1. Give the formal description of the DFA $M_2$ from Exercise 1.1. Use a $4 \times 2$ table to describe $\delta$.

2. Exercise 1.4, parts a, f, i.

3. Exercise 1.5, parts c, e, f.

4. Problem 1.25.

5. (a) Give the state diagram for a DFA $M$ that accepts the language

$$L = \{w \in \{0, 1\}^* \mid w \text{ is the binary representation of a multiple of } 5\}.$$  

For the purposes of this problem, assume that $\varepsilon$ represents the integer 0, and that leading 0's are o.k. For instance, $\varepsilon$, 11001, and 00101 are all in $L$, but 110 and 00001 are not.

Hint: Let the state set be $\{q_0, q_1, q_2, q_3, q_4\}$, and maintain the property that $w$ takes $M$ from $q_0$ to $q_i$ if and only if $w'$ mod 5 = $i$, where $w'$ is the integer with binary representation $w$. Now think, for example, about what the remainder mod 5 of (the integer with binary representation) $w$ would be, if you know that the remainder mod 5 of (the integer with binary representation) $w$ is 3.

(b) Suppose you wanted to solve part 5a now for multiples of $k$ instead of multiples of 5, and you took the state set to be $\{q_0, q_1, \ldots, q_{k-1}\}$, generalizing the hint above. For $\sigma \in \{0, 1\}$, what would $\delta(q_i, \sigma)$ be? What is the initial state and the set $F'$ of accept states?