



**NATIONAL INSTITUTE OF TECHNOLOGY PATNA
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
END-SEMESTER EXAMINATION – DECEMBER, 2024**

B. Tech CSE & B.Tech-M.Tech-DD-CSE-CS/DS
IIIrd Semester CS34104– Data Structures Max.Marks:60

Answer All questions

Note: Answer all parts of the question at the same place

Q. No	Question	Marks	CO	BL
1	<p>a. How can we simulate the stack using queue, and also mention the time complexity of push and pop operations in this scenario.</p> <p>b. Assume that the operators $+$, $-$, \times, are right-associative and \wedge is a left-associative operator (\wedge is an exponential operator i.e., 2^3^4 is 4096). The order of precedence (from highest to lowest) is: $+, -$ (+ and - has equal precedence).</p> <p>X \wedge</p> <p>Translate the following infix expression into a postfix expression based on the above precedence and associative rules using stack. You must show the contents of the stack and partial output after reading every character from the infix expression.</p> <p>Infix Expression: $a - b \times c + d \wedge e \wedge f - g + h$</p> <p><i>Caution: Think about what to do when the precedence of the two operators (one is on top of the stack and another one is the currently reading from input) is same and their associativity is right to left or left to right?</i></p>	05M 10M	CO4 CO1, CO3, & CO4	Create Understand, Evaluate & Apply
2	<p>a. Mention the limitation of Dijkstra's algorithm with an example graph with at least four vertices. How it can be overcome?</p> <p>b. Apply Prims and Kruskal algorithms to find the minimum spanning tree on the following undirected graph $G = (\{A, B, C, D, E, F, G\}, (A, C, 2), (A, D, 5), (C, B, 4), (C, D, 3), (C, E, 2), (D, E, 3), (D, F, 2), (E, F, 4), (B, G, 2)\}$. You must show all the steps in construction of minimum spanning tree.</p>	04M 08M	CO4 CO4	Analyze Understand & Apply
3	<p>Design the algorithm/pseudocode/function/procedure for the following operations on a circular queue which is implemented using arrays:</p> <ol style="list-style-type: none"> Enqueuing an element Dequeueing an element Display all the elements 	09M	CO1 & CO2	Create
4	<p>a. Insert the following sequence of numbers in the given order into the initially empty AVL Tree. Show the resultant tree and the type of violation if any, after each and every step. 21, 26, 30, 9, 4, 14, 28, 18, 15, 10, 2, 3, 7. From the above constructed AVL tree delete the element 21 and show the resultant tree.</p> <p>b. Construct the Min-Heap using the following sequence of numbers: 21, 26, 30, 9, 4, 14, 28, 18, 15, 10, 2, 3, 7. Also show the resultant heap after deleting the minimum element.</p>	8M 4M	CO3 & CO4 CO3 & CO4	Understand & apply Understand & apply

- a. Consider the following 14 options:
1. **Stable sorting algorithm**
 2. In-Place sorting algorithm
 3. **Space complexity is $O(n)$**
 4. **Worst-case Time complexity is $O(n^2)$**
 5. **Best case Time complexity is $\Omega(n)$**
 6. Worst case Time complexity is $O(n\log n)$
 7. **Worst case Time complexity is $O(\log n)$**
 8. Best case Time complexity is $\Omega(1)$
 9. **Internal sorting algorithm**
 10. Time complexity is the same in worst and best cases
 11. **Worst Case Time complexity is $O(n)$**
 12. Searching Tree
 13. **Balancing factor is either zero or one.**
 14. Searching algorithm.

For the following, A to J related to sorting, searching, or tree, pick the first two true options about the question from the above-mentioned 14 options. For example, if it is a **linear search**, the answers are 8, and 11 (No other preceded options are correct). Choosing any answer marks will not be given (For example, in the above case, 14 also matches with linear search, but 8 and 11 are preceded by 14). Also, mention for any A to J, there are no matches or only one match.

- 13
12
12
78
- A. Merge Sort
 - B. Insertion Sort
 - C. Bubble Sort
 - D. Binary Search
 - E. Heap Sort
 - F. Selection Sort
 - G. Quick sort
 - H. Deleting an element from the Binary search tree.
 - I. AVL Tree
 - J. Binary Search Tree

- b. Consider the in-order and pre-order traversal of a binary search tree are (1, 2, 3, 4, 5, 6, 8, 10, 25) and (4, 3, 1, 2, 10, 8, 5, 6, 25), respectively. Construct the unique binary search tree for the given in-order and pre-order traversals

10M	CO4 & CO5	Remember & understand & apply
2M	CO3 & CO4	Create

NATIONAL INSTITUTE OF TECHNOLOGY PATNA
 Department of Computer Science and Engineering
END-SEMESTER EXAMINATION - DECEMBER, 2024

B.Tech (UG)

Semester-III/V

Course Name: Operating System

Code:

CS34111/CS57102

Max. Marks: 60

Max. Time: 3 Hours

Answer All questions

Instruction:

1. Attempt All questions.
2. You may answer the questions in any order. However, all parts of the same question must be answered together.
3. Assume any suitable data, if necessary. Clearly state any reasonable assumption you make.
4. The Marks, CO (Course Outcome), and BL (Bloom's Levels: Remember(1), Understand (2), Apply(3), Analyse(4), Evaluate (5), Create (6)) related to questions are on the right-hand margin.

Q. No	Question	Marks	CO	BL																
1	<p>A. Consider the following C program is executed on a Unix/Linux system:</p> <pre>#include<unistd.h> int main() { int i; for (i=0; i<10; i++) { if(i%3==0) fork(); } while (i<20) if(i==15) fork(); fork(); return(0); }</pre> <p>Answer the following questions.</p> <ul style="list-style-type: none"> • The total number of fork () call is _____ and • The total number of child processes created is _____. <p>B. You are tasked with evaluating the performance of a multi-programmed operating system using preemptive priority scheduling. The system is managing the following processes:</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <th style="text-align: center;">Process</th><th style="text-align: center;">Arrival Time</th><th style="text-align: center;">Priority (Low value High Priority)</th><th style="text-align: center;">CPU, IO, CPU Burst</th></tr> <tr> <td style="text-align: center;">P₁</td><td style="text-align: center;">0</td><td style="text-align: center;">4</td><td style="text-align: center;">3, 5, 3</td></tr> <tr> <td style="text-align: center;">P₂</td><td style="text-align: center;">1</td><td style="text-align: center;">3</td><td style="text-align: center;">3,3,3</td></tr> <tr> <td style="text-align: center;">P₃</td><td style="text-align: center;">3</td><td style="text-align: center;">2</td><td style="text-align: center;">2,6,4</td></tr> </table> <ul style="list-style-type: none"> • Find the order of execution of processes based on their arrival times, priorities, and burst durations. • Compute the average waiting time and • Average turnaround time for the processes. 	Process	Arrival Time	Priority (Low value High Priority)	CPU, IO, CPU Burst	P ₁	0	4	3, 5, 3	P ₂	1	3	3,3,3	P ₃	3	2	2,6,4	4M	CO-1	BL -5
Process	Arrival Time	Priority (Low value High Priority)	CPU, IO, CPU Burst																	
P ₁	0	4	3, 5, 3																	
P ₂	1	3	3,3,3																	
P ₃	3	2	2,6,4																	
1	<p>A. A software application requires two processes to communicate with each other to exchange data. Process A generates data and sends it to Process B for processing. Using your understanding of IPC mechanisms, describe how you would implement this communication using:</p> <ul style="list-style-type: none"> • Shared memory • Message passing <p>B. A counting semaphore was initialized to 10. Then 6 P (wait) and 10 V(signal) and 6 P (wait) operations were completed on this semaphore. Find the value of semaphore.</p> <p>C. Develop a semaphore-based solution to synchronize the access to three instances of a shared resource among five different processes. Assume that all processes attempt to access the resource at time t=0.</p>	8M	CO-1	BL -5																
2	<p>A. A software application requires two processes to communicate with each other to exchange data. Process A generates data and sends it to Process B for processing. Using your understanding of IPC mechanisms, describe how you would implement this communication using:</p> <ul style="list-style-type: none"> • Shared memory • Message passing <p>B. A counting semaphore was initialized to 10. Then 6 P (wait) and 10 V(signal) and 6 P (wait) operations were completed on this semaphore. Find the value of semaphore.</p> <p>C. Develop a semaphore-based solution to synchronize the access to three instances of a shared resource among five different processes. Assume that all processes attempt to access the resource at time t=0.</p>	3M	CO-1	BL -3																
		3M	CO-2	BL -3																
		6M	CO-2	BL -6																

3	<p>A single processor system has three resource type X, Y, and Z, which are shared by four processes. There are 5 units of each resource type. Consider the following scenario, where the column "alloc" denotes the number of units of each resource type requested by a process, and the column "max request" denotes the maximum number of units of each resource type requested by a process in order to complete execution. If Banker's algorithm is applied for the above scenario, then answer the following questions:</p> <ul style="list-style-type: none"> Find the Need Matrix. If the resource requests of processes are served in increasing order of their IDs, then find the safe sequence(s). (<i>Incase of Tie</i>) The process will finish LAST is _____. <table border="1" style="margin-top: 10px; border-collapse: collapse;"> <thead> <tr> <th rowspan="2">Process</th> <th colspan="3">Alloc</th> <th colspan="3">Max Request</th> </tr> <tr> <th>X</th> <th>Y</th> <th>Z</th> <th>X</th> <th>Y</th> <th>Z</th> </tr> </thead> <tbody> <tr> <td>P0</td> <td>1</td> <td>1</td> <td>1</td> <td>4</td> <td>2</td> <td>4</td> </tr> <tr> <td>P1</td> <td>1</td> <td>0</td> <td>1</td> <td>3</td> <td>1</td> <td>1</td> </tr> <tr> <td>P2</td> <td>0</td> <td>1</td> <td>0</td> <td>2</td> <td>2</td> <td>2</td> </tr> <tr> <td>P3</td> <td>1</td> <td>1</td> <td>1</td> <td>4</td> <td>2</td> <td>4</td> </tr> </tbody> </table> <p>B. Consider a machine with 64 MB physical memory and a 32 bit virtual address space. If the page size is 4KB, what is the approximate size of the page table?</p> <p>C. A system is managing memory using segmentation, and fragmentation is becoming a performance bottleneck. Explain why does segmentation lead to external fragmentation? Can the system suffer from internal fragmentation?</p>	Process	Alloc			Max Request			X	Y	Z	X	Y	Z	P0	1	1	1	4	2	4	P1	1	0	1	3	1	1	P2	0	1	0	2	2	2	P3	1	1	1	4	2	4	3M	CO-3	BL -3
Process	Alloc			Max Request																																									
	X	Y	Z	X	Y	Z																																							
P0	1	1	1	4	2	4																																							
P1	1	0	1	3	1	1																																							
P2	0	1	0	2	2	2																																							
P3	1	1	1	4	2	4																																							
4	<p>A. Assume that a main memory with only 3 frames. The page size and logical address is represented by 4 and 8 bits respectively. The following logical addresses are generated by the CPU: 00011001, 10011001, 10101001, 00111111, 00001010, 11111111, 10111111, 00011001, 10011001, 10101001, 10111111, 01111111, 00001010, 10101001, 00111111, 10011001. Answer the following questions:</p> <ul style="list-style-type: none"> What are the page references or numbers? With detail illustration find the number of page faults occur with LRU and Optimal page replacement algorithm. <p>B. Apply your understanding of file structures and access methods to justify your design choices for a multimedia application that needs to store and retrieve video files efficiently.</p>	3+3+3 M	CO-3	BL -4																																									
5	<p>A disk has 200 tracks (numbered 0 through 199). The read write head is currently at 120 number. If the following track numbers are requested: 30, 70, 115, 130, 110, 80, 20, 25, then find the total number of head movements using a. SSTF, b. FCFS, c. SCAN, d. C-SCAN, e. LOOK, f. C-LOOK. In addition, analyse which algorithm performs better and what are the possible reasons?</p>	12M	CO-4	BL -4																																									



**NATIONAL INSTITUTE OF TECHNOLOGY PATNA
END-SEMESTER EXAMINATION, DECEMBER 2024**

Program: B.Tech-M.Tech-DD

Department: CSE & MA-MCT

Semester: 3rd

Course Name: Object Oriented Programming

Course Code: CS34105/CS37101

Full Marks: 60

Duration of Examination: 3 Hrs

INSTRUCTIONS

- Please mention your section at the top of the answer script.
 - Answer all the questions. Assume Missing data, if any.
 - Each question includes the corresponding marks, Course Outcome (CO), and Bloom's Level (BL).

Q.1. Give the output of the following program code: (2×6=12M) (CO-2 , BL- Understand, Analyse, Evaluate)

a). class Demo { private Demo() { System.out.println("Private Constructor"); } public static void display() { Demo obj = new Demo(); System.out.println("Display Method Called"); } } public class Main { public static void main(String[] args) { Demo.display(); } }	b). class Output { public static void main(String[] args) { Output output = new Output(); output.go(); } void go() { int value = 7; for (int i = 1; i < 8; i++) { value++; if (i > 4) { System.out.print(++value + " "); } if (value > 14) { System.out.println(" i = " + i); break; }}}} <i>value = 7 8 9 10 11 12 13 14 15 16</i> <i>13 15 i</i>
c). class Outer { private static String message = "Hello, World!"; static class Nested { private void display() { System.out.println("Message: " + message); } } public static void main(String[] args) { Nested nested = new Nested(); nested.display(); } }	d). private class MyClass { void display() { System.out.println("Private Top-Level Class"); } } public class Main { public static void main(String[] args) { MyClass obj = new MyClass(); obj.display(); } }
e). public class Main { public static void main(String[] args) { double d = 99.99; int i = d; System.out.println(i); } }	f). public class Main { public static void main(String[] args) { outer: for (int i = 1; i <= 3; i++) { inner: for (int j = 1; j <= 3; j++) { if (i == 2 && j == 2) { continue outer; } System.out.println("i = " + i + ", j = " + j); } } } }

Q.2. a). Write a Java program to demonstrate a NullPointerException. Handle the exception using a try-catch block and display an appropriate message when the exception occurs. (6M)(CO-3)(BL- Apply)

Q.2. b). Write a Java program to demonstrate the use of multiple catch blocks to handle at least two different exceptions. Why its important to place more specific exceptions before more general ones? Explain with a suitable example. (6M)(CO-3)(BL- Apply, Understand)

Q.3. a). Write a Java program to read and write objects to a file using the necessary file handling classes. (6M)(CO-4)(BL- Apply)

Q.3. b). Write a Java program to count the number of words in a text file. Handle exceptions such as FileNotFoundException and IOException. (6M)(CO-4)(BL- Create, Apply)

Q.4. a). Explain why Java allows multiple inheritance through interfaces but not through classes. Provide a logical reason for this design decision and give examples where multiple inheritance using interfaces is beneficial. (4M)(CO-2)(BL- Analyse, Understand)

Q.4. b). How does Java support **runtime polymorphism**? Explain in detail with an example. (5M)(CO-1,2)(BL- Remember)

Q.4. c). Write a Java program to create a jagged array that stores the marks of 4 students in different subjects. Each student has a different number of subjects. Display the total marks for each student.

Example Input:

Student 1: {85, 90, 78}

Student 2: {88, 92}

Student 3: {75, 80, 85, 70}

(3M)(CO-2)(BL- Apply)

Q.5. a). In Java, can an abstract class implement an interface? If so, how does it affect the implementation of methods in concrete subclasses? Provide a logical explanation. (4M)(CO-2)(BL- Understand)

Q.5. b). Write a Java program that uses Wrapper Classes to convert a given string into its corresponding Integer, Double, and Character values. Ensure that your program handles invalid input properly and displays an appropriate error message when the conversion fails. (5M)(CO-2,3)(BL- Apply)

Q.5. c). How does Java manage memory allocation for objects and methods? Explain. (3M) (CO-1)(BL- Remember, Understand)

NATIONAL INSTITUTE OF TECHNOLOGY PATNA

End Semester Exam, July- December 2024

Social and Professional Ethics (HS34151)

B. Tech. Sem. 3 (CSE)/ B.Tech. + M. Tech. DD (CS & DS) Sem. 3

Time: 3 hours

M.M. 60

Note: Answer the following questions in maximum 350- 400 words each. Each question carries equal marks.

- ~~Q~~ 1. What do you mean by social and professional ethics? Discuss its characteristics & relevance for you.
2. What is panchkosh? Discuss its role in balancing with harmony on life.
3. Define value and explain its typology.
4. Corruption is a social problem. Justify this statement and suggest remedial measures to eradicate this problem.
5. Write down an essay on the life sketch of:
Pandit Madan Mohan Malviya OR Mahatama Gandhi

नोट: निम्नलिखित प्रत्येक प्रश्न का उत्तर अधिकतम 300-350 शब्दों में दें। प्रत्येक प्रश्न समान अंक का है।

- सामाजिक और व्यावसायिक नैतिकता से आपका क्या अभिप्राय है? इसकी विशेषताओं और आपके लिए प्रासंगिकता पर चर्चा करें।
- पंचकोश क्या है? जीवन में सामंजस्य के साथ संतुलन बनाने में इसकी भूमिका पर चर्चा करें।
- मूल्य को परिभ्रष्ट करें और इसके प्रकार की व्याख्या करें।
- भ्रष्टाचार एक सामाजिक समस्या है। इस कथन को उचित ठहराएँ और इस समस्या को सिटाने के लिए 3प्रचारात्मक उपाय सुझाएँ।
- पंडित मदन मोहन मालवीय या महात्मा गांधी के जीवन पर एक निबंध लिखें।

NATIONAL INSTITUTE OF TECHNOLOGY PATNA
 Department of Computer Science & Engineering
END SEMESTER EXAMINATION, Dec. 2024

B. Tech. (UG)

Course Name: Database Management System

Maximum Time: 3 hours

Semester- 03
 Code: CS34109
 Max. Marks: 60

Instruction:

1. Attempt All questions.
2. You may answer the questions in any order. However, all parts of the same question must be answered together.
3. Assume any suitable data, if necessary. Clearly state any reasonable assumption you make.
4. The Marks, CO (Course Outcome), and BL (Bloom's Level) related to questions are on the right-hand margin.

		Mar ks	CO	BL			
1.	Identify types of integrity violations in the given pieces of SQL codes and suggest solution to handle them.	3X4	CO	A			
	a) SQL Code 1: --INSERT INTO Users (ID, Name) VALUES (1, 'Alice'); --INSERT INTO Users (ID, Name) VALUES (1, 'Bob');			4			
	b) SQL Code 2: --CREATE TABLE Users (Email VARCHAR(255) UNIQUE); --INSERT INTO Users (Email) VALUES ('test@example.com'); --INSERT INTO Users (Email) VALUES ('test@example.com');						
	c) SQL Code 3: --CREATE TABLE Departments (DeptID INT PRIMARY KEY); --CREATE TABLE Employees (EmpID INT PRIMARY KEY, DeptID INT, FOREIGN KEY (DeptID) REFERENCES Departments(DeptID)); -- Inserting a non-existing DeptID INSERT INTO Employees (EmpID, DeptID) VALUES (1, 999);						
2.	Consider the following two transactions and a mixed schedule SSS. Transactions:	6+6	CO	E			
	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 5px;">T1: Read(A) Write(A) Write(B)</td><td style="padding: 5px;">T2: Write(A) Read(B)</td><td style="padding: 5px;">Schedule SSS: T1: Read(A) T2: Write(A) T1: Write(A) T1: Write(B) T2: Read(B)</td></tr> </table> <p> <input checked="" type="checkbox"/> a) Determine if SSS is conflict-serializable by applying proper method. <input checked="" type="checkbox"/> b) Suggest methods for removing conflicts from a schedule. </p>	T1: Read(A) Write(A) Write(B)	T2: Write(A) Read(B)	Schedule SSS: T1: Read(A) T2: Write(A) T1: Write(A) T1: Write(B) T2: Read(B)		5	
T1: Read(A) Write(A) Write(B)	T2: Write(A) Read(B)	Schedule SSS: T1: Read(A) T2: Write(A) T1: Write(A) T1: Write(B) T2: Read(B)					
3.	At XBM Corp, the IT department has been struggling with their employee records. The data includes details about employees, their departments, locations, and areas of expertise. However, the current system is causing major headaches:	4X3	CO	A			
	<p> <input checked="" type="checkbox"/> a) The system often ends up with multiple entries for the same employee, making updates and deletions a nightmare. Adding new data is tricky, especially when some information is missing. Transform the given unstructured dataset into a format where no single entry contains multiple unrelated values. How will you ensure that each attribute represents a single, atomic piece of data, and explain how this step simplifies data management and prevents anomalies. </p>		4, CO 1				

- b)** Certain pieces of information seem to repeat unnecessarily, leading to bloated storage. Worse, some combinations of data don't make sense and confuse the reporting tools. Reorganize the dataset to ensure that every piece of data depends entirely on the appropriate context or group. Identify attributes that do not directly belong and move them to a more relevant structure. *Suggest solution how this transformation eliminates redundancy and ensures logical consistency.*
- c)** Occasionally, deleting one piece of information causes unrelated but critical data to vanish, leaving the system incomplete. Restructure the dataset to prevent the loss of unrelated but critical data when a piece of information is deleted. Ensure that each attribute is stored independently of others that are not directly related. *Redesign the schema to resolve deletion anomalies and preserves the integrity of the system.*
4. In a university, the student information system manages various relations, such as students, courses, and their enrolment details. However, the administration is having trouble retrieving certain sets of data for reporting and analysis. Professor Meera has tasked you with writing relational algebra queries to answer some complex questions based on the data:
- Students Enrolled in All Courses in a Department: The university offers many courses in different departments, and Professor Meera wants to identify students who are enrolled in all courses offered by the Computer Science department.
 - Students with Same Grade in Different Courses: Additionally, she needs a list of students who have taken at least one course with the same grade as another student, but in a different course. This would help identify students with similar academic performance, even if they're in different courses.
 - Students Not Enrolled in Any Courses: Finally, Professor Meera wants a report of students who are not enrolled in any courses. This would help identify students who might need academic advising.
- Answer the following questions:
- Write a relational algebra query to find the names of students who are enrolled in all courses offered by the Computer Science department.
 - Using relational algebra, write a query to find the names and majors of students who have taken at least one course with the same grade as another student, but in a different course.
 - Construct a relational algebra query to list the names of students who are not enrolled in any courses.
5. Consider the following: account(account_number, branch_name, balance)
 branch(branch_name, branch_city, assets) customer(customer_name, customer_street, customer_city) loan(loan_number, branch_name, amount)
 depositor((customer_name, account_number) borrower(customer_name, loan_number)) Write queries in SQL for any four:
- For all customers who have a loan from the bank, find their names, loan numbers, and loan amount.
 - Find the customer names, loan numbers, and loan amounts, for all loans at the Patna branch.
 - Find the maximum across all branches of the total balance at each branch.

Learning Outcomes:

- CO 1. define data independence, data models, schema, and database instances. Also, distinguish among different database models and their practical implications.
- CO 2. translate queries to Relational Algebra, Relational calculus and using Structure Query Language statements used in the creation and manipulation of database
- CO 3. identify the methodology of conceptual modelling through Entity Relationship
- CO 4. analyze and design an actual database application and develop and evaluate an actual database application
- CO 5. Describe basic database storage structures, access techniques, and transaction processing.



[Attempt all questions; Answer concisely only in blue/black ink; Use pencil only for artwork;

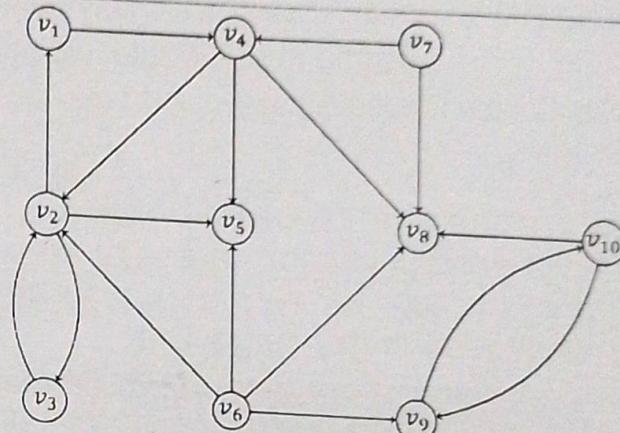
Assume missing data; No mobile phones, smart gadgets]

[Marks, Course Outcome and Bloom's Level are mentioned on right-hand side of each question]

Sl.	Questions	CO BL	
1. a.	Determine the chromatic number of wheel graph W_n ($n \in \mathbb{Z}^+, n \geq 3$). (Write proper reason in every step.) व्हील (पहिया) ग्राफ W_n ($n \in \mathbb{Z}^+, n \geq 3$) की क्रोमेटिक नंबर (वर्णिक संख्या) निर्धारित करो। (प्रत्येक स्टेप के लिए उचित कारण लिखो।) [Course outcome(s) evaluated: CO-4(Apply/Solve)]	(5)	CO-4 Level-3
b.	Define Hamilton circuit of simple undirected graph G . सरल ऑनडिरेक्टेड ग्राफ G की हैमिल्टन सर्किट का परिभाषा लिखो। [Course outcome evaluated: CO-1(Remember/Recall)]	(1)	CO-1 Level-1
c.	Determine the number of Hamilton circuits present in the adjoining graph $K_{3,4}$. (Show every step with proper reason.) उपरोक्त ग्राफ $K_{3,4}$ में मौजूद हैमिल्टन सर्किट की संख्या निर्धारित करो। (प्रत्येक स्टेप को उचित कारण के साथ लिखो।) [Course outcome(s) evaluated: CO-4(Apply/Solve)]	(4)	CO-4 Level-3
2. a.	Prove that any tree $T = (V, E)$ with two or more vertices (i.e., $ V = n$, $n \in \mathbb{Z}^+, n \geq 2$) must contain at least two pendant vertices. साबित करों कि दो या अधिक वर्टेसस (शीर्षों) वाले किसी भी ट्री (पेंड) $T = (V, E)$ (जहाँ, $ V = n$, $n \in \mathbb{Z}^+, n \geq 2$) में कम से कम दो पेंडेंट वर्टेसस अवश्य होने चाहिए। [Course outcome(s) evaluated: CO-6(Analyze/Prove)]	(5)	CO-6 Level-4
b.	Prove that in a digraph $G = (V, E)$, where $V = \{v_1, \dots, v_n\}$, the sum of in-degrees of all the n vertices is same as the sum of their out-degrees, which is also same as the number of arcs in G . साबित करों कि एक डायग्राफ $G = (V, E)$ में, जहाँ $V = \{v_1, \dots, v_n\}$, सभी n वर्टेसस (शीर्षों) की इन-डिग्री का योग उन सभी वर्टेसस की आउट-डिग्री के योग के समान हैं, जो G में आर्क की संख्या के समान भी होता है। [Course outcome(s) evaluated: CO-6(Analyze/Prove)]	(5)	CO-6 Level-4
3. a.	Consider a simple graph $G = (V, E)$, where $V = \{v_1, v_2, v_3, v_4, v_5, v_6\}$. Their degree values are given: $\deg(v_1) = 5$, $\deg(v_2) = 4$, $\deg(v_3) = 3$, $\deg(v_4) = 2$, $\deg(v_5) = x$, and $\deg(v_6) = y$, where x and y are unknown degree values. Among all the values of x and y , graph G exists only for some values. Use the properties and/or theorems of simple graphs as well as graphic sequence of simple graphs to identify the minimum possible value of $x + y$.	(5)	CO-5 Level-3

Sl.

3. a. मान लों एक सरल ग्राफ $G = (V, E)$, जहां $V = \{v_1, v_2, v_3, v_4, v_5, v_6\}$ । उन वर्टेसिस की डिग्रियों का मान इस प्रकार है: $\deg(v_1) = 5$, $\deg(v_2) = 4$, $\deg(v_3) = 3$, $\deg(v_4) = 2$, $\deg(v_5) = x$, और $\deg(v_6) = y$, जहां x और y के मान पता नहीं हैं। x और y के सभी मानों के बीच, ग्राफ G का निर्माण केवल कुछ मानों के लिए ही संभव है। सरल ग्राफ तथा (सरल ग्राफ के) ग्राफिक सीकेस (अनुक्रम) का प्रॉपर्टीज़ (गुणों) और/या थिओरम्ज़ (प्रमेयों) को उपयोग करों, ताकि $x + y$ के न्यूनतम संभावित मान की पहचान की जा सके। [Course outcome(s) evaluated: CO-4(Apply/Use)]
- b. Write down the graph realization problem. (1)
ग्राफ रियलाइज़ेशन समस्या को लिखो। [Course outcome evaluated: CO-1(Remember/Recall)]
- c. Consider the adjoining digraph $\vec{G} = (V, \vec{E})$, which has multiple strongly connected components, each such component being a strongly connected directed subgraph. Explain that the directed subgraph $\vec{H} = (v, \vec{e})$ with vertices $v = \{v_1, v_2, v_3, v_4\}$, where $v \subseteq V$ and $\vec{e} \subseteq \vec{E}$, is a strongly connected component of \vec{G} . (4)
मान लों उपरोक्त डायग्राफ $\vec{G} = (V, \vec{E})$, जिसमें कई स्ट्रॉनाली कनेक्टेड कॉम्पोनेंट्स हैं, और प्रत्येक वह कॉम्पोनेंट एक स्ट्रॉनाली कनेक्टेड डिरेक्टेड सबग्राफ हैं। व्याख्या करों कि एक डिरेक्टेड सबग्राफ $\vec{H} = (v, \vec{e})$, जिसमें $v = \{v_1, v_2, v_3, v_4\}$, $v \subseteq V$ और $\vec{e} \subseteq \vec{E}$ हैं, वह \vec{G} का एक स्ट्रॉनाली कनेक्टेड कॉम्पोनेंट है। [Course outcome(s) evaluated: CO-2(Understand/Explain)]
- d. Consider a simple connected undirected graph $G = (V, E)$, where $V = \{v_1, v_2, v_3, v_4, v_5, v_6, v_7\}$. Two distinct vertices v_i and v_j ($v_i, v_j \in V$) are adjacent if $|i - j|$ is an even number. Represent G in terms of its adjacency matrix. (5)
मान लों एक सरल कनेक्टेड ऑनडिरेक्टेड ग्राफ $G = (V, E)$, जहां $= \{v_1, v_2, v_3, v_4, v_5, v_6, v_7\}$ । दो अलग-अलग वर्टेसिस v_i और v_j ($v_i, v_j \in V$) निकटवर्ती हैं यदि $|i - j|$ एक सम संख्या है। G को उसके ऑड़ज़सेंसी मैट्रिक्स के रूप में रिप्रेज़ेंट करो। [Course outcome(s) evaluated: CO-3(Understand/Represent)]
- b. An influence graph is a simple digraph for modelling group activity, where certain people can influence the thinking of others. Each person of the group is represented by a vertex. There is a directed edge from vertex u to vertex v when the person represented by vertex u can influence the person represented by vertex v . Consider a company's board of directors. In a board meeting, the President can influence the Director of Research and Development, the Director of Marketing, and the Director of Operations; the Director of Research and Development can influence the Director of Operations; the Director of Marketing can influence the Director of Operations; and no one can influence, or be influenced by, the Chief Financial Officer. Represent this behaviour of the board meeting in terms of an influence graph. (5)



SI.

Questions

CO BL

4. b. एक इन्फलुएंस (प्रभाव) ग्राफ़ ग्रूप गतिविधि की मॉडलिंग को एक सरल डायग्राफ़ में व्यक्त करते हैं, जहाँ ग्रूप में कुछ लोग दूसरों की सोच को प्रभावित कर सकते हैं। ग्रूप के प्रत्येक व्यक्ति को एक वर्टेक्स द्वारा दर्शाया जाता है। वर्टेक्स u से वर्टेक्स v तक एक डिरेक्टेड एज होता है, जब वर्टेक्स u द्वारा दर्शाया गया व्यक्ति वर्टेक्स v द्वारा दर्शाएं गए व्यक्ति को प्रभावित कर सकता है।
 मान लों के किसी एक कंपनी का निदेशक मंडल हैं। एक बोर्ड की मीटिंग (बैठक) में, प्रेज़िडन्ट (सभाध्यक्ष) अनुसंधान एवं विकास निदेशक, विपणन निदेशक और संचालन निदेशक को प्रभावित कर सकता हैं; अनुसंधान एवं विकास निदेशक संचालन निदेशक को प्रभावित कर सकते हैं; विपणन निदेशक संचालन निदेशक को प्रभावित कर सकता हैं; और कोई भी सदस्य मुख्य वित्तीय अधिकारी को प्रभावित नहीं कर सकता है, या उनसे प्रभावित नहीं हो सकता है। बोर्ड मीटिंग के इस व्यवहार को एक इन्फलुएंस ग्राफ़ के रूप में रिप्रेज़ेंट करों।

[Course outcome(s) evaluated: CO-3(Understand/Represent)]

5. a. Consider that $S_n = \sum_{k=1}^n k$ is the sum of the first n positive integers ($n \in \mathbb{Z}^+$). Also, it is given that the initial condition is $S_1 = 1$. Identify the recurrence equation of S_n and find the closed-form solution of that recurrence. (8)

मान लों के $S_n = \sum_{k=1}^n k$ (जहाँ $n \in \mathbb{Z}^+$) प्रथम n पॉज़िटिव इन्टिज़र्स (धनात्मक पूर्णांकों) का योग है। साथ ही, यह भी दिया गया है कि प्रारंभिक शर्त $S_1 = 1$ है। S_n का रेकर्स (पुनरावृत्ति) समीकरण निकालों और उस रेकर्स समीकरण का बंद-रूप समाधान को निर्धारित करों।

[Course outcome(s) evaluated: CO-4(Apply/Solve)]

- b. Write down the Master theorem for solving a divide-and-conquer recurrence. (2)

मास्टर थिओरम लिखों, जिसका उपयोग डिवाइड-और-कॉन्कर रेकर्स को सुलझाने के लिए किया जाता है।

[Course outcome evaluated: CO-1(Remember/Recall)]

6. a. For two ordinary generating functions $G(x) = \sum_{k=0}^{\infty} (a_k \cdot x^k)$, and $F(x) = \sum_{k=0}^{\infty} (b_k \cdot x^k)$, where coefficients $a_k, b_k \in \mathbb{Z}$, define their sum and product. (4)

दिए गए दो ऑर्डिनरी जनरेटिंग फ़ंक्शंस $G(x) = \sum_{k=0}^{\infty} (a_k \cdot x^k)$ और $F(x) = \sum_{k=0}^{\infty} (b_k \cdot x^k)$, जिसमें कॉफ़िशिएंट्स (गुणांक) $a_k, b_k \in \mathbb{Z}$, उसकी योगफल और गुणनफल की परिभाषा लिखों।

[Course outcome evaluated: CO-1(Remember/Recall)]

- b. Define reflexive closure, symmetric closure, and transitive closure of binary relation \mathcal{R} on finite set A . (6)

फ़ाइनाइट (परिमित) सेट A पर बाइनरी रिलेशन \mathcal{R} के रिफ्लेक्टिव (प्रतिवर्ती) क्लोज़र, सिमेट्रिक (सममित) क्लोज़र और ट्रांज़िटिव (परिवर्तनशील) क्लोज़र की परिभाषा लिखों।

[Course outcome evaluated: CO-1(Remember/Recall)]

List of Course Outcomes of "Discrete Mathematics and Graph Theory": After completing this course, a student should be able to —

CO-1. recall mathematical logic terminologies and principles, discrete structures terminologies and principles, counting principles, recurrence relation terminologies and principles, graph terminologies and principles, tree terminologies and principles, as well as graph coloring and covering principles;

[Bloom level: Remember; Mapped to: PO-1]

CO-2. explain concepts of logical equivalence, quantification, sum rule, product rule, inclusion-exclusion, pigeonhole, generating functions, graph connectedness, Euler trails and Hamilton paths, shortest path rule, tree traversal, spanning tree, graph planarity, coloring rule, covering and portioning of graph;

[Bloom level: Understand; Mapped to: PO-1, PO-2]

CO-3. represent given instructions on contemporary scenarios through graphs and trees; [Bloom level: Understand; Mapped to: PO-1, PO-2]