

1. Simplify the circuit shown in Figure 1, using a Karnaugh map. Your answer must include:

- The initial Boolean expression for the output of the circuit (X).
- Its expansion into a standard PoS.
- The Karnaugh map itself, which must be clearly labelled and include all the required groupings to derive the simplified expression.

Which of the Karnaugh map's Prime Implicants are not Essential Prime Implicants? Explain.

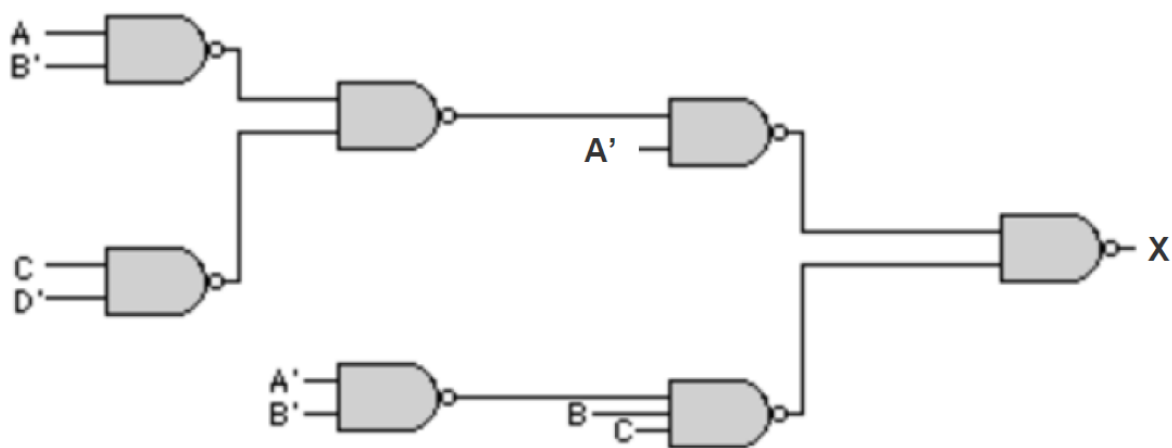


Figure 1

2. Using a 5-variable Karnaugh Map, find the minimal PoS for the Boolean function,

$$G(M, N, O, P, Q) = \sum m(1, 3, 5, 8, 10, 12, 16, 20, 21, 25) + d(0, 4, 7, 28, 30).$$

3. Design a combinational circuit with three inputs **x**, **y** and **z**, and three outputs **A**, **B** and **C**. When the binary input is a value below **5**, the binary output is one greater than the input; otherwise, the binary output is one less than the input. Your answer must include all the required steps i.e., the Truth Table, the Karnaugh maps and the circuit diagram for a minimum cost solution (in terms of the number of logic gates required), i.e. using least number of logic gates.