Queen Mary
University of London

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

Monday, 9 May, 2016, 10:00 am

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:

Edmund Robinson

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Question 1

This question is about Computer Architecture

(a) Draw an architecture diagram of a von Neumann machine and label the parts.

[5 marks]

(b) Give one example of a way in which the architecture of a modern PC conforms to that of a von Neumann Machine and one way in which it differs. Include a sentence or two in justification of each. **[4 marks]**

(c) Give an example of a modern machine that most people would not normally think of as a computer, but which can nevertheless be regarded as one. Justify your answer both in terms of the way it functions, and its internal architecture. **[4 marks]**

(d) State *Moore's Law*. For maximal credit give the property that Moore originally formulated. Explain how you can observe the continuing effects of this law by reference to the processor chips used on mobile phones.

[6 marks]

(e) Define the concepts of:

(i) latency

(ii) bandwidth

For each of these give the units in which it is measured and an example of a communication situation where it is the key limiting factor. **[6 marks]**

Question 2

This question is about forms of digital representation.

(a) This part of the question is about spotting a representation in the wild.
A new computer game you have bought comes with a key: "97af e4b3 0651 3cd2". You are told to omit the spaces when you type it in. What representation do you think is being used? How many bits are represented? And what bit sequence does it represent? **[4 marks]**

(b) This part of the question is about the 2's complement representation of signed integers. It uses 8-bit 2's complement as an example.

(i) What is the largest positive number that can be represented in 8-bit 2's complement, and what is its representation?

(ii) What is the smallest negative (i.e. most negative) number that can be represented and what is its representation?

(iii) What number is represented by 10010101? Explain your reasoning.

[5 marks]

(c) This part of the question is about floating point representation. It uses the IEEE 64-bit standard as an example, but any necessary details of that representation are summarised here. The IEEE standard representation has three components. One component is the *sign* of the representation, given by a single bit representing '+' or '-'. The next component is the *exponent*, consisting of 12 bits, representing the numbers from -1022 to 1023. The final component represents the *significand* and it consists of 51 bits, where $b_1 b_2 \ldots b_{51}$ represents the binary $1.b_1 b_2 \ldots b_{51}$, so that $00\ldots0$ represents $1.00\ldots0$ and $10100\ldots0$ represents $1.10100\ldots0$.

(i) If we write the largest positive number that can be represented in this format as $2^x * y$, where y is a binary expansion between 1 and 2, then what is x and what is y?

(ii) What is the smallest number greater than 0 that can be represented? Give it in the form $2^x * y$.

(iii) What happens if we add 3 to 2^{52}? What whole numbers might we get as a result? Explain why we get these results.

[6 marks]

(d) This part is about text representation.

(i) How many bits does the ASCII character set use?

(ii) The character 'A' has number 65 in the ASCII character set, similarly 'a' has number 97 and '0' (zero) has number 48. Which characters have numbers: 67, 102, 54? Explain how you know the answers.

(iii) Give the key reason why other character representation systems, such as Unicode, were developed.

[6 marks]

(e) This part is about MP3 audio and other multimedia representation.

(i) Explain the difference between *lossy* and *non-lossy* compression?

(ii) Why does MP3 (like almost all other multimedia compression algorithms) use lossy compression?

[4 marks]

Question 3

This question is about Assembly Language

(a) Explain the concept of *Interpreters* and how they are linked to Assembly Language and in turn Machine Coding.

[5 marks]

(b) Explain what a register is, and also where arithmetic operations are performed in a computer. Explain what the MIPS instruction

```
lw $t0 x
```

does, where $t0 is a register, and how the MIPS instruction lw differs from the instruction li . Explain also what the MIPS instruction

```
sw $t2 z
```

does, where $t2 is a register and z is a memory location. What do instructions lw and sw stand for?

[6 marks]

(c) Explain what the MIPS instruction

```
mult $t0 $t1; mflo $t2
```

does, where $t0, $t1, and $t2 are registers. Explain whether the results obtained from this arithmetic operation using the instruction above will be the complete expected outcome available from register $t2.

[7 marks]

(d) Now write a MIPS program that will load the numbers 20 and 35 into registers $t0 and $t1, respectively, and then multiplies the two numbers and returns the whole 64-bit result (both lower and higher 32 bits) into registers $t2 and $t3.

[7 marks]

Question 4

This question is about Computer Networks

The figure below shows the Wireshark program displaying a packet it has captured (we are looking at packet No. 7 below towards the end of the top pane).

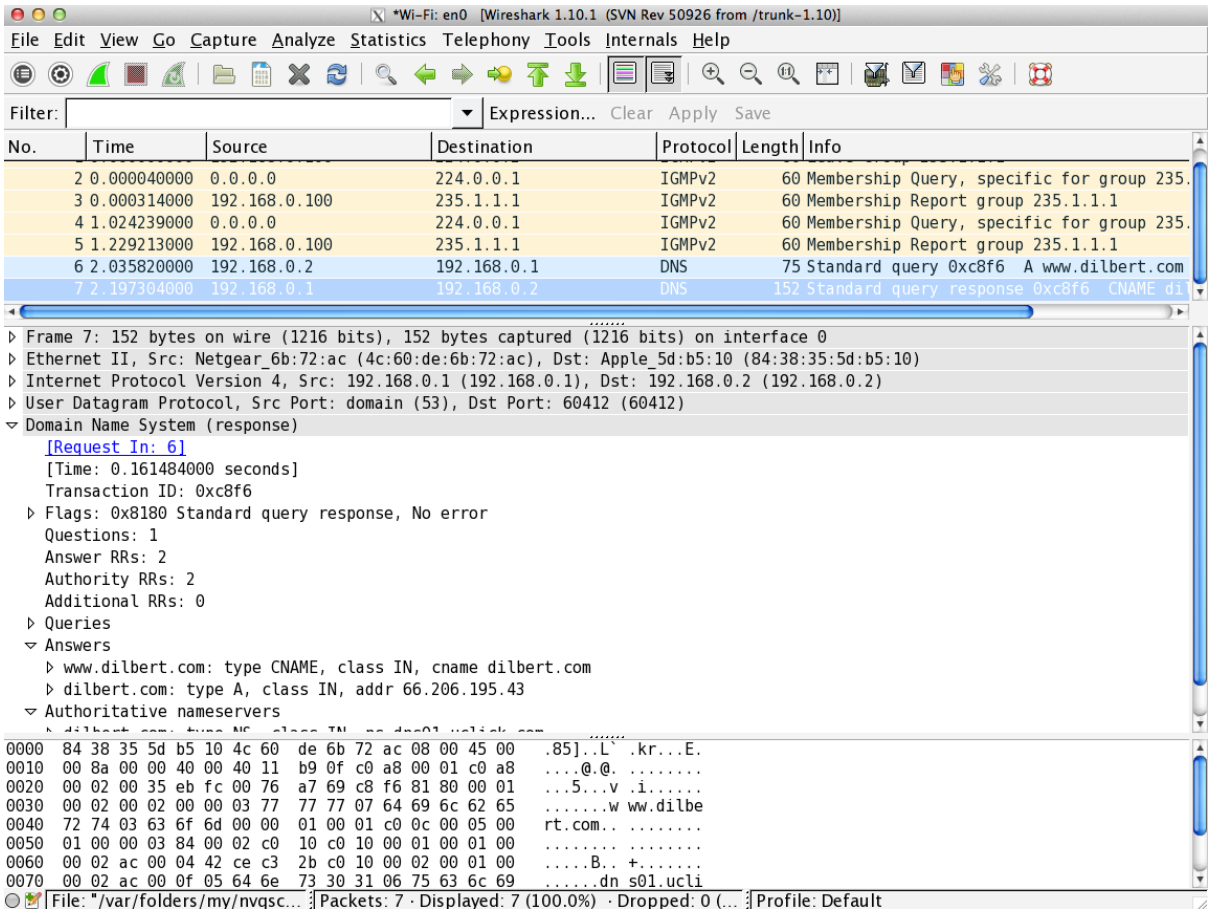

Figure 1: Wireshark display of packet 7

(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) Explain what the two IP addresses 192.168.0.1 to 192.168.0.2 represent in this communication and what message is being sent. How is packet (6) related to packet (7)?

[6 marks]

(c) Which ports are being used (packet 7) 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 packets called for TCP (Transmission Control Protocol) and IP (Internet Protocol)? What is SMTP and what is it used for?

[4 marks]

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

End of questions