# EECS 168 Final Exam Review Session Solution

## True/False and Multiple Choice

1. What kind of return statement is valid for a void function?
   a. return 0;
   b. return “”;
   [✓ c. return;]
   d. No return statement is valid.

A void doesn’t *have to* have a “return” statement. But we can add one, as long as we don’t add anything between “return” and the semicolon.

2. (T/[✓ F]) All functions must have parameters.

No function is required to have parameters. Functions can have as many parameters as you want them to have (0 or more parameters). The one exception is destructors, which cannot have any parameters at all.

3. The first element of an array is at index…
   a. -1
   [✓ b. 0]
   c. 1
   d. 2

Array indexes always start at 0.

4. The last index of an array of size 5 is…
   a. 5
   b. -1
   c. 0
   [✓ d. 4]

Array indexes always end at size – 1.

5. ([✓ T]/F) Each parameter of a function requires a type.

Function parameters are regular variables. Variables in C++ require a type. When you *pass in* a variable to a function you don’t have to explicitly state the type though (because you should have declared the variable and its type earlier in code).

6. For loops are preferred when…
   [✓ a. The number of iterations is defined by a number or variable]
   b. We want the loop to continue until a specific event happens
   c. The loop should be guaranteed to run at least once
   d. Never

For loops start at a number and end at a number, so we usually use them for things like iterating through an array. Option b is related to while loops and option c is related to “do while” loops. In practice, we can almost always use loops interchangeably. This is just a “rule of thumb”, not an actual strict programming rule.

7. (T/[✓ F]) Passing an array to a function makes a copy of the entire array.

When you “pass an array” you’re actually passing a *pointer to an array*. What this does is it makes the pointer that is the parameter point to whatever the pointer that was passed in was pointing to.

8. The size of a stack-allocated array must be known at…
    a. The beginning of the program
    b. Compile time (by the time we're compiling the program)
    c. Runtime (by the time we're running the program)
    d. It doesn't matter

The size of a stack-allocated must be known at compile time (for example, int arr[4] or int arr[size] where "size" has value 5 at compile time). However, for a heap-allocated array we can do something like int* arr = new int[size], where size is not known until runtime (because the user inputs the size). The size of a heap-allocated array can also be set at compile time, but it is not necessary. For stack-allocated arrays, it is required.

9. What is the correct syntax for creating a heap-allocated array of size "size"?
    a. int[] arr = new int* [size]
    b. int[] * arr = new int [size]
    c. int * arr = int [size]
    d. int * arr = new int [size]

Option d creates a heap-allocated array of integers. A, b, and c are not valid syntax.

10. (T/F) Passing a double (by value) to a function makes a copy of that double.

Passing any type of variable value makes a copy. If you pass it by reference, you make the variable that is a parameter *reference* the variable that was passed in. So any changes to the function's parameter variable also changes the variable that was passed in.

11. What is the correct syntax for creating a heap-allocated array (of size "size") of pointers to "Triangle" objects?
    a. Triangle* arr = new Triangle*[size];
    b. Triangle* arr = new Triangle[size];
    c. Triangle** arr = new Triangle*[size];
    d. Triangle* arr = new Triangle();

Option a is not valid syntax, 'b' is a heap-allocated array of Triangle objects, 'c' is a heap-allocated array of pointers, and 'd' is not an array but a heap-allocated object. C is the only good option. However, the array of pointers could have each pointer point to an array of Triangle objects rather than pointing to Triangle objects directly. Judging from this single line of code we can't know. There is an example of the distinction between these two in the Memory Allocation section.

12. When would you want to create a heap-allocated array of pointers to objects?
    a. Never.
    b. When your class doesn't have a constructor with 0 parameters.
    c. When your class has a constructor with at least one parameter.
    d. When your class doesn't have a destructor.

Some people were asking why would we ever want to use an array of pointers to objects (such as option c in question 11) vs just an array of objects (option b in question 11). When you don't have a default (parameterless) constructor and you want to create an array, you have to use an array of pointers to objects rather than an array of objects.

13. Which of the following tells us we're allocating something in the heap rather than the stack?
    a. We are using pointers
    b. We are creating an array
    c. We are using the word "new"
    d. We are creating a 2D array

Using "new" is a the only good way to know when we're allocating something in the heap rather than the stack.

14. How do we get rid of stack-allocated arrays?
    a. We don't have to, the computer does it by itself
    b. Use the keyword delete[]
    c. Empty the array
    d. Set it to nullptr

Any variable that is stack-allocated gets "deleted" by the computer once we are done with the function that holds that variable. We don't need to manually "delete" anything that is stack-allocated.

15. What is the best way to avoid memory leaks?
    a. Not using pointers at all
    b. Using "delete" on everything created using "new"
    c. Setting our array pointer(s) to nullptr
    d. Using valgrind

The best way is to use "delete" for every "new". Using valgrind is good for determining whether we have leaks or not but it is best to avoid leaks entirely by deleting everything created using "new".

## Memory Management

Finish the definition for the main function such that there are no memory leaks. Assume Car is class with a single, default constructor (no parameters) and getters and setters for “year” and “make”. The Car class is defined in problem 4 of Code Writing. **Suggestion: Do Memory Allocation first (next page).**

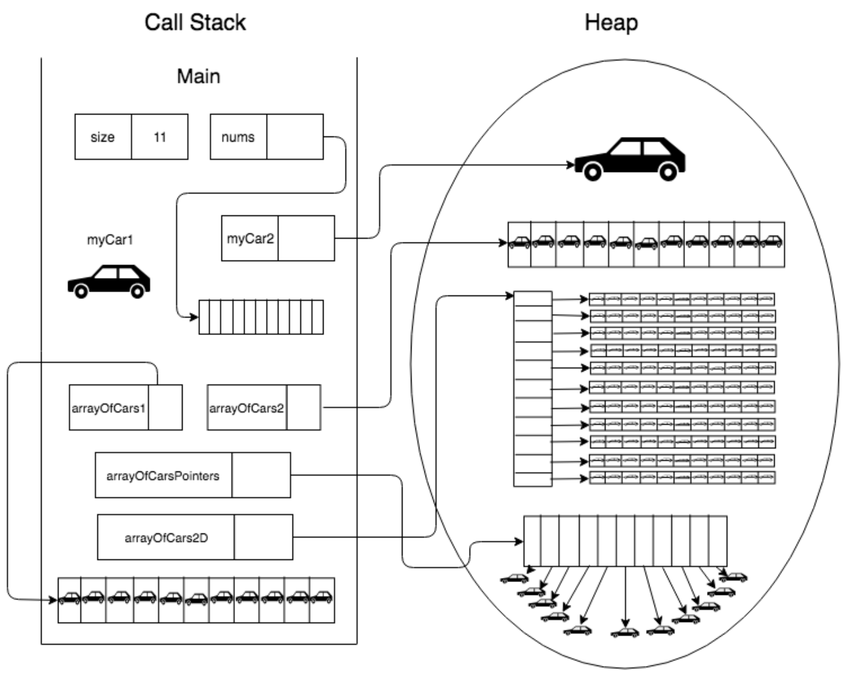
```
int main()
{
         int size = 11;
         int nums[4];
         Car myCar; //Stack-allocated car object
        Car * myCar2 = new Car(); //Heap-allocated Car object

        Car arrayOfCars1[size]; //Stack-allocated array of Car objects
         Car * arrayOfCars2 = new Car[size]; //Heap-allocated array of Car objects

         Car ** arrayOfCarPointers = new Car*[size]; //Array of pointers
        for (int i = 0; i < size; i++)
         {
                  arrayOfCarPointers[i] = new Car(); //Each pointer points to a Car (so now
arrayOfCarPointers is an array of pointers to objects)
         }

        Car ** arrayOfCars2D = new Car*[size]; //Array of pointers
        for (int i = 0; i < size; i++) {
                 arrayOfCars2D[i] = new Car[size]; //Each pointer points to an array of Cars (since
each pointer points to an array, arrayOfCars2D is considered a 2D array)
        }

         bool temp = false;
         double myHeapAllocatedvariable = 1.5;

         //Your code here

         delete myCar2;
         delete[] arrayOfCars2;

         for (int i = 0; i < size; i++)
        {
                  delete arrayOfCarPointers[i]; //Here we’re deleting objects, so we don’t need the
[] after delete
         }
         delete[] arrayOfCarPointers; //Deleting an array of pointers to car objects

         for (int i = 0; i < size; i++)
        {
                  delete[] arrayOfCars2D[i]; //Here we’re deleting arrays, so we Do need the []
after delete
         }
         delete[] arrayOfCars2D; //Deleting an array of pointers to arrays of car objects

         return 0;
}
```

## Memory Allocation

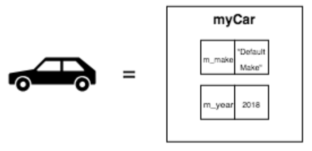
Fill in the table regarding the variables in the Memory Management question (previous page).

| Variable | Type | Stack or Heap? |
|---|---|---|
| size | integer | stack |
| nums | array of integers | stack |
| nums[1] | integer | stack |
| myCar | Car object | stack |
| arrayOfCars1 | array of Cars | stack |
| arrayOfCars1[0] | Car object | stack |
| myCar2 | Car object | heap |
| arrayOfCars2 | array of Cars | heap |
| arrayOfCars2[1] | Car object | heap |
| arrayOfCarPointers | array of pointers | heap |
| arrayOfCarPointers[3] | pointer to a Car object | heap |
| arrayOfCars2D | array of pointers | heap |
| arrayOfCars2D[2] | pointer to an array of Cars | heap |
| temp | boolean | stack |
| myHeapAllocatedVariable | double | stack |

***Note**: All the variables declared with a "*" are *actually* stack-allocated pointers that point to something in the stack or heap. However, for "type" I'm filling in what they're pointing to and for "stack/heap" I'm deciding whether ***what they point to*** is in the stack or the heap. This is most likely what you would want to answer in the exam if a question like this comes up.



Notes:



If you have to draw an object on the test don't draw the actual thing it's representing, draw a box with its member variables inside. I just did it here because I had a ton of Car objects.

## Code Tracing

Code that runs

```
//Circle.h
class Circle {
        public:
                Circle(double radius) { //Constructor takes in a radius and sets the member variable
"m_radius" to the value of "radius"
                        m_radius = radius;
                }
                double calculateArea() { //Returns the area
                        return 3.1416 * m_radius * m_radius;
                }
                void setRadius(double radius) { //Takes in a radius and sets "m_radius" to the value
of "radius" if that value is >= 0; otherwise it does nothing
                        if (radius >= 0) {
                                m_radius = radius;
                        }
                }
                double getRadius() {
                        return m_radius; //Returns the radius
                }
        private:
                double m_radius; //Private variable called m_radius
};

//main.cpp
Circle* func2(int r) { //Creates a circle and returns a pointer it
        Circle* circleObject = new Circle(r); //Creates a heap-allocated Circle object of radius "r"; the
constructor sets "m_radius" to 1
        return circleObject;
}

void func(char x, double& y, double& z, Circle* circlePtr) { //y and z are passed by reference, x is passed
by value, and circlePtr just points to whatever the passed in pointer pointed to (in this case, nullptr)
        x = 'n'; //"x" from main is passed in by value, so whatever
        circlePtr = func2(1); //circlePtr points to the heap-allocated Circle created by func2; we're
passing in 1 as the radius. Since we have no access to this Circle other than circlePtr, which gets removed
from the stack once func stops running, we create a memory leak.
        y = circlePtr->calculateArea(); //Calling a function to get the area of the circle created; also note
"y" is passed in by value so any change to "y" in this function affects "a" in main.
        z = -2; //This change to this "z" affects the "z" in main since "z" is passed by reference
}

int main() {
        char x = 'm';
        double a = 4;
        double z = 3;
        Circle* ptr = nullptr;
        func(x, a, z, ptr); //This call affects a and z only because they are passed in by reference. Ptr is
unaffected because the function func() just changes what circlePtr points to.
        Circle* ptr2 = func2(4); //Makes ptr2 point to a heap-allocated Circle object of radius 4 (see
definition of the func2() function)
        cout << x << ", " << a << endl;

        if (ptr != nullptr) { //func() changed what circlePtr pointed to from nullptr to a heap-allocated
Circle. However "ptr" remained unchanged, so it still points to nullptr. So the condition for this if
statement is false.
                    ptr->setRadius(z);
                cout << ptr->getRadius() << endl;
        }
        if (ptr2 != nullptr) { //This is true because we made ptr2 point to a Circle.
```

Output to terminal

```
m, 3.1416
4
```

```
                        ptr2->setRadius(z); //Attempts to set the radius to -2. However, if you see the
definition of setRadius you'll notice this is not allowed, so this line does nothing.
                        cout << ptr2->getRadius() << endl; //The radius here is the original radius of the Circle
ptr2 points to (4).
            }

            delete ptr;
            delete ptr2;
            return 0;
}
```

Code that runs | Output to terminal

```
char* reverse(char* arr, int& size) {
        size = 7; //Since size is passed by reference, the "size" in main is affected by anything we do with the
"size" in this reverse function. However, as I mention below, size should have been initialized to 7. So this line
does not change anything
        char* newArr = new char[size]; //Creates an array of chars
        for (int i = 0; i < size; i++) {
                newArr[i] = arr[size - 1 - i]; //Copies the characters from the original array into newArr in
reverse order
        }
        return newArr;
}

int main() {
        int size = 7; //This was an error in the original question, it should have been 7 not 0.
        string myStr = "kwahyaj";
        char* myArr = new char[size]; //Creating an array of characters
        char* myOtherArr = nullptr;

        for (int i = 0; i < myStr.length(); i++)
        {
          myArr[i] = myStr.at(myStr.length() - i - 1); //myStr.length() returns the length of the string which is 7).
The myStr.at() function returns a character from the string at the position indicated. The positions go from 0 to
length – 1 (7 – 1).This loop goes from 7 – 0 – 1 = 6 to 7 – (7 – 1) – 1 = 0, so what we're doing is copying each
character of the string into the array (in reverse order). [j, a, y, h, a, w, k]
        }

        myOtherArr = reverse(myArr, size); //myOtherArr is the reverse of myArr. [k, w, a, h, a, y, a, j]

        for (int i = 0; i < size; i++)
        {
          cout << myArr[i]; //Prints every character in myArr[i], so prints "jayhawk"
        }
        cout << '\n';
        cout << myStr << endl; //Prints the original string, so prints "kwahyaj"

        char** my2DArr = new char*[size]; //Creating an array of pointers
        for (int i = 0; i < size; i++)
        {
                my2DArr[i] = reverse(myOtherArr, size); //Each pointer points to an array of chars which is
the reverse of myOtherArr. So each row in this 2D array cointans [j, a, y, h, a, w, k].
        }

        for (int i = 0; i < size; i++)
        {
                for (int j = 0; j < size; j++)
                {
                        if (i >= j) { //Drawing and visualizing the 2D array helps
                                cout << my2DArr[i][j];
                        }

                }
                cout << endl; //Endl at the end of each row
        }

        delete[] myArr; //Deletes the first array of characters
        delete[] myOtherArr; //Deletes the second array of characters
        for (int i = 0; i < size; i++)
        {
                delete[] my2DArr[i]; //To delete a 2D array, we first have to delete each row
        }
        delete[] my2DArr; //Deletes the array of pointers itself
        return 0;
}
```

```
  0 1 2 3 4 5 6
0 j
1 j a
2 j a y
3 j a y h
4 j a y h a
5 j a y h a w
6 j a y h a w k
```

Output to terminal:

```
jayhawk
kwahyaj
j
ja
jay
jayh
jayha
jayhaw
jayhawk
```

## Code Writing

**Note: I added significantly more details to these questions since the original ones where a little vague.**

1. Write a function that takes in a 2D array of integers and returns an array of the even integers in the 2D array. The function should take in the 2D array, the number of rows, the number of columns, and a variable for the size of the 1D array. The size of the 1D array can be initialized to 0 in main, but the function should modify the "size" variable in main to be equal to the amount of even integers.

2. Write a class StringClass that holds a heap-allocated array of characters.
   a. The function must have the following methods:
      - **StringClass(int length);** //Constructor that initializes the size and initializes the array
      - **~StringClass();**
      - **char getCharacter(int index) const;**
      - **void setCharacter(int index, char c);**
      - **int getLength() const;**

   b. Overload the assignment operator (write a function to use the assignment operator (the "=" operator) with StringClass objects and strings).

      **bool operator==(std::string rhs) const;**

      Example:
      StringClass myStrObject(8); //Pass in the size of the string
      myStrObject = "a string"; //In your function you can assume you'll get a string of the right size (in this case a string of length 8).

      Also, overload the comparison operator for equality (the "==" operator) so that we can verify whether two strings a StringClass and a string are equal.

      **bool operator=(std::string rhs) const;**

      Example:
      ```
      StringClass myStrObject(5);
      If (myStrObject == "Hello")
      {
              cout << "Equal!\n";
      }
      ```

   c. Write a copy constructor for a StringClass object. The copy constructor should copy the length, create a new array, and copy character by character.

      **StringClass(const StringClass& strClassObject);**

3. Write a class SocialMedia that holds an array of Users (User is a class). Obtain the number of users and each user's email, password, name, and age from a file called "data.txt".

Data.txt:
```
5
myEmail@socialmedia.com password Spongebob 20
emailAddresss@socialmedia.com 12345 Patrick 15
badEmail@socialmedia.com insecurePassword Squidward 40
UserEmail@socialmedia.com 54321 Gary 23
runningOutOfEmailNames@socialmedia.com abcde Plankton 32
```

The User class must contain a constructor with parameters for email, password, name, and age as well as getters and setters.

In the SocialMedia class make a "login" function that takes in an email and a password. The function should first verify if a user with that email exists. If such a user exists, the function should verify if that user's password matches the password passed in to the login function. Print a message telling the user whether the login was successful or not.

In the SocialMedia class also make a "search" function that takes in a char and prints all the Users whose name starts with that character and prints their name, age, and email address.

In main.cpp create a SocialMedia object and give the user options (login, search, or quit) until the user decides to quit.

4. Write code to print every Car object created in the program in the "Memory Allocation" question (including the Car objects that are inside arrays). Below are the Car.h and Car.cpp files.

```
//Car.h
#ifndef CAR_H
#define CAR_H

#include <string>

Class Car {
        private:
                string m_make;
                string m_model;
                int year;
        public:
                Car();
                void setMake(string make);
                string getMake() const;
                void setYear(int year);
                int getYear() const;
};

#endif
```

As stated in the "Memory Allocation" question, the Car constructor initializes make and year to "default" values. You won't necessarily use all the functions defined in this class. The goal of this problem is to use whatever functions you need to use to do all the printing.

```
//Car.cpp
#include “Car.h”
Car::Car()
{
            m_make = “Default Make”;
            m_year = 2018;
}
void Car::setMake(string make)
{
            m_make = make;
}
string Car::getMake() const
{
            return m_make;
}
void Car::setYear(int year)
{
            m_year = year;
}
Int Car::getYear() const
{
            return m_year;
}
```

## Code Writing Solutions

The solutions are posted in the following link:
https://github.com/brianquiroz216/EECS-168-SI-Final-Review-Session-Solution

For some questions that didn’t require a main.cpp I created one just so the program had some context in which it could be ran and tested. In the actual exam don’t do anything extra unless they ask you to because you’ll run out of time if you try to write more code than you have to.