Queen Mary
University of London

***BSC HONS / BSC(ENG) HONS / MSCI HONS* Examination by course unit**

Thursday 4 May 2017 2:30 pm

ECS404U Computer Systems and Networks

Duration: 2 hours 30 minutes

YOU ARE NOT PERMITTED TO READ THE CONTENTS OF THIS QUESTION PAPER UNTIL INSTRUCTED TO DO SO BY AN INVIGILATOR

Answer ALL Four Questions.

Cross out any answers that you do not wish to be marked.

Calculators are permitted in this examination. Please state on your answer book the name and

type of machine used.

Complete all rough workings in the answer book and cross through any work that is not to be assessed.

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EXAM PAPERS MUST NOT BE REMOVED FROM THE EXAM ROOM

Examiners:
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Akram Alomainy

Question 1

This question is about Computer Architecture

(a) Give short definitions of the following concepts:

(i) microprocessor

(ii) microcontroller

Explain what distinguishes one from the other. **[5 marks]**

(b) Explain whether you would expect the following devices to contain a microprocessor, microcontroller, both, or neither. Give reasons for your answer.

(i) a smartphone

(ii) a burglar alarm

(iii) a television set

(iv) an electric fire

[5 marks]

(c) One of the ways in which modern computers differ from the von Neumann model is that instead of a single memory, there is a **memory hierarchy**. Explain what is meant by the memory hierarchy. Explain how it is ordered. List three things you would typically expect to find in the memory hierarchy, state how they are ordered in it, and explain why they are in this ordering. **[5 marks]**

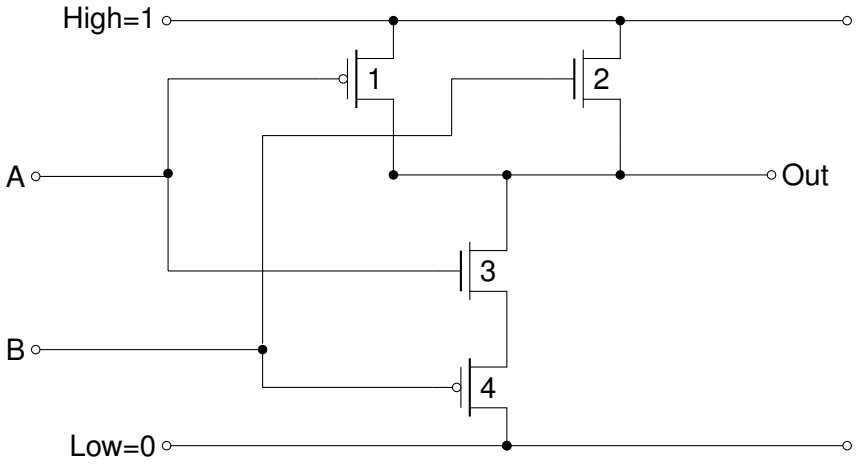
(d) Define the notion of **cache** as used in computer architecture and give two examples of computations, one illustrating when such a cache is efficient and one illustrating when it is inefficient. Explain why in each case. **[5 marks]**

(e) The diagram below depicts a logic gate.

(i) Explain the difference between the transistors labelled 1 and 2.

(ii) When A is High (1) and B Low (0), explain which transistors are on and off.

(iii) Explain what voltage is at Out under those circumstances.



[5 marks]

Question 2

This question is about forms of digital representation.

(a) This part of the question is about hexadecimal, binary and text representation.
The following sequence is obtained as the hex dump of the contents of a short text file encoded in UTF-8:
`6162 636a 6b41 4243 4a4b 3031 3233`
Recall that the ASCII code for the character '0' (zero) is 48, for the character 'A' it is 65, and for the character 'a' it is 97 (these are expressed in decimal).

(i) Give the bit sequences represented by:
- The first group of four hex digits: `6162`
- The third group of four hex digits: `6b41`

Explain how you reach your answers.

(ii) Explain the link between ASCII and UTF-8, and also explain why UTF-8 is different from ASCII.

(iii) Explaining your reasoning, what character sequence is represented by the entire sequence given above?

[10 marks]

(b) This part of the question is about binary representation of numbers.

(i) What numbers are represented by the 8-bit sequences `1100 0111` and `0001 0001` when viewed as **unsigned integers**? (Explain your reasoning.)

(ii) What numbers are represented by the 8-bit sequences `1100 0111` and `0001 0001` when viewed as **signed integers** in 8-bit two's complement? (Explain your reasoning.)

(iii) Show that you understand how to perform long multiplication in binary by using it to multiply these two numbers. Give your working.

(iv) What does your answer represent when viewed as an unsigned integer?

(v) What do the eight rightmost bits of your answer represent when viewed as an integer in 8-bit two's complement?

[10 marks]

(c) For this part question assume that each pixel on a camera is coloured and uses 24-bit colour.

(i) Calculate how much storage is required to store an uncompressed image taken by a 13 Megapixel camera.

(ii) Explain why cameras use compression to store images, name the usual compression algorithm used, and explain why lossy, rather than non-lossy compression is used.

[5 marks]

Question 3

This question is about Assembly Language

(a) Considering that data lives in the RAM and calculations happen in the CPU, what bottleneck issues might this create with regards to speed of operations.

[5 marks]

(b) Explain what Compilation is in terms of computer programming and how it is linked to Assembly language. **[4 marks]**

(c) Explain what the MIPS instruction

```
subu $t2 $t0 $t1
```

does, where $t0, $t1, and $t2 are registers. Explain whether the operation can be used on unsigned and signed numbers and if not, what instruction should be used.
Now write a MIPS program that will load the values 55 and 31 into registers $t0, and $t1, respectively, and use the instruction above to perform the subtraction and therefore store the outcome into memory location y.

[7 marks]

(d) Write a MIPS program that will load the values stored in memory locations x and y into registers $t0 and $t1, respectively, and then perform subtractions on these two signed numbers with the results saved in register $t2.
Then, multiply the outcome of this subtraction by the value in register $t0 and ensure that the full multiplication process outcome is saved into the main memory locations w and z.

[9 marks]

Question 4

This question is about Computer Networks

(a) Networks work in one of two ways: circuit-based and packet-based networking, Explain each type with examples and define whether modern networks are circuit or packet-based. **[6 marks]**

(b) Mention at least one example for each of the following layers in the OSI networking model:

i) application

ii) transport

iii) internet

iv) link

[4 marks]

(c) If SMTP (Simple Mail Transfer Protocol) is used for sending e-mails, what are the three common protocols used in receiving emails in computer networking? Also mention in your answer the two common mail Messaging Structures standards used.

[5 marks]

(d) Packets are used in computer networking to encapsulate messages and important information for communications between different machines and ports. What are packets called for TCP (Transmission Control Protocol) and IP (Internet Protocol)?

[4 marks]

(e) Usually in a TCP packet header a port number is mentioned, what does this number signify and are these ports public or private? The TCP packet header also includes a field for 'checksum'. What is this used for?

[6 marks]

End of questions