The Theory of Computation
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Addison-Wesley-Longman, 1998

Solution Manual
Chapter 3, Problem 3.7

1. This machine is a bit hard to describe, because its two loops have different lengths and can both be part of accepting paths. Fortunately, each loop is simple: one loop eats strings of length $3i$ that have a 0 at every third position and leads to acceptance of strings of length $3k$, for $k \geq 1$, where every third character is a 0 except the last, which is a 1; the other loop leads to acceptance of strings of length $4k + 3$ for $k \geq 0$, where the third character and every fourth character thereafter is a 1. Fortunately also, the two loops can be thought of as starting at the same state.
   Note that, regardless of which loops are used, acceptance requires a traversal of the four states and thus any accepted string ends with a block of three characters, the first two arbitrary and the last a 1. Every time we go through a loop, we prefix this block by a block of three characters, the first two arbitrary and the third a 0 (the short loop) or by a block of four characters, the first two and the fourth arbitrary and the third a 1. (Thus accepted strings can be of arbitrary length, except for 0, 1, 2, 4, 5, and 8.) A student remarked that we could think of the blocks of 3 as octal digits; in that case, the machine accepts all strings composed of octal digits, such that the last digit is odd and such that all other odd digits are always followed by one (arbitrary) extra bit.
2. This machine accepts strings of length $3k$, for $k \geq 0$, where every substring of characters at positions $3i$, $3i + 1$, and $3i + 2$ (i.e., every block of 3 characters starting on multiples of 3) contains two 0s and one 1.
3. This machine accepts strings of 0s of length $5k + 2$, for $k \geq 0$.