Name: KEY **Id#**

COE 405, Term 131

Design & Modeling of Digital Systems

Quiz# 1

Date: Tuesday, Oct. 1, 2013

Q.1. Consider the two functions: $F_1(A,B,C,D) = AB + BC + CD + \overline{A}\overline{D}$ and $F_2(A,B,C,D) = ABC + \overline{A}\overline{B}\overline{C} + \overline{A}D + A\overline{D}$

(i) Compute the expansion of F_1 and F_2 using the **Orthonormal Basis** $\{\varnothing_1 = \overline{A}\overline{B}$, $\varnothing_2 = \overline{A}B$, $\varnothing_3 = A\overline{B}$, $\varnothing_4 = AB\}$.

(ii) Compute the function $F_1 \oplus F_2$.

(i) $F1 = \overline{A}\overline{B}[CD + \overline{D}] + \overline{A}B[C + CD + \overline{D}] + A\overline{B}[CD] + AB[1]$

$= \overline{A}\overline{B}[C + \overline{D}] + \overline{A}B[C + \overline{D}] + A\overline{B}[CD] + AB[1]$

$F2 = \overline{A}\overline{B}[\overline{C} + D] + \overline{A}B[D] + A\overline{B}[\overline{D}] + AB[C + \overline{D}]$

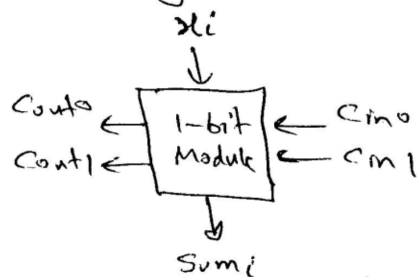
(ii) $F1 \oplus F2 = \overline{A}\overline{B}[(C+\overline{D}) \oplus (\overline{C}+D)] + \overline{A}B[(C+\overline{D}) \oplus D] + A\overline{B}[CD \oplus \overline{D}] + AB[1 \oplus (C+\overline{D})]$

$= \overline{A}\overline{B}[C\overline{D} + \overline{C}D] + \overline{A}B[\overline{C} + \overline{D}] + A\overline{B}[C + \overline{D}] + AB[\overline{C}D]$

Q.2. It is required to design a combinational circuit that computes the equation Y=3*X+2, where X is an n-bit unsigned number.

- **(i)** Design the circuit as a modular circuit where each module receives a single bit of the input, X_i.
- **(ii)** Derive the truth table of your 1-bit module in (i).
- **(iii)** Derive minimized two-level sum-of-product equations for your 1-bit module circuit.

(i) By analyzing the circuit functionality, we determine that the maximum carry-out is 2. Thus, we need 2 bits for the carry-in and 2 bits for the carry-out between modules.



Note the +2 will be achieved by setting Cin1 Cin0 = 10 in the first module.

(ii) Truth Table:

Cin1	Cin0	xi	Cout1	Cout0	Sumi
0	0	0	0	0	0
0	0	1	0	1	1
0	1	0	0	0	1
0	1	1	1	0	0
1	0	0	0	1	0
1	0	1	1	0	1
1	1	0	x	x	x
1	1	1	x	x	x

(iii)

C_{in1} \ $C_{in0}x_i$	00	01	11	10
0	0	0	1	0
1	0	1	X	X

$$C_{out1} = C_{in0}x_i + C_{in1}x_i$$

C_{in1} \ $C_{in0}x_i$	00	01	11	10
0	0	1	0	0
1	1	0	x	x

$$C_{out0} = \overline{C_{in1}}\,\overline{C_{in0}}\,x_i + C_{in1}\overline{x_i}$$

C_{in1} \ $C_{in0}x_i$	00	01	11	10
0	0	1	0	1
1	0	1	X	X

$$Sum_i = \overline{C_{in0}}\,x_i + C_{in0}\overline{x_i}$$