

ACSE-5

Final Individual Coursework

**Answer 4 out of the 6 questions in Part A and
2 out of the 5 questions in part B and
1 out of the 2 questions in part C**

Total Marks: 100

Total time for activity: 3hrs

Section A: (Answer all 4 out of 6 questions)**(10 marks each)****Question A.1**

Write declarations for the following: a pointer to a character, an array of 10 integers, a reference to an array of 10 integers, a pointer to an array of character strings, a pointer to a pointer to a character, a constant integer, a pointer to a constant integer, and a constant pointer to an integer. Initialize each one.

Question A.2

You are a child minder and the children you are looking after would like to watch a movie. However, parents have instructed that the children should watch a movie that contains the word “happy” in the title and lasts less than 70 minutes. Write a programme that asks the user to enter a movie title and movie duration. The program should continue asking for a new movie title until you find one that meets the parent’s specification (i.e., contains “happy” and is <70 minutes long). Once you have found the appropriate movie, print an “accepted” and “rejected” list, which shows all of the previously entered movie titles.

Question A.3

Write a **function** that takes in a string and then reverses the order of the characters in the string. For instance, changes “diagonal” to “lanogaid”. The main section of the program should allow the user to enter a string, it should then call the function to reverse the string’s order and display the resultant string.

Question A.4

Write a function that swaps (exchanges the values of) two integers. Use **int*** as the argument type. Write another swap function using **int&** as the argument type.

Question A.5

Read (from a file or from the screen) a sequence of possibly whitespace-separated (name,value) pairs, for example:

John 20
Jane 21
Pippa 58
John 50
Pippa 10

where the name is a single whitespace-separated word (John) and the value is an integer or a floating-point value (20). Compute and print the sum and mean for each name (for Pippa = $58 + 10/2$) and the sum and mean for all names $((20 + 21 + 58 + 50 + 10)/5)$.

Question A.6

Write a **function** that takes in a string and changes that string to Title Case. Title Case means that each letter should be lower case unless it is either the first letter in the string or if the preceding

letter is a space, in which case the letter should be a capital. Allow the user to enter a string, use the function to convert the string to Title Case and then display the result. For example (where bold is user input):

Enter a sting to convert: **mAke This tITle cAse**

Output: Make This Title Case

Section B: (Answer 2 out of 5 questions only)

(20 marks each)

Question B.1

Generate 10,000 uniformly distributed random integers in the range 0 to 1,023 and store them in

1. a standard library `vector<int>`
2. a standard library `list<int>`
3. a standard library `set<int>`

Notice: At the end of the insertion each container should have the same 10,000 elements.

In each case, calculate the arithmetic mean of the elements of the vector (as if you didn't know it already). Time the resulting loops. Measure and report onto the screen the memory consumption for the three containers.

Question B.2

Fibonacci numbers F_n , form a sequence, called the Fibonacci sequence, such that each number is the sum of the two preceding ones, starting from 0 and 1. That is,

$$F_0 = 0$$

$$F_1 = 1$$

and for $n > 1$:

$$F_n = F_{n-1} + F_{n-2}$$

Use standard library containers and functions to compute a sequence of the first 100 Fibonacci numbers. Do not use recursion (a recursive function is a function that calls itself). Instead, store Fibonacci numbers in a `std::map` as you compute them and reuse information in this map to compute future numbers. Print the 100 Fibonacci sequence to a text file.

Question B.3

A shop owner has found that her staff are not very good at working out the best way to give out change. Write a program that allows the staff to enter the amount an item cost, as well as the amount of money tendered. The program should then calculate the change to be given (number of £20, £10, £5 notes and £1, 50p, 20p, 10p, 5p, 2p and 1p coins).

The amounts should be entered as floating point pounds.pence amounts (e.g. 32.65 pounds). The computer should then convert these amounts into an integer number of pence (remember type casting).

Once the change in pence has been calculated, the program should work out the type of change to be given by giving as many of the larger notes or coins as possible. For example, 664p change should be 1×£5, 1×£1, 1×50p, 0×20p, 1×10p, 0×5p, 2×2p and 0×1p. (A clue: Make use of integer maths)

Question B.4

Write a function that, given an `istream` and a `vector<string>`, produces a `map<string,int>` holding each string and the number of times that the string appears.

Create a text file “ComputerProgramming.txt” with the following text:

Computer programming is the process of designing and building an executable computer program for accomplishing a specific computing task. Programming involves tasks such as analysis, generating algorithms, profiling algorithms' accuracy and resource consumption, and the implementation of algorithms in a chosen programming language commonly referred to as coding. The source code of a program is written in one or more programming languages. The purpose of programming is to find a sequence of instructions that will automate the performance of a task for solving a given problem. The process of programming thus often requires expertise in several different subjects, including knowledge of the application domain, specialized algorithms, and formal logic. Related programming tasks include testing, debugging, maintaining a program's source code, implementation of build systems, and management of derived artefacts such as machine code of computer programs. These might be considered part of the programming process, but often the term software development is used for this larger process with the term programming, implementation, or coding reserved for the actual writing of source code. Software engineering combines engineering techniques with software development practices.

Run the program on this text file and print out how many times each word appears in descending order.

Question B.5

Write a class that can store a 3x3 matrix of floating point numbers. Write **member functions** that can (1) fill the array using user input, (2) display the matrix and (3) return the *trace* of the matrix (the trace of a square matrix is the sum of the elements in its diagonal).

The program should then randomly generate 100 different matrices and display the average of the traces of these matrices. Use dynamically allocated objects to store the matrices. Remember to free the memory when you are finished with it.

You may download the code on the ACSE-5 github labelled “assessment_matrix.zip”. This is a modified version of our Matrix and CSRMatrix classes from previous lectures. You may use this code in this question if you wish.

Section C: (Answer 1 out of 2 questions only)

(20 marks each)

Question C.1

Download the code on the ACSE-5 github labelled “assessment_matrix.zip”. This is a modified version of our Matrix and CSRMatrix classes from previous lectures. You are to implement a copy constructor in the CSRMatrix class. This method takes in a dense Matrix<T> as its only input and then initialises a sparse copy of the input matrix.

Please submit only your CSRMatrix.cpp file and a cpp file containing a main method that populates a dense matrix that has some zero entries, then calls the copy constructor to build a new CSRMatrix and prints the resulting sparse matrix. When calculating the sparsity of the dense matrix, just ignore any entries with magnitude that are below 1×10^{-13} .

Question C.2

Write your own version of the `std::shared_ptr<T>` templated smart pointer, called *myShrdPtr* (note you cannot use the `std::shared_ptr<T>` in your implementation). This should be a templated class, where you are required to implement a constructor that takes a raw pointer as input and takes ownership of that memory.

You should also implement a copy constructor that takes an existing *myShrdPtr* and copies it. The *myShrdPtr* should keep track of how many other *myShrdPtr*'s point at the same object they own. You must include a destructor that deletes the memory owned by the *myShrdPtr* when there are no other *myShrdPtr* pointing at the same object. You must also overload the dereferencing operator, `*`, which returns the object *myShrdPtr* is pointing at by reference.

How would you change the implementation of *myShrdPtr* if this class were trying to implement `std::weak_ptr`? Write a few sentences describing your proposed changes (note you don't have to make any changes or write extra code; please be specific about your proposed changes, for example, would your dereferencing operator change?) in a document and upload the source files of *myShrdPtr*. You should also upload a cpp file containing a main method that builds a new instance of *myShrdPtr*.