The Midterm

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UCL Computer Science

CS 0019
7th February 2019
Midterm Exam

- 21st February, 3:05 PM
- Darwin B40 Lecture Theatre
- 1 hour 25 minutes
- UCL standard calculators permitted
- No other reference materials (books, notes) permitted
- Covers all assigned readings and lectures through 19th February and Courseworks 1 - 3
- Please be sure to bring an HB pencil for filling in True/False/Don’t Know answer sheet
- Absence can only be excused by unforeseeable extenuating circumstances (through CS ECs process)
Rubric

■ Part I: multi-part short answer questions
  - A scenario, and multiple questions about that scenario, each of which you answer
  - No choice of questions; all students answer all questions

■ Part II: True/False/Don’t Know questions
  - A scenario and a series of five statements about that scenario
  - For each statement, you must indicate whether the statement is true, false, or that you do not know (“T”, “F”, or “D”)
  - Any number of statements may be true (from 0 through 5)
  - For each true statement you identify as true and false statement you identify as false, you receive 1 mark
  - For each statement whose truth or falsehood you contradict, you lose 1 mark (negative marking discourages guessing)
  - “D” answers neither gain nor lose marks
  - Sum of “raw” marks for Part II normalized across the class
Example Multi-Part Short Answer Question

Consider the disassembly of the x86-64 code for C function f1() shown below (in this lecture, on the next slide).

(a) How many arguments does f1() take? [1 mark]

(b) How much space on the stack does a single invocation of f1() allocate for local variables? [1 mark]

(c) How much of this space on the stack does a single invocation of f1() use for local variables? [2 marks]

(d) Which registers does f1() save on the stack before it makes a function call and does f1() restore from the stack after the function call returns? [2 marks]

(e) For each register in your answer to (d), why does f1() save that register on the stack? [3 marks]

(f) Write the C function that you would expect to compile into f1(). [6 marks]
__f1:

0: 55  pushq  %rbp
1: 48 89 e5  movq  %rsp,  %rbp
4: 48 83 ec 20  subq  $32,  %rsp
8: 48 89 7d f0  movq  %rdi,  -16(%rbp)
c: 48 83 7d f0 00  cmpq  $0,  -16(%rbp)
11: 0f 84 28 00 00 00  je  40  <__f1+0x3F>
17: 48 8b 45 f0  movq  -16(%rbp),  %rax
1b: 48 8b 4d f0  movq  -16(%rbp),  %rcx
1f: 48 83 e9 01  subq  $1,  %rcx
23: 48 89 cf  movq  %rcx,  %rdi
26: 48 89 45 e8  movq  %rax,  -24(%rbp)
2a: e8 d1 ff ff ff  callq  -47  <__f1>
2f: 48 8b 4d e8  movq  -24(%rbp),  %rcx
33: 48 01 c1  addq  %rax,  %rcx
36: 48 89 4d f8  movq  %rcx,  -8(%rbp)
3a: e9 08 00 00 00  jmp  8  <__f1+0x47>
3f: 48 c7 45 f8 00 00 00 00  movq  $0,  -8(%rbp)
47: 48 8b 45 f8  movq  -8(%rbp),  %rax
4b: 48 83 c4 20  addq  $32,  %rsp
4f: 5d  popq  %rbp
50: c3  retq
Answers to Multi-Part Short Answer Question

(a) One.
(b) 32 bytes.
(c) 24 bytes.
(d) %rbp, %rax
(e) %rbp: callee-saved, used as frame pointer, so must be saved and restored upon entry and exit to hold correct value upon return to caller; %rax: caller-saved, used as return value, so will be clobbered by callee.
(f) long f1(long x)
   {
      if (x)
         return x + f1(x - 1);
      else
         return 0;
   }
Example True/False/Don’t Know Question

Consider the following C structure and its use, which are to be compiled on an x86-64 machine:

```c
struct foo {
    char x[5];
    uint16_t i;
    char y;
};
struct foo bar[16];
```

A. `sizeof(struct foo)` is 8.

B. Swapping the order of `x[]` and `i` in the `struct foo` declaration changes `sizeof(struct foo)`.

C. `malloc(sizeof(struct foo))` will return storage aligned neither more coarsely nor more finely than needed by `struct foo`.

D. In general, for any `struct str` whose members are of any C type, whether a basic x86-64 C type (e.g., `long`, `char`) or a derived type built from such basic types (e.g., array of `chars`, `struct`, `pointer`), sorting `struct str`’s members in increasing order of alignment in the `struct str` declaration yields the smallest possible `sizeof(struct foo)`.
Example True/False/Don’t Know Question

Consider the following C structure and its use, which are to be compiled on an x86-64 machine:

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A. `sizeof(struct foo)` is 8. **False.**

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B. Swapping the order of `x[]` and `i` in the `struct foo` declaration changes `sizeof(struct foo)`. **True.**

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D. In general, for any `struct str` whose members are of any C type, whether a basic x86-64 C type (e.g., `long`, `char`) or a derived type built from such basic types (e.g., array of `chars`, `struct`, pointer), sorting `struct str`’s members in increasing order of alignment in the `struct str` declaration yields the smallest possible `sizeof(struct foo).`
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C. `malloc(sizeof(struct foo))` will return storage aligned neither more coarsely nor more finely than needed by `struct foo`. **False.**
D. In general, for any `struct str` whose members are of any C type, whether a basic x86-64 C type (e.g., `long`, `char`) or a derived type built from such basic types (e.g., array of `chars`, `struct`, pointer), sorting `struct str`’s members in increasing order of alignment in the `struct str` declaration yields the smallest possible `sizeof(struct foo).`
Consider the following C structure and its use, which are to be compiled on an x86-64 machine:

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A. `sizeof(struct foo)` is 8. **False.**
B. Swapping the order of `x[]` and `i` in the `struct foo` declaration changes `sizeof(struct foo)`. **True.**
C. `malloc(sizeof(struct foo))` will return storage aligned neither more coarsely nor more finely than needed by `struct foo`. **False.**
D. In general, for any `struct str` whose members are of any C type, whether a basic x86-64 C type (e.g., `long`, `char`) or a derived type built from such basic types (e.g., array of `chars`, `struct`, `pointer`), sorting `struct str`’s members in increasing order of alignment in the `struct str` declaration yields the smallest possible `sizeof(struct foo)`. **True.**