Instructions: Write your name and PID in your answer file. Write the question number and your answer for each question. Upload your file to the Curator no later than 5:00 pm on Wednesday, February 27.

For questions 1 through 5, select an answer from the following choices:

1) $\Theta(1)$
2) $\Theta(\log n)$
3) $\Theta(n)$
4) $\Theta(n \log n)$
5) $\Theta(n^2)$
6) $\Theta(n^2 \log n)$
7) $\Theta(2^n)$
8) None of these

Apply the theorems given in the course notes to determine the appropriate big-$\Theta$ classification of the given function. All logarithms are base 2.

1. $f(n) = 4n^2 + 97n + 1000$ is ___________
2. $f(n) = 17$ is ___________
3. $f(n) = n + 3n\log n$ is ___________
4. $f(n) = 9n + 13\log n$ is ___________
5. $f(n) = 17\log n^2$ is ___________ // careful here...

For questions 6 through 10, select an answer from the following choices:

1) $O(1)$
2) $O(\log N)$
3) $O(N)$
4) $O(N \log N)$
5) $O(N^2)$
6) None of these

Assume that $N$ is an integer variable with a positive value, and that any other declarations necessary to make the code fragment given syntactically and logically correct are present. For each code fragment, we are looking for a tight upper bound.

6. Execution of the following code fragment is best described as being $O(\underline{\hspace{2cm}})$.

```cpp
int Idx;
for (Idx = 0; Idx < N; Idx++) {
    cout << A[Idx] << endl;
}
```

7. Execution of the following code fragment is best described as being $O(\underline{\hspace{2cm}})$.

```cpp
int i = N;
while (i > 0) {
    int Sum = 0;
    int j;
    for (j = 0; j < N; j++)
        Sum++;
    cout << Sum << end;
    i--;
}
```
8. Execution of the following code fragment is **best described** as being $O(______)$.

```c
int i = N;
while (i > 0) {
    int Sum = 0;
    int j;
    for (j = 0; j < i; j++)
        Sum++;
    cout << Sum << end;
    i--;
}
```

9. Execution of the following code fragment is **best described** as being $O(______)$.

```c
int Max = int(pow(2.0, N)); // Max == 2 to the power N
int Sum = 0;
int i;
for (i = 1; i <= Max; i++) {
    int j;
    for (j = 1; j <= Max; j = 2*j)
        Sum++;
}
```

10. Execution of the following code fragment is **best described** as being $O(______)$.

```c
int Max = N;
int Sum = 0;
int i;
for (i = 1; i <= Max; i++) {
    int j;
    for (j = 1; j <= Max; j = 2*j)
        Sum++;
}
```

For questions 11 through 13, assume that $N$ is an integer variable with a positive value, and that any other declarations necessary to make the code fragment given syntactically and logically correct are present.

For each question, apply the complexity analysis rules given in the course notes to determine the **exact** time complexity $T(N)$ of the execution of the given code fragment.

Be sure to apply the rules exactly as stated or you will surely obtain incorrect answers.

11. int Idx;
    for (Idx = 0; Idx < N; Idx++) {
        cout << A[Idx] << endl;
    }

12. int i = N;
   while (i > 0) {
      int Sum = 0;
      int j;
      for (j = 0; j < N; j++)
         Sum = Sum + 1;
      cout << Sum << end;
      i--;
   }

13. int i = N;
   while (i > 0) {
      int Sum = 0;
      int j;
      for (int j = 0; j < i; j++)
         Sum = Sum + 1;
      cout << Sum << end;
      i--;
   }

For questions 14 and 15, suppose that the execution of a particular algorithm requires carrying out $T(N)$ operations, where $N$ is the number of inputs that must be processed and

$$T(N) = N \log_2 N.$$  

Assume the algorithm will be executed on hardware capable of carrying out $10^6$ operations per second.

14. To the nearest minute, how much time would be needed to execute this algorithm on the specified hardware, if $N$ equals $10^9$?

15. To the nearest minute, how much time would be needed to execute this algorithm on the specified hardware, if $N$ equals $2 \times 10^9$?