

Sample_Midterm

Instructions: Answer all questions, marking T for True or F for False in the T/F questions. Write answers clearly for short answer questions, for longer problems provide well commented code and explanations. Keep answers concise and organized.

Recursion (10 points)

1. Write a recursive C++ function to calculate the factorial of a positive integer 'n'. Provide function definition and its base case.

```
// put code here
```

C++

2. Write a recursive C++ function to compute the nth Fibonacci number. Provide the function definition and its base case.

```
// put code here
```

C++

Math Review (15 points)

3. True or False: Induction is a technique used to prove the correctness of algorithms or mathematical statements.
4. Explain the concept of geometric series and provide a formula to calculate the sum of a geometric series.
5. Prove by induction that for all positive integers n , $1 + 2 + 3 + \dots + n = (n * (n + 1)) / 2$.

Answer:

Markdown

C++ Basic Concepts (15 points)

6. Explain the differences between 'public', 'private', and 'protected' access specifiers in C++ classes.
7. Discuss different parameter passing methods in C++ (e.g., pass by value, pass by reference) and provide examples for each.
8. Define and explain the concept of function objects in C++.

Generic Programming

9. Write a C++ function template that swaps two values of any data type. Provide the function template definition and usage example

```
// code goes here
```

C++

10. Explain the concept of a class template in C++ and provide an example of a class template for a generic data structure.

Algorithm Analysis

11. Define and explain the formal notations 'Big O', 'Big Omega', and 'Big Theta' used for analyzing algorithm complexity. Provide an example for each.
12. Analyze the time complexity of a simple sorting algorithm (e.g., bubble sort) in terms of Big O notation.

Data Structures and Algorithms

13. Explain the circular array concept in the implementation of a deque data structure. How is the number of elements determined in a deque?
14. Provide the key methods and their time complexities for a doubly-linked list and its iterator implementation.
15. Describe the concept and prototype of a stack and its applications. Provide an example of an application using a stack data structure.
16. Explain the concept and prototype of a queue and its applications. Provide an example of an application using a queue data structure.

Project Questions

17. Write a code snippet in C++ that demonstrates the insertion operation in a circular deque. Include comments explaining the code.

```
// code goes here
```

C++

18. Write a code snippet in C++ that demonstrates the implementation of Depth-First Search (DFS) using a stack data structure. Include comments explaining the code.

```
// code goes here
```

C++

1. Explain the concept of postfix evaluation and provide an example of an expression to be evaluated using a stack-based algorithm.