



**MASINDE MULIRO UNIVERSITY OF
SCIENCE AND TECHNOLOGY
(MMUST)**

MAIN CAMPUS

**UNIVERSITY SPECIAL/SUPPLEMENTARY EXAMINATIONS
2021/2022 ACADEMIC YEAR**

THIRD YEAR 2ND SEMESTER EXAMINATIONS

**BACHELOR OF SCIENCE IN
COMPUTER SCIENCE**

COURSE CODE: BCS 362

COURSE TITLE: GENERIC PROGRAMMING WITH C++

DATE: 02/08/2022
TBD **TIME:** TBD 11:00 A.M - 1:00 P.M

INSTRUCTIONS TO CANDIDATES

THIS IS AN OPEN BOOK EXAMINATION

Answer Question **ONE (1)** and Any **OTHER 2** questions

Ensure your answers/ideas are clearly expressed

All your answers must be clearly numbered

Write in ink. Rough work can be done (in answer booklet) in pencil and will not be marked. Cross out any rough work.

Calculators, phones, tablets, computers not allowed

TIME: 2 Hours

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 04 Printed Pages. Please Turn Over. ►

QUESTION ONE: COMPULSORY QUESTION**[20 MARKS]**

(a) A printer maintains a list of jobs to be printed by storing their job IDs in a spooler (queue). These job IDs could be of any type depending on the system. Using **vector** container, write the definition of a class template **PrinterQueue** that simulates the printer spooler. Include functions;

(i) **atTheFront()** that return ID for job at the front of the queue. [1 Marks]

(ii) **join(...)** that adds a job ID at the back of the queue. [1 Marks]

(iii) **atTheBack()** that return ID for job at the back of the queue. Declare this function inside the class template and provide its implementation outside the class template [3 Marks]

(iv) **leave()** that removes a job ID from of the queue. [2 Marks]

(b) An array is declared as

```
1 array<array<float, 5>, 6> data;
```

Using **size()** function in class template **array** to get the number of elements in **data**, write a program that uses range based for loops to calculate the average of the elements in the array data. [3 Marks]

(c) A class is declared as

```
1 class DivideByZeroException : public std::runtime_error
```

(i) Write the definition of a constructor that passes error message **You attempted to divide by zero** to the constructor of the base-class. [2 Marks]

(ii) Write definition of a function declared as **double divide(double x, double y)** such that it *throws* **DivideByZeroException** if $y = 0$, otherwise it returns the quotient of y and x . [2 Marks]

(iii) Write the main function to test your class. Your main function should try to call the function **divide()** and display the quotient of the two numbers passed to it or catch an exception and display the error message. [3 Marks]

(iv) Write a C++ function that estimates and returns the value of π using the formula

$$\pi = 2 \times \frac{2}{\sqrt{2}} \times \frac{2}{\sqrt{2 + \sqrt{2}}} \times \frac{2}{\sqrt{2 + \sqrt{2 + \sqrt{2}}}} \dots$$

Note that, this formula has infinite number of terms with increasing complexity, so you must multiply additional terms until the size of the next term is 1. [3 Marks]

QUESTION TWO

[20 MARKS]

- (a) A word editor maintains the words written in a stack. Every word typed is pushed to a stack. When the typist issues an undo command, the last word to be typed is removed from the stack. A word can be made up of strings, integers, floating point values, characters etc. For example, the following sentence

Angulu is a nice guy

has 5 words.

Using a **deque** container, write definition of a C++ generic class **Sentence** that simulates the editor container. Include the following functions/methods

- (i) A default constructor that creates an empty stack. [2 Marks]
 - (ii) **count()** that returns the number of words in a sentence. [2 Marks]
 - (iii) **last()** that returns the last word to be typed in the most recent sentence. [2 Marks]
 - (iv) **type(...)** that adds a word to a sentence. [2 Marks]
 - (v) **undo()** that removes a word from a sentence and return the removed word. [2 Marks]
 - (vi) A generic method/function **display(...)** that displays the contents of a stack. [3 Marks]
- (b) What would be the output of Line 4, 5, 6, 7, 8 and 9 of code segment below if Line 3 displays 0X6FFE44 on a machine that uses 64 bit hexadecimal addresses and 32 bits to represent floating point numbers. [3 Marks]

```
1 float d = 20;
2 float *p = &d;
3 cout << p << "\n";
4 cout << (p + 2) << "\n";
5 cout << *(p + 2) << "\n";
6 cout << (*p + 2) << "\n";
7 cout << p[0] << "\n";
8 cout << sizeof(*p) << "\n";
9 cout << sizeof(p) << "\n";
```

(c) A program is partially defined as

```
1 vector<float> data;  
2 vector<float> num(20);  
3 vector<float> res;  
4 res.push_back(123);  
5 res.push_back(54);
```

- (i) Write a line of code that will preserve enough space for vector **data** such that it can contain elements of vector **num** and vector **res** even when these vectors are changing dynamically. [1 Mark]
- (ii) Write a line of code that will put the value 768.125 as 15TH element of vector **num**. Do not use subscript operator. [1 Mark]
- (iii) Without using a loop, write two lines of code that will copy elements of vector **num** and vector **res** to vector **data**. Elements of **num** are copied to **data** before elements of **res** are copied. [2 Marks]

QUESTION THREE

[20 MARKS]

- (a) A linked list is a linear collection of data structures (nodes) whose order does not depend on physical placement in memory, but every data element points to the next data element. The number of nodes in a list are not fixed and can grow or shrink on demand. Write definition of a C++ class **Node** that can be used to implement a linked list. In your class
- (i) Declare instance variables of a node as private members of the class. Note: A node has data (value) and an address to the next node. [2 Marks]
 - (ii) Define an explicit default constructor that uses member initializer list to initialize data element to the value passed to it and address of the next node to null. [2 Marks]
 - (iii) Define a function **setNext(...)** that sets the address of the next node on the list. [2 Marks]
 - (iv) Define a function **getNext()** that returns the address of the next node, as stored by the current node. [2 Marks]
 - (v) In global namespace, write definition of function **void printList(...)** that displays the data elements in a linked list. [4 Marks]
 - (vi) Write a main function, in it, create a linked list of four integers (10, 20, 30, 40) and invoke the function defined in (v) above to display the elements in the list. [4 Marks]

- (b) Write a recursive function that returns Fibonacci sequence 0, 1, 1, 2, 3, 5, 8... where the n^{th} number F_n in the sequence is given by

$$F_n = F_{n-1} + F_{n-2} \quad \text{for} \quad F_0 = 0 \text{ and } F_1 = 1$$

[4 Marks]

QUESTION FOUR

[20 MARKS]

- (a) A class hierarchy is defined as

```
1 class Person{
2     private:
3         string name;
4     public:
5         virtual void howToMove() final {cout << "Walking"; }
6 };
7 class Student:Person{
8     public:
9         void howToMove() { cout << "Skiing\n"; }
10        virtual Student(){ }
11};
```

Explain **TWO** errors in the code above.

[2 Marks]

- (b) What would be the output of the code below if a string **MMUST is a great university** is entered at line 3. [2 Marks]

```
1 char name[40];
2 char name_2[40];
3 cin >> name;
4 cout << name << endl;
5 cin.get(name_2, 40);
6 cout << name_2 << endl;
```

- (c) A function is declared as

```
1 int gcd(int, int);
```

- (i) Write a main function that declares a constant pointer to this function. Use this pointer to invoke the function definition of this function and pass value 6 and 4 to it. [2 Marks]

- (ii) Display the memory address where the function gcd() lives. [1 Marks]

(d) A class hierarchy is defined as

```
1 class Point{
2     private:
3         int x, y;
4     public:
5         Point(int x1, int y1){
6             x = x1;
7             y = y1;
8         }
9 };
10 class Line:public Point{
11     private:
12         int a=10, b=20;
13     public:
14 };
```

(i) Write a directive to be included in class **Line** such that it inherits constructors of class **Point**. [1 Marks]

(ii) Assuming class **Line** has a line of code you provided as answer to (i) above, what would be the effect of the following two lines of code? [1 Marks]

```
1 Line line(2, 4);
2 Line lone;
```

(e) A positive integer is called a perfect number if it is equal to the sum of all of its positive divisors, excluding itself. For example, **6** is the first perfect number because $6 = 3 + 2 + 1$. The next is $28 = 14 + 7 + 4 + 2 + 1$. There are four perfect numbers less than **10,000**. Write a C++ program to find and display all these four numbers. [3 Marks]

(f) Given a 4 digit number representing a year, the day on which the 1st of January falls can be calculated using the following formula (Gaus's formula):

$$day = R(5R(Year - 1, 4) + 4R(Year - 1, 100) + 6R(Year - 1, 400), 7)$$

Where $R(m,n)$ is the remainder after dividing n by m e.g. $R(10, 3)$ is 1. The program produces a number in the range $0 \dots 6$, where 0 is index of an element **Monday** in a list, 1 is the index of element **Tuesday** and so on till 6 is index of element **Sunday**. Consider first 4 lines of a program shown on page 7.

```

1 int daysPerMonth[12] = {31, 28, 31, 30, 31, 30, 31, 31, 30, 31,
2   30, 31};
3 string months[12] = {"January", "February", "March", "April", "
4   May", "June", "July", "August", "September", "October", "
   November", "December"};
   int startDay;
   int monthNumber;

```

- (i) Write a function **firstJan(...)** which returns the name of the day on which first of January fall in year passed to it. [3 Marks]
- (ii) Write a function **monthCalendar(int)** which receives the number of a month (between 1 and 12) and then prints the calendar for that month in a 6 row by 7 column grid. Assume February has 28 days for all the years. For 11 (November) as month and 2020 for year, Your output should match the example output shown below (user input underlined, text before input is a prompt). [5 Marks]

Question 4(f) Example Output

Enter the year (as a four digit number) : 2020

First of January 2020 is on a Wednesday

Enter the month(as an integer between 1 and 12): 11

Calendar for November 2020

Mo	Tu	We	Th	Fr	Sa	Su
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						