Final Exam S25 Final V3

CSCI 13500: Software Analysis and Design 1

Hunter College, City University of New York

June 23, 2025, 11:30 AM - 1:30 PM, N 1001 D

Exam Rules

- Show all your work. Your grade will be based on the work shown.
- The exam is closed book and closed notes with the exception of a provided cheat sheet.
- When taking the exam, you may bring pens and pencils.
- Scratch paper is provided. For your convenience, you may take the scratch paper and cheat sheet off. But make sure **not** to put solutions to the scratch paper.
- You may not use a computer, calculator, tablet, phone, earbuds, i-watch, or any other electronic device. **If any electronic device is out of backpack, you will get zero for this exam.**
- Unless the problem explicitly requests, no need to include libraries and using namespace std.
- **Do not open this exam until instructed to do so.**

Hunter College regards acts of academic dishonesty (e.g., plagiarism, cheating on examinations, obtaining unfair advantage, and falsification of records and official documents) as serious offenses against the values of intellectual honesty. The College is committed to enforcing the CUNY Policy on Academic Integrity and will pursue cases of academic dishonesty according to the Hunter College Academic Integrity Procedures.

I will not touch any electronic device, including but not limit to cell phone, airpod, or electronic watch during the whole exam, except when showing a virtual ID. I understand that all cases of academic dishonesty will be reported to the Dean of Students and will result in sanctions.
Name:
EmpID:
Email:
Signature:

1 (30 points) Answer the following questions.

(1) Given `string houses[] = {"ranch", "townhouse", "cape cod"}`, what is houses[2].substr(3).length()?

(2) Given a declaration `std::vector<int> v(2, 3); v.push_back(4);`, what is the value of v[1] + v[2]?

(3) What is the **maximum** integer that expression (rand() % 5 + 6) % 3 can generate?

(4) Given `int num = std::to_string(-135).size() - 3;`, where `to_string` converts an integer to a string and `size` method returns the number of characters of a string. What is the value for num?

(5) What is the value of `1 + (6 + 1) / (5 % 8)` in C++?

(6) Write **header** of a function called percentEven, given an array *arr* of string type with *size* many elements, return the percentage (may contain decimal parts) of elements in array with even size.

(7) Declare class Person as follows.

```
1 class Person {
2 public:
3     string name;
4     char gender;
5 };
```

Declare a Person object `me` and initialize its name as *your name* and gender as *your gender*.

(8) Given `string names[] = {"Ann", "Bob", "Charles"};` What is the value of `*(names + 2) + " Smith"`?

(9) Given the following code segment.

```
int main() {
    int numRows = 10;
    int** arr;

    //TODO: write a statement to initialize arr to be
    //a dynamically allocated array with numRows elements of int* type.
    //WRITE YOUR ANSWER IN THE FOLLOWING BOX.
```

```

```

```
    return 0;
}
```

(10) Suppose we have main function defined as follows.

```
int main() {
   double m = 1.1;
   double n = 2.2;
   //In foo, if m < n, exchange the values of m and n, then return true,
   //otherwise, return false.
   bool b = foo(m, n);

   cout << m << " " << n << " " << boolalpha << b << endl;
   //expected output: 2.2 1.1 true
   return 0;
}
```

What is the **header** of function foo?

(11) What is output calling `foo` with an array with elements 7, 6, -5, 5 and its corresponding size?

```
int foo(int* arr, int size) {
    int i = 0;
    while (i < size && arr[i] > 0)
        i++;

    return i;
}
```

(12) What is the output for the following code?

```
vector<int> nums = {2, 1, -2, 5};

int result = 1;
for (int i = 0; i < nums.size(); i++)
    if (nums[i] % 2 == 0)
       result *= nums[i];

cout << result << endl;
```

(13) What the output of the following code? For simplicity, we omit library and using namespace statement.

```
int main() {
    int numRows = 4;
    int numCols = 5;
    for (int row = 0; row < numRows; row++) {
        for (int col = 0; col < numCols; col++) {
            if (row < numRows / 2 && col >= numCols / 2)
               cout << "a";
            else cout << "-";
        }
        cout << endl;
    }
    return 0;
}
```

(14) What is the output of the following code? Assume that libraries and standard namespace are set up.

```
int foo(vector<string> v, char ch);

int main() {
    vector<string> v = {"abc", "", "hello", "bcc", "hi", "uc"};
    cout << foo(v, 'c') << endl;
    return 0;
}

int foo(vector<string> v, char ch) {
    int result = 0;
    for (int i = 0; i < v.size(); i++)
        if (v[i] != "" && v[i][v[i].length() - 1] == ch)
           result++;

    return result;
}
```

(15) Given arr with values 1, -2, 2, 6, 0, -1 with size 6, what will be the value of arr after calling foo on arr and size?

```
void foo(int arr[], int size) {
    int value = arr[0];
    int i = 1;
    int j = size -1;
    while (i < j) {
        while (i < j && arr[i] <= value)
            i++;

        while (j > i && arr[j] > value)
            j--;

        if (i < j)
           swap(arr[i], arr[j]);
    }
    swap(arr[0], arr[i-1]);
}
```

2 (15 points) Answer the following questions.

(1) Define a function, `rem_succ_spaces`, for a string, return a string with all spaces after the last non-space character from the original string rmoved.

For example, given a string with value `"  hello, how are you    "`,

the returned string is `"  hello, how are you"`.

Hint: you might use the following functions from cctype library.

int isspace (int c); Check if character is space or not

(2) Write a function `pointerToLastLongest` that returns a **pointer** to the **last** occurrence (if there are more than one occurrence) of the longest string in an array of string type with *size* many elements.

If size is 0, return nullptr.

For example, suppose an array has elements `"hey", "", "hi", "wow", "us"`, then the return of the function is a pointer to string "wow".

3 (10 points) Programming exercise on class

1. Define class for representing length in feet and inches. It is reasonable to define it to have two integer fields:

   `foot` for the number of feet, and

   `inch` for the number of inches. Note that a foot has 12 inches, so we need to make sure that inch is in [0, 11].

   Define non-member function `multiply`, given Length object len and integer parameter times, the function should create and return a length object that is the product of `len` and `times`. Example:

   Suppose `len` is {2, 7} and `times` is 3. Then the return of multiply function on the above parameters is {7, 9}.

   Reason: 2 feet 7 inches is 2 * 12 + 7 = 31 inches. Multiply 31 by 3 is 93 inches, which equals 7 feet and 9 inches.

4 (10 points) Write codes of vector

Define a function called `all_identical`, for a vector `v` of chars, if `v` is empty, return false, otherwise, return true if and only if all elements are identical.

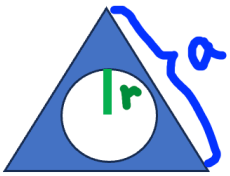
For example, given an empty vector, the return is false.

Given a vector of chars with elements `'a', 'b', 'a'`, the return is false.

Given a vector of chars with elements `'b', 'b', 'b'`, the return is true.

5 (15 points) Define class.

1. Define a CirTri as the region between a circle nested into an equilateral triangle. The shapes are concentric (share the same center). It has two parameters:



   (a) radius of the circle **r**

   (b) edge of the eqilateral triangle **a**

2. **Assume that CirTri.hpp is provided** where data members **r** and **a** are declared as double types. **Your job** is to define **CirTri.cpp** with the following requirement.

3. Define a default constructor, set data members **r** to be 1.0 and **a** to be 3.5.

4. Define a non-default constructor, which takes formal parameters r and a, both are double types.

   (a) If r is positive and a is at least $2\sqrt{3}$ times of r, set data member **r** by given parameter r and set data member **a** by given parameter a.

   (b) otherwise, set data members **r** to be 1 and **a** to be 3.5.

5. Define method **getArea**, return the value of $\frac{\sqrt{3}}{4}a^2 - \pi r^2$, where π is defined as `M_PI` in `cmath` library. Note that a and r are data members.

6. Define method **setRadius**, if given parameter r is positive and no larger than $2\sqrt{3}\mathbf{a}$, where **a** is a data member, reset data member **r** by given parameter r.

Define **CirTriTest.cpp**, do the following:

7. Create a CirTri object named **shape** from its non-default constructor with the radius of the circle as 1.6 and the edge of the triangle as 6.5.

8. Reset the radius of shape to be 1.35.

9. Find out and print the area of shape.

6 (10 points) function on vectors

Define a function called `pickEqualElms`, given two **sorted** vectors of integers `v1` and `v2`, do the following:

Pick up the elements that exists in both `v1` and `v2`, also in **sorted** order. **Warning**: cannot use sort or find method from algorithm library. For simplicity, we assume that there is no redundant elements in each vector.

For example, if v1 is {1, 2, 3} and v2 is {2, 3}, the returned vector has elements {2, 3}.

If v1 is {1, 2, 3} and v2 is {-1, 6}, the returned vector is empty.

Hint: how do we merge two sorted vectors to get a merged sorted vector?

7 (10 points) Define recursive function

Define a recursive function `isSumEven`, given an array of int with size many elements, test whether the sum of the array is even or not.

Hint: the sum of two odd integers or two even integers are even. The sum of an odd and an even integer is odd.

For example, for array with elements 1, 2, the return is false. For array with elements 1, 2, 3, the return is true.

Warning: If you do not use recursion, you will not get any point.
No repetition statement, global or static variables are allowed in this function.
Use array, not vector.