

Homework 5

- All homework must be turned in on PDF format. This can be scanned or typed in any paper size, but the format must be PDF and the file must be readable. This document can be modified for your homework submission. An additional homework template is available on Canvas to assist you in creating your answers, and content from lecture notes can be used.
- All final answers must be circled or in green.
- All homework must have a name on the top of **every** page.
- Submission errors (not in PDF, illegible, etc.) will not be re-graded.

TEMPLATES

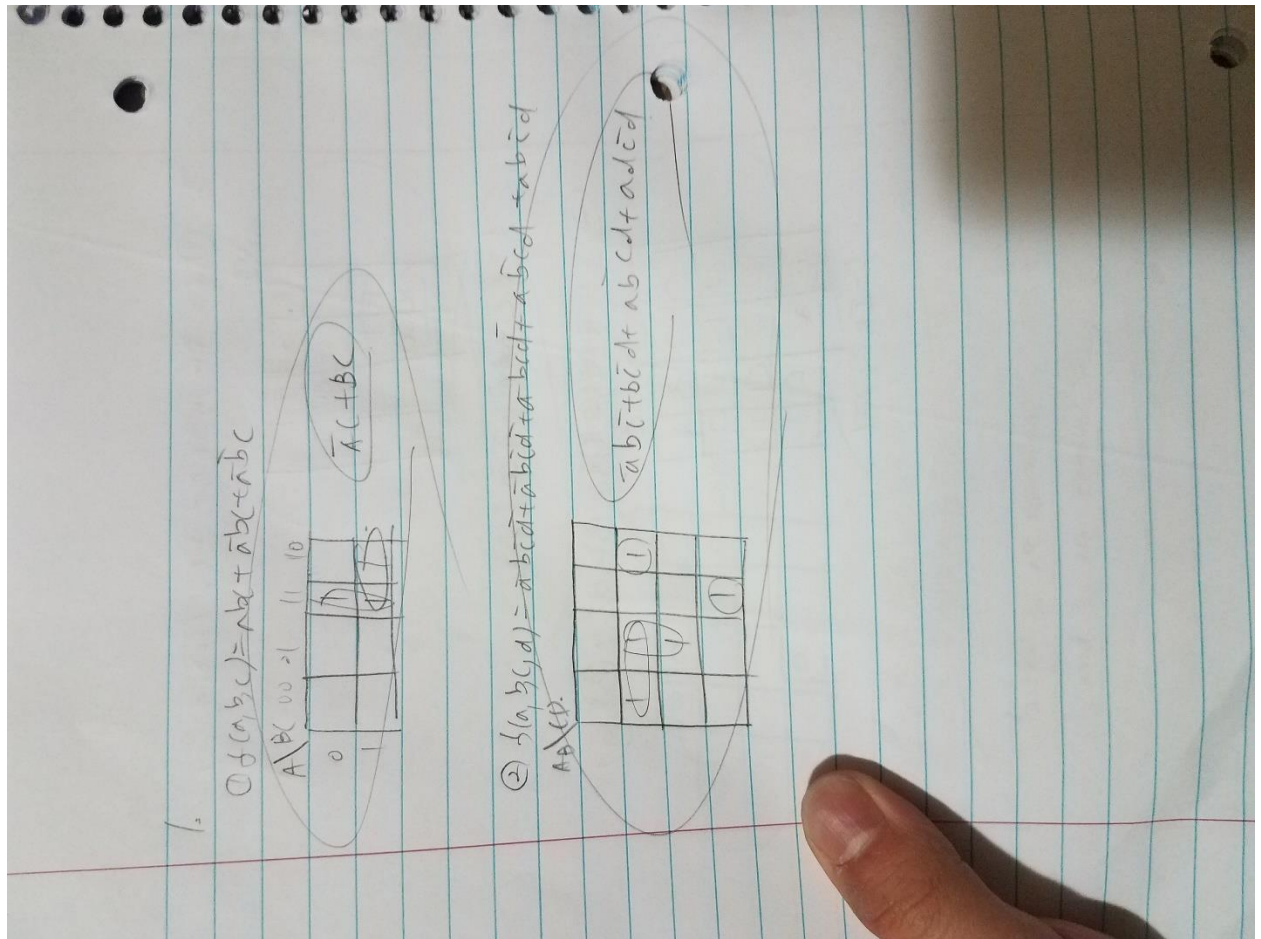
For K-maps, you can use the following table template to help you complete this HW faster. Note when copying-and-pasting images (i.e., the “circles”), they **1**) are anchored to a location which they move with the table and **2**) pasting and imagine “on” an image will cause problems: make sure the image is pasted to the body of the document: if you paste a circle and it does not appear, this is most likely why.

| | | | | |
|-----------|---|---|---|---|
| <i>ab</i> | 1 | 1 | 1 | 1 |
| | 1 | 1 | 1 | 1 |
| | | | | |
| | | | | 1 |

Problem 1 (2 pts each)

Minimize the following functions using K-maps into their **minimal SOP** form.

1. $f(a, b, c) = abc + \bar{a}bc + \bar{a}\bar{b}c$
2. $f(a, b, c, d) = \bar{a}b\bar{c}\bar{d} + \bar{a}b\bar{c}d + \bar{a}bc\bar{d} + \bar{a}bcd + ab\bar{c}d$



Problem 2 (2 pts)

Determine which of the following functions are equivalent without using Boolean reduction (i.e., using K-maps). Hint: plot the implicants onto K-maps.

$$f_1(A, B, C, D) = AC + BD + A\bar{B}\bar{D}$$

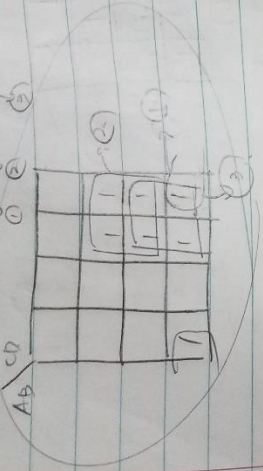
$$f_2(A, B, C, D) = A\bar{B}\bar{D} + AB + \bar{A}B\bar{C}$$

$$f_3(A, B, C, D) = BD + A\bar{B}\bar{D} + ACD + ABC$$

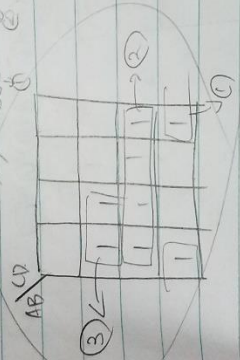
$$f_4(A, B, C, D) = AC + A\bar{B}\bar{C}\bar{D} + \bar{A}BD + B\bar{C}D$$

$$f_5(A, B, C, D) = (B + \bar{D})(A + B)(A + \bar{C})$$

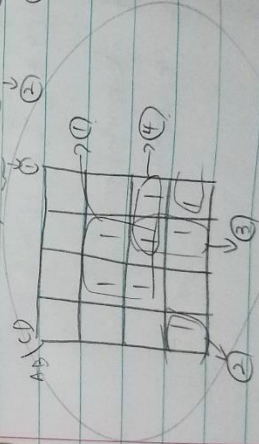
$$2. \quad f_1(A, B, C, D) = A + B\bar{D} + A\bar{B}\bar{D} = \sum m(6, 7, 8, 9, 11, 14, 15)$$



$$f_2(A, B, C, D) = A\bar{B}\bar{D} + A\bar{B}D + A\bar{B}\bar{C} = \sum m(4, 5, 8, 9, 12, 13, 14, 15)$$



$$f_3(A, B, C, D) = B\bar{D} + A\bar{B}\bar{D} + A\bar{B}C = \sum m(5, 7, 8, 9, 11, 14, 15)$$



$$f_4(A, B, C, D) = AC + AB\bar{C}\bar{D} + \bar{A}B\bar{C}D + B\bar{C}D$$

| | | | | | |
|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 |
| 0 | 0 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 1 | 1 | 0 |
| 2 | 0 | 1 | 1 | 1 | 0 |
| 3 | 0 | 0 | 0 | 0 | 1 |

$$= \sum m(5, 7, 8, 10, 11, 13, 14, 15)$$

$$f_5(A, B, C, D) = (B + \bar{D})(A + \bar{B})(A + \bar{C})$$

| | | | | | |
|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 1 | 1 | 1 | 0 |
| 2 | 0 | 1 | 1 | 1 | 0 |
| 3 | 0 | 0 | 0 | 0 | 1 |

$$= \prod M(0, 1, 2, 3, 6, 7, 9, 11)$$

$$= \sum m(4, 5, 8, 10, 12, 13, 14, 15)$$

$\therefore f_2$ and f_5 are equivalent
 f_3 and f_4 are equivalent

Problem 3 (2 pts each)

Minimize the following functions using a K-map. Express your answers in **minimal SOP** form.

1. $f(A, B, C, D) = \sum m(0, 3, 6, 7, 12, 13) + d(1, 8, 9, 10)$
2. $f(A, B, C, D) = \prod (0, 1, 2, 6, 7, 10, 11, 12, 13) \cdot D(3, 8, 9)$

3. ① $f = \sum m(0, 3, 6, 7, 12, 13) + d(1, 8, 9, 10)$

| | | | | |
|-------|----|----|----|----|
| AB\CD | 00 | 01 | 11 | 10 |
| 00 | 1 | x | 1 | 0 |
| 01 | 1 | 1 | 1 | 1 |
| 11 | 1 | 1 | 1 | 1 |
| 10 | 1 | 1 | 1 | 1 |
| 11 | 1 | 1 | 1 | 1 |

$f = \overline{B}\overline{C} + A\overline{C} + \overline{A}CD + \overline{A}BC$

② $f = \prod (0, 1, 2, 6, 7, 10, 11, 12, 13) \cdot D(3, 8, 9)$

| | | | | |
|-------|----|----|----|----|
| AB\CD | 00 | 01 | 11 | 10 |
| 00 | 1 | 1 | 1 | 1 |
| 01 | 1 | 1 | 1 | 1 |
| 11 | 1 | 1 | 1 | 1 |
| 10 | 1 | 1 | 1 | 1 |
| 11 | 1 | 1 | 1 | 1 |

$f = \overline{A}B\overline{C} + AB\overline{C}$