Northwestern University
Electrical and Computer Engineering
ECE303: Advanced Logic Design, Spring 02
Prof. Hai Zhou

Apr. 11, 2002
Handout #1
Due: Apr. 18

## Homework 1

You may discuss the assignments with your classmates but need to write down your solutions independently. Be careful with your handwriting. Unclear solutions will be assumed to be wrong.

1. (20 pts) Design a two-level combinational circuit to perform the incremental by 1 operation modulo 15 for 4 bit binary numbers in the range 0000 to 1111, e.g. $f(0010) = 0011$, $f(1111) = 0000$.
   (a) Fill in the truth table for the 4 output function.
   (b) Fill in the four 4-variable Karnaugh maps and find minimized sum of products for each output function.
   (c) Apply the Quine-McCluskey method to minimize the output function for the least significant bit.
2. (20 pts) Simplify the following two-level functions using the rules of Boolean algebra:
   (a) $f(x, y, z) = (x + y)(\bar{x} + y + z)(\bar{x} + y + z)$
   (b) $g(x, y, z) = y\bar{z} + \bar{x}yz + xyz$
3. (20 pts) Given the following functions in minterm form, use Karnaugh maps to simplify the functions in the sum-of-products form:
   (a) $f(a, b, c, d) = \sum m(0, 1, 4, 5, 12, 13)$
   (b) $g(a, b, c, d) = \sum m(0, 2, 4, 6)$
4. (20 pts) Given the following functions in maxterm form, use Karnaugh maps to simplify the functions in the product-of-sums form:
   (a) $f(a, b, c, d) = \prod M(0, 3, 7, 9, 11, 15)$
   (b) $g(a, b, c, d) = \prod M(0, 1, 6, 7)$
5. (20 pts) Given the following functions in minterm form, use the Quine-McCluskey method to simplify the functions:
   (a) $f(a, b, c) = \sum m(2, 3, 4, 5)$
   (b) $f(a, b, c, d) = \sum m(1, 5, 7, 8, 9, 13, 15) + d(4, 14)$