CSE140 Midterm 1, October 22, 2012, Name_____

(I) (Problem Formulation and Canonical Expression) A voting machine has four binary inputs (a, b, c, d) and one binary output f. Output function $f(a, b, c, d) = 1$ when two or more inputs are 1, otherwise $f(a, b, c, d) = 0$. For example, $f(1, 0, 1, 1) = 1$, while $f(0, 0, 1, 0) = 0$.

I.1 Write the truth table of the voting machine (10pts).

I.2 Describe function f in the canonical product-of-sums format (10pts).

(II) (15pts) (Consensus Theorem) Prove the following using Boolean algebra. $a'b + a'c'd + b'c'd = a'b + b'c'd$.

(III) (15pts) (Shannon's Expansion) Given a function $f(a, b, c)$ prove the following equality using Boolean algebra. $bf(a, 1, c) + b'f(a, 0, c) = (b + f(a, 0, c))(b' + f(a, 1, c))$

(IV) (25pts) (Karnaugh Map) Use Karnaugh map to simplify function $f(a,b,c) = \sum m(2,3,4,7) + \sum d(0,5)$. List **all possible** minimal **sum of products** expressions. Show the Boolean expressions. No need for the logic diagram.

(V) (25pts) (Karnaugh Map) Use Karnaugh map to simplify function $f(a,b,c) = \sum m(1,6) + \sum d(0,5)$. List **all possible** minimal **product of sums** expressions. Show the Boolean expressions. No need for the logic diagram.