

3.18

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

	BC				
	00	01	11	10	
A					$\bar{A}C$
0		1	1	1	$\bar{A}B$
1				1	
					$B\bar{C}$

Static 1-hazard may occur when the inputs ABC change from 011 $\rightarrow$ 010 or 010 $\rightarrow$ 011

So, we need to include prime implicant $\bar{A}B$ in our hazard-free implementation.

Hazard-free implementation:

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

b) $F(A, B, C, D) = \sum m(0, 4, 5, 6, 7, 9, 11, 13, 14)$

	CD				
	00	01	11	10	
AB					
00	1	0	0	0	$\bar{A}B^*$
01	1	1	1	1	
11	0	1	0	1	$B\bar{C}\bar{D}^*$
10	0	1	1	0	
					$\bar{A}\bar{C}\bar{D}^*$
					$A\bar{C}\bar{D}$
					$A\bar{B}D^*$

The prime implicants $\bar{A}\bar{C}\bar{D}$, $\bar{A}B$, $B\bar{C}\bar{D}$, and $A\bar{B}D$ are essential and need to be included in the final solution. The remaining minterm (m_{13}) can be covered by either $B\bar{C}\bar{D}$ or $A\bar{C}\bar{D}$.

However, if $B\bar{C}\bar{D}$ is selected, $1101 \leftrightarrow 1001$ transition or if $A\bar{C}\bar{D}$ is selected, $0101 \leftrightarrow 1101$ transition results in a static 1-hazard. So both prime implicants need to be included in hazard-free implementation

Hazard-free implementation:

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

2.37

a) $F = ABCD + ABDE = ABD(C+E)$

b) $F = ACD + BC + ABE + BD = ACD + B(C+AE+D)$

c) $F = AC + ADE + BC + BDE = A(C+DE) + B(C+DE)$
 $= (A+B)(C+DE)$

d) $F = AD + AE + BD + BE + CD + CE + AF$
 $= A(D+E) + B(D+E) + C(D+E) + AF$
 $= (A+B+C)(D+E) + AF$

e) $F = ACE + ACF + ADE + ADF + BCE + BCF + BDE + BDF$
 $= AC(E+F) + AD(E+F) + BC(E+F) + BD(E+F)$
 $= (AC + AD + BC + BD)(E+F)$
 $= (A(C+D) + B(C+D))(E+F)$
 $= (A+B)(C+D)(E+F)$

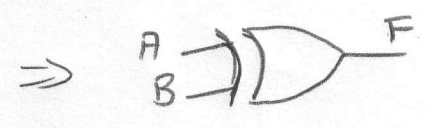
2.38

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

$$= \underbrace{\bar{A}A}_0 + \bar{A}B + A\bar{B} + \underbrace{B\bar{B}}_0$$

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

$$= A \oplus B$$



2.40

a

SHIFT	$\bar{I}_0$	$\bar{I}_1$	O_0	O_1
0	0	0	0	0
0	0	1	0	1
0	1	0	1	0
0	1	1	1	1
1	0	0	0	0
1	0	1	0	0
1	1	0	0	1
1	1	1	0	1

b

SELECT	IN	O_0	O_1
0	0	0	0
0	1	1	0
1	0	0	0
1	1	0	1

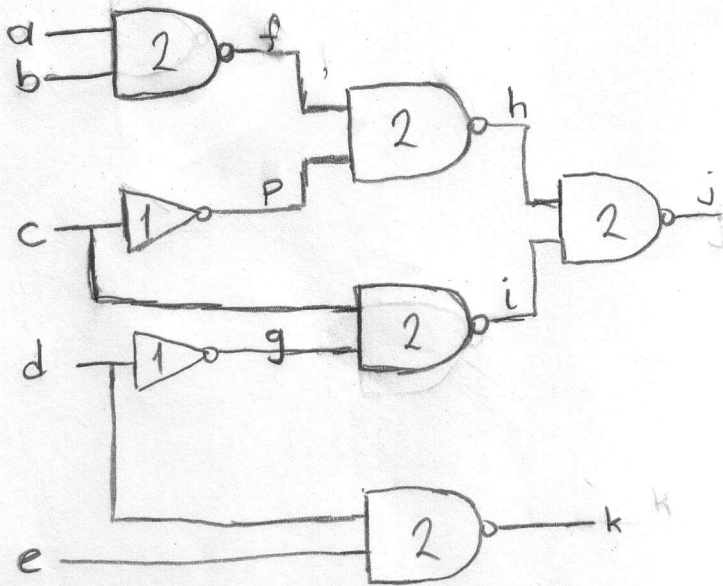
c

SELECT	$\bar{I}_0$	$\bar{I}_1$	OUT
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

Additional

Critical Path Analysis

[A]



Critical paths:

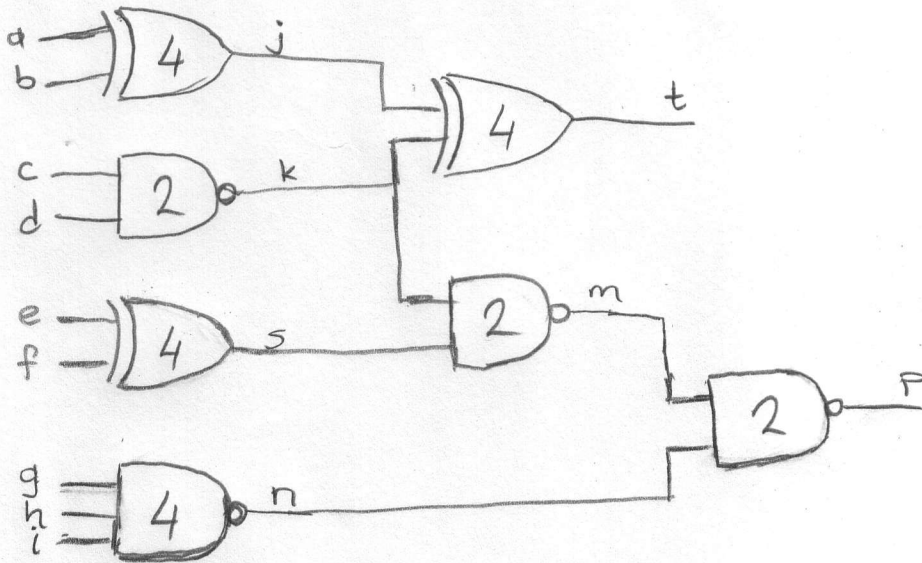
$a \rightarrow f \rightarrow h \rightarrow j$

$b \rightarrow f \rightarrow h \rightarrow j$

Total delay:

$$2 + 2 + 2 = 6 \text{ ns}$$

[B]



Critical paths:

① $a \rightarrow j \rightarrow t$

② $b \rightarrow j \rightarrow t$

③ $e \rightarrow s \rightarrow m \rightarrow p$

④ $f \rightarrow s \rightarrow m \rightarrow p$

Total Delay:

①, ② : $4 + 4 = 8 \text{ ns}$

③, ④ : $4 + 2 + 2 = 8 \text{ ns}$