



UTM
UNIVERSITI TEKNOLOGI MALAYSIA

NAME :MUHAMMAD IRFAN DANIEL BIN ABD KARIM

MATRIC NO :A19EC0197

TOPIC :TUTORIAL 4: BOOLEAN ALGEBRA AND LOGIC
SIMPLIFICATION

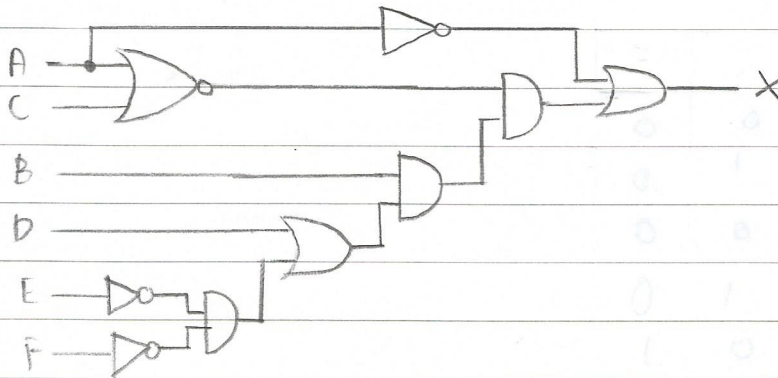
NAME OF LECTURER :PUAN RASHIDAH BINTI KADIR

SUBJECT :SCSR 1013-02 DIGITAL LOGIC

DIGITAL LOGICTutorial 4: Boolean Algebra and Logic Simplification.

1. Using any logic gates, draw the logic diagram of the given function, do NOT simplify the function

$$X = \overline{A} + B(D + \overline{E}F)(\overline{A} + C)$$



2. Directly apply DeMorgan's law to the following expressions. You do NOT have to simplify the expressions.

$$\begin{aligned} \text{i) } Y &= \overline{(A + \overline{B} + C)} + \overline{CDE} \\ &= \overline{A} \overline{\overline{B}} \overline{C} + (\overline{C} + \overline{D} + \overline{E}) \\ &= \overline{A} B \overline{C} + C + \overline{D} + \overline{E} \end{aligned}$$

$$\begin{aligned} \text{ii) } Y &= \overline{P + \overline{Q}(R + SP)} \\ &= \overline{P} (\overline{\overline{Q}(R + SP)}) \\ &= \overline{P} (Q + \overline{(R + SP)}) \\ &= \overline{P} (Q + \overline{R} + \overline{S} + \overline{P}) \end{aligned}$$

3. Simplify the function using Boolean Algebra

$$\begin{aligned} Y &= AB\overline{C} + A\overline{B} + ABC + \overline{A}\overline{B} \\ &= AB(C + \overline{C}) + \overline{B}(A + \overline{A}) \\ &= AB + \overline{B} \\ &= A + \overline{B} \end{aligned}$$

4. Develop a truth table for the following expression. From the truth table derive a standard product-of-sums (POS) expression.

$$f = (A + \bar{B})(A + C)(A + B + \bar{C})$$

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

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

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

5. Use a Karnaugh map to reduce the expression to a minimum sum-of-products (SOP) form.

$$f = \bar{A}B(C\bar{D} + CD) + ACD$$

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

$$= \bar{A}B C \bar{D} + \bar{A}B C D + A B C D + A \bar{B} C D$$

$$0110 \quad 0111 \quad 1111 \quad 1011$$

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

$$\begin{array}{r} 0111 \\ 0110 \\ \hline \bar{A}BC \end{array}$$

$$\begin{array}{r} 1111 \\ 1011 \\ \hline ACD \end{array}$$

$$f = \bar{A}BC + ACD$$

6. For the truth table given below,

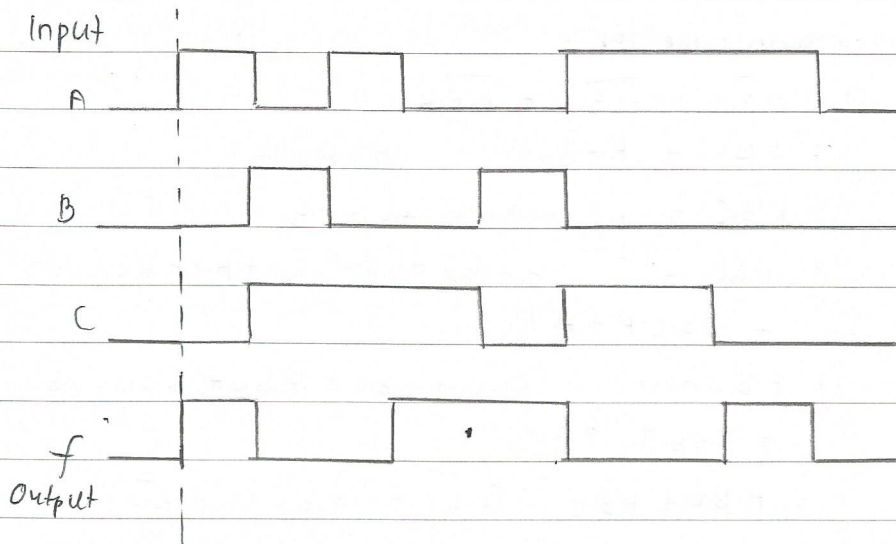
A	B	C	f
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1

- Express the output function, f in standard Sum-of-Products (SOP) form.
- Express the output function, f in standard Product-of-Sums (POS) form.
- If the following waveforms are applied to the inputs, A , B and C of the logic circuit, draw the output waveform for the function, f .

$$i) f = \bar{A}\bar{B}C + \bar{A}B\bar{C} + A\bar{B}C$$

$$ii) f = (A+B+C)(A+\bar{B}+\bar{C})(\bar{A}+B+\bar{C})(\bar{A}+\bar{B}+C)$$

iii) Input



7. Below is the truth table of a three-input XOR gate.

A	B	C	Y
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1

i) Express Y in standard sum-of-product (SOP) variable form.

ii) Express Y in standard product-of-sum (POS) variable form.

i) SOP $Y = \bar{A}\bar{B}C + \bar{A}B\bar{C} + A\bar{B}\bar{C} + ABC$

ii) POS $Y = (A+B+C)(A+\bar{B}+\bar{C})(\bar{A}+B+\bar{C})(\bar{A}+\bar{B}+C)$

8. Construct the truth table for

$$Y = A\bar{B}C + \bar{A}\bar{B}C + \bar{A}CB$$

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

$$= A\bar{B}C + \bar{A}C + \bar{B}C + \bar{A}B + \bar{C}B$$

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

$$= A\bar{B}C + \bar{A}BC + \bar{A}\bar{B}C + \bar{A}B\bar{C} + \bar{A}\bar{B}\bar{C} + \bar{A}B\bar{C} + \bar{A}B\bar{C} + \bar{A}B\bar{C}$$

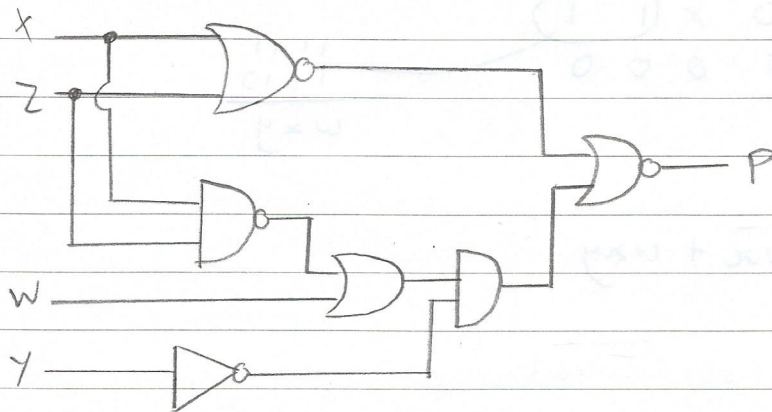
$$= A\bar{B}C + \bar{A}\bar{B}C + \bar{A}BC + \bar{A}\bar{B}\bar{C} + \bar{A}B\bar{C}$$

Truth table:

A	B	C	Y
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	0

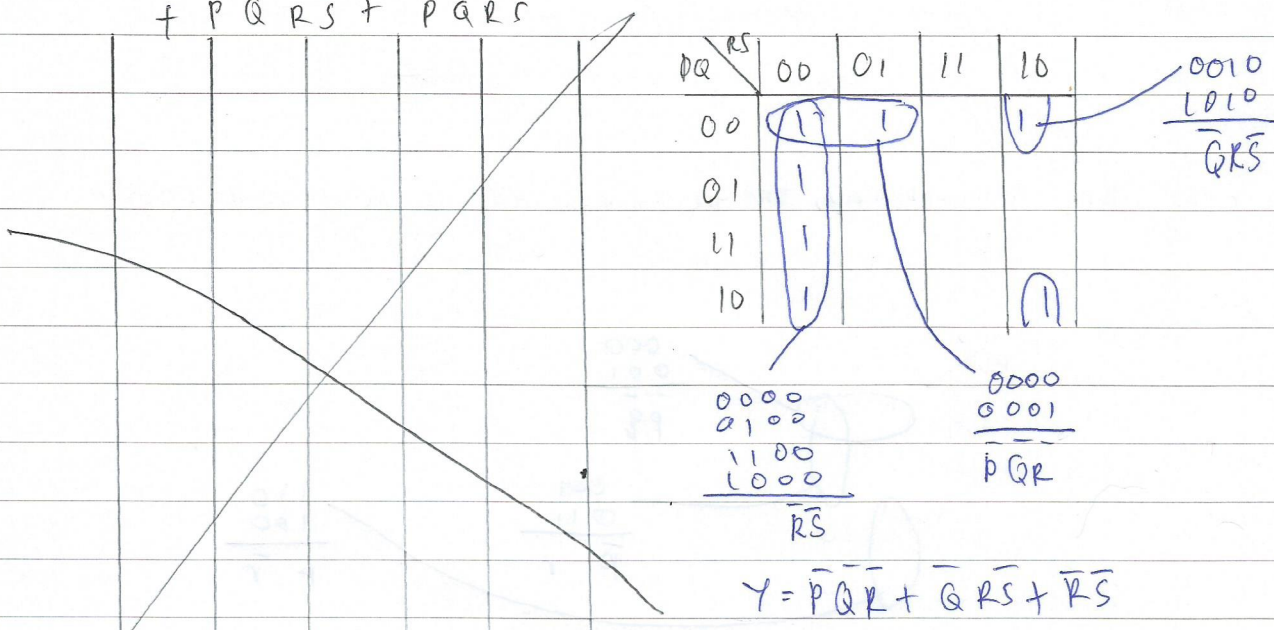
Q- Using any logic gates, draw the logic diagram for of
 $P = \overline{(x+z)}$

$$P = \overline{(x+z)} + \overline{Y} (w + xz)$$



10- Using Karnaugh map, find the minimum SOP expression for the following function.

$$Y = \overline{P}\overline{Q}\overline{R}\overline{S} + \overline{P}\overline{Q}\overline{R}S + \overline{P}\overline{Q}R\overline{S} + \overline{P}\overline{Q}RS + P\overline{Q}\overline{R}\overline{S} + P\overline{Q}\overline{R}S$$

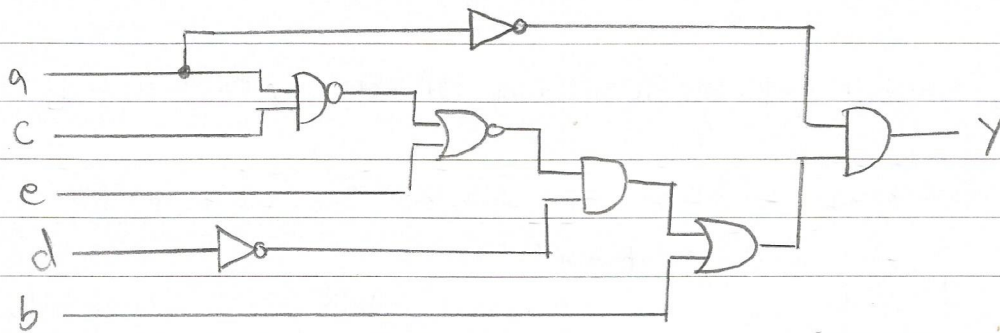


ii) $G(w, x, y, z) = \sum m(1, 3, 14, 15) + d(0, 2, 6, 8, 13)$

$w \backslash yz$	00	01	11	10	
00	X	1	1	X	$\begin{array}{r} 0001 \\ 0011 \\ \hline \bar{w}\bar{x}z \end{array}$
01	0	0	0	X	
11	0	X	1	1	$\begin{array}{r} 1111 \\ 1110 \\ \hline wxy \end{array}$
10	X	0	0	0	

$G = \bar{w}\bar{x}z + wxy$

11. Implement $Y = \bar{a}(btd(\bar{a}cte))$ using any type of logic devices.



12. Using Karnaugh Map, find the minimum SOP of the given m-notation:

$F(p, q, r) = \sum m(0, 1, 3, 4, 6)$

$pq \backslash r$	0	1	
00	1	1	$\begin{array}{r} 000 \\ 001 \\ \hline \bar{p}q \end{array}$
01	0	1	
11	1	0	$\begin{array}{r} 001 \\ 011 \\ \hline \bar{p}r \end{array}$
10	1	0	

$F = \bar{p}q + \bar{p}r + pr$

13. Prove that $xy + x\bar{y} + \bar{x}y = x + \bar{y}$

$$\begin{aligned} xy + x\bar{y} + \bar{x}y &= x(y + \bar{y}) + \bar{x}y \\ &= x + \bar{x}y \\ &= x + \bar{y} \end{aligned}$$