Name: ______________________________ **Student ID:** ______________

Q1.- A combinational circuit taking a nonnegative three digit binary number ABC as input decides whether it is an even number or the two most significant digits A & B are equal (indicating it with output E = 1) and whether the sum of its two least significant digits B & C is odd (indicating it with output O = 1).

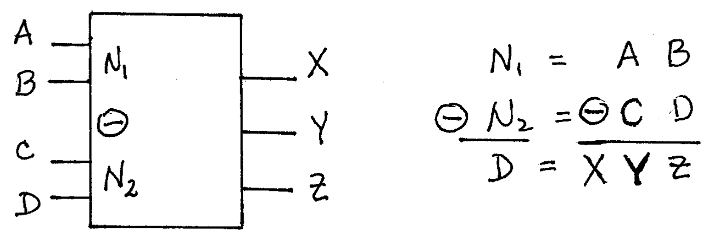
(a) Write output E in canonical sum-of-products (SoP) form. [3 pts]

(b) Write output O in canonical product-of-sums (PoS) form. [3 pts]

(c) Use Boolean identities to find the minimized SoP form for output E. [3 pts]

(d) Use Boolean identities to find the minimized PoS form for output O. [3 pts]

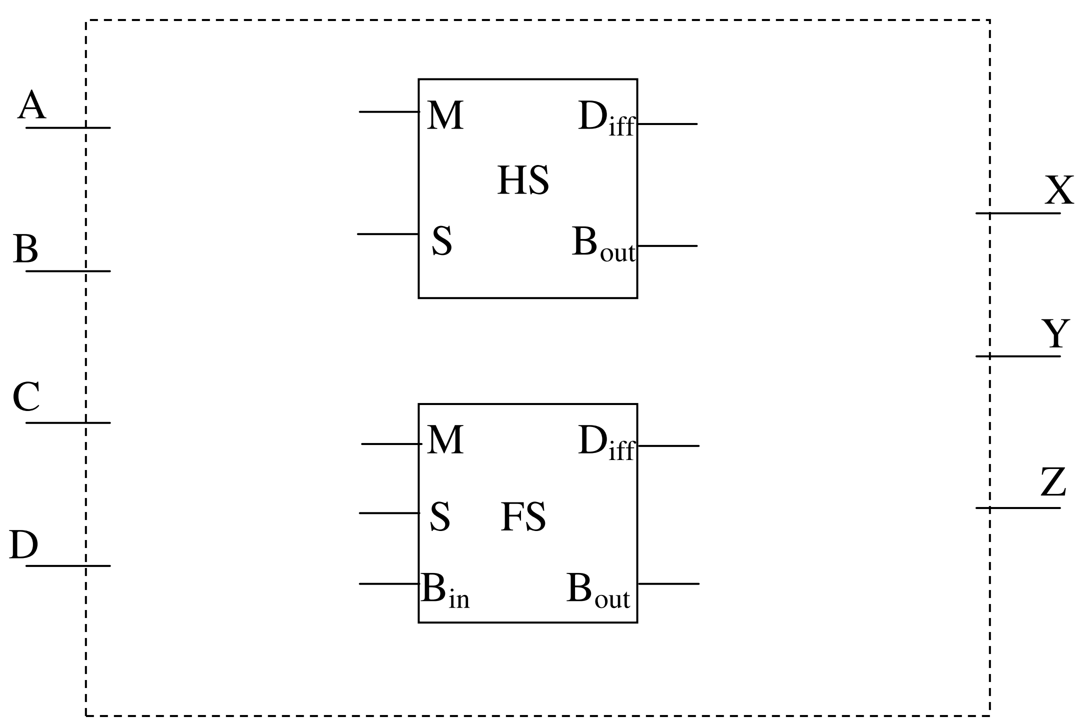
Q2.- The logic box shown below performs the substraction of two 2-bit numbers N_1 =AB (minuend) & N_2 = CD (subtrahend). The result (difference) is a three bit number D = XYZ.



(a) Build the truth table for the functions X, Y & Z. [3 pts]
Note: Values of D result in 3-bit 2's complement.

(b) Use K-maps to minimize the functions X, Y & Z in sum of products form. [5 pts]

(c) You are given one half subtractor and one full subtractor as shown below.
Complete the diagram to obtain the difference D = XYZ of $N_1 - N_2 =$ AB − CD.
M - minuend, S - subtrahend, D_{iff} - difference, B_{in} - borrow-in, B_{out} - borrow-out [4 pts]



Q3.- Draw the circuit for the following function g

(a) as written below using AND, OR & NOT gates (assume 2 & 3-input gates are available). [2 pts]

(b) using NAND gates only (assume literal complements as well as 2 and 3-input gates are available). [3 pts]

(c) using NOR gates only (assume literal complements as well as 2 and 3-input gates are available). [3 pts]

$$g = \left(\overline{(A+B)\cdot\bar{C}} + B\bar{C}D\right)\cdot E\cdot(A+B)$$

Note: Do not use Boolean algebra or K-map simplification in any of the three parts above.

Q4.- The function f is given by

$$f(A,B,C) = \sum m_i(0,5,6,7)$$

(a) Implement this function f using an 8:1 multiplexer. [4 pts]

(b) Implement the same function f using a 4:1 multiplexer. [4 pts]

Basic Boolean Identities

	Identity	Comments
1.	$A+0=A$	Operations with 0 and 1
2.	$A+1=1$	Operations with 0 and 1
3.	$A+A=A$	Idompotent
4.	$A+\overline{A}=1$	Complementarity
5.	$A\cdot 0=0$	Operations with 0 and 1
6.	$A\cdot 1=A$	Operations with 0 and 1
7.	$A\cdot A=A$	Idompotent
8.	$A\cdot\overline{A}=0$	Complementarity
9.	$\overline{\overline{A}}=A$	Involution
10.	$A+B=B+A$	Commutative
11.	$A\cdot B=B\cdot A$	Commutative
12.	$A+(B+C)=(A+B)+C=A+B+C$	Associative
13.	$A\cdot(B\cdot C)=(A\cdot B)\cdot C=A\cdot B\cdot C$	Associative
14.	$A\cdot(B+C)=(A\cdot B)+(A\cdot C)$	Distributive
15.	$A+(B\cdot C)=(A+B)\cdot(A+C)$	Distributive
16.	$A+(A\cdot B)=A$	Absorption
17.	$A\cdot(A+B)=A$	Absorption
18.	$(A\cdot B)+(\overline{A}\cdot C)+(B\cdot C)=(A\cdot B)+(\overline{A}\cdot C)$	Consensus
19.	$\overline{A+B+C+\ldots}=\overline{A}\cdot\overline{B}\cdot\overline{C}\cdot\ldots$	De Morgan
20.	$\overline{A\cdot B\cdot C\cdot\ldots}=\overline{A}+\overline{B}+\overline{C}+\ldots$	De Morgan
21.	$(A+\overline{B})\cdot B=A\cdot B$	Simplification
22.	$(A\cdot\overline{B})+B=A+B$	Simplification