THE AUSTRALIAN NATIONAL UNIVERSITY

Mid Semester Examination, April 2008

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!

Name (family name first):

Student Number:

Official use only:

Q1 (12)	Q2 (18)	Total (30)

QUESTION 1 [12 marks]

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

Address	`0x02000411`	`0x02000412`	`0x02000413`	`0x02000414`	`0x02000415`
Binary value	`0010 1010`	`1001 0101`	`1100 0110`	`0110 0111`	`0011 0110`

Assume `sizeof(x)` and `sizeof(y)` are both 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: %d\n", x+y);
```

Clearly show how you derive your answer.

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

Question 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 mantissa (with an implicit leading bit). Convert the fractional decimal number 21.375 into IEEE single-precision floating point format. Give your answer in binary and hexadecimal.

QUESTION 1(b) **[2 marks]**

(c) Can all numbers that can be represented by a finite fractional decimal value be exactly represented using a finite number of binary digits? Concisely substantiate your claim.

QUESTION 1(c) **[1 mark]**

(d) Signed integers may be represented on a computer by reserving the topmost bit to represent the sign. Give two advantages that the two's complement representation has over this scheme.

QUESTION 1(d) **[1 mark]**

Question 1 (continued)

(e) In modern computer systems, there is a *memory hierarchy*. Briefly explain the reason(s) why these arise.

QUESTION 1(e) **[1 mark]**

(f) Common addressing modes in computers are the immediate, direct, indexed and stack modes. What high level language features does each of these addressing modes support?

QUESTION 1(f) **[4 marks]**

Student Number: .....

QUESTION 2 [18 marks]

(a) Write C statements to declare an integer variable `i` initialized to `0`, and a pointer to an integer `pi` initialized to the address of `i`.

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[256], i;
   int n = atoi(argv[1]);
   a[0] = 0;
   for (i=1; i<n; i++)
     a[i] = a[i-1] + i;
   printf("%d\n", a[i-1]);
   return 0;
}
```

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

(i) Write the output produced by the command `./foo 4` (*hint:* in this case, the variable `n` will have the value of 4).

QUESTION 2(b)[i]	**[1 mark]**

(ii) Suppose n represents an integer and $0 \leq n \leq 256$. In terms of n, state what the command `./foo` n produces.

QUESTION 2(b)[ii]	**[1 mark]**

Question 2 (continued)

(c) Consider the following code fragment:

```
int a[] = {1, 2, 4, 7};
int b[] = {1, 2, 5, 7};
int ia = 3, ib = 3;
int count = 0;
while (ia >= 0  &&  ib >= 0) {
  if (a[ia] == b[ib]) {
    ia = ia - 1; ib = ib - 1;
    count++;
  } else if (a[ia] < b[ib])
    ib = ib - 1;
  else
    ia = ia - 1;
}
```

After the above while loop finishes, `count` contains what value?

(a) 3 (b) 2 (c) 1 (d) 0

QUESTION 2(c) **[2 marks]**

(d) In the loop of part (c) above, suppose `a[]` and `b[]` were sorted arrays of arbitrary length, and `ia` and `ib` were initialized to their lengths minus one respectively. Describe in plain English what the while loop would compute.

QUESTION 2(d) **[2 marks]**

Question 2 (continued)

(e) Consider the following function definition.

```
int strlen(const char *s);
// returns the length of the string s,
// not including the terminating '\0' character
```

Write an implementation of `strlen()`. Your code must not call any other function.

QUESTION 2(e) **[2 marks]**

(f) C provides a function called `malloc()` for dynamic allocation of memory. Give two advantages of using this as opposed to static memory allocation (see Q2(b) for an example of the latter).

QUESTION 2(f) **[2 marks]**

Question 2 (continued)

(g) The lines of code provided below are all jumbled. When the lines are correctly ordered, the code computes the percentage of elements in the integer array `c` (of length `N`, where `N` ≥ 0) whose value is equal to its index.

```
rate = 0;
i++;
}
i = 0;
rate = count * 100 / N ;
while (i < N) {
count++;
if (i == c[i])
count = 0;
if (N > 0)
```

Re-write all of the lines of code above in the correct order.

QUESTION 2(g) **[3 marks]**

Question 2 (continued)

(h) Consider the function `void printCheckerBoard(int n)` which prints out an `n` by `n` checkerboard with asterisks (`'*'`) representing black squares and spaces (`' '`) representing white squares. For example, the call `printCheckerBoard(8);` would produce the following output:

```
* * * *
 * * * *
* * * *
 * * * *
* * * *
 * * * *
* * * *
 * * * *
```

Write code for the function `printCheckerBoard()`.

QUESTION 2(h) **[4 marks]**

Additional answers to QUESTION __(__)[__]

Additional answers to QUESTION __(__)[__]

Student Number: .....

Additional answers to QUESTION __(__)[__]

Additional answers to QUESTION __(__)[__]

Additional answers to QUESTION __(__)[__]

Appendix

x	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