

Mata Kuliah

Dasar Teknik Digital

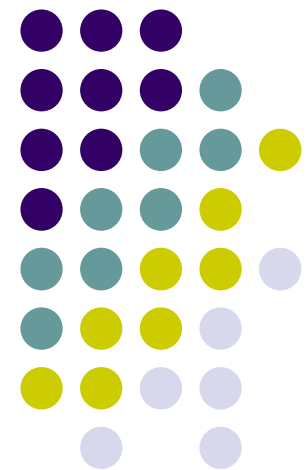
TKE 113



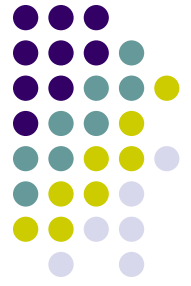
5. RANGKAIAN KOMBINASI

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Fahmi, S.T, M.Sc

Departemen Teknik Elektro
Universitas Sumatera Utara USU
2006



Perancangan rangkaian logika:

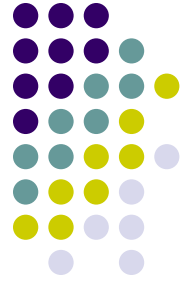


➤ ada uraian verbal tentang apa yang hendak direalisasikan

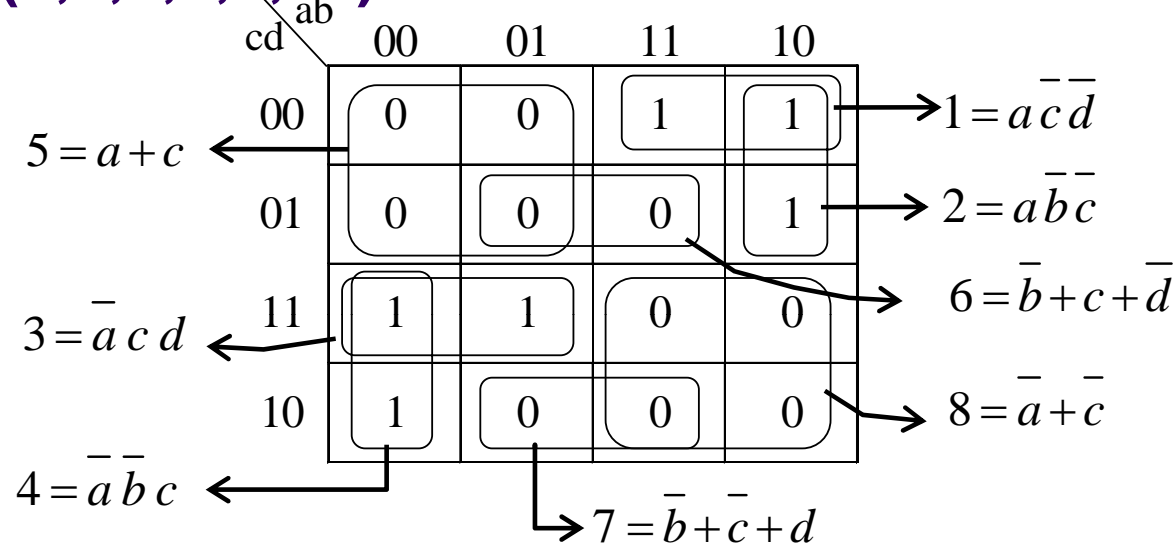
Langkah:

- tetapkan kebutuhan masukan dan keluaran dan namai
- susun tabel kebenaran menyatakan hubungan masukan dan keluaran yang diinginkan
- rumuskan keluaran sebagai fungsi masukan
- sederhanakan fungsi keluaran tersebut
- gambarkan diagram rangkaian logikanya
- sesuaikan rangkaian ini dengan kendala:
 - jumlah gerbang dan jenisnya yang tersedia
 - cacah masukan setiap gerbang
 - waktu tunda (waktu perambatan)
 - interkoneksi antar bagian-bagian rangkaian
 - kemampuan setiap gerbang untuk mencatu (drive) gerbang berikutnya (fan out).
- Harga rangkaian logika: cacah gerbang dan cacah masukan keseluruhannya

Waktu Tunda + Harga rangkaian: diagram pohon



$$f = \Sigma m(2,3,7,8,9,12)$$



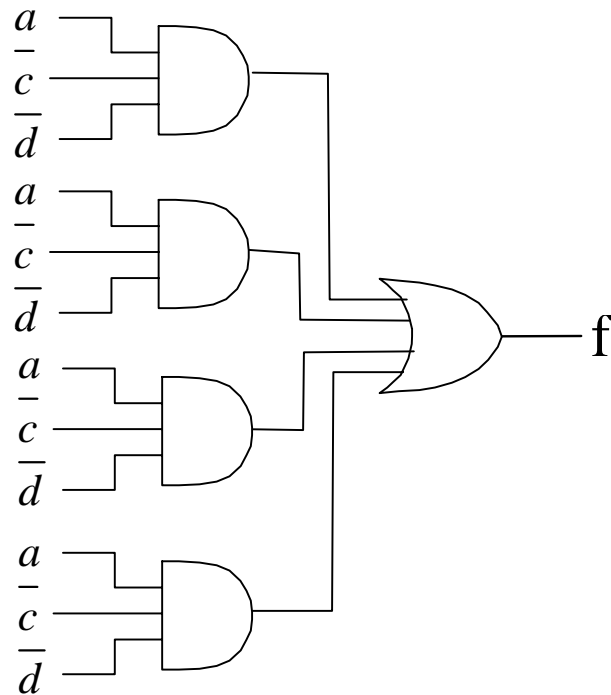
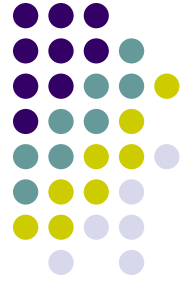
Penggabungan sukumaks $f = 5.6.7.8$

$$f = (a + c)(\bar{b} + c + \bar{d})(\bar{b} + \bar{c} + d)(\bar{a} + \bar{c}) \quad \text{OR-AND}$$

Penggabungan sukumin $f = 1 + 2 + 3 + 4$

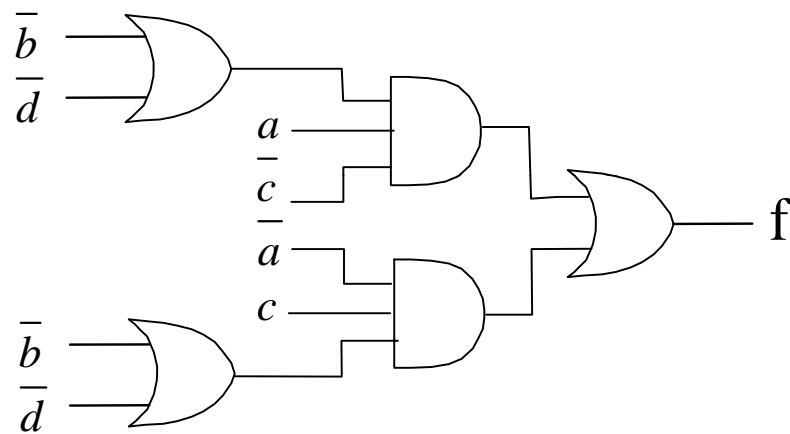
$$f = a \bar{c} \bar{d} + a \bar{b} \bar{c} + \bar{a} c d + \bar{a} \bar{b} c \quad \text{AND-OR}$$

REALISASI sukumin



AND-OR 2 Tingkat

Harga: 5 gerbang 16 masukan

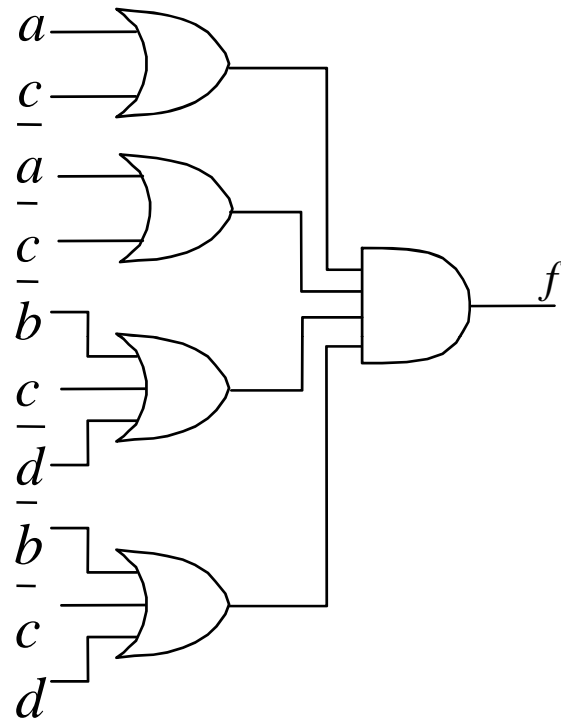


OR-AND 3Tingkat

Harga: 5 gerbang 12 masukan

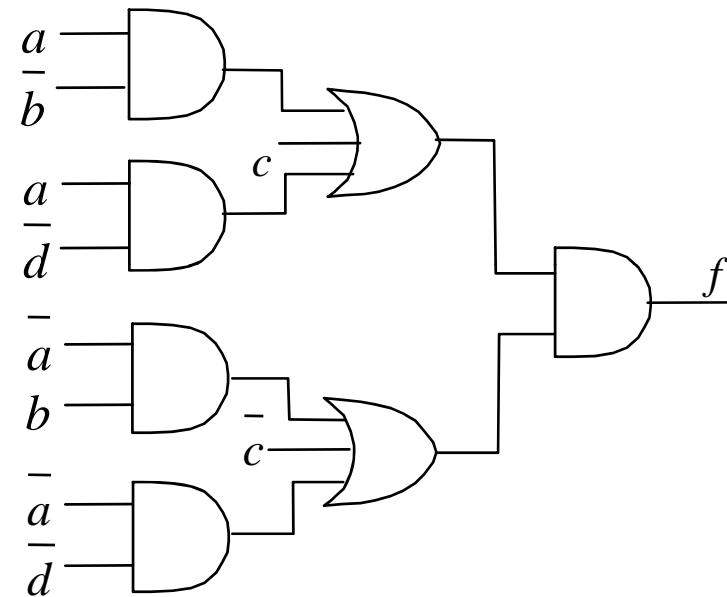


REALISASI sukumaks



(a)
OR-AND 2 Tingkat

Harga: 5 gerbang 14 masukan



(b)
AND-OR 3 Tingkat

Harga: 7 gerbang 16 masukan

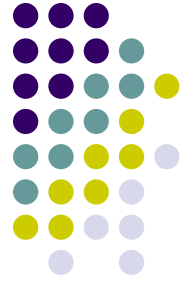
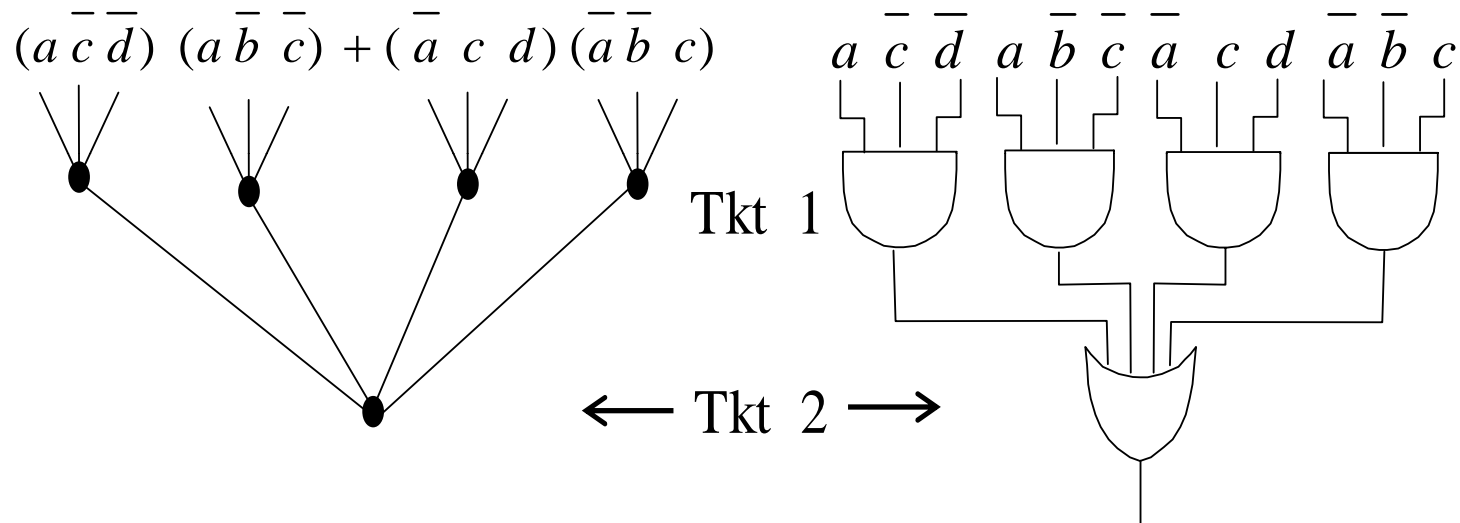


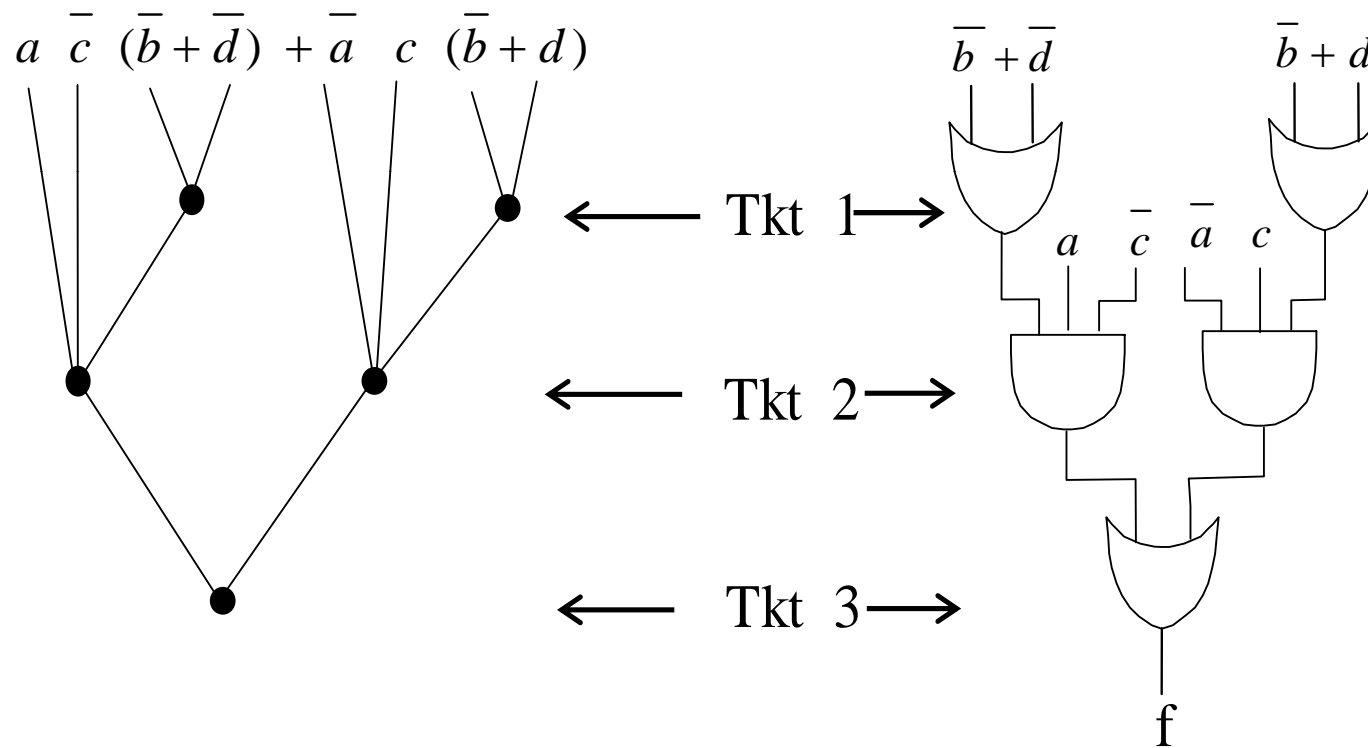
Diagram Pohon 2 Tingkat



(a)

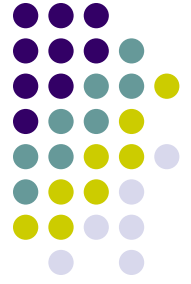


Diagram Pohon 3 Tingkat



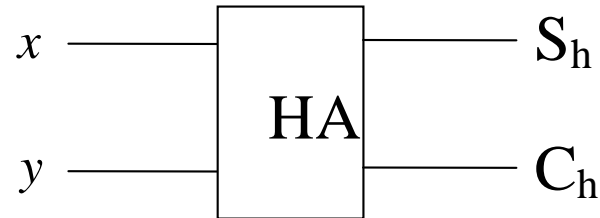
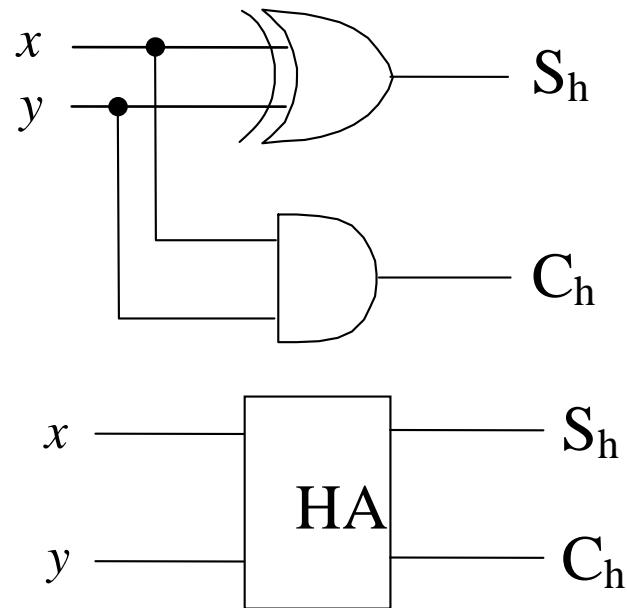
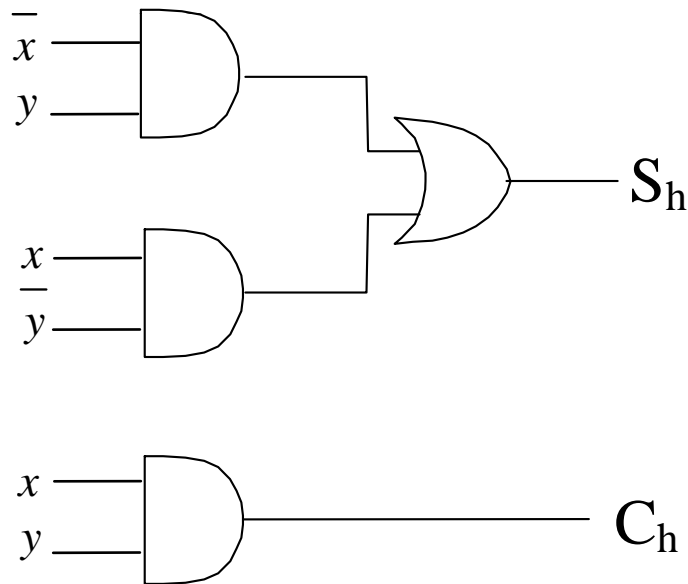
(b)

Penjumlah Paruh (Half Adder)

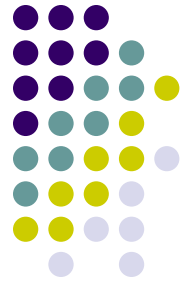


x	y	S _h	C _h
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

$$S_h = \bar{x}y + x\bar{y} = x \oplus y \quad C_h = xy$$



Penjumlahan Penuh (Full Adder)



x y z	S _f	C _f
0 0 0	0	0
0 0 1	1	0
0 1 0	1	0
0 1 1	0	1
1 0 0	1	0
1 0 1	0	1
1 1 0	0	1
1 1 1	1	1

xy \ z	00	01	11	10
0		1		1
1	1		1	

S_f

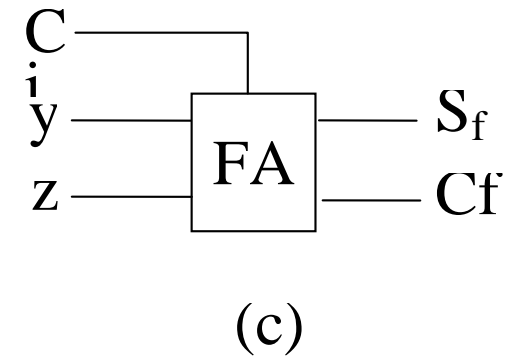
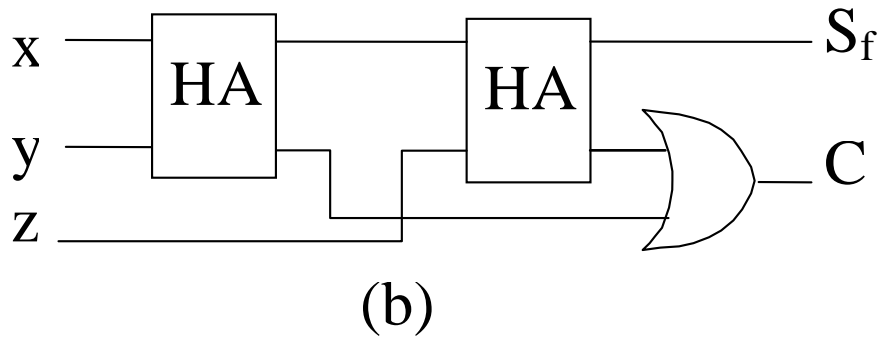
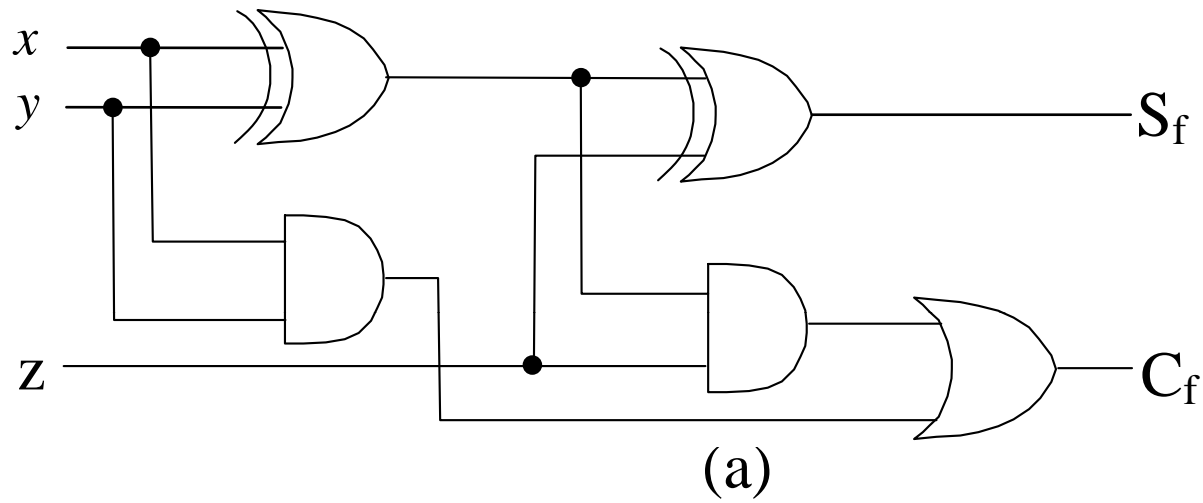
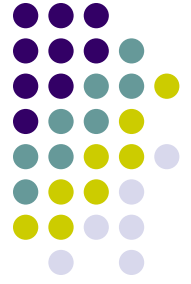
xy \ z	00	01	11	10
0			1	
1		1	1	1

C_f

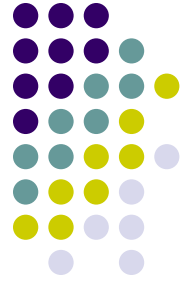
$$\begin{aligned}
 S_f &= \overline{x} \overline{y} z + \overline{x} y \overline{z} + x \overline{y} \overline{z} + x y z \\
 &= (\overline{x} \overline{y} + x y) z + (\overline{x} y + x \overline{y}) \overline{z} \\
 &= (x \oplus y) z + (x \oplus y) \overline{z} = (x \oplus y) \oplus z
 \end{aligned}$$

$$C_f = x y + x z + y z = x y + (\overline{x} y + x \overline{y}) z = x y + (x \oplus y) z$$

Rangkaian Penjumlah Penuh



Pengurang (Subtractor)



x	y	D _h	B _h
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

Paruh

$$D_h = \bar{x}y + x\bar{y} = (x \oplus y)$$

$$B_f = \bar{x}y$$

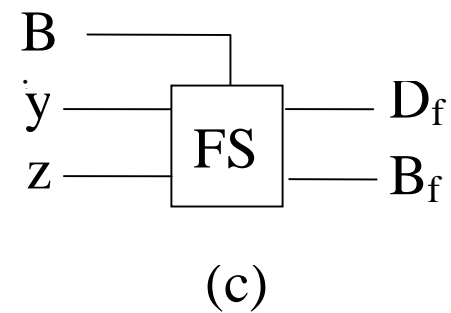
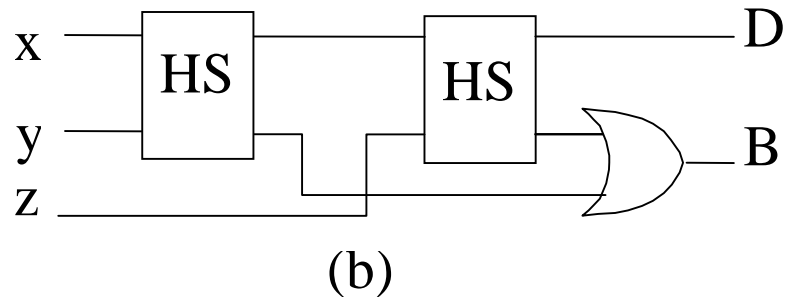
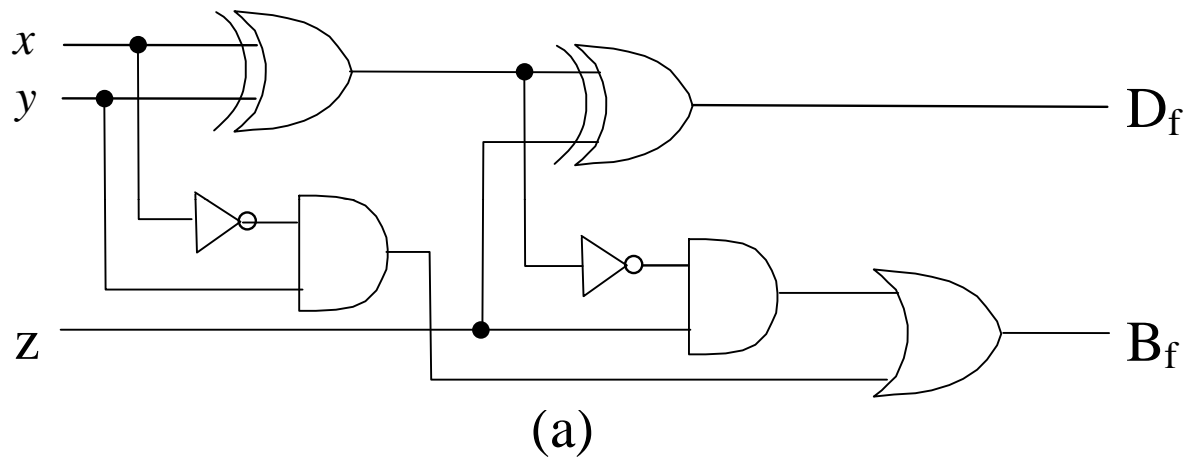
x	y	z	D _f	B _f
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

Penuh

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

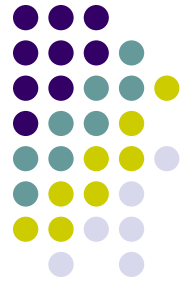
$$B_f = \bar{x}\bar{y}z + \bar{x}y\bar{z} + x\bar{y}\bar{z} + xy\bar{z} = \bar{x}\bar{y} + (x\bar{y} + xy)\bar{z} = \bar{x}\bar{y} + (x \oplus y)\bar{z}$$

Rangkaian Pengurang Penuh



Pengubah Kode:

BCD-ke-XS3



Desi- mal	BCD A B C D	XS-3 P Q R S
0	0 0 0 0	0 0 1 1
1	0 0 0 1	0 1 0 0
2	0 0 1 0	0 1 0 1
3	0 0 1 1	0 1 1 0
4	0 1 0 0	0 1 1 1
5	0 1 0 1	1 0 0 0
6	0 1 1 0	1 0 0 1
7	0 1 1 1	1 0 1 0
8	1 0 0 0	1 0 1 1
9	1 0 0 1	1 1 0 0

Peta pengubah kode BCD-ke-XS3



cd \ ab	00	01	11	10
00			x	1
01		1	x	1
11		1	x	x
10		1	x	x

$$P = a + bc + bd$$

cd \ ab	00	01	11	10
00		1	x	
01	1		x	1
11	1		x	x
10	1		x	x

$$Q = \bar{b}c + \bar{b}d + b\bar{c}\bar{d}$$

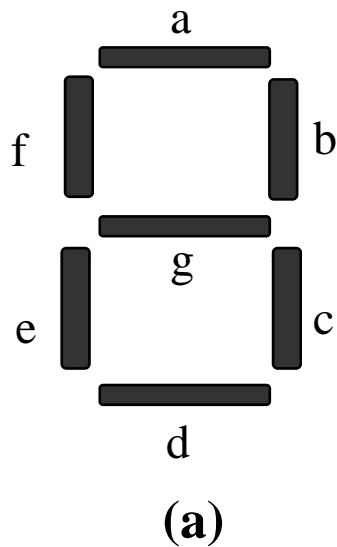
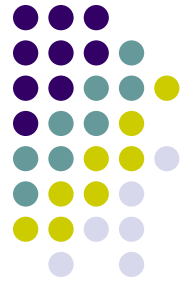
cd \ ab	00	01	11	10
00	1	1	x	1
01			x	
11	1	1	x	x
10			x	x

$$R = \bar{c}\bar{d} + cd$$

cd \ ab	00	01	11	10
00	1	1	x	1
01			x	
11			x	x
10	1	1	x	x

$$R = d$$

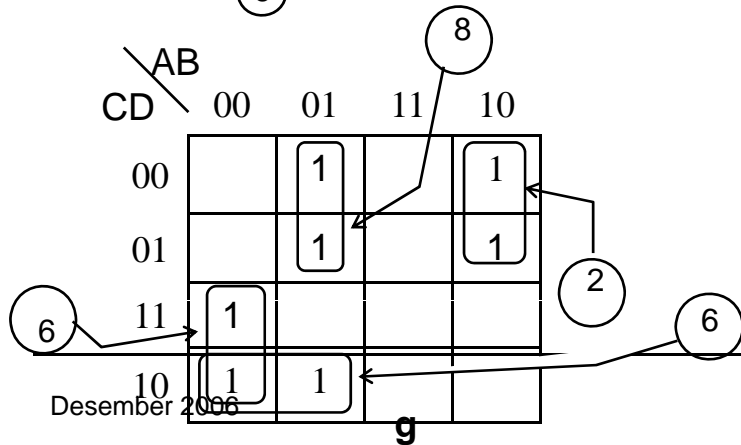
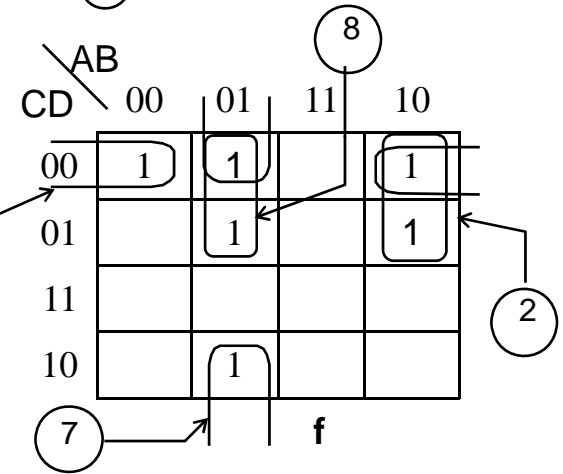
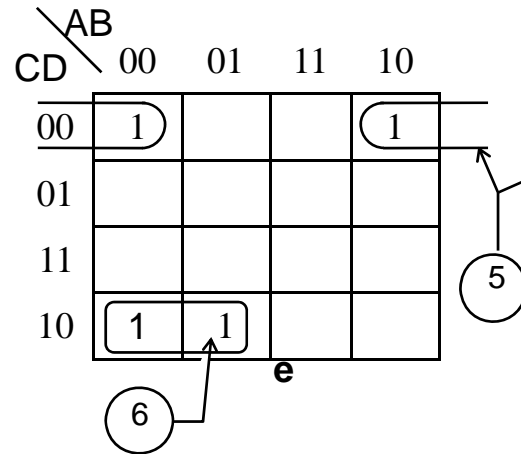
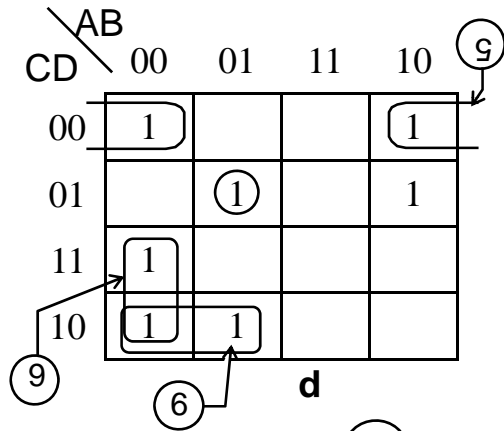
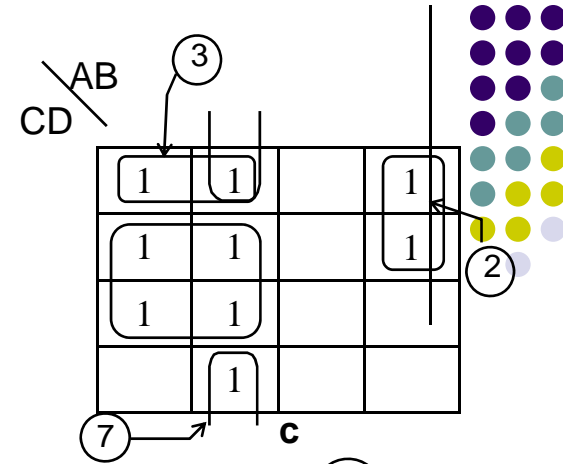
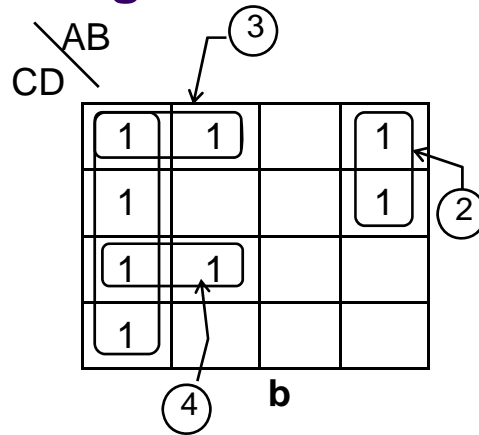
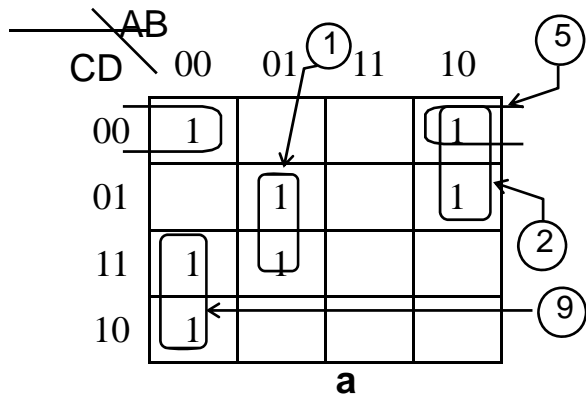
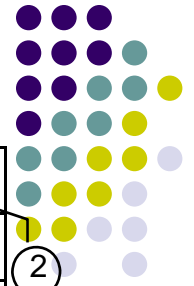
Pengubah Kode: BCD-ke-LED 7segmen



Desimal	BCD				LED 7-segmen						
	A	B	C	D	a	b	c	d	e	f	g
0	0	0	0	0	1	1	1	1	1	1	0
1	0	0	0	1	0	1	1	0	0	0	0
2	0	0	1	0	1	1	0	1	1	0	1
3	0	0	1	1	1	1	1	1	0	0	1
4	0	1	0	0	0	1	1	0	0	1	1
5	0	1	0	1	1	0	1	1	0	1	1
6	0	1	1	0	0	0	1	1	1	1	1
7	0	1	1	1	1	1	1	0	0	0	0
8	1	0	0	0	1	1	1	1	1	1	1
9	1	0	0	1	1	1	1	0	0	1	1
10,11	1	0	1	x	0	0	0	0	0	0	0
12,13, 14,15	1	1	x	x	0	0	0	0	0	0	0

(b)

Pengubah BCD-ke-LED 7 segmen



Pengubah BCD-ke-LED 7 segmen



$$\begin{aligned} a(A, B, C, D) &= \textcircled{1} + \textcircled{2} + \textcircled{5} + \textcircled{9} \\ &= \overline{A}B\overline{D} + A\overline{B}C + \overline{B}C\overline{D} + \overline{A}B\overline{C} \end{aligned}$$

$$\begin{aligned} b(A, B, C, D) &= \textcircled{2} + \textcircled{3} + \textcircled{4} + \overline{A}\overline{B} \\ &= A\overline{B}C + \overline{A}C\overline{D} + \overline{A}C\overline{D} + \overline{A}\overline{B} \end{aligned}$$

$$\begin{aligned} c(A, B, C, D) &= \textcircled{2} + \textcircled{3} + \textcircled{7} + \overline{A}D \\ &= A\overline{B}C + \overline{A}C\overline{D} + \overline{A}B\overline{D} + \overline{A}D \end{aligned}$$

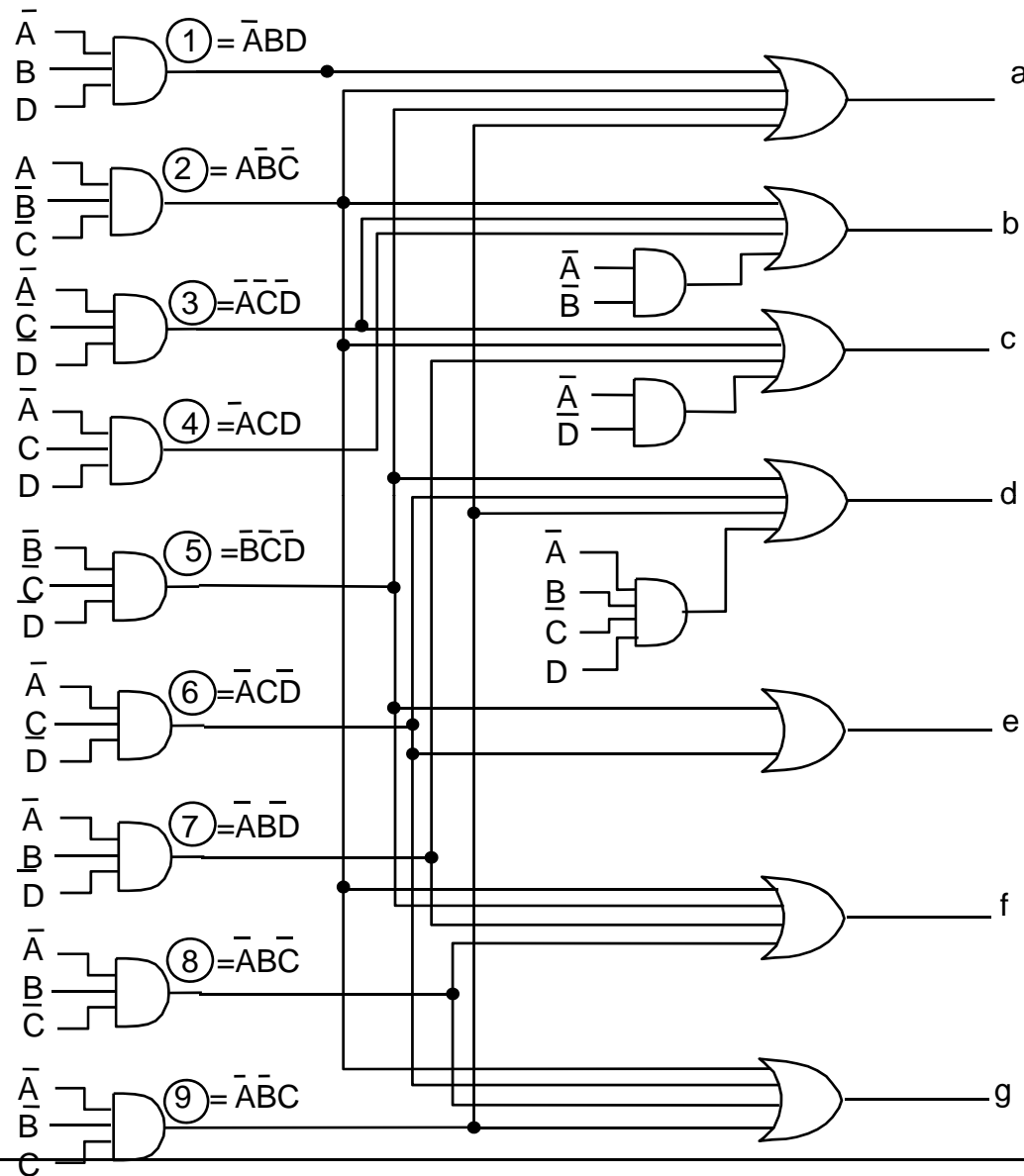
$$\begin{aligned} d(A, B, C, D) &= \textcircled{5} + \textcircled{6} + \textcircled{9} + \overline{A}\overline{B}\overline{C}D \\ &= \overline{B}C\overline{D} + \overline{A}C\overline{D} + \overline{A}\overline{B}C + \overline{A}\overline{B}\overline{C}D \end{aligned}$$

$$\begin{aligned} e(A, B, C, D) &= \textcircled{5} + \textcircled{6} \\ &= \overline{B}C\overline{D} + \overline{A}C\overline{D} \end{aligned}$$

$$\begin{aligned} f(A, B, C, D) &= \textcircled{2} + \textcircled{5} + \textcircled{7} + \textcircled{8} \\ &= A\overline{B}C + \overline{B}C\overline{D} + \overline{A}B\overline{D} + \overline{A}\overline{B}C \end{aligned}$$

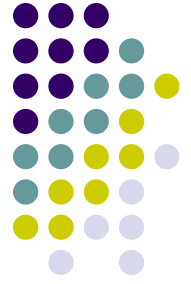
$$\begin{aligned} g(A, B, C, D) &= \textcircled{2} + \textcircled{6} + \textcircled{8} + \textcircled{9} \\ &= A\overline{B}C + \overline{A}C\overline{D} + \overline{A}\overline{B}C + \overline{A}\overline{B}C \end{aligned}$$

Pengubah BCD-ke-LED 7 segmen



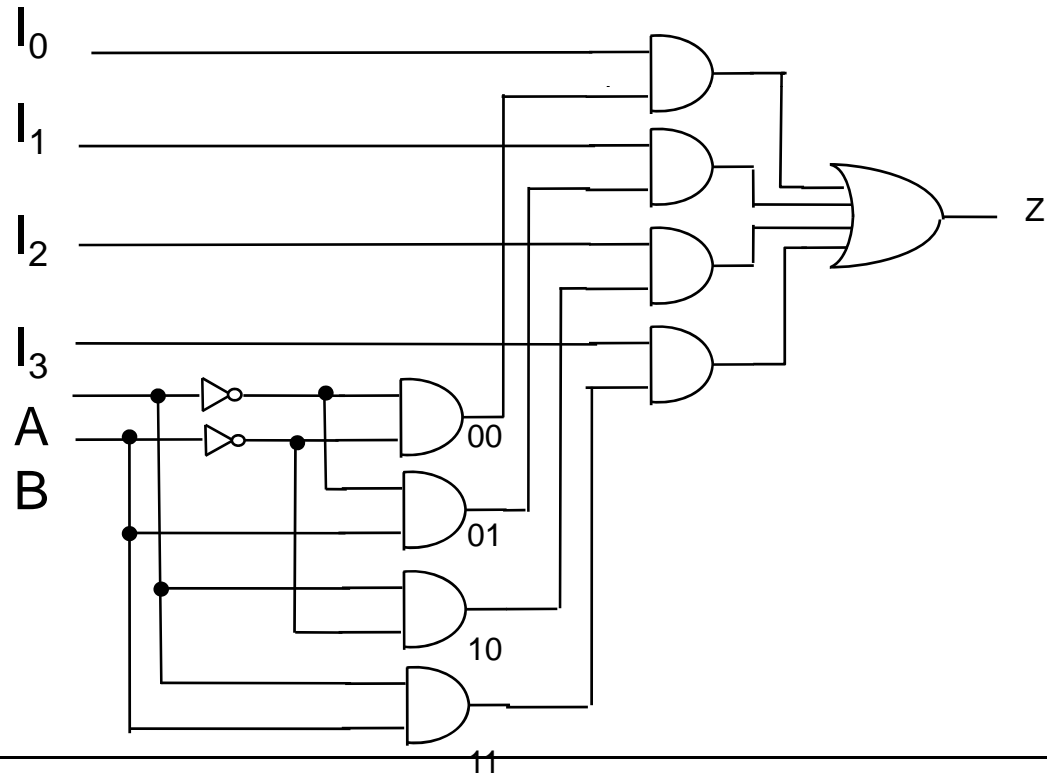
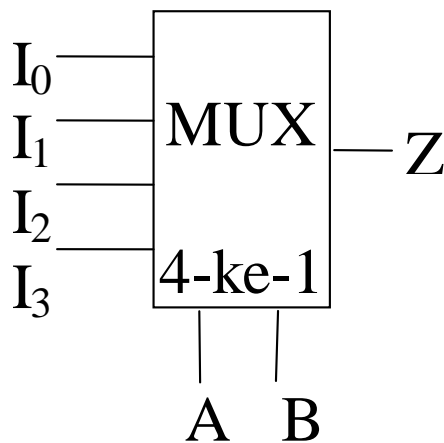
MULTIPLEXER = Data Selector

Memilih 1 dari 2^n masukan



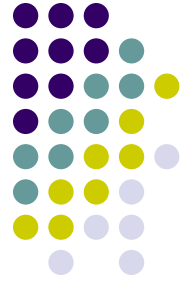
A	B	Z
0	0	I_0
0	1	I_1
1	0	I_2
1	1	I_3

$$\begin{aligned}
 Z &= \sum_{i=0}^{2^n-1} m_i I_i \\
 &= m_0 I_0 + m_1 I_1 + m_2 I_2 + m_3 I_3 \quad \text{untuk } n=2 \\
 &= \overline{A} \overline{B} I_0 + \overline{A} B I_1 + A \overline{B} I_2 + A B I_3
 \end{aligned}$$

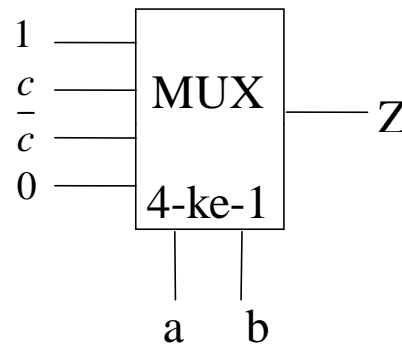


Contoh aplikasi Multiplexer (MUX)

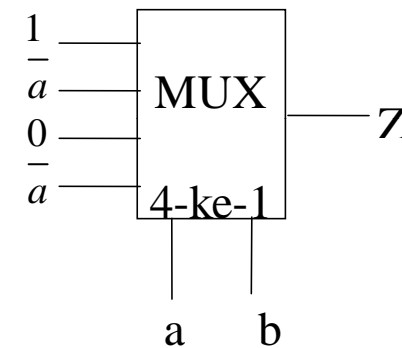
Merealisasikan fungsi Z dengan tabel kebenaran berikut ini dengan menggunakan MUX 4x1.



a	b	c	Z
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0
1	1	1	1

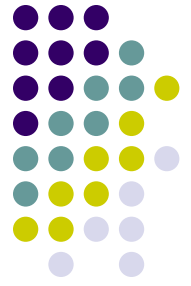


$$Z = \overline{a}\overline{b} + \overline{a}bc + a\overline{b}\overline{c}$$



$$Z = \overline{b}c + \overline{a}\overline{b}c + \overline{a}bc$$

Decoder = demultiplexer (binary-to-decimal decoder)

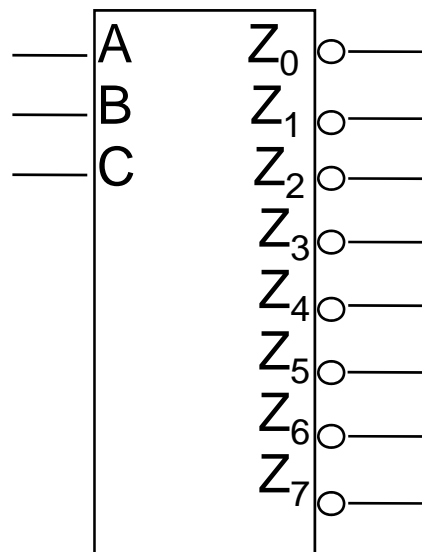


Mengaktifkan salah satu dan hanya salah satu dari keluaran, keluaran ke n , n = nomor sukumin yang dibentuk masukan pemilih.

Inverting : keluaran aktif = 0 : $z_i = m_i$ —

Non-inverting : keluaran aktif = 1 : $z_i = m_i$ —

Contoh: dekoder keluaran dibalik 3 x 8 dengan pemilih A, B, dan C.

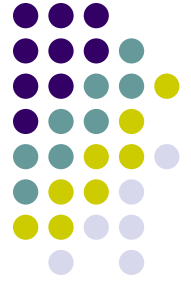


A	B	C	Z_0	Z_1	Z_2	Z_3	Z_4	Z_5	Z_6	Z_7
0	0	0	0	1	1	1	1	1	1	1
0	0	1	1	0	1	1	1	1	1	1
0	1	0	1	1	0	1	1	1	1	1
0	1	1	1	1	1	0	1	1	1	1
1	0	0	1	1	1	1	0	1	1	1
1	0	1	1	1	1	1	1	0	1	1
1	1	0	1	1	1	1	1	1	0	1
1	1	1	1	1	1	1	1	1	1	0

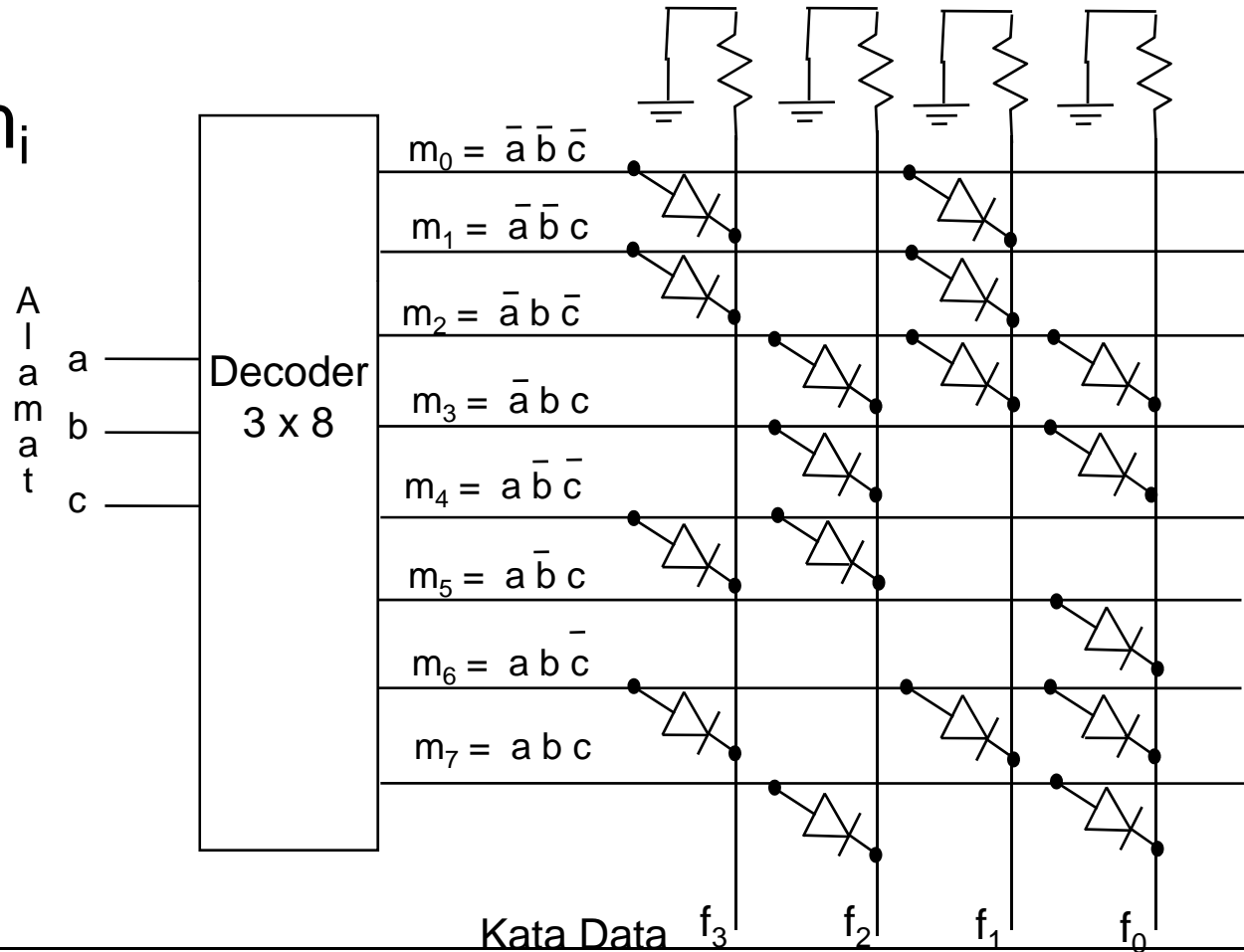
ROM (Read Only Memory)

Merealisasikan fungsi keluaran ganda dengan masukan ganda (MIMO)

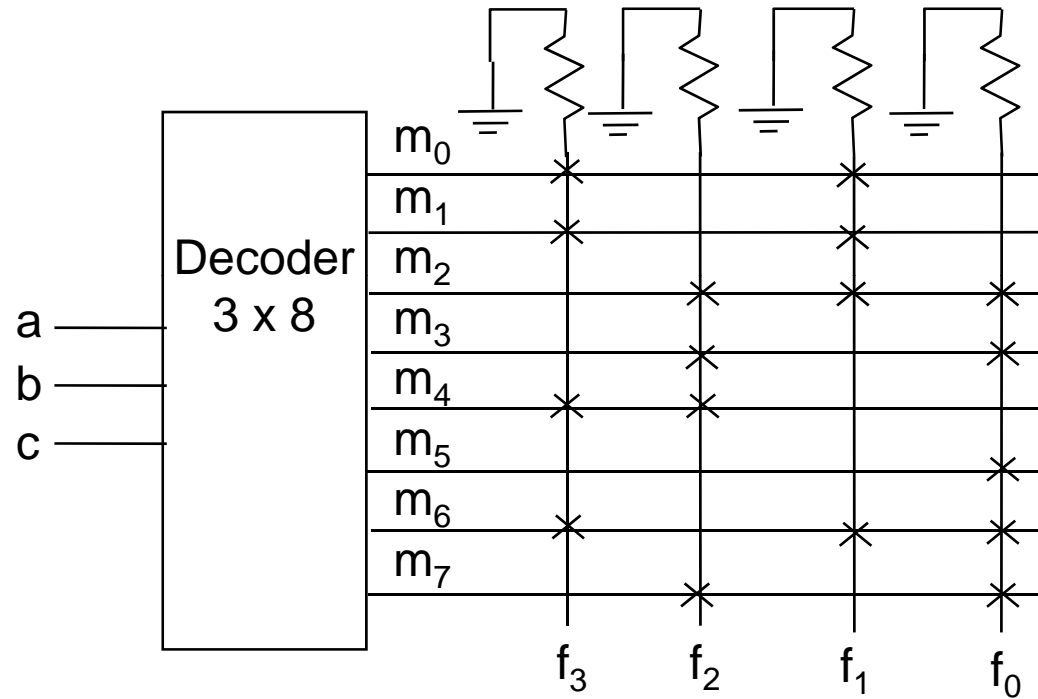
Masukan= dekoder Keluaran= matriks OR



$$F_k = \sum m_i$$

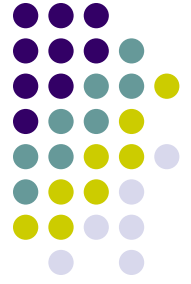


Simbol ROM disederhanakan



(b)

PLA (*Programmed Logic Array*) dan PAL (*Programmable Array Logic*)

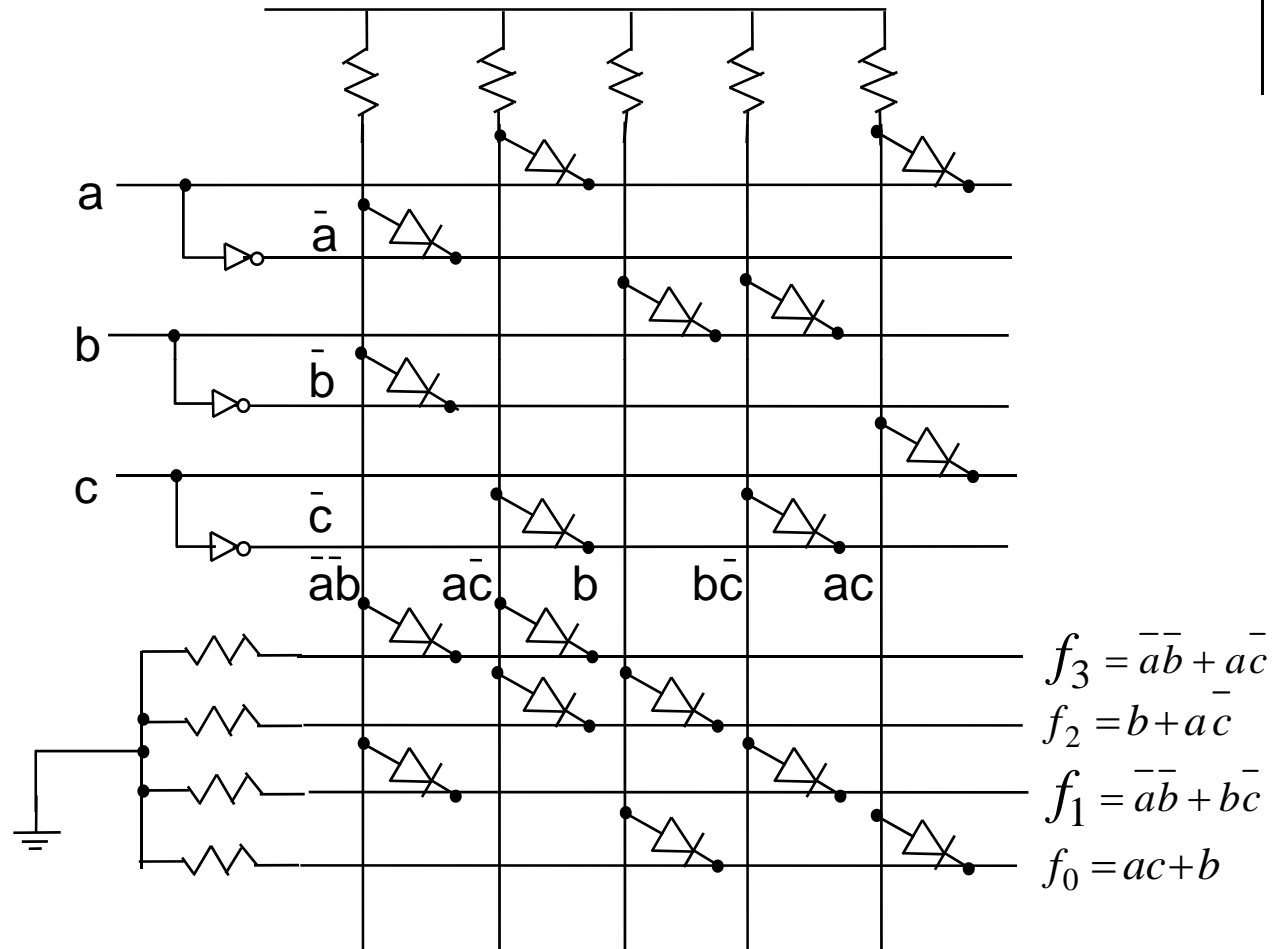
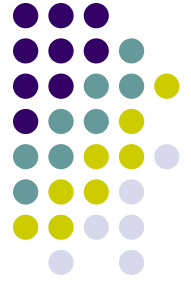


Perbedaan PLA dan ROM pada masukan

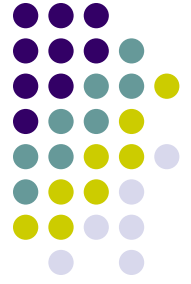
PLA: Masukannya matriks AND, hanya sukumin yang dibutuhkan yang direalisasikan

ROM: Masukannya Dekoder, semua sukumin direalisasikan

Realisasi PLA



PAL

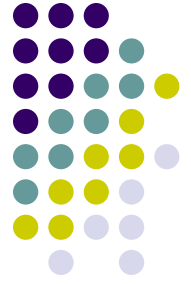


Perbedaan PAL dan PLA pada keluarannya:

PLA: matriks OR keluaran dapat diprogram

PLA: matriks OR terhubung tetap (tak dapat diprogram)

PLA dan PAL: matriks AND masukannya dapat diprogram



Realisasi PAL

