FZU ID : 831903230
MU ID : 19104294 **CS220 Computer Architecture**
NAME : MENGYU RAO **Digital Logic Design**
Practical 3

Part A

(a) Plot the function f(A,B,C,D) = Σm (0,4,5,8,9,10,12) on a k-map. You may need to draw a truth table first.

Truth table:

A	B	C	D	f
0	0	0	0	1
0	0	1	0	0
0	0	0	1	0
0	0	1	1	0
0	1	0	0	1
0	1	0	1	1
0	1	1	0	0
0	1	1	1	0
1	0	0	0	1
1	0	0	1	1
1	0	1	0	1
1	0	1	1	0
1	1	0	0	1
1	1	0	1	0
1	1	1	0	0
1	1	1	1	0

k-map:

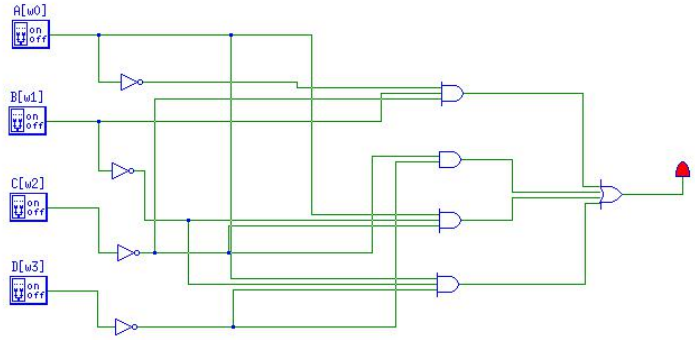
CD \ AB	00	01	11	10
00	1	1	1	1
01	0	1	0	1
11	0	0	0	0
10	0	0	0	1

(b) Using the minimisation procedure on the k-map, write a minimal Sum-of-Products expression for the function f using AND, OR and NOT operators.

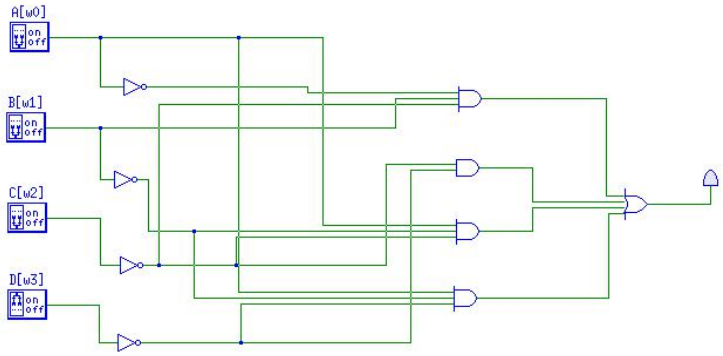
$$f = \overline{C}\,\overline{D} + \overline{A}B\overline{C} + A\overline{B}\,\overline{C} + A\overline{B}\,\overline{D}$$
$$= \overline{C}\,\overline{D} + \overline{C}(\overline{A}B + A\overline{B}) + A\overline{B}\,\overline{D}$$

(c) Implement the function on the simulator and verify its behaviour against the K-map (or truth table) for the function.

A = 0 B = 0 C = 0 D = 0 f = 1



A = 0 B = 0 C = 0 D = 1 f = 0



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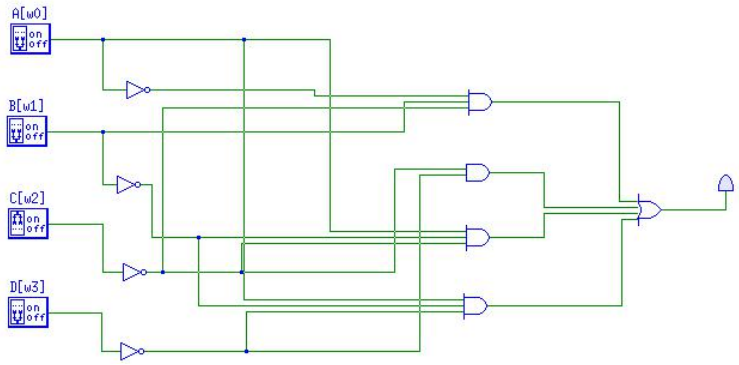

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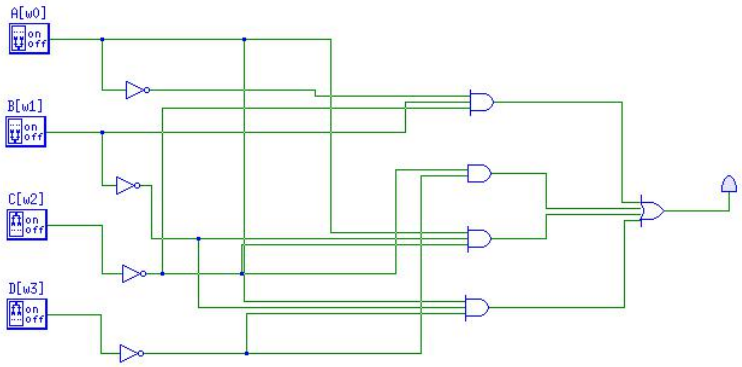
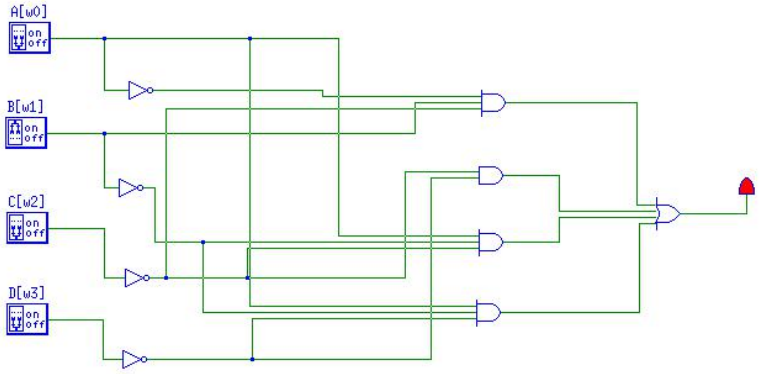
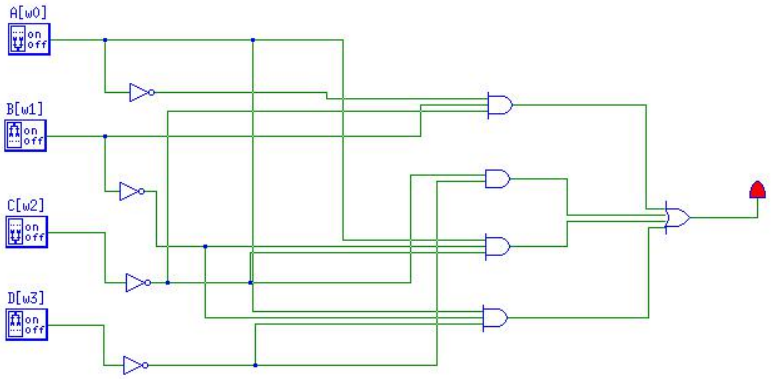


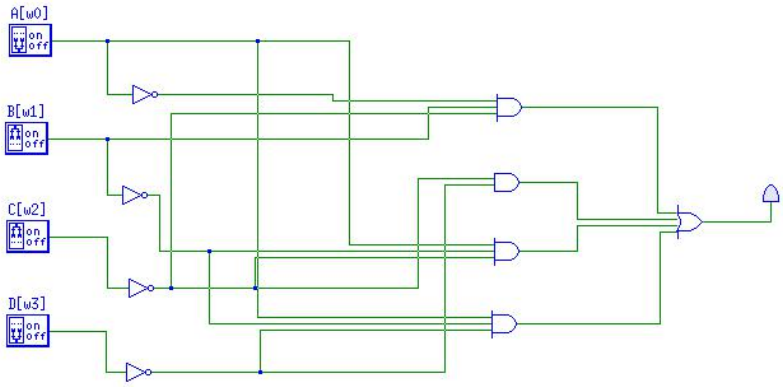
A = 0 B = 1 C = 0 D = 0 f = 1



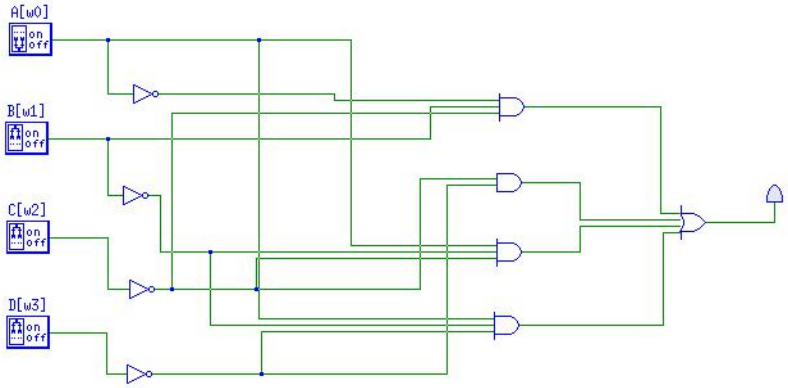
A = 0 B = 1 C = 0 D = 1 f = 1



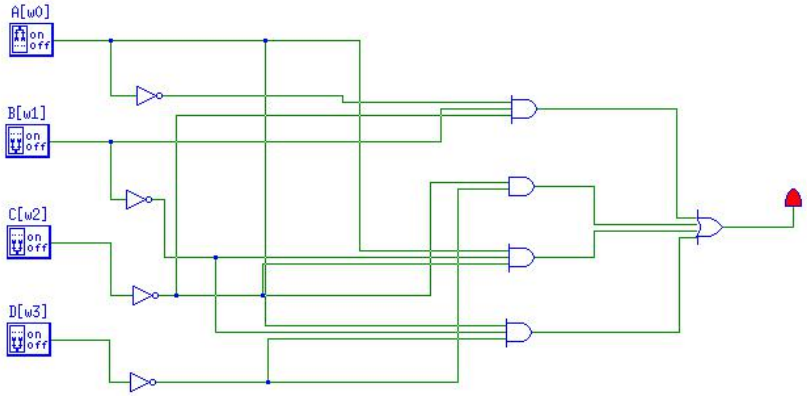
A = 0 B = 1 C = 1 D = 0 f = 0



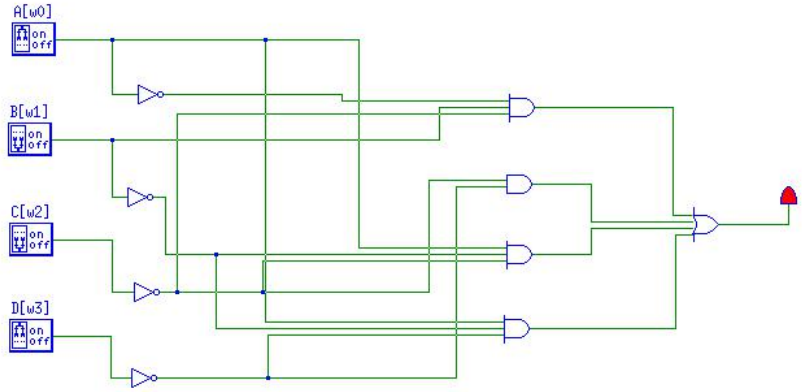
A = 0 B = 1 C = 1 D = 1 f = 0



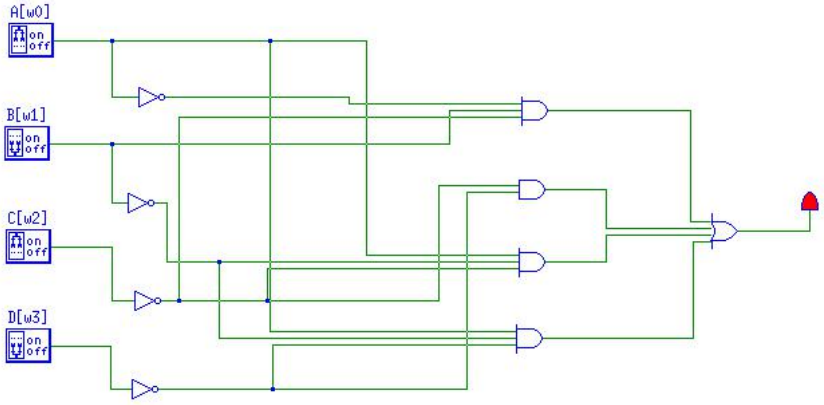
A = 1 B = 0 C = 0 D = 0 f = 1



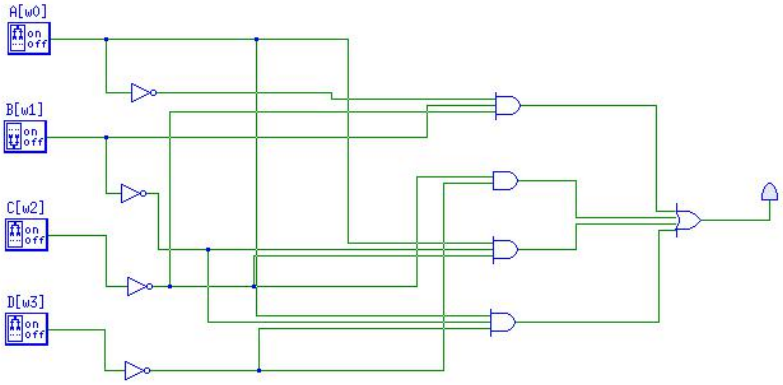
A = 1 B = 0 C = 0 D = 1 f = 1



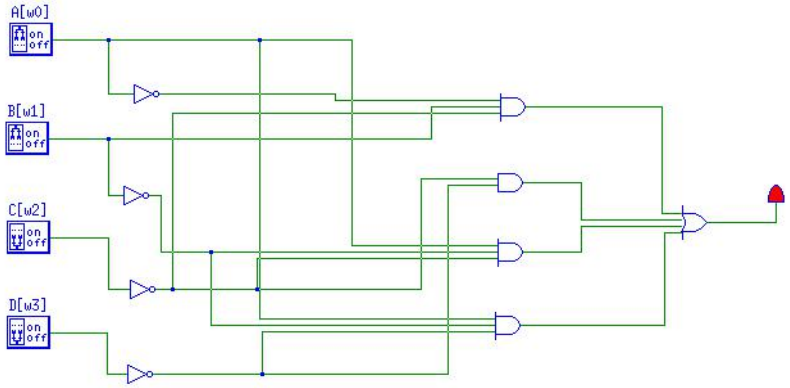
A = 1 B = 0 C = 1 D = 0 f = 1



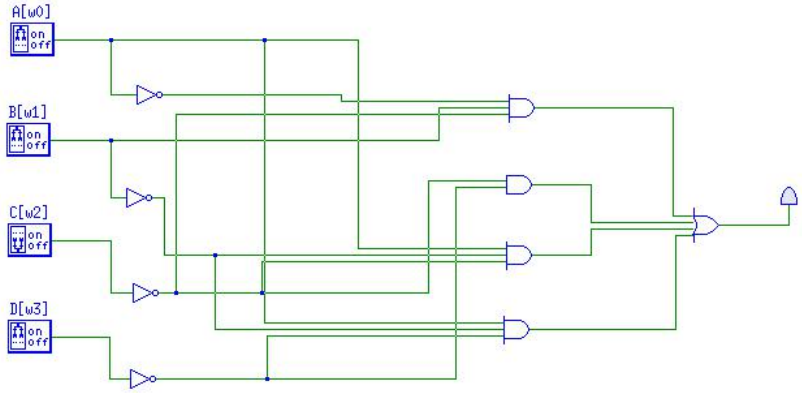
A = 1 B = 0 C = 1 D = 1 f = 0



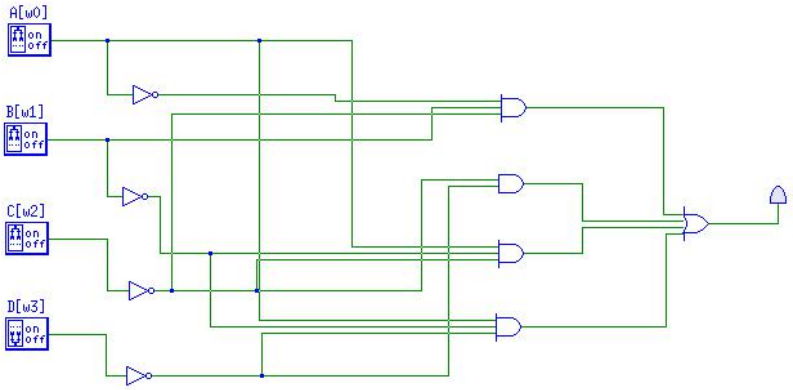
A = 1 B = 1 C = 0 D = 0 f = 1



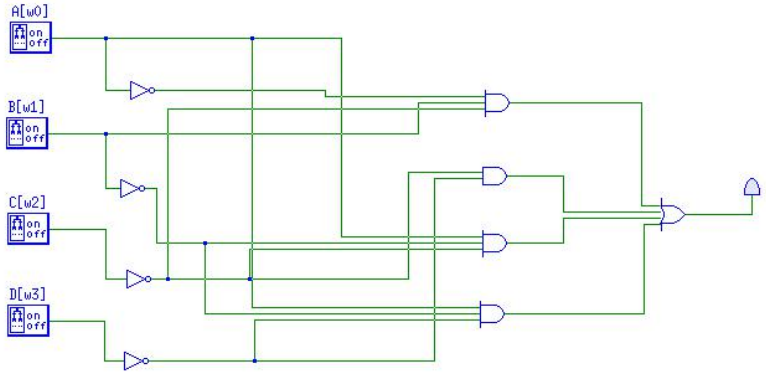
A = 1 B = 1 C = 0 D = 1 f = 0



A = 1 B = 1 C = 1 D = 0 f = 0

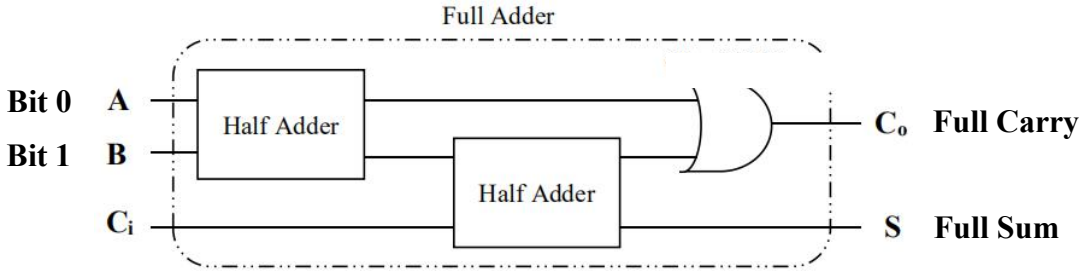


A = 1 B = 1 C = 1 D = 1 f = 0



Part B

(a) Draw a truth table for a 1-bit full adder circuit.



A	B	C_i	S	C_o
0	0	0	0	0
0	1	0	1	0
1	0	0	1	0
1	1	0	0	1
0	0	1	1	0
0	1	1	0	1
1	0	1	0	1
1	1	1	1	1

(b) Plot the sum and carry functions on separate k-maps.

Sum function on k-map:

C \ AB	00	01	11	10
0	0	1	0	1
1	1	0	1	0

$$S = A \oplus B \oplus C_i$$

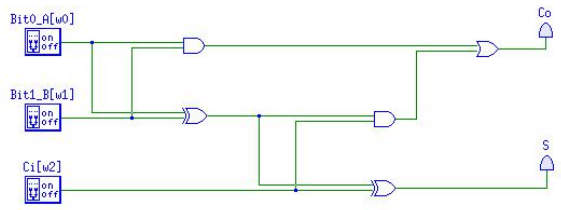
Carry function on k-map:

C \ AB	00	01	11	10
0	0	0	1	0
1	0	1	1	1

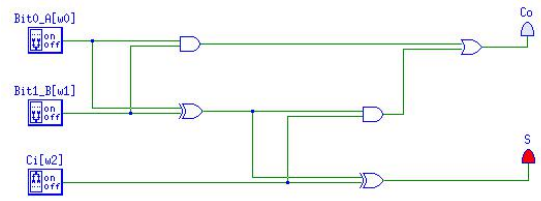
$$C_0 = AB + (A \oplus B)C_i$$

(c) Design and construct a 1-bit full adder using only five two-input logic gates (either EXOR, OR, AND, NOT)

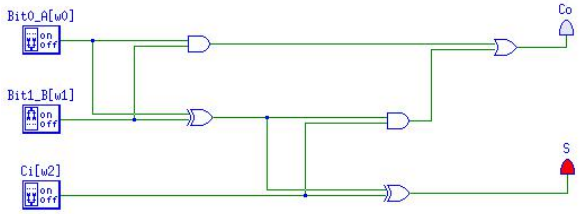
A = 0 B = 0 Ci = 0 S = 0 Co = 0



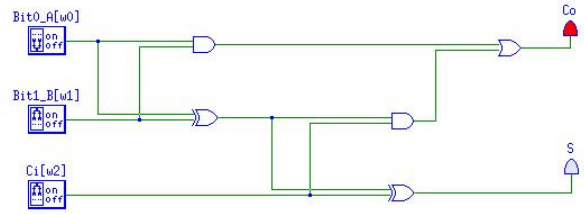
A = 0 B = 0 Ci = 1 S = 1 Co = 0



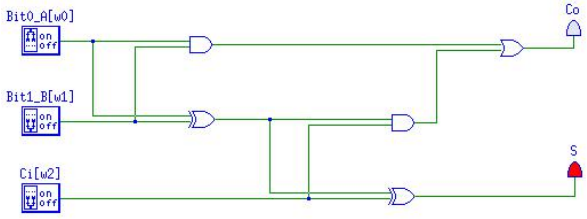
A = 0 B = 1 Ci = 0 S = 1 Co = 0



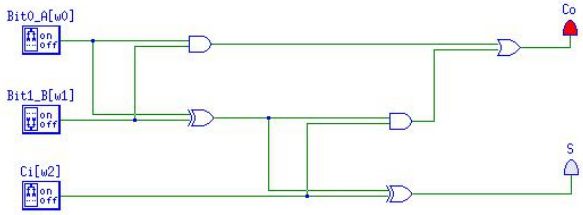
A = 0 B = 1 Ci = 1 S = 0 Co = 1



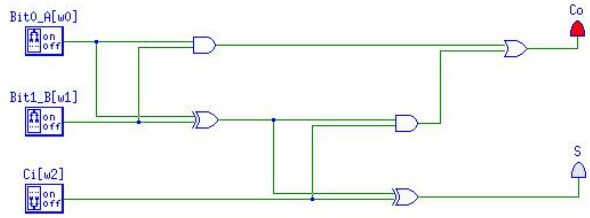
A = 1 B = 0 Ci = 0 S = 1 Co = 0



A = 1 B = 0 Ci = 1 S = 0 Co = 1



A = 1 B = 1 Ci = 0 S = 0 Co = 1



A = 1 B = 1 Ci = 1 S = 1 Co = 1