Please fill in your Student Number and Name.

Student Number : _____

Name:

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Student Number:

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University of Cape Town ~ Department of Computer Science

Computer Science 1015F ~ 2009

January Exam

Question	Max	Internal	External	Question	Max	Internal	External
1	10			7	8		
2	10			8	7		
3	10			9	15		
4	10			10	20		
5	5						
6	5						
				TOTAL	**100**		

Marks : 100

Time : 180 minutes

Instructions:

a) Answer all questions.

b) Write your answers in pen in the spaces provided.

c) Show all calculations where applicable.

Question 1 [10]

a) What is a computer program? [1]

b) Are all computer programs also algorithms? Explain your answer. [1]

c) What is the purpose of an Operating System? [1]

d) What is the purpose of an IDE? [1]

e) What is the difference between high-level and low-level programming languages? [2]

f) Give 2 examples of high level languages (other than Java) and 2 examples of low level languages. [2]

g) What is the purpose of the following hardware components: (i) CPU (ii) ROM? [2]

Question 2 [10]

Consider the following program and answer the questions that follow.

```
public int action ( int number )
{
   int x=0;
   while (number>0)
   {
      x = x*10 + (number%10);
      number = number / 10;
   }
   return x;
}
```

a) What does this method do? [2]

b) What is the local variable in this method? [1]

c) This program exploits integer division. Explain what integer division is. [2]

d) Briefly describe an alternative solution to this problem. [2]

e) Assume you want to use statement coverage to test the method. What value is NOT a suitable test value by itself? [1]

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f) What are 2 techniques that can be used to find errors in a program? [2]

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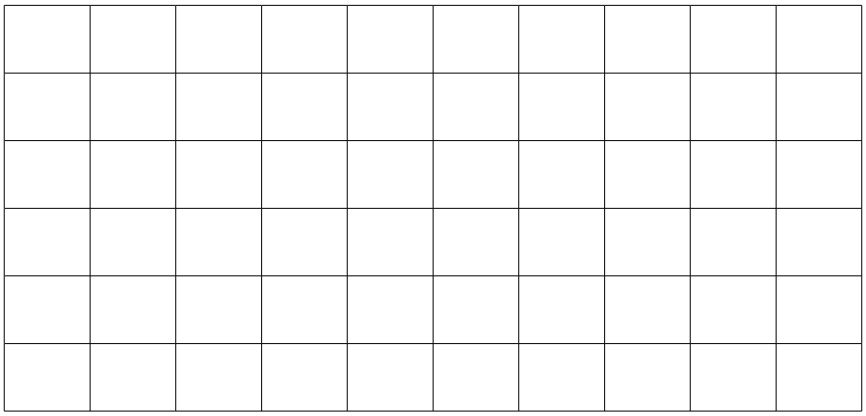
Question 3 [10]

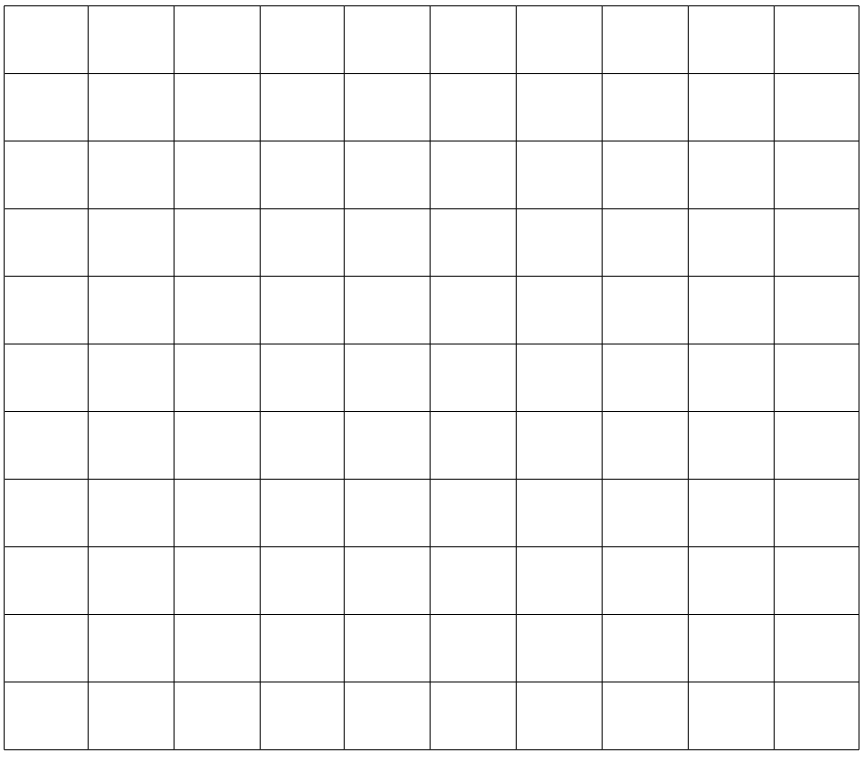
Consider the following method and answer the questions that follow.

```
public void drawShape ( int n )
{
   for ( int i=n; i>0; i-- )
   {
      for ( int j=0; j<i; j++ )
         System.out.print ('*');
      System.out.println ();
   }
}
```

a) What is the output if n = 2? Write one character in each block and assume the top-left corner is where the output starts. [2]



b) What is the output if n = 4? Write one character in each block and assume the top-left corner is where the output starts. [2]



c) Rewrite the following 2 lines of the program in the form of a **while** loop. [2]

```
for ( int j=0; j<i; j++ )
   System.out.print ('*');
```

g) Write a method to draw the following square of single digit integers, for any given height from 1-9. In the example below the height is 5. [4]

```
12345
12345
12345
12345
12345
```

Question 4 [10]

Examine the following incomplete class definition and answer the questions that follow.

```
public class TwoNumbers
{
   private int one;
   private int two;

   public int getOne ()
   { return one; }
   public int getTwo ()
   { return two; }
   ...
}
```

a) Write a constructor that takes 2 integers as parameters to initialise the instance variables. [2]

b) Write mutators for the 2 instance variables. [4]

c) Why are the accessors and mutators needed? [1]

d) Write the code to create an object with the initial values [5, 8] and assign this object to the variable thePair. [1]

e) What is overloading? [1]

f) What is encapsulation? [1]

Question 5 [5]

Consider the Course class below:

```
public class Course
{   String name;
    int credits;
    static int total;
    Student classrep;
    ...
    public void increaseTotal(   )
    {   total++;          }
    public void increaseCredits (  )
    {   credits++;        }
    public int getCredits(  )
    {   return credits;   }
    ...
}
```

Now consider the Java code below that uses this Course class:

```
Course cs1 = new Course( );
Course cs2 = new Course( );
...
System.out.println( cs1.credits );    // line 1
System.out.println( cs2.credits );    // line 2
System.out.println( cs1.total );      // line 3
System.out.println( cs2.total );      // line 4
cs1.increaseTotal( );
cs1.increaseCredits( );
cs2.increaseTotal( );
cs2.increaseCredits( );
System.out.println( cs1.credits );    // line 9
System.out.println( cs2.credits );    // line 10
System.out.println( cs1.total );      // line 11
System.out.println( cs2.total );      // line 12
```

a) Suppose that the output printed by line 1, line 2, line 3 and line 4 are all zeroes. What output will be printed by lines 9 to 12? [2]

b) In the code you are shown method `getCredits()`. Now write a method `getClassrep()` that returns the Student stored in the classrep instance variable using the copy constructor of the Student class. [2]

c) For what reason should we use the copy constructor in the getClassrep( ) method? [1]

Question 6 [5]

Write Java code to do each of the following tasks:

a) Define a 1-dimensional array that holds the following integer values: [1]

```
1  1  0  0  0  0  0  0
```

b) Add the first and second elements and put the result in the 3rd element; add the second and third elements and put the result in the 4th element; add the third and fourth elements and put the result in the 5th element; and so on. [2]

```
1  1  0  0  0  0  0  0
```

would become

```
1  1  2  3  5  8  13  21
```

c) Print out every second value in the array using a loop. [2]

For example, for

```
1  1  2  3  5  8  13  21
```

you would print

```
1  3  8  21
```

Question 7 [8]

a) Write Java code to set the elements of a 2-dimensional array to the values indicated below. Two loops must be used and no value may be read in. Define all variables used. The code should work for any square array. [6]

-2	0	1	2	3
10	-2	1	2	3
20	20	-2	2	3
30	30	30	-2	3
40	40	40	40	-2

```
public static void main ( String [ ] args )
{
   int max = 5;
```

```
}
```

b) If the 2 for loops in your program were swopped around would this change the result of the program? [1]

c) Explain why. [1]

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Question 8 [7]

You are given the class `square` below where each side of the square is the same length.

```
public class square
{
   protected int side1;

   public square ( int s )
   { side1 = s; }

   public int perimeter ( )
   { return  4*side1; }

   public String toString ( )
   { return "Side 1 =" + side 1; }
}
```

Write a derived class called `quadrilateral`. `quadrilateral` is similar to `square`, except that each side has a different length. Use the principles of inheritance in your solution and rewrite each of the methods. [7]

Question 9 [15]

a) Convert the binary number 0101101.101 to decimal, showing your working. [2]

b) Convert the binary number 0101101101 to hexadecimal, showing your working. [2]

c) Convert the decimal number 25.75 to binary, showing your working. [2]

d) Calculate 6 - 9 using 8-bit 2's complement binary representation, showing all your working (i.e. convert the numbers to 2's complement before adding). [2]

e) Find the Boolean expression for F(A,B) using the table below. [2]

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

f) Write the value -2.5 as a floating point number using IEEE754 representation (bias of 127 added to the exponent; first bit is the sign bit, next 8 bits are the biased exponent, rightmost 23 bits are the significand). Show all your working. [5]

Question 10 [20]

Encryption for the Masses

Encryption is the process of safeguarding information by converting it into a form where it cannot be understood or read without some effort.

You have been asked to investigate a simple encryption solution that rotates the vowels in a message as follows:

"a" becomes "e", "e" becomes "i", "i" becomes "o", "o" becomes "u", "u" becomes "a"

You are provided with a list of letters and need to produce a single string as output. If a letter is not a vowel, it must remain as is. Assume that the list of letters is entirely in lowercase.

For example, the message {"b", "r", "e", "a", "k"} would become "briek".

a) Describe (in English) the algorithm you will use to perform the encryption. [4]

b) Describe 2 classes you could use in your solution and what the purpose of each is. [4]

c) Write the code for the **scramble** method that does the encryption and returns the encrypted string. Assume the letters to be encrypted are passed as a parameter that is an array of Strings and the return value is a String. A Driver class and code skeleton are provided for you. [10]

```
class EncryptDriver
{
   public static void main ( String [] args )
   {
      String [] letters = {"b", "r", "e", "a", "k"};
      Encrypt cipher = new Encrypt ();
      System.out.println (cipher.scramble (letters));
   }
}

class Encrypt
{
   public String scramble ( String [] letters )
   {
```

```
   }
}
```

d) If the input to your method was provided as a single String instead of as separate letters, explain how you could convert it into separate letters. [2]

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