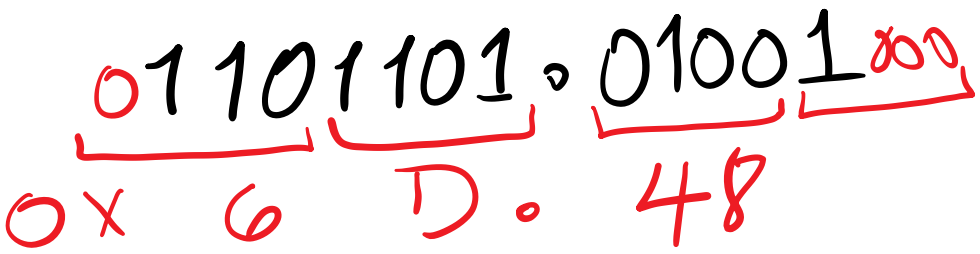
Midterm exam

1. Consider unsigned integers, convert binary number $(1101101.01001)_2$ to octal number and hexadecimal number.



2. Please convert decimal number $(65.63)_{10}$ to binary (get 4 significant digits for the fraction part).

   01000001.1010

3. Do the calculation for signed binary number: **101101-010111**. What is the result in binary? What is the result in decimal? Is there overflow?
   010110
   Yes there is an overflow.
4. Show the step-by-step calculation procedure for **-118-21**, assuming 8-bit signed binary is used. What is the result in binary? Is there overflow? Why?
   01110101, yes there is an overflow
   Decimal value is 117

5.

What are the decimal numbers, x and y, represented in the specified code?

$$x = (110000111011)_{2421}$$
$$y = (110000111011)_{\text{EXCESS-3}}$$

Solution

Look up the corresponding bit patterns from the table. $x = 635$, $y = 908$

6.

For the function $E(w, x, y, z)$, we are given the following boolean expression

$$E(w, x, y, z) = w'x'y'z + w'xy'z' + w'xy'z + w'xyz' + wx'y'z$$

I. Simplify the given boolean expression. Indicate at each simplification step the identity used.

Solution:

Method 1:

$$\begin{aligned}
E(w,x,y,z) &= w'x'y'z + w'xy'z' + w'xy'z + w'xyz' + wx'y'z \\
&= w'xy'z' + w'xy'z + w'xyz' + wx'y'z + w'x'y'z && \text{...Commutativity} \\
&= w'xy'z' + w'xy'z + w'xyz' + (w + w')x'y'z && \text{...Distributivity} \\
&= w'xy'z' + w'xy'z + w'xyz' + (1)x'y'z && \text{...Complement} \\
&= w'xy'z' + w'xy'z + w'xyz' + x'y'z && \text{...Identity} \\
&= w'xy'(z' + z) + w'xyz' + x'y'z && \text{...Distributivity} \\
&= w'xy'(1) + w'xyz' + x'y'z && \text{...Complement} \\
&= w'xy' + w'xyz' + x'y'z && \text{...Identity} \\
&= w'x(y' + yz') + x'y'z && \text{...Distributivity} \\
&= w'x(y' + z') + x'y'z && \text{...Simplification} \\
&= w'xy' + w'xz' + x'y'z && \text{...Distributivity}
\end{aligned}$$

II.Complete the K-map for the given expression.

Solution:

wx \ yz	00	01	11	10
00	0	1	0	0
01	1	1	0	1
11	0	0	0	0
10	0	1	0	0

III. Which of the following are the essential prime implicants for the above expression?

(a) $w'y'z$ (b) $x'y'z$ (c) $w'xyz'$ (d) $w'xz'$

Solution: b, d

IV. Which of the following are the minimal SOP expression for the above function

(a) $w'y'z + x'y'z + w'xy' + w'xz'$ (b) $w'y'z + w'xy' + w'xyz' + wx'y'z$

(c) $w'y'z + x'y'z + w'xz$ (d) $x'y'z + w'xy' + w'xz'$

Solution: c, d

V. Which of the following are the essential prime implicates for the above expression:

(a) $w' + x'$ (b) $w' + y'$ (c) $y' + z'$ (d) $x + z$

Solution: a, c, d

VI. Which of the following are the minimal POS expression for the above function:

(a) $(w' + x').(w' + y').(y' + z').(x + y')$ (b) $(w' + x').(w' + y').(y' + z').(x + z)$

(c) $(w' + x').(y' + z').(x + z)$ (d) $(w' + x').(y' + z').(x + y')$

Solution: c

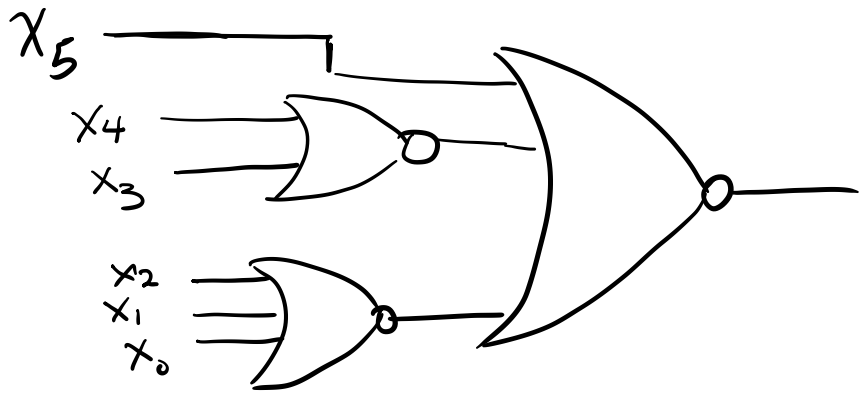
7. implement the following expression using only NOR gates:

$Z = x_5'(x_4'x_3)'(x_2'x_1'x_0')'$

$$\Big(\big(x_5' (x_4' x_3')' (x_2' x_1' x_0')' \big)' \Big)'$$

$$\big(x_5 + (x_4' x_3') + (x_2' x_1' x_0') \big)'$$

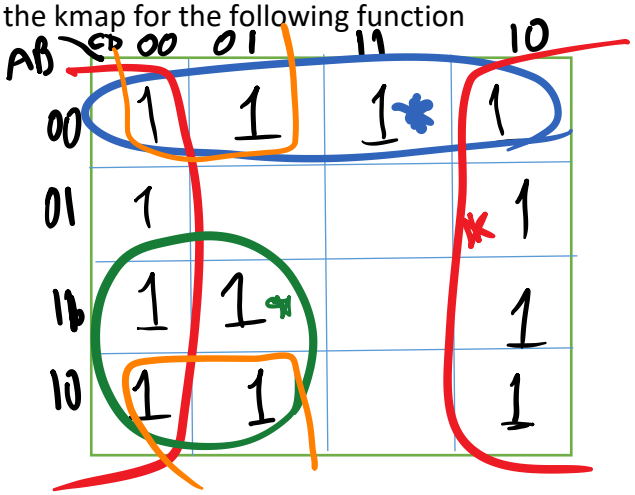
$$\big(x_5 + (x_4 + x_3)' (x_2 + x_1 + x_0)' \big)'$$



8. For the following function:

$$F(A,B,C,D) = A\overline{D} + \overline{B}\,\overline{C}D + BC\overline{D} + AB\overline{C} + \overline{C}\,\overline{D} + \overline{A}\,\overline{B}C$$

a. Draw the kmap for the following function



$\overline{B}\,\overline{C}$

$\overline{A}\,\overline{B}$ *

$\overline{D}$ *

$A\overline{C}$ *

3EPI's

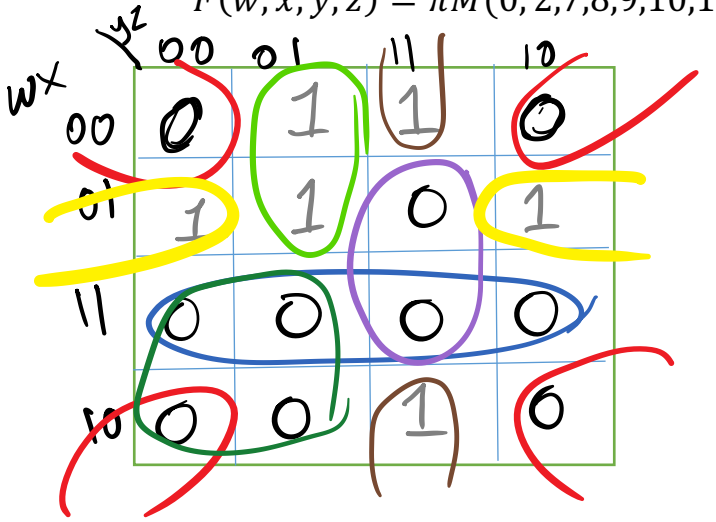
b. Find out all the PIs, and determine which ones are EPIs. Please make sure to indicate all the product terms for the PIs.

9. Using Kmap simplify the following Expression to

   a. Sum of Products

   b. Product of Sums

$$F(w,x,y,z) = \pi M(0,2,7,8,9,10,12,13,14,15)$$



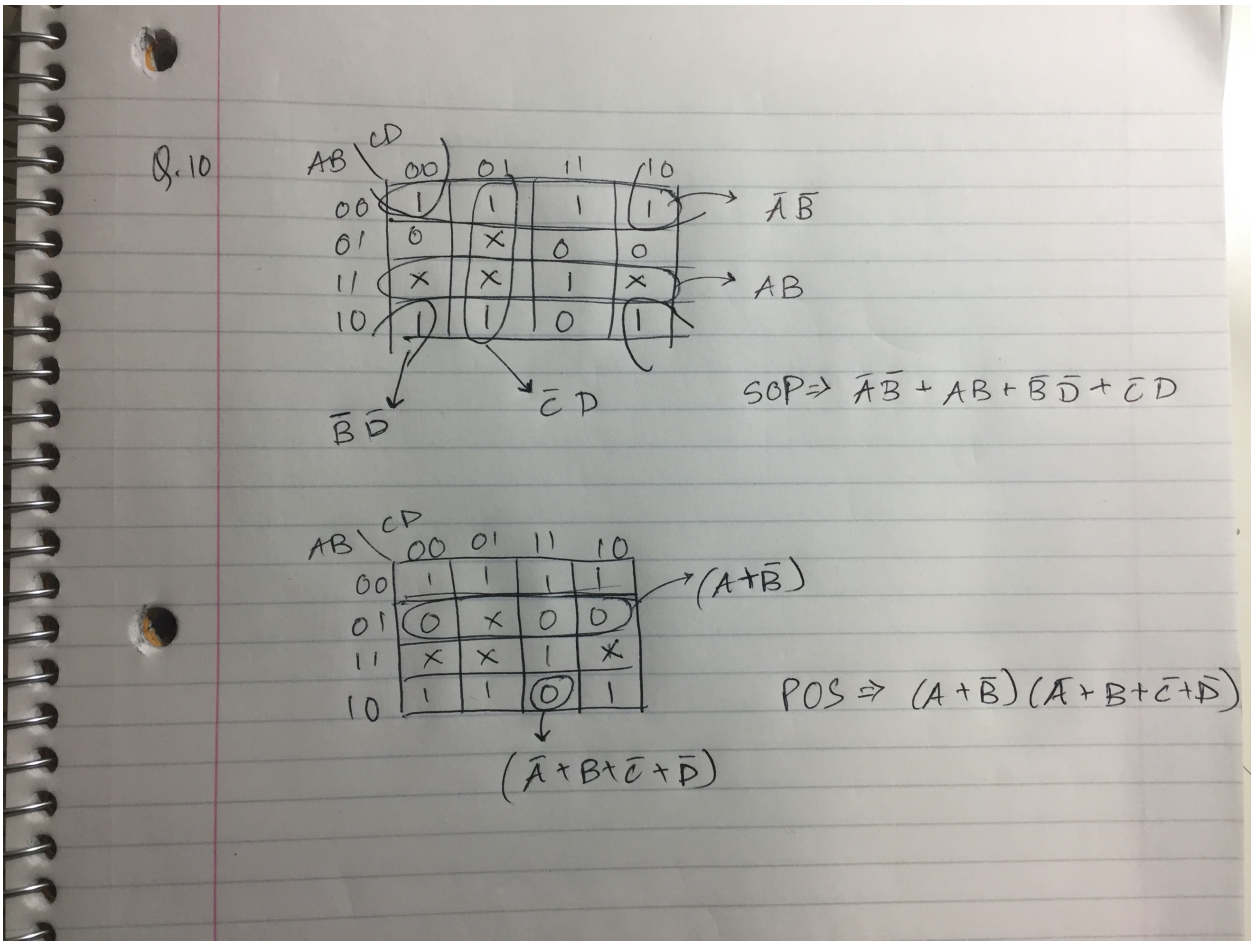
a) $F = \bar{w}\bar{y}z + \bar{x}yz + \bar{w}x\bar{z}$

b) $\overline{\bar{x}\bar{z} + wx + w\bar{y} + xyz}$

$F = (x+z)(\bar{w}+\bar{x})(\bar{w}+y)(\bar{x}+\bar{y}+\bar{z})$

10. Given a function $F(A,B,C,D) = \sum m(0,1,2,3,8,9,10,15) + \sum d(5,12,13,14)$

   a. Draw K-map for function
   b. From the K-map you draw, derive the simplest SOP (Sum-of-Product) representation for the above function with don't cares.
   c. From the K-map you draw, derive the simplest POS (product of sum) representation for the above function with don't cares.



11. Given the logic circuit diagram below:

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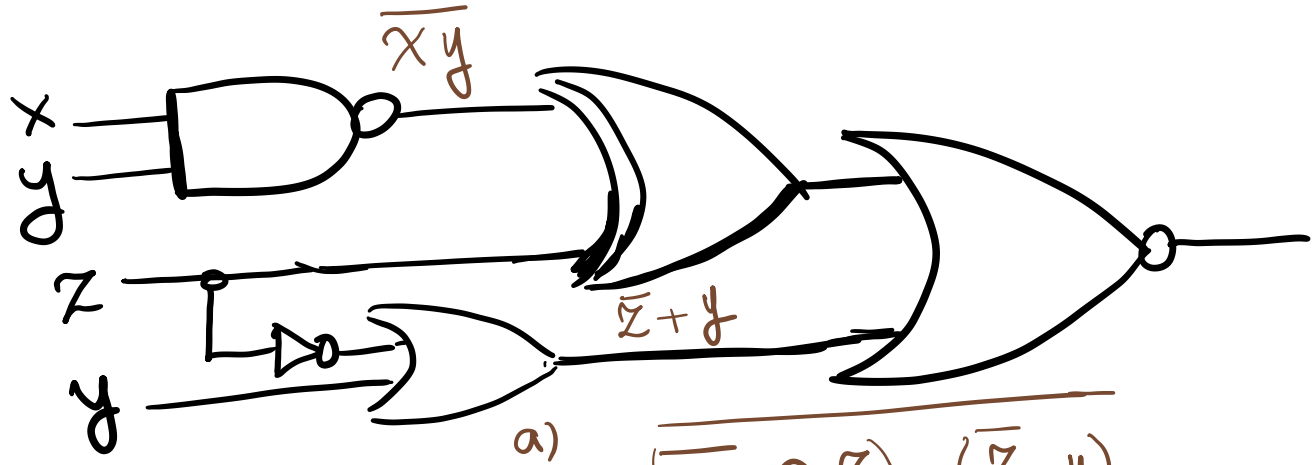

a) $F = \overline{(\overline{xy} \oplus z) + (\bar{z} + y)}$

a. Figure out the logic function F (x,y,z)
b. Simplify the function
c. Find the complement of the function

b. $(\overline{\overline{xy} \oplus z} \cdot (\overline{\bar{x} + y + \bar{z}})(z\bar{y})$

$= \overline{(xyz + (\bar{x} + \bar{y})\bar{z})(z\bar{y})}$

$= ((\overline{\overline{xy}} \cdot z + \overline{xy}\,\bar{z})(z\bar{y}) = \overline{\bar{y}}$

$= (xy\bar{z} + \bar{x}z + \bar{y}z)z\bar{y} \Rightarrow \bar{x}\bar{y}z + \bar{y}z$

$\bar{y}z(\bar{x} + 1) = \bar{y}z$

c) $\overline{\bar{y}z} = y + \bar{z}$