|   | X | Y | Z |
|-------|---|---|---|
| Pig → | 0 | 0 | 0 |
| cat → | 0 | 0 | 1 |
| dog → | 0 | 1 | 0 |
| mouse → | 0 | 1 | 1 |
| Skunk → | 1 | 0 | 0 |
| Chicken → | 1 | 0 | 1 |
| cow → | 1 | 1 | 0 |
| worm → | 1 | 1 | 1 |

1 ⊸  ON

0 ⊸  OFF

Decoder

$X$
$Y$
$Z$

$m_0$ → Pig
$m_1$ → cat
$m_2$ → dog
$m_3$ → mouse
$m_4$ → skunk
$m_5$ → chick
$m_6$ → cow
$m_7$ → worm

# 9.4 Decoders & Encoders

3-to-8 line decoder

inputs: $x$, $y$, $z$

| output | minterm |
|--------|---------|
| $x'y'z'$ | $m_0$ |
| $x'y'z$ | $m_1$ |
| $x'yz'$ | $m_2$ |
| $x'yz$ | $m_3$ |
| $xy'z'$ | $m_4$ |
| $xy'z$ | $m_5$ |
| $xyz'$ | $m_6$ |
| $xyz$ | $m_7$ |
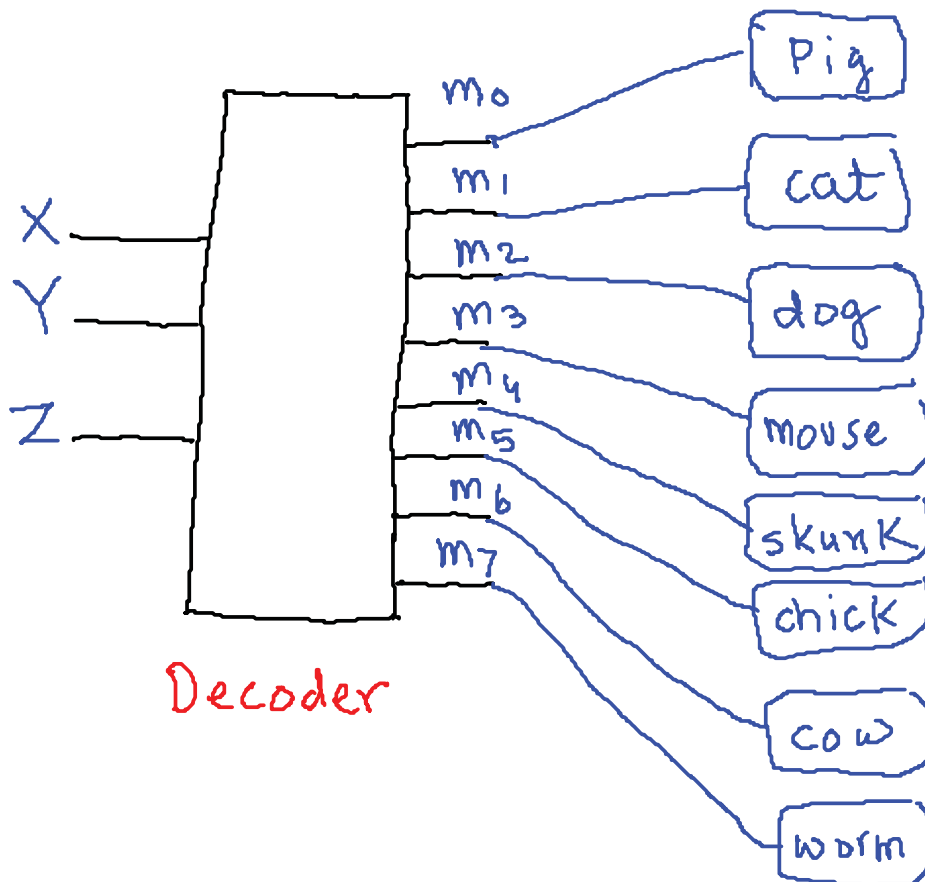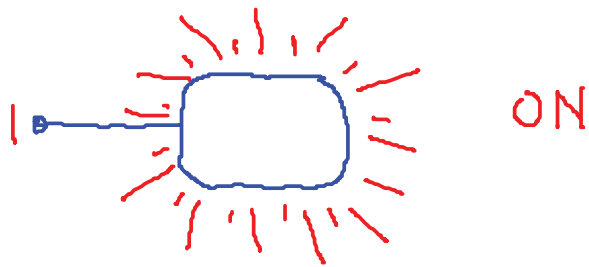
minterms
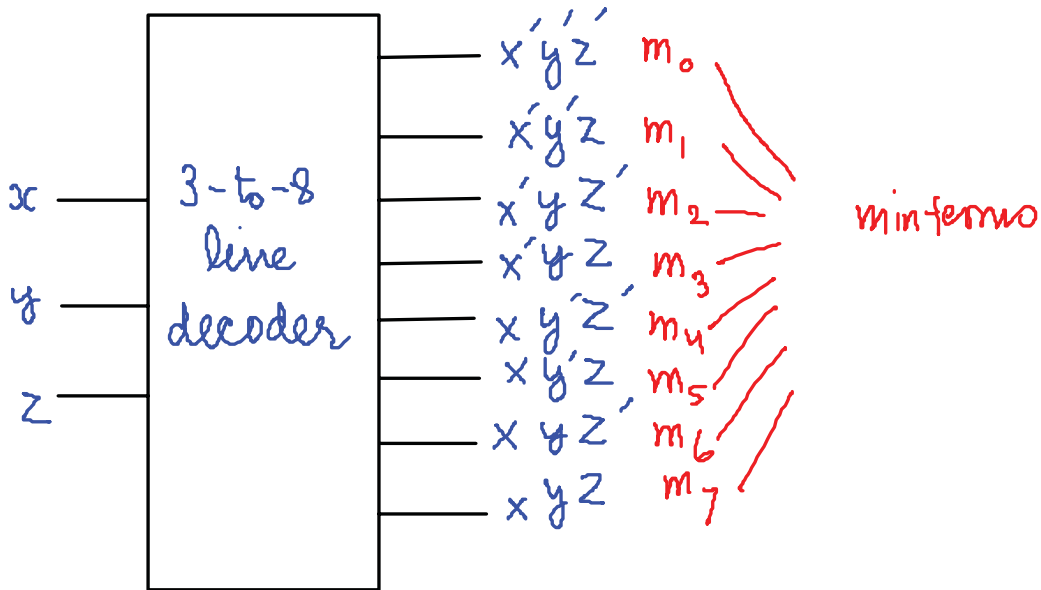
| $x$ | $y$ | $z$ | $m_0$ | $m_1$ | $m_2$ | $m_3$ | $m_4$ | $m_5$ | $m_6$ | $m_7$ |
|-----|-----|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

<span style="color:red">4-to-10 Line Decoder</span>



When a BCD digit is used as an input, one of the output lines will go low to indicate which of the 10 decimal digits is present
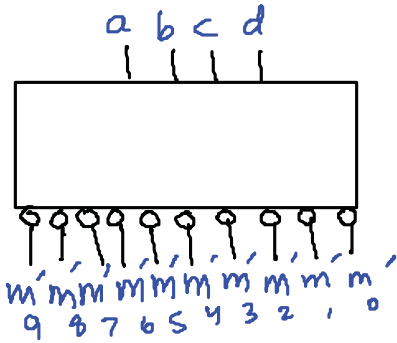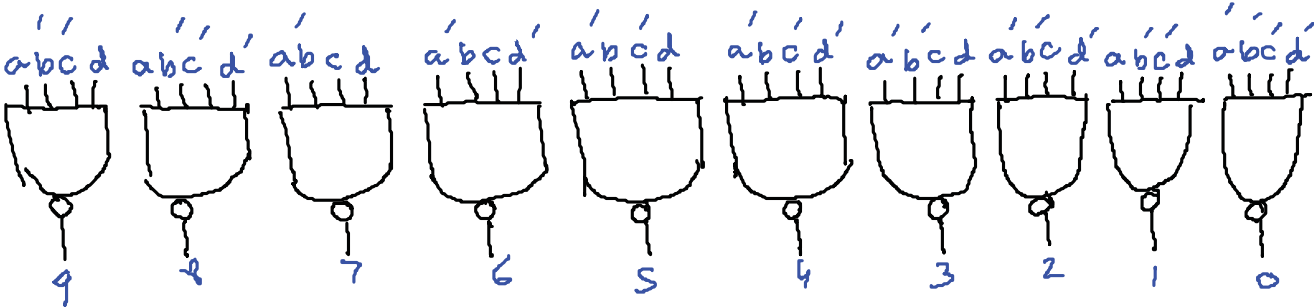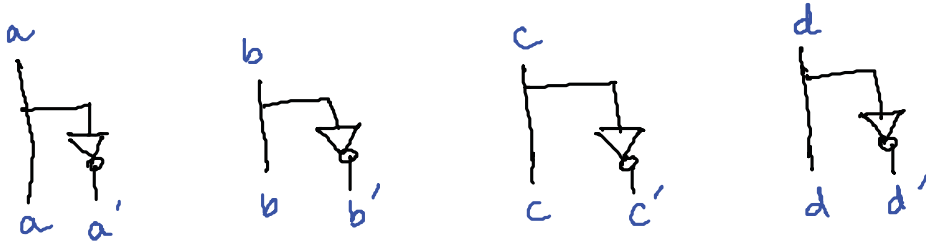
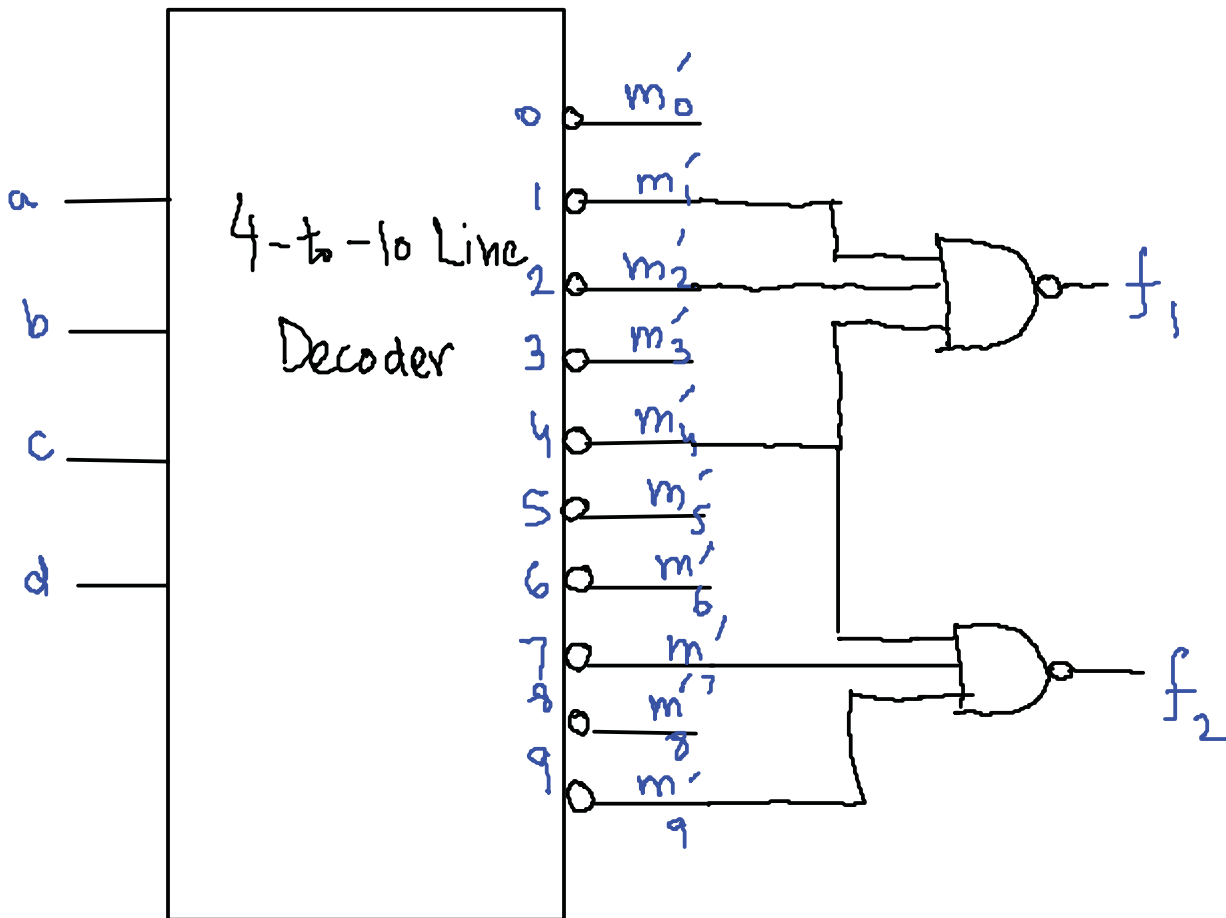| input BCD | | | | Decimal Digits | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| a | b | c | d | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 |
| 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 |
| 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |
| 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |

implimenting functions using decoders
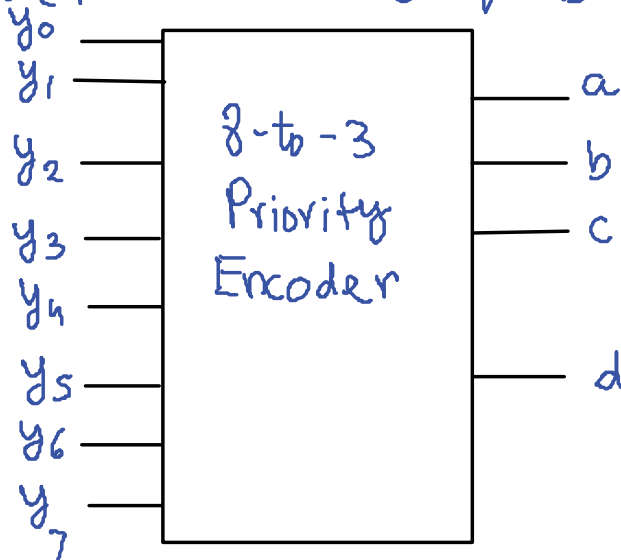
$$f_1(a\,b\,c\,d) = m_1 + m_2 + m_4$$

$$f_2(a,b,c\,d) = m_4 + m_7 + m_9$$

$$f_1' = (m_1' m_2' m_3') \rightarrow f_1 = (m_1' m_2' m_3')'$$

$$f_2' = (m_4' m_7' m_9') \rightarrow f_2 = (m_4' m_7' m_9')'$$

Encoder — Inverse of Decoder



8-to-3 Priority Encoder

Inputs: $y_0, y_1, y_2, y_3, y_4, y_5, y_6, y_7$
Outputs: $a, b, c, d$

| $y_7$ | $y_6$ | $y_5$ | $y_4$ | $y_3$ | $y_2$ | $y_1$ | $y_0$ | $a$ | $b$ | $c$ | $d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | X | 0 | 0 | 1 | 1 |
| 0 | 0 | 0 | 0 | 0 | 1 | X | X | 0 | 1 | 0 | 1 |
| 0 | 0 | 0 | 0 | 1 | X | X | X | 0 | 1 | 1 | 1 |
| 0 | 0 | 0 | 1 | X | X | X | X | 1 | 0 | 0 | 1 |
| 0 | 0 | 1 | X | X | X | X | X | 1 | 0 | 1 | 1 |
| 0 | 1 | X | X | X | X | X | X | 1 | 1 | 0 | 1 |
| 1 | X | X | X | X | X | X | X | 1 | 1 | 1 | 1 |

Priority : If more than one input is 1 then the highest numbered input determines the output

e.g  $y_1 = 1, y_4 = 1, y_5 = 1$     $y_1 \to X, y_4 \to X, y_5 = 1$