1. Combinational Circuits

(a) decimal  |x|2 x1 x0  |X|>2
  0   0 0 0 0
  1   0 0 1 0
  2   0 1 0 0
  3   0 1 1 1
 -4  1 0 0 1
 -3  1 0 1 1
 -2  1 1 0 0
 -1  1 1 1 0

(b) $x_2'x_1x_0 + x_2x_1'x_0' + x_2x_1'x_0$

(c) The circuit does not match the function in parts (a) and (b).

The following input to the circuit will incorrectly result in a 0 output: 100.

The following inputs will incorrectly result in a 1 output: 001 and 010.

2. Regular Expressions, Deterministic Finite State Automata

a) The answer, iii) generates all desired strings and only desired strings.
   i) can generate a string that starts with b.
   ii) cannot generate a single a.
   iv) can generate a string that starts with b.
   v) cannot generate a single a.

b) The answer, i) accepts all desired strings and only desired strings.
   ii) accepts the empty string.
   iii) accepts strings that start with b.

3. Linked Lists

(a) • i) returns true
    • ii) returns true
    • iii) returns false
    • iv) returns false

(b) `linky_dink` returns true for a null-terminated linked list. It returns false for a circular linked list, even if the circular part is preceded by a straight path.

(c) $N$

For a null terminated linked list, b will traverse each node once before the method returns true. For a circular linked list, b which is traveling twice as quickly as a, will catch up to a in a constant number of circuits of the length $N$ list.
4. Turing Machine

\[
\ldots \downarrow 0 \ 0 \ 0 \ 0 \ 1 \ 0 \ 1 \ 1 \ x \ x \ x \ x \ \ldots
\]

(a)

(b) The Turing Machine subtracts 1 from the binary number on the tape.

5. Data Structures

(a) Symbol Table
(b) Binary Search Tree
(c) Stack

6. True or False Circle your answer.

T (a) P is the set of search problems solvable in Polynomial time by a deterministic Turing Machine.

F (b) NP is the set of search problems not solvable in Polynomial time by a deterministic Turing Machine.

F (c) For proper encapsulation, instance variables should always be declared public.

F (d) Because the Halting Problem is unsolvable, it is impossible to tell if your TSP program for Assignment 6 has an infinite loop.

T (e) A Universal Turing Machine can compute anything that any other Turing Machine could possibly compute.

T (g) If P equals NP, then the Traveling Salesperson Problem can be solved in polynomial time by a deterministic Turing Machine.

F (h) If P does not equal NP, then there is no case of the Traveling Salesperson Problem for which you can find the optimal tour in polynomial time.

F (j) Factoring is known to be in NP but has not been proven to be NP-complete, so the discovery of a polynomial-time algorithm for factoring would mean that P equals NP.

F (k) Factoring is known to be in NP but has not been proven to be NP-complete, so no polynomial-time algorithm for factoring is possible.

7. Number Systems

(a) 012C
(b) FFC7
(c) 163
8. TOY Programming

(a) 0000
The program repeatedly reads integers from standard input and XORs them together. It terminates when it reads the value 0000. Recall that XORing a bit with itself always yields 0. Thus, $a \land a = 0$ for any integer $a$.

(b) ACDC
Observe that the XOR of a sequence of integers is independent of the order in which you do it. That is $a \land b \land a \land b = a \land a \land b \land b = 0$. Thus, all the integers cancel each other out except ACDC.