



Register number:

Date and session:

ST. JOSEPH'S UNIVERSITY, BENGALURU-27  
UG (MATHEMATICS) - II SEMESTER  
SEMESTER EXAMINATION: APRIL, 2023  
(Examination conducted in May 2023)  
**MTOE 4: MATHEMATICS FOR BIOLOGISTS**  
**(For current batch students only)**

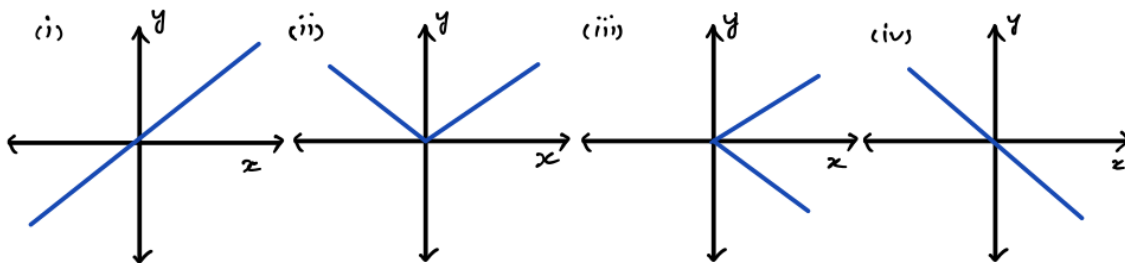
Duration: 2 Hours

Max. Marks: 60

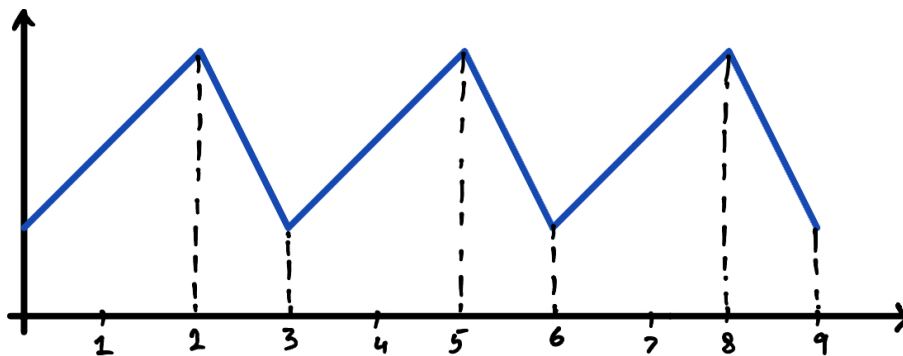
1. The paper contains **THREE** printed pages and **THREE** part.
2. Calculators are allowed.

**Part A: Answer any 6**

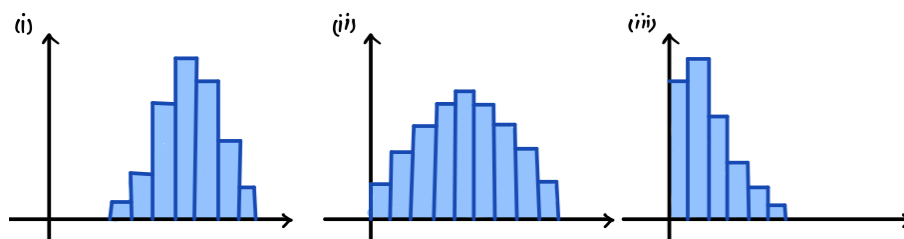
1. Compute the number of molecules in one unit cell of a face centered cubic lattice. [2]
2. Which of the following pictures is **NOT** the graph of a function of  $x$ ? [2]



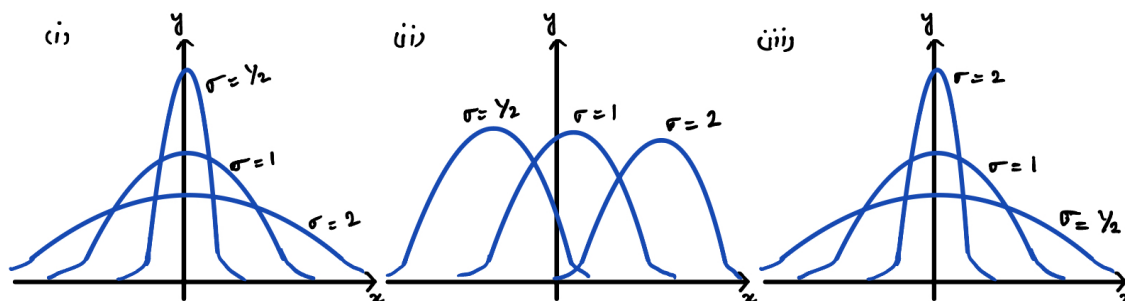
3. The growth and shrinkage of a microtubule is depicted in the graph below. Draw the graph of its slope. [2]



4. Compute  $\int x \sin(x) dx$ . [2]
5. How many DNA molecules of length 15 can we get such that the same base does not occur consecutively? (The bases that comprise a DNA molecule are Adenine, Guanine, Cytosine and Thymine). [2]
6. Suppose in a hospital there are 10 babies born everyday. What is the probability that 40% of the babies born are girls? (Assume that sex ratio is 1:1). [2]
7. A new drug has 70% probability of curing a disease. Which of the following diagrams is the most accurate representation of the probability histogram of the number of people cured by the drug? [2]



8. Which of the following pictures accurately depicts how a normal distribution curve changes with standard deviation  $\sigma$ ? [2]



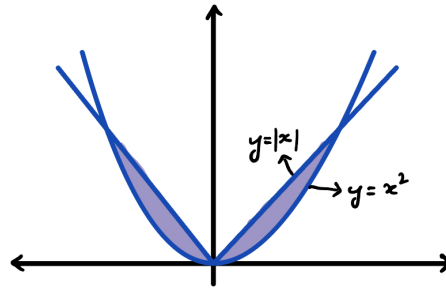
### Part B: Answer any 3

9. Cell division in a eukaryotic cell takes 10 seconds. If a circular eukaryotic cell of **diameter**  $20\mu m$  is placed in a petridish of **diameter**  $2mm$  then how long will it take for the cell to divide and populate almost half the petridish? [6]
10. Using the method of matrices, balance the chemical equation,  $KClO_3 \rightarrow KClO_4 + KCl$ . [6]
11. Plot the function  $f(x) = \frac{x}{1+x}$  (in the graph paper provided) at the points  $x = 0, 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5$  and sketch the graph. Is this graph above or below the line  $y = 1$ ? [6]
12. Compute the slope of the function  $f(x) = \sin(x)$  at the point  $x_1$ . You may assume  $\lim_{t \rightarrow 0} \frac{\sin(t)}{t} = 1$  and  $\sin(A) - \sin(B) = 2 \cos\left(\frac{A+B}{2}\right) \cdot \sin\left(\frac{A-B}{2}\right)$ . [6]

13. Compute the value of  $\frac{d}{dx}[x \log_e(x) + \cos(\sin(x))]$  and  $\frac{d}{dx}[x^2 \sin^2(x)e^x]$ . [3+3]

**Part C: Answer any 5**

14. Compute the formula for the number of radioactive nuclei that remain after time  $t$  during radioactive decay of an isotope starting with  $N_0$  radionuclei. [6]
15. Compute the area of the shaded region between the curves  $y = |x|$  and  $y = x^2$  given below. [6]



16. a) Compute  $\int_0^1 x^2 e^x$ .  
 b) From a group of 7 men and 6 women, 5 persons are to be selected to form a committee so that at least 3 men are there on the committee. In how many ways can it be done? [3+3]
17. An apartment complex has 45 apartments with the following number of residents in each apartment: [6]

2	1	3	5	2	2	2	1	4	2	6	2	4	3	1
2	4	3	1	4	4	2	4	4	2	2	3	1	4	2
3	1	5	2	4	1	3	2	4	4	2	5	1	3	4

Draw the frequency table for this data and represent it as a histogram. Also compute the mean and standard deviation of this data.

18. The Biochemistry Department has eight Ph.D students who are assigned the same office. They are equally likely study at home as in the office. Find the minimum number of desks that should be put in the office so that each student has a desk at least 90% of the time. [6]
19. a) In a certain company there are 3 employees who earn Rs. 20000, 4 who earn Rs. 25000, 3 who earn Rs. 30000 and 5 who earn Rs. 35000. What is the median of the employee's salaries? [6]  
 b) Suppose 95% of students are between 1.1m and 1.7m tall. Assuming the heights of students are distributed normally, compute the mean and standard deviation of the data. [3+3]
20. The probability that John hits a target is  $p = \frac{1}{4}$ . He fires 6 times. Find the probability that he hits the target (a) exactly 2 times, (b) more than 4 times, (c) at least once. [6]