Answer ALL of Part I and TWO questions from Part II

You are advised to spend not more than 1 hour on Part I.

Part I

1. a) Consider the design of an integer set class in C++. The class should be named IntSet and support the following access operations:

```
void IntSet::add(int) ;        // Add an integer to the set if not already present
void IntSet::remove(int) ;  // Remove an integer from the set if present
int IntSet::isMember(int) ; // Return true if an integer is in the set, else false
```

Write down the class definition, including all the member function declarations needed for creating, deleting, copying and assigning instances of the class, and any member variables required for data structures.

[10 marks]

b) Write the member function definitions needed to implement the class. Make sure that instances of the class will behave correctly when copied and assigned, and that the code is properly commented.

[25 marks]

c) How could the IntSet class be modified to provide sets of any type (for example, set of char, set of String, etc.)? Outline the changes that need be made to the class and member function definitions.

What properties must a type possess to allow it to be used with the modified set class?

[10 marks]

d) How efficient is your set class with respect to speed of access and the amount of storage used?

[5 marks]

[Total 50 marks]

Part II

(Answer two of the following questions.)

2. a) Explain the following concepts with respect to C++:

   Abstraction
   Encapsulation
   Declaration
   Scope
   Lifetime
   Friend

   [3 marks each]

   b) Outline how inheritance is supported by C++. What are the different kinds of inheritance?

   [7 marks]
   [Total 25 marks]

3. a) What does the following function do? Describe how it works.

```
float* f(float* x, int n)
    {
        float* a = &x[0] ;
        float* b = &x[n-1] ;
        while (a < b)
            {
                float c = *a ;
                *a++ = *b ;
                *b-- = c ;
            }
        return x ;
    }
```

   [5 marks]

   b) Explain the relationship between pointers and arrays. How is array indexing done using pointers?

   [8 marks]

   c) What are dynamic variables? Explain how they are created and destroyed.
   Illustrate your answer by describing how an array of pointers to character arrays can be implemented using dynamic variables.

   [12 marks]
   [Total 25 marks]

4. a) Write a function to remove the tab characters from a text file and replace them with sufficient spaces to maintain the same text layout.

The declaration of the required function is:

void removetabs(ifstream& infile, ofstream& outfile, int tabs[], int linelength) ;

where

infile is the input file stream containing text with tabs in.

outfile is the output file stream that the text without tabs is written to.

tabs is an array of size *linelength* with elements containing one at the positions corresponding to tab stops and zero otherwise.

linelength is the maximum number of characters in a line of text.

[15 marks]

b) How can the function be tested? Outline the testing process and provide a test plan.

[10 marks]

[Total 25 marks]

END OF PAPER