Basic Logic

Please do problems 2.54, 3.7, 3.8, 3.18, and 3.23 from the textbook.

Here are three additional problems for this week:

1. Two-Level Implementations of Truth Tables

A. For the following truth table, find a canonical three-input "sum-of-products" implementation. Express your answer both in algebraic form, and as a gate diagram.

A	B	C	$F(A, B, C)$
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

B. Using Boolean algebra properties, or by reading ahead in notes set 2.1 and using a K-map, or by being clever, find the simplest two-level implementation of the truth table in Part A involving the fewest gates. Express your answer both in algebraic form, and as a gate diagram.

C. For the following truth table, will a canonical three-input "sum-of-products" implementation, or a canonical "product-of-sums" two-level implementation, require the fewest gates? Choose the simplest to implement. Express your answer both in algebraic form, and as a gate diagram.

A	B	C	$F(A,B,C)$
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

D. Using Boolean algebra properties, or by reading ahead in notes set 2.1 and using a K-map, or by being clever, find the simplest two-level implementation of the truth table in Part A involving the fewest gates. Express your answer both in algebraic form, and as a gate diagram.

2. De Morgan's Laws
Apply De Morgan's Laws to simplify the following logical expression into a form involving only ANDs, ORs, and literals of the binary inputs A, B, C, and D: Recall from the notes that "literals" include both the variables and their complements.

$$\overline{\overline{((\overline{A}+B)\overline{C})}D}$$

3. Generating Truth Tables
The C program `truthtable.c`, found on the course website or in the directory `/class/ece199/hw5`, generates the truthtable for a three-input AND function.

A. Modify the program (or write your own) to print a truth table with the answers to Problem 2.54 from the textbook. Compare your answers to those you computed by hand earlier, as a check of your program/hand-calculation correctness (or at least consistency!) (Hint: you may find the table of bitwise operators in C in the textbook (Table 12.2) useful. Make liberal use of parentheses to make sure the operations are performed in the desired order.) Turn in a printout of your program, and another of the truth table output the program produces, as your solution.

B. Extend the program to compute and print four-input truth tables. Use your new program to compute truth tables for both the original expression in Problem 2 above and for your simplified expression, and confirm that they are the same. Turn in a printout of your program, and another of the truth table output the program produces, as your solution.