Marks

Question 25 — The Software Developer's View of the Hardware (20 marks)

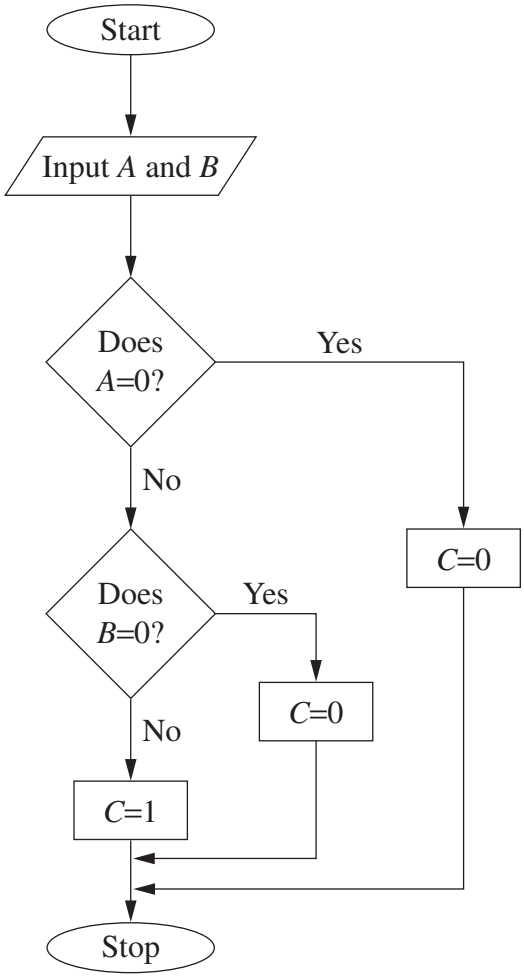
(a) (i) Explain how a fraction is represented in single precision floating point binary representation. **3**

(ii) Convert the decimal number 45 (ie 45_{10}) to a hexadecimal number. **2**

(iii) Using four-bit binary representation and two's complement, perform the following subtraction: 1110−0111. **2**

(b) (i) Describe the function of a flip-flop, and briefly explain how it achieves its purpose. You may use a diagram to illustrate your answer. **3**

(ii) **4**



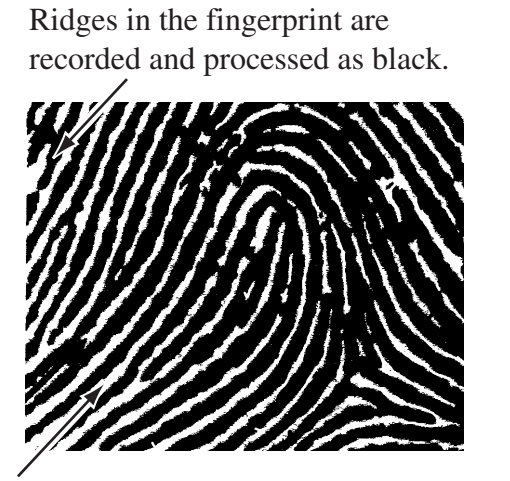
The flowchart above describes the logic of an AND gate where the values of *A* and *B* are binary digits.

Use the flowchart to draw a truth table for an AND gate. Also draw a flowchart that describes the logic of an OR gate.

Question 25 continues on page 20

Question 25 (continued)

(c) A fingerprint scanner is used by a software development company to maintain a high level of security at its premises. The fingerprint scanner operates in black and white mode only. **6**



When employees arrive at the workplace they must:

- place their index finger on an imaging pad located at the door; and
- wait for a scan of their fingerprint to be taken.

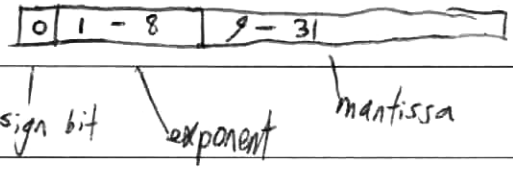
The image produced by the scan of the fingerprint is then sent to a central computer as a data stream. It is compared to the stored set of fingerprint data records for all employees. If a match is found, the door is opened.

In each of the data packets sent from the fingerprint scanner to the central computer there is header information, data characters and trailer information.

Compare and contrast the data stream that would be sent from the scanner to the central computer with the data stream that would be sent from the central computer to the door. Make specific reference to header information, data characters and trailer information for both data streams.

End of paper

25) a) i) Numbers are stored in single precision floating format as:



The sign bit shows if it is negative or positive

The exponent is the power of 2, plus 127.

The mantissa contains the fraction part, the leading 1 is implied. Then each bit represents a decreasing power of 2, so bit 9 corresponds to 2^{-1} and bit 10 to 2^{-2} and so on.

Binary 1s indicate to add that fraction to the total.

The total is then adjusted by the exponent to change the value of each bit.

ii) $45 > 2 \times 16$ and $45 < 3 \times 16$

so $45 - 32 = 13$

and hex $13 = D$ so $45_{10} = 2D_{16}$

as $45 = 2 \times 16 + 13$

iii) 1110 − 0111 = 1110 + −0111

verify in decimal: 1110 = 14
0111 = 7
14 − 7 = 7
∴ true.

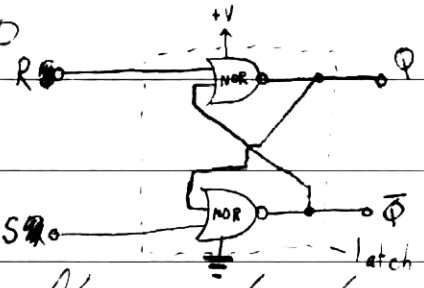
so −0111 in 2's complement:

1000 + 1 = 1001

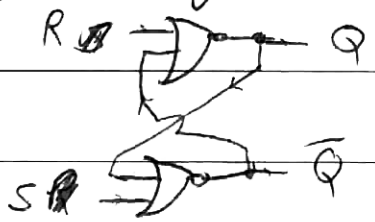
so 1110 +
1001
10111

and the extra 1 is discarded, so

1110 − 0111 = 0111



b) i) The function of a flip flop is to hold a binary digit, in other words, to act as a bit of 'memory'. This is accomplished feedback circuits and logic gates, e.g:

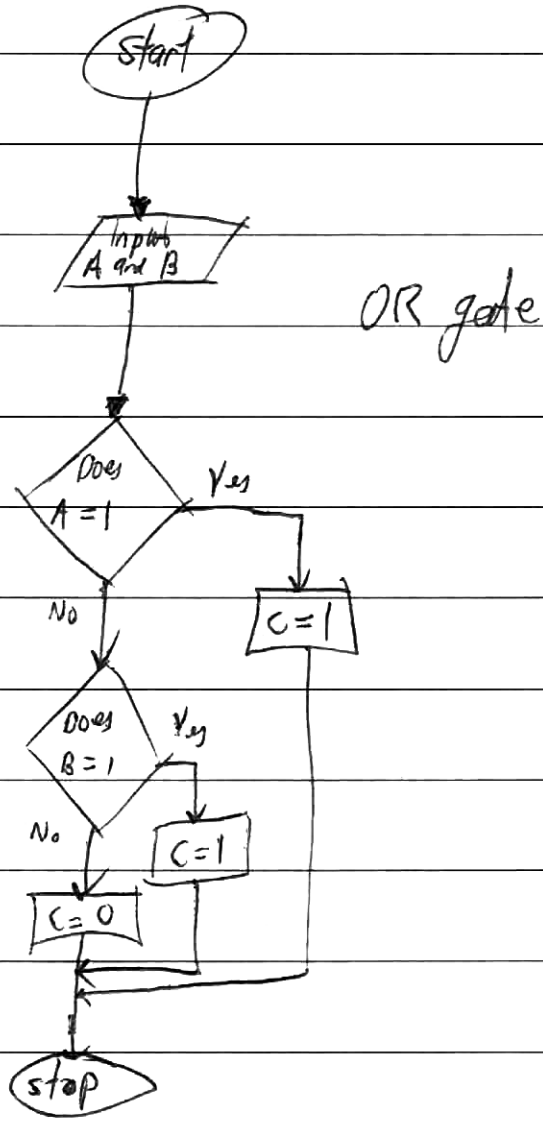


The value from the top input feeds to the bottom, and the bottom to the top, giving an electric loop which holds the last value when S=R=0.
The latch is 'set' if S=1, R=0 and 'reset' if S=0, R=1. If S=R=1 then the outputs oscillate, an illegal state.
If NAND gates are used, then the same results are obtained from opposite input values.

A flip flop may also be clocked, whereby input is only accepted when the clock input is high.

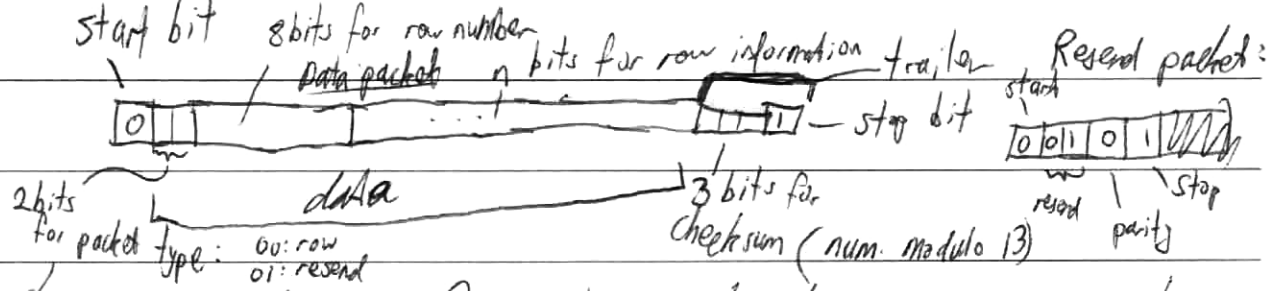
ii) AND gate

A	B	C	
0	0	0	← yes to 1st condition
0	1	0	
1	0	0	← yes to 2nd condition
1	1	1	← no to both.



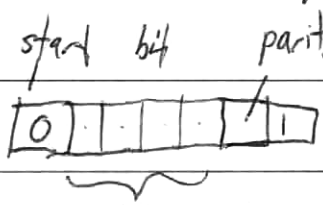
OR gate

c) The scanner would send the information as 1 for black, and 0 for white in data stream, sending perhaps a line at a time. So the structure would be:



This would be a fairly large packet, and could be broken up into multiple packets per row.

Contrastingly, the computers packet to the scanner would be much simpler.



So the larger packets will use a checksum to insure ~~accurate~~ accurate transmission, whereas the short packets need only a parity bit. The ~~scanner~~ computer largely only sends flag type messages, where the scanner may send data, or a flag (resend message).

Note: If ~~data~~ packets need splitting (due to size):