Cpr E 281 HW04
ELECTRICAL AND COMPUTER ENGINEERING
IOWA STATE UNIVERSITY

Minimization and Karnaugh Maps
Assigned Date: Fourth Week
Due Date: Monday, Sep. 19, 2016

P1. (20 points) Use a K-map to find the minimal sum-of-products (SOP) expression for the following four problems. Show the terms that are grouped in each K-map.

a) (5 points)

A \ BC	00	01	11	10
0	0	0	0	1
1	1	0	0	1

b) (5 points)

AB \ CD	00	01	11	10
00	1	0	0	1
01	0	1	1	0
11	0	0	0	0
10	1	0	0	1

c) (5 points) $F(A,B,C) = \sum m(1,2,3,5,7)$

d) (5 points) $F(A,B,C,D) = \sum m(1,3,4,5,6,7,9,11,13,15)$

P2. (15 points) Use a K-map to find the minimal product-of-sums (POS) expression for the following three problems. Show the terms that are grouped in each K-map.

a) (5 points)

A \ BC	00	01	11	10
0	0	0	0	1
1	1	0	0	1

b) (5 points)

AB \ CD	00	01	11	10
00	1	0	0	1
01	0	1	1	0
11	0	1	1	0
10	1	0	0	1

c) (5 points) $F(A,B,C,D) = \prod M(5,7,11,13,15)$

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P3. (15 points) A four-variable function $F(w,x,y,z)$ is called a *majority* function if $F = 1$ when any three or all four of its input variables are equal to 1.

a) (5 points) Draw the truth table for the majority function.
b) (5 points) Use a K-map to derive the minimal SOP expressions for the majority function.
c) (5 points) Use a K-map to derive the minimal POS expressions for the majority function.

P4. (10 points) Use a K-map to derive the minimal SOP expressions for the following Boolean function:

$$F(A,B,C,D) = ACD' + C'D + AB' + ABCD$$

P5. (20 points) Design a circuit that accepts a 4-bit number X= $x_3x_2x_1x_0$ as input and generates a 1-bit output *P* that is equal to 1 if the input number is a prime. (0 and 1 are not prime; 2, 3, 5, etc., are prime.)

a) (10 points) Write down the truth table for the output *P*.
b) (10 points) Derive the simplest SOP expressions for the output *P*.

P6. (20 points) Design a circuit that accepts a 3-bit number X= $x_2x_1x_0$ as input and generates a 6-bit number Y= $y_5y_4y_3y_2y_1y_0$ as output, which is equal to the square of the input number (i.e., $Y=X^2$).

a) (10 points) Write down the truth table for the six output lines $y_5y_4y_3y_2y_1y_0$ that jointly represent the number Y in binary.
b) (10 points) Derive the simplest SOP expressions for each bit of the output. That is, derive six expressions: one for y_5, another for y_4, and so on.