U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

June 2025 Semester End Main Examinations

Programme: B.E. **Semester: IV**
Branch: Chemical Engineering **Duration: 3 hrs.**
Course Code: 19MA4BSSAP **Max Marks: 100**
Course: Statistics and Probability

Instructions: 1. All units have internal choice, answer one full question from each unit.
2. Missing data, if any, may be suitably assumed.
3. Use of Statistical tables is permitted.

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Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

		UNIT - 1	CO	PO	Marks
1	a)	Estimate the chloric residual in a swimming pool 5 hours after it has been treated with chemicals by fitting an exponential curve of the form $y = ab^x$ to the following data: x (No. hours): 2, 4, 6, 8, 10, 12 y (chlorine residual parts/million): 1.8, 1.5, 1.4, 1.1, 1.1, 0.9	2	1	**6**
	b)	Alpha particles are emitted by radioactive source at the rate of three per every minute on the average. The number of particles is distributed according to the Poisson distribution. Calculate (i) the probability of getting no emissions in one minute (ii) at least two emissions in one minute (ii) at most one emission in one minute	2	1	**7**
	c)	If the total cholesterol values for a certain population are approximately normally distributed with a mean of 200mg/ml and standard deviation of 20mg/ml. Find the probability that an individual selected at random from this population will have a cholesterol value: i) Between 180 and 200mg/ml. ii) Greater than 225mg/ml. iii) Less than 150mg/ml.	2	1	**7**
		OR			
2	a)	Establish the formula $r = \dfrac{a^2\sigma_x{}^2 + b^2\sigma_y{}^2 - \sigma^2{}_{ax+by}}{-2ab\ \sigma_x\ \sigma_y}$.	1	1	**6**
	b)	Fit a Poisson distribution to the following data: R.B.C. count per cell (x): 0, 1, 2, 3, 4, 5, Total No. of cells (f): 11, 20, 28, 24, 12, 5, 100	2	1	**7**
	c)	In an examination taken by 500 candidates, average and standard deviation of marks obtained are 40 and 10. Assuming normal distribution, find i. How many have scored above 60? ii. How many will pass if 50 is fixed as the minimum for passing?	2	1	**7**

			UNIT - 2			
	3	a)	A habitual gambler is a member of two clubs A and B. He visits either of the clubs every day for playing cards. He never visits club A on two consecutive days. But, if he visits club B on a particular day, then the next day he is as likely to visit club B or club A. i) Find the transition matrix of this Markov chain. ii) Show that the matrix is a regular stochastic matrix.	3	1	**6**
		b)	Two fruits are selected at random from a bag containing 3 Apples, 2 Oranges and 4 Mangoes. If X and Y are respectively, the number of Apples and the number of Oranges included among the two fruits drawn from the bag, find the probability associated with all possible pair of values (x, y). Also find the covariance between the variables X and Y.	2	1	**7**
		c)	If X and Y are independent random variables, X takes values 2, 5, 7 with probability 1/2, 1/4, 1/4 respectively and Y takes values 3, 4, 5 with probability 1/3, 1/3, 1/3 respectively. Find (i) Joint probability distribution of X and Y, (ii) $E(X), E(Y), E(XY),$ and $E(X+Y)$.	2	1	**7**
			OR			
	4	a)	The joint probability function of two random variable X and Y is given by $f(x,y) = k(2x+3y)$ for $0 \le x \le 2; 1 \le y \le 3$. (i) Find the constant k. (ii) Calculate the marginal distribution of X and Y. (iii) Check whether X and Y are stochastically independent or not.	2	1	**6**
		b)	Three balls are drawn at random from a box containing 2 white, 3 red and 4 black balls. If X denotes the number of white balls and Y denotes the number of red balls drawn, find the joint probability distribution of (X, Y) and also the covariance of X and Y.	2	1	**7**
		c)	Three children A, B, C are throwing a ball to each other. A always throws the ball to B and B always throws ball to C. However, C is just as likely to throw the ball to B as to A. Find the transition matrix of the Markov process. Suppose C is the first person with the ball, then find the probability that A, B and C having a ball after 3rd throws.	3	1	**7**
			UNIT - 3			
	5	a)	Apply CRD to analyze the data	4	1	**10**

A-32	D-34	E-39	D-36	C-35
B-37	B-43	C-41	A-42	E-35
C-40	A-35	E-33	A-33	D-35
D-37	E-35	B-37	E-32	C-32
E-43	A-35	C-37	D-39	B-32
B-38	C-27	D-37	B-31	A-40

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c) An experiment was conducted on the yield of potatoes in a randomized block design with four replications. Analyse the following 2^2 factorial design. — 4 — 1 — **10**

Block	Treatment Combinations			
(1)	(1) - 23	K - 25	P - 22	KP - 38
(2)	P - 40	(1) - 26	K - 36	KP - 38
(3)	(1) - 29	K - 20	KP - 30	P - 20
(4)	KP - 34	K - 31	P - 24	(1) - 28

OR

6 a) Data recorded on yield of four varieties in an experiment with four replications for which one value is missing. Estimate the missing value and construct the ANOVA table by applying RBD technique. — 4 — 1 — **10**

P 5.52	R 5.57	Q 5.071	S 9.16
S 6.69	R 5.14	Q -	P 6.09
S 2.89	P 6.02	Q 6.53	R 2.83
R 9.76	Q 6.25	S 8.9	P 9.77

b) An oil company tested 4 different blends - A, B, C and D of gasoline for fuel efficiency according to a Latin Square Design in order to control for the variability of 4 different drivers and 4 different models of cars. Fuel efficiency was measured in miles per gallon after driving the cars over a standard course. The data are presented below. Analyse the data. — 4 — 1 — **10**

Driver	Car Model			
	I	II	III	IV
1	D-15.5	B-33.9	C-13.2	A-29.1
2	B-16.3	C-26.6	A-19.4	D-22.8
3	C-10.8	A-31.8	D-17.1	B-30.3
4	A-14.7	D-34	B-19.7	C-21.6

UNIT - 4

7 a) A company claims that the mean thermal efficiency of diesel engines produced by them is 32.3. A random sample of 40 engines was examined, which showed the mean thermal efficiency of 31.4 and standard deviation of 1.6. Check whether the company's claim is true? Use 5% level of significance. — 4 — 1 — **6**

b) In 210 families of females with primary unipolar major depression, they found that alcoholism was present in 89. Of 299 control families, alcoholism was present in 94. Do these data provide sufficient evidence for us to conclude that alcoholism is more likely to be present in families of subjects with unipolar depression? Use $(\alpha = 5\%)$ — 4 — 1 — **7**

c) The mean yield of two sets of plots and their variability are as given below. Examine whether the difference in the variability in yields is significant. Use $(\alpha = 5\%)$. — 4 — 1 — **7**

	Set of 40 plots	Set of 60 plots
Mean yield per plot	1258 kg	1243 kg
S.D. per plot	34	28

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<table>
<tr><td></td><td></td><td></td><td>OR</td><td></td><td></td><td></td></tr>
<tr><td></td><td>8</td><td>a)</td><td>In an otological examination of schoolchildren, out of 146 children examined 21 were found to have some type of otological abnormalities. Does it confirm with statement that 20% of the schoolchildren have otological abnormalities? Use 1% L.O.S.</td><td>4</td><td>1</td><td>6</td></tr>
<tr><td></td><td></td><td>b)</td><td>In an elementary school examination, the mean grade of 32 boys was 72 with a standard deviation of 8, while the mean grade of 36 girls was 75 with a standard deviation of 6. Test the hypothesis that the average performance of girls is better than boys. Use 1% L.O.S.</td><td>4</td><td>1</td><td>7</td></tr>
<tr><td></td><td></td><td>c)</td><td>In an infantile paralysis epidemic 500 persons contracted the disease.300 received no serum treatment and of them 75 became paralysed. Of those who received serum treatment 65 became paralysed. Was the serum treatment effective? Use 5% L.O.S.</td><td>4</td><td>1</td><td>7</td></tr>
<tr><td></td><td></td><td></td><td>UNIT - 5</td><td></td><td></td><td></td></tr>
<tr><td></td><td>9</td><td>a)</td><td>In a study of usefulness of yoga in weight reduction, a random sample of 8 persons undergoing yoga were examined of their weight before and after yoga with the following results:
<table>
<tr><td>Before</td><td>209</td><td>178</td><td>169</td><td>212</td><td>180</td><td>192</td></tr>
<tr><td>After</td><td>196</td><td>171</td><td>170</td><td>207</td><td>177</td><td>190</td></tr>
</table>
Test whether yoga is useful in weight reduction at $\alpha = 1\%$.</td><td>4</td><td>1</td><td>6</td></tr>
<tr><td></td><td></td><td>b)</td><td>Two sample polls of votes for 2 candidates A and B are taken from residents of different areas. The results are given below. Examine whether the nature of the area is related to voting prefernces in this election using Chi Square distribution at 5% level of significance.
<table>
<tr><td></td><td colspan="2">Votes for</td></tr>
<tr><td>Area</td><td>A</td><td>B</td></tr>
<tr><td>Rural</td><td>620</td><td>380</td></tr>
<tr><td>Urban</td><td>550</td><td>450</td></tr>
</table></td><td>4</td><td>1</td><td>7</td></tr>
<tr><td></td><td></td><td>c)</td><td>The chloride content of water was measured at three different stations of a lake. The seasonal averages of chloride in mg/l are given below. Analyse the data by two factor analyses.
<table>
<tr><td rowspan="2">Season</td><td colspan="3">Stations</td></tr>
<tr><td>S_1</td><td>S_2</td><td>S_3</td></tr>
<tr><td>Summer</td><td>187.4</td><td>341.8</td><td>240.6</td></tr>
<tr><td>Monsoon</td><td>172.9</td><td>198.2</td><td>150.2</td></tr>
<tr><td>Winter</td><td>154.3</td><td>157.4</td><td>137.1</td></tr>
</table></td><td>4</td><td>1</td><td>7</td></tr>
<tr><td></td><td></td><td></td><td>OR</td><td></td><td></td><td></td></tr>
<tr><td></td><td>10</td><td>a)</td><td>From an experiment on milk yield (in lbs.) of cows fed with two diets – field wilted alfalfa (diet 1) and dewatered alfalfa (diet 2), the following data are obtained.
<table>
<tr><td>Diets</td><td>Sample Sizes</td><td>Standard deviations</td></tr>
<tr><td>Field wilted alfalfa</td><td>13</td><td>4.8541</td></tr>
<tr><td>Dewatered alfalfa</td><td>12</td><td>4.2847</td></tr>
</table>
Test whether the population variances are same at $\alpha = 5\%$.</td><td>4</td><td>1</td><td>6</td></tr>
</table>

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		b)	A group of 10 rats fed on a diet A and another group of 8 rats fed on a different diet B, recorded the following increase in weights. Diet A: 5, 6, 8, 1, 12, 4, 3, 9, 6, 10 Diet B: 2, 3, 6, 8, 10, 1, 2, 8, -, - Apply difference of mean test and test the superiority of diet A over that of B? Use 1% L.O.S.	4	1	**7**
		c)	It is desired to test whether the number of gamma rays emitted per second by a certain radioactive substance is a random variable having the Poisson distribution with mean 2.4. Use the following data obtained for 300 one-second intervals to test this null hypothesis. Use 5% L.O.S.	4	1	**7**

Diet A	5	6	8	1	12	4	3	9	6	10
Diet B	2	3	6	8	10	1	2	8	-	-

Number of gamma rays	0	1	2	3	4	5	6	7 or more
Frequency	19	48	66	74	44	35	10	5

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