Computer Science
Open, Round 2
Test #401

1. Write your 6-digit ID# in the I.D. NUMBER grid, left-justified, and bubble. Check that each column has only one number darkened.

2. In the EXAM NO. grid, write the 3-digit Test # on this test cover and bubble.

3. In the Name blank, print your name; in the Subject blank, print the name of the test; in the Date blank, print your school name (no abbreviations).

4. Scoring for this test is 5 times the number correct + the number omitted.

5. You may not sit adjacent to anyone from your school.

6. TURN OFF ALL CELL PHONES OR OTHER PORTABLE ELECTRONIC DEVICES NOW.

7. No calculators may be used on this test.

8. Any inappropriate behavior or any form of cheating will lead to a ban of the student and/or school from future national conventions, disqualification of the student and/or school from this convention, at the discretion of the Mu Alpha Theta Governing Council.

9. If a student believes a test item is defective, select "E) NOTA" and file a Dispute Form explaining why.

10. If a problem has multiple correct answers, any of those answers will be counted as correct. Do not select "E) NOTA" in that instance.

11. Unless a question asks for an approximation or a rounded answer, give the exact answer.

Note: For all questions, answer "(E) NOTA" means none of the above answers is correct.

Note: All values will be listed of the appropriate type (e.g., `7.0` is a `double`, `7` is an `int`, "7" is a `string`, and '7' is a `char`).

1. Consider the following code excerpt:

```
Integer value = null;
return (value != null) ? 0 : value;
```

   What value (if any) is returned after running this excerpt?

   (A) `0`   (B) `null`   (C) `true`   (D) `false`   (E) NOTA

2. Consider the following code excerpt:

```
boolean A = true;
boolean B = false;
boolean C = false;
boolean D = true;

if (A && B || C) {
    return 1;
}
if (B || C && D) {
    return 2;
}
if ((B || C) && D) {
    return 3;
}
if ((D && B) || (A && C || D)) {
    return 4;
}
```

   What value (if any) is returned after running this excerpt?

   (A) `1`   (B) `2`   (C) `3`   (D) `4`   (E) NOTA

3. What is the binary representation of 267?

   (A) 100001011   (B) 100010011   (C) 100111010   (D) 110000001   (E) NOTA

4. What is the hexadecimal representation of 2013?

    (A) 7D3   (B) 7EC   (C) 7DC   (D) 7CF   (E) NOTA

5. Consider the following method:

```
public static void mystery(int a, int b) {
   int c = 2;
   if (a + c < b) {
      c = c + 8;
   } else {
      b = b + 10;
   }
   if (a + c < b) {
      c = c + 8;
   } else {
      b = b + 10;
   }
   System.out.println(b + " " + c);
}
```

    Find the output for the following call: `mystery(12,5);`

    (A) "25 2"   (B) "15 10"   (C) "25 10"   (D) "15 18"   (E) NOTA

6. The standard binary search algorithm runs in ___ time.

    (A) O(nlog(n))   (B) O(n²)   (C) O(log(n))   (D) O(n)   (E) NOTA

7. Find the output of the following expression:

    `"3 * 12" + 12 * 4 + " 42 % 6"`

    (A) `84`   (B) `"3 * 12" + 12 * 4 + " 42 % 6"`

    (C) `"3 * 1248 42 % 6"`   (D) `"36 + 48 + 7"`   (E) NOTA

8. What is the last line of output from the following loop?

```
int total = 25;
for (int number = 1; number <= (total / 2); number++) {
   total = total - number;
   System.out.println(total + " " + number);
}
```

(A) "3 7" (B) "10 5" (C) "10 6" (D) "16 5" (E) NOTA

9. Consider the following method that manipulates an array of integers:

```
public static void mystery(int[] list) {
   for (int i = 1; i < list.length; i++) {
      if (list[i - 1] % 2 == 0) {
         list[i - 1]++;
         list[i]++;
      }
   }
}
```

Given that the list [2, 3, 4, 5, 6] is passed as a parameter to mystery, what value is stored in list after the method executes?

(A) [3, 5, 5, 4, 5]   (B) [2, 3, 4, 5, 6]

(C) [2, 4, 5, 5, 6]   (D) [3, 5, 5, 5, 6]   (E) NOTA

10. A library needs a program to store information about the books in its selection. For each book they want to keep track of the author, the catalog number, and the year of publication. Which of the following is the best design?

(A) Use one class, `Book`, which has three data fields: `string author`, `double catalogNum`, and `int pubYear`.

(B) Use four unrelated classes: `Book`, `Author`, `CatalogNum`, and `PubYear`.

(C) Use a class `Book` which has three subclasses: `Author`, `CatalogNum`, and `PubYear`.

(D) Use three classes: `Author`, `CatalogNum`, and `Pubyear`, each with a subclass `Book`.

(E) NOTA

11. Consider the following method and call:

```
public void mystery(int n) {
   if (n > 100) {
      System.out.println(n);
   } else {
      mystery(2 * n);
      System.out.println(", " + n);
   }
}
```

What output is produced by the call `mystery(10);`?

(A) "`10, 20, 40, 80, 160`"   (B) "`160`"   (C) "`160, `"

(D) "`, 10`"   (E) NOTA

12. Which of the following is the output of an XOR with input bits 1 and 1:

(A) 0   (B) 1   (C) 2   (D) 3   (E) NOTA

13. The in-order traversal of a tree will yield a sorted listing of elements of the tree in...

   (A) Binary Trees   (B) Binary Search Trees   (C) Heaps

   (D) Extended Trees   (E) NOTA

14. The post-order traversal of a binary tree is: `4, 5, 2, 6, 3, 1`. What is the pre-order traversal?

   (A) `1, 2, 6, 3, 4, 5`   (B) `1, 4, 2, 6, 5, 3`

   (C) `1, 2, 4, 3, 5, 6`   (D) `1, 2, 4, 5, 3, 6`   (E) NOTA

15. Rank the following sorting algorithms by their average time complexity (best to worst):

Bogosort, Bubble sort, Merge sort

   (A) Bogosort, Bubble sort, Merge sort   (B) Bubble sort, Merge sort, Bogosort

   (C) Merge sort, Bubble sort, Bogosort   (D) Merge sort, Bogosort, Bubble sort

   (E) NOTA

16. Rank the following (1-7) into increasing order of growth, with 1 as the slowest growing and 7 as the fastest growing:

constant, cubic, exponential, linear, logarithmic, nlog(n), quadratic

   Which are entries 5 and 6, respectively?

   (A) exponential and quadratic   (B) quadratic and cubic

   (C) constant and quadratic   (D) nlog(n) and exponential   (E) NOTA

17. Which data structure allows deleting elements from the front and inserting at the end?

   (A) Stack   (B) Queue   (C) Binary Tree   (D) Heap   (E) NOTA

18. Consider the following method:

```java
public void f(int a, int b) {
   if (a/b != 0)
      f(a/b,b);
   System.out.print(a % b);
}
```
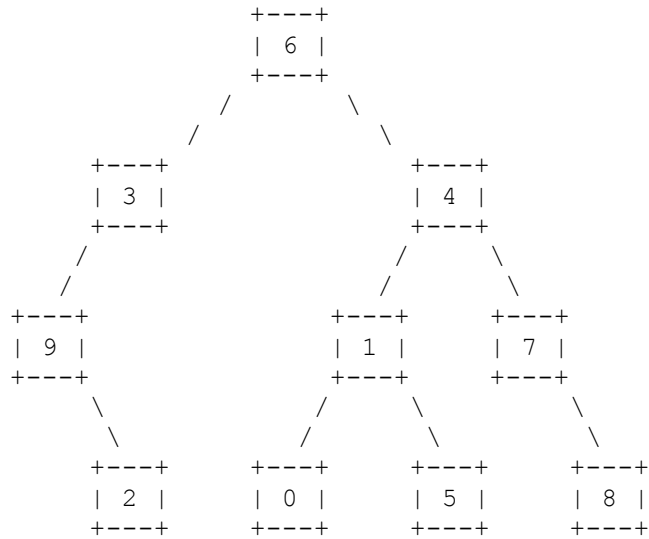
What is the output of the call `f(4,2);`?

   (A) "221"   (B) "201"   (C) "101"   (D) "100"   (E) NOTA

19. If every node in a graph is adjacent to every other node in the graph, then the graph is said to be…

   (A) isolated   (B) finite   (C) complete   (D) nuclear   (E) NOTA
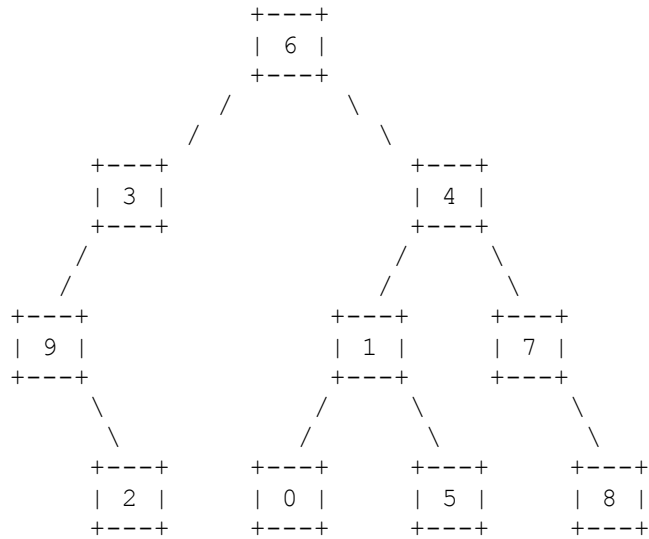
For questions 20-22 use the following tree:

```
                              +---+
                              | 6 |
                              +---+
                            /        \
                          /            \
               +---+                        +---+
               | 3 |                        | 4 |
               +---+                        +---+
              /                           /        \
            /                           /            \
       +---+                      +---+            +---+
       | 9 |                      | 1 |            | 7 |
       +---+                      +---+            +---+
           \                     /       \             \
             \                 /           \             \
            +---+          +---+          +---+          +---+
            | 2 |          | 0 |          | 5 |          | 8 |
            +---+          +---+          +---+          +---+
```

20. Which is the pre-order traversal?

   (A) 9, 2, 3, 6, 0, 1, 5, 4, 7, 8

   (B) 6, 3, 9, 2, 4, 1, 0, 5, 7, 8

   (C) 2, 9, 3, 0, 5, 1, 8, 7, 4, 6

   (D) 9, 3, 2, 6, 0, 1, 4, 5, 7, 8

   (E) NOTA

21. Which is the post-order traversal?

   (A) 9, 2, 3, 6, 0, 1, 5, 4, 7, 8

   (B) 6, 3, 9, 2, 4, 1, 0, 5, 7, 8

   (C) 2, 9, 3, 0, 5, 1, 8, 7, 4, 6

   (D) 9, 3, 2, 6, 0, 1, 4, 5, 7, 8

   (E) NOTA

The tree has been reproduced for your convenience:

```
                            +---+
                            | 6 |
                            +---+
                           /     \
                          /       \
                  +---+             +---+
                  | 3 |             | 4 |
                  +---+             +---+
                 /                 /     \
                /                 /       \
        +---+             +---+     +---+
        | 9 |             | 1 |     | 7 |
        +---+             +---+     +---+
            \            /     \         \
             \          /       \         \
             +---+   +---+   +---+     +---+
             | 2 |   | 0 |   | 5 |     | 8 |
             +---+   +---+   +---+     +---+
```

22. Which is the in-order traversal?

    (A) 9, 2, 3, 6, 0, 1, 5, 4, 7, 8

    (B) 6, 3, 9, 2, 4, 1, 0, 5, 7, 8

    (C) 2, 9, 3, 0, 5, 1, 8, 7, 4, 6

    (D) 9, 3, 2, 6, 0, 1, 4, 5, 7, 8

    (E) NOTA

23. Suppose you would like to find the shortest path between two intersections on a city map, a starting point and a destination. Which algorithm would you implement?

    (A) Euclidean Algorithm   (B) Dijkstra's Algorithm

    (C) Nearest Neighbor Algorithm   (D) Prim's Algorithm   (E) NOTA

24. How many primitive data types are there in Java? (Note: Do **NOT** count `string`.)

    (A) 4   (B) 6   (C) 8   (D) 12   (E) NOTA

25. Consider the following classes:

    ```
    public class Vehicle {…}

    public class Car extends Vehicle {…}

    public class Truck extends Car {…}
    ```

    Which of the following is **NOT** legal statement?

    (A) `Vehicle v = new Truck();` (B) `Vehicle v = new Car();`

    (C) `Car c = new Truck();` (D) `Truck t = new Truck();` (E) NOTA

26. The name of the author of *The Art of Computer Programming*, also known as the "father of algorithm analysis", is…?

    (A) Alan Turing (B) Linus Torvalds (C) Donald Knuth (D) Tony Hoare   (E) NOTA

For questions 27 through 30 assume that the following classes have been defined:

```
public class Gorge extends Cliff {
    public void method2() {
        System.out.println("Gorge 2");
    }

    public void method3() {
        System.out.println("Gorge 3");
    }
}

public class Hill extends Peak {
    public void method2() {
        System.out.println("Hill 2");
    }

    public void method3() {
        System.out.println("Hill 3");
    }
}

public class Peak {
    public void method1() {
        System.out.println("Peak 1");
        method3();
    }

    public void method3() {
        System.out.println("Peak 3");
    }
}

public class Cliff extends Peak {
    public void method3() {
        System.out.println("Cliff 3");
        super.method3();
    }
}
```

Also assume the following variables have been defined:

```
Peak var1 = new Hill();
Peak var2 = new Gorge();
Peak var3 = new Peak();
Object var4 = new Cliff();
```

What is the output produced by the following statements? (If the statement produces more than one line of output then the line breaks will be indicated with a '/')

27. `var4.method1();`

   (A) "Peak 1"/"Cliff 3"/"Peak 3"

   (B) "Peak 1"/"Cliff 3"/ "Cliff 3"   (C) compiler error

   (D) runtime error   (E) NOTA

28. `((Hill)var1).method2();`

   (A) "Hill 2"   (B) "Peak 2"   (C) compiler error

   (D) runtime error   (E) NOTA

29. `var3.method1();`

   (A) "Peak 1"/"Peak 1"   (B) "Peak 1"/"Peak 3"

   (C) compiler error   (D) runtime error   (E) NOTA

30. `var2.method1();`

   (A) "Peak 1"/"Peak 3"   (B) "Peak 1"/"Gorge 3"

   (C) compiler error   (D) runtime error   (E) NOTA