Queen Mary
University of London

Main Examination Period 2017-2018

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.

Instructions: This paper contains FOUR questions. **Answer ALL 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.

Possession of unauthorised material at any time when under examination conditions is an assessment offence and can lead to expulsion from QMUL. Check now to ensure you do not have any notes, mobile phones, smartwatches or unauthorised electronic devices on your person. If you do, raise your hand and give them to an invigilator immediately.

It is also an offence to have any writing of any kind on your person, including on your body. If you are found to have hidden unauthorised material elsewhere, including toilets and cloakrooms it will be treated as being found in your possession. Unauthorised material found on your mobile phone or other electronic device will be considered the same as being in possession of paper notes. A mobile phone that causes a disruption in the exam is also an assessment offence.

Exam papers must not be removed from the exam room.

Examiners: Dr A Alomainy and Prof E Robinson

Question 1

This question is about Computer Architecture

(a) Explain the function of each of these standard computer components

(i) central processing unit (CPU)

(ii) main memory

(iii) long-term memory

(iv) motherboard

[5 marks]

(b) Figure 1, taken from course notes, shows the HP Proliant BL660c, a rack-mounted server. Draw a diagram of the von Neumann computer architecture and explain one way in which the Proliant conforms to the architecture, and one way in which it differs.

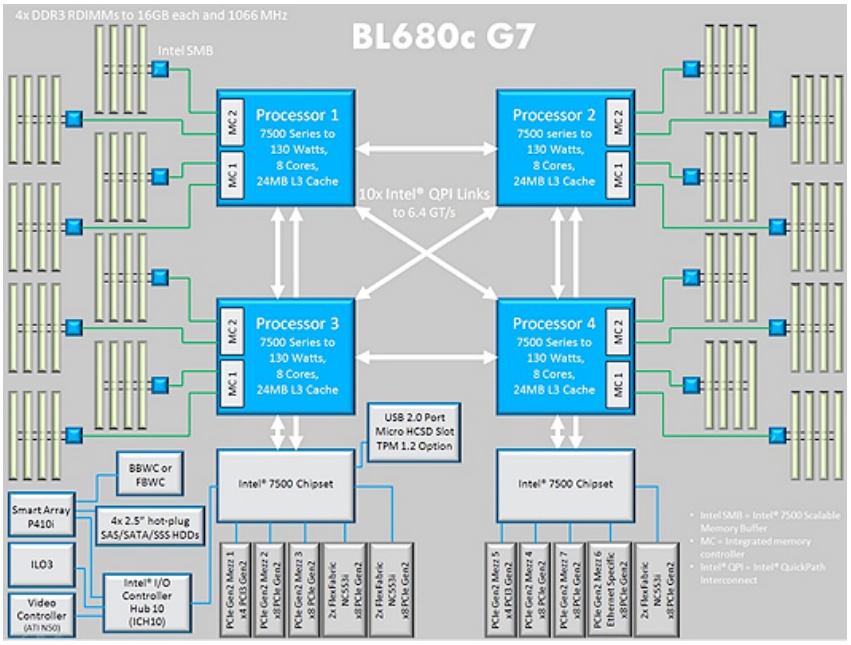

Figure 1: HP Proliant BL660c

[5 marks]

(c) Explain the concept of *memory hierarchy*, give an example of a typical memory hierarchy and explain why the members of the hierarchy are in the order you have given. **[5 marks]**

(d) Transistors as switches. The transistors used in VLSI have three connections: *gate*, *source* and *drain*.

(i) Explain the roles of these connections when the transistor functions as a switch.

(ii) Explain the difference between *nmos* and *pmos* transistors in terms of this functionality.

[5 marks]

Question continues on next page

(e) Figure 2 shows a standard SRAM memory cell. Describe the two possible stable states it can be in (determined by the potential on A and B) when the two transistors at W1 and W2 are off so that when viewed as switches, these switches are open.

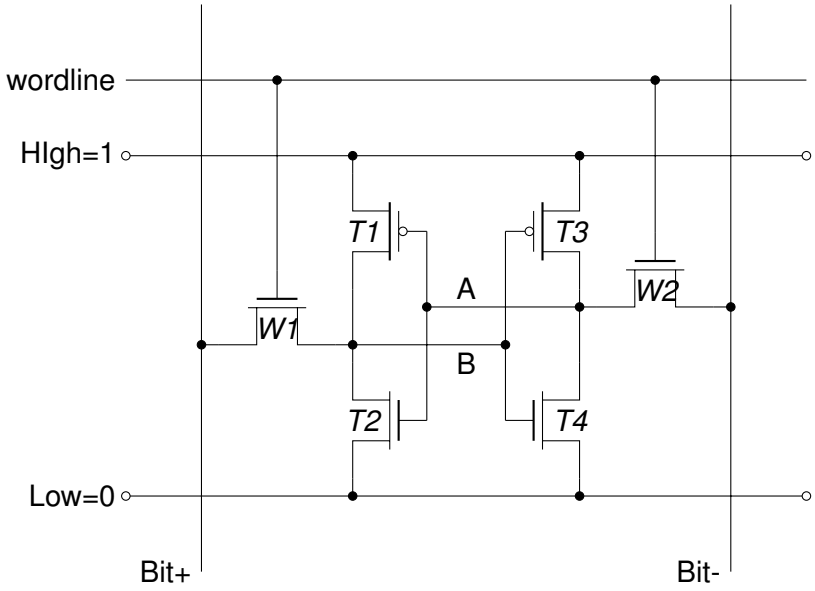

Figure 2: SRAM memory cell

[5 marks]

Question 2

This question is about forms of digital representation.

(a) This part is about the binary representation of (unsigned) numbers, and addition and multiplication in binary.

(i) The following bit sequences represent unsigned integers in binary form. Translate them to standard decimal explaining your reasoning:

- `0010 1101`
- `0001 0101`

(ii) Using the standard *binary long addition* algorithm, compute the *sum* of `0010 1101` and `0001 0101` as unsigned binary integers. Your answer should also be an unsigned binary integer.

(iii) Using the standard *binary long multiplication* algorithm, compute the *product* of `0010 1101` and `0001 0101` as unsigned binary integers. Your answer should also be an unsigned binary integer.

[8 marks]

(b) This part is about binary representation of signed integers.

(i) Explain how 8-bit two's complement represents negative numbers, using the example of the representation of the decimal number -30.

(ii) Give one key reason why computers use two's complement to represent signed integers, rather than, as we do, a direct representation of sign and magnitude.

[5 marks]

(c) This part is about the concept of byte and the difference between Big and Little Endian representations.

(i) Explain what is meant by a *byte*.

(ii) 32-bit two's complement is a representation of signed integers using 32 bits, but can (in principle) be implemented as either big or little endian. Explain the difference between big and little endian using the byte sequence:

01111001 11110001 11110010 11110011

You do not need to calculate exactly which numbers this represents in the two forms, but do need to explain the difference.

[5 marks]

(d) 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 ASCII. For the avoidance of confusion, we are using modern ASCII where characters are 8 bits:
`4153 4349 4931 3233 3461 7363 6969`
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).

Question continues on next page

(i) Give the bit sequences represented by:

- The first group of four hex digits: `4153`
- The third group of four hex digits: `4931`

Explain how you reach your answers.

(ii) Given that character codes are each 8 bits, translate the second group of four hex digits into two decimal codes, each between 0 and 127.

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

[7 marks]

Question 3

This question is about Assembly Language

(a) Explain the main cause of processing delays in executing programs and functions as linked to memory and data exchange and highlight a solution commonly used in computer architectures to overcome this bottleneck issue. **[4 marks]**

(b) Explain what a register is, and where arithmetic operations take place in a computer. Explain what the MIPS instruction

```
li $t0 30
```

does, where $t0 is a register, and where z is a location in the main memory and how it is different that $la . Explain also what the MIPS instruction

```
sw $t1 x
```

does, where $t1 is a register, x is is a memory location.

[4 marks]

(c) Mention three methods that are used by the MIPS Assembler to get data into the program.

[3 marks]

(d) Explain what the MIPS instruction

```
div $t1 $t0
```

does, where $t0, and $t1 are registers. Would the instruction store the outcome in one register? If not then explain your answer by describing exactly where it will be saved.

[7 marks]

(e) Now write a MIPS program that will load the numbers 40 and 80 into registers $t0 and $t1, respectively, and then divides $t1 by $t0 . Then the program should store the full division results into registers $t2 and $t3 followed by storing in memory locations w and z, respectively. **[7 marks]**

Question 4

This question is about Computer Networks

Figure 3 shows the Wireshark program displaying a packet it has captured (we are looking at packet No. 338 below towards the end of the top pane).

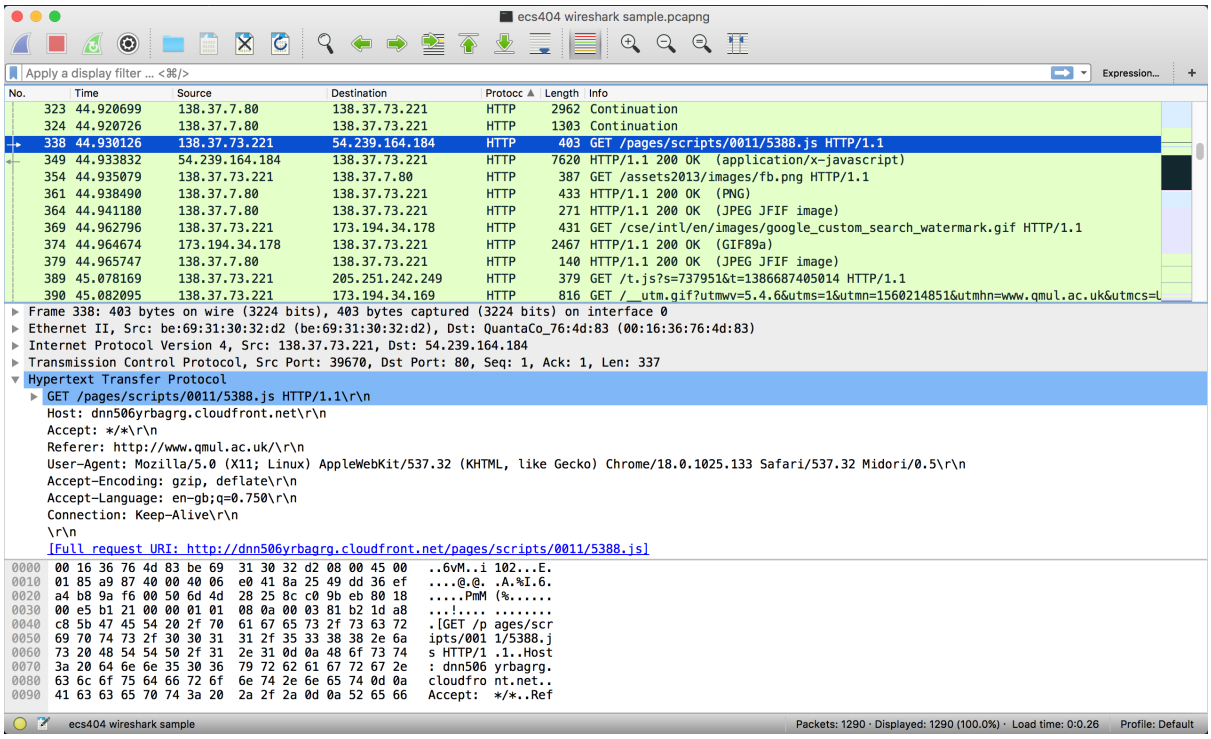

Figure 3: Wireshark display of packet 338

(a) Which protocols are being used in the following layers:

i) application

ii) transport

iii) internet

iv) link

In each case identify how you know the answer from the screenshot.

[5 marks]

(b) Identify the source and destination IP addresses for this specific packet and explain what message is being sent. How is packet (338) related to packet (349)?

[6 marks]

(c) Which 'ports' are being used (packet 338) and what is their function?

[4 marks]

(d) Packets are used in computer networking to encapsulate messages and important information for communications between different machines and ports. What are

Question continues on next page

packets called for TCP (Transmission Control Protocol) and IP (Internet Protocol)? What is SMTP and what is it used for?

[4 marks]

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

End of questions