UNIVERSITY OF JOHANNESBURG

FACULTY OF SCIENCE

ACADEMY FOR INFORMATION TECHNOLOGY

MODULE CSC1B10
Introduction to data structures (C++)
CAMPUS **APK**

NOVEMBER EXAMINATION

DATE: 2014-11-11 **SESSION 08:00 – 12:00**

ASSESSOR(S) **DR DA COULTER**

INTERNAL MODERATOR **DR 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: A multi-agent system (MAS) contains many different agents which are independent programs each capable of performing an assigned task. There are many different types of agent such as learning agents, reflexive agents and utility agents. Each kind of agent performs its task in its own way. An MAS is capable of adding and removing agents to itself. When the MAS is asked to perform a task it delegates that task to its agents.					(5)
Write the **most** correct option in your answer books						
1.2	In an inheritance based implementation it is a good idea for destructors to be….					
	A private	B protected	C virtual	D explicitly invoked	E static	
1.3	An abstract base class cannot be…					
	A instantiated	B deleted	C passed reference	D dereferenced	E derived from	
1.4	It is better to use friend functions than member functions during operator overloading unless you are forced to do otherwise.					
	True		False		無[1]	
1.5	In order to differentiate between the prefix and postfix version of increment and decrement operators a(n) … parameter is added.					
	A `int`	B value	C reference	D bool	E `optional`	
1.6	Under which of the following circumstances is the copy constructor for the Q1 class not called?					
	A passed by value	B returned by value	C passed by reference	D when thrown	E when caught	
Write your answers to the following in your answer books						
1.7	When should **`structs`** be used as opposed to **`classes`**?					(2)
1.8	Assume that a class called Q1 exists. Within the member functions of Q1 what type does the reserved word **`this`** have?					(2)
1.9	Define the following principles / techniques of object orientation • Encapsulation • Inheritance • Composition / Aggregation					(3)
1.10	Describe how polymorphism may be achieved.					(3)

.

[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 (10)

Complete the following code. The provided code makes reuse of Malik's unordered list to create a queue through the appropriate use of overriding. The code is generic and uses the approach to separating interface and implementation with template based types as discussed in class.

ExamQueue.h

```
#ifndef EXAMQUEUE_H
#define EXAMQUEUE_H

#include <iostream>
#include <cstdlib>
#include "unorderedLinkedList.h"

 (a)
class ExamQueue :  (b)   unorderedLinkedList<T>
{
public:

    virtual void insertFirst(const T& newItem);

    virtual void deleteNode(const T& deleteItem);

      (c)
      (d)  std::ostream& operator<<(std::ostream& lhs, ExamQueue<T1>& rhs);
};

#include (e)

#endif
```

ExamQueue.inc

```
template <typename T>
void ExamQueue<T>::insertFirst(const T& newItem)
{
    this->   (f)     (newItem);
}

template <typename T>
void ExamQueue<T>::deleteNode(const T& deleteItem)
{
    unorderedLinkedList<T>::deleteNode(     (g)      );
}

template <typename T1>
std::ostream& operator<<(std::ostream& lhs, ExamQueue<T1>& rhs)
{
    for(linkedListIterator<T1> i = rhs. (h)    ; i != rhs. (i)   ; ++i)
        lhs << *i << " ";
    return (j) ;
}
```

2.2 Write code to define a generic node type as used in Malik's singly linked list types. (5)

2.3 Describe how exception handling and inheritance can be used to create a robust error handling system. Be sure to describe the keywords used in exception handling and their meaning. (4)

2.4	If a given class has dynamically allocated data as part of its state then it must support three operations which are collectively known as the Big Three. Name and describe these operations.	(6)
2.5	Draw a series of images which depict the removal of an internal node (i.e. a node which is neither the first node nor the last node) from an unordered singly linked list.	(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 `operations.txt` is made up of lines in the following format:
	
	`OP NUM1 NUM2 EOL`
	
	Where OP is either the character '+' or '*' representing addition or multiplication. NUM1 and NUM2 are textual representations of integers while EOL is the system's representation of the end of the line.
	
	Write code which reads in all of these lines and outputs the result of applying the operation to the two numbers. For example if the text file contained…
	`+ 5 2`
	`* 3 5`
	
	… the output would be:
	`7`
	`15`
	
	Please show code for the opening / closing of the file.
		(5)

3.2	Define a structure which stores the data from each line in the previous question. Show the line of code used to write one of these structures (called s1) to a file called `operations.dat` in a file object called `file`. You do not need to show the opening or closing of the file.	(5)
3.3	Assume that `operations.dat` via a file object called `file` has had an unknown number of records written to it. Show how you would calculate the number of records within the file. You do not need to show the opening or closing of the file.	(5)
3.4	Describe how bit masking is used to represent the different modes a file stream object may be opened in.	(5)

3.5	Consider the following function which saves the contents of a C-string to a file:
	`void save(char* data, int size, ofstream& file)`
	`{`
	`  //error checking for array and file omitted`
	`  for(int i = 0; i < size; i++)`
	`  {`
	`  file << data[i] << endl;`
	`  }`
	`}`
	Analyse the above function asymptotically using Big-O notation. State any assumptions made.
		(10)

.

[30]

QUESTION 4

The Utopian Game Development Association requires a dynamically linked library (DLL) called `ujmath.dll` for their upcoming AAA sports title called Ball of Duty. The library must export the following function

- d2D which takes four integers and returns a double representing the distance between two points in 2D space according to the following formula

$$d2D(x_1,\ y_1,\ x_2,\ y_2) = \sqrt{(x_1 - x_2)^2 + (x_2 - y_2)^2}$$

4.1	Write an appropriate header file for the library	(6)
4.2	Give the command line instructions required to compile the DLL itself assuming the source code to the library resides in a file called `UJMath.cpp`	(10)
4.3	Give the command line instructions required to compile an executable called `game.exe` (from the source file `Game.cpp`) which **implicitly** links to the DLL.	(4)

.

[20]