

CS-472: Design Technologies for Integrated Systems

Exercise Problem Set 7

Date: 04/12/2025

Topics: Binary Decision Diagrams (cf. slide set 10), Algebraic methods (cf. slide set 11)

Problem 1

A Boolean function $f(x, y, z)$ is given as the following truth table.

x	y	z	f
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

- Draw the complete, **non-reduced** BDD with the variable order $x < y < z$.
- Apply the reduction rules.
- Derive a SOP from the BDD.
- Transform the BDD to use complemented edges.

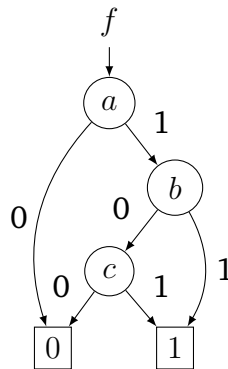
Problem 2

Consider the functions $f = ab + bc$ and $g = ac$.

- Draw the BDDs (reduced and ordered) for f , g and \bar{g} (select a variable order that minimizes the BDDs).
- Use the ITE operator to compute $f \oplus g$ and draw the BDD of $f \oplus g$.

Problem 3

Given the following zero-suppressed BDD (ZDD):



- Write down the item set represented by the ZDD.
- Give an SOP of the characteristic function f . (Verify f with the item set!)

Problem 4

Consider the following relations among Boolean variables $a, b, c, d, e, x, y, z, u$:

$$x = a\bar{d} + \bar{a}\bar{b} + \bar{a}\bar{d} + bc + b\bar{d} + ac$$

$$y = a + b$$

$$z = \bar{a}\bar{c} + \bar{a}\bar{d} + \bar{b}\bar{c} + \bar{b}\bar{d} + e$$

$$u = \bar{a}c + \bar{a}d + \bar{b}d + e$$

- Draw the logic network, where inputs are $\{a, b, c, d, e\}$, outputs are $\{x, y, z, u\}$, and each node of the network can compute arbitrary function.
- Perform the algebraic division of f_x/f_y (f_x denotes the Boolean function of x in terms of a, b, c, d and e).
- Substitute y in f_x and redraw the network.

Problem 5

For the following functions:

$$F = abc + abd + cd\bar{}$$

$$G = \bar{b}d + a\bar{b} + \bar{b}c$$

- Compute all kernels and co-kernels of F and G .
- Extract a multiple-cube sub-expression common to F and G .