EXAMINATION PAPER

MODULE: *Foundations of Computing*

MODULE CODE: *Comp1421*

DATE:

ASSESSMENT 002: Examination

TIME ALLOWED: 60 minutes

EXAMINER: Pete Moody

MODERATOR: Chris Bowers

Instructions to Registry and Invigilators:
All candidates will be provided with a copy of this question paper, which contains space for the candidates answers. No additional materials will be provided to candidates.

Instructions to Candidates:
This is a closed-book examination. You are not allowed to use notes, books or the internet. You may use a calculator providing it is not programmable.

Answer the questions by typing directly into this booklet.

Additional time is given to uploading your answers, you may not need to use all of this time.

You should attempt to answer all questions in the paper.

Student Number

Part A. Algorithms and Data – Short Answers

Question 1 [1 mark]
Read these lines of WeeBee code.

```
add(pip,30,10);
height = 20;
height = 40;
pip.jump(height);
```

How high does Pip jump? [1 mark]

Question 2 [3 marks]
Read these lines of WeeBee code.

```
add(grog,40,30);
add(pip,20,30);
pip.spin();
grog.rest();
grog.flyto(50,30);
pip.rest();
grog.flyto(pip);
pip.jump();
```

At the end of the code execution:

Where is Grog? [1 mark]

Where is Pip? [1 mark]

What was the last action Pip did? [1 mark]

Question 3 [2 Marks]
Read these lines of code. Assume all variable have been declared.

```
a = 14;
b = 20;
b = a;
```

What are the values of a and b when the code has run?

a =

b =

Question 4 [2 marks]
Read these lines of code.

```
int a = 1;
int b = 3;
a = b + 2*a;
```

What are the values of a and b when the code has run?

a =

b =

Question 5 [2 marks]
Read these lines of code.

```
int p = 4;
int q = 5;
q = p - 1;
p = q;
```

What are the values of p and q when the code has run?

p =

q =

Question 6 [2 marks]
Look at this code.

```
if ( a < b )
  println(a);
else
  println(b);
```

Write down in simple English the **goal** of this code. Do not write down what each line does.

Question 7 [2 marks]
Consider the following Pentium assembler code.

```
mov eax, 5
mov ebx, 3
inc eax
mov ebx,eax
```

What are the values in registers eax and ebx when the program is run?

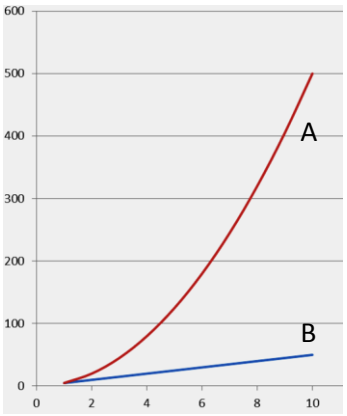
eax =

ebx =

Question 8 [1 mark]

Look at the graphs below which shows how the time an algorithm takes to complete, as the length of the data array is increased.

time



length

Which graph best describes an algorithm of order $O(n)$?

Part B Algorithms and Data – Long Answers

Question 9 [6 marks]

An Arduino is connected to two LEDs on a breadboard. Here is some code.

```
int redLED = 13;
int greenLED = 12;

void loop() {
  digitalWrite(redLED,LOW);
  digitalWrite(greenLED,LOW);
  delay(1000);
  digitalWrite(redLED,HIGH);
  digitalWrite(greenLED,HIGH);
  delay(1000);
}
```

(a) Which colored LED is attached to which pin? [2 marks]

(b) Explain what you see when the code is run [4 marks]

Question 10 [2 marks]

There are 3 algorithms with the following "orders"

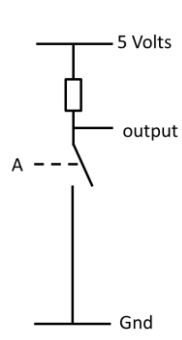
A	$O(n)$
B	$O(n^2)$
C	$O(\log n)$

(a) If you increase the data size (n) which algorithm (A,B, or C) will show the largest increase in running speed? [1 mark]

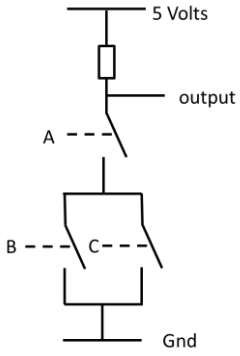
(b) For an $O(n)$ problem, if you doubled the problem size, by what factor will the time-to-completion increase? [1 mark]

Question 11 [4 Marks]

Here are two electronic circuits with switches A, B, and C. There is also a resistor in each circuit.



circuit 1



circuit 2

Here is the truth table for circuit 1

A	output
0 (open)	1 (HIGH)
1 (closed)	0 (LOW)

(a) What type of logic gate does this circuit resemble? [1 mark]

(b) Use this information to complete the truth table for circuit 2. Use only the symbols "0" or "1". [3 marks]

A	B	C	output
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

Question 12 [4 marks]

This question is about a Finite State Machine which moves a turtle in the WeeBee game engine. Here is some state code for STATE_1. There is no code for STATE_2. Assume this is located within the WeeBee engine loop() block of code.

```
switch(state) {

  case STATE_1:
    vX = 0;
    vY = 10;
    omega = 0;
    if(y >= 50)
      state = STATE_2;
    break;

  case STATE_2:

    break;

}
```

(a) Describe the behaviour of the turtle when it is in STATE_1 [1 mark]

(b) When does the turtle transit to STATE_2? [1 mark]

(c) Write in the space below code for STATE_2 to make the following happen: [2 marks]
* the turtle moves backwards with a reasonable speed.
* when the turtle has retreated beyond y = 10, the turtle transits into STATE_1

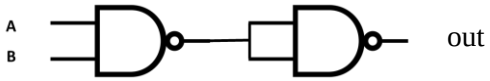
Part C. Boolean logic

Question 13. [2 marks]

The figure below shows a NAND-gate and its truth table

A	B	out
0	0	1
0	1	1
1	0	1
1	1	0

Now complete the truth table for this combination of NAND-gates



A	B	out
0	0	
0	1	
1	0	
1	1	

Question 14. [9 marks]

Consider the following Boolean expressions. For each expression, carry out a simplification using Boolean Algebra Show your working on the right.

The symbol "~" means NOT, so ~A.B means "Not A and B".

(a) L = A.B + ~A.B

(b) L = A.~B + A.B + ~B.B + A.A

(c) L = A + A.~B

(a) [2 marks]

(b) [4 marks]

(c) [3 marks]

Part D. Vectors and matrix transformations	
Question 15. [5 marks] (a) A point is located at coordinates $\begin{bmatrix}3\\2\end{bmatrix}$. Find the vector which would translate the point to coordinates $\begin{bmatrix}5\\2\end{bmatrix}$. (b) The vector $\begin{bmatrix}2\\1\end{bmatrix}$ is transformed by multiplying it by the matrix $\begin{bmatrix}0 & -1\\1 & 0\end{bmatrix}$. Find the location of the transformed vector. (c) Consider the matrix $\begin{bmatrix}0 & -1\\-1 & 0\end{bmatrix}$. What sort of transformation does this matrix achieve. A template for working out is provided on the right	(a) [2 marks] $\begin{bmatrix}5\\2\end{bmatrix} = \begin{bmatrix}3\\2\end{bmatrix} + [\quad]$ (b) [2 marks] $\begin{bmatrix}0 & -1\\1 & 0\end{bmatrix}\begin{bmatrix}2\\1\end{bmatrix} = [\quad]$ (c) Template. Insert numbers of your choice. You will get credit for using the template $\begin{bmatrix}0 & -1\\1 & 0\end{bmatrix}[\quad] = [\quad]$ $\begin{bmatrix}0 & -1\\1 & 0\end{bmatrix}[\quad] = [\quad]$ $\begin{bmatrix}0 & -1\\1 & 0\end{bmatrix}[\quad] = [\quad]$ $\begin{bmatrix}0 & -1\\1 & 0\end{bmatrix}[\quad] = [\quad]$ Transformation is [1 mark]