COMPSCI 300: Programming II – Comprehensive Test (Modules 7–9)

Instructions: Answer all questions. Part A is multiple choice (2 points each). Part B is short answer (4 points each). Topics covered: Algorithm Analysis, Recursion, Sorting & Searching.

Part A — Multiple Choice (2 pts each)

1. Which of the following best describes the purpose of algorithm analysis?
A. To determine correctness under all inputs
B. To measure how runtime changes as input size grows
C. To test all possible inputs
D. To ensure termination in finite time

2. The runtime of the following code is:
```
for (int i = 0; i < 1000; i++) System.out.println(i);
```
A. O(1)
B. O(N)
C. O(N^2)
D. O(log N)

3. The “worst-case” scenario of an algorithm refers to:
A. When it performs the fewest operations
B. When it performs the most operations
C. When it fails to compile
D. When it terminates early

4. A recursive function must have:
A. No base case
B. A base case and recursive case
C. Only loops
D. A static variable

5. Which of the following statements is true about recursion?
A. Always faster than iteration
B. Uses less memory than iteration
C. Every recursive call adds a new stack frame
D. Cannot be used for searching

6. What is the runtime of the following recursive method?
```
public static int factorial(int n) {
if (n == 0) return 1;
return n * factorial(n - 1);
}
```
A. O(N^2)
B. O(N)
C. O(1)
D. O(log N)

7. Linear search is best used when:
A. The data is sorted
B. The dataset is small or unsorted
C. You require O(log N) performance
D. You have duplicate elements

8. Which sorting algorithm has the best average-case runtime complexity?
A. Bubble Sort
B. Merge Sort
C. Insertion Sort
D. Selection Sort

9. Insertion Sort performs fastest when:
A. The array is already sorted
B. The array is in reverse order
C. The array is large and random
D. The array has duplicates

10. In QuickSort, selecting a poor pivot can cause what runtime?
A. O(N)
B. $O(N^2)$
C. O(log N)
D. O(N log N)

Part B — Short Answer (4 pts each)

11. Explain why recursion often requires more memory than iteration.

12. Write a recursive method called sumArray that returns the sum of all integers in an array.

```
public static int sumArray(int[] arr, int n) {
// your code
}
```

13. Describe a real-world scenario where Linear Search would be more efficient than Binary Search.

14. Given an array of 8 elements, explain the first 3 merge steps in Merge Sort.

15. Analyze the following code and determine its Big-O runtime:

```
for (int i = 0; i < n; i++)
for (int j = 0; j < i; j++)
System.out.println(i + j);
```