I (One point each) Answer True or False. Unless otherwise noted, all numbers are in decimal.

_T_ a. An *Essential Prime Implicant* must include at least one element of the on-set that is not covered by any other implicant.

_T_ b. For any given Boolean Expression, there is one and only one Truth Table.

_T_ c. The Boolean expression $\overline{A \cdot B} + \overline{A} \cdot \overline{B}$ represents the output of a two-input Exclusive OR gate.

_F_ d. The sum of a negative number in 8 bit sign-magnitude form and the same number in its 8 bit two's complement form results in all 8 bits becoming 0.

_F_ f. A NOR gate cannot be implemented using only NAND gates.

_T_ e. In a 6-bit Twos-Complement representation, $-27 = (100101)_2$.

_T_ g. $(A + B + C + D) = \overline{\overline{(A + C)}\,\overline{(B + D)}}$.

_T_ h. The sign-magnitude representation of a positive number N and the corresponding negative number (–N) differ only in one bit.

_T_ i. A P-Channel MOS transistor forms a conducting channel when its gate is negative with respect to its source.

_F_ j. Carry-lookahead circuit increases the carry propagation time of the corresponding ripple carry adder.

II (10 points) Use the Quine-McCluskey Method to find the minimum sum of products form for the Boolean expression $F(A, B, C, D) = \Sigma m(0,2,8,10,11,13,14,15) + \Sigma d(3,4)$

QUINE-McCLUSKEY IMPLICATION TABLE

Minterms	Column 1	Column 2	Column 3
0	0000 ✓	00_0 ✓	_0_0 *
		0_00 *	
2	0010 ✓	_000	
4	0100 ✓	001_ ✓	
8	1000 ✓	_010 ✓	
		10_0 ✓	_01_ *
3	0011 ✓	_011 ✓	
10	1010 ✓		
11	1011 ✓	101_ ✓	1_1_ *
13	1101 ✓	1_10 ✓	
14	1110 ✓	1_1_ ✓	
15	1111 ✓	11_1 * ✓	
		111_ ✓	

PRIME IMPLICANT CHART

Minterms / Prime Implicants	0	2	8	10	11	13	14	15	
0,2,8,10	_0_0	✗	✗	⊗	✗					EPI
2,3,10,11	_01_		✗		✗	✗				NOT NEEDED
10,11,14,15	1_1_				✗	✗		⊗	✗	EPI
0,4	0_00	✗								NOT NEEDED
13,15	11_1						⊗		✗	EPI

FINAL BOOLEAN EXPRESSION: $F = \overline{B}\,\overline{D} + AC + ABD$

III Consider a function $F(A, B, C, D, E)$ as described by the K-Map below. The input variables
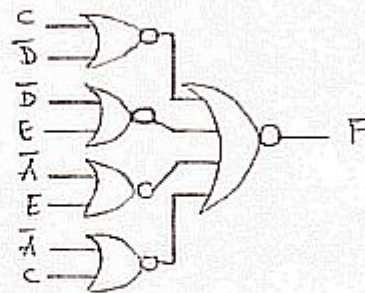are available in both True and Complement form.
   a. (3 points) Find the minimized Product of Sums expression of F.
   b. (2 points) Implement the PoS using only NOR gates.
   c. (3 points) Find the minimized Sum of Products expression of F.
   d. (2 points) Implement the SoP using only NAND gates.
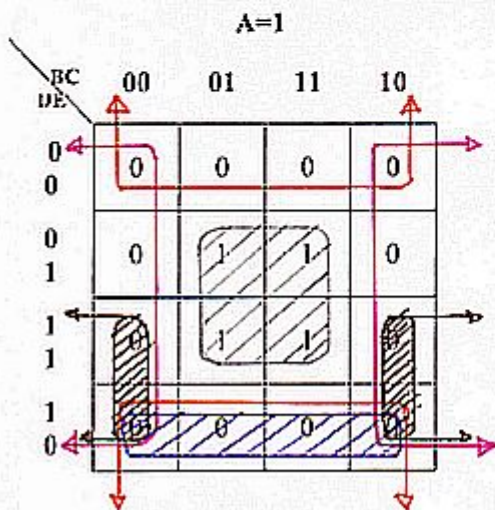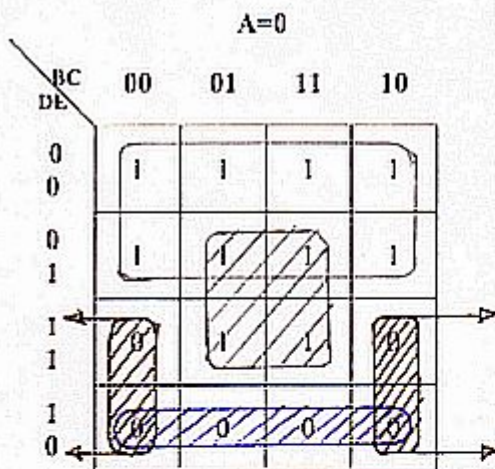
Note that shaded regions connect
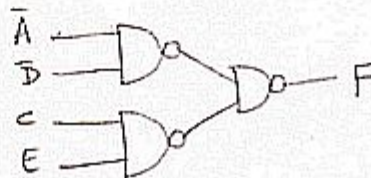Implicants on the top (A=0) and
bottom (A=1) figures.

a. $F = (C + \bar{D})(\bar{D} + E)(\bar{A} + E)(\bar{A} + C)$

b. $F = \overline{(C + \bar{D})(\bar{D} + E)(\bar{A} + E)(\bar{A} + C)}$

$= \overline{(C + \bar{D})} + \overline{(\bar{D} + E)} + \overline{(\bar{A} + E)} + \overline{(\bar{A} + C)}$

c. $F = \bar{A}\bar{D} + CE$

d. $F = \overline{\bar{A}\bar{D} + CE}$

$= \overline{\bar{A}\bar{D}} \cdot \overline{CE}$

IV (a) Draw lines connecting items on list A to their corresponding items with same value in list
    B. Subscript TC indicates *Twos-Complement* representation. Numbers without
    subscripts are in Decimal notation.

LIST A   LIST B

108                             $(11111111)_{TC}$

$(111111)_{TC}$ 21

$(210)_3$ $(010000)_4$

$(0100)_{16}$ $(20)_3$-$(10)_{16}$

$(110000)_{TC}+(000110)_{TC}$ $(01101100)_2$
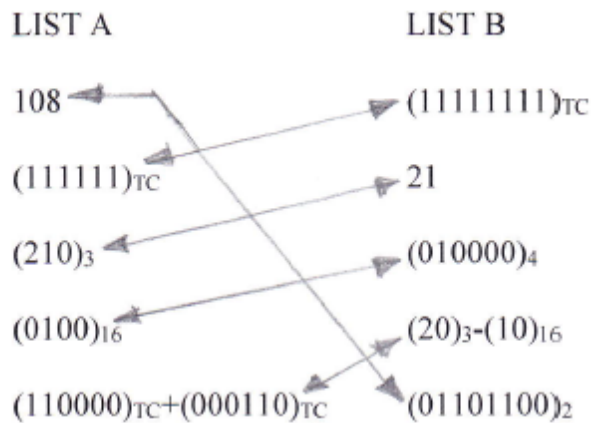
(b) (5 points) Show the arrangement of CMOS transistors to realize the function $\overline{(A.B)} + C + D$