ECE 120: Introduction to Computing Spring 2019 ZJUI

due at start of section on Friday 8 March 2019

Homework 2: Operations on Bits

1. **Boolean Functions**

   Write a truth table for the following Boolean functions (all in one table)

   a. f1 = A AND [B OR (NOT C)] AND (NOT D)
   b. f2 = (NOT A) OR (NOT B) OR [(NOT C) AND D]
   c. f3 = NOT {(NOT A) OR [(NOT B) AND C] OR D}
   d. f4 = A AND B AND [C OR (NOT D)]
   e. Now compare the functions. From the truth table, what can you say about the four functions?

2. **Bitwise Logic**

   Calculate the resulting bit patterns for the following operations. The operand bit patterns are given in hexadecimal notation (preceded by an "x," following Patt & Patel's notation). Write your answers using binary notation, NOT HEXADECIMAL.

   a. xECEB AND xCAFE
   b. NOT (x1234 XOR xFEDC)
   c. x9347 OR xCB03

3. **Logical Completeness**

   a. Prove that the 2-input NOR function (OR followed by NOT) is logically complete.
   b. Write the function F = (A XOR B) AND (C XOR D) using only AND, OR, and NOT.

4. **Precision of Floating-Point**

   Consider the IEEE 754 single-precision floating-point representation discussed in the book and in lecture.

   a. Can every fraction F ($0 \leq F \leq 1$) representable using only two digits after the decimal point (such as 0.42) be represented exactly in floating-point? Explain your answer.
   b. Can the number 10^8 be represented exactly in floating-point? Explain your answer.
   c. Can the number 10^{11} be represented exactly in floating-point? Explain your answer.

5. **Conversion to Floating-Point**

   For each of the following decimal numbers, convert the number to base 2 notation, using only as many bits as are necessary to precisely specify the number (using no leading nor trailing zeroes), then convert your answer into the IEEE 754 single-precision floating-point representation. Show your work.

   a. -101.3839111328125
   b. 23.8046875

6. **Conversion from Floating-Point**

   For each of the following bit patterns, calculate the number represented by the bits when interpreted using the IEEE 754 single-precision floating-point representation. Write your answer in decimal (scientific notation is fine). Show your work.

   a. 1 01011000 10111010000000000000000
   b. 0 10010011 10010001000000000000000

7. **Pizza Time!**

   Almost every college student in the United States loves pizza, but not everyone can agree on what toppings to include. Help four of your friends to determine what they should order to avoid starvation while completing their ECE120 homework…

   Available toppings include:
   B – bell pepper (a vegetable)
   H – ham (a meat)
   M – mushroom (a vegetable)
   P – pepperoni (a meat)
   S – sausage (a meat)

   Start by translating each person's needs into a Boolean logic expression based on the variables B, H, M, P, and S. Cheese is considered a vegetarian food for the purpose of this problem (so a pizza with no toppings is vegetarian, for example).

   a. Jan hates sausage, but won't eat vegetarian pizza.
   b. Alice wants at least one vegetable and at least one meat.
   c. Bob hates ham.
   d. Xin doesn't want more than one topping with "pepper" in its name.

   e. Finally, determine what toppings to include on the pizza!