Sample Midterm Examination

There are five questions. Be precise, show every step, and state your assumptions (if any), to get full credit.

1. Use the Quine-McClusky method to find the minimized product of sums expression for the function \( F(A, B, C) = A \oplus B \oplus C \).

2. Implement the minimized form of the following logic expression.

   \[ F(A, B, C, D) = \sum m(1, 5, 6, 9, 11, 13) \]

   (a) Use a two-level NAND-NAND gate network.
   (b) Use a two-level NOR-NOR gate network.
   (c) Which implementation is better?

3. Implement a 1-bit full adder by two 4:1 multiplexers. You may assume that all inputs and their complements are available.

4. Implement the following function by

   \[ F(A, B, C, D) = \bar{A}BC + AD + AC \]

   (a) A 4:16 decoder with a 16-input OR gate;
   (b) A 16-word ROM;
   (c) A PLA.

5. Design a 4-bit circuit that can perform either BCD or binary addition under the control of a mode setting, \( M \). When \( M = 0 \), the circuit’s outputs implement binary addition. When \( M = 1 \), the output are BCD addition.