# Motilal Nehru National Institute of Technology Allahabad
## Prayagraj-211004 [India]

## Computer Science and Engineering Department

## End Semester (Odd) Examination (2023-24)

| Programme Name: MCA | Semester: III |
|---|---|
| Course Code: (CS33105) | Course Name: Object-Based Modeling |
| Branch: CSED | Student Reg. No.: 2 0 2 2 C A 0 1 4 |
| Duration: 2 Hours 30 Minutes | Max. Marks: 50 |

**Instructions:**
Attempt all questions and make suitable assumption whenever required.
Draw neat diagrams whenever required.

| Q. No | | Question Description | CO |
|---|---|---|---|
| 1 | (a) | Define the term constructor. Enlist and explain different constructors supported by object-oriented modeling with suitable examples for each type. **(3M)** | CO1 |
| | (b) | How can you define the access levels and scope for an attribute? Enlist and explain different types of access levels along with scope with suitable examples for each type. **(4M)** | CO1 |
| | (c) | Write briefly about the "include" and "extend" relationship used in object-based modeling. What type of precautions must you take while deciding on these relationships? **(3M)** | CO1 |
| 2 | (a) | An online AI-based recommendation system for diet care has a Database, a Professional Nutritionist, a Recommendation System, a Trained Model, and Users as the main Actors. Define the role and responsibilities of each actor. Draw and explain the **Use Case Diagram** and the **UML Collaboration Diagram** for such a recommendation system. **(5M)** | CO2 |
| | (b) | YouTube, Facebook, and Instagram are social networking platforms that use video suggestion systems based on the user's input, such as previous search results, trending, preferences, and similar views of the people. Draw and explain the **UML Class Diagram** in brief. Enlist the importance of the UML State Chart Diagram. Draw the **UML State Chart Diagram** for such a video suggestion system. **(5M)** | CO2 |

3    (a)  In object-oriented analysis, how is relationship identification among objects very  CO3
important? What essential steps must be taken while identifying the relationship
among the objects? Enlist and briefly explain the different types of relationships the
objects will have. **(3M)**

    (b)  Analyzing use cases and UML diagrams is very important for defining class  CO3
responsibility. Justify with suitable examples for each. What are the essential
guidelines one should follow for determining class responsibility for

        i.      Defining the attributes of a class.

        ii.     Defining the object responsibility to methods and messages. **(4M)**

    (c)  From Q. 2(a), analyze the use case diagram, enlist the proper two methods for each  CO3
class, and write their definitions with suitable attributes. **(3M)**

4    (a)  Discuss the following in brief with a suitable example  CO4

        i.      Handling boundary conditions

        ii.     Common architectural styles

        iii.    Hardware-software trade-off **(3M)**

    (b)  Enlist and briefly explain the essential decisions a system designer must take while  CO4
designing a system. **(4M)**

    (c)  Why breaking a complex system into subsystems is important in object-based  CO4
modeling. Justify your answer with a suitable example. **(3M)**

5    (a)  Reusability is one of the most essential aspects of object-based modeling. Justify  CO5
your answer with the following definitions and the usefulness of

        1.  Decorator design pattern

        2.  Proxy Pattern

        3.  Momento pattern

        4.  Singleton pattern

    Support your answer with a suitable code for each pattern. **(4M)**

    (b)  MNNIT BOG has decided to give a salary hike to its employees. Instead of hiking  CO5
all, the BOG has decided to hike only for the employees who met at least two
criteria among the following

        1.  Published at least two SCI research papers

        2.  Published at least one patent

        3.  Completed at least three years of experience

    Can you design the classes and functions to help BOG to process the hike
approvals? Write your answers with suitable design patterns, frameworks, and
interface codes. **(6M)**

### Computer Science and Engineering Department
### End Semester (Even) Examination 2023-24

Programme Name: MCA                          Semester: III

Course Code: CS33104

Course Name: Analysis of Algorithms          Student Reg. No.: 2 0 2 2 C A 0 1 4

Duration: 150 Minutes   2.5hr                 Max. Marks: 50

**Instructions: (Related to Questions)**
1. *Precise answer with proper justification will be considered to get complete marks.*
2. *Attempt all questions.*

| | | | Marks |
|---|---|---|---|
| Q1 | | Consider the following algorithm.<br><br>**Algorithm** *Enigma*(A[0..n − 1, 0..n − 1])<br>//Input: A matrix A[0..n − 1, 0..n − 1] of real numbers<br>**for** i ← 0 to n − 2 **do**<br>    **for** j ← i + 1 to n − 1 **do**<br>        **if** A[i, j] = A[j, i]<br>            **return** false<br><br>**return** true | | 10 |
| | a. | What does this algorithm compute? | |
| | b. | What is its basic operation? | |
| | c. | How many times is the basic operation executed? | |
| | d. | What is the efficiency class of this algorithm? | |
| | e. | Suggest an improvement or a better algorithm altogether and indicate its efficiency class. If you cannot do it, try to prove that, in fact, it cannot be done. | |

| Q 2 | a | Consider the problem of searching for genes in DNA sequences using Horspool's algorithm. A DNA sequence consists of a text on the alphabet {A, C, G, T} and the gene or gene segment is the pattern. Construct the shift table for the following gene segment of your chromosome 10: **TCCTATTCTT** | 3 |
|---|---|---|---|
| | b | How many character comparisons will be made by Horspool's algorithm in searching for each of the following patterns in the binary text of 1000 zeros?<br><br>a. 00001         b. 10000         c. 01010 | 9 |
| Q 3 | a | The time required by a nondeterministic algorithm performing on any given input is the minimum number of steps needed to reach a successful completion if there exists a sequence of choices leading to such a completion. Justify the above statement if it is correct by comparing and contrasting with 0/1 knapsack problem, stating the both deterministic using dynamic programming and non-deterministic algorithm pseudo code along with their time complexities. Demonstrate both algorithms with an example. | 12 |
| Q 4 | a | Assume that Mr. Merrill M. Flood, is a school bus driver would like start from school, to pick up students by visiting five places mentioned as {$N_0$, $N_1$, $N_2$, $N_3$, $N_4$} and drop them back to the school. The cost matrix is given as follows. | 12 |

|   | $N_0$ | $N_1$ | $N_2$ | $N_3$ | $N_4$ |
|---|---|---|---|---|---|
| $N_0$ | INF- | 20 | 30 | 10 | 11 |
| $N_1$ | 15 | INF | 16 | 4 | 2 |
| $N_2$ | 3 | 5 | INF | 2 | 4 |
| $N_3$ | 19 | 6 | 18 | INF | 3 |
| $N_4$ | 16 | 4 | 7 | 16 | INF |

Determine the shortest yet most efficient route using branch & bound algorithm to take to visit a list of specific destinations with a goal is to find the shortest route from a set of different routes to minimize the total distance traveled and the travel cost.

| Q5 | a | Give a counter example why greedy strategy won't work for vertex cover problem and set cover problem. Determine the greedy algorithms of the same with their time complexities | 4 |
|---|---|---|---|

**End Semester (odd) Examination 2023-2024**

| Programme Name: MCA | Semester: 3rd |
|---|---|
| Course code: CS33102 | Course Name: Database Management System |
| Registration No. | 2 0 2 2 C A 0 J 4 |
| Duration: $2\frac{1}{2}$ Hours | Total marks 50 |

*Instructions:*

1. *Attempt all the questions and mention the question number against each answer.*

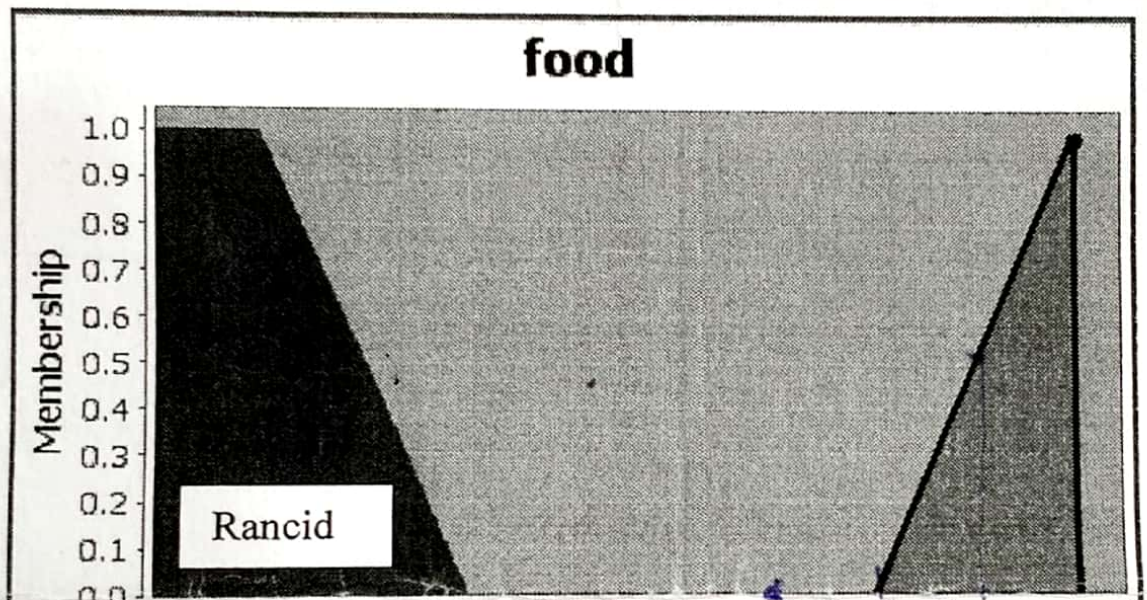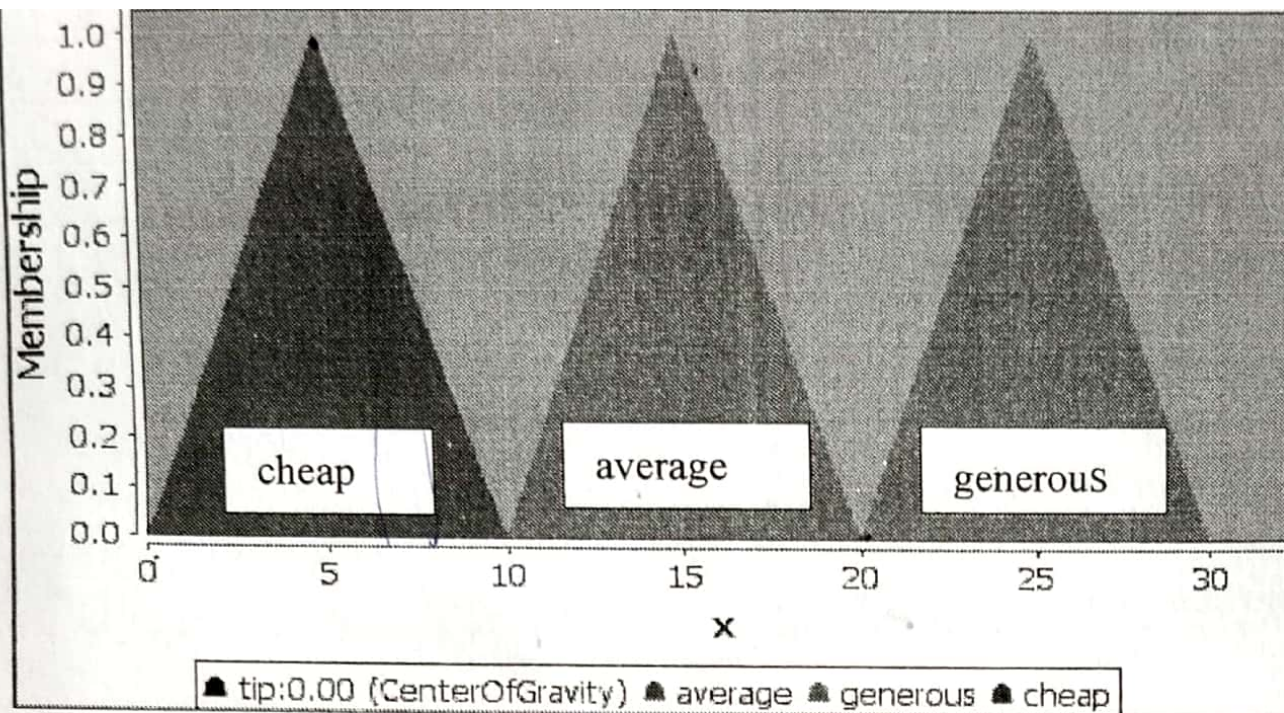|  |  | Marks |
|---|---|---|
| Q.1 | What is Primary indexing? Explain different types of primary indexing with the help of examples. | [2+3] |
| Q.2 | Suppose you have a table named "Orders" and it has six attributes i.e., OrderID (Primary Key), CustomerID, OrderDate, ProductID, Quantity, and TotalAmount. The table contains 1,000,000 records, and you want to create a clustering index on the "OrderDate" column.<br>a) Calculate the number of levels in the B+ tree index structure for the clustering index, assuming each node can store a maximum of 100 keys.<br>b) Calculate the storage overhead in terms of the number of index nodes for this clustering index. | [3+3] |
| Q.3 | Consider the following two relations:<br>Students (student_id, student_name, age, major)<br>Grades (student_id, course_id, grade)<br>Write a relational algebra expression to find the names of students who are majoring in CSED and have received an 'A' grade in the course with the course_id 'CS33102'. | [3] |
| Q.4 | Suppose R (A, B, C, D, E, F) is a relation and a set of its Functional Dependency is FD = {A → B, BC → D, E → A, and BF → E}, find the prime and non-prime attributes and determine whether the given R is in BCNF and decompose it into BCNF if it is not in BCNF? | [2+4] |
| Q.5 | Write a short note on concurrency control and two-phase locking protocol. What are the problems encountered with concurrent transactions? Explain through examples. | [3+3] |
| Q.6 | Consider a B+ tree in which the search key is 16 bytes long, block size is 1024 bytes, record pointer is 10 bytes long and block pointer is 8 bytes long. Find the maximum number of keys that can be accommodated in each non-leaf node of the tree. | [3] |

| | | |
|---|---|---|
| Q.7 | What is database system architecture? Draw the database system architecture and explain its all the major components. | [1+5] |
| Q.8 | Construct a left biased B-tree of order 4 with the following set of data: 90, 49, 60, 79, 108, 120, 23, 34, 53, 57, 69, 74, 83, 88, 96, 105, 113, 118 After that construct a new B-tree by deleting 53, 78 and 69 from that B-tree. | [3+3] |
| Q.9 | Explain the significance of the ACID properties in the context of database transactions. Illustrate with examples how these properties contribute to maintaining the integrity and reliability of database transactions. Additionally, discuss the potential challenges or trade-offs that may arise in ensuring ACID properties and how they impact the design and performance of database systems. | [2+2+2] |
| Q.10 | Explain logical and physical data independence through examples. | [3] |

**Instructions (related to question paper):**
1. *All questions are compulsory*
2. *Attempt the questions strictly in sequential order.*
3. *Calculator is allowed*
4. *Write assumptions correctly (in case you feel data is missing)*

| | Marks |
|---|---|
| **Write the answer of the following question** | |
| | **[12]** |

Create a fuzzy control system which models how you might choose to tip at a restaurant. When tipping, you consider the service and food quality, rated between 0 and 10. You use this to leave a tip of between 0 and 30%.

You would formulate this problem as:

| Antecedents (Inputs) | Consequents (Outputs) |
|---|---|
| **service** | **tip** |
| ▪ Universe (i.e, crisp value range): How good was the service of the wait staff, on a scale of 0 to 10? | ▪ Universe: How much should we tip, on a scale of 0% to 30% (0 to 30) |
| ▪ **Fuzzy set (i.e, fuzzy value range): poor, good, excellent** | ▪ **Fuzzy set: cheap, average, generous** |
| **food quality** | |
| • Universe: How tasty was the food, on a scale of 0 to 10? | **Rules** |
| | **RULE 1 :** IF service IS poor OR food IS rancid THEN tip IS cheap; |
| • **Fuzzy set: rancid, delicious** | **RULE 2 :** IF service IS good THEN tip IS average; |
| | **RULE 3 :** IF service IS excellent AND food IS delicious THEN tip IS generous; |
| | **RULE 4 :** IF service IS good AND food IS delicious THEN tip IS generous |

**If I tell this controller that I rated the service as 6, and the food quality as 8, find out the tip using fuzzy control system which uses Centre of Gravity Method (COG) as defuzzification method. (Note: Solve the questions step by step)**

tip:0.00 (CenterOfGravity) ▲ average ▲ generous ▲ cheap

**food**

b. Explain the problem of "dying ReLU" and how it can be addressed in neural networks?

c. How do ReLU and Leaky ReLU functions affect the vanishing gradient problem in neural networks?

| Q3 | Write the answer of the following question | |
|---|---|---|
| | Considering the concept of defuzzification with a **brief example**, **discuss how the** Mamdani and Sugeno approaches vary in their methods for generating crisp output from fuzzy logic. **Explain a scenario** where the output of a Sugeno fuzzy inference system could be identical to that of a Mamdani system despite their structural differences? **How might this occur**, and **what factors influence** such a convergence of results? | (6) |
| Q4 | Write the answer of the following questions | (6) |

Take three-dimensional loss function given in equation 1

$$L(w_1, w_2, w_3, w_4) = 5w_1^2 + 2w_2^2 + w_3^2 + 2w_4^2 \quad \text{------------} \quad (1)$$

The initial guess for the weight parameters $w_1 = 2.0$, $w_2 = 3.0$ and $w_3 = 1.5$, $w_4 = 1.0$ The learning rate $(\alpha)$ is set to 0.1. Perform two iterations of the Adagrad algorithm and calculate the updated values of weights at the end of each iteration.

| Q5 | Consider a two-dimensional function $f(x,y) = (x^2 + y^2)$ that needs to be minimize using a genetic algorithm. The chromosomes are represented in binary encoding with a length of 10 bits.<br>The genetic algorithm employs a roulette wheel selection method for parent selection. The crossover probability is set to 0.8, and the mutation probability is set to 0.1. The $x$-values should be within the range [-5, 5], and the $y$-values should be within the range [-6, 7].<br>Given an initial population of 6 chromosomes in their binary representation, perform one iteration of the genetic algorithm by selecting parents using the roulette wheel method, performing crossover with the specified probability, and applying mutation with the given probability. Show the process step-by-step, including parent selection, crossover, and mutation, while ensuring that the decoded $x$ and $y$ values respect the limits of [-5, 5] for $x$ and [-6, 7] for $y$. (Perform question step by step and assume if you feel data is missing but with proper reasoning). | (12) |
| | Write short notes on following | (8) |

a. Crossover and Mutation Probability

b. SoftMax vs Sigmoidal Activation function

c. Classification of optimization algorithms

d. Saddle Point with reference to Gradient Descent algorithm

## Department of Computer Science and Engineering
### End Semester Examination, Session 2023-24 (Odd)

Programme: *MCA*  Branch: *NA*  Semester: 3<sup>rd</sup>
Course Name: *Operating System*
Course Code: *CS35104*  Max. Marks: *50*
Time: *150 Mins*  Registration No.: | 2 | 0 | 2 | 2 | C | A | 0 | 1 | 4 |

**Instructions (related to question paper):**
1. *Attempt ALL Questions*
2. *Try to answer the questions serially and attempt all the parts of a question at one place.*

Marks

**Q1**  Consider the following CPU scheduling scheme. When a process is created, or has become ready after a wait, it is added to the end of the ready queue. When the scheduler runs, it selects a ready process with the highest priorities (ties are broken using FCFS ordering) and gives the CPU to this process, for a maximum of 5 ms. At the end of 5 ms (or earlier, if the process wants to do an I/O), the scheduler runs again. If the process is pre-empted. it is added, to the end of the ready queue: The priority of a process is calculated according to the following rules:
(The lower the number, the lower the priority.
• The initial priority of all processes is 5.
• At the end of a CPU burst, the priority of the process that was running, is updated using the following formula:
new priority = old priority + 2 *(5 - duration of CPU burst just completed).
• Processes P1, P2, P3, and P4 are created simultaneously in the said order. Their CPU-burst and I/O-burst time spans are given in the following table. Assume that all I/O requests are for different devices.

| PROCESS | CPU | I/O | CPU | I/O | CPU |
|---------|-----|-----|-----|-----|-----|
| P1 | 2 | 1 | 2 | | |
| P2 | 7 | 3 | 4 | | |
| P3 | 2 | 3. | 5 | 7 | 8 |
| P4 | 6 | 1 | 4 | 2 | 1 |

**a**  Draw the Gantt chart for the processes. Show also the changes to the ready queue at each stage.  8

**b**  Calculate the Cumulative Waiting Time and Turnaround time for each process.  8

**Q2**  A system has three processes and four identical resources. Each process requires at most two of the resources at any given time.

**a**  What do you mean by a deadlock? Explain with an example.  2

**b**  Can deadlock occur in this system? Explain.  2

**c**  If there are $m$ processes, and each could request up to $n$ resources, how many resources must be available in the system to ensure that deadlock will never occur?  2

**d**  If there are $m$ processes and $r$ resources in the system, what maximum number of resources, could each process request, if all processes must have the same maximum?  2

**Q3** A variable-partition multiprogramming system uses a free memory list to track available memory. The current list contains entries of 150KB, 360KB, 400KB, 625KB, and 200KB. The system receives requests for 215KB, 171KB, 86KB, and 481KB, in that order. Describe the final contents of the free memory list if the system used each of the following memory placement strategies:

|  |  |  |
|---|---|---|
| a | Best Fit | 2 |
| b | First Fit | 2 |
| c | Worst Fit | 2 |
| d | Next Fit | 2 |

**Q4** Write short notes on the following

|  |  |  |
|---|---|---|
| a | Process Vs Threads | 2 |
| b | Critical Section | 2 |
| c | System Calls | 2 |
| d | Virtual Memory | 2 |

**Q5** a Calculate the number of page faults for the following reference string using second-chance algorithm with frame size 3 and compare the result with FIFO algorithm:     4
5 0 2 1 0 3 0 2 4 3 0 3 2 1 3 0 1 5

b There is a system with 64 pages of 512 bytes page size and a physical memory of 32 frames. How many bits are required in the logical and physical address     2

c A process has relocatable code of size of 900 K. The relocation register is loaded with 40020 K and the limit register contains the address 41000 K. If the processor generates a logical address 990, where will it be located in the physical memory?     2

d Calculate the number of page faults for the following reference string using LRU page replacement algorithm with frame size as 3. 5 0 2 1 0 3 0 2 4 3 0 3 2 1 3 0 1 5     2

73 , 41