

**ENGINEERING MATHEMATICS AND BIostatISTICS
(BIOT 6121)**

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

**Group – A
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) If A is a symmetric matrix then $(A+A^T)$ is
(a) symmetric matrix (b) skew-symmetric matrix
(c) identity matrix (d) none of these.
- (ii) If λ is an eigen value of a non-singular matrix A , then $\frac{1}{\lambda}$ is an eigen value of
(a) $A - I$ (b) A^T (c) A^2 (d) A^{-1} .
- (iii) Student's t-test is used to test population mean when population variance is always unknown and the sample size is
(a) Less than 30 (b) More than 30 (c) Any size (d) None of them.
- (iv) Correlation Analysis aims at
(a) Both "Establishing relation between two variables" and "Measuring the extent of relation between two variables"
(b) Measuring the extent of relation between two variables
(c) Predicting one variable for a given value of the other variable
(d) Establishing relation between two variables
- (v) If chi-square test's calculated value is less than critical value, then H_0 is always
(a) Accepted or rejected both (b) Accepted
(c) Rejected (d) None of these.
- (vi) The statistical test can be utilized to validate the statement 'people having high cholesterol suffer more from hypertension'.
(a) Student's t-test (b) Regression analysis
(c) Pearson correlation coefficient (d) ANOVA.
- (vii) The sum of squares of deviations from mean is
(a) Undefined (b) Minimum (c) Zero (d) Maximum
- (viii) Which of the following describe the middle part of a group of numbers?
(a) Measures of central tendency (b) Measures of shape
(c) Measures of variability (d) Measures of association.

- (ix) Which of the following is not a measure of central tendency?
 (a) Percentile (b) Quartile (c) Standard Deviation (d) Mode.
- (x) Which one is the not measure of dispersion?
 (a) Variance (b) The range (c) 50th percentile (d) Interquartile range.

Group- B

2. (a) Solve the ordinary differential equation $\frac{dy}{dx} + \frac{y \cos x + \sin y + y}{\sin x + x \cos y + x} = 0$.
 [(CO1)(Evaluate/HOCQ)]

- (b) Find the rank of the following matrix when i) $a \neq -1$, ii) $a = -1$:

$$\begin{bmatrix} a & -1 & -1 \\ -1 & a & -1 \\ -1 & -1 & a \\ 1 & 1 & 1 \end{bmatrix}$$

[(CO1)(Understand /LOCQ)]

6 + 6 = 12

3. (a) Evaluate y when $x = 0.1$, given $\frac{dy}{dx} = \frac{y-x}{y+x}$ with $y(0) = 1$, by Euler's method taking $h = 0.2$.
 [(CO1)(Evaluate/HOCQ)]

- (b) Reduce the matrix $\begin{bmatrix} 1 & 3 & 4 & 3 \\ 3 & 9 & 12 & 3 \\ 1 & 3 & 4 & 1 \end{bmatrix}$ to a row reduced echelon form and hence find its rank.
 [(CO1)(Understand/LOCQ)]

6 + 6 = 12

Group - C

4. (a) A piece of equipment will function only when all three components A,B,C are working. The probability of A failing during one year is 0.15, that B failing is 0.05 and C is 0.10. What is the probability that the equipment will fail before the end of the year.
 [(CO2)(Design/HOCQ)]

- (b) Following data relate to increase in dry weight of the pods of a plant after a particular treatment. Calculate the mean standard deviation and standard error from the following distribution.

observation	1	2	3	4	5	6	7	8	9	10
Increase in dry weight	4.25	4.20	4.15	3.35	3.25	4.70	3.25	3.75	3.70	3.90

[(CO2)(Calculate/IOCQ)]

6 + 6 = 12

5. (a) In a survey of 950 families in a village the following distribution of numbers of children was obtained.

No of children	0-2	2-4	4-6	6-8	8-10	10-12
No of families	272	328	205	120	15	10

Find the mean, median and standard deviation of the above distribution.

[(CO2)(Evaluate/HOCQ)]

- (b) The probability that a student passes a Physics test is $\frac{2}{3}$ and the probability that he passes both Physics and English test is $\frac{14}{45}$. The probability that he passes at least one test is $\frac{4}{5}$. What is the probability that the student passes the English test?

[(CO2)(Evaluate/HOCQ)]

6 + 6 = 12

Group - D

6. (a) A college conducts both day and night classes intended to be identical. A sample of 100 day students yields examination results as under:

$$X_1 = 72.4 \text{ \& } \sigma_1 = 14.8$$

A sample of 200 night students yields examination results as under:

$$X_2 = 73.9 \text{ \& } \sigma_1 = 17.9$$

Are the two means statistically equal at 10% level? Critical value of $Z_\alpha = 1.645$

[(CO4)(Remember/LOCQ)]

- (b) Two samples were drawn from two normal populations. From the following data test whether the two samples have the same variances at 5% level.

Sample-I	60	65	71	74	76	82	85	87		
Sample-II	64	66	67	85	78	88	86	85	63	91

Critical value of $F_{0.05}$ for df 7 is 3.68.

[(CO4)(Understand/LOCQ)]

6 + 6 = 12

7. (a) Two curly winged flies when mated, produce 61 curly and 35 straight winged progeny. Use a chi-square test to determine whether these numbers fit a 3:1 ratio. Given that $\chi^2_{0.05}$ for df 1 at 0.05 = 3.84.

[(CO3)(Analyze/IOCQ)]

- (b) Test whether the prevalence of filarial is associated with sex.

Sex	No. of carriers	No. of non-carriers	Total studied
Male	78	412	490
Female	57	553	610

Given that $\chi^2_{0.05}$ at df 1 = 3.84.

[(CO3)(Analyze/IOCQ)]

6 + 6 = 12

Group - E

8. (a) For 10 observations on price (x) and supply (y), the following data were obtained (in appropriate units):

$$\sum x = 130, \sum y = 220, \sum x^2 = 2238, \sum y^2 = 5506, \sum xy = 3467$$

Obtain the line of regression of y on x and estimate the supply when the price is 16 units.

[(CO4)(Calculate/IOCQ)]

- (b) Given the following results of height and weight of 1000 students:

$\bar{Y} = 68$ inches, $\bar{X} = 150$ lbs, $r = 0.60$, $\sigma_y = 2.50$ inch, $\sigma_x = 10$ lbs. Amit weights 100 lbs. Sumeet is 5 feet tall. Estimate the height of Amit from his weight and the weight of Sumeet from his height.

[(CO4)(Calculate/HOCQ)]

6 + 6 = 12

9. (a) Calculate the correlation coefficient between the price and consumption of the following data:

Price	15	18	21	24	27	30	33
consumption	10	10	8	7	7	6	6

[(CO4)(Evaluate/HOCQ)]

- (b) From the data given below estimate the height of father whose son's height is 70".
 Father: mean height is 67" and SD is 3.5", Son: mean height is 65" and SD is 2.5"

[(CO4)(Evaluate/HOCQ)]

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	25	25	50

Course Outcome (CO):

After completing the course, the students will be able to:

1. Understand the basic principles of linear algebra, concept of function, limit, continuity and normal distribution.
2. Comprehend and use the different statistical models of dispersion and probability dispersion.
3. Apply the mathematical and biostatistical models in biological systems for testing of hypotheses, estimation of group differences and case-control studies.
4. Interpret the concept of correlation and regression analysis of variables along with analysis of variance.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question