University of New Brunswick

Computer Science

CS3853: Computer Architecture and Organization Instructor: Joannah Nanjekye, jnanjeky@unb.ca Due Date: July 26, 2024 — 11:59 PM

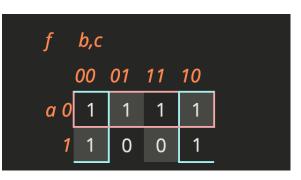
ASSIGNMENT 2

Submission instructions:

• Submit a pdf file to the Desire2Learn dropbox

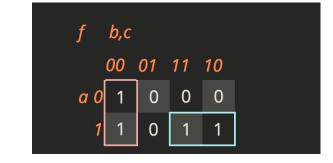
Problem 1. Find the respective expressions for following Boolean functions using Karnaugh maps:

F(A,B,C) = ∑m(0, 1, 2, 3, 4, 6)
Solution: 3 points



 $F=\overline{A}+\overline{C}$

F(A,B,C) = ∑m(0, 4, 6, 7)
Solution: 3 points



$$F = \overline{BC} + AB$$

| y ₀ | | | AB | | |
|-----------------------|----|----|----|----|----|
| | | 00 | 01 | 11 | 10 |
| | 00 | 1 | 0 | 0 | 1 |
| CD | 01 | 1 | 1 | 1 | 0 |
| | 11 | 0 | 1 | 1 | 0 |
| | 10 | 1 | 1 | 0 | 1 |

F(A, B, C, D) = ∑m(0, 1, 2, 5, 6, 7, 8, 10, 13, 15)
Solution: 3 points

- $F = \overline{ABC} + \overline{AC}D + \overline{A}C\overline{D} + \overline{A}BC + \overline{BD} + BD$
- $F(w_1, w_2, w_3, w_4) = \prod m(0, 2, 3, 8, 9, 11, 15) + \sum d(4,5,6)$ Solution: 3 points

| f | w3, | w4 | | | |
|----------|-----|----|----|----|--|
| | 00 | 01 | 11 | 10 | |
| w1,w2 00 | 0 | 1 | 0 | 0 | |
| 01 | 0 | 0 | 1 | 0 | |
| 11 | 1 | 1 | 0 | 1 | |
| 10 | 0 | 0 | 0 | 1 | |

 $F(w1, w2, w3, w4) = (w1 + \overline{w2} + w3)(w1 + w4)(\overline{w1} + \overline{w3} + \overline{w4})(w2 + \overline{w3} + \overline{w4})(\overline{w1} + w2 + w3)(w1 + w4)(\overline{w1} + w4)(w1 + w4)$

Problem 2. Find the respective expressions for following Boolean functions using the Quine-McCluskey tabular algorithm:

• F(A, B, C) = ∑m(0, 1, 2, 3, 4, 6) Solution: 8 points

> Variable = a,b,c 1. min terms and their binary representations Group A1 0 000 \rightarrow 1 001 → Group A2 2 010 → 4 100 → 3 011 → Group A3 6 110 → 2. merging of min term 0,1 00- \rightarrow Group B1 0,2 0-0 → (A1,A2) 0,4 -00 → 1,3 0-1 → 2,3 01- → Group B2 (A2,A3) 2,6 -10 → 4,6 1-0 → 3. merging of min term pairs Group C1 0,1,2,3 0-- √ (B1,B2) 0,2,4,6 --0 √ 1. Prime implicant chart (ignore the don't cares) PIs\Minterms 0 1 2 3 4 6 a,b,c X X X X 0,1,2,3 0---

0,2,4,6

X

X X X --0

 $F = \overline{AC}$

| (0) 000000 (1) 000001 (2) 00010 (4) 00100 (16) 100000 (3) 00011 (6) 00110 (12) 01100 (17) 10001 (18) 10010 (20) 10100 (24) 11000 (14) 01110 | | | (0,1) (0,2) (0,4) (0,16) (1,3) (1,17) (2,3) (2,6) (2,18) (4,6) (4,12) (4,20) (16,17) | | | | | (() () | (0,1, (0,2, (0,2, (0,4, (4,6, (4,12) 16,2(12,14) | 1,2,3) 16,17) 2,4,6) 16,18) 16,20) 12,14) ,20,28) 0,24,28) 0,24,28) 4,28,30) 5,30,31) | -11-0 | | | | |
|---|---|-------------|--|--|--------|---|-------------|---------------|--|---|-------|--------|--------|----|--|
| (14) 01110 (28) 11100 (15) 01111 (30) 11110 (31) 11111 (31) 11111 | (| | | 1000- 100-00 1-000 0-110 011-0 -1100 1-100 0111- -1110 111-0 -1111 | | | 16 x | 17 x | 18 | 20 | 24 | 28 | 30 | 31 | |
| (0,2,16,18) x (0,4,16,20) x (4,6,12,14) (4,12,20,28) (16,20,24,28) (16,20,24,28) | x | x x x | x | x x | x | | x x x | | x | x x x | x | x x | | | |
| (12,14,28,30) (14,15,30,31) | | | | x | x x | x | | | | | | x | x x | x | |

• $F(A,B,C,D,E) = \sum m(0,1,2, 3, 4, 6,12,14,15,16,17,18,20,24,28,30,31)$ Solution: 12 points

 $F = \overline{ABC} + \overline{BCD} + A\overline{CE} + BCD + AD\overline{E}$

 $Combinational \ and \ Sequential \ Circuits \ Assignment \ 2$

| (3) 00011 √ | (3,11) 0-011 √ | (3,11,19,27)011 |
|---------------|-----------------|---------------------|
| (5) 00101 √ | (3,19) -0011 √ | (5,13,21,29)101 |
| (6) 00110 √ | (5,13) 0-101 √ | (9,11,25,27) -10-1 |
| (9) 01001 🗸 | (5,21) -0101 √ | (9,13,25,29) -1-01 |
| (10) 01010 🗸 | (6,22) -0110 | (10,11,26,27) -101- |
| (11) 01011 🗸 | (9,11) 010-1 🗸 | |
| (13) 01101 🗸 | (9,13) 01-01 🗸 | |
| (19) 10011 √ | (9,25) -1001 √ | |
| (21) 10101 🗸 | (10,11) 0101- 🗸 | |
| (22) 10110 🗸 | (10,26) -1010 🗸 | |
| (25) 11001 √ | (11,27) -1011 🗸 | |
| (26) 11010 🗸 | (13,29) -1101 🗸 | |
| (23) 10111 √ | (19,23) 10-11 | |
| (27) 110111 √ | (19,27) 1-011 🗸 | |
| (29) 11101 √ | (21,23) 101-1 | |
| (2)) 11101 V | (21,29) 1-101 🗸 | |
| | (22,23) 1011- | |
| | (25,27) 110-1 √ | |
| | (25,29) 11-01 √ | |
| | (26,27) 1101- √ | |

| • | $F(A,B,C,D,E) = \sum m(3,5,6,9,10,11,13,19,21,22,23,25,26,27,29)$ |
|---|---|
| | Solution: 12 points |

| | 3 | 5 | 6 | 9 | 10 | 11 | 13 | | 19 | 21 | 22 | 23 | 25 | 26 | 27 | 29 | |
|---------------|---|---|---|---|----|----|----|--|----|----|----|----|----|----|----|----|--|
| (3,11,19,27) | х | | | | | х | | | x | | | | | | x | | |
| (5,13,21,29) | | x | | | | | x | | | x | | | | | | x | |
| (9,11,25,27) | | | | x | | x | | | | | | | x | | x | | |
| (9,13,25,29) | | | | x | | | x | | | | | | x | | | x | |
| (10,11,26,27) | | | | | х | х | | | | | | | | х | x | | |
| (6,22) | | | x | | | | | | | | х | | | | | | |
| (19,23) | | | | | | | | | х | | | х | | | | | |
| (21,23) | | | | | | | | | | х | | х | | | | | |
| (22,23) | | | | | | | | | | | x | x | | | | | |

 $F = \overline{C}DE + C\overline{D}E + B\overline{C}E + B\overline{C}D + \overline{B}CD\overline{E} + A\overline{B}DE$