The University of Alabama in Huntsville
ECE Department
EE 202 – 02
Test 1 Solution
Fall 2016

In order to get full credit, you *must* show your work! You may use additional sheets of paper for your work, please put your name on each additional sheet. You *may* use a calculator.

x + 0 = x	x · 1 = x
x + x' = 1	x · x' = 0
x + x = x	x · x = x
x + 1 = 1	x · 0 = 0
(x')' = x	
x + y = y + x	xy = yx
x + (y + z) = (x + y) + z	x(yz) = (xy)z
x(y + z) = xy + xz	x + yz = (x + y)(x + z)
(x + y)' = x'y'	(xy)' = x' + y'
x + xy = x	x(x + y) = x

1. (1 point) A _**Gray**_ code is one in which only one bit in the code group changes in going from one number to the next.
2. (1 point) A group of binary cells is called a _**register**_.
3. (1 point) The _**distributive**_ law states that x(y + z) = xy + xz.
4. (1 point) The principle of _**duality**_ states that every algebraic expression of Boolean algebra remains valid if the operators and identity elements are interchanged.
5. (1 point) The _**complement**_ of a function F is obtained from an interchange of 0's for 1's and 1's for 0's in the value of F.
6. (10 points) Convert (51032_6) to decimal:

5 x 64 + 1 x 63 + 0 x62 + 3 x 61 + 2 x60 = 5 x 1296 + 1 x 216 + 0 x 36 + 3 x 6 + 2 x 1
= 6480 + 216 + 0 + 18 + 2 = 6716

7. (15 points) Obtain the truth table of the following function and express it in sum-of-minterms and product-of-maxterms forms.

F = (cd +ab'c + bd')(a' + b + d)

a	b	c	d	cd	ab'c	bd'	cd +ab'c + bd'	a' + b + d	F
0	0	0	0	0	0	0	0	1	0
0	0	0	1	0	0	0	0	1	0
0	0	1	0	0	0	0	0	1	0
0	0	1	1	1	0	0	1	1	1
0	1	0	0	0	0	1	1	1	1
0	1	0	1	0	0	0	0	1	0
0	1	1	0	0	0	1	1	1	1
0	1	1	1	1	0	0	1	1	1
1	0	0	0	0	0	0	0	0	0
1	0	0	1	0	0	0	0	1	0
1	0	1	0	0	1	0	1	0	0
1	0	1	1	1	1	0	1	1	1
1	1	0	0	0	0	1	1	1	1
1	1	0	1	0	0	0	0	1	0
1	1	1	0	0	0	1	1	1	1
1	1	1	1	1	0	0	1	1	1

$F = \sum(3, 4, 6, 7, 11, 12, 14, 15)$
$F = \prod(0, 1, 2, 5, 8, 9, 10, 13)$

8. (10 points) Reduce a'bc + abc' + abc + a'bc' to a minimum number of literals using Boolean algebra.

a'bc + abc' + abc + a'bc' = (a'bc + a'bc') + (abc' + abc) = a'b(c + c') + ab(c' + c) = a'b(1) + ab(1) = a'b + ab = b(a' + a) = b(1) = b

9. (15 points) Convert decimal +64 and +72 to binary, using the 8-bit signed-2's-complement representation. Then perform the binary equivalent of (-64) + (-72). Convert the answer back to decimal and verify that it is correct or explain why it is not.

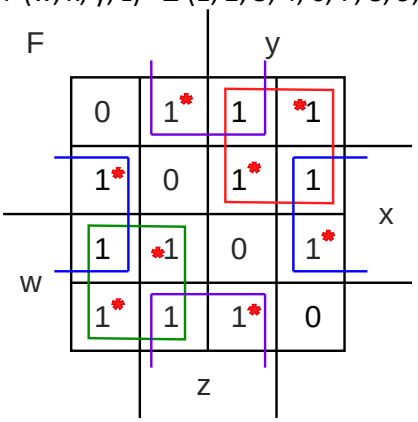
+64 = 0 × -128 + 1 × 64 + 0 × 32 + 0 × 16 + 0 × 8 + 0 × 4 + 0 × 2 + 0 × 1 = 0010 0000
+72 = 0 × -128 + 1 × 64 + 0 × 32 + 0 × 16 + 1 × 8 + 0 × 4 + 0 × 2 + 0 × 1 = 0100 1000
-64 = 1 × -128 + 1 × 64 + 0 × 32 + 0 × 16 + 0 × 8 + 0 × 4 + 0 × 2 + 0 × 1 = 1100 0000
-72 = 1 × -128 + 0 × 64 + 1 × 32 + 1 × 16 + 1 × 8 + 0 × 4 + 0 × 2 + 0 × 1 = 1011 1000

-64 1100 0000
-72 1011 1000
0111 1000
0111 1000 =0 × -128 + 1 × 64 + 1 × 32 + 1 × 16 + 1 × 8 + 0 × 4 + 0 × 2 + 0 × 1 =
-64 + 32 + 16 + 8 = 120 ×

The result doesn't match because -128 is the most negative number that can be represented in 8-bit signed-2's complement and -64 + -72 = -136. This is an overflow situation.

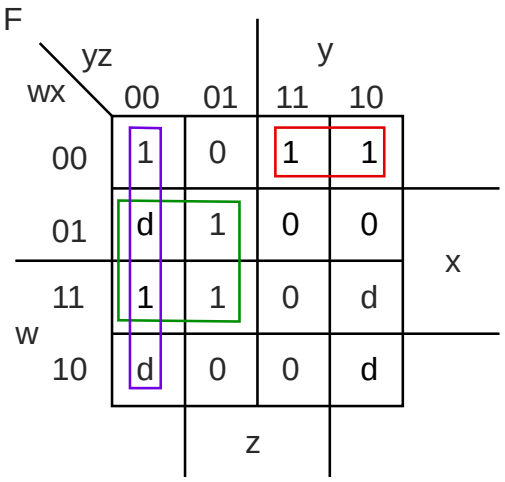
10. (5 points) Convert 1011 0111 0011 0001 1100 0101 1010 1011 to hexadecimal.
0xB731 C5AB

11. (15 points) Find all the prime implicants for the following Boolean function, and determine which are essential:
F (w, x, y, z) =Σ (1, 2, 3, 4, 6, 7, 8, 9, 11, 12, 13, 14)

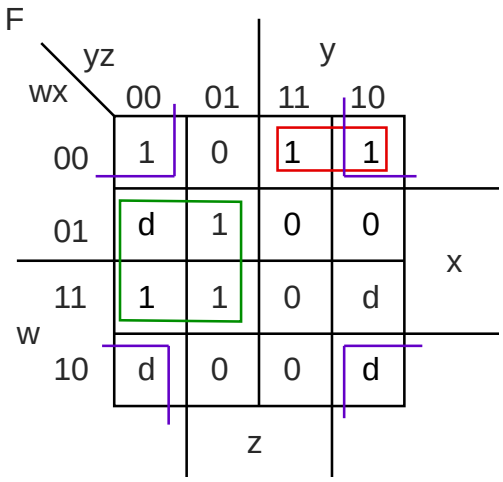


The prime implicants are w'y, wy', xz', and x'z. Since each prime implicant has at least two minterms that are covered by no other prime implicants (indicated with *), all prime implicants are essential.

12. (15 points) Simplify the following Boolean function, using a four-variable map.
F (w, x, y, z) = Σ(0, 2, 3, 5, 12, 13))
d (w, x, y, z) = Σ(4, 8, 10, 14)



F = y'z' + xy' + w'x'y **or**



F = x'z' + xy' + w'x'y

13. (10 points) Convert the following circuit into a circuit that contains only NAND gates.