1. Optimize the following functions $F$ together with the don’t-care conditions $d$ in (1) sum-of-products and (2) product-of-sums forms:

   (a) $F(A, B, C, D) = \Pi M (1, 3, 4, 6, 9, 11)$
       $d(A, B, C, D) = \Sigma m(0, 2, 5, 8, 10, 12, 14)$

   (b) $F(A, B, C, D) = \Sigma m(3, 4, 9, 15)$
       $d(A, B, C, D) = \Sigma m (0, 1, 2, 5, 10, 12, 14)$

2. Design a circuit with 4-bit BCD input $A, B, C, D$ that produces an output $W, X, Y, Z$ that is equal to the input + 6 in binary. For example, 9 (1001) + 6 (0110) = 15 (1111). The outputs for invalid inputs are don’t-cares. Show the truth table, simplifications, and the circuit diagram.

3. Design an 8 x 1 multiplexer using two 4 x 1 multiplexers and one 2 x 1 multiplexer.

4. Build a 4 x 16 decoder with $E$ input using one 1 x 2 and two 3 x 8 decoders with $E$ inputs.

5. A combinational circuit is defined by the following Boolean functions

   $F_1 = (X + Z)' + XYZ$
   $F_2 = (X + Z)' + X'YZ$

   Design the circuit with a decoder and external OR gates.

6. Implement the following Boolean function with an 8 x 1 multiplexer and a single inverter with variable $D$ as its input:

   $F(A, B, C, D) = \Sigma m(2, 4, 6, 9, 10, 11, 15)$