1. (Horowitz and Hill, 8.14, page 493): Find logic to perform multiplication of two 2-bit unsigned numbers (i.e., each 0 to 3), producing a 4-bit result. Hint: Use a separate Karnaugh map for each output bit.

Implement the corresponding circuit with any combination of gates. One solution involves several AND gates, one XOR gate, and one inverter.

2. (Horowitz and Hill, 8.25, page 514): Design a synchronous 2-bit UP/DOWN counter: It has a clock input, and a control input ($U/D'$); the outputs are the two flip-flop outputs $Q_1$ and $Q_2$. If $U/D'$ is high, it goes through a normal binary counting sequence; if LOW, it counts backward – $Q_2Q_1 = 00, 11, 10, 01, 00, \ldots$.

One solution involves two D-type flip-flops, two XOR gates, and an inverter.

3. Denote a prime from 1 to 15 by the four-bit sequence $A_4A_3A_2A_1$, where $A_4$ is the most significant bit (8-bit) and $A_1$ is the least significant bit (1-bit). Make a Karnaugh map with $A_4A_3$ along the horizontal axis and $A_2A_1$ along the vertical axis and denote a prime by 1, non-prime by 0. Find a combinatorial logic which determines using the four bits whether the number is prime. You need not draw the gates which implement this logic.