

This question paper contains 8 printed pages.

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Your Roll No

M.Sc.-Ph.D Biomedical Science / II Sem. J

Paper— MBS-203 · Application of Statistics and
Mathematics for Biology

(Admissions of 2009 and onwards)

Time . 3 hours

Maximum Marks : 70

*(Write your Roll No on the top immediately
on receipt of this question paper)*

- *Attempt seven questions in all. Question No. 1 is compulsory. All questions carry equal marks.*

*Use of scientific calculator and statistical
tables is allowed*

1. (i) If $X \sim N(\mu, \sigma^2)$, then

$$E(\bar{X}) = \dots, V(\bar{X}) = \dots$$

- (ii) If $X \sim B(n_1, p)$ and $Y \sim B(n_2, p)$ are independent random variables, then the distribution of $X + Y$ is
.....

- (iii) If a statistic t follows Student's t -distribution with n d f then t^2 follows ...

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- (iv) If X_1 and Y are two independent Chi-square variables with n_1 and n_2 df's respectively, then F-statistic is defined by
- (v) If X_1 and X_2 are independent random variables, then m.g.f. of $X_1 + X_2$ ($M_{X_1+X_2}(t)$) is equal to
- (vi) If X is a random variable that takes only non-negative values, then Markov's inequality states that for any $a > 0$,

(vii) If $S^2 = \frac{1}{n-1} \sum_{i=1}^n (X_i - \bar{X})^2$,

then $E(S^2) = \dots$

and $\text{Var}(S^2) \rightarrow \dots$ as $n \rightarrow \infty$.

- (viii) If U and V are two functions of x possessing derivatives of n th order, then n th derivative of their product is $(U \cdot V)_n = \dots$
- (ix) Let X_1, X_2, \dots, X_n be a sequence of independent and identically distributed random variables each with mean μ and variance σ^2 , then distribution of

$$\frac{X_1 + X_2 + \dots + X_n - n\mu}{\sigma\sqrt{n}}$$

tends to as $n \rightarrow \infty$.

- (x) Karl Pearson's coefficient of skewness is given by
..... What are its limits? 10
2. (a) Of 100 patients in a hospital with a certain disease, ten are chosen to undergo a drug treatment that increases the percentage cured rate from 50% in the untreated case to 75%. If a doctor later encounters a cured patient, what is the probability that he received the drug treatment? 5
- (b) A study of the nutritional value of a certain kind of bread shows that the amount of thiamine (vitamin B₁) in a slice may be looked upon as a random variable with $\mu = 0.260$ mg and $\sigma = 0.005$ mg. According to Chebyshev's inequality, between what values must be the thiamine content of:
- (i) at least $\frac{35}{36}$ of all slices of this bread
- (ii) at least $\frac{143}{144}$ of all slices of this bread? 5
3. (a) Suppose it is known that in a certain population 10% of the population is colourblind. If a random

sample of 25 people is drawn from this population, find the probability that:

(i) Five or fewer will be colourblind

(ii) Two, three or four will be colourblind. 5

(b) It has been established that for a certain type of client the average length of a home visit by a public health nurse is 45 minutes with a standard deviation of 15 minutes, and for a second type of client the average home visit is 30 minutes long with a standard deviation of 20 minutes. If a nurse randomly visits 35 clients from the first and 40 clients from the second population, what is the probability that average length of home visit will differ between the two groups by 20 or more minutes? 5

4. (a) In a sample of 600 men from a certain large city, 450 are found to be smokers. In another large city out of a sample of 900, 450 are smokers. Do the data indicate that the cities are significantly different with respect to the prevalence of smoking among men? 5

(b) A certain stimulus is administered to each of the 12 patients² and it resulted in the following increases of blood pressure:

$d = 5, 2, 8, -1, 3, 0, -2, 1, 5, 0, 4, 6$

Can it be concluded that the stimulus will, in general, be accompanied by an increase in blood pressure?

(Given $t_{11}(0.05)=1.80$) 5

5. (a) A survey of 320 families with 5 children each revealed the following distribution:

<i>No of boys</i>	5	4	3	2	1	0
<i>No of girls</i>	0	1	2	3	4	5
<i>No of families</i>	14	56	110	88	40	12

Is this result consistent with the hypothesis that the male and female births are equally probable?

(Given $\chi_{0.05}^2(5)=11.07$) 5

- (b) A random sample of 10 boys had the following I.Q.'s:

70, 120, 110, 101, 88, 83, 95, 98, 107, 100.

Do these data support the assumption of a population mean I.Q. of 100? Find a reasonable range in which most of mean I.Q. values of sample of 10 boys lie. (Given $t_{0.05,9}=2.262$) 5

- 6 (a) In a partially destroyed laboratory, from the record of analysis of correlation data, the following results are legible.

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Variance of $X=9$,

Regression equations are:

$$8X - 10Y + 66 = 0, 40X - 18Y = 214.$$

What are:

- (i) mean values of X and Y
 - (ii) the correlation coefficient between X and Y
 - (iii) Standard deviation of Y 5.
- (b) The following data pertain to the chlorine residual in a swimming pool at various times after it has been treated with chemicals:

<i>Number of hours</i>	<i>Chlorine residual (parts per million)</i>
2	1.8
4	1.5
6	1.4
8	1.1
10	1.1
12	0.9

- (i) Fit a least squares line from which we can predict the chlorine residual in terms of the number of hours since the pool has been treated with chemicals.

(u) Use the equation of least squares line to estimate the chlorine residual in the pool 5 hours after it has been treated with chemicals. 5

7 (a) If X and Y are independent Poisson random variables with respective means λ_1 and λ_2 , calculate the conditional expected value of X given $X+Y=n$ 5

(b) Let X_1, X_2, \dots, X_n be a random sample from a rectangular population with p.d.f.

$$f(x, \theta) = \frac{1}{\theta}, \quad 0 \leq x \leq \theta, \theta > 0.$$

Obtain maximum likelihood estimator for θ . 5

8. (a) Let X_1, X_2, \dots, X_n be a random sample from Poisson population with parameter λ . Find MVU estimator for λ 5

(b) In a survey of injection drug users in a large city, a researcher found that 18 out of 423 were HIV positive. Can it be concluded that fewer than 5% of the injection drug users in the sampled population are HIV positive? 5

9. (a) If $y = e^{m \sin^{-1} x}$, show that:

$$(1-x^2)y_{n+2} - (2n+1)xy_{n+1} - (n^2+m^2)y_n = 0. \quad 5$$

(b) If $u = \cot^{-1} \left(\frac{x+y}{\sqrt{x} + \sqrt{y}} \right)$, show that:

$$x \frac{\partial u}{\partial x} + y \frac{\partial u}{\partial y} + \frac{1}{4} \sin 2u = 0. \quad 5$$