

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.

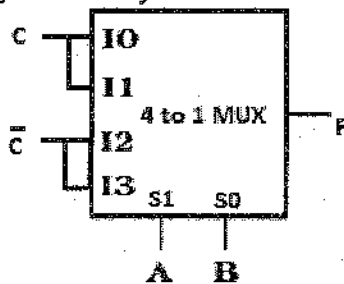
Instructions to the candidates:

- ☸ 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 [35 MARKS]

1. Identify the choice that best answers the question (You MUST show your procedure). [10 Marks]

1) The logic realized by the circuit shown in figure is



- a) $F = B \oplus C$ c) $F = \overline{B \oplus C}$
b) $F = A \oplus C$ d) $F = \overline{A \oplus C}$

2) Identify the function which generates K-map shown

	AB	00	01	11	10
C					
0		0	0	1	0
1		1	1	0	1

- a) $F(A, B, C) = \Sigma(1, 3, 4, 7)$
b) $F(A, B, C) = \Pi(1, 3, 4, 7)$
c) $F(A, B, C) = \Sigma(1, 3, 5, 6)$
d) $F(A, B, C) = \Pi(1, 3, 5, 6)$

3) The Boolean expression $(\overline{A} \cdot B + A \cdot \overline{B} + A \cdot B)$ is equivalent to

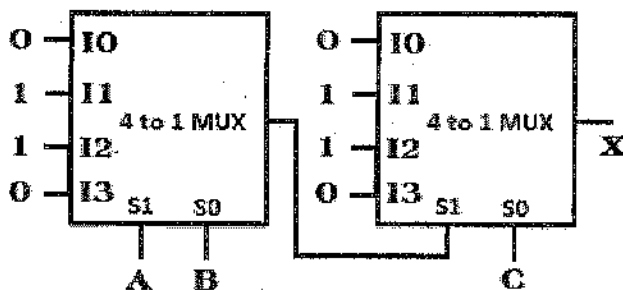
- (A) $A + B$ (B) $\overline{A \cdot B}$
(C) $\overline{A + B}$ (D) $A \cdot B$

4) Which of logic function is illustrated by the figure



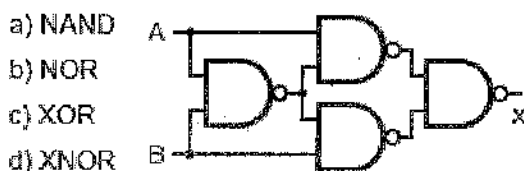
- a) XOR b) NOR c) AND d) NAND

5) In the following circuit, X given by



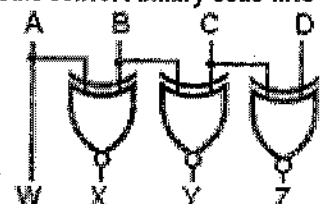
- a) $X = \overline{A}BC + A\overline{B}C + ABC\overline{C} + \overline{A}B\overline{C}$
b) $X = AB + BC + AC$
c) $X = \overline{A}B\overline{C} + \overline{A}B\overline{C} + \overline{A}B\overline{C} + \overline{A}B\overline{C}$
d) $X = \overline{A}B + \overline{B}C + \overline{A}C$

6) Which logic function does the circuit perform?



7) The given logic circuit convert binary code into

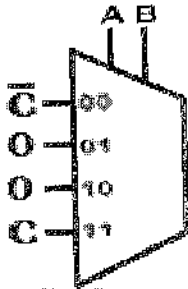
- a) Excess-3 Code
b) BCD Code
c) Gray Code



2. Which of the following expression is correct and which is not? Correct if possible (You MUST show your procedure).

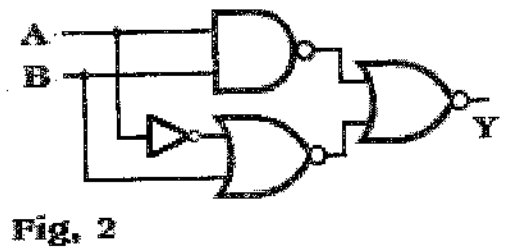
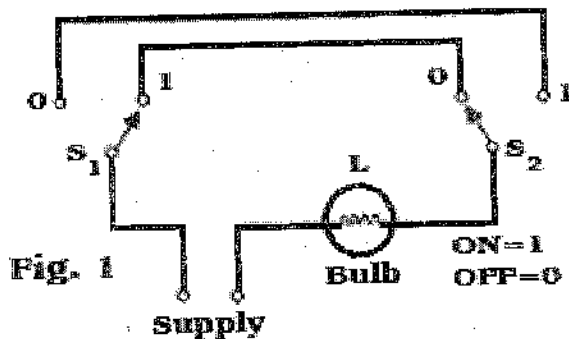
[15 Marks]

- 2.1. $\bar{A} \oplus \bar{B} = A \oplus B$
- 2.2. $A + BC = (A + B)(B + C)$
- 2.3. Addition of 648 and 487 in BCD Code is 1735.
- 2.4. An 8-to-1 multiplexer requires 2 select lines.
- 2.5. The gray equivalent of decimal number 43 is (100110).
- 2.6. The function $F(A, B, C) = \sum m(0, 7)$ can be implemented using A and B as select inputs to a 4-to-1 multiplexer. The correct implementation is illustrated by the right figure.
- 2.7. When simplified with Boolean algebra $(X + Y)(Y + Z)$ simplifies to X.
- 2.8. The code where all successive numbers differ from their preceding number by single bit is a binary code.
- 2.9. If a decoder has 16 outputs, it requires 3 inputs to choose all possible outputs.
- 2.10. The range of numbers which can be represented by 9-bits if we are representing two's complement integers is (- 256 to 255)



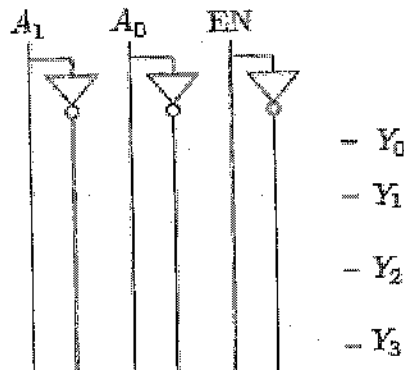
3. A staircase light shown in fig. 1 is controlled by two switches one at the top of the stairs and another at the bottom of stairs. Realize the circuit using AND-OR gates. After that, simplify the function given by fig. 2 using Boolean algebra.

[5 Marks]



4. Show how a 2-to-4 decoder with an enable input could be implemented by adding only wires and AND gates to the schematic below. Then, construct a 3-to-8 decoder with two 2-to-4 decoders with enable.

[5 Marks]



QUESTION NUMBER TWO [25 MARKS]

1. Perform the following additions and subtractions of the following unsigned integers. Use the fewest number of bits to represent both operators. For the addition, determine whether there is an overflow. For the subtraction, determine whether we need to keep borrowing from a higher byte.

a) $52 + 17$

b) $24 - 34$

[6 Marks]

2. Displays for blind persons are using Braille cells with digitally controllable points. You will design a combinatorial circuit which translates from the bit vector X in BCD code (the digits 0 to 9 binary coded), to the bit vector Y in Braille alphabet numbers, see the figure below.

[8 Marks]

1	2	3	4	5	6	7	8	9	0

3. Draw the minimum NAND implementation for F (A, B, C, D).

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

[4 Marks]

4. Design a control unit for a steam boiler. 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]

