

UNIVERSITY OF EDINBURGH  
COLLEGE OF SCIENCE AND ENGINEERING  
SCHOOL OF INFORMATICS

**INFORMATICS 2C:  
COMPUTER SYSTEMS AND SOFTWARE ENGINEERING**

**Thursday 8 December 2005**

**09:30 to 11:30**

Convener: Mark Jerrum  
External Examiner: Rob Irving

**INSTRUCTIONS TO CANDIDATES**

1. Candidates in the third or later year of study for the degrees of MA(General), BA(Relig Stud), BD, BCom, BSc(Social Science), BSc(Science) and BEng should put a tick (✓) in the box on the front cover of the script book.
2. Answer Parts A, B and C. The multiple choice questions in Part A are worth 50% in total and are each worth the same amount. Mark one answer only for each question - multiple answers will score 0. Marks will not be deducted for incorrect multiple choice exam answers. Raw multiple choice scores may be rescaled at the discretion of the exam board. Parts B and C are each worth 25%. Answer ONE question from Part B and ONE question from Part C. If you attempt two questions in either Part B or Part C, cross out one answer; if you do not, then the examiners will cross out the last question you answered in each Part.
3. Use the special mark sheet for Part A. Answer Parts B and C each in a separate script book.

Write as legibly as possible.  
**CALCULATORS ARE NOT PERMITTED.**

**Part A**

**ANSWER ALL QUESTIONS IN PART A. Use the special mark sheet.**

1. Which of the following interactions is **not** expressible in a use case diagram?
  - (a) a user interacting with a class or object
  - (b) an class or object interacting with another class or object
  - (c) a user interacting with a user
  - (d) none of the above – they are all expressible
  
2. Which of the following is a valid entry in the operations compartment of a class in a class diagram?
  - (a) bottlesInCellar(w : Wine) : Integer
  - (b) casesInReserve(Wine) : Integer
  - (c) \*bottlesOnOrder : Integer
  - (d) all of the above
  - (e) none of the above
  
3. Which of the following is an instance of the *generalization* relation between classifiers?
  - (a) association between classes
  - (b) reference to one object by another
  - (c) class inheritance
  - (d) the <<uses>> relation in a class diagram
  
4. A sample of 1000 hard disk drives is tested with continuous read/write accesses for one year. At the end of the year, 100 drives have failed. Which of the following can be reasonably stated?
  - (a) The mean time to failure for this brand is one year.
  - (b) The rate of occurrence of failures in this brand is about one per decade.
  - (c) The probability of failure on demand is 0.1.
  - (d) The probability of failure on demand is 0.001.

5. In the terminology of process improvement, a process is *methodical* if:
- (a) Staff are required to keep time sheets showing when they worked on which piece of code.
  - (b) The process follows rules specified in the Quality Manual.
  - (c) The process uses a defined development method such as UP or Extreme Programming
  - (d) none of the above
6. The term of protection for a patent is:
- (a) 5 years
  - (b) the life of the inventor
  - (c) 17 years
  - (d) the life of the inventor plus 25 years

***In the real exam, there will be about twice as many MCQ questions of this type on the SE thread.***

7. What does the following C function do (when it runs on a 32-bit machine)?

```
unsigned int
mystery(unsigned int x)
{
    x |= (x >> 1);
    x |= (x >> 2);
    x |= (x >> 4);
    x |= (x >> 8);
    x |= (x >> 16);
    return (x & ~(x >> 1));
}
```

- (a) Counts the number of 1's in x.
- (b) Counts the number of 0's in x.
- (c) Divides x by  $2^{17} - 1$ .
- (d) Returns a number based on x with all the 1's in x except for the most significant cleared.
- (e) None of the above.

8. Consider a direct-mapped cache with 1024 blocks/lines, each containing one 32-bit word. How many bits are needed for the index field, assuming 32-bit addresses?
- (a) 10
  - (b) 12
  - (c) 18
  - (d) 20
  - (e) 22
9. Using 2's complement, 8-bit arithmetic, which of the following is the result of  $114 + 28$ ?
- (a) 142
  - (b) -114
  - (c) -28
  - (d) -14
  - (e) -15
10. Which of the following boolean expressions is equivalent to  $\bar{a}.\bar{b}.\bar{c} + \bar{a}.\bar{b}.c + a.\bar{b}.\bar{c} + a.\bar{b}.c$
- (a)  $a.\bar{b}$
  - (b) 0 (false)
  - (c)  $\bar{a}.c$
  - (d)  $\bar{b}$
  - (e)  $c$

**In the real exam there will be 12 questions like these for the systems part.**

**Part B**

**ANSWER ONE QUESTION FROM PART B**

1. Useful data for costing a project include the estimated amount of code that has to be written. One traditional measure is *lines of code*. Explain why this is not by itself a meaningful measure.

[5%]

Explain how the notion of *function points* attempts to improve on *lines of code* as a metric. Describe briefly how to calculate the number of function points.

[10%]

You are charged with costing a proposed project to write the control software for a new European–Japanese space probe. Describe the possible techniques available to you for estimating the size of the project (whether in lines of code or function points), and say, with justification, which you would adopt.

[10%]

*In the real exam, there will be a second question of the same type, and you will choose one of them*

**Part C**

**ANSWER ONE QUESTION FROM PART C**

1. Show how the following Java program can be implemented with MIPS instructions:

```
while (a <= b) {  
    a = a + 1;  
    if (a > 10)  
        a = 0;  
    b = b - 1;  
}
```

[10%]

Give the boolean expressions for a 1-bit full-adder. You may want to use a truth table to help you derive the expressions.

[6%]

Describe the detailed steps taken when a read access hits at the (first-level) cache of a processor. Assume that the cache is direct mapped. You can choose the size of the cache, the blocks (or lines).

[9%]

2. First part of second question	[10%]
Second part of second question	[5%]
Third part of second question	[5%]
Fourth part of second question	[5%]

# Specimen Answers

## Part A

1. c
2. a
3. c
4. b
5. c
6. c
7. d
8. a
9. b
10. d



## Part B

1. (a) Because the content of a line of code is wildly language dependent: e.g. a line of SQL may be hundreds or thousands of lines of C. (3 marks for the main statement, 2 for expanding with an example or otherwise.)
- (b) 3 marks for explaining that FPs attempt to measure functionality rather than an arbitrary measure of code complexity. 5 marks for saying that they are a weighted sum of i/o, user interactions, external interfaces and files. 3 marks for saying that additional weightings are applied to estimate more abstract things such as code re-use, the amount of distributed processing, etc.
- (c) 4 marks for describing most of algorithmic cost modelling, expert consensus, analogy, available effort, available funds. 2 marks for describing COCOMO briefly (plus 2 bonus marks for people who go into more detail than was on the slides). 4 marks for a good justification – which will almost certainly be a.c.m. and probably COCOMO in particular, on the grounds that this is a highly complex project costing hundreds of millions, so neither the commissioners nor the auditors will accept anything less than the fullest possible analysis! (Which does not say that it is the most reliable analysis.)

## Part C

1. (a) Assume  $a$  is held in  $\$s0$  and  $b$  in  $\$s1$ .

```
        li    $t1, 10
loop:   slt   $t0, $s1, $s0    # is b < a?
        bne  $t0, $zero, end  # yes? out of the loop!
        addi $s0, $s0, 1
        slt  $t0, $t1, $s0    # is 10 < a?
        beq  $t0, $zero, skip # no? skip
        add  $s0, $zero, $zero # a = 0
skip:   addi $s1, $s1, -1     # b--
        j    loop
end:
```

- (b) If  $c$  is the carry in,  $sum = \bar{a}.\bar{b}.c + \bar{a}.b.\bar{c} + a.\bar{b}.\bar{c} + a.b.c$   
 $carry = a.b + a.c + b.c$
- (c) *book work*
2. (a) Answer  
(b) Answer  
(c) Answer  
(d) Answer