CSCI 2100: Data Structures, Fall 2022
Lab Practice, September 23, 2022

Name:	Email Address:	@slu.edu

1. One cheat sheet is allowed in this exam.

2. Print your full name and your email address in the boxes above.

3. Print your name at the top of every page.

4. Please write clearly and legibly. If I can't read your answer, I can't give you credit.

5. Remember, these are NOT necessarily in order of difficulty. Please read all the problems first, and don't allow yourself to get stuck on a single problem.

#	1	2	3	4	5	Total
Max	20	20	20	30	10	100
Score						

1. (a) (10 points) Fill in the diagram below to represent the underlying memory configuration that is present after the following commands are executed (Note: identifiers should be represented by $\{a, b, c, d, e\}$ not containing pointer($*$) or reference($\&$) symbols):

```
char a =   'x';
char *b =   &a;
char *c = new char('y');
char &d = *b;
char e = *c;
```

Identifiers	Value	Address
a, d	x	248
b	248	247
c	245	246
	y	245
e	y	244
		243
		242
		241

(b) (10 points) Based upon your solution to the above problem, fill in the below diagram to portray the updated configuration after the completion of the following additional commands.

```
d = 'z';
```

Identifiers	Value	Address
a, d	z	248
b	248	247
c	245	246
	y	245
e	y	244
		243
		242
		241

2. (a) (5 points) What output is generated by the following code fragment when main is executed?

```cpp
#include <iostream>
using namespace std;

class student{
public:
    int id;

    student():id(3){ cout<<"Constructor is called for ID "<<id<<endl;}
    student(int input):id(input){ cout<<"Constructor is called for ID "<<id<<endl;}
    student(student &obj){id = 2;}

    ~student(){
       cout<<"Destructor is called for "<<id<<endl;
    }
};

 void functionA(){
       student Bob;
       cout<<"Student ID is: "<<Bob.id<<endl;
 }

 int main(){
    student Eve(1);
    student Alice(Eve);

    functionA();
    cout<<"Student ID is: "<<Eve.id<<endl;
    cout<<"Student ID is: "<<Alice.id<<endl;

    return 0;
}
```

The output:

Constructor is called for ID 1
Constructor is called for ID 3
Student ID is: 3
Destructor is called for 3
Student ID is: 1
Student ID is: 2
Destructor is called for 2
Destructor is called for 1

(b) (10 points) According to **class student** in question (a), please answer the questions
below.
i) The following main function will cause memory leakage issue to your computer. Can
you explain why? How to fix this program?
Ans:
The following program will cause memory leakage because the student object is not
released. To fix this issue, just add **delete Alice;** before return 0;
ii) Write a function print(...) to print the Bob's ID.

```
int main(){
    student *Alice = new student;
    cout<<"Student ID is: "<<Alice->id<<endl;

    student Bob(2);

    print(Bob);

    return 0;
}
```

Your function:

```
void print(student);  // function declaration (before the main function)

void print(student obj){
    cout<<obj.id<<endl;
}
```

(c) (5 points) Write a print function to print the Bob's ID..

```
int main(){
    student *Alice = new student;
    cout<<"Student ID is: "<<Alice->id<<endl;

    student Bob(2);

    print(&Bob);

    return 0;
}
```

Your function:

```
void print(student*);  // function declaration (before the main function)

void print(student *obj){
    cout<<obj->id<<endl;
}
```

3. (20 points) Please answer the following questions.

   (a) (5 pt) Please use a pointer *ptr* to initialize an int array with 10 elements.

   ```
   int  *ptr = new int[10];   or  int (*ptr)[5] = new int[2][5];
   ```

   (b) (15 pt) What is the output of the following program. Assume the address of num is **10**, the address of ptr_1 is **20**, the address of ptr_2 is **30**, the address of ptr_3 is **40**

   ```cpp
    #include <iostream>
   using namespace std;

   int main(){
       int num = 1;
       int *ptr_1 = &num;
       int **ptr_2 = &ptr_1;
       int ***ptr_3 = &ptr_2;

       cout<<*ptr_1<<endl;
       cout<<ptr_1<<endl;
       cout<<&ptr_1<<endl;

       cout<<*ptr_2<<endl;
       cout<<*&ptr_2<<endl;
       cout<<**&ptr_2<<endl;

       cout<<*ptr_3<<endl;

       return 0;
   }
   ```

   Your Answer:
   1
   10
   20
   10
   20
   10
   20

4. (30 points) Some of the following programs or initializations **may** have bugs or memory leakage issue. Please fix these programs. If a program can produce the correct output, please write: **Program ended with exit code: 0**. (Hint: at least one program will produce the correct output)

   (a) (5 pt) Array initialization.

   ```
   int arr[5] = {1, 2, 3, 4, 5, 6};
   ```

   Ans:

   ```
   int arr[] = {1, 2, 3, 4, 5, 6};
   ```

   (b) (5 pt) Delete arr.

   ```
   int *arr = new int[5];
   delete arr;
   ```

   Ans:

   ```
   delete [] arr;
   ```

   (c) (5 pt) The output of the program should be: 6. (*cout* << [the last element in the array] << *endl;*)

   ```
   #include <iostream>
   using namespace std;

   int main(){
       int arr[3] = {1, 2, 3};
       int temp = 0;
       int i = 0;

       for(; i<3; i++){
           temp += arr[i];
       }
       cout<<temp<<endl;

       return 0;
   }
   ```

   Ans: Program ended with exit code: 0

(d) (5 pt) Get the id of an object.

```
#include <iostream>
using namespace std;

class student{
private:
    int id;
public:
    student(int input):id(input){}

    int GetId(student);
};

int student::GetId(student obj){
    return obj.id;
}

int main(){
    student Alice(1);
    cout<<Alice.GetId(Alice)<<endl;      /* The output should be 1. */
    return 0;
}
```

Ans:

Program ended with exit code: 0

(e) (5 pt) Get the id of an object.

```cpp
#include <iostream>
using namespace std;

class student{
private:
    int id;
public:
    student(int input):id(input+1){}

    int GetId(student);
};

int student::GetId(student obj){
    return obj.id;
}

int main(){
    student Alice(1);
    cout<<Alice.GetId(Alice)<<endl;   /* The output should be 1. */
    return 0;
}
```

Ans:

```
 student(int input):id(input+1){} =>  student(int input):id(input){}
```

(f) (5 pt) Using for loop to access an array.

```cpp
#include <iostream>
using namespace std;

int main(){
    int arr[3] = {0};

    for (int i=0; i<=3; i++) {   // print all the elements in arr[3]
        cout<<arr[i]<<endl;
    }
    return 0;
}
```

Ans:

```
 for (int i=0; i<=3; i++) =>  for (int i=0; i<3; i++)
```

5. (a) (10 points) Please write a program to ask user's favorite song.

    An example of system input and output:

    Output: What is your favorite song?

    Input: [User input] (example: Hey Jude)

    Output: I like [User input] too.

    Your program:

```cpp
#include <iostream>
#include <string>
using namespace std;

int main(){
    string name;
    cout<<"What is your favorite song?"<<endl;
    getline(cin, name);
    cout<<"I like "<<name<<" too."<<endl;

    return 0;
}
```

(scratch paper)