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Question Paper Code: R4M26

B.E. / B.Tech. DEGREE EXAMINATION, APRIL / MAY 2025

Fourth Semester

Artificial Intelligence and Data Science

R21UMA426 – PROBABILITY AND STATISTICAL TECHNIQUES

(Common to CSD Engineering branches)

(Regulations R2021)

Duration: Three hours

Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. The r^{th} moment about origin is CO6- U
(a) $\mu(X)$ (b) $\mu(X^2)$ (c) $\mu(X^r)$ (d) None of the above
2. A Continuous r.v has a p.d.f CO1- App
 $f(x) = 3x^2, 0 \leq x \leq 1$, If $P(X > b) = 0.05$, then value of b is
(a) 0.9308 (b) 0.9803 (c) 0.9830 (d) 0.9038
3. For Geometric Distribution CO6 -U
(a) $E(X) = \sigma^2$ (b) $E(X) > \sigma^2$ (c) $E(X) < \sigma^2$ (d) $E(X) \geq \sigma^2$
4. If $M_x(t) = (0.7 + 0.3e^t)^{10}$ then value of mean is CO6 –U
(a) 3 (b) 0.21 (c) 70 (d) 2.1
5. $\text{Var}(2X + 3) =$ _____ CO3 – App
a) $4\text{Var}(X) + 9\text{Var}(Y)$ b) $4\text{Var}(X)$ c) $9\text{Var}(Y)$ d) 0
6. If the regression lines of two variables x and y are $3x + 2y - 26 = 0$ and $6x + y - 31 = 0$ then the arithmetic mean of x is CO3–App
(a) 4 (b) 7 (c) 4,7 (d) 3

7. If T is an unbiased estimator for θ , then T^2 is a Estimator for θ^2 . CO6 – U
 (a) unbiased (b) biased (c) Both (a) & (b) (d) None of the above
8. Bias of an estimator can be CO 6 – U
 (a) Negative (b) Positive (c) Zero (d) Both (a) & (b)
9. The degrees of freedom in t-tests is CO6- U
 (a) n-1 (b) n-2 (c) n-3 (d) n-4
10. Chi-square test is very popularly known as a test of CO6- U
 (a) Independent of attributes (b) t- test (c) F-test (d) goodness of fit

PART – B (5 x 2= 10 Marks)

11. In the probability density function $f(x) = k(8 - x)$, $0 \leq x \leq 2$, Find K CO1 -App
12. If Moment generating function $M_x(t) = \frac{2}{2-t}$, find the variance value CO2 -App
13. The regression of X on Y and Y on X are respectively $4X + 5Y = 33$ and $20X + 9Y = 107$ Find the means of X and Y CO3 -App
14. Explain: Fisher – Neymann Criterion. CO6- U
15. State the applications of Chi-square distribution CO6-U

PART – C (5 x 16= 80 Marks)

16. (a) (i) A RV X has the following distribution CO1-App (8)

x	0	1	2	3	4	5	6
P(X)	2a	3a	5a	7a	9a	12a	15a

Compute 1) $p(X \leq 2)$, $p(x > 2)$, $p(2 < x < 5)$ (2) Find the distribution function of x

- (ii) The joint probability mass function of (X,Y) is given by CO1-App (8)

$$P(x, y) = k(x + 2y), x = 0, 1, 2 \text{ \& } y = 0, 1, 2 \text{ Compute}$$

Or

- (b) (i) The joint pdf CO1-App (8)

$$f(x, y) = x^2 + \frac{xy}{3}, 0 \leq x \leq 1, 0 \leq y \leq 2$$

Compute (i) Conditional density function

(ii) Are X and Y independent?

- (ii) If the joint distribution function of the RV (X,Y) is given by CO1-App (8)
- $$F(x, y) = \begin{cases} (1 - e^{-x})(1 - e^{-y}), & x > 0, y > 0 \\ 0 & \text{otherwise} \end{cases}$$
- Compute the (i) marginal density functions of X and Y (ii) Are X and Y independent?
17. (a) (i) Compute the moment generating function of Poisson distribution and hence Compute it's mean and variance. CO3-App (8)
- (ii) Out of 800 families with 4 children each, how many families would be expected to have (1) 2 boys and 2 girls (2) at least 1 boy (3) at most 2 girls. (4)Children of both gender CO3-App (8)
- Or
- (b) (i) State and prove Memory less property of Exponential distribution CO3-App (8)
- (ii) A random variable X has a uniform distribution over (-4,4) compute CO3-App (8)
- (a) $P(X < 2)$ (b) $P(|X| < 3)$ and (C) $P(X > 1)$
18. (a) (i) Obtain the Correlation coefficient for the following data CO3-App (8)
- | | | | | | | | | |
|---|-----|-----|-----|-----|-----|-----|-----|-----|
| X | 12 | 15 | 17 | 18 | 23 | 16 | 25 | 27 |
| Y | 110 | 120 | 124 | 130 | 136 | 122 | 140 | 143 |
- (ii) Obtain the rank Correlation coefficient for the following data: CO3-App (8)
- | | | | | | | | | |
|---|----|----|----|----|----|----|----|----|
| X | 12 | 15 | 17 | 18 | 12 | 16 | 15 | 27 |
| Y | 14 | 10 | 14 | 13 | 16 | 10 | 14 | 15 |
- Or
- (b) i). If $\sigma_1 = 2, \sigma_2 = \sigma_3 = 3, r_{12} = 0.4, r_{23} = 0.3, r_{31} = 0.5$ Compute CO3-App (8)
- (i) $r_{23.1}$ (ii) $R_{1.23}$ (iii) $b_{13.2}$ (iv) $b_{12.3}$
- (ii) Joint pdf of X and Y is $f(x, y) = \begin{cases} 2 - x - y, & 0 \leq x \leq 1, 0 \leq y \leq 1 \\ 0 & \text{elsewhere} \end{cases}$. CO3-App (8)
- Compute Regression Equations
19. (a) (i) If $x_1, x_2, x_3, \dots, x_n$ is a random sample from a normal population CO4- App (8)
- $N(\mu, 1)$. Show that $t = \frac{1}{n} \sum_{i=1}^n x_i^2$ is an unbiased estimator of $\mu^2 + 1$.

(ii) The mean weekly sales of soap bars in departmental stores were 146.3 bars per store. After an advertising campaign the mean weekly sales in 400 stores for a typical week increased to 153.7 and showed a standard deviation of 17.2. Was the advertising campaign successful? CO4-App (8)

Or

(b) In random sampling from normal population $N(\mu, \sigma^2)$, find the maximum likelihood estimators for 1) μ when σ^2 is known 2) σ^2 when μ is known and 3) The simultaneous estimation of μ and σ^2 . CO4- App (16)

20. (a) (i) A sample of analysis of examination results of 500 students was made . It was found that 220 students have failed , 170 students have secured a third, 90 has secured a second class and rest a first class 20, these figures support general belief that the above categories are in the ratio 4:3:2:1 respectively. CO5- Ana (8)

(ii) A certain injection administered to each of 12 patients resulted in the following increases of blood pressure 8,8,7,5,4,1,0,0,-1,-1 can it be concluded that the injection will be in general accompanied by an increase in BP ? Using t – test. CO5- Ana (8)

Or

(b) (i) In one sample of 10 observations, the sum of the squares of the deviations of the sample values from the sample mean was 120 and in another sample of 12 observations it was 314. Test whether this difference is significant at 5% level of significance CO5- Ana (8)

(ii) A group of 10 rats fed on diet A and another group of 8 rats fed on diet B, recorded the following increase in weight. CO5- Ana (8)

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

Find the variances are significantly different.