University of Cape Town

Department of Computer Science

Computer Science CSC115F

Final Exam

November 2005

Marks: 115	• Approximate marks per question are shown in brackets
Time: 3 hours	• The use of calculators is permitted

Surname Initials

NAME:

STUDENT NO: **COURSE CODE:** CSC

This paper consists of 13 questions and 23 pages (including this cover page).

Mark Allocation							
Question	**Marks**	**Internal**	**External**	**Quest**	**Marks**	**Internal**	**External**
1	[9]			9	[10]		
2	[10]			10	[10]		
3	[7]			11	[5]		
4	[8]			12	[3]		
5	[6]			13	[12]		
6	[5]			14	[4]		
7	[10]			15	[6]		
8	[10]						
Total				**Total**			
					Grand Total		
					Final Mark		
Internal Examiner:				**External Examiner:**			

Section 1

<u>Question 1</u> - 9 Marks

1. Describe the principle of mathematical induction, how do we use it in recursion?

[3]

2. Write a recursive program to sum the n numbers of a sequence where the first element is 5 and the difference between each new element and its predecessor is 3

   Example: given n as 5 the sequence is 5, 8, 11, 14, 17 and the sum is 55.

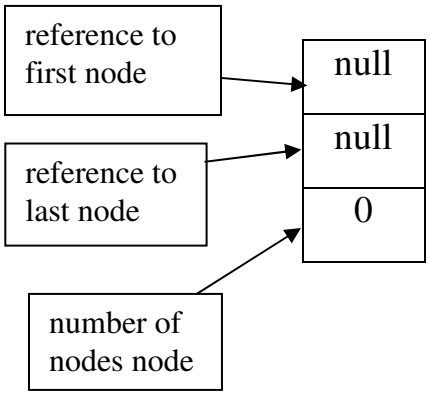
[3]

3. Show how the stack frame works as the program in the previous section executes when n has a value of 2

[3]

<u>Question 2</u> - 10 Marks

1. Write a default method to create the charlist header shown in the diagram.



[10]

Question 3 – 7 Marks

1. Draw a diagram to represent the process of removing a node from a CharList show the creation of the temporary node reference and the way in which the node is deleted.

[2]

2. Write a Java method that will remove the first element from CharList and return its value. Hint there are 3 cases to consider.

[5]

Question 4 – 8 Marks

1. Compare and contrast singly linked lists and doubly linked lists

[3]

2. Write a Java method for a DoublyLinked list class (with a header node) that finds a particular value in the list, sets currentNode to that node and returns true. Otherwise, leaves currentNode as it was and returns false.

[5]

Question 5 – 6 Marks

1. Explain the advantages of a programming language with exceptions?

[2]

2. Show how you would rewrite the following so that the Turtle errors would be caught using 'try' and 'catch' blocks

```
// Demonstration of a program that throws a TurtleException
import turtlegraphics.*;
public class DemoWithoutTryCatch
{
        public static void main(String [] args) throws TurtleException
        {
                Turtle myTurtle = new Turtle();
                // Move off the screen (should throw an exception)
                myTurtle.move(1000);
                // This never executes
                System.out.println("Program finished");
        }
}
```

[4]

Section 2

Question 6 - 5 marks

a) What do we mean by Reverse Polish Notation, giving an example?

[1]

b) Show how the expression (7+5) x 2 can be converted to reverse polish notation using a stack. Show all the steps not just the final solution.

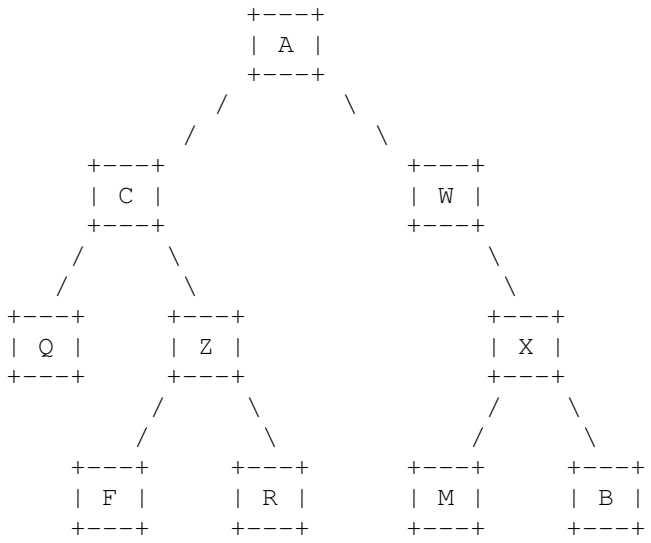
[4]

Question 7 – 10 Marks

1. Write the definition of Binary Search Tree.

[1]

2. Binary Tree Traversals.
   Consider the following tree.



Fill in each of the traversals below:

a) Preorder traversal

[2]

b) Inorder traversal

[2]

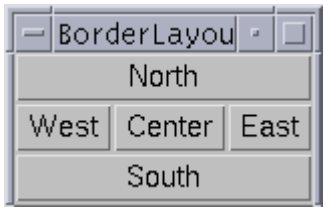
c) Postorder traversal

[2]

3. Given an empty binary search tree of integers, show the structure of the tree after each of the values 6, 1, 3, 8, 9, 4 is inserted. Show the steps not just the final solution. [3]

Question 8 – 10 Marks

1. Please write the Java AWT Code for the below GUI frame using Border Layout as the Layout Manager



[5]

2. Using (1) above set the size of the frame and show it?

[2]

3. Make your class from (1) above a subclass of Frame. Write the single line of code that calls the constructor for the Frame class with the title for the window?

[1]

4. Given that a java.awt.Button can generate an ActionEvent which listener interface would you expect to have to implement, in a class which would handle this event?

- FocusListener
- ComponentListener
- ActionListener
- ItemListener

[1]

5. Please fill in the blank in the below code?

[1]

public void actionPerformed(_____)

Section 3

Question 9 – 10 Marks

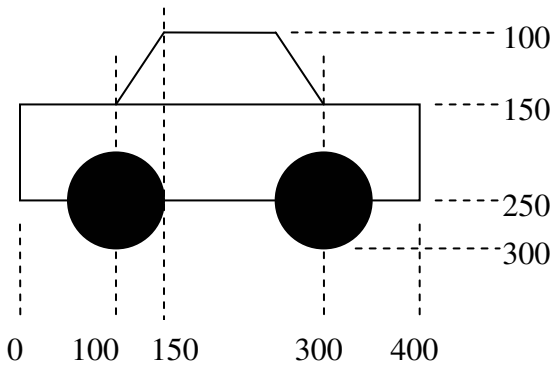
For the following questions, assume the Java2D graphics primitives:
Arc2D.Float (x, y, width, height, start, extent, type)
Ellipse2D.Float (x, y, width, height)
Line2D.Float (x1, y1, x2, y2)
Rectangle2D.Float (x, y, width, height)
RoundRectangle2D.Float (x, y, width, height, arcwidth, archeight)
Assume the API methods:
setColor (Color c)
draw (Shape s)
fill (Shape s)

1. Fill in the blanks in the following method to draw a rectangle without using the primitive Rectangle2D shape. Assume that w and h are width and height respectively.

```
void myDrawRectangle ( Graphics2D canvas, float x, float y, float w, float
h )
{
  canvas.draw (new Line2D.Float ( _____, _____, _____, _____ ));
  canvas.draw (new Line2D.Float ( _____, _____, _____, _____ ));
  canvas.draw (new Line2D.Float ( _____, _____, _____, _____ ));
  canvas.draw (new Line2D.Float ( _____, _____, _____, _____ ));
}
```

[4]

2. Write a method to draw the following figure using the Java2D API. Dimensions are indicated with dashed lines. Where no dimensions are listed, assume the figure is symmetrical.



[6]

Question 10 - 10 Marks

Show all calculation for the following questions.

1. Convert 120.75_{10} to radix 2.

[2]

2. Convert 120.75_{10} to hexadecimal.

[1]

3. Use 4-bit 1's complement binary addition to calculate 7_{10} - 3_{10}.

[3]

4. What test must be done to check for an overflow in the above binary addition calculation?

[1]

5. Represent the floating point number 18.75_{10} in single-precision IEEE 754 format.

[3]

<u>Question 11</u> – 5 Marks

1. What Boolean operator corresponds to the following truth table?

A	B	F
0	0	0
0	1	1
1	0	1
1	1	1

[1]

2. Using a truth table, prove the identity: $A \cdot \left(B + \overline{B}\right) = A$

[4]

Section 4

<u>Question 12</u> – 3 Marks

1. You are given the following state of the MIPS machine. Give all the steps when the next instruction is carried out (i.e. the instruction add $t2, $t2, $t3)

   Show the values of the appropriate registers at each of the steps (load, increment, execute).

   ```
   28.    addi  $t2, $0, 7
   32.    addi  $t3, $0, 2
   36.    add   $t2, $t2, $t3
   40.
   ```

	Instruction Reg	**Program Counter**	**$t2**	**$t3**
Initially		**36**	**7**	**2**

[3]

<u>Question 13</u> – 12 Marks

1. Write a MIPS assembler program to do the same as the following JAVA program.

```
public static void main (String [] args)
{
        int [] x = {3, 4, 7, 6, 1, 5, 20, 4, 1, 7};
        int big = 0;

        for(int i =0; i < 10; i++)
                if(x[i] > big) big = x[i];

        System.out.println(big);
}
```

   Note: In your MIPS program it is much easier for your loop to go from 0 to 40 in steps of 4 because of byte addressing.

Given:

```
        .data
big:    .word 0
  i:    .word 0
four:   .word 4
forty:  .word 40
```

```
        .text
        .globl main
```

[12]

Question 14 – 4 Marks

1. For a 2 pass assembler give:

    a) the two main purposes of the first pass.

[2]

    b) the two main purposes of the second pass.

[2]

Question 15 – 6 Marks

1. Dad is aged 50, Mom is aged 40 and Son is aged 20. They agree to buy a CD if those voting for it have a confined age between 60 and 110 inclusive
   (i.e. 110 >= combined age >= 60)

   For this problem:
   a) Give the truth table;
   b) Construct the Boolean expression for a True outcome;
   c) Use a Karnugh map to optimize this expression; and
   d) Draw the optimized circuit.

   [6]

   Show all your working.