

# ASSIGNMENT BOOKLET

## **Post Graduate Diploma in Applied Statistics** **(Specialisations in Industrial Statistics/Biostatistics)**

**MST-001 to MSTL-003**

**(Valid from 1<sup>st</sup> January 2024 to 31<sup>st</sup> December, 2024)**

**It is compulsory to submit the assignments  
before filling the Examination Form.  
Candidates should submit the latest assignments  
for the courses for which they filled the  
examination form.**



**School of Sciences  
Indira Gandhi National Open University  
Maidan Garhi, New Delhi-110068  
(2024)**

Dear Student,

Please read the information on assignments in the Programme Guide that we have sent you after your enrolment. A weightage of 30%, as you are aware, has been earmarked for continuous evaluation, **which would consist of one tutor-marked assignment** for this course. The assignments for MST-001 to MSTE-004 have been given in this booklet.

### **Instructions for Formatting Your Assignments**

Before attempting the assignment, please read the following instructions carefully:

- 1) On top of the first page of your answer sheet, please write the details exactly in the following format:

ENROLLMENT NO :.....

NAME :.....

ADDRESS :.....

.....

.....

PROGRAMME CODE: .....

COURSE CODE: .....

COURSE TITLE: .....

STUDY CENTRE: ..... DATE: .....

### **PLEASE FOLLOW THE ABOVE FORMAT STRICTLY TO FACILITATE EVALUATION AND TO AVOID DELAY.**

- 2) Use only foolscap size writing paper (but not of very thin variety) for writing your answers.
- 3) Leave 4 cm margin on the left, top and bottom of your answer sheet.
- 4) Your answers should be precise.
- 5) This assignment is to be submitted at the Study Centre.

**We strongly suggest that you should retain a copy of your answer sheets.**

- 6) This assignment is valid from January 1<sup>st</sup> , 2024 up to December 31, 2024.
- 7) The latest assignments should be submitted by the candidate.
- 8) **You cannot fill the Exam Form for this course** till you have submitted this assignment. So solve it and **submit it to your study centre at the earliest**. If you wish to appear in the **TEE, June 2024**, you should submit your TMAs by **March 31, 2024**. Similarly, If you wish to appear in the **TEE, December 2024**, you should submit your TMAs by **September 30, 2024**.

We wish you good luck.

**TUTOR MARKED ASSIGNMENT**  
**MST-001: Foundation in Mathematics and Statistics**

Course Code: MST-001

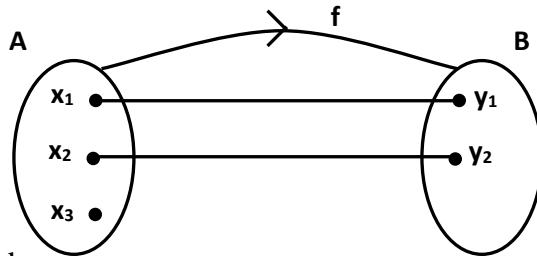
Assignment Code: MST-001/TMA/2024

Maximum Marks: 100

**Note: All questions are compulsory. Answer in your own words.**

1. State whether the following statements are True or False and also give the reason in support of your answer.  $(2 \times 5 = 10)$

- Collection of rich persons in India forms a set.
- Following rule is a function from A to B.



- $\frac{d}{dx}(9-7x)^5 = 45(9-7x)^4$
- In exclusive method, upper limit of a class is included in the same class.
- The order of the matrix  $\begin{bmatrix} 2 & 5 & 6 \\ 4 & 3 & 1 \end{bmatrix}$  is  $3 \times 2$ .

2. If four cards are chosen from a pack of 52 playing cards then find the number of ways that all four cards are:

- of same suit
- red
- face cards
- king
- of different suit

$(2 + 2 + 2 + 2 + 2)$

3. Arrange the numbers 49, 36, 42, 19, 22, 27, 14, 13, 24, 48, 23, 28, 17, 42, 39, 45, 22, 24, 17, 41, 18, 42, 38, 43, 11, 27, 36, 13, 40, 30, 24, 10, 18, 47, 18, 19, 23, 12, 27 in stretched stem-and-leaf display that has single-digit starting parts and leaves, but has stem width of 5.  $(10)$

4. If the universal set is  $U = \{1, 2, 3, 4, 5, 6, 7, 8\}$  and  $A = \{2, 3, 6, 7\}$ ,  $B = \{4, 6, 8\}$ ,  $C = \{6, 7, 8\}$  are the subsets of  $U$ , then verify

- De-Morgan's laws
- left distributive law

$(5 + 5)$

5. Evaluate the following:

- $\int x^2 e^{2x} dx$
- $\frac{dy}{dx}$ , where  $y = (4x+5)^4 (9x+4)^5$

$(5 + 5)$

6. a) Prove that  $\begin{vmatrix} a & b & c \\ b & c & a \\ c & a & b \end{vmatrix} = (a+b+c)(ab+bc+ca - a^2 - b^2 - c^2)$

b) What do you mean by primary data and secondary data? Also give an example in each case. **(5 + 5)**

7. Draw a box plot with whisker, +ve sign and outliers for the following data:  
 42, 37, 28, 23, 32, 25, 26, 39, 38, 41, 22, 38, 21, 31, 26, 36, 42, 52, 50, 47, 24, 53, 28 **(20)**

8. a) Find the values of **a** and **b**, if the function **f** given below is continuous at  $x = 2$

$$f(x) = \begin{cases} a+b, & x < 2 \\ a+bx+4, & x = 2 \\ 5, & x > 2 \end{cases}$$

b) Draw a histogram for the following data:

Wages	40 – 49	50 – 69	70 – 99	100 – 109	110 – 119
No of workers	2	20	60	35	4

Also draw frequency polygon in the same graph. **(8 + 12)**

## TUTOR MARKED ASSIGNMENT

### MST-002: Descriptive Statistics

Course Code: MST-002

Assignment Code: MST-002/TMA/2024

Maximum Marks: 100

**Note: All questions are compulsory. Answer in your own words.**

1. State whether the following statements are True or False and also give the reason in support of your answer.  $(2 \times 5 = 10)$

- a) If standard deviation of  $x$  is 5, standard deviation of  $y = 2x - 3$  is 7.
- b) Mean deviation is least when calculated from the median.
- c) The correlation coefficient between  $x$  and  $(a - x)$  is -1.
- d) The regression coefficients  $b_{yx}$  and  $b_{xy}$  of a data are 1.2 and 0.8, respectively.
- e) If  $(AB) = 10$ ,  $(\alpha B) = 15$ ,  $(A\beta) = 20$  and  $(\alpha\beta) = 30$  then  $A$  and  $B$  are associated.

2. a) Find the missing information from the following data:

	Group I	Group II	Group III	Combined
Number	50	?	90	200
Standard Deviation	6	7	?	7.746
Mean	113	?	115	116

b) If AM and GM of two numbers are 30 and 18, respectively, find the numbers.  $(7+3)$

3. a) The frequency distribution of the marks obtained by the 25 students each of the two sections is given as follows:

Marks:	10-20	20-30	30-40	40-50	50-60
Section A:	2	5	10	5	3
Section B:	3	7	8	5	2

Find which section is more consistent.

b) Mean and Standard deviation of 18 observations are found to be 7 and 4, respectively. On comparing the original data, it was found that an observation 12 was miscopied as 21 in the calculations. Calculate correct mean and standard deviation.  $(7+3)$

4. The equations of two regression lines are given as follows:

$$4x - 5y + 30 = 0$$

$$20x - 9y - 107 = 0$$

Calculate (i) regression coefficients,  $b_{yx}$  and  $b_{xy}$ ; (ii) correlation coefficient  $r(x, y)$ ; (iii) Mean of  $X$  and  $Y$ ; and (iv) the value of  $\sigma_y$  if  $\sigma_x = 3$ .  $(10)$

5. A researcher collects the following information for two variables  $x$  and  $y$ :

$n = 20$ ,  $r = 0.5$ , mean  $(x) = 15$ , mean  $(y) = 20$ ,  $\sigma_x = 4$  and  $\sigma_y = 5$

Later it was found that one pair of values  $(x, y)$  has been wrongly taken as  $(16, 30)$  whereas the correct values were  $(26, 35)$ . Find the correct value of  $r(x, y)$ .  $(10)$

6. a) If  $a, b, c, d$  are constants, then show that the coefficient of correlation between  $ax+b$  and  $cy+d$  is numerically equal to that between  $x$  and  $y$ .

b) A statistician wanted to compare two methods A and B of teaching. He selected a random sample of 22 students. He grouped them into 11 pairs so that the students in pair have approximately equal scores on an intelligence test. In each pair one student was taught by method A and the other by method B and examined after the course. The marks obtained by both methods are given as:

Methods	1	2	3	4	5	6	7	8	9	10	11
Method A	24	29	19	14	30	19	27	30	20	28	11
Method B	37	35	16	26	23	27	19	20	16	11	21

Find the rank correlation coefficient. (3+7)

7. a) Fit an exponential curve of the form  $Y = ab^X$  to the following data:

X: 1 2 3 4 5 6 7 8

Y: 1.0 1.2 1.8 2.5 3.6 4.7 6.6 9.1

b) Calculate the first, second and third quartile for the following data:

Class: Below 30 30-40 40-50 50-60 60-70 70-80 80 and above

Frequency: 69 167 207 65 58 27 10

Also find the quartile deviation and coefficient of quartile deviation. (10+10)

8. a) Board of Directors of Labour Union wishes to sample the opinion of its members before submitting a change in its contribution at a forthcoming annual meeting. Questionnaires are sent to a random sample of 200 members in three union locals. The results of the survey are as follows:

Reaction	Union Locals			Total
	A	B	C	
Favour Change	35	45	20	100
Against Change	15	25	16	56
No Response	10	10	24	44
Total	60	80	60	200

Determine the amount of association between the Union locals and their reactions using coefficient of contingency and interpret the result.

b) 600 candidates were appeared in an examination. The boys outnumbered girls by 15% of all candidates. Number of passed exceeded the number of failed candidates by 300. Boys failing in the examination numbered 80. Determine the coefficient of association. (12+8)

## TUTOR MARKED ASSIGNMENT

### MST-003: Probability Theory

Course Code: MST-003

Assignment Code: MST-003/TMA/2024

Maximum Marks: 100

**Note: All questions are compulsory. Answer in your own words.**

1. Which of the following statements are true or false? Give reason in support of your answer.

**(2×5 = 10)**

a) When two dice are thrown simultaneously then total number of sample points in the sample space will be 12.

b) Expected value of a continuous random variable  $X$  is defined as  $E(X) = \int_{-\infty}^{\infty} x f(x) dx$ .

c) If  $X$  and  $Y$  are independent random variable then  $V(X - Y) = V(X) - V(Y)$ .

d) If  $X \sim B(4, 3)$  then variance of  $X$  is 12.

e) If probability density function of a normally distributed random variable  $X$  is

$$f(x) = \frac{1}{6\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-46}{6}\right)^2}, \quad -\infty < x < \infty$$

then variance of  $X$  is 36.

2. An insurance company selected 6000 drivers from a city at random in order to find a relationship between age and accidents. The following table shows the results to these 6000 drivers.

Age of drivers (in years) Class Interval	Accidents in one year				
	0	1	2	3	4 or more
18 – 25	700	310	225	110	85
25 – 40	1100	290	200	105	80
40 – 50	1200	235	175	80	55
50 and above	600	205	140	70	35

If a driver from the city is selected at random, find the probability of the following events:

a) Age lying between 18 – 25 and meet 3 accidents

b) Age lying between 18 – 40 and meet 1 accident

c) Age more than 25 years and meet at most one accident

d) Having no accident in the year

e) Age lying between 18 – 40 and meet at least 3 accidents

**(2 + 2 + 2 + 2 + 2)**

3. Determine the constant  $k$  such that the function  $f(x) = kx^2(1-x)^5$ ,  $0 < x < 1$  is a beta distribution of first kind. Also, find its mean and variance. **(10)**

4. An insurance company insured 2000 scooter drivers, 3000 car drivers and 5000 truck drivers. The probabilities that scooter, car and truck drivers meet an accident are 0.02, 0.04, and 0.25 respectively. One of the insured persons meets with an accident. What is the probability that he is a  
 a) Scooter driver  
 b) Car driver **(5 + 5)**

5. The following table represents the joint probability distribution of the discrete random variable (X, Y):

		Y		
		1	2	3
X	1	0.2	0.2	0.1
	2	0.1	0.3	0.1

Find

a) The marginal distributions.  
 b) The conditional distribution of Y given X = 2 **(5 + 5)**

6. a) A rain coat dealer can earn Rs 800 per day during a rainy day. If it is a dry day, he can lose Rs 150 per day. What is his expectation, if the probability of rain is 0.6?  
 b) A player tosses two unbiased coins. He wins Rs. 10 if 2 heads appear, Rs. 5 if one head appears and Rs 1 if no head appears. Find the expected value of the amount won by him. **(5 + 5)**

7. a) (i) Let X and Y be two independent random variables such that  $X \sim B(5, 0.06)$  and  $Y \sim B(4, 0.6)$ . Find  $P[X + Y > 1]$   
 (ii) Comment on the statement: “The mean of a binomial distribution is 4 and variance 5”.  
 b) If the probability that an individual suffers a bad reaction from an injection of a given serum is 0.002, determine the probability that out of 400 individuals  
 (i) exactly 2  
 (ii) more than 3  
 (iii) at least one  
 individuals suffer from bad reaction. **(10 + 10)**

8. a) A die is rolled. If the outcome is a number greater than 2, what is the probability that it is an odd prime number?  
 b) A person is known to hit the target in 3 out of 4 shots whereas another person is known to hit 2 out of 5 shots. Find the probability that the target being hit when they both try.  
 c) Events A, B, C are mutually exclusive and exhaustive. If odds against A are 4:1 and against B are 3:2. Find the odds against event C. **(7 + 7 + 6)**

# **TUTOR MARKED ASSIGNMENT**

## **MST-004: Statistical Inference**

**Course Code: MST-004**

**Assignment Code: MST-004/TMA/2024**

**Maximum Marks: 100**

**Note: All questions are compulsory. Answer in your own words.**

1. State whether the following statements are True or False. Give reason in support of your answer. **(2×5=10)**
  - a) If probability density function of a t-distribution is  $f(t) = \frac{1}{\pi(1+t^2)}$ ;  $-\infty < t < \infty$  then degrees of freedom of the distribution will be 1.
  - b) If  $T_1$  and  $T_2$  are two estimators of a parameter  $\theta$  such that  $\text{Var}(T_1) = 1/2n$  and  $\text{Var}(T_2) = 2/n$  then  $T_1$  is more efficient than  $T_2$ .
  - c) If the probability of non rejection of  $H_0$  when  $H_1$  is true is 0.4 then power of the test will be 0.6.
  - d) The Wilcoxon signed-rank test is more powerful than the sign test.
  - e) The t-test is used for testing the independence of two attributes.
2. a) A random sample of nine college students yielded the following data concerning the number of hours per day each student spent in using mobile phone:  
$$5, 2, 7, 5.5, 3.5, 4, 5, 4.5, 4$$
Estimate the average number of hours per day spent in using mobile phone by the college students.  
b) If the sample values are 3, 5, 2, 7, and 0 then obtain the ML estimate for parameter  $\theta$  for the following distribution :  
$$f(x, \theta) = \theta e^{-\theta x}; \quad 0 \leq x, \theta > 0$$
 **(5+5)**
3. A sample of 100 tyres is taken from a lot. The mean life of the tyres selected is the sample is found to be 40,000 kms with a standard deviation of 3200 kms. Is it reasonable to suppose the mean life of tyres in the lot as 41,000 kms at 5% level of significance? Also establish 95% confidence limits within which the mean life of tyres in the lot is expected to lie. **(10)**
4. The blood cholesterol levels of a population of workers have mean 202 mg/dl and standard deviation 14 mg/dl. If a sample of 36 workers is selected from the population and sample mean is calculated then find
  - i) mean and standard error of the sampling distribution of the mean.
  - ii) approximate the probability that the sample mean of their blood cholesterol levels will lie between 198 mg/dl and 206 mg/dl. **(5+5)**

5. The following data relate to the number of items produced per shift followed normal distribution by two workers Rahul and Ramesh for a number of days:

<b>Rahul</b>	19	22	24	27	24	18	20	19	25	
<b>Ramesh</b>	26	37	40	35	30	40	26	30	35	45

Can it be inferred that Rahul is more stable worker compared to Ramesh by testing the variation in the item produced by them at 5% level of significance. (10)

6 a) In a city, 36 out of a random sample of 500 men were found to drink at a certain date. After the heavy increase in tax on intoxicants, another sample of 100 men in the same city included 6 drinkers. Do you feel that the observed proportion of drinkers decreasing significantly at 1% level?

b) In a locality, 100 persons were randomly selected and asked about their educational achievements. The results were as follows:

Sex	Education			Total
	Middle	High School	College	
<b>Male</b>	12	13	25	50
<b>Female</b>	22	13	15	50
<b>Total</b>	34	26	40	100

Can we say that education depends on sex at 5% level of significance? (5+5)

7. Complete the following table:

S. No.	Test for	Name of the Test	Null and Alternative Hypotheses	Test Statistic	Assumptions for Applying the Test	Decision Rule (in short)
<b>1</b>	Population mean when population variation is known					
<b>2</b>	Population mean when population variation is unknown					
<b>3</b>	Population proportion					
<b>4</b>	Difference of two population means					
<b>5</b>	Two population standard deviation					
<b>6</b>	Difference of two population proportion					
<b>7</b>	Independence of two attributes					

(20)

8. A company is trying to improve the work efficiency of its employees. It has organized a special training programme for all employees. In order to assess the effectiveness of the training programme, the company has selected 10 employees randomly and administered a well-structured questionnaire. The scores (out of 100) obtained by the employees are given in the following table:

S. No	Before Training	After Training
1	60	68
2	62	70
3	67	80
4	64	74
5	66	66
6	63	72
7	69	84
8	63	60
9	60	65
10	62	90

To examine whether the training programme has improved efficiency of the employees, give the answer of the following:

- i) Are both samples are paired or independent?
- ii) Formulate the null and alternative hypotheses.
- iii) Which parametric test is used for testing the null hypothesis if it is known that the scores of the employees before and after the training programme follow the normal distribution? Conduct the test at 1% level of significance and conclude the result.
- iv) Which non-parametric test is used for testing the null hypothesis if it is known that the scores of the employees before and after the training programme do not follow the normal distribution but the distribution of the differences of scores before and after the training is symmetrical about its median? Conduct the test at 1% level of significance and conclude the result.

(2+2+8+8)

## **TUTOR MARKED ASSIGNMENT**

### **MST-005: Statistical Techniques**

**Course Code: MST-005**

**Assignment Code: MST-005/TMA/2024**

**Maximum Marks: 100**

**Note: All questions are compulsory. Answer in your own words.**

1. State whether the following statements are true or false and also give the reason in support of your answer. (2×5=10)
  - c) In SRSWOR, the possible numbers of sample of size  $n$  from a population of size  $N$  if sampling is done with replacement is  $N^n$ .
  - d) One-way analysis of variance is a generalization of the two sample t-test.
  - e) If experimental error is reduced considerably and the efficiency of the design is decreased.
  - f) If strata are heterogeneous then stratified sampling schemes provides estimates with greater precision.
  - g) If one wants to convert random numbers selected from two digit numbers 00-99 to uniformly distributed  $U(0, 1)$  variables then one has to divide them by 99.
2. Assume that you have to perform a sample survey for Family expenditure of the faculty of Indira Gandhi National Open University. Then explain the main steps involved in the planning and execution of that sample survey. (10)
- 3 a) In a class of Statistics, total number of students is 30. Select the linear and circular systematic random samples of 10 students. The age of 30 students is given below:

Age:	22	25	22	21	22	25	24	23	22	21	20	21
	22	23	25	23	24	22	24	21	20	23	21	22
	20	20	21	22	25							

(5)

- 3 b) To determine the yield rate of wheat in a district of Punjab, 6 groups were constructed of 6 plots each. The data is given in the following table:

<b>Plot No.</b>	<b>Group 1</b>	<b>Group 2</b>	<b>Group 3</b>	<b>Group 4</b>	<b>Group 5</b>	<b>Group 6</b>
1	8	6	18	13	17	12
2	13	5	8	7	15	15
3	11	16	6	13	10	11
4	26	5	10	6	21	17
5	13	16	16	7	20	8
6	31	5	20	2	25	10

Select a cluster sample of 3 clusters from the given data and find sample mean. (5)

4. Three varieties A, B and C of wheat are shown in five plots each of the following fields per acre as obtained:

Plots	A	B	C
1	8	7	12
2	10	5	9
3	7	10	13
4	14	9	12
5	11	9	14

Set up a table of analysis of variance and find out whether there is significant difference between the fields of these varieties. (10)

5. An experiment was planned to study the effect of Sulphate, Potash and Super Phosphate on the yield of potatoes. All the combinations of 2 levels of Super Phosphate [0 cent ( $p_0$ ) and 5 cent ( $p_1$ )/ acre] and two levels of Sulphate and Potash [0 cent ( $k_0$ ) and 5 cent ( $k_1$ )/acre] were studied in a randomised block design with 4 replications each. The (1/70) yields [lb per plot = (1/70) acre] obtained are given in table below:

Blocks	Yields (lbs per plot)			
	(1)	k	p	kp
I	(1) 23	25	22	38
II	p 40	(1) 26	k 36	kp 38
III	(1) 29	k 20	pk 30	p 20
IV	kp 34	k 31	p 24	(1) 28

Analyse the data and give your conclusions. (10)

6. By generating 10 uniform random variate  $U(0, 1)$  estimate the integral

$$\theta = \frac{1}{\sqrt{2\pi}} \int_{-1}^2 e^{-x^2/2} dx$$

Recognizing this function as probability density function of  $N(0, 1)$ , compare the value of  $\theta$  with  $\hat{\theta}$ . (10)

7. A sample of 100 villagers is to be drawn from a population of villages A and B. The population means and population mean squares of their monthly wages are given below:

Village	$N_i$	$\bar{X}_i$	$S_i^2$
Collage A	400	60	20
Collage B	200	120	80

Find the number of samples using Proportional and Neyman allocation techniques and compare. Obtain the sample mean and variances for the Proportional Allocation and SRSWOR for the given information. Then Find the percentage gain in precision of variances of sample mean under the proportional allocation over that of SRSWOR.

(20)

8. A manufacturer wishes to determine the effectiveness of four types of machines (A, B, C and D) in the production of bolts. To accumulate this, the numbers of defective bolts produced for each of two shifts in the results are shown in the following table:

Machine	First shift					Second Shift				
	M	T	W	Th	F	M	T	W	Th	F
A	6	4	5	5	4	5	7	4	6	8
B	10	8	7	7	9	7	9	12	8	8
C	7	5	6	5	9	9	7	5	4	6
D	8	4	6	5	5	5	7	9	7	10

Perform an analysis of variance to determine at 5% level of significance, whether there is a difference (a) Between the machines and (b) Between the shifts. (20)

## **TUTOR MARKED ASSIGNMENT**

### **MSTE-001: Industrial Statistics-I**

**Course Code: MSTE-001**

**Assignment Code: MSTE-001/TMA/2024**

**Maximum Marks: 100**

**Note: All questions are compulsory. Answer in your own words.**

1. State whether the following statements are True or False. Give reason in support of your answer.  $(2 \times 5 = 10)$
- a) If the average number of defects in an item is 4, the upper control limit of the c-chart will be 12.
- b) The specification limits and natural tolerance limits are same in statistical quality control.
- c) If the probability of making a decision about acceptance or rejection of a lot on the first sample is 0.80 and the sizes of the first and second samples are 10 and 15, respectively, then the average sample number for the double sampling plan will be 25.
- d) Two independent components of a system are connected in series configuration. If the reliabilities of these components are 0.1 and 0.30, respectively then the reliability of the system will be 0.65.
- e) A point in the pictorial representation of a decision tree having states of nature as immediate sub-branches is known as decision point.

2. To monitor the manufacturing process of mobile phones, a quality controller randomly selected 100 mobile phones from the production line, each day over 15 days. The mobile phones were inspected for defectives and the number of defective mobile phones found each day was recorded. The data are given below:

<b>Subgroup Number</b>	<b>Number of Mobile Phones Inspected</b>	<b>Number of Defective Mobile Phones</b>
1	100	3
2	100	6
3	100	4
4	100	6
5	100	20
6	100	2
7	100	6
8	100	7
9	100	3
10	100	0
11	100	6
12	100	15
13	100	5
14	100	7
15	100	6

i) Determine the trial centre line and control limits for the fraction defective using the above data. (4)

ii) Construct the control chart on graph paper and determine that the process is stable or not. If there is any out-of-control point, determine the revised centre line and control limits. (6)

3. A shirt manufacturing company supplies shirts in lots of size 250 to the buyer. A single sampling plan with  $n = 20$  and  $c = 1$  is being used for the lot inspection. The company and the buyer decide that  $AQL = 0.04$  and  $LTPD = 0.10$ . If there are 15 defective in each lot, compute the

- probability of accepting the lot. (2)
- producer's risk and consumer's risk. (4)
- average outgoing quality (AOQ), if the rejected lots are screened and all defective shirts are replaced by non-defectives. (2)
- average total inspection (ATI). (2)

4. The failure density function of a random variable  $T$  is given by

$$f(t) = \begin{cases} 0.011 e^{-0.011t}, & t \geq 0 \\ 0, & \text{otherwise} \end{cases}$$

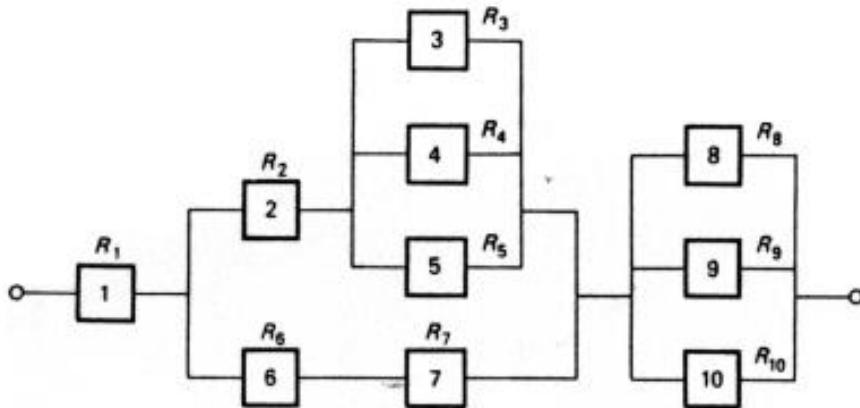
Calculate, the

- reliability of the component. (2)
- reliability of the component for a 100 hour mission time. (2)
- mean time to failure (MTTF). (2)
- median of the random variable  $T$ . (2)
- life of the component, if the reliability of 0.96 is desired. (2)

5. Solve the two-person zero-sum game having the following payoff matrix for player A: (10)

		Player B				
		$B_1$	$B_2$	$B_3$	$B_4$	$B_5$
Player A	$A_1$	3	4	5	-2	3
	$A_2$	1	6	-3	3	7

6. The system shown below is made up of ten components. Components 3, 4 and 5 are not identical and at least one component of this group must be available for system success. Components 8, 9 and 10 are identical and for this particular group it is necessary that two out of the three components functions.



What is the system reliability if  $R_1 = R_3 = R_5 = R_7 = R_9 = 0.85$  and  $R_2 = R_4 = R_6 = R_8 = R_{10} = 0.95$  (10)

7. A small electronic device is designed to emit a timing signal of 200 milliseconds (ms) duration. In the production of this device, 10 subgroups of four units are taken at periodic intervals and tested. The results are shown in the following table:

Subgroup Number	Duration of Automatic Signal (in ms)			
	a	b	c	d
1	195	201	194	201
2	204	190	199	195
3	195	197	205	201
4	211	198	193	180
5	204	193	197	200
6	200	202	195	200
7	196	198	197	196
8	201	197	206	207
9	200	202	204	192
10	203	201	209	192

i) Estimate the process mean and standard deviation. (4)  
 ii) Determine the centre line and control limits for the process mean and process variability. (4)  
 iii) By plotting the charts on graph paper, determine that the process is stable or not with respect to the process mean and process variability. If necessary, compute revised control limits. (12)

8. The failure data of 10 electronic components are shown in the table given below:

Failure Number	1	2	3	4	5	6	7	8	9	10
Operating Time (in hours)	3	5	31	51	76	116	140	182	250	302

Estimate, the

i) reliability. (5)  
 ii) cumulative failure distribution. (5)  
 iii) failure density. (5)  
 iv) failure rate functions. (5)

## TUTOR MARKED ASSIGNMENT

### MSTE-002: Industrial Statistics-II

Course Code: MSTE-002

Assignment Code: MSTE-002/TMA/2024

Maximum Marks: 100

**Note: All questions are compulsory. Answer in your own words.**

1. State whether the following statements are True or False and also give the reason in support of your answer.  $(2 \times 5 = 10)$ 
  - a) The Set  $S = \{(x, y) : 0 \leq y \leq 5 \text{ when } 0 \leq x \leq 2 \text{ and } 3 \leq y \leq 5 \text{ when } 2 \leq x \leq 7\}$  is not a convex set.
  - b) If 10 is added to each of the entries of the cost matrix of a  $3 \times 3$  assignment problem, then the total cost of an optimal assignment for the changed cost matrix will increase by 10.
  - c) The solution to a transportation problem with  $m$ -rows (supplies) and  $n$ -columns (destinations) is feasible if number of positive allocations is  $m + n$ .
  - d) The Value  $d_i \geq 3$  indicates an outlying observation in regression analysis.
  - e) Variations which occur due to natural forces and operate in a regular and periodic manner over a span of less than or equal to one year are termed as cyclic variations.
2. (a) Rewrite the following linear programming problem in Standard form:

$$\text{Minimise } Z = 2x_1 + x_2 + 4x_3$$

Subject to the Constraints:

$$-2x_1 + 4x_2 \leq 4$$

$$x_1 + 2x_2 + x_3 \geq 5$$

$$2x_1 + 3x_3 \leq 2$$

$$x_1 \geq 0, x_2 \geq 0, x_3 \geq 0$$

(5)

- (b) Solve the following LPP using graphical method:

$$\text{Maximize } Z = 3x_1 + 2x_2$$

Subject to the Constraints:

$$-2x_1 + x_2 \leq 1$$

$$x_1 \leq 2$$

$$x_1 + x_2 \leq 3$$

$$x_1, x_2 \geq 0$$

(5)

3. Solve the following LPP using Simplex method:

$$\text{Maximize } Z = x_1 + 2x_2$$

Subject to the Constraints:  $-x_1 + 2x_2 \leq 8$

$$x_1 + 2x_2 \leq 12$$

$$x_1 - x_2 \leq 3$$

$$x_1, x_2 \geq 0$$

(10)

4. A department head has four subordinates, and four tasks to be performed. The subordinates differ in efficiency, and the tasks differ in their intrinsic difficulty. His estimate, of the time each man would take to perform each task, is given in the table below:

Tasks	Subordinates			
	E	F	G	H
A	18	26	17	11
B	13	28	14	26
C	38	19	18	15
D	19	26	24	10

How should the tasks be allocated, one to a subordinate, so as to minimise the total man hour? (10)

5. a) Use graphical method to minimise the time added to process the following jobs on the machines shown:

Job 1:	Sequence	A	B	C	D	E
	Time	3	4	2	6	2
Job 2:	Sequence	B	C	A	D	E
	Time	5	4	3	2	6

Calculate the total time elapsed to complete both the jobs. (4)

b) The following data comprising the number of customers (in hundred) and monthly sales (in thousand Rupees):

Number of Customers (in hundred)	4	6	6	8	10	14	18	20	22	26	28	30
Monthly Sales (in thousand Rs)	1.8	3.5	5.8	7.8	8.7	9.8	10.7	11.5	12.9	13.6	14.2	15

Calculate the residuals and determine the standardised residuals for the model

$$Y = 2.6185 + 0.4369 X \quad (6)$$

6. a) A Statistician collected the data of 78 values with two independent variable  $X_1$  and  $X_2$ , and considered the four models:

(i)  $Y = B_0 + e$ ; (ii)  $Y = B_0 + B_1 X_1 + e$ ; (iii)  $Y = B_0 + B_1 X_1 + e$  and (iv)  $Y = B_0 + B_1 X_1 + B_2 X_2 + e$ .

The results obtained are:  $\hat{\sigma}^2 = 0.91$ ,  $SS B_0 = 652.42$ ,  $SS B_0, B_1 = 679.34$ ,  $SS B_0, B_2 = 654.00$ , and  $SS B_0, B_1, B_2 = 687.79$ . Find the additional contribution of (i)  $X_2$  over  $X_1$  and (ii)  $X_1$  over  $X_2$ . Test whether their inclusion in the model is justified. (5)

b) Fifteen successive observations on a stationary time series are as follows:

34, 24    23    31    38    34    35    31    29    28    25    27  
32    33    30

Calculate  $r_6, r_7, r_8$  and  $r_9$  and plot the correlogram. (5)

7. Calculate seasonal indices by the ratio to moving average method from the following data:

Year Quarter	2001	2002	2003	2004
Q <sub>1</sub>	750	860	900	1000
Q <sub>2</sub>	600	650	720	780
Q <sub>3</sub>	540	630	660	720
Q <sub>4</sub>	590	800	850	930

(20)

8. Consider the following Transportation problem:

Factory	Godowns						Stock Available
	1	2	3	4	5	6	
A	7	5	7	7	5	3	60
B	9	11	6	11	-	5	20
C	11	10	6	2	2	8	90
D	9	10	9	6	9	12	50
Demand	60	20	40	20	40	40	

It is not possible to transport any quantity from Factory B to Godown 5. Determine:

(a) Basic Feasible Solution by Vogel's Approximation Method.  
 (b) Optimum solution using MODI method. (20)

## **TUTOR MARKED ASSIGNMENT**

### **MSTE-003: Biostatistics-I**

**Course Code: MSTE-003**

**Assignment Code: MSTE-003/TMA/2024**

**Maximum Marks: 100**

**Note: All questions are compulsory. Answer in your own words.**

**3. State whether the following statements are **True** or **False**. Give reason in support of your answer: **(2×5=10)****

- (a) Suppose A is the exposure and B is a confounding factor for outcome C, then there will be a path from A to C via B.**
- (b) Doing exercise may also be a regimen.**
- (c) In clinical trials, a control only may be: treatment or no treatment.**
- (d) In Greville's method, the central death rate is more in the life table than the population.**
- (e) In a slope ratio assay, both regression lines have common slope.**

**2. Explain with examples:**

- (a) Various sources of demographic data in India**
- (b) Types of bioassays**
- (c) LD50 and ED50**

**(5+5+5)**

**3.(a) Differentiate between complete and abridged life tables.**

**(b) The data on population and number of deaths for different age groups of Districts A and B in the year 2001 were collected in the following table:**

<b>Age Group (Years)</b>	<b>District A</b>		<b>District B</b>	
	<b>Population</b>	<b>No. of Deaths</b>	<b>Population</b>	<b>No. of Deaths</b>
0 - 5	55,300	385	51,165	805
5 - 15	109,125	410	98,170	510
15-35	1,72,050	675	1,68,450	790
35-50	1,15,600	1625	1,40,625	990
50 & above	2,65,775	3288	2,40,900	2485

Calculate standardised death rate by direct method, taking population of District A as the standard population.

**(5+5)**

3. In a parallel-line assay, total 18 guinea pigs, 4 guinea pigs each from 3 different breeds were selected and classified into 4 groups for each breed. Two groups were administered with two doses of the standard preparation and remaining two groups with two doses of the test preparation. The responses of these doses are recorded in the following table:

Breed	Dose (Standard)			Dose (Test)		
	10 (in $\mu$ L)	15 (in $\mu$ L)	20 (in $\mu$ L)	5 (in $\mu$ L)	10 (in $\mu$ L)	15 (in $\mu$ L)
1	25	42	55	20	43	64
2	23	47	52	23	42	66
3	22	38	58	24	44	67

- (i) Determine the dose-response regression models for both preparations.
- (ii) Test whether the dose-response curves of both preparations are linear and parallel to each other or not.
- (iii) Interpret whether the relative potency and its confidence interval can be computed or not.

(8+15+2)

5.(a) If  $D^+$  and  $D^-$  denote presence and absence, respectively, of a disease and  $T^+$  and  $T^-$  denote test result as positive and negative, respectively, then on the basis of the following information:

	$D^+$	$D^-$	Total
$T^+$	145	2000	2145
$T^-$	15	48000	48015
Total	160	50000	50160

Find: (i) sensitivity (ii) specificity (iii) positive and negative predictive values.

(b) Obtain sample size for the following given information:

$$\delta = 0.04, \pi_1 = 0.72, \pi_2 = 0.84, \alpha = 0.01, \beta = 0.25$$

(5+5)

6.(a) Explain design and analysis of data of case control study in detail.

(b) Creatinine excretion is a parameter of kidney function. Generally speaking, lower values indicate better health. This depends on body weight. A researcher conducted a study on creatinine excretion in test group and control group to find the efficacy of a new drug. The subjects were randomly divided. He included 100 subjects in each group but for this exercise consider only 10 subjects in each group. The data obtained on creatinine level in these 10 subjects are as follows:

Test group: 16.6 19.8 17.1 17.0 15.6 20.3 24.7 18.5 17.6 22.0

Control group: 23.2 22.0 21.9 16.7 14.2 23.2 24.8 25.5 28.1 21.8

Do you think that creatinine excretion was really lower in the test group on average?

**(15+5)**

7. Suppose you try a regimen A on 1000 subjects and regimen B on 1600 subjects. Results of the trial show that efficacies of regimen A and B are 76% and 82% respectively. Suppose doctor determines 4% as superiority margin. Can you consider regimen B as superior to regimen A.

**(10)**

## **TUTOR MARKED ASSIGNMENT**

### **MSTE-004: Biostatistics-II**

**Course Code: MSTE-004**

**Assignment Code: MSTE-004/TMA/2024**

**Maximum Marks: 100**

**Note: All questions are compulsory. Answer in your own words.**

**1.** State whether the following statements are **True** or **False**. Give reason in support of your answer: **(2×5=10)**

**(a)** The value of sensitivity of the following results of a diagnostic test is 0.85.

Disease	Test result		Total
	+	-	
Present	170	30	200
Absent	20	280	300

**(b)** For the following cohort study, the relative risk for the lung cancer among smokers is 3.5.

	Lung Cancer	No Lung Cancer	Total
Smokers	100	1220	1320
Non-smokers	50	2260	2310

**(c)** The logit link function is  $\log[-\log(1-\pi)]$ .

**(d)** We define three indicator/dummy variables for a regressor variable with three categories.

**(e)** Left censoring occurs whenever the exact time of occurrence of an event is not known.

**2.** Differentiate between Chi-square tests for association and homogeneity of proportions. Also mention the assumptions of these tests.

**(10)**

**3.** A random sample of 250 patients was selected and their workout timing and diabetes status were recorded. The following table shows the workout timing and severity of diabetes:

Workout (in minutes)	Severity of diabetes status		
	Low	Moderate	High
0 –15	06	27	19
15 to 30	08	36	17
30 to 45	21	45	33
≥ 45	14	18	06

Test at 5% level of significance whether workout habit and diabetes are associated with to each other or not.

**(10)**

4.(a) Explain the assumptions underlying multiple linear regression model.

(b) Suppose a researcher wants to evaluate the effect of cholesterol on the blood pressure. The following data on serum cholesterol (in mg/dL) and systolic blood pressure (in mm/Hg) were obtained for 15 patients to explore the relationship between cholesterol and blood pressure:

S. No.	Cholesterol (mg/dL)	SBP (mm/Hg)
1	300	150
2	410	270
3	380	210
4	530	310
5	570	350
6	490	310
7	340	210
8	320	150
9	280	110
10	550	320
11	340	220
12	350	170
13	410	260
14	390	230
15	450	270

- (i) Fit a linear regression model using the method of least squares.
- (ii) Construct the normal probability plot for the data on serum cholesterol and systolic blood pressure.
- (iii) Test the significance of the fitted regression model.

(5+15)

4. Write a short note on the following:

- (i) Polytomous logistic models
- (ii) Poisson regression
- (iii) Kaplan and Meier method

(12)

6. The following data on diagnosis of coronary heart disease (where 0 indicating absence and 1 indicating presence), serum cholesterol (in mg/dl), resting blood pressure (in mmHg) and weight (in kg) were obtained for 80 patients to explore the relationship of coronary heart disease with cholesterol and weight.

S. No.	Serum Cholesterol (mg/dl)	Weight (kg)	Number of Patients having CHD	Total Number of Patients
1	420	60	10	20
2	450	68	15	30
3	400	54	4	15
4	510	74	2	10
5	480	62	1	5

- (i) Fit a multiple logistic model for the dependence of coronary heart disease on the average serum cholesterol and weight considering  $\hat{\beta}_0^0 = 4.279$ ,  $\hat{\beta}_1^0 = -0.035$  and  $\hat{\beta}_2^0 = 0.172$  as the initial values of the parameters (solve only for one Iteration).
- (ii) Test the significance of the fitted model using Hosmer-Lemeshow test at 5% level of significance.

(12+8)

7.(a) Describe censoring and differentiate between different types of censoring with the help of examples which are not considered in Block 4 of MSTE-004.

(b) A study was conducted on 185 patients aged more than 45 years which are followed until the time of death or up to 10 years, whichever comes first. The patients have different covariates: age, gender (male/female), systolic blood pressure, smoking (yes/no), total serum cholesterol and diabetes (yes/no). The objective of this study is to determine which covariate influences the survival time. An analysis is conducted to investigate differences in all-cause mortality between men and women participating in the study. Suppose we obtain the following results after applying the Cox regression hazard model analyses:

Risk Factor	Parameter Estimate	SE
Age	0.150	0.010
Gender	0.450	0.150
Systolic Blood Pressure	0.015	0.008
Smoking	0.650	0.170
Total Serum Cholesterol	0.002	0.004
Diabetes	-0.350	0.250

- (i) Obtain hazard ratio and interpret the results.
- (ii) Find the 99% confidence interval for the hazard ratio.
- (iii) Test whether the covariates are significant or not at 1% level of significance.

(8+10)