THE AUSTRALIAN NATIONAL UNIVERSITY

Mid Semester Examination, April 2010

COMP2300 / COMP6300 (Introduction to Computer Systems)

Writing Period: 1 hour duration

Study Period: 0 minutes duration

Permitted Materials: One A4 page with notes on both sides. NO calculator permitted.

Questions are NOT equally weighted.
This exam will contribute 20% (redeemable) to your final assessment.

The questions are followed by labelled, framed blank panels into which your answers are to be written. Additional answer panels are provided (at the end of the paper) should you wish to use more space for an answer than is provided in the associated labelled panels. If you use an additional panel, be sure to indicate clearly the question and part to which it refers to.

The marking scheme will put a high value on clarity so, as a general guide, it is better to give fewer answers in a clear manner than to outline a greater number in a sketchy, half-answered fashion. The Appendix contains a table with powers of 2 values in decimal.

Please write clearly - if we cannot read your writing you may lose marks!

Student	Number:		
Official use Q1 (13)	e only: Q2 (17)	Total (30)	

QUESTION 1 [13 marks]

(a) Assume memory addresses 0x02000411 to 0x02000415 contain the following 8-bit binary values:

Address	0x02000411	0x02000412	0x02000413	0x02000414	0x02000415
Binary value	0010 1011	1001 0011	1100 1001	0010 0111	0001 0101

Assume the C declaration of short int x, y; (with sizeof(x) and sizeof(y) both being 2), &x = 0x02000412 and &y = 0x02000414, and the data storage is big endian.

(i) What would be printed by the following C statement? printf("Values for x+y: %x %o\n", x+y, x+y); Clearly show how you derive your answers.

QUESTION 1(a)[i]	[2 marks]

(ii) What would be printed by the following C statement? printf("Value for $(x+y)>>8: %d\n", (x+y)>>8);$ where >> is the bitwise right-shift operator (which present the sign of the 2's complement value on the left). Clearly show how you derive your answer.

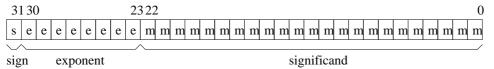
QUESTION 1(a)[ii]	[1 mark]

Įuo	estion 1 (continued)
(b)	The IEEE single-precision floating-point standard is: 1 bit sign, 8 bits exponent with a bias of 127, and the remaining 23 bits are the significand (mantissa), with an implicit leading bit. What floating point number is represented by the following 32-bit number (given in hexadecimal representation): 0xC2940000
	For full marks, your answer should be expressed as a single decimal number accurate to four decimal digits.
	QUESTION 1(b) [2 marks]
(c)	Negative integers can be represented by reserving a bit to represent the sign (for example for 8-bit: 10000000, 10000001, 1111111111 could represent -0, -1 and -127). State two
	advantages of two's complement arithmetic over this representation. [I mark]

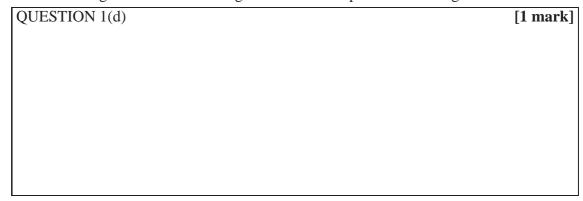
Student Number:

Question 1 (continued)

(d)	In the IEEE single-precision floating-point standard, the three components of the number
	have the following ordering:



What advantage would this ordering have over other possible orderings?



(e) A half-adder circuit is given by the following table:

Inputs		Output		
X	Y	Sum	Carry	
0	0	0	0	
0	1	1	0	
1	0	1	0	
1	1	0	1	

Outline how it could be constructed using basic gates (AND, OR, XOR, NOT, etc). *Note: it is not necessary to give a formal circuit diagram in your answer.*

QUESTION 1(e)	[2 marks]

Que	estion 1 (continued) Student Number:	••
(f)	Briefly describe the function of the <i>bus</i> in a computer.	
(-)	QUESTION 1(f) [1 mark]
(g)	Briefly describe the function of the <i>control unit</i> within the Central Processing Unit.	
(5)	QUESTION 1(g) [2 marks	1
(h)	Variable instruction length is a characteristic of CISC computers. In contrast, the origin RISC computers had a fixed instruction length. What was the primary advantage of having a fixed instruction length?	
	QUESTION 1(h) [1 mark]

QUESTION 2 [17 marks]

(a) Write C statements to declare an single-precision floating point variable x initialized to 1.0, and a floating point pointer px initialized to the address of x.

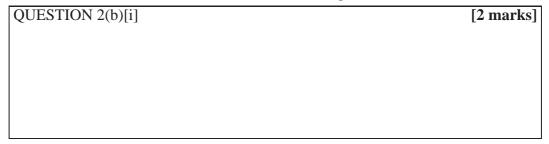
```
QUESTION 2(a) [1 mark]
```

(b) Consider the following C program foo.c

```
#include <stdio.h>
#include <stdlib.h>
int main(int argc, char *argv[]) {
   int a[64], i;
   int n = atoi(argv[1]);
   a[0] = 0;
   for (i = 1; i < n; i++) {
      a[i] = a[i-1] + 2 * i;
   }
   printf("%4d\n", a[n-1]);
   return 0;
}</pre>
```

Suppose the program was compiled and linked into an executable program called foo.

(i) Write the output produced by the command ./foo 5, clearly indicating spaces (with a '__'). *Hint:* in this case, the variable n will be assigned the value of 5.



(ii) Suppose n represents an integer and $0 \le n < 64$. In terms of n, state what the command ./foo n produces.

STION 2(b)[ii]	[1 mark]

Que	estion 2 (continued) Student Number:
(iii)	What is the main limitation of the above program, and briefly describe the best way to rectify it.
	QUESTION 2(b)[iii] [2 marks]
(iv)	Even after this limitation is removed, the above program can still abort with a 'seg-
	mentation violation' error. Briefly describe how this can occur, and indicate how you would rectify this.
	QUESTION 2(b)[iv] [2 marks]
the fi	e a sequence of C statements that (i) defines a structure called safestr consisting of ields s (of type pointer to char) and len of type integer, (ii) declares a variable ss of struct safestr, and (iii) initializes its s field to 64 bytes of dynamically allocated tory and its len field to 64.
QU	ESTION 2(c) [2 marks]

(c)

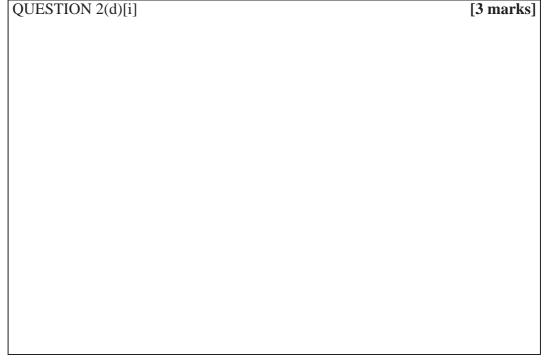
Question 2 (continued)

(d) Consider the following function definition.

```
void hist(int n, int p[], int k, int h[]);
// post: h[i] is the number of occurrences of i
// in p[0], p[1], ...., p[n-1]
// for each i such that 0 <= i < k
// example: if n=6, p = {0,1,3,1,1,3} and k=4, h = {1,3,0,2}</pre>
```

Suppose that the C file hist.c contained am implementation of the hist() function, and the C program histogram.c calls this function.

(i) Write an implementation of the hist() function.



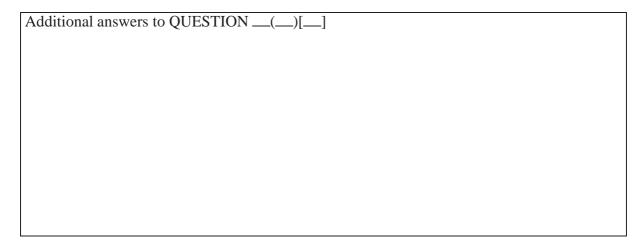
(ii) C provides an assert() facility. Illustrate how the facility could be used in the above function.

QUESTION 2(d)[ii]	[1 mark]

Que	Puestion 2 (continued) Student Number:			
(iii)	Write the contents of a header file, hist.h, which, if included at the top of hist.c and histogram.c, would ensure that the call of hist() in histogram.c was consistent with its implementation in hist.c.			
	QUESTION 2(d)[iii] [1 mark]			
(iv)	Suppose the system was compiled using gcc -c hist.cand gcc -c histogram.cand linked into an executable program using gcc -o histogram histogram.ohist.o. Briefly explain how the reference of the external symbol hist is resolved into an address during the linking stage.			
	QUESTION 2(d)[iv] [2 marks]			

Additional answers to QUESTION()[]			
Additional answers to QUESTION()[]			
Additional answers to QUESTION()[]			

	Student Number:
Additional answers to QUESTION()[.]
Additional answers to QUESTION()[1
(<u> </u>	



Appendix

х	2^x
-5	0.03125
-4	0.0625
-3	0.125
-2	0.25
-1	0.5
0	1
1	2
2	4
3	8
4	16
5	32
6	64
7	128
8	256
9	512
10	1024
11	2048
12	4096
13	8192
14	16384
15	32768
16	65536

Table 1: Powers of 2 in decimal