Midterm Examination **ECED2200 – Digital Circuits** **February 16, 2012**

Name: ____________________________________ **Student ID:** _________________

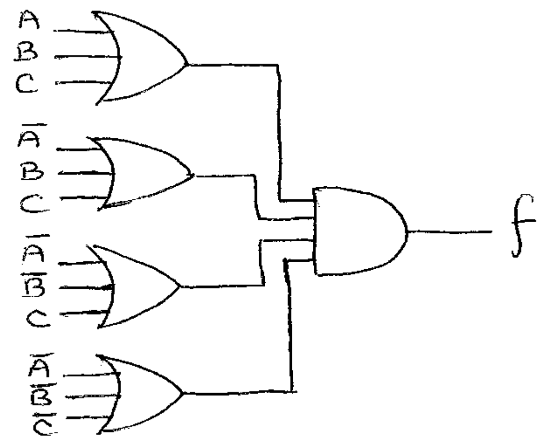
Q1.- Consider the function *f* realized by the logic circuit shown below.

(a) Analyze the circuit and write the canonical product of sums (PoS) expression for *f*.

(b) Use Boolean algebra to simplify the expression of *f* found in (a) above to its minimized sum of products (SoP) form.

(c) Use the K-map method to verify the result found in part (b) above.

(d) Is the minimized SoP expression found hazard-free? Explain and if it is not provide the hazard-free SoP form.



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

$$f(A,B,C,D) = \sum m_i(0,1,2,4,5,6,7,8,10)$$

(a) Prepare its truth table.

(b) Map the function f in a K-map and identify:

i. One implicant that is not a prime implicant,

ii. One prime implicant that is not essential, and

iii. All essential prime implicants.

In identifying each implicant above list all the minterms in each of them.

(c) Write the minimized SoP form for *f*.

Q3.- Given the multilevel function f below

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

Assume literal complements are available.

(a) Draw the circuit implementing this function using NOT gates and 2-input AND & OR gates.

(b) Convert the circuit to NOR-only and draw the circuit for *f* using only 2-input NOR gates.

(c) Convert the circuit to NAND-only and draw the circuit for *f* using only 2-input NAND gates.

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