1. Do Problem 5, Section 9.2 of the text.

2. Write (formally and completely) a Turing Machine program that computes the function \( f \) which adds three nonzero integers in unary. Assume the input strings are separated by 0's (e.g. \( f(11101011) = 111111 \).)

3. Consider the binary encoding \(< M >\) of a TM \( M \) (to be) described in class (Recall that \( Q = \{ q_1, q_2, \ldots, q_n \} \), \( \Gamma = \{ a_1, a_2, \ldots, a_m \} \) with \( a_m = \square \), initial state \( q_1 \) and final state \( q_2 \), \( L = 0 \), \( R = 00 \).) For
\[
< M > = 1110101010010011010010010111
\]
(a) With initial ID \( q_1a_1a_1a_2 \), construct the sequence of IDs of \( M \). Does \( M \) accept the string \( a_1a_1a_1a_2 \)? (Hint: The sequence starts as \( q_1a_1a_1a_2 \rightarrow a_2q_1a_1a_1a_2 \).)
(b) Repeat part (a) with the initial ID \( q_1a_1a_1a_1a_1 \). Does \( M \) accept the string \( a_1a_1a_1a_1 \)?
(c) Does \( M \) always halt?
(d) Determine the language accepted by \( M \). Is this language regular?

4. Suppose the transition function of a TM \( M \) with tape alphabet \( \{ 0, 1, \square \} \) contains no triplet \((q_i, X_j, D_k)\) where \( D_k = L \) (for Left). Show that \( L(M) \) is regular.

5. Write (formally and completely) a Turing Machine program that computes the function \( g \) which adds 1 to a nonzero binary number (e.g. \( g(10010) = 10011 \), \( g(10011) = 10100 \), \( g(111) = 1000 \)).

6. Suppose \( M \) is a Turing Machine (TM) that recognizes the language \( \mathcal{L} \). Are the following statements true or false? Be sure to give reasons for your answers. (Note: A language is called decidable (recursive) if it is recognized by a TM that always halts.)
(a) \( M \) halts on every \( w \in \mathcal{L} \).
(b) If \( \mathcal{L} \) is decidable, then \( M \) always halts.
(c) If \( M \) always halts, then \( \mathcal{L} \) is decidable.
(d) If \( \mathcal{L} \) is nonempty, then \( M \) halts on some \( w \).
(e) There is a TM that recognizes the language \( \overline{\mathcal{L}} \).
(f) There is a TM that recognizes the language \( \mathcal{L}^* \).

7. Do Problem 6, Section 11.1 of the text.

8. Show how to simulate a standard TM that always halts by a TM which always leaves its tape blank before it halts.