4.3 $F_1 = \sum m(0, 4, 5, 6)$; $F_2 = \sum m(0, 3, 4, 6, 7)$; $F_1 + F_2 = \sum m(0, 3, 4, 5, 6, 7)$

General rule: $F_1 + F_2$ is the sum of all minterms that are present in either F_1 or F_2.

Proof: Let $F_1 = \sum_{i=0}^{2^n-1} a_i m_i$; $F_2 = \sum_{j=0}^{2^n-1} b_j m_j$; $F_1 + F_2 = \sum_{i=0}^{2^n-1} a_i m_i + \sum_{j=0}^{2^n-1} b_j m_j = a_0 m_0 + a_1 m_1 + a_2 m_2 + \ldots$

$+ b_0 m_0 + b_1 m_1 + b_2 m_2 + \ldots = (a_0 + b_0)\, m_0 + (a_1 + b_1)\, m_1 + (a_2 + b_2)\, m_2 + \ldots = \sum_{i=0}^{2^n-1} (a_i + b_i)\, m_i$

4.4 (a) $2^{2^n} = 2^{2^2} = 2^4 = 16$

4.4 (b)

$x\ y$	z_0	z_1	z_2	z_3	z_4	z_5	z_6	z_7	z_8	z_9	z_{10}	z_{11}	z_{12}	z_{13}	z_{14}	z_{15}
0 0	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
0 1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
1 0	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
1 1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	0	$x'y'$	$x'y$	x'	xy'	y'	$x'y+xy'$	$x'+y'$	xy	$x'y'+xy$	y	$x'+y$	x	$x+y'$	$x+y$	1

4.5

$A\ B\ C$	$D\ \ E\ \ F$	Z
0 0 0	1 1 X[3]	1
0 0 1	X[2] X[2] 1	1
0 1 0	X[1] X[1] X[1]	X
0 1 1	X[2] X[2] 1	1
1 0 0	X[4] 0 0	0
1 0 1	X[2] X[2] 1	1
1 1 0	X[1] X[1] X[1]	X
1 1 1	X[4] 0 0	0

Alternate Solutions

$A\ B\ C$	$D\ \ E\ \ F$	Z
0 1 1	1 1 X[3]	1
1 1 1	0 X[4] 0	0

[1] These truth table entries were made don't cares because ABC = 110 and ABC = 010 can never occur

[2] These truth table entries were made don't cares because when F is 1, the output Z of the OR gate will be 1 regardless of its other input. So changing D and E cannot affect Z.

[3] These truth table entries were made don't cares because when D and E are both 1, the output Z of the OR gate will be 1 regardless of the value of F.

[4] These truth table entries were made don't cares because when one input of the AND gate is 0, the output will be 0 regardless of the value of its other input.

4.9 (a) $F = abc' + b'(a + a')(c + c') = abc' + ab'c + ab'c' + a'b'c + a'b'c'$; $F = \sum m(0, 1, 4, 5, 6)$

4.9 (b) Remaining terms are maxterms: $F = \prod M(2, 3, 7)$

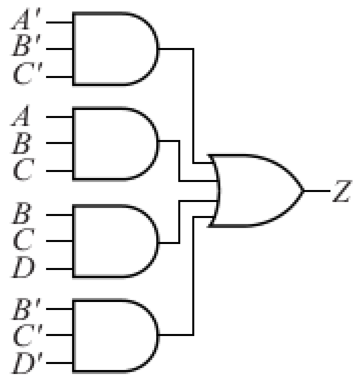
4.9 (c) Maxterms of F are minterms of F':
$F' = \sum m(2, 3, 7)$

4.9 (d) Minterms of F are maxterms of F':
$F' = \prod M(0, 1, 4, 5, 6)$

4.13

A B C D	Z
0 0 0 0	1
0 0 0 1	1
0 0 1 0	0
0 0 1 1	0
0 1 0 0	0
0 1 0 1	0
0 1 1 0	0
0 1 1 1	1
1 0 0 0	1
1 0 0 1	0
1 0 1 0	0
1 0 1 1	0
1 1 0 0	0
1 1 0 1	0
1 1 1 0	1
1 1 1 1	1

$Z = A'B'C'D' + A'B'C'D + AB'C'D'$
$\quad + ABCD' + ABCD + A'BCD$
$\quad = A'B'C' + ABC + AB'C'D' +$
$\quad A'BCD$
$\quad = A'B'C' + ABC + AB'C'D' +$
$\quad A'BCD + \underline{BCD} + \underline{B'C'D'}$
(Added consensus terms)
$\therefore Z = A'B'C' + ABC + BCD +$
$\quad B'C'D'$



4.20 $Z = AB + AC + BC$

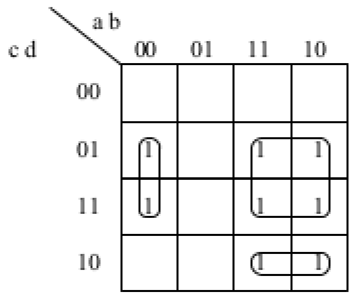
4.29 (a) $f(A,B,C,D) = AB + A'CD = ABC'D' + ABC'D$
$\quad + ABCD' + ABCD + A'B'CD + A'BCD$
$\quad = (A+A'CD)(B+A'CD) = (A+C)(A+D)(A'+B)$
$\quad (B+C)(B+D)$
$f(A,B,C,D) = (A+B'+C+D')(A+B'+C+D)$
$\quad (A+B+C+D')(A+B+C+D)(A+B'+C'+D)$
$\quad (A+B'+C+D)(A+B+C'+D)(A+B+C+D)$
$\quad (A'+B+C'+D')(A'+B+C'+D)(A'+B+C+D')$
$\quad (A'+B+C+D)(A'+B+C+D')(A'+B+C+D)$
$\quad (A+B+C+D')(A+B+C+D)(A'+B+C'+D)$
$\quad (A'+B+C+D)(A+B+C'+D)(A+B+C+D)$
$\quad = (A+B'+C+D')(A+B+C+D')(A+B'+C'+D)$
$\quad (A+B'+C+D)(A+B+C'+D)\ (A+B+C+D)$
$\quad (A'+B+C'+D')(A'+B+C'+D)(A'+B+C+D')$
$\quad (A'+B+C+D)$

Note: Consensus could have been applied twice to write $f = (A+C)(A+D)(A'+B)$ *and save some work.*

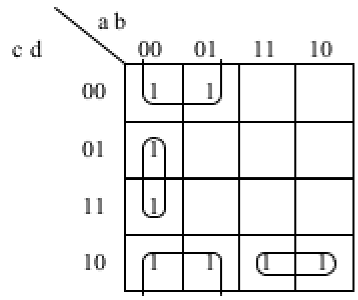
4.29 (b) $f(A,B,C,D) = (A+B+D')(A'+C)(C+D)$
$\quad = (A+B+D')(A'D+C) = AC+A'BD+BC+CD'$
$\quad = AC(B+B')(D+D')+A'BD(C+C')$
$\quad +BC(A+A')(D+D')+(A+A')(B+B')CD'$
$\quad = ABCD+ABCD'+AB'CD+AB'CD'+A'BCD$
$\quad +A'BC'D+ABCD+ABCD'+ABCD+A'BCD'$
$\quad +ABCD'+AB'CD'+A'BCD'+A'B'CD'$
$\quad = ABCD+ABCD'+AB'CD+AB'CD'+A'BCD$
$\quad +A'BC'D+A'BCD'+A'B'CD'$
$f(A,B,C,D) = (A+B+CC'+D')(A'+BB'+C+DD')$
$\quad (AA'+BB'+C+D)$
$\quad = (A+B+C+D')(A+B+C'+D')(A'+B+C+D)$
$\quad (A'+B+C+D')(A'+B'+C+D)(A'+B'+C+D')$
$\quad (A+B+C+D)\ (A+B'+C+D)(A'+B+C+D)$
$\quad (A'+B'+C+D)$
$\quad = (A+B+C+D')(A+B+C'+D')(A'+B+C+D)$
$\quad (A'+B+C+D')(A'+B'+C+D)(A'+B'+C+D')$
$\quad (A+B+C+D)(A+B'+C+D)$

7.8 For the solution to 7.8, see FLD p. 700.

7.9



$f_1 = \underline{acd'} + ad + \underline{\underline{a'b'd}}$



$f_2 = a'd' + \underline{\underline{a'b'd}} + \underline{acd'}$

6 gates

), 11)
10, 11, 12)

7.22 (a) F is 0 if any 3 (or 4) of the inputs are 1 so

$F = (A + B' + C' + D')\,(A' + B' + C + D')$
$(A' + B' + C' + D')(A' + B' + C' + D)$
$(A' + B + C' + D')$
$= (A' + B' + C')(A' + B' + D')(A' + C' + D')$
$(B' + C' + D')$

(b) $F = (A' + B' + C'D')(A'B' + C' + D')$ *or*
$F = (A' + C' + B'D')(A'C' + B' + D')$