S6 ICT Practice Paper (Set 2): Data Structures and Program Tracing, IPv4 Subnetting and Transmission Time, Relational Database and SQL, Multimedia File Size and Compression, RSA and Digital Signatures, System Development and Critical Path (100 marks)

ICT · S6

S6 ICT practice paper: 24 parts, 100 marks, 75 minutes on stacks and queues, IPv4 subnetting, SQL, multimedia file size, RSA and digital signatures.

Question 1 - Data Structures and Program Tracing (16 marks)

A program implements a stack with a Python list (only append and pop) and a queue with collections.deque (append to enqueue, popleft to dequeue). The stack starts empty; the queue starts with 5 elements A, B, C, D, E with A at the front.

#	Question
1	The operations push(3), push(7), push(5), pop(), push(1), pop() are carried out in order. Write the final stack contents from top to bottom.
2	Evaluate the postfix expression 6 2 3 * - 4 2 / + and show the intermediate result after each operator.
3	The queue is dequeued twice, then F, G and H are enqueued. State the final queue length, the front element and the rear element.
4	How many pointers must be changed to insert a new node at the head of a singly linked list? How many comparisons at most does binary search need on a sorted array of 1,024 elements? Compare the time complexity of the two operations.

Question 2 - IPv4 Subnetting and Transmission Time (18 marks)

A school is allocated the network 192.168.10.0/24 and the administrator splits it into 4 equal subnets; one subnet is 192.168.10.64/26. Separately, a 12 MB file is sent over a 100 Mbps link with 8% protocol overhead (1 MB = 10^6 bytes).

#	Question
5	Write the dotted-decimal subnet mask for /26 and calculate the number of usable hosts per subnet.
6	How many bits must be borrowed to split the /24 into 4 subnets? For 192.168.10.64/26 state the network address, the broadcast address and the usable host range.
7	Calculate the time in seconds, to 4 decimal places, needed to transfer the 12 MB file over that link.
8	Should live video streaming use TCP or UDP? Give one reason and one corresponding risk.

Question 3 - Relational Database and SQL (16 marks)

A tutorial school database has three relations: Student(SID, SName, Class) with 6 students, Course(CID, CTitle, Teacher) with 3 courses, and Enrol(SID, CID, Score) with 9 enrolment records. Student S06 has no enrolment. The classes are 4A (three students), 4B (two students) and 5A (one student).

#	Question
9	State the primary key of each of the three relations and the foreign keys in Enrol.
10	Write an SQL statement that lists the number of students in each class, sorted by class, and give the result of the query.
11	If Student and Enrol are merged into EnrolAll(SID, SName, CID, CTitle, Score), explain why it violates second normal form (2NF) and give the decomposed table structure.
12	How many rows does an INNER JOIN of Student and Enrol return? How many rows does a LEFT JOIN with Student as the left table return? Explain the difference.

Question 4 - Multimedia File Size and Compression (16 marks)

A bitmap image of 1024 x 768 pixels with a colour depth of 24 bits; an uncompressed audio clip sampled at 44.1 kHz, 16-bit, stereo, 60 seconds long (1 MiB = 1,048,576 bytes).

#	Question
13	Calculate the uncompressed size of the image in bytes and in MiB.
14	If lossless compression reduces the file to one eighth, give the compressed size in bytes and KiB, and explain why a bitmap image rarely reaches that ratio.
15	Calculate the uncompressed size of the audio clip in bytes and in MiB to 3 decimal places.
16	Compare lossy and lossless compression and state which one should be used for digital camera photos and for medical scan images.

Question 5 - RSA and Digital Signatures (18 marks)

A system uses RSA with the primes $p = 5$ and $q = 11$ and public exponent $e = 3$. The plaintext to be sent is $m = 7$. The system also protects important files with digital signatures.

#	Question
17	Calculate the modulus n, Euler totient $\phi(n)$ and the private exponent d.
18	Encrypt the plaintext with the public key and then decrypt with the private key to verify the result.
19	Why does TLS use both symmetric and asymmetric encryption? Explain the role of each in a connection.
20	Describe how a digital signature is created and verified, and state the role of the hash function.

Question 6 - System Development and Critical Path (16 marks)

The activities of an enrolment system project are: A (3 days) and B (4 days) may start at once; C (5 days) waits for A; D (2 days) waits for B; E (4 days) waits for both C and D; F (3 days) waits for E. The project is run by a team and needs user acceptance.

#	Question
21	List the five main phases of the system development life cycle (SDLC) in the correct order and state which phase is usually the most expensive.
22	Calculate the critical path, the project duration and the slack of activity D.
23	If the login function passes module-level tests but fails once connected to the database, which type of testing is needed? State who is responsible for unit testing and for user acceptance testing.
24	Name two main actors in a use case diagram for online enrolment and explain why a data flow diagram (DFD) is drawn during design.