



11

تقديم دونز واللاتريك

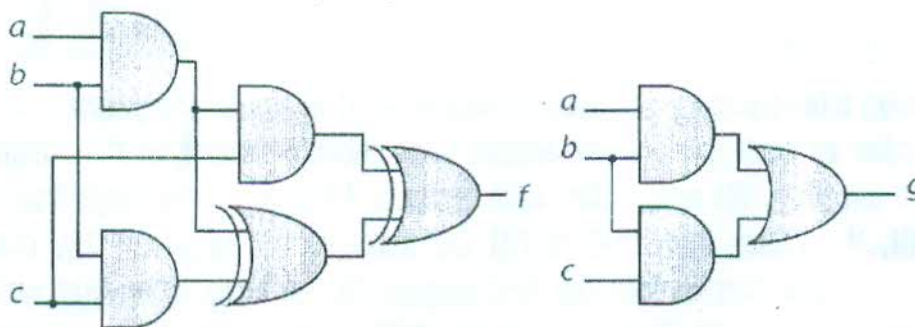
The maximum mark for the examination paper is 60 marks, and the mark obtainable for each part of a question is shown in brackets alongside the question.

Instructions to the candidates:

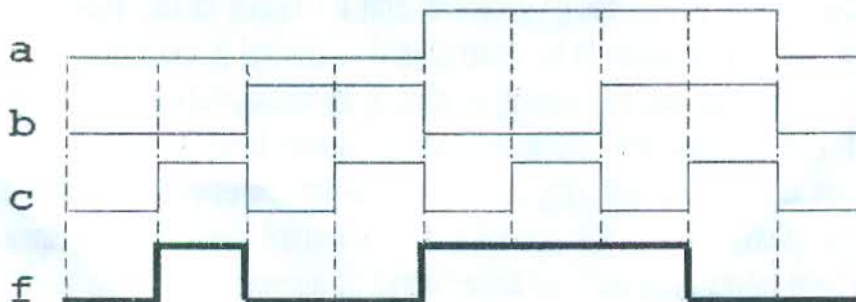
- ☉ Clarify your answer with the suitable sketches as you can.
- ☉ Please use a pen or heavy pencil to ensure legibility.
- ☉ Please attempt all questions.

QUESTION NUMBER ONE [25 MARKS]

1. What are three different ways of representing a signed number? Express the decimal number (- 46) as an 8-bit numbers in each of them, and then perform each of the following operations using the 2's complement form:
 a) $125 + 58$, b) $-127 + 31$. Determine whether there is an overflow. [7 Marks]
2. Show the bit configuration that represents the decimal number 136.6875. Hereafter, represent the decimal number 136 in gray code (You MUST show your procedure). [6 Marks]
3. Consider the two circuits shown in figure. Use Boolean algebraic transformations to prove or disprove that the two circuits given below implement the same function (do not use a truth table or Karnaugh map). [6 Marks]



4. The following is the timing diagram of a logic circuit with 3 inputs. Sketch the logic circuit that generates this waveform. Then, write the VHDL code for the circuit described by the given timing diagram (Do not simplify). [6 Marks]



QUESTION NUMBER TWO [35 MARKS]

1. Draw the minimum NAND implementation for the following Boolean expression:

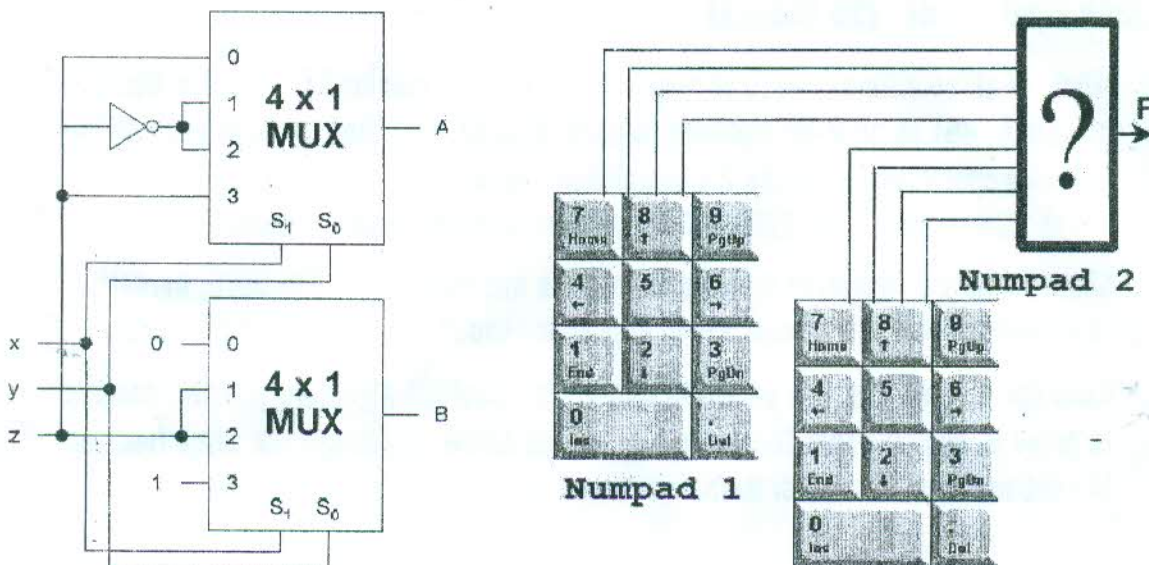
$$F(A, B, C, D) = \sum m(1, 5, 8, 13, 14, 15) + D(3, 10, 12)$$

[6 Marks]

2. Answer the following questions regarding combinational logic.

- Using only 2-to-1 MUXs, implement the XOR gate.
- Determine the outputs functions A and B as sums of minterms. You may use any process to determine the result, but show your work.
- The circuit shown in figure has the functionality of a commonly used arithmetic component. What does the circuit do and what are other names for A and B?

[8 Marks]



3. Design a logic circuit that opens a lock ($F = 1$) whenever one presses the correct number on each numpad. We encode each decimal number on the numpad using BCD encoding. We expect that each group of 4 bits be in the range from 0000 to 1001, the values from 1010 to 1111 are assumed not to occur. Tip: create two circuits: one that verifies the first number (9), and the other that verifies the second number (5). Then perform the AND operation on the two outputs. This avoids creating a truth table with 8 inputs!

[7 Marks]

4. Draw the block diagram for binary parallel adder/subtractor.

[7 Marks]

5. Using decoders and gates, design a control unit for steam boiler. Temperature and liquid level are two variables to be controlled. The control is exercised by switching ON or OFF the heater and by opening or closing an appropriate valve. If both liquid level and temperature are above normal, or liquid level is below normal and temperature is above normal, ring an alarm, then let the control unit to provide an appropriate solution. If liquid is normal and temperature above normal, close heater and open both valves otherwise the boiler works as normal.

[7 Marks]