

Master of Biomedical Engineering Examination, 2025

(1st Year, 1st Semester)**Biomathematics and Biostatistics****Time: Three hours****Full Marks:100**

Use Separate Answer Scripts for each Part

Part-I (50 Marks)

Answer any five questions

- Q-1) Applying Lagrange's interpolation formula find a polynomial which approximates the following data 10 Marks
[CO2]

x	-2	-1	2	3
f(x)	-12	-8	3	5

- Q-2) 10 Marks
[CO4]

x	1.5	2.0	2.5	3.0	3.5	4.0
y	3.375	7.000	13.625	24.000	38.875	59.000

Find the values of $\frac{dy}{dx}$ at $x = 2.1$ and $\frac{d^2y}{dx^2}$ at $x = 2.1$

- Q-3) (i) Evaluate 5 Marks
[CO5]

$$I = \int_{0.1}^{0.2} \sqrt{(1-x^2)} dx$$

Using Simpson's $\frac{1}{3}$ rule, taking eight sub – intervals

- Q-3) (ii) Find the Laplace transform of $\cos^2 2t$ 5 Marks
[CO1]

- Q-4) Find the root correct upto three decimal places for the following equation using 10 Marks
[CO3] Newton Raphson method

- Q-5) Solve the following set of equations, correct upto three decimal places, using Jacobi's method 10 Marks
[CO3]

$$\begin{aligned}83x + 11y - 4z &= 95 \\7x + 52y + 13z &= 104 \\3x + 8y + 29z &= 71\end{aligned}$$

- Q-6) Solve the following set of equations using Gaussian Elimination method 10 Marks
[CO3]

$$\begin{aligned}5x - 2y + z &= 4 \\7x + y - 5z &= 8 \\3x + 7y + 4z &= 10\end{aligned}$$

- Q-7) Apply Runge-Kutta fourth order method to find the value of y for x = 1 in steps of 0.5 given that y = 1 when x = 0 and that 10 Marks
[CO3]

$$\frac{dy}{dx} = \frac{y - x}{y + x}$$

- Q-8) Solve: 10 Marks
[CO3]

$$x^2 \frac{d^2y}{dx^2} - x \frac{dy}{dx} + y = 2 \log x$$

MASTER OF BIO-MEDICAL ENGINEERING; FIRST-YEAR

FIRST SEMESTER EXAM 2025

Subject Code: PG/PE/T/114A

BIOMATHEMATICS AND BIOSTATISTICS

PART II (50 Marks)

(Answer any five questions (10×5))

1. 1. A sample of 400 cells has a mean length of $67.47 \mu\text{m}$. Can it be reasonably regarded as a sample from a large population with mean height of $67.39 \mu\text{m}$ and standard deviation of $1.30 \mu\text{m}$?

a) Test at a 5% level of significance ($Z_{0.05} = 1.96$)

b) Explain which would be the appropriate hypothesis test for this dataset

c) Considering the hypothesis test results, decide which Type I or Type II errors are possible, and describe this error. (4+2+4)

2. 2. A group of seven-week-old chickens reared on a high protein diet weigh 12, 15, 11, 16, 14, 14, and 16 ounces; a second group of five chickens, similarly treated except that they receive a low protein diet, weigh 8, 10, 14, 10 and 13 ounces. Test at 5 per cent level whether there is significant evidence that additional protein has increased the weight of the chickens. Use assumed mean (or A_1) = 10 for the sample of 7 and assumed mean (or A_2) = 8 for the sample of 5 chickens in your calculation ($t_{13, 0.05} = 1.771$).

a) Explain which would be the appropriate hypothesis test for this dataset

b) Considering the hypothesis test results, decide which Type I or Type II errors are possible, and describe this error.

c) Define dot plot, and stem-and-leaf display for quantitative data with diagrams

(4+1+2+3)

3. The average score of all sixth graders in school district A on a math aptitude test is 75, with a standard deviation of 8.1. A random sample of 100 students with a mean score of 71 in one school was taken. Does this indicate that the students of this school are significantly less skilled in their mathematical abilities than the average student in the district? (Use a 5% level of significance)

a) Explain how the data for this hypothesis test is appropriate for a Z test

b) Test the hypothesis at i) $p = 0.01$ ($Z_{0.01} = 2.33$) and ii) $p = 0.05$ ($Z_{0.05} = 1.64$).

c) What are Type I or Type II errors? Considering the hypothesis test results, decide which Type I or Type II errors are possible and why.

(2+ (4+2) + 2)

4. The survey on random people from two districts of West Bengal, Kolkata and North 24 Parganas, asked about their willingness to take a vaccine. The results of the survey are displayed in the contingency table above.

Residence	Willingness to take the vaccine	
	YES	NO
Kolkata	127	81
North 24 Parganas	248	344

a) Explain how the data for this hypothesis test is appropriate for a chi-square test concerning independence

b) A 0.05 significance level is chosen for a hypothesis test to see if there is any evidence of a relationship between locations of residence and whether or not willing to take the vaccine ($\chi^2_{1; 0.05} = 3.841$).

c) Considering the hypothesis test results, decide which Type I or Type II errors are possible and why. (1 + 8 + 1)

5. Voters in a particular state are surveyed. Each respondent is assigned an identification number, and information about each of the following is recorded: sex of the voter and age

ID No.	Sex	Age
8	M	35
27	F	20
34	F	35
18	M	41
4	M	39
14	M	59
23	F	20
39	M	52
54	F	44
44	M	46
17	F	40
12	F	34
26	F	24
11	M	62
38	M	44

(a) Complete the construction of the figure to obtain a stem-and-leaf display for males and a stem-and-leaf display for females.

(c) Find the five-number summary for males and the five-number summary for females.

(d) Construct a box plot for males and a box plot for females.

4+4+2

6. A private school principal claims that the students in his class are above average in intelligence. A random sample of nine students' IQ scores are 89, 99, 105, 116, 116, 118, 119, 125 and 128. Is there sufficient evidence to support the principal's claim? The average IQ of all the students of this school is 100 with a standard deviation of 15. (Given $t_{8; 0.05} = 1.860$ and $t_{8; 0.01} = 2.896$)

a) Explain how the data for this hypothesis test is appropriate for a Student's t-test.

c) Decide whether H_0 would have been rejected or accepted with the following significance level: (i) $\alpha = 0.01$, (ii) $\alpha = 0.05$.

d) Considering the hypothesis test result, decide which Type I or Type II errors are possible and explain.

2 + (4+2)+ 2

7. Genetic theory states that children having one parent of blood type A and the other of blood type B will always be of one of three types, A , AB , and B , and the proportion of three types will be on an average be as 1: 2: 1. A report states that out of 300 children having one A parent and B parent, 30 per cent were found to be type A , 45 per cent type AB , and the remainder type B .

a) Explain how the data for this hypothesis test is appropriate for a chi-square test concerning independence

b) A 0.05 significance level is chosen for a hypothesis test to see if there is any evidence of a relationship between locations of residence and whether or not willing to take the vaccine ($\chi^2_{2, 0.05} = 5.991$).

c) Considering the hypothesis test results, decide which Type I or Type II errors are possible and why.

(1 + 8 + 1)