Boise State University
Department of Electrical and Computer Engineering
EE 230 Digital Systems
Test 1, September 19, 2006

Name: _____ *Row #:* _____

Instructions: *Show all steps and logic circuits for full or partial credits. It is very important that you write clearly, so that your test can be graded appropriately and fairly. This is a closed book and closed notes test. A Boolean algebraic basic rules table has been provided.*

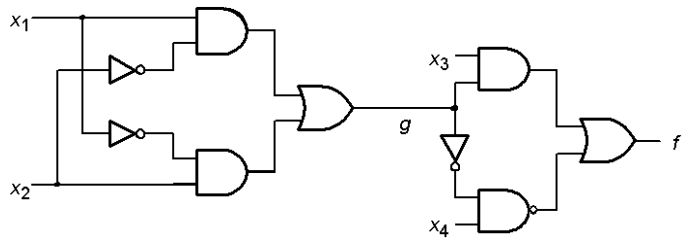
1. *(35 points)* Design the simplest circuit that has three inputs, x_1, x_2, and x_3, which produces an output value of 1 whenever two or more of the input variables have the value 1; otherwise, the output has to be 0.

a. the truth table,
b. the simplest logic equation,
c. build the circuit using NOT, AND, and OR gates,
d. convert the circuit in (c) using just NAND gates,
e. build the circuit using just NOR gates, and
f. calculate the cost of your circuit in (c), (d), and (e) assuming that the input variables are available in both uncomplemented and complemented forms.

2. *(20 points)* Design the simplest circuit that has two inputs, x_1, and x_2, which produces an output value of 1 whenever the inputs are equal; otherwise, the output has to be 0.

a. the truth table,
b. the simplest logic equation,
c. produces a timing diagram of inputs (x_1, and x_2), output, and internal signals

3. *(15 points)* Determine *f*.



4. *(30 points)* A circuit with two outputs has to implement the following functions

$$f(x_1, x_2, x_3, x_4) = \sum m(0,2,4,6,9) + D(10,11)$$

$$g(x_1, x_2, x_3, x_4) = \sum m(2,4,6,10,15) + D(0,13,14)$$

Design the minimum-cost circuit and compare its cost with combined costs of two circuits that implement *f* and *g* separately. Assume that the input variables are available in both uncomplemented and complemented forms.