Code: 20A54404

R20

B.Tech II Year II Semester (R20) Regular Examinations August/September 2022

DETERMINISTIC & STOCHASTIC STATISTICAL METHODS

(Common to IT, CSE, CSE (AI), CSE (AI&ML) and AI&DS)

Time: 3 hours | Max. Marks: 70

PART – A

(Compulsory Question)

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1 Answer the following: (10 X 02 = 20 Marks)

(a) Define covariance and give suitable example. 2M

(b) Describe the Gram Schmidt process. 2M

(c) Define the random variable with example. 2M

(d) Discuss the Weibull distribution with suitable example. 2M

(e) Explain the transition probability matrix in a simple manner. 2M

(f) Briefly discus the first and higher order Markov process 2M

(g) Define moment generating function. 2M

(h) Discuss briefly Kullback-Leibler deviance. 2M

(i) Write an example for unconstrained optimization technique. 2M

(j) Define linear classification. 2M

PART – B

(Answer all the questions: 05 X 10 = 50 Marks)

2 Given B = {u_1, u_2, u_3} where u_1 = (1, 2, 1), u_2 = (1, 1, 3) and u_3 = (2, 1, 1), use the Gram-Schmidt procedure to Obtain a corresponding orthonormal B. 10M

OR

3 Obtain the singular value decomposition (SVD) of A, $U\sum V^T$, where $A=\begin{bmatrix}0 & -2\\ 1 & 5\end{bmatrix}$. 10M

4 In a given city, 6% of all drivers get at least one parking ticket per year. Use the Poisson approximation to the binomial distribution to determine the probabilities that among 80 drivers: (i) 4 will get at least one parking ticket in any given year. (ii) At least 3 will get at least one parking ticket in any given year. (iii) Anywhere from 3 to 6, inclusive, will get at least one parking ticket in any given year. 10M

OR

5 Suppose X is a uniform random variable in the interval (-3, 3) and $Y = X^2$. Obtain the cumulative distribution function of the random variable Y. Also calculate the mean and variance of the random variable X. 10M

6 The transition probability matrix of a Markov chain with states 0, 1, 2 is P = $\begin{pmatrix}\frac{3}{4} & \frac{1}{4} & 0\\ \frac{1}{4} & \frac{1}{2} & \frac{1}{4}\\ 0 & \frac{3}{4} & \frac{1}{4}\end{pmatrix}$ and the initial state distribution of the chain is $P(X_0=i)$ i) = $\frac{1}{3}$, i = 0, 1, 2. 10M

Obtain: (i) $P(X_2= 2)$. (ii) $P(X_2= 2, X_1= 1, X_0= 2)$.

OR

Contd. in page 2

7 A market research team has conducted a survey of customer buying habits with respect to three brands of talcum power in an area. It estimates at present, 20% of the customers buy brand A, 50% of the customers buy brand B and 30% of the customers buy brand C. In addition, the team has analyzed its survey and has determined the following brand switching matrix. 10M

Brand Next Bought / Brand Just Bought	A	B	C
A	0.6	0.3	0.1
B	0.4	0.5	0.1
C	0.2	0.1	0.7

Determine the expected distribution of consumers two time periods later.

8 Let X, Y, Z denote 3 jointly distributed RVs with joint density function then: 10M

$$f(x, y, z) = \begin{cases} \frac{12}{7}(x^2 + yz); \ 0 \le x \le 1,\ 0 \le y \le 1, 0 \le z \le 1 \\ 0; \ \text{otherwise} \end{cases}$$

Determine the conditional expectation of $U = X^2 + Y + Z$ given $X = x$, $Y = y$.

OR

9 Suppose that a rectangle is constructed by first choosing its length, X and then choosing its width Y. Its length X is selected form an exponential distribution with mean $= 1/\lambda = 5$. Once the length has been chosen its width, Y, is selected from a uniform distribution from 0 to $\frac{1}{2}$ its length. Find the mean and variance of the area of the rectangle $A = XY$. 10M

10 Solve a nonlinear programming problem by Karush-Kuhn-Tucker conditions maximize $f(x, y) = xy$ subject to $x^2 + y^2 \le 2$, $x, y \ge 0$. 10M

OR

11 Determine the slope and intercept and graph the linear inequalities: 10M

(i) $5x + 2y > -6$.

(ii) $8x - 5y \ge 5$.

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(Common to IT, CSE, (AI&DS), CSE(AI&ML), CSE(AI) and (AI&ML))

Time: 3 hours Max. Marks: 70

PART – A

(Compulsory Question)

*****

1 Answer the following: (10 X 02 = 20 Marks)

(a) List the advantages of reducing dimension of the data. 2M

(b) Find the variance between two variables X=(2,4,6,8,10) ,Y=(1,3,8,11,12). 2M

(c) If a random variable has a Poisson distribution such that P(1) = P(2), find the mean of the distribution. 2M

(d) Write down the mean and variance of exponential distribution. 2M

(e) What are the uses of Markov analysis? 2M

(f) Give any two properties of Transition probability matrix. 2M

(g) Differentiate between Multiple correlation and Partial correlation. 2M

(h) Write the steps to find the partial correlation coefficients. 2M

(i) Explain the role of optimization in machine learning algorithm. 2M

(j) Describe the significance of Loss function in machine learning. 2M

PART – B

(Answer all the questions: 05 X 10 = 50 Marks)

2 Consider the two dimensional pattern (2, 1) (3, 5) (4, 3) (5, 6) (6, 7) (7, 8). Compute the principal component using PCA algorithm. 10M

OR

3 Find the Singular value decomposition for the matrix 10M

$$A = \begin{bmatrix} 3 & 3 & 2 \\ 2 & 3 & -2 \end{bmatrix}.$$

4 (a) A variate X has the probability distribution: 5M

X	-3	6	9
P(X = x)	1/6	1/2	1/3

Find E(X) and E(2X+1).

(b) A random variable X has a uniform distribution over (-3,3), find k for which P(X > k) = 1/3. Also evaluate P(X < 2). 5M

OR

5 (a) In a test on 2000 electric bulbs, it was found that the life of a particular make, was normally distributed with an average life of 2040 hours and standard deviation of 60 hours. Estimate the number of bulbs likely to burn for (i) more than 2150 hours (ii) less than 1950 hours and (iii) more than 1920 hours and but less than 2160 hours. 5M

(b) The probability that a pen manufactured by a company will be defective is 1/10. If 12 such pens are manufactured, find the probability that (i) exactly two will be defective (ii) none will be defective. 5M

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6 Consider the Markov chain with three states s = {1, 2, 3} that has the following transition matrix 10M

$$P=\begin{bmatrix} \frac{1}{2} & \frac{1}{4} & \frac{1}{4} \\ \frac{1}{3} & 0 & \frac{2}{3} \\ \frac{1}{2} & \frac{1}{2} & 0 \end{bmatrix}.$$

(i) Draw the state transition diagram for the chain,

(ii) If we know $P(x_1 = 1) = P(x_2 = 2) = {}^{1}/_{4}$ find,

$P(x_1 = 3, x_2 = 2, x_3 = 1)$.

OR

7 The three state Markov chain is given by the transition probability matrix. Check whether the chain is irreducible or not? Identify whether the following Markov chain is regular and ergodic 10M

$$P = \begin{bmatrix} 0 & 0 & 1 \\ 0.5 & 0 & 0.5 \\ 0 & 1 & 0 \end{bmatrix}.$$

8 Let X and Y be two random variables with joint probability density function 10M

$F(x, y) = Axy$; $0<x<y<1$

$=0$; otherwise

Find A. Also find the marginal density function of X and Y.

OR

9 Given data X_1= 2, 5, 7, 8, 5 10M

X_2 = 8, 8, 6, 5, 3

X_3 = 0, 1, 1, 3, 4

Calculate the co-efficient of partial correlation.

10 Perform the linear regression algorithm for the given data below to predict the glucose level of the people with age group. 10M

Subject	Age(X)	Glucose level(Y)
1	43	99
2	21	65
3	25	79
4	42	75
5	57	87
6	59	81
7	55	?

OR

11 Find the maximum or minimum of the function $f(x) = x_1^2 + x_2^2 + x_3^2 - 4x_1 - 8x_2 - 12x_3 + 56$. 10M

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Time: 3 hours | Max. Marks: 70

PART – A

(Compulsory Question)

*****

1 Answer the following: (10 X 02 = 20 Marks)

(a) Define covariance and give suitable example. 2M

(b) Describe the Principal Component Analysis (PCA). 2M

(c) Define the continuous random variable with example. 2M

(d) Discuss the Poisson distribution with suitable example. 2M

(e) Explain the Markov Process in a simple manner. 2M

(f) Briefly discus the steady state condition in Markov chain. 2M

(g) If $r_{12} = r_{13} = r_{23} = r$, $-1 < r < +1$, then write the formula for $r_{12.3}$. 2M

(h) What is meant joint entropy? 2M

(i) Write any one condition for Kuhn–Tucker condition. 2M

(j) Discuss the use of Gradient Descent optimization algorithm. 2M

PART – B

(Answer all the questions: 05 X 10 = 50 Marks)

2 The following data shows the relationship between the number of hours that 10 persons studied for a French test and their scores on the test. 10M

Hours Studied (x)	4	9	10	14	4	7	12	22	1	17
Test Score (y)	31	58	65	73	37	44	60	91	21	64

Obtain the equation of the least squares line that approximates the regression of the test scores on the number of hours studied. Also predict the average test score of a person who studied 14 hours for the test.

OR

3 Obtain the singular value decomposition (SVD) of A, $U\sum V^T$, where $A = \begin{bmatrix} 3 & 2 & 2 \\ 2 & 3 & -2 \end{bmatrix}$. 10M

4 The probability density function of the random variable X is given by: 10M

$$f(x) = \begin{cases} \frac{c}{\sqrt{x}}, & for\ 0 < x < 4 \\ 0, & else\ where \end{cases}$$

Determine: (i) The value of c. (ii) P(X<1) and (iii) $P(X \geq 1)$.

OR

5 Suppose that during periods of transcendental meditation the reduction of a person's oxygen consumption with mean = 37.6 CC/min and SD = 4.6 CC/min. Determine the probabilities that during a period of transcendental meditation a person's oxygen consumption will be reduced by: (i) At least 44.5 CC/min. (ii) At most 35.0 CC/min. (ii) Anywhere from 30.0 to 40.0 CC/min. 10M

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6	Consider a bike share problem with only 3 stations: A, B, C. Suppose that all bikes must be returned to the station at the end of the day, so that all the bikes are at some station. Each day, the distribution of bikes at each station changes, as the bikes get returned to different stations from where they are borrowed. Of the bikes borrowed from station A, 30% are returned to station A, 50% end up at station B, and 20% end up at station C. Of the bikes borrowed from station B, 10% end up at station A, 60% of have been returned to of the bikes borrowed from station C, 10% end up at station A, 10% end up at station B, and 80% are returned to station C. (i) Express this information as a transition probability matrix and determine the probabilities of bike being at a particular station after two days. (ii) Suppose when we start observing the bike share program, 30% of the bikes are at station A, 45% of the bikes are at station B and 25% are at station C, determine the distribution of bikes at the end of the next day and after two days.	10M
	OR	
7	Three children (denoted by 1, 2, 3) arranged in a circle play a game of throwing a ball to one another. At each stage the child having the ball is equally likely to throw it into any one of the other two children. Suppose that X_0 denote the child who had the ball initially and X_n $(n \geq 1)$ denotes the child who had the ball after n throws. Determine the transition probability matrix P. Calculate $\Pr\{X_2 = 1/X_0 = 1\}$, $\Pr\{X_2 = 2/X_0 = 3\}$, $\Pr\{X_2 = 3/X_0 = 2\}$ and the probability that the child who had originally the ball will have it after 2 throws.	10M
8	Let X, Y, Z denote 3 jointly distributed random variable with joint density function then: f(x,y,z) = $\begin{cases} k(x^2+yz); 0 \leq x \leq 1,\ 0 \leq y \leq 1, 0 \leq z \leq 1 \\ 0; otherwise \end{cases}$ (i) Find the value of K. (ii) Determine the marginal distributions of X, Y and Z.	10M
	OR	
9	Let X, Y, Z denote 3 jointly distributed random variable with joint density function then: f(x,y,z) = $\begin{cases} \frac{12}{7}(x^2+yz);\ 0 \leq x \leq 1,\ 0 \leq y \leq 1, 0 \leq z \leq 1 \\ 0; otherwise \end{cases}$ Determine E[XYZ].	10M
10	Gradient descent method to solve the following problem approximate sin(x) with a degree *5* polynomial within the range *-3<x< 3*.	10M
	OR	
11	A company makes two products (X and Y) using two machines (A and B). Each unit of X that is produced requires 50 minutes processing time on machine A and 30 minutes processing time on machine B. Each unit of Y that is produced requires 24 minutes processing time on machine A and 33 minutes processing time on machine B. At the start of the current week there are 30 units of X and 90 units of Y in stock. Available processing time on machine A is forecast to be 40 hours and on machine B is forecast to be 35 hours. The demand for X in the current week is forecast to be 75 units and for Y is forecast to be 95 units. Company policy is to maximize the combined sum of the units of X and the units of Y in stock at the end of the week. (i) Formulate the problem of deciding how much of each product to make in the current week as a linear program. (ii) Solve this linear program graphically.	10M

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