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M.E./M.Tech. Degree Examinations, January 2017

First Semester

BIOTECHNOLOGY

MA16185 – APPLIED STATISTICS FOR BIOTECHNOLOGISTS

(Regulation 2016)

QP Code:104096

Time: Three hours

Maximum : 100 marks

Answer ALL questions

PART A - (10 X 2 = 20 Marks)

1. In a family of three children what is the probability that the first two are boys?
2. If the probabilities are 0.87, 0.36 and 0.29 that, while under warranty, a new car will require repairs on the engine, drive train, or both, what is the probability that a car will require one or the other or both kinds of repairs under warranty?
3. If the marginal distribution of two random variables is known, is it possible to determine their joint distribution? Justify your answer.
4. Is it possible for a Poisson random variable to have mean 3 and variance $\frac{1}{3}$? Justify.
5. If X and Y are independent standard normal variables, what is the correlation coefficient between them?
6. Write the normal equations for the curve $y = ax^2 + bx + c$.
7. Define level of significance in testing of hypothesis.
8. Explain Type I and Type II errors.
9. Is a 2x2 Latin square design possible? Explain.
10. What are the basic principles in design of experiments?

PART B - (5 X16 = 80 Marks)

11. (a) (i) A coin with $P(\text{head}) = p = 1-q$ is tossed n times. Show that the probability that the number of heads obtained is even is $\frac{1}{2} [1 + (q - p)^n]$ (8)

- (ii) The probability function of an infinite distribution is given by $P(X = j) = \frac{1}{k^j}$ ($j = 1, 2, \dots, \infty$). Find the value of k . Also find $P(X \text{ is even})$, $P(X \geq 5)$ and $P(X \text{ is divisible by } 3)$. (8)

(OR)

- (b) (i) The distribution function of a random variable X is given by $F(x) = 1 - (1+x)e^{-x}$, $x \geq 0$. Find the density function, mean and variance of X . (8)
- (ii) For a certain binary communication channel, the probability that a transmitted '0' is received as a '0' is 0.95 and the probability that a transmitted '1' is received as a '1' is 0.90. If the probability that a '0' is transmitted is 0.4, find the probability that (i) a '1' is received and (ii) a '1' was transmitted given that a '1' was received. (8)
12. (a) (i) Three balls are drawn at random without replacement from a box containing 2 white, 3 red and 4 black balls. If X denotes the number of white balls drawn and Y denotes the number of red balls drawn, find the joint probability distribution of X and Y . Are X and Y independent? (8)
- (ii) The marks obtained by a number of students in a certain subject are approximately normally distributed with mean 65 and standard deviation 5. If three students are selected at random from this group, what is the probability that at least one of them would have scored above 75? (8)

(OR)

- (b) (i) Define a binomial random variable determine its mean and variance. (8)
- (ii) The time (in hours) required to repair a machine is exponentially distributed with parameter $\lambda = \frac{1}{2}$. (a) What is the probability that the repair time exceeds 2 hours? (b) What is the conditional probability that a repair takes at least 10 hours given that it has already exceeded 9 hours? (8)
13. (a) If (X, Y) is a two dimensional random variable uniformly distributed over the triangular region R bounded by $y=0$, $x=3$ and $y = \frac{4}{3}x$, find the correlation coefficient between X and Y . (16)

(OR)

- (b) (i) If X , Y and Z are uncorrelated random variables with zero means and standard deviations 5, 12 and 9 respectively and if $U=X+Y$ and $V=Y+Z$, find the correlation coefficient between U and V . (8)

- (ii) The following are measurements of the air velocity and evaporation coefficient of burning fuel droplets in an impulse engine: (8)

Air velocity cm/sec (x)	Evaporation coefficient mm ² /sec(y)
20	0.18
60	0.37
100	0.35
140	0.78
180	0.56
220	0.75
260	1.18
300	1.36
340	1.17
380	1.65

Fit a straight line to these data by the method of least squares and use it to estimate the evaporation coefficient of a droplet when the air velocity is 190 cm/sec.

14. (a) (i) The following random samples are measurements of the heat-producing capacity (in millions of calories per ton) of specimens of coal from two mines: (8)

Mine 1: 8260 8130 8350 8070 8340
 Mine 2: 7950 7890 7900 8140 7920 7840

Use the 0.01 level of significance to test whether the difference between the means of these two samples is significant.

- (ii) It is desired to determine whether there is less variability in the silver plating done by company 1 than in that done by company 2. If independent random variables of size 12 of the two companies' work yield $s_1 = 0.035$ and $s_2 = 0.062$ test the null hypothesis $\sigma_1^2 = \sigma_2^2$ against the alternate hypothesis $\sigma_1^2 < \sigma_2^2$ at 0.05 level of significance. (8)

(OR)

(b) (i) In a study designed to investigate whether certain detonators used with explosives in coal mining meet the requirement that at least 90% will ignite the explosives when charged, it is found that 174 of 200 detonators function properly. Test the null hypothesis $p = 0.90$ against the alternate hypothesis $p < 0.90$ at the 0.05 level of significance. (8)

(ii) Suppose that during 400 five-minute intervals the air traffic control of an airport received 0,1,2,...,13 radio messages with respective frequencies of 3,15,47,76,68,74,39,15,9,5,2,0 and 1. Test at the 0.01 level of significance whether the data can be looked upon as values of a random variable having a Poisson distribution with $\lambda = 4.6$ (8)

15. (a) Varieties of a crop are tested in a randomised block design with four replications, the layout being as given below. The yields are given in kilograms. Analyse for significance. (16)

C48	A51	B52	A49
A47	B49	C52	C51
B49	C53	A49	B50

(OR)

(b) Analyse the variance in the following Latin square of yields (in kgs) of paddy where A, B, C, D denote the different methods of cultivation. (16)

D122 A121 C123 B122

B124 C123 A122 D125

A120 B119 D120 C121

C122 D123 B121 A123

Examine whether the different methods of cultivation have given significantly different yields.