College of Computer Science
Northeastern University
COM 1722: Freshman Honors Seminar

Winter 2003
Handout 2
7 January 2003

# Homework 1 (due Jan 14)

Please turn in Problems 3 through 5.

## 1. Reading

Read Sections 2.1.1, 2.2–2.4, 2.5.1, and 2.6 of the handout given. This handout is taken from the textbook "Introduction to Computing Systems: From Bits & Gates to C & Beyond", by Y. Patt and S. Patel, McGraw-Hill. A copy of the book is available in the Reserve collection in the Snell Library.

## 2. Practice Exercises

Convert the following 2's complement binary numbers to decimal: 1010, 01011010, 111010100.

Convert the following decimal numbers to 8-bit 2's complement binary numbers: 102, -128, -34.

Use 2's complement 8-bit binary arithmetic to add the numbers 37 and 72, and to subtract the number 98 from 11.

## 3. DeMorgan's Theorems

$$\overline{A+B} = \overline{A} \cdot \overline{B} \text{ and } \overline{A \cdot B} = \overline{A} + \overline{B}$$

Prove DeMorgan's theorems using a truth table.

## 4. Universality of NOR

Using a NOR gate as your basic building block, show how to construct circuits for the NOT, AND, OR and XOR functions. You may design the circuits in any order, and may use a circuit in the construction of subsequent circuits. The truth tables for these functions are given below.

1. NOT:

| $A$ | $\overline{A}$ |
|---|---|
| 0 | 1 |
| 1 | 0 |

2. AND:

| $A$ | $B$ | $A \cdot B$ |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

3. OR:

| $A$ | $B$ | $A + B$ |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |

4. XOR:

| $A$ | $B$ | $A \oplus B$ |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

**5. Building an adder**

Using your collection of gates, draw a circuit for a 4-bit adder that implements grade school arithmetic, as discussed in class. You do not need to deal with carry overflow. You should proceed by first constructing a 1-bit adder, and then showing how to use 1-bit adders to construct a 4-bit adder.