1.1 Systems Architecture: 30-minute Pack

OCR J277 · Calculators not allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Convert the 8 bit binary number 11010110 to hexadecimal.

(a) Show your working and give your final answer as a two digit hexadecimal number. **(2)**

(Total for Question 1 is 2 marks)

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2 Embedded systems are different from general purpose computer systems.

(a) Explain two ways in which an embedded system is different from a general purpose computer system. **(4)**

(Total for Question 2 is 4 marks)

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3 A simple program is stored in main memory as follows:
address 200: LDA 500
address 201: ADD 501
address 202: STA 502
address 203: HALT
The table below shows the contents of the Program Counter (PC), Memory Address Register (MAR) and Memory Data Register (MDR) during three consecutive fetch cycles. Some values are missing.
Cycle 1: PC (start) = 200, MAR = (i), MDR = (ii), PC (after increment) = 201
Cycle 2: PC (start) = 201, MAR = 201, MDR = ADD 501, PC (after increment) = (iii)
Cycle 3: PC (start) = 202, MAR = (iv), MDR = STA 502, PC (after increment) = 203

(a) Complete the missing value (i), the contents of the MAR in cycle 1. **(1)**

(b) Complete the missing value (ii), the contents of the MDR in cycle 1. **(1)**

(c) Complete the missing value (iii), the contents of the PC after cycle 2. **(1)**

(d) Complete the missing value (iv), the contents of the MAR in cycle 3. **(1)**

(Total for Question 3 is 4 marks)

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4 Each of the following registers plays a specific role in the fetch, decode, execute cycle: MAR, MDR, PC, CIR, Accumulator. State the function of each register.

(a) State the function of each of the five registers: MAR, MDR, PC, CIR, Accumulator. **(5)**

(Total for Question 4 is 5 marks)

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5 A CPU has a clock speed of 3.2 GHz.

(a) Calculate the total number of clock cycles the CPU completes in 5 seconds. Show your working. **(3)**

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(Total for Question 5 is 3 marks)

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6 Clock speed is one factor that affects the performance of a CPU.

(a) Explain how increasing the clock speed of a CPU can improve its performance, and explain one reason why performance does not always increase proportionally as clock speed rises. **(3)**

(Total for Question 6 is 3 marks)

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7 A student is choosing a CPU for video editing software that has been optimised to make use of multiple cores. Two CPUs are available:
CPU X: clock speed 3.6 GHz, 4 cores, 8 MB cache.
CPU Y: clock speed 2.8 GHz, 8 cores, 12 MB cache.

(a) Using the data given, justify which CPU, X or Y, is likely to give better performance for this video editing task. **(4)**

(Total for Question 7 is 4 marks)

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8 A gaming laptop has 8 cores and a clock speed of 2.0 GHz. A rival laptop has 4 cores and a clock speed of 3.5 GHz.

(a) Discuss, using your knowledge of the factors affecting CPU performance, why the 8 core laptop is not guaranteed to run all software faster than the 4 core, higher clock speed, laptop. **(3)**

(Total for Question 8 is 3 marks)

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Mark scheme · 1.1 Systems Architecture: 30-minute Pack

Question 1

(a) Binary split into two correct nibbles: 1101 and 0110, oe **M1**

(a) D6, cao **A1**

(a) Answer: D6

Question 2

(a) point 1 identified: dedicated/single function, oe **B1**

(a) expansion: an embedded system is designed and programmed to carry out one specific task (e.g. controlling a washing machine's wash cycle), whereas a general purpose computer can run many different programs for many tasks, oe **B1**

(a) point 2 identified: limited/fixed hardware resources, oe **B1**

(a) expansion: embedded systems typically have limited processing power, memory and user interface to reduce cost, size or power consumption, because they only need to support one function, whereas general purpose computers have more powerful, flexible hardware to support varied software, oe **B1**

(a) Answer: Embedded systems have a single, dedicated function and limited/fixed hardware, unlike flexible, multi purpose general computers.

Question 3

(a) 200, cao (the address held in the PC is copied to the MAR) **B1**

(a) Answer: 200

(b) LDA 500, cao (the instruction stored at address 200) **B1**

(b) Answer: LDA 500

(c) 202, cao (PC incremented by 1 from 201) **B1**

(c) Answer: 202

(d) 202, cao (ft from (iii), copy of the PC at the start of cycle 3) **B1**

(d) Answer: 202

Question 4

(a) MAR, memory address register, holds the address of the memory location currently being read from or written to, oe **B1**

(a) MDR, memory data register, holds the data or instruction being transferred to or from memory, oe **B1**

(a) PC, program counter, holds the address of the next instruction to be fetched, oe **B1**

(a) CIR, current instruction register, holds the instruction that is currently being decoded or executed, oe **B1**

(a) Accumulator, stores the results of calculations or logic operations carried out by the ALU, oe **B1**

(a) Answer: MAR holds the address to be accessed; MDR holds the data/instruction transferred; PC holds the address of the next instruction; CIR holds the instruction being decoded/executed; Accumulator stores the results of ALU operations.

Question 5

(a) 3.2 GHz converted to Hz, 3.2 x 10^9 cycles per second, oe **M1**

(a) 3.2 x 10^9 x 5 (correct method to multiply by time in seconds) **M1**

(a) 1.6 x 10^{10} cycles, awrt (accept 16 000 000 000 or 16 x 10^9), cao **A1**

(a) Answer: 1.6 x 10^{10} clock cycles

Question 6

(a) clock speed is the number of fetch, decode, execute cycles the CPU can complete per second (measured in Hz/GHz), oe **B1**

(a) increasing clock speed means more cycles, so more instructions, can be processed per second, improving performance, oe **B1**

(a) however, increasing clock speed too far can cause the CPU to overheat/use more power, or performance may be limited by other components (e.g. RAM speed), so gains are limited, oe **B1**

(a) Answer: Higher clock speed means more instruction cycles per second, but heat/power/other bottlenecks limit further gains.

Question 7

(a) CPU Y identified as likely to give better performance for this task **B1**

(a) the software is optimised for multiple cores, so having more cores (8 vs 4) allows more threads/tasks to be processed in parallel, oe **B1**

(a) the larger cache (12 MB vs 8 MB) means more data/instructions can be stored close to the CPU, reducing time spent accessing RAM, oe **B1**

(a) although CPU X has a higher clock speed, this is less significant here because the software can make full use of extra cores rather than relying on a single fast core, oe **B1**

(a) Answer: CPU Y, because its extra cores and larger cache benefit multi-core optimised software more than CPU X's higher clock speed.

Question 8

(a) any three from: not all software is written or optimised to make use of multiple cores; some programs are single threaded and can only use one core at a time **B1**

(a) for a single threaded task, the laptop with the higher clock speed (3.5 GHz) may complete instructions faster on that one core than the 8 core laptop running at only 2.0 GHz **B1**

(a) overall performance depends on a combination of factors (clock speed, number of cores, cache size, and how well software is optimised), not on core count alone (max 3 marks awarded overall) **B1**

(a) Answer: Performance depends on clock speed, core count and software optimisation together, so more cores does not guarantee faster performance for every task.

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