S5 ICT Practice Paper 4 | Subnetting, TCP/IP, databases, complexity, compression and information security

Senior Secondary ICT

S5 ICT practice paper 4: IPv4 subnetting, TCP/IP layers, normalisation and SQL, algorithm complexity, file sizes and information security, with full answers.

1. IPv4 subnetting and usable hosts (18 marks)

Usable hosts = 2^n - 2, where n is the number of host bits (network and broadcast addresses are excluded).

#	Question
1	(a) For the network 192.168.10.0/26, find the number of addresses per subnet, the number of usable hosts, and how many /26 subnets a /24 block yields.
2	(b) For the network 10.0.0.0/22, find the subnet mask, the number of addresses and the number of usable hosts.
3	(c) For the host address 172.16.5.130/27, find the network address, the broadcast address and the usable host range.
4	(d) A /24 block 192.168.1.0 must be split into at least 5 subnets with at least 25 hosts each. Find the most suitable prefix length and justify it.

2. TCP/IP layers and protocols (16 marks)

Name the layer and the protocol in each answer.

#	Question
5	(a) List the four layers of the TCP/IP model and give one protocol for each.
6	(b) Compare TCP and UDP on four points: connection, reliability, overhead and typical use.
7	(c) A link has an MTU of 1500 bytes, with a 20-byte IP header and a 20-byte TCP header. Find the MSS and the payload as a percentage of the frame.
8	(d) Outline the three steps of the TCP three-way handshake and state its purpose.

3. Database normalisation and SQL (18 marks)

Use standard SQL syntax and state the dependency when normalising.

#	Question
9	(a) State the requirements of first, second and third normal form.
10	(b) The table Enrol(student_id, student_name, class_code, class_teacher) has two dependency problems. Identify them and decompose the table into 3NF.
11	(c) Write the SQL that lists each class whose average score is above 70, with its average score.
12	(d) Write the SQL that lists every student name with the teacher of that student class (a two-table join).

4. Algorithm complexity and sorting (16 marks)

Show the expression used for each answer.

#	Question
13	(a) For a sorted array of 1,048,576 elements, how many comparisons do linear search and binary search need in the worst case?
14	(b) For 1024 elements, bubble sort makes n(n-1)/2 comparisons in the worst case while merge sort makes about n log2 n. Compute both and compare.
15	(c) Take the array [42, 17, 68, 9, 55, 23, 71, 34] and run one Lomuto partition with the last element as pivot. Give the resulting array and the pivot index.
16	(d) Order O(n^2), O(n log n), O(log n) and O(1) from slowest to fastest growth and give one example of each.

5. Digital file sizes and compression (16 marks)

1 MiB = 1,048,576 bytes and 1 MB = 1,000,000 bytes.

#	Question
17	(a) An uncompressed 1920 x 1080 bitmap at 24-bit colour depth: find its size in MiB and in MB.
18	(b) Find the size of an uncompressed 3-minute WAV file at 44.1 kHz, 16-bit, stereo.
19	(c) A row of indexed-colour pixels reads WWWWBBBBWWWWWWBBB at 1 byte per pixel. Encode it with run-length encoding using 2 bytes per (colour, count) pair, and find the compressed size and the compression ratio.
20	(d) Compare lossy and lossless compression, giving one example of each and when it is used.

6. Information security and legislation (16 marks)

Name the technique and state what it protects.

#	Question
21	(a) Compare symmetric and asymmetric encryption, giving one algorithm and one use for each.
22	(b) Explain how a digital signature provides both integrity and non-repudiation.
23	(c) Name three common network attacks and one defence for each.
24	(d) Of the six data protection principles in Hong Kong Personal Data (Privacy) Ordinance (Cap. 486), explain the two most relevant to collecting and using customer data, with one example each.