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Question Paper Code : 10797

M.E./M.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2023.

First Semester

Information Technology

MA 4108 – APPLIED PROBABILITY AND STATISTICAL ANALYSIS

(Regulations 2021)

Time : Three hours   Maximum : 100 marks

Approved – Statistical Tables may be permitted.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. A message can follow different paths through servers on a network. The sender's message can go to one of five servers for the first step; each of them can send to five servers at the second step; each of those can send to four servers at the third step; and then the message goes to the recipient's server. How many paths are possible?

2. Decide whether a discrete or continuous random variable is the best model for each of the following variables:

    (a) The time until a projectile return to earth.

    (b) The number of times a transistor in a computer memory changes state in one operation.

3. Define a two-dimensional random variable. Give an example for the outcome of a random experiment, that is a two-dimensional random variable.

4. Find the probability distribution of $X + Y$ from the bivariate distribution of (X, Y) given below:

X \ Y	1	2
1	0.1	0.2
2	0.3	0.4

5. Define: Type 1 error and Type 2 error in testing of hypothesis.

6. Differentiate parameter and statistics in sampling with example.

7. Write the formula for finding the interval estimate for the population mean.

8. Differentiate point estimate and interval estimate with example.

9. What are various classifications of analysis of variance?

10. Explain completely randomized design briefly.

PART B — (5 × 13 = 65 marks)

11. (a) Customers are used to evaluate preliminary product designs. In the past, 95% of highly successful products received good reviews, 60% of moderately successful products received good reviews, and 10% of poor products received good reviews. In addition, 40% of products have been highly successful, 35% have been moderately successful, and 25% have been poor products.

    (i) What is the probability that a product attains a good review?

    (ii) If a new design attains a good review, what is the probability that it will be a highly successful product?

    (iii) If a product does not attain a good review, what is the probability that it will be a highly successful product?

Or

(b) The weight of a sophisticated running shoe is normally distributed with a mean of 12 ounces and a standard deviation of 0.5 ounce.

    (i) What is the probability that a shoe weighs more than 13 ounces?

    (ii) What must the standard deviation of weight be in order for the company to state that 99.9% of its shoes are less than 13 ounces?

    (iii) If the standard deviation remains at 0.5 ounce, what must the mean weight be in order for the company to state that 99.9% of its shoes are less than 13 ounces?

12. (a) Determine the value of C that makes the function $c(x+y)$ a joint probability mass function over the nine points with $x=1,2,3$ and $y=1,2,3$.

    (i) Find $P(X=2, Y<2)$

    (ii) $P(X=1)$

    (iii) The marginal probability distribution of the random variable X.

    (iv) The conditional probability distribution of Y given that $X=1$.

    (v) Are X and Y independent?

Or

(b) An article in the *Tappi Journal* (March, 1986) presented data on green liquor Na_2S concentration (in grams per liter) and paper machine production (in tons per day). The data (read from a graph) are shown as follows:

y:	40	42	49	46	44	48	46	43	53	52
x:	825	830	890	895	890	910	915	960	990	1010

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(i) Fit a simple linear regression model with y = green liquor Na^2S concentration and x = production.

(ii) Find the fitted value of y corresponding to $x = 910$.

13. (a) (i) An intelligent test was administered to a large group of boys who scored on an average 64.5 marks. The same test was given to a group of 400 boys. They scored an average of 62.5 marks with a SD 12.5 marks. Examine if the difference is significant.

(ii) The SD of a random sample of 1000 is found to be 2.6 and the SD of another random sample of 500 is 2.7. Assuming the samples to be independent, find whether the two samples could have come from populations with the same SD.

Or

(b) The following data corresponds to number printing mistakes observed per page in a book. Fit Poisson distribution to the data and test the goodness of fit using Chi square test.

x: 0   1   2   3   4   5

y: 20 75 15 20 5   5

14. (a) (i) A manufacturer of electric bulbs, finds the SD of the life of lamps to be 100 hrs. He wants to change the process, if the new process results in a smaller variation in the life of lamps. In adopting a new process, a sample of 150 bulbs gave a SD of 95 hrs. Is the manufacturer justified in changing the process? Find 95% CI for the difference of their variances.

(ii) A bank credit card department claims that 60% of all card holders do not pay their bills on time. In a random sample of 200 card holders, 136 are behind in their bills. Test the claim. Find 95% confidence interval for the proportion of card holders who are behind in their bills.

Or

(b) (i) A scientist conducts a study comparing the effects of two different types of fertilizer on the yield of a particular variety of on the tomato plant. A random sample of 60 plant using Green thumb fertilizer had a mean yield of 32.2 tomatoes with a S.D. of 8.5. A random sample of 72 plants using supergro fertilizer had a mean yield of 28.4 tomatoes with a S.D of 9.3 test if there is a difference in yield at 5% level. Also find 95% CI for the difference in yield.

(ii) If 12 determinations of the specific heat of iron have a standard deviation of 0.0086, test the null hypothesis that $\sigma = 0.010$ for such determinations. Use the alternate hypothesis $\sigma \neq 0.010$ and the level of significance $\alpha = 0.01$. Also find 95% CI for σ.

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15. (a) The following data represents the number of units of production per day turned out by 5 different workers using 4 different types of machines:
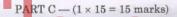
Machines

		A	B	C	D
	1	44	38	47	36
Workers	2	46	40	52	43
	3	34	36	44	32
	4	43	38	46	33
	5	38	42	49	39

(i) Test whether the five men differ with respect to mean productivity.

(ii) Test whether the mean productivity is the same for the four different machine types.

Or

(b) In 5×5 Latin square experiment, the data collected is given in the following table, yield per plot given in quintals for the five different cultivation treatments A, B, C, D and E. Perform the analysis of variance.

A48	E66	D56	C52	B61
D64	B62	A50	E64	C63
B69	A53	C60	D61	E67
C57	D58	E67	B65	A55
E67	C57	B66	A60	D57

PART C — ($1 \times 15 = 15$ marks)

16. (a) A manufacturing company employs two inspecting devices to sample a fraction of their output for quality control purposes. The first inspection moniter is able to accurately detect 99.3% of the defective items it receives, whereas the second is able to do so in 99.7% of the cases. Assume that four defective items are produced and sent out for inspection. Let X and Y denote the number of items that will be identified as defective by inspecting devices 1 and 2, respectively. Assume the devices are independent. Determine

(i) $f_{X,Y}(x, y)$ (ii) $f_X(x)$

(iii) $E(X)$ (iv) Are X and Y independent?

(v) Find covariance and correlation.

Or

(b) Based on information collected in an agro-economic survey on 1,000 randomly selected fields about the tenancy status of the cultivators of theses fields and use of fertilizers, the following classification was noted:

	Owned	Rented	Total
Using fertilizers	416	184	600
Not using fertilizers	64	336	400
Total	480	520	1000

Would you conclude that owner cultivations are more included towards the use of fertilizers at 5% level. Use Chi-square test.

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