

*Answer THREE questions, including question 1 or question 2 (or both).*

1. Design a C++ function called `remove_duplicates`. The function should take a string and return nothing. However it should remove duplicated consecutive words in the string. For example, if the string `a_string` contains,

```
"Hello I am am a little little string"
```

then the result of performing,

```
remove_duplicates(a_string)
```

should be that `a_string` is modified to contain,

```
"Hello I am a little string"
```

You may assume that there is only a single space between each word, and that there are no spaces at the beginning or end of the string. You may make use of the usual function `strlen`, but you may not make use of any other functions written for you. Your answer should include a full design, and properly commented C++.

[Total 33 marks]

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2. A bank requires a class that will allow them to represent certain “transfer” transactions. A “transfer” transaction consists of a name and account number for the account to be debited, a name and account number for the account to be credited, and the amount of money to be moved. There should be no limit on the length of the names, account numbers should have at most seven figures, and the amount to be moved should always be positive. Design a C++ class called `Transfer` which meets this need. The class should have a constructor and destructor, an overload of `operator<<`, and copy semantics. The constructor should make sure that “transfer” transactions always have the format described, such that it is not possible, for example, to have a transaction with an eight figure account number. You may make use of the usual functions `strlen` and `strcpy` but you may not make use of any other functions written for you.

[Total 33 marks]

3. a. Explain what it means for a function to be “recursive”. Design a recursive function called `negatives` which takes an array of `ints` along with the size of the array, and returns the number of negative numbers in the array.

[5 marks]

- b. Explain, giving as much detail as you can and including pseudo-code descriptions, how sorting can be accomplished using a binary search tree. Illustrate your answer using the specific example of sorting the numbers 5, 2, 20, 21, 14, 0, 5 into ascending order.

[20 marks]

- c. Explain, illustrating your answer with suitable examples, the circumstances in which the advantages to be gained by using a basic binary search tree can be lost. How can this be avoided?

[8 marks]

[Total 33 marks]

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4. Write an essay on the subject of classes in C++. Your answer should include illustrative examples written in C++.

[Total 33 marks]

5. a. Briefly describe each of the following features of C++ and explain how they are used, including examples of C++ code where necessary: pointers, passing by reference, constructors, protected members, template functions and template classes.

[25 marks]

- b. Explain in detail, illustrating your answer with examples of C++, the ways in which `const` can be used in C++ programming.

[8 marks]

[Total 33 marks]

END OF PAPER