FACULTY OF SCIENCE

ACADEMY OF COMPUTER SCIENCE AND SOFTWARE ENGINEERING

MODULE CSC01B1
Introduction to data structures (C++)
CAMPUS **APK**

NOVEMBER EXAMINATION
2019

DATE: 2019-11-19 **SESSION: 08:30 – 12:00**

ASSESSOR(S) **PROF DA COULTER**

INTERNAL MODERATOR **PROF DT VAN DER HAAR**

DURATION 2 HOURS **MARKS 100**

SURNAME, INITIALS (or ID NUMBER):_____

STUDENT NUMBER: _____

CONTACT NR: _____

NUMBER OF PAGES: 5 PAGES

REQUIREMENTS: NON-PROGRAMMABLE CALCULATORS ARE PERMITTED

Q1	
Q2	
Q3	
Q4	
Total	

QUESTION 1

Draw the following in your answer book						
1.1	Use UML to model the following scenario: Short Learning Programmes, Certificates, and Degrees are all kinds of Qualification. All qualifications have a unique alphanumeric code, a set of entrance requirements defined as a string in the XML format. Each qualification is capable of checking those requirements but does so in its own way. The entrance requirements can be queried and set when the qualification is created but cannot be changed after that. An academic department has a set of qualifications and the ability to add and remove them. These qualifications can continue to exist independently of the department.					(5)
Write the **most** correct option in your answer books						
1.2	Altering the behaviour of an existing base class' non-virtual member function in a derived class is called…					
	A redefining	B overriding	C inheriting	D composing	E abstracting	
1.3	A class which contains a pure virtual function automatically becomes an … class					
	A interface	B abstract base	C exception	D embedded	E auto	
1.4	Safely implementing two-dimensional indexing via the function invocation operator "()" is simpler than double indexing "[][]"					
	True		False		無[1]	
1.5	Which keyword is preferred when introducing a type parameter during generic programming?					
	A **`class`**	B **`template`**	C **`typename`**	D **`struct`**	E **`enum`**	
1.6	Which of the following operators can be implemented in order to support operator chaining?					
	A `operator>>`	B `operator<<`	C `operator==`	D `operator=`	E `A to D`	
Write your answers to the following in your answer books						
1.7	Is the concept of a Stack an abstract data type? Make use of the definition of an abstract data type to justify your answer.					(3)
1.8	Differentiate between the concepts of overloading and overriding a function					(2)
1.9	Assume you had an unknown data structure which supported insertion and removal. The following values are inserted and then removed: A B C. What order would the returned values be in if the following data structure were used. a) Stack b) Queue					(2)
1.10	Which object orientated concept is being described: i. A smartphone has a search engine app ii. A smartphone uses its apps to answer queries for its user iii. A search engine app is a kind of app					(3)

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[20]

[1] The Sino-Japanese ideogram Wu/Mu in this case represents a question which is flawed.

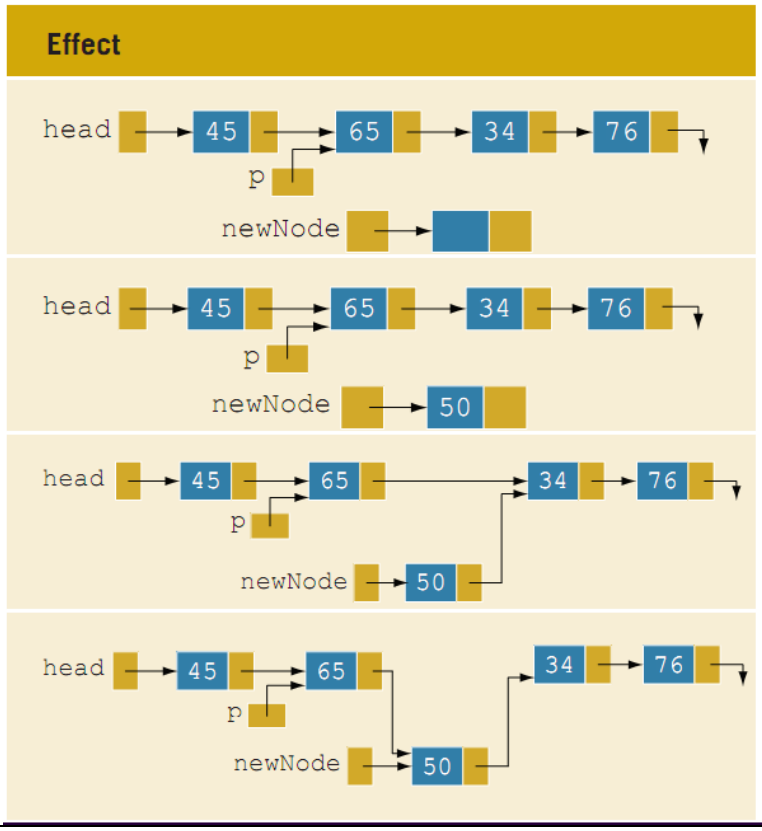
QUESTION 2

Write your answers to the following in your answer books

2.1

```
#ifndef DATASET_H
#define DATASET_H

#include <iostream>

using namespace std;

 (a)  StatusCode
{
    SUCCESS,
    ERROR_RANGE
};

(b)       < (c)      T>
class DataSet
{
(d)    :
    DataSet();
    DataSet(int intLength);
    DataSet(         (e)         objOriginal);
    ///o1 = o2 = o3
    DataSet<T>& operator=(const DataSet<T>& objRHS);

    ///cout << o1 << endl << o2 << endl
    [redacted]
    (f)      ostream& operator<<(ostream& sLHS, const DataSet<T1>& objRHS);
    ///T value = o[i] or o[i] = value
    (g) operator[](int intIndex);

    int getLength() const;

    static const int MAX_LENGTH = 100000000;
    static const int MIN_LENGTH = 1;
    static const int DEFAULT_LENGTH = 10;

   (h)DataSet();
private:
    void enforceRange(int intValue, int intMin, int intMax) const;
    void setup(int intLength);
    void freeState();
    void copyState(const DataSet<T>& objOriginal);

    (i) _data;
    int _length;
};

   (j)      "DataSet.imp"

#endif // DATASET_H
```

(10)

2.2	Assume that the class in question 2.1 was expanded to contain two-dimensional data. Provide the prototype for a single overloaded operator which would easily allow for the reading and modification of such data.	(2)
2.3	If a class has dynamically allocated resources (such as a dynamic array) as part of its state. What three operations will the class need to support?	(3)
2.4	Provide code for a node in a generic singly-linked list.	(5)
2.5	Assume that your generic code list was instantiated to contain integers. Provide code for the following insertion operation depicted in the following diagram. 	(5)
2.6	Assume that the list data type provides the following operations. Insert, Remove, and Access. Provide code for a very simple exception hierarchy which covers those cases as well has how those exceptions could be detected in your main function.	(5)

[30]

QUESTION 3

In your answer books please write the necessary C++ code for the following statements, and answer the remaining questions. Unless otherwise indicated you may assume that the necessary header files are included**. Most of the marks in this section are awarded for the file handling operations.**

3.1	The text file `fleet-telemetry.txt` is made up of lines in the following format: `EPOCHTIME LICENSE LAT LONG ODO SPEED FUEL EOL` Where `EPOCHTIME` is an integer depicting the number of seconds since 1 January 1970. `LAT` and `LONG` are real numbers indicating the location of a vehicle in the fleet. `LICENCE` is the registration number of the vehicle as a whitespace-free string. `ODO` and `FUEL` are integers depicting the distance travelled and fuel reserve percentage of the vehicle respectively. `EOL` is the system's representation of the end of the line. Write code for a function which finds and prints the licence numbers of all vehicles with fuel levels below 25% after a given epoch time. Please show code for the opening / closing of the file.	(5)

3.2	Define a structure with alignment packing/padding disabled to represent the data for one Vehicle. You may assume that licence numbers are exactly 8 characters long and contain no spaces, and that you need as much precision as possible to store real numbers.	(5)
3.3	Assume that the file `fleet-telemetry.dat` is a pre-existing binary file of homogenous records of the type defined in question 3.2. Write code for a function which accesses a particular record by its index. Please show code for the opening / closing of the file.	(5)
3.4	Assume that the file `fleet-telemetry.dat` is a pre-existing binary file of homogenous records of the type defined in question 3.2. Write code for a function which searches for a vehicle by its licence registration number and returns that record. You may reuse your function from question 3.3.	(5)

3.5	Consider the following code which duplicates the state of objects of the class given in from question 2.1. Analyse the above code asymptotically using Big-O notation. State any assumptions made.
	
	`template <typename T>`
	`void DataSet<T>::copyState(const DataSet<T>& objOriginal)`
	`{`
	`  setup(objOriginal._length);`
	`  for(int i = 0; i < _length; i++)`
	`  {`
	`  _data[i] = objOriginal._data[i];`
	`  }`
	`}`
		(10)

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QUESTION 4

In order to manage the fleet from question 3 you have to create a Dynamic Link Library to help calculate the Euclidean distance between two vehicles. For your convenience the latitude and longitude are already converted into x and y grid coordinates:

```
double distance(double x1, double y1, double x2, double y2);
```

4.1	Provide code for implementing this library (both the header and cpp file)	(10)
4.2	Provide the contents of a comprehensive batch file which will compile this DLL for future use.	(10)

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