CS1320

THE UNIVERSITY OF WARWICK

First Year Examinations: Summer 2015

Computer Organisation and Architecture

Time allowed: 2 hours.

Answer **FOUR** questions.

Read carefully the instructions on the answer book and make sure that the particulars required are entered on **each** answer book.

Approved calculators are allowed.

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1. (a) Explain why it is desirable to have more than one possible representation for a value. Give an example of where this might be useful in computer system design. [3]

   (b) i. Convert 158_{10} to 8-bit wide unsigned binary. [3]

   ii. Convert 1001111100100111_2 to hexadecimal. [3]

   iii. Convert 2144_{10} to octal. [4]

   iv. Explain the concept of *overflow*. Your answer should describe why the concept is relevant to computer system design. [3]

   v. Show how 18_{10} can be subtracted from 46_{10} in two's complement. [5]

   (c) Convert 2.0625_{10} to an 8-bit wide fixed point binary representation. Comment on the range of your fixed point representation. [4]

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2. (a) A 1-bit full-adder performs addition on two significant bits and a previous carry bit.

   i. State whether a 1-bit full adder is an example of a combinatorial or sequential logic circuit. Justify your answer. [4]

   ii. Design the logic circuit for a 1-bit full adder. [8]

   (b) D-type flip-flops are used in the design of many common sequential logic circuits.

   i. Draw and explain the truth table for a D-type flip-flop. [3]

   ii. Design an N-bit register using D-type flip-flops. Your design should be capable of storing N bits in response to a single clock cycle. State any assumptions. [7]

   (c) Explain the operation of a decoder. Your answer should include the truth table for an active-high 2-to-4 line decoder. [3]

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3. Karnaugh maps and Boolean algebra can be used to simplify logical expressions.

   $F = (A + \bar{B}).(\bar{A} + C).(B + \bar{C})$

   $G = W.X + \bar{W}.X.\bar{Y}.Z + \bar{W}.X.Y.Z + W.\bar{X}.\bar{Y}.\bar{Z}$

   (a) Reduce F to its simplest form using a Karnaugh map or Boolean algebra. [8]

   (b) Reduce G to its simplest form using Boolean algebra. [9]

   (c) Design a logic circuit that implements F. [8]

4. (a) Interrupts and memory mapping are common mechanisms for I/O.

      i. Explain the operation of interrupt-driven I/O. [5]

      ii. Compare the advantages and disadvantages of memory mapped I/O and interrupt-driven I/O. [5]

   (b) Microprocessors function on the basis of a set of interacting components.

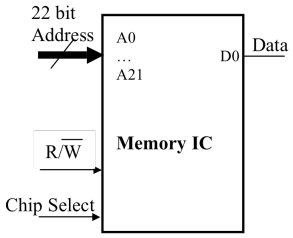
      i. Give a detailed account of the fetch-decode-execute cycle. Your answer should give details of the specific microprocessor components involved. [8]

      ii. Using a suitable example, explain how the condition code register (CCR) is used to bring about change in control flow during program execution. [4]

      iii. Distinguish between micro-operations and macro-instructions. [3]

5. (a) Explain the memory hierarchy with the aid of a diagram. Comment on the motivation for the hierarchy and its role in computer system design. [10]

   (b) The diagram below shows a 4M×1 memory integrated circuit (IC). Explain how a collection of these ICs could be organised in the design of a 16M×8 memory. Justify the organisation and state how many ICs would be required. [7]



   (c) Computer systems commonly use caches to improve performance.

      i. Outline the role of caches in the memory hierarchy. [3]

      ii. Explain what is meant by *spatial locality* and *temporal locality*. Your answer should explain how these concepts relate to cache performance. [5]