Name: ____________________________________ **Student ID:** ________________

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

(a) Write output P in canonical sum-of-products (SoP) form.

(b) Write output E in canonical product-of-sums (PoS) form.

(c) Use Boolean identities to find the minimized SoP form for output P.

(d) Use Boolean identities to find the minimized PoS form for output E.

Q2.- Given the following function in product-of-sums (PoS) form:

$$f(A,B,C,D) = \prod M_i(1,5,6,7,8,10,14,15)$$

Map the function *f* in a K-map and:

a) Find the minimized PoS expression for *f*.

b) Check if the minimized expression found in (a) is hazard-free. Justify.

If it is not hazard-free provide a PoS hazard-free expression for *f*.

c) Find the minimized SoP expression for *f*.

d) Check if the minimized expression found in (c) is hazard-free. Justify.

If it is not hazard-free provide a SoP hazard-free expression for *f*.

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).

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

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

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

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

Q4.- Design a converter that maps a 4-bit binary code into a 4-bit Gray code. The 4-bit Gray code sequence is defined as follows: 0000, 0001, 0011, 0010, 0110, 0111, 0101, 0100, 1100, 1101, 1111, 1110, 1010, 1011, 1001, 1000.

(a) Give the truth table.

(b) Find the minimized expressions for the output functions.

(c) Show how to implement this code converter as either a PAL or a PLA circuit, whichever you consider more appropriate. Justify your choice.

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