2-1

(a)

X	Y	Z	$\overline{XYZ}$	$\overline{X}+\overline{Y}+\overline{Z}$
0	0	0	1	1
0	0	1	1	1
0	1	0	1	1
0	1	1	1	1
1	0	0	1	1
1	0	1	1	1
1	1	0	1	1
1	1	1	0	0

2-2

(a)

$\overline{X}\,\overline{Y}+\overline{X}Y+XY$

$=\overline{X}(\overline{Y}+Y)+XY+\overline{X}Y$

$=\overline{X}+Y(\overline{X}+X)$

$=\overline{X}+Y$

So $\overline{X}\,\overline{Y}+\overline{X}Y+XY=\overline{X}+Y$

(c)

$Y+\overline{X}Z+XY$

$=(Y+X)(Y+\overline{Y})+\overline{X}Z$

$=Y+X+\overline{X}Z$

$=(X+\overline{X})(X+Z)+Y$

$=X+Y+Z$

So $Y+\overline{X}Z+XY=X+Y+Z$

2-3

(a)

$A B \overline{C}+B \overline{C D}+B C+\overline{C} D$

$=A B \overline{C}+B \overline{C}+B \overline{D}+B C+\overline{C} D$

$=A B \overline{C}+B+\overline{C} D$

$=B+B \overline{D}+A B \overline{C} \overline{D}+A B \overline{C} D+\overline{C} D$

$=B+B \overline{D}+\overline{C} D$

$=B+\overline{C} D$

So $A B \overline{C}+B \overline{C D}+B C+\overline{C} D=B+\overline{C} D$

(c)

$A \overline{D}+\overline{A} B+\overline{C} D+\overline{B} C$

$=\overline{(\overline{A}+D)(A+\overline{B})(C+\overline{D})(B+\overline{C})}$

$=\overline{(0+\overline{A} \overline{B}+A D+\overline{B} D)(B C+B \overline{D}+0+\overline{C} \overline{D})}$

$=\overline{\overline{A} \overline{B} \overline{C} \overline{D}+A B C D}$

$=(\overline{A}+\overline{B}+\overline{C}+\overline{D})(A+B+C+D)$

So $A \overline{D}+\overline{A} B+\overline{C} D+\overline{B} C=(\overline{A}+\overline{B}+\overline{C}+\overline{D})(A+B+C+D)$

2-6

(b)

$(\overline{A+B+C}) \cdot \overline{A B C}$

$=\overline{A+B+C+A B C}$

$=\overline{A+B+C}$

$=\overline{A} \overline{B} \overline{C}$

(d)

$\overline{A} \overline{B} D+\overline{A} \overline{C} D+B D$

$=(\overline{A} \overline{B}+B+\overline{A} \overline{C}) D$

$=(\overline{A}+B+\overline{A} \overline{C}) D$

$=(\overline{A}+B) D$

2-10

(a)

X	Y	Z	$(XY+Z)(Y+XZ)$
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

So it can be written as sum of Minterms: $\overline{X}YZ + X\overline{Y}Z + XY\overline{Z} + XYZ$.

Also it can be written as product of Maxterms:
$(\overline{X}+Y+Z)(X+\overline{Y}+Z)(X+Y+\overline{Z})(X+Y+Z)$

(c)

W	X	Y	Z	$WX\overline{Y}+WX\overline{Z}+WXZ+Y\overline{Z}$
0	0	0	0	0
0	0	0	1	0
0	0	1	0	1
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	1
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	1
1	0	1	1	0
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

So it can be written as sum of Minterms:
$\overline{W}\,\overline{X}Y\overline{Z} + \overline{W}XY\overline{Z} + W\overline{X}Y\overline{Z} + WX\overline{Y}\,\overline{Z} + WX\overline{Y}Z + WXY\overline{Z} + WXYZ.$

Also it can be written as product of Maxterms:
$(\overline{W} + X + \overline{Y} + \overline{Z})(\overline{W} + X + Y + \overline{Z})(\overline{W} + X + Y + Z)$

$(W + \overline{X} + \overline{Y} + \overline{Z})(W + \overline{X} + Y + \overline{Z})(W + \overline{X} + Y + Z)(W + X + \overline{Y} + \overline{Z})$

$(W + X + Y + \overline{Z})(W + X + Y + Z)$

2-11

(a)

$E = \sum m(1, 2, 4, 6) = \prod M(0, 3, 5, 7)$

$F = \sum m(0, 2, 4, 7) = \prod M(1, 3, 5, 6)$

(c)

$E + F = \sum m(0, 1, 2, 4, 6, 7)$

$E \cdot F = \sum m(2, 4)$

(d)

$E = \overline{X}\,\overline{Y}Z + \overline{X}Y\overline{Z} + X\overline{Y}\,\overline{Z} + XY\overline{Z}$

$F = \overline{X}\,\overline{Y}\,\overline{Z} + \overline{X}Y\overline{Z} + X\overline{Y}\,\overline{Z} + XYZ$

2-12

(b)

$\overline{X} + X(X + \overline{Y})(Y + \overline{Z})$

$= (\overline{X} + X)(\overline{X} + X(X + \overline{Y})(Y + \overline{Z}))$

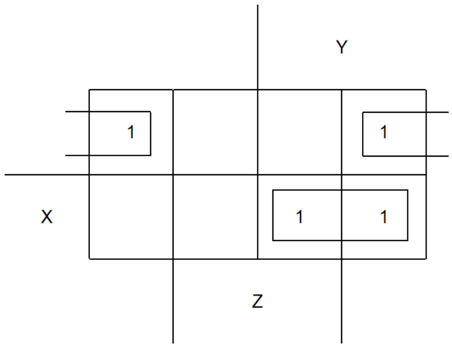
$= (\overline{X} + X + \overline{Y})(\overline{X} + Y + \overline{Z})$

$= \overline{X} + Y + \overline{Z}$

So its SOP is $\overline{X} + Y + \overline{Z}$, its POS is $(\overline{X} + X + \overline{Y})(\overline{X} + Y + \overline{Z})$

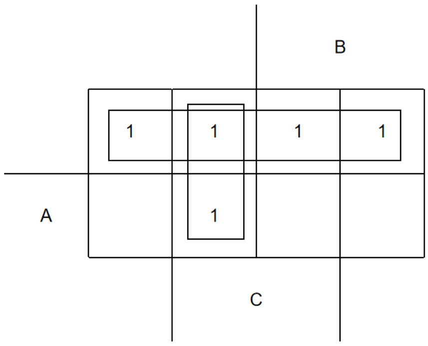
2-15

(a)



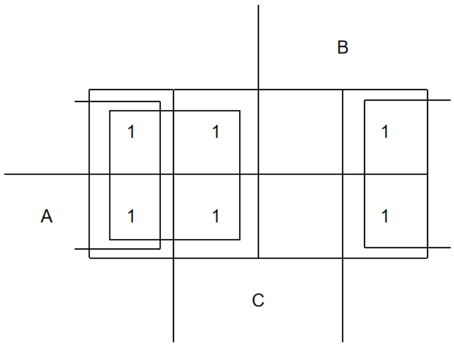
So it is $XY + \overline{X}\,\overline{Z}$

(b)



So it is $\overline{A} + \overline{B}C$

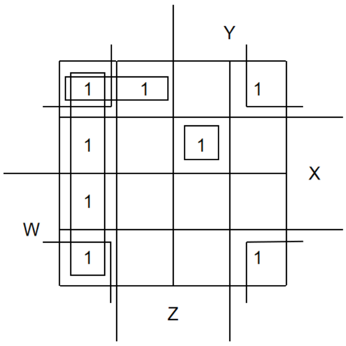
(c)



So it is $\overline{B} + \overline{C}$

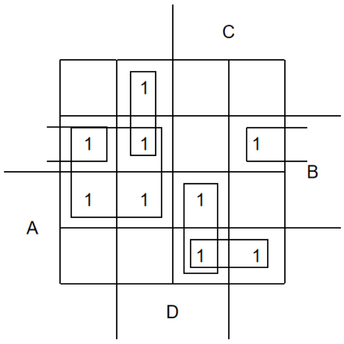
2-17

(a)



So $F = \overline{X}\,\overline{Z} + \overline{Y}\,\overline{Z} + \overline{W}\,\overline{X}\,\overline{Y} + \overline{W}XYZ$

(b)



So $F = B\overline{C} + \overline{A}\,\overline{C}D + \overline{A}B\overline{D} + A\overline{B}C + ACD$

2-19

(a)

Prime implicants: $WX, XZ, W\overline{Z}, \overline{X}\,\overline{Z}$

Essential prime implicants: $XZ, \overline{X}\,\overline{Z}$

(b)

Prime implicants: $AC, CD, \overline{B}C, \overline{B}\,\overline{D}, \overline{A}BD$

Essential prime implicants: $AC, \overline{B}\,\overline{D}, \overline{A}BD$

(c)

Prime implicants: $AB, AC, AD, B\overline{C}, \overline{B}D, \overline{C}D$

Essential prime implicants: $AC, B\overline{C}, \overline{B}D$

2-22

(a)

$A\overline{C} + \overline{B}D + \overline{A}CD + ABCD$

$= A\overline{C} + \overline{B}D + \overline{A}\overline{B}CD + \overline{A}BCD + ABCD$

$= A\overline{C} + (\overline{B} + BC)D$

$= A\overline{C} + \overline{B}D + CD$

$= (A + D(\overline{B} + C))(\overline{C} + D(\overline{B} + C))$

$= (A + D)(\overline{C} + D)(A + \overline{B} + C)$

So its sum-of-product is $A\overline{C} + \overline{B}D + CD$, its product-of-sum is $(A + D)(\overline{C} + D)(A + \overline{B} + C)$

2-25

(a)

Prime implicants: $AB, AC, BC, \overline{A}\overline{B}\overline{C}$

Essential prime implicants: AB, AC, BC

$F = AB + AC + BC$

(b)

Prime implicants: $WXY, WY\overline{Z}, \overline{W}X\overline{Y}, \overline{W}\overline{Y}\overline{Z}, XZ, \overline{X}\overline{Z}$

Essential prime implicants: $\overline{X}\overline{Z}$

$F = \overline{X}\overline{Z} + WXY + \overline{W}X\overline{Y}$

(c)

Prime implicants: $A\overline{D}, \overline{A}B, B\overline{D}, C$

Essential prime implicants: $A\overline{D}, C$

$F = A\overline{D} + C + \overline{A}B$

2-29

From C or $\overline{D}$ to F:

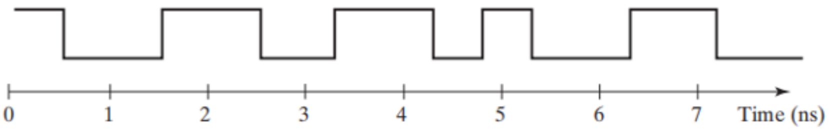
$0.073 \cdot 3 + 0.048 = 0.267$

So the t_{pd} of the longest path is 0.267 ns.

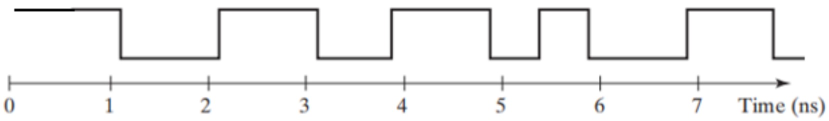
2-30

(I guess the delay should be 0.6ns and the rejection time should be 0.4ns...)

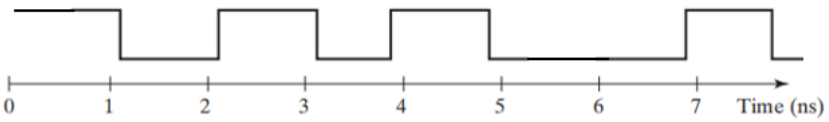
(a)



(b)



(c)



2-31

(a)

$A, B, \overline{C} \rightarrow F$:

$t'_{PHL} = t_{PHL} + t_{PLH} = 0.56ns$

$t'_{PLH} = t_{PLH} + t_{PHL} = 0.56ns$

So $t_{pd} = 0.56ns$

$\overline{B} \rightarrow F$:

$t'_{PHL} = 2t_{PHL} + t_{PLH} = 0.76ns$

$t'_{PLH} = 2t_{PLH} + t_{PHL} = 0.92ns$

So $t_{pd} = 0.84ns$

$C, D \rightarrow F$:

$t'_{PHL} = 2t_{PHL} + 2t_{PLH} = 1.12ns$

$t'_{PLH} = 2t_{PLH} + 2t_{PHL} = 1.12ns$

So $t_{pd} = 1.12ns$

(b)

$A, B, \overline{C} \rightarrow F : 2t_{pd} = 2 \cdot 0.28 = 0.56ns$

$\overline{B} \rightarrow F : 3t_{pd} = 3 \cdot 0.28 = 0.84ns$

$C, D \rightarrow F : 4t_{pd} = 4 \cdot 0.28 = 1.12ns$

(c)

For each path with an even number of gates, $t_{PHL} = t_{PLH} = t_{pd}$.

If for each gate $t'_{PHL} \neq t'_{PLH}$, then for each path with an odd number of gates, $t_{PHL} \neq t_{PLH} \neq t_{pd}$, but t_{pd} of the path is equal to the sum of t'_{pd} of each gate.