

**UNIVERSITY OF LONDON**

**GOLDSMITHS COLLEGE**

**B. Sc. Examination 2013**

**COMPUTING AND INFORMATION SYSTEMS**

**IS51009B (COMP101)**

**Data Representation and Architecture Modelling**

**Duration: 2 hours 15 minutes**

**Date and time:**

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*There are five questions in this paper. You should answer no more than THREE questions. Full marks will be awarded for complete answers to a total of THREE questions. Each question carries 25 marks. The marks for each part of a question are indicated at the end of the part in [.] brackets.*

*There are 75 marks available on this paper.*

*Electronic calculators must not be programmed prior to the examination. Calculators which display graphics, text or algebraic equations are not allowed.*

**THIS PAPER MUST NOT BE REMOVED FROM THE  
EXAMINATION ROOM**

## QUESTION 1

(a) (i) Which one of the following statements is **CORRECT**?

- (1) A word is always two bytes.
- (2) A Unicode character can be stored in 8 bits.
- (3) One byte can be represented by two hexadecimal digits.
- (4) None of the above.

[ 2 Marks ]

(ii) Which of the following statements about 8-bit two's complement are **CORRECT**? More than one answer may apply.

- (1) The representable range is -127 to +128.
- (2) The representable range is -128 to +127.
- (3) The most significant bit has a weight of  $-2^8$ .
- (4) To calculate  $-x$  from  $x$ , we flip all the bits and add 1.

[ 3 Marks ]

(iii) Which of the following statements about IEEE 754 single precision floating point numbers are **CORRECT**? More than one answer may apply.

- (1) The exponent is represented in two's complement notation.
- (2) The word 11111111110000000000000000000000 represents *NaN*.
- (3) The word  $80000000_{16}$  represents the number -0.
- (4) The number  $8.1_{10}$  can be represented exactly.

[ 3 Marks ]

(b) (i) Calculate the 8-bit two's complement representation of the following decimal numbers:

$$x = 112, \quad y = 21, \quad z = -67$$

(ii) Showing details of your working, calculate using signed 8-bit two's complement the following sums:

$$x + y, \quad y + z, \quad x + z$$

Which one results in an overflow?

[ 7 Marks ]

(c) (i) Give the 32-bit IEEE 754 representation of the floating point number  $-5.125_{10}$ .

(ii) How would  $-\infty$  and the smallest normalised number be represented in this 32-bit format?

[ 10 Marks ]

## QUESTION 2

- (a) (i) Which one of the following have the shortest access time?
- (1) Cache.
  - (2) RAM.
  - (3) ROM.
  - (4) Hardisk.

[ 2 Marks ]

- (ii) Which one of the following statements is **CORRECT**?
- (1) The address bus is used by the CPU to direct and monitor the actions of the other functional areas of the computer.
  - (2) The data bus handles the transfer of all data and instructions between functional areas of the computer.
  - (3) The control bus consists of all the signals necessary to define any of the possible memory address locations within the computer
  - (4) None of the above.

[ 3 Marks ]

- (iii) The principle of locality of reference justifies the use of:
- (1) Virtual memory.
  - (2) Interrupts.
  - (3) Main memory.
  - (4) Cache memory.

[ 3 Marks ]

- (b) How does a full associative memory cache differ from direct mapped one? State the advantages and disadvantages of each.

[ 6 Marks ]

- (c) Consider a direct-mapped cache with the following characteristics:

- 20-bit address
- four words per block
- 1024 cache lines (i.e. the cache can store up 1024 blocks),

- (i) Find the number of bits representing the word id.
- (ii) Find the number of bits representing the cache line id.
- (iii) Find the number of bits representing the tag id.
- (iv) What line of the cache is supposed to hold the block that contains the word from the twenty-bit address  $3A456_{16}$ . What is the tag number that will be stored with the block?

[ 11 Marks ]

### QUESTION 3

- (a) (i) Which one of the following statements is **CORRECT** about system software?
- (1) It includes programs that enable you to perform various tasks required at home, school, and business.
  - (2) It helps run the computer and coordinate instructions between application software and the computer's hardware devices.
  - (3) Microsoft Word is an example of system software.
  - (4) It contains formulas that are preprogrammed into your software.

[ 2 Marks ]

- (ii) Which of the following statements about software are **CORRECT**? More than one answer may apply.

- (1) All data in a file is stored as binary numbers.
- (2) A file format specifies how to interpret the sequence of numbers stored in a file.
- (3) File extensions are used to decide which operating system to use when opening the file.
- (4) Programs and data can be stored as files on secondary storage.

[ 3 Marks ]

- (iii) Which of the following statements about pipelined processors are **CORRECT**? More than one answer may apply.

- (1) Adding more pipeline stages usually increases control and data hazards.
- (2) Adding more pipeline stages is one good way to increase the clock rate of a processor.
- (3) Changing the number of pipeline stages typically requires changes in the instruction set architecture.
- (4) Adding more pipeline stages always improves performance.

[ 3 Marks ]

- (b) Describe three different types of pipelining hazards and explain two ways used to reduce the pipeline stall time.

[ 8 Marks ]

- (c) Consider a pipeline that has five stages: instruction fetch (IF), instruction decode (ID), instruction execution (EX), memory access (MEM), write back (WB).

<b>Add</b> $r_1, r_2, r_3$	store the result of $r_2 + r_3$ in $r_1$
<b>Sub</b> $r_1, r_4, r_1$	store the result of $r_4 - r_1$ in $r_1$
<b>Add</b> $r_6, r_5, r_1$	store the result of $r_1 + r_5$ in $r_6$

- (i) Does pipeline execution of the above sequence of instructions generate a hazard? If yes, what type of hazard is it?
- (ii) Fill in the table below to show how this sequence of instructions executes. Show stalls in the schedule, if any, by writing “stall” in that square. The first row for the **Add** instruction is written for you. How many clock cycles does it take for the instruction sequence to complete?

Clock Cycle	1	2	3	4	5	6	7	8	9	10	11	12
<b>Add</b> $r_1, r_2, r_3$	IF	ID	EX	MEM	WB							
<b>Sub</b> $r_1, r_4, r_1$												
<b>Add</b> $r_6, r_5, r_1$												

- (iii) Forwarding is a technique used to reduce pipeline stalls: forwarding allows a stage to send a computed value on to the location(s) in the pipeline waiting for it. Fill in the table below to show how this sequence of instructions executes if forwarding is implemented. How many clock cycles does it take for the instruction sequence to complete?

Clock Cycle	1	2	3	4	5	6	7	8	9	10
<b>Add</b> $r_1, r_2, r_3$	IF	ID	EX	MEM	WB					
<b>Sub</b> $r_1, r_4, r_1$										
<b>Add</b> $r_6, r_5, r_1$										

[ 9 Marks ]

#### QUESTION 4

- (a) (i) Which one of the following statements is **CORRECT**? A page fault occurs when
- (1) the page is corrupted by application software.
  - (2) the page is in memory.
  - (3) the page is not in memory.
  - (4) one tries to divide a number by 0.

[ 2 Marks ]

- (ii) Which one of the following statements is **CORRECT**? The size of virtual memory depends on
- (1) the size of the data bus.
  - (2) the size of main memory.
  - (3) the size of address bus.
  - (4) none of the above.

[ 3 Marks ]

- (iii) Which of these statements are **CORRECT** about cache memory? More than one answer may apply.
- (1) Cache memory uses temporal and spatial localities to enhance a computer's performance.
  - (2) Temporal locality: if a particular memory location is referenced at a particular time, then it is likely that nearby memory locations will be referenced in the near future.
  - (3) A cache miss refers to a failed attempt to read or write a piece of data in the cache.
  - (4) Direct mapped-cache: each memory location maps to just one location in the cache.

[ 3 Marks ]

- (b) What is the role of the process control block (PCB)? Write down the information included in a PCB.

[ 7 Marks ]

- (c) (i) What is the difference between swapping and paging?  
(ii) What are the advantages/disadvantages of a small size page over a large one.

[ 10 Marks ]

## QUESTION 5

- (a) (i) Which protocol is used for reliably transporting data on the Internet?
- (1) UDP.
  - (2) SMTP.
  - (3) TCP.
  - (4) HTTP.

[ 2 Marks ]

- (ii) Which one of the following statements gives a correct description of POP3 and IMAP?
- (1) Two different protocols to send emails.
  - (2) Two different protocols to send and retrieve emails.
  - (3) Two different protocols to publish web pages.
  - (4) Two different protocols to retrieve emails.

[ 3 Marks ]

- (iii) Which one of the following statements is **NOT CORRECT**?
- (1) TCP stands for Transmission Control Protocol.
  - (2) IP adds header information to data so that it can be routed effectively from a source to a destination computer through the Internet.
  - (3) IP addresses are used to specify the location of a specific computer connected to the Internet.
  - (4) TCP compresses and decompresses packets so they can be transferred efficiently.

[ 3 Marks ]

- (b) Explain how error control is achieved in the TCP/IP model and state which layer is responsible for this.

[ 7 Marks ]

- (c) Suppose you are given a host with an IP address 192.115.65.103 and a subnet mask 255.255.255.248
- (i) What network class does it belong to?
  - (ii) What is the subnet address?
  - (iii) What is the host address?
  - (iv) What is the broadcast address?
  - (v) What is the number of possible hosts and range of host addresses in this subnet?

[ 10 Marks ]