VALPARAISO UNIVERSITY
ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT

ECE 221 **Examination #1** **Fall 2002**

Name: _____

Honor Code Pledge: _____

_____

_____

Signature:_____

This is an open-book examination to be performed by each student individually. No calculators are permitted. Write your name on the line above before you start the exam, and then write out and sign the honor code after you have completed the exam. For each question show the development of your solutions and then place your final answer in the space provided.

Problem 1	/20
Problem 2	/30
Problem 3	/25
Problem 4	/25
Total	/100

Question 1: Number Systems and Binary Representations (20 points)

a) (10 points) The meaning of the sequence B=00110110 depends on the context in which it is used. Show the proper decimal value given the following interpretations:.

B is a binary integer	Decimal Value:_____
B is a BCD sequence	Decimal Value:_____
B is a 2's complement number	Decimal Value:_____
B is an ASCII code number	Decimal Value:_____
B is a Gray code number	Decimal Value:_____

b) (5 points each) Compute the following values:

```
    1 0 1 1 0 0 1 1    (binary)
+           3 9        (decimal)
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```


(hexadecimal)

```
        7 6    (hexadecimal)
-       7 6    (octal)
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(decimal)

Question 2: Minimal Two-Level Realizations (30 points)

A logic function of four variables is completely specified by the following expression:

$$f(A, B, C, D) = \bar{B}(\bar{A}\bar{C} + C\bar{D}) + BCD + A\bar{C}(\bar{D} + BD) + \bar{B}CD$$

a) (5 points) Map this function on the Karnaugh Map given at the right on this page. Be sure that every cell contains either a 1 or 0.

Answer the questions below assuming you want a minimized **SOP** expression.

b) (5 points) Circle all of the prime implicants on the map, and list them on the appropriate line below, separated by commas.

c) (5 points) Determine which of the prime implicants are essential, and list them on the appropriate line below.

d) (5 points) Determine which of the prime implicants are secondary, and list them on the appropriate line below.

CD \ AB	00	01	11	10
00				
01				
11				
10				

e) (5 points) Determine the minimal sum of products expression (SOP) for this function and write it on the appropriate line.

Prime Implicants = _____

Essential Prime Implicants = _____

Secondary Prime Implicants = _____

Minimized SOP f(A,B,C,D) = _____

f) (5 points) Determine the minimal product of sums expression (POS) for this function and write it on the line below.

Minimized POS f(A,B,C,D) = _____

Question 3: Word Problem (25 points)

A three-bit digital shaft encoder indicates the octant of shaft rotation as shown by the codes for A, B, and C in the table on the right (WATCH OUT!!). You are to design a combination logic circuit having three inputs (A, B, C) and three outputs (G, Y, R). Each output will activate a light: (Green, Yellow, and Red). Only the Green light will be on when the shaft is in octant 4. In octants 3 and 5 both the Green and Yellow lights will be on. The Yellow light is also on in octants 2, 6, and 7. The Red light is on only in octants 1, 2, 7 and 8.

Octant	A	B	C	G	Y	R
1	0	0	0			
2	0	1	0			
3	1	1	0			
4	1	0	0			
5	1	0	1			
6	1	1	1			
7	0	1	1			
8	0	0	1			

a) (6 points) Put the appropriate values for G, Y and R in the table

b) (6 points) From inspection of the completed table, fill in the K-Maps for G, Y, and R

c) (9 points) Write the sum of products expressions for G, Y, and R as indicated below.

G

BC \ A	0	1
00		
01		
11		
10		

Y

BC \ A	0	1
00		
01		
11		
10		

R

BC \ A	0	1
00		
01		
11		
10		

G = _____ *Y* = _____ *R* = _____

d) (4 points) Assuming that A, B, and C are available only in uncomplemented form, create the two circuits for G and Y using a minimum of 2-input NAND gates.

G Circuit	Y Circuit