FINAL EXAM

EMPLID

CSCI 135 NAME: FIRST LAST

1 (16%) *MOCK EXAM MOCK EXAM MOCK EXAM MOCK EXAM MOCK EXAM*

(3%) **i** What is a pointer?

A variable that contains the memory address of another variable.

(2%) **ii** What does the **&** operator do?

Returns the address of its operand.

(2%) **iii** What does the ***** operator do?

Depending on the context, it indicates that the declared variable is of a pointer type, or dereferences a pointer variable returning the value, to which it points.

(3%) **iv** What does the **->** operator do?

Dereferences a pointer to an object of a class type and accesses its member.

(3%) **v** What is the public interface of a class?

The public interface of a class are its public properties -- functions and variables accessible to users of the class.

(3%) **vi** Can a function return a pointer to a ***dynamic*** array? Why?

Yes, because memory for the dynamic array is allocated on the memory heap and persists even after the function returns.

2 (11%)

(5%) **i** What is the output of the following code snippet? Show your work and put answer in the box:

```
int num = 0;
int* ptr = &num;
*ptr = 80;
num = 90;
cout << *ptr << endl;
```

num
0
80
90

Answer: 90

(6%) **ii** What is the output of the following code snippet? Show your work and put answer in the box:

```
int arr[10] = { 18, 29, 8, 4, 15, 6, 74, 28, 95, 11 };
int* ptr = arr;
ptr = ptr + 5;
cout << *ptr << endl;
```

*ptr
18
6

Answer: 6

3 (9%) Write a recursive function that determines the number of digits in a positive number `n`. Hint: If `n` is `< 10`, it has one digit; otherwise, it has one more digit than `(n/10)` has.

```
int determine_number_of_digits(int n)
{
    if (n < 10) //base case
    {
        return 1;
    }
    else //recursive case
    {
        return determine_number_of_digits(n/10) + 1;
    }
}
```

4 (18%)

(6%) **i** Write a function that replaces the value to which `p` points with `x`, if `x` is greater, and always returns the old value to which `p` was pointing.

```
double replace_if_greater(double* p, double x)
{
    double old = *p;
    if (x > old)
    {
      *p = x;
    }
    return old;
}
```

(6%) **ii** Write a function that reverses in place a non-empty `string s`.

```
void reverse_in_place(string& s)
{
    char tmp;
    for (int i = 0; i < s.length/2; i++)
    {
        tmp = s[i];
        s[i] = s[s.length() - i - 1];
        s[s.length() - i - 1] = tmp;
    }
}
```

(6%) **iii** Write a function that removes the last string from a non-empty vector of strings, adds the new string to the vector, and and returns the removed string.

```
string replace(vector<string>& my_vector, string new_string)
{
    string old = my_vector.pop_back();
    my_vector.push_back(new_string);
    return old;
}
```

5 (16%)

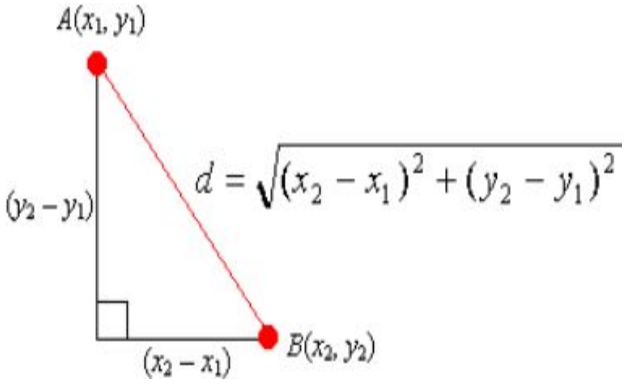
(4%) **i** Define a simple data-only **`class Point`** (with only public data members and no member functions – the book would call it a **`struct`**).

A point has a **`double x`** and a **`double y`** coordinates.

```
class Point
{
public:
    double x;
    double y;
};
```

(6%) **ii** Write a function that computes the distance from **`Point a`** to **`Point b`**.

```
#include <cmath>
double compute_distance(Point a, Point b)
{
    double dx = b.x - a.x;
    double dy = b.y - a.y;
    return sqrt(pow(dx, 2) + pow(dy, 2));
}
```



(6%) **iii** Write a **`main()`** function that reads the coordinates of the two points from the user input, calls your function, and displays the result.

```
int main()
{
    Point a;
    Point b;
    cout << "x and y of two points: ";
    cin >> a.x >> a.y >> b.x >> b.y;
    cout << compute_distance(a, b);
}
```

6 (18%)

(9%) **i** Implement a class **`Rectangle`**. Provide a constructor to construct a rectangle with a given width and length, member functions **`get_perimeter()`** and **`get_area()`** that compute the perimeter and area, and a member function void **`resize(double factor)`** that resizes the rectangle by multiplying the width and length by the given factor.

```
class Rectangle
{
public:
    Rectangle(double l, double w);
    double get_perimeter();
    double get_area();
    void resize(double factor);
private:
    double length;
    double width;
};

Rectangle::Rectangle(double l, double w);
{
    length = l;
    width = w;
}
```

```
double Rectangle::get_perimeter()
{
    return 2 * (length + width);
}

double Rectangle::get_area();
{
    return length * width;
}

void Rectangle::resize(
                    double factor);
{
    width = length * factor;
    width = length * factor;
}
```

(9%) **ii** Write individual one line commands to accomplish the following (1.5 points each):

1 Create a local rectangle object of size 2 wide by 4 long;

```
Rectangle r  = (2, 4);
```

2 Increase its size by 50%;

```
r.resize(1.5);
```

3 Print out its perimeter and its area;

```
cout << r.get_perimeter << " " << r.get_area << endl;
```

4 Create another rectangle object, but this time in the dynamic memory;

```
Rectangle * r2 = new Rectangle(2, 4);
```

5 Deallocate this object's memory;

```
delete r2;
```

6 Take care of the dangling pointer.

```
r2 = nullptr;
```

7 (12%)

In the game of Tic-Tac-Toe, at any moment each of the nine cells may be either empty or occupied by a cross or a circle. When one of the two players makes her next move, she places her sign (a cross or a circle) on the board. A player wins, when there are three of her signs on the board in a row in a straight line -- the way it is with the line of circles in the picture.

Write the function for next move, which places the player's **`Symbol s`** on the board at **`Position p`**, based on the declarations and prototype below. The function must return the outcome of the move: won, did not win, or illegal, if the cell is outside of the board or was already occupied.

```
enum Symbol { CROSS, CIRCLE, EMPTY };
enum Outcome { WON, NOT_WON, ILLEGAL };
class Position {
public:
   int row;
   int col;
};
```

```
Outcome next_move (Symbol board [3][3], Symbol s, Position p);
```

```
Outcome next_move (Symbol board[3][3],
Symbol s, Position p)
{
    if (board[row][col] != EMPTY)
    {
        return ILLEGAL;
    }

    board[row][col] = s;

    if (board[0][0] == board[0][1] &&
           board[0][1] == board[0][2])
    {
        return WON;
    }
    if (board[1][0] == board[1][1] &&
           board[1][1] == board[1][2])
    {
        return WON;
    }
    if (board[2][0] == board[2][1] &&
           board[2][1] == board[2][2])
    {
        return WON;
    }
    if (board[0][0] == board[1][0] &&
           board[1][0] == board[2][0])
    {
        return WON;
    }
    if (board[0][1] == board[1][1] &&
           board[1][1] == board[2][1])
    {
        return WON;
    }
    if (board[0][2] == board[1][2] &&
           board[1][2] == board[2][2])
    {
        return WON;
    }
    if (board[0][0] == board[1][1] &&
           board[1][1] == board[2][2])
    {
        return WON;
    }
    if (board[0][0] == board[1][1] &&
           board[1][1] == board[2][2])
    {
        return WON;
    }
    if (board[2][0] == board[1][1] &&
           board[1][1] == board[0][2])
    {
        return WON;
    }
    else
    {
        return NOT_WON;
    }
}
```

Variable and Constant Definitions

```
int cans_per_pack = 6;

const double CAN_VOLUME = 0.335;
```

Type, *Name*, *Initial value*

Mathematical Operations

```
#include <cmath>
```

`pow(x, y)`	Raising to a power x^y
`sqrt(x)`	Square root $\sqrt{x}$
`log10(x)`	Decimal log $\log_{10}(x)$
`abs(x)`	Absolute value $\lvert x \rvert$
`sin(x)`, `cos(x)`, `tan(x)`	Sine, cosine, tangent of x (x in radians)

Selected Operators and Their Precedence

(See Appendix B for the complete list.)

`[]`	Array element access
`++ -- !`	Increment, decrement, Boolean *not*
`* / %`	Multiplication, division, remainder
`+ -`	Addition, subtraction
`< <= > >=`	Comparisons
`== !=`	Equal, not equal
`&&`	Boolean *and*
`||`	Boolean *or*
`=`	Assignment

Loop Statements

Condition

```
while (balance < TARGET)
{
   year++;
   balance = balance * (1 + rate / 100);
}
```

Executed while condition is true

Initialization, *Condition*, *Update*

```
for (int i = 0; i < 10; i++)
{
   cout << i << endl;
}
```

Loop body executed at least once

```
do
{
   cout << "Enter a positive integer: ";
   cin >> input;
}
while (input <= 0);
```

Conditional Statement

Condition

```
if (floor >= 13)
{
   actual_floor = floor - 1;
}
else if (floor >= 0)
{
   actual_floor = floor;
}
else
{
   cout << "Floor negative" << endl;
}
```

Executed when condition is true

Second condition (optional)

Executed when all conditions are false (optional)

String Operations

```
#include <string>
string s = "Hello";
int n = s.length(); // 5
string t = s.substr(1, 3); // "ell"
string c = s.substr(2, 1); // "l"
char ch = s[2]; // 'l'
for (int i = 0; i < s.length(); i++)
{
   string c = s.substr(i, 1);
   or char ch = s[i];
   Process c or ch
}
```

Function Definitions

Return type, *Parameter type and name*

```
double cube_volume(double side_length)
{
   double vol = side_length * side_length * side_length;
   return vol;
}
```

Exits function and returns result.

Reference parameter

```
void deposit(double& balance, double amount)
{
   balance = balance + amount;
}
```

Modifies supplied argument

Arrays

Element type, *Length*

```
int numbers[5];
int squares[] = { 0, 1, 4, 9, 16 };
int magic_square[4][4] =
{
   { 16, 3, 2, 13 },
   { 5, 10, 11, 8 },
   { 9, 6, 7, 12 },
   { 4, 15, 14, 1 }
};

for (int i = 0; i < size; i++)
{
   Process numbers[i]
}
```

Vectors

```
#include<vector>
vector<int> values = { 0, 1, 4, 9, 16 };

vector<string> names;

names.push_back("Ann");
names.push_back("Cindy"); // names.size() is now 2

names.pop_back(); // Removes last element

names[0] = "Beth"; // Use [] for element access
```

Element type

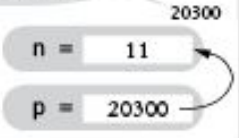
Initial values (C++ 11)

Initially empty

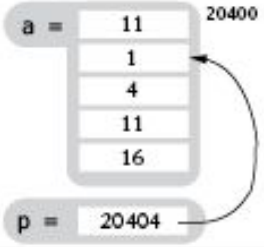
Add elements to the end

Pointers

```
int n = 10;
int* p = &n; // p set to address of n
*p = 11; // n is now 11
```




```
int a[5] = { 0, 1, 4, 9, 16 };
p = a; // p points to start of a
*p = 11; // a[0] is now 11
p++; // p points to a[1]
p[2] = 11; // a[3] is now 11
```



Input and Output

```
#include <iostream>
cin >> x; // x can be int, double, string
cout << x;
while (cin >> x) { Process x }
if (cin.fail()) // Previous input failed
#include <fstream>
string filename = ...;
ifstream in(filename);
ofstream out("output.txt");
string line; getline(in, line);
char ch; in.get(ch);
```

Static Variables

```
void increment_print() {
   static int s_value = 0; //static duration
   s_value++;
   cout << s_value << '\n';
} //s_value is not destroyed, but goes out of scope
int main() {
   increment_print(); //1
   increment_print(); //2
}
```

Static Data Members

```
class Item {
private:
   int m_id;
   static int s_id_counter;
public:
   Item() {
      m_id = s_id_counter++;
   }
   int get_id() const {
      return m_id;
   }
};
int Item::s_id_counter = 1;
int main() { //
   Item first;
   Item second;
   cout << first.get_id();  //1
   cout << second.get_id();//2
}
```

Range-based for Loop

```
for (int v : values)
{
   cout << v << endl;
}
```

An array, vector, or other container (C++ 11)

Output Manipulators

```
#include <iomanip>
```

`endl`	Output new line
`fixed`	Fixed format for floating-point
`setprecision(`*n*`)`	Number of digits after decimal point for fixed format
`setw(`*n*`)`	Field width for the next item
`left`	Left alignment (use for strings)
`right`	Right alignment (default)
`setfill(`*ch*`)`	Fill character (default: space)

Enumerations, Switch Statement

```
enum Color { RED, GREEN, BLUE };
Color my_color = RED;

switch (my_color) {
   case RED :
      cout << "red";  break;
   case GREEN:
      cout << "green"; break;
   case BLUE :
      cout << "blue"; break;
}
```

Class Definition

```
class BankAccount
{
public:
   BankAccount(double amount);
   void deposit(double amount);
   double get_balance() const;
   ...
private:
   double balance;
};

void BankAccount::deposit(double amount)
{
   balance = balance + amount;
}
```

Constructor declaration

Member function declaration

Accessor member function

Data member

Member function definition

Inheritance

```
class CheckingAccount : public BankAccount
{
public:
   void deposit(double amount);
private:
   int transactions;
};

void CheckingAccount::deposit(double amount)
{
   BankAccount::deposit(amount);
   transactions++;
}
```

Derived class

Base class

Member function overrides base class

Added data member in derived class

Calls base class member function