(3 Hours) **Total Marks: 80**

N.B. : **(1)** Question No. 1 is compulsory.

(2) Attempt any three questions out of remaining five questions

Q.1 (a) By using matrices, solve the following system of linear equation **(5)**

$4x - y + 2z + w = 0$, $2x + 3y - z - 2w = 0$, $7y - 4z - 5w = 0$,

$2x - 11y + 7z + 8w = 0$.

(b) State Central limit theorem. Let $\bar{X}$ be the mean of a random sample of size 50 drawn from a population with mean 116 and standard deviation 40. **(5)**

a. Find the mean and standard deviation of $\bar{X}$.

b. Find the probability that $\bar{X}$ assumes a value between 114 and 118.

(c) Obtain the graph of $y = e^{-4x}$ **(5)**

(d) Compare constrained and non-constrained optimization Techniques. **(5)**

Q.2. (a) Find Singular Value of Decomposition of matrix $A = \begin{bmatrix} 1 & 1 & 0 \\ 0 & 1 & 1 \end{bmatrix}$ **(10)**

(b) Ten students were given intensive coaching for a month in Mechanics. The scores obtained in tests are given below. **(10)**

Sr. No	1	2	3	4	5	6	7	8	9	10
Marks in 1st test	52	54	51	58	63	65	46	67	70	78
Marks in 2nd test	70	60	70	70	65	72	54	87	79	91

Does the score from test 1 to test 2 show an improvement? Test at 5% level of significance.

Q.3. (a) Calculate the expected frequencies for the following data presuming the two attributes viz. condition of home and condition of child independent **(10)**

		Condition of Home	
		Clean	Dirty
Condition of Child	Clean	70	50
	Fairly Clean	80	20
	Dirty	35	45

Use test at 5% level to find whether the two attributes are independent.

(b) Draw two Pie diagrams to represent the following data giving profits of different partners in a firm. **(10)**

Partner	**Profit (in ₹) 2021**	**Profit (in ₹) 2022**
A	14	9
B	16	10
C	29	27
D	17	25
E	16	18
F	8	11
Total	**100**	**100**

Q.4. (a) Find 3 yearly moving averages and represent these on a graph paper. Also represent the original time series on the graph. **(10)**

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007
Sales (in lakhs)	31	33	30	34	38	40	45	49	44

(b) Minimize the function $f(x_1, x_2) = 4x_1 + 8x_2 - x_1^2 - x_2^2$ **(10)**
subject to $x_1 + x_2 = 4, \quad x_1, x_2 \geq 0$

Q.5. (a) Explain the need for exploratory data analysis. Also list and explain exploratory data analysis techniques. **(10)**

(b) Find the root of the equation $x^3 - 4x - 9 = 0$ using bisection method correct three decimal places in the interval (2, 3). **(10)**

Q.6. (a) Describe with example and action to be taken for the following **(10)**

1. Data Cleaning
2. Irrelevant data
3. Incorrect dataS
4. Handle Missing Data
5. Outliers

(b) Write a short note on linear discriminant analysis techniques and principal component analysis algorithm **(10)**