CS-472: Design Technologies for Integrated Systems

Exercise Problem Set 5 Solution Date: 19/10/2023

Topic: Resource sharing (cf. slide set 6), two-level logic synthesis (cf. slide set 7)

Problem 1

Consider the following set of scheduled operations.

operation ID	latency	start time	resource type
1	1	1	ALU
2	2	1	ALU
3	4	2	ALU
4	3	2	ALU
5	2	5	ALU
6	2	2	ALU
7	3	6	ALU
8	4	5	ALU
9	2	4	ALU

cf: Slide set 6 pp. 13–15.

(a) Draw the interval and conflict graphs.
Ans: (The interval graph can also be drawn left-to-right.)

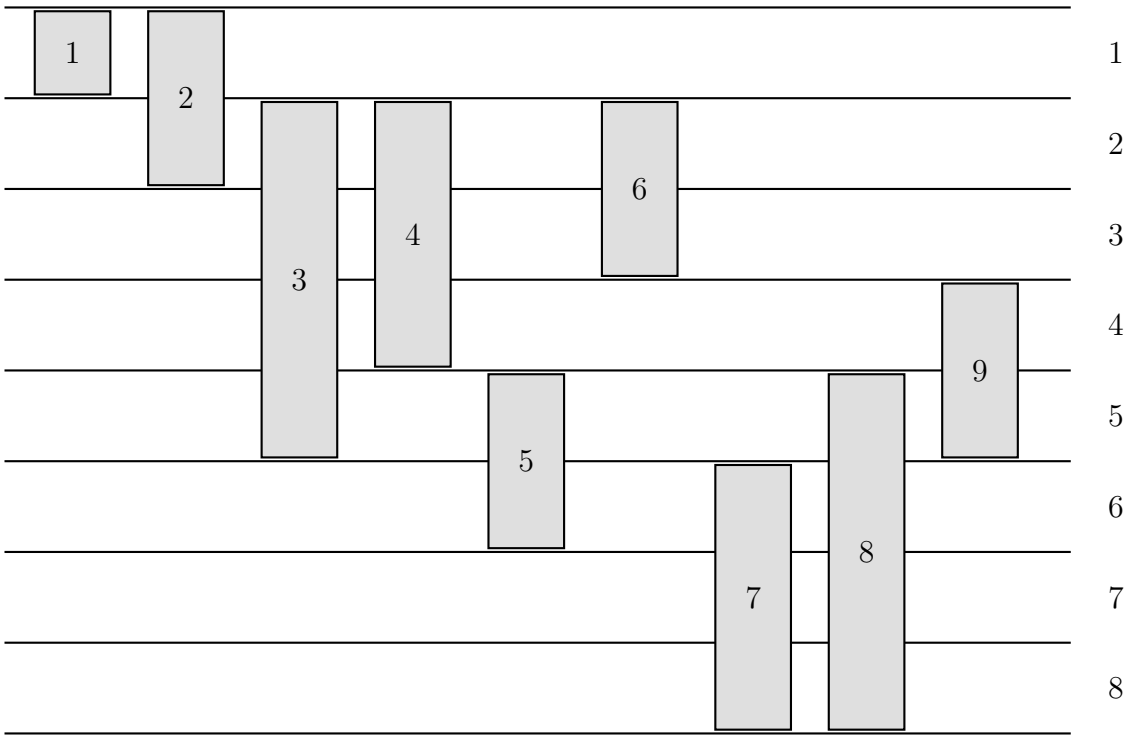


Figure 1: Interval graph

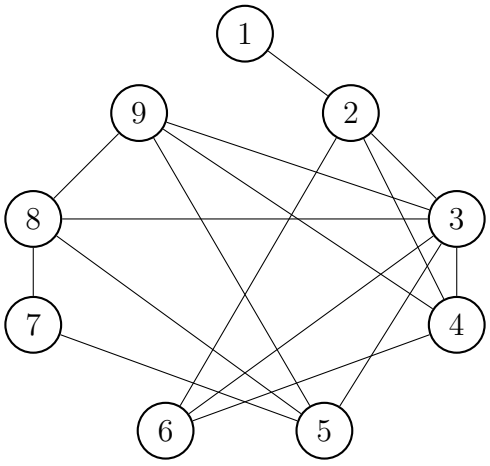


Figure 2: Conflict graph

(b) Determine the minimum number of ALUs needed using the left-edge algorithm. Show the coloring in both interval and conflict graphs.
Ans: At least 4 ALUs are needed. (The interval graph can also be drawn left-to-right, and it is not unique.)

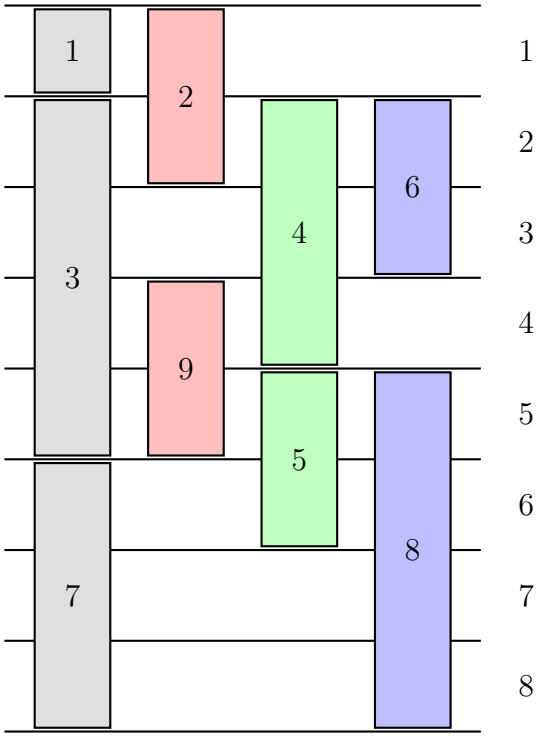


Figure 3: Colored interval graph

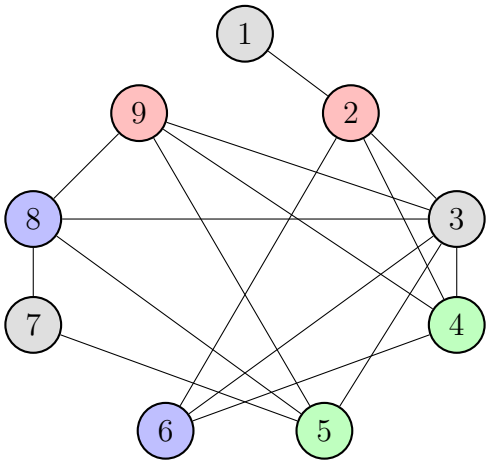
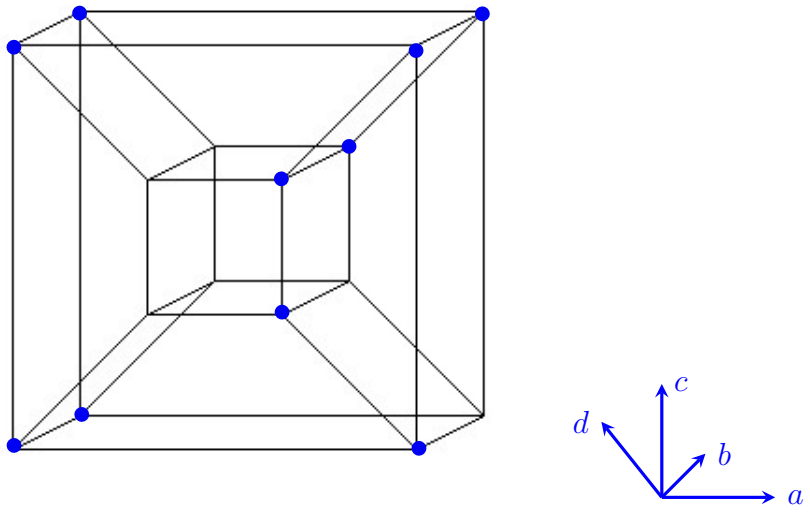


Figure 4: Colored conflict graph

Problem 2

Given the function $F = \bar{a}d + ac + a\bar{b}\bar{c}$

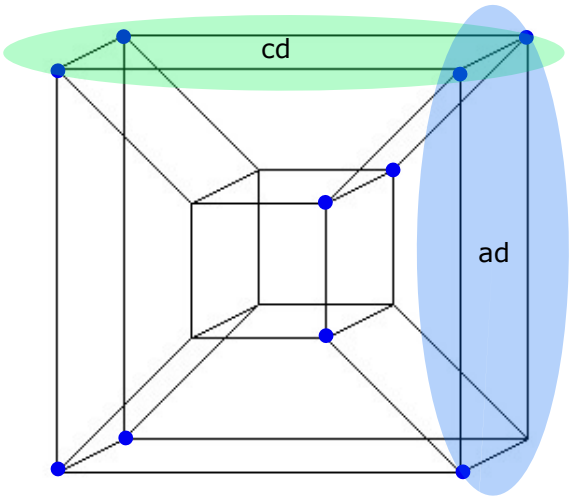
(a) Draw the minterms on the cube
Ans:



(b) Use the cube to show if the following cubes are contained in F:

- cd
- ad

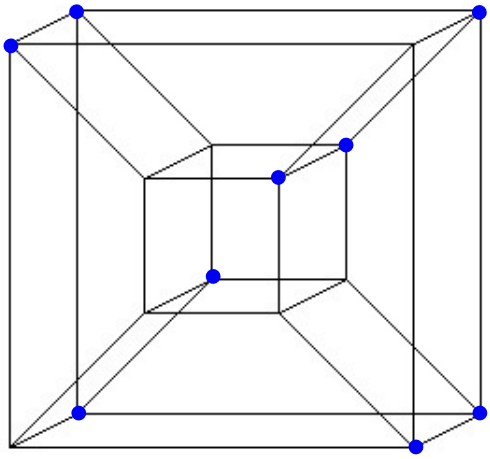
Ans:
cd is contained while ad is not contained since minterm $ab\bar{c}d$ is not in the ON-set.

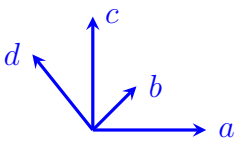


Problem 3

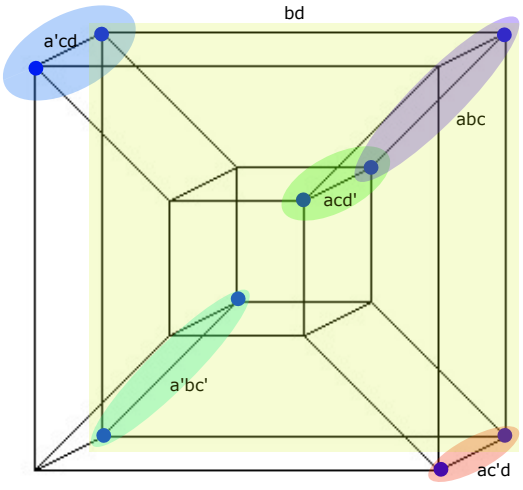
Given the function $F = \bar{a}b\bar{c} + a\bar{c}d + \bar{a}cd + ac\bar{d} + bd$

(a) Draw the minterms on the cube.
Ans: $\bar{a}b\bar{c}\bar{d}, \bar{a}b\bar{c}d, \bar{a}\bar{b}\bar{c}d, ab\bar{c}d, \bar{a}\bar{b}cd, \bar{a}bcd, a\bar{b}c\bar{d}, abcd, abcd$

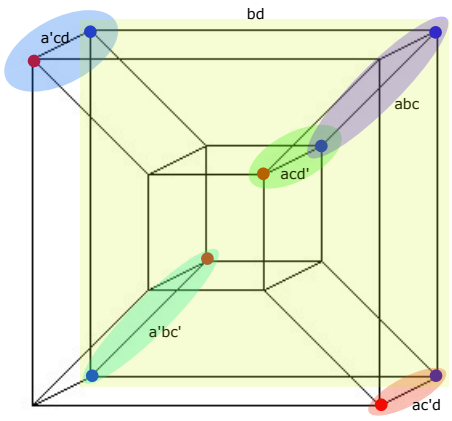




(b) List all the primes (also on the cube).
Ans: $\bar{a}cd, \bar{a}b\bar{c}, a\bar{c}d, ac\bar{d}, abc, bd$



(c) List all the essential primes.
Ans: $\bar{a}cd, \bar{a}b\bar{c}, a\bar{c}d, acd\bar{}$



(d) Find a minimum cover using McCluskey's method.
Ans:

	$\bar{a}b\bar{c}$	$a\bar{c}d$	$\bar{a}cd$	$acd\bar{}$	abc	bd
0011			1			
0100	1					
0101	1					1
0111			1			1
1001		1				
1010				1		
1101		1				1
1110				1	1	
1111					1	1

(e) Show the obtained cover on the cube.
Ans: