

THE UNIVERSITY OF WARWICK

First Year Examinations: Summer 2014

Computer Organisation and Architecture

Text

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) Justify the use of the binary number system in computer systems. [2]
(b) i. Convert 88_{10} to unsigned 8-bit binary. [3]
ii. Show how 28_{10} can be subtracted from 88_{10} using two's complement. [3]
iii. Convert 111110101010100_2 to hexadecimal. [3]
iv. Convert 1463_{10} to octal. [3]
v. Calculate the difference between 1463_{10} and 2545_8 in two's complement. [6]
(c) i. Explain floating point representation. Your answer should outline the advantages and disadvantages of floating point representation. [3]
ii. Convert 4.625_{10} to an 8-bit wide fixed point binary representation. Comment on the range of your fixed point representation. [2]
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2. (a) Distinguish between combinatorial and sequential logic. [3]
(b) A 1-bit full-adder performs addition on two bits and a previous carry bit.
i. Show the truth table and logic circuit for a 1-bit half adder. [4]
ii. Show how an N-bit full adder can be designed based on N 1-bit full-adders. Your answer should include the logic circuit for a 1-bit full adder. [8]
(c) D-type flip-flops are commonly used in circuit design.
i. Draw and explain the truth table for a D-type flip flop. [3]
ii. Show how D-type flip flops can be used in the design of an N-bit counter. [7]
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3. (a) Explain the motivations for the simplification of logical expressions. [4]
(b) Karnaugh maps and Boolean algebra can both be used to simplify logical expressions, such as the ones shown below.

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

- i. Simplify F using Karnaugh maps or Boolean algebra. [9]
ii. Design a logic circuit that implements F . [8]
(c) Comment on the advantages and disadvantages of using a Karnaugh map to simplify a logical expression instead of Boolean algebra. [4]
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4. (a) Explain the memory hierarchy using a labelled diagram. Your answer should focus on the motivation for the hierarchy and its role in computer system design. [10]
(b) Cache memory is commonly used to improve computer system performance.
i. Explain the term *cache memory*. [3]
ii. Explain why it is possible to significantly improve performance using relatively small cache sizes. [3]
(c) Interrupt-driven I/O is commonly used by computer systems.
i. Explain the concept of interrupt-driven I/O. Your answer should incorporate the concept of *context switching*. [5]
ii. Outline a situation where interrupt-driven I/O would be unsuitable. Your answer should suggest a more appropriate I/O mechanism for this situation. [4]
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5. (a) Distinguish between high-level and low-level programming languages. Your answer should comment on the motivations, applications and characteristics of each. [4]
(b) Microprocessors consist of a set of components that interact to provide function.
i. Explain what is meant by the term *von Neumann architecture*. [2]
ii. Explain the roles of the arithmetic logic unit (ALU), program counter (PC) and instruction register (IR) in program execution. [5]
iii. Using an example in assembler, explain how the condition code register (CCR) is used to affect change in control flow during program execution. [4]
(c) Control units can be designed using a hardwired approach.
i. Explain the role of the control unit in a microprocessor. [3]
ii. Explain how hardwired control units operate. [4]
iii. Discuss the advantages and disadvantages of a hardwired control unit design. [3]
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