S4 Information and Communication Technology Practice Paper: Number Systems and Coding, Logic Gates and Truth Tables, Image and Audio File Size, Spreadsheet Formulas and Absolute References, IP Addressing and Subnetting, Algorithm Tracing and Complexity

S4 Information and Communication Technology | Time: 75 minutes |

Question 1: Number Base Conversion and Character Encoding (20 marks)

A computer stores data in binary, and programmers often use hexadecimal as a short form. One 8-bit byte can hold an unsigned integer from 0 to 255, and the two's complement form is used for negative values.

1. Convert the binary number 1101 0110 to decimal and to hexadecimal.

2. Express -58 in 8-bit two's complement, showing both binary and hexadecimal.

3. Convert 3400 to hexadecimal and state how many 4-bit nibbles are needed.

4. In UTF-8 an English letter takes 1 byte and a common Chinese character takes 3 bytes. Compare the bytes used by 1000 letters and 1000 Chinese characters.

Question 2: Logic Gates and Truth Tables (16 marks)

A combinational logic circuit has the output Y = (A AND NOT B) OR (A AND B), where A and B are the inputs. AND, OR, NOT, NAND and XOR gates each have their own truth table.

5. Give the value of Y for the four input combinations from 00 to 11 and state what the circuit actually does.

6. Use De Morgan laws to write equivalent expressions for NOT (A OR B) and NOT (A AND B).

7. How can a single NAND gate be wired to produce NOT A?

8. What is the minimum number of NAND gates needed to build one XOR gate?

Question 3: File Size of Images and Audio (18 marks)

The size of digital media depends on resolution, colour depth, sampling rate and bit depth. Use 1 MB = 1048576 bytes and 1 kB = 1 000 bytes.

9. How many bytes and how many MB does an uncompressed 1024 x 768 image with a 24-bit colour depth occupy?

10. After lossless compression at a ratio of 8 to 1, what are the new size in bytes and in MB?

11. How many bytes and how many MB does an uncompressed 44 kHz, 16-bit, stereo recording of 180 seconds occupy?

12. A 4-minute MP3 at 128 kbps occupies how many bytes and how many MB?

Question 4: Spreadsheet Formulas and References (16 marks)

In a spreadsheet, columns A, B and C hold the item name, unit price and quantity, column D holds the amount (price x quantity), and cell E1 holds the tax rate of 5 per cent. Rows 2 to 4 hold three items, with B2 = 45 and C2 = 12.

13. If D2 contains =B2*C2, what does the formula become when copied to D4?

14. E holds the tax for each item. Write the formula for E2 so that it can be copied down while still pointing at the tax rate cell.

15. Column F should show "Wholesale" when the quantity is 10 or more and "Retail" otherwise. Write the IF function for F2.

16. Using B2, C2 and the 5 per cent tax rate, find the amount in D2, the tax in E2 and the total including tax.

Question 5: IP Addressing, Subnetting and Transmission (16 marks)

A computer has the IP address 192.168.10.35 with the prefix /26, that is the subnet mask 255.255.255.192. The remaining parts are about file transfer and network topologies.

17. Find the network address, the broadcast address and the number of usable hosts of this subnet.

18. A 5 MB file is sent over a 20 Mbps link. Ignoring overhead, find the time needed in seconds to three decimal places.

19. Give one advantage and one disadvantage of the star topology.

20. A 100 Mbps leased line measures 62 Mbps of throughput. Find its efficiency as a percentage.

Question 6: Algorithm Tracing and Complexity (14 marks)

The following pseudocode sums squares in a loop (the equals sign denotes assignment): total = 0 FOR i = 1 TO 5 total = total + i x i NEXT i The remaining parts concern search algorithms and nested loops.

21. Trace the pseudocode, giving the value of total after each i, and state the final result.

22. In 1000 sorted items, what is the maximum number of comparisons for a linear search and for a binary search?

23. A double loop runs FOR j = 1 TO 3 inside FOR i = 1 TO 4. How many times does the inner loop body run in total?

24. Replacing an O(n squared) algorithm by an O(n log n) one for 1000000 items, with log2 n = 20, how many million operations are saved and roughly how many times faster is it?

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