimental result support the theory?

| No. of Yeast cells in the square | Observed frequency | Expected frequency |
|---|---|---|
| 0 | 103 | 106 |
| 1 | 143 | 141 |
| 2 | 98 | 93 |
| 3 | 42 | 41 |
| 4 | 8 | 14 |
| 5 | 6 | 5 |

18) A sample of 10 is drawn randomly from a certain population. The sum of the squared deviations from the mean of the given sample is 50. Test the hypothesis that the variance of the population is 5 at 5 per cent level of significance.

19) The number of misprints on a page of the daily mercury has a Poisson distribution with mean 1.2. Find the probability that the number of errors (a) on page four is 2, (b) on page three is less than 3 (c) on page first ten pages total 5 (d) on all forty pages adds up to at least 3.

20) A factory produces nails and packs them in the boxes of 200. If the probability that a nail is substandard is 0.006, find the probability that a box is selected at random contains at most two nails which are substandard.

21) Suppose on an average 1 house in 1000 in a certain district has a fire during a year. If there are 2000 houses in that district, what is the probability that exactly 5 houses will have a year?

22) A garden pea plant is heterozygous (genetically mixed) for the gene pair Tt, where the gene T (for tall) is dominant over the gene t (for short). The plant produced 35 tall and 25 short offspring. Find out whether the plant was self-fertilised or fertilised by a short plant.

23) Genetic theory states that children having one parent of blood type M and the other of blood type N will always be of one of the three types M, MN, N and that proportions of these types will, on an average be 1:2:1. A report states that out of 300 children having one M parent and one N parent, 30% were found to be of type M, 45% of type MN and the remainder of type N. Test the hypothesis by $\chi^2$ test.

24) Find the most likely price in Mumbai corresponding to the price of Rs. 70 at Kolkata from the following:

| | Kolkata | Mumbai |
|---|---|---|
| Average price | 65 | 67 |
| Standard deviation | 2.5 | 3.5 |

Correlation coefficient between the prices of commodities in the two cities is 0.8?

25) A multiple-choice test consists of 8 questions with 3 answers to each question (of which only one is correct). A student answers each question by rolling a balanced die and checking the first answer if he gets 1 or 2, the second answer if he gets 3 or 4 and the third answer if he gets 5 or 6. To get a distinction, the student must secure at least 75% correct answers. If there is no negative marking, what is the probability that a student secures a distinction? **Ans: 0.0197**