Exercise 7.1

(a)

$$x_1 = \texttt{dec}(101) = 5, \qquad x_2 = \texttt{dec}(0) = 0, \qquad x_3 = \texttt{dec}(11) = 3, \qquad y = \texttt{dec}(1001) = 9$$

(b)

$$x_1 = \texttt{dec}(11) = 3, \qquad x_2 = \texttt{dec}(100) = 4, \qquad x_3 = \texttt{dec}(1) = 1, \qquad y = \textit{undefined}$$

Exercise 7.2

Read hints

Exercise 7.3

To show that the composition $(f \circ g) : \Sigma_1^* \to \Sigma_2^*$ is Turing-computable, we can build a TM that simulates the computations of f and g sequentially. This TM would work as follows:

1. Start the TM with the input x
2. Use a Turing machine that simulates the computation of g on x. If $g(x)$ is undefined, then halt and output "undefined".
3. Use a Turing machine that simulates the computation of f on $g(x)$. If $f(g(x))$ is undefined, then halt and output "undefined"

If g(x) is undefined -> undefined

Exercise 7.4

Exercise 7.5