

This problem set has 19 questions, for a total of **75** points. Answer the questions below and mark your answers in the spaces provided. Additionally, fill out the bubble sheet provided **clearly** for your Gradescope submission. If the question asks for showing your work, you must provide details on how your answer was calculated.

Your Name: _____

1. Which of the following descriptions best describes what **mystery** does?

```
int mystery(int *arr, int n) {  
    if(n == 1) return arr[0];  
    int val = mystery(arr + 1, n - 1)  
    return (arr[0] > val) ? arr[0] : val;  
}
```

- A. find the minimum element of arr B. find the maximum element of arr C. find the the sum of all elements of arr D. sort all elements of arr

1. _____

2. Which of the following descriptions best describes what **mystery** does?

```
bool mystery(int n, int i) {  
    if (n <= 2)  
        return (n == 2) ? true : false;  
    if (n % i == 0)  
        return false;  
    if (i * i > n)  
        return true;  
  
    return mystery(n, i + 1);  
}
```

- A. determine if n is an even number B. determine if n is a prime number C. determine if i evenly divides n D. determine if n is an odd number

2. _____

3. Given the following sorting algorithm, determine if it is **stable**, **in-place**, **both**, or **neither**.

```
int sort(int *arr, int n) {  
    if (n <= 1) return;  
    sort(arr, n-1);  
    int tmp = arr[n-1];  
    int j = n-2;  
    while (j >= 0 && arr[j] > tmp) {  
        arr[j+1] = arr[j];  
        j--;  
    }  
    arr[j+1] = tmp;  
}
```

A. stable B. in-place C. both D. neither

3. _____

4. Solve the following recurrence relation: $T(0) = 1; T(n) = T(n + 1) + 3$

A. $3n + 1$ B. $3n - 1$ C. $1 - 3n$

4. _____

5. Solve the following recurrence relation: $T(1) = 1; T(n) = 2T(n/2) + n$

A. $n + \log n$ B. $n \log n$ C. $n + n \log n$ D. $n^2 + n \log n$

5. _____

6. Is a vector the best underlying structure to implement a queue with? Justify your answer.

A. Yes B. No

6. _____

7. Would a stack (A) or queue (B) be more efficient for an undo button in a text editor

7. _____

8. Would a stack (A) or queue (B) be more efficient for a web server connection manager

8. _____

9. Would a stack (A) or queue (B) be more efficient for a breadth-first search

9. _____

10. Would a stack (A) or queue (B) be more efficient for a depth-first search

10. _____

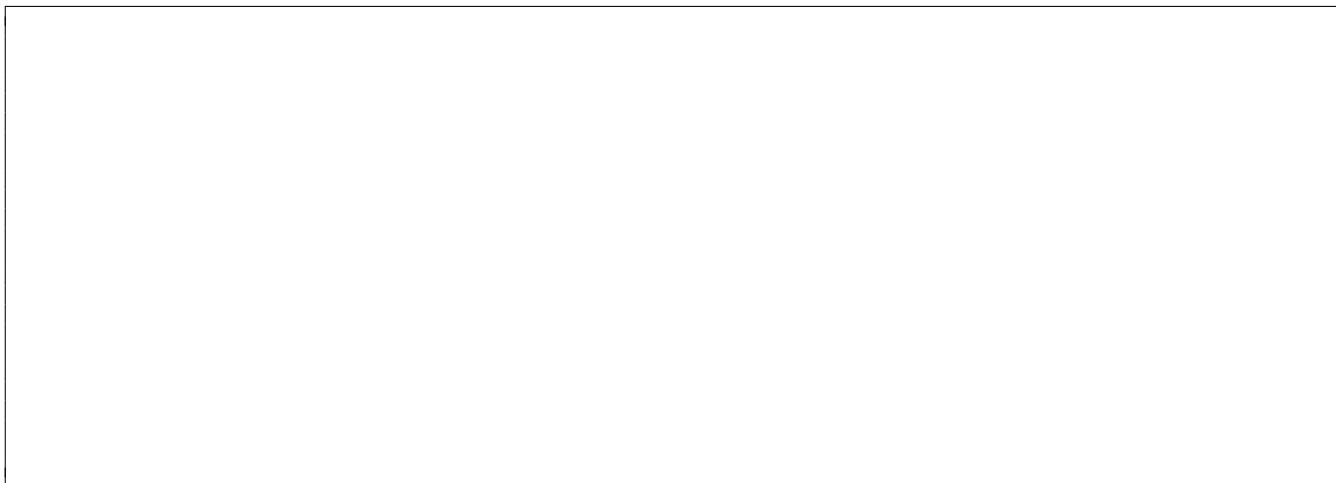
11. Given the following function **mystery**, determine its output assuming **stack** has had the following elements inserted in order: 7, 20, 300, 5, 10

```
int mystery(std::stack<int> stack) {
    int result = 0;
    int loop = stack.size();
    for(int i = 0 ; i < loop; i++) {
        if(!(i % 2)) {
            result += stack.top();
        }
        else {
            result *= stack.top();
        }
        stack.pop();
    }
    return result;
}
```

A. 2210 B. 60050 C. 7007 D. 10640

11. _____

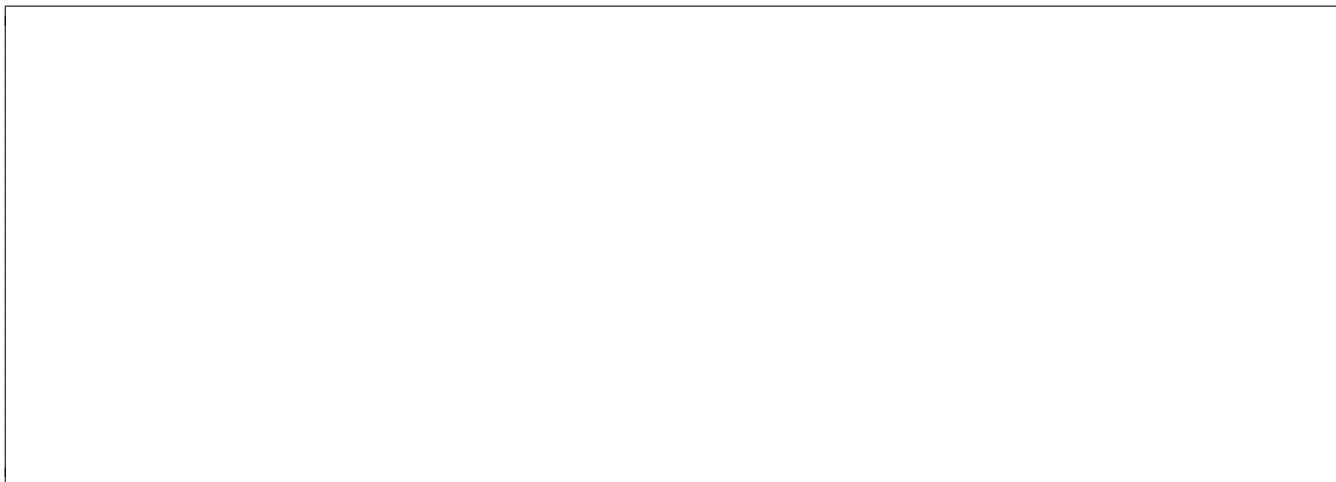
12. If a Binary Tree is complete, does that necessarily mean it is also full? Justify your answer with drawings of trees.



A. Yes B. No

12. _____

13. If a Binary Tree is full, does that necessarily mean it is also complete? Justify your answer with drawings of trees.



A. Yes B. No

13. _____

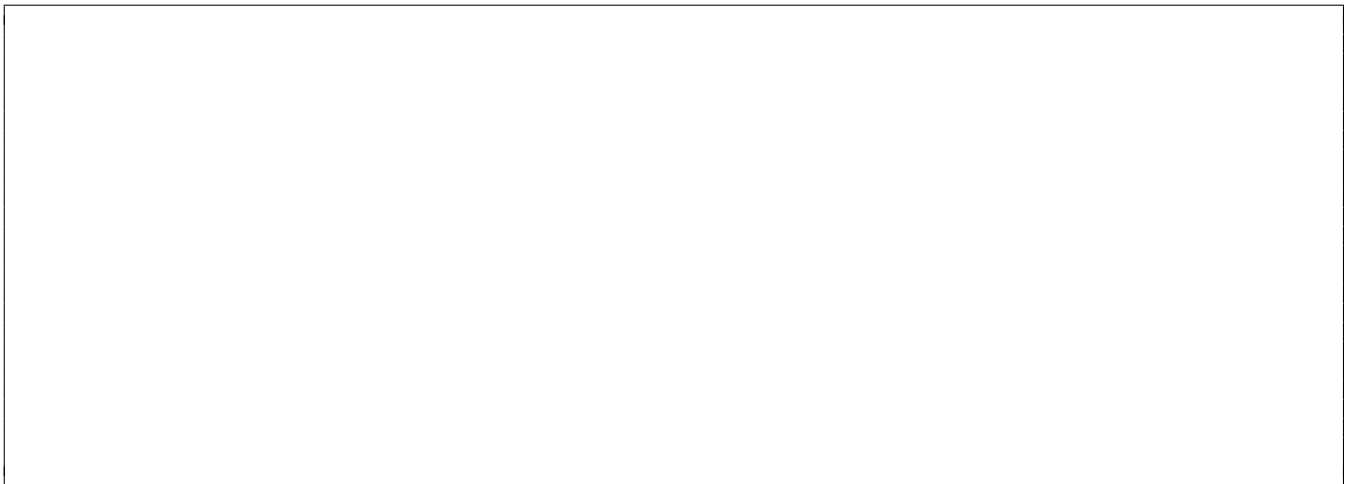
14. Assume a binary search tree has undergone the following insertions in order: 10, 7, 15, 12, 13, 4, 8, 1, 19, 20, 5. Which of the following represents the output of a post-order traversal on the resulting tree?



- A. 10, 7, 15, 4, 8, 12, 19, 1, 5, 13, 20 B. 1, 4, 5, 7, 8, 10, 12, 13, 15, 19, 20 C. 10, 7, 4, 1, 5, 8, 15, 12, 13, 19, 20 D. 1, 5, 4, 8, 7, 13, 12, 20, 19, 15, 10

14. _____

15. Assume a binary search tree has undergone the following insertions in order: 20, 10, 30, 5, 4, 1, 6, 24, 52, 28, 13. Which of the following represents the output of a pre-order traversal on the resulting tree?



- A. 1, 4, 5, 6, 10, 13, 20, 24, 28, 30, 52 B. 20, 10, 5, 4, 1, 6, 13, 30, 24, 28, 52 C. 1, 4, 6, 5, 13, 10, 28, 24, 52, 30, 20 D. 10, 7, 4, 1, 5, 8, 15, 12, 13, 19, 20

15. _____

For questions 16 - 19, let T be a full k -ary tree, where $k = 2$ (a.k.a. *binary tree*), with n nodes. Let h denote the height of T .

16. What is the minimum number of leaves for T of height h ? Justify your answer.

Example when $h = 0$: T , being a *full tree* can have a minimum of 1 leaf.

A. 2^h B. $2h$ C. 2^{h-1} D. $2^h - 1$ E. $h + 1$

16. _____

17. What is the maximum number of leaves for T ? Justify your answer.

A. 2^h B. $2h$ C. 2^{h-1} D. $2^h - 1$ E. $h + 1$

17. _____

18. What is the minimum number of internal nodes for T ? Justify your answer.

A. 2^h B. $2h$ C. 2^{h-1} D. h E. $h + 1$

18. _____

19. What is the maximum number of internal nodes for T ? Justify your answer.

A. 2^h B. $2h$ C. 2^{h-1} D. $2^h - 1$ E. $h + 1$

19. _____