1.6

a.)

Sequential - the next state is dependant on current the current state of the machine

b.)

Combinational - the output only is dependant on the input

c.)

Combinational - again the output is only dependant on the input
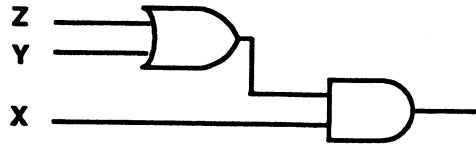
d.)

Sequential - the output coin is dependant on the current state (how much change has already been dispensed)
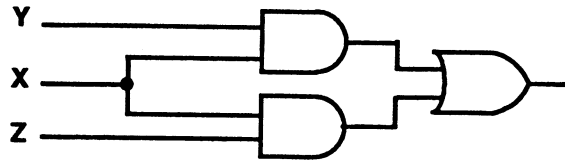
e.)

Sequential - the sounding of the alarm is dependant on a comparison of the current time and the retained state of the preset alarm time
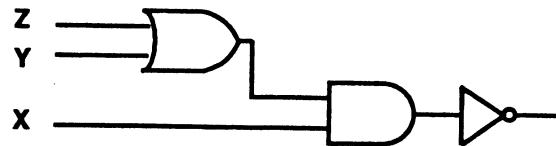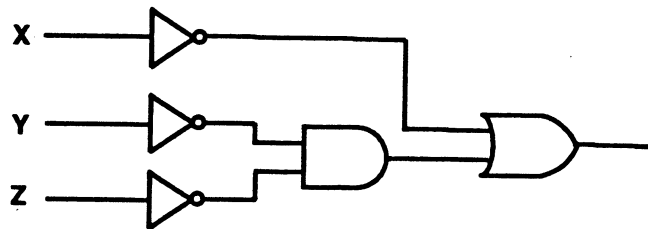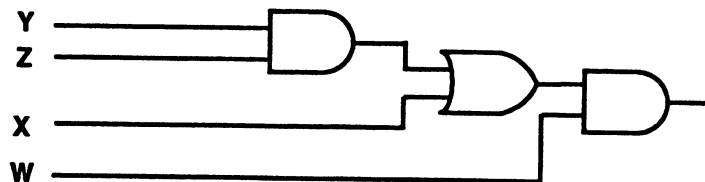
2.1

a.)   X(Y + Z)

b.)   X Y + X Z

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

d.) $\overline{X} + \overline{Y}\,\overline{Z}$

e.)   W (X + Y Z)

2.7

a.) $(X + Y)(X + \overline{Y}) = X$
$= (X + Y)(X + \overline{Y})$
$= XX + X\overline{Y} + XY + Y\overline{Y}$
$= X + X(\overline{Y} + Y) + 0$
$= X + X(1)$
$= X$

b.) $X(X + Y) = X$
$= X(X + Y)$
$= XX + XY$
$= X + XY$
$= X(1 + Y)$
$= X(1)$
$= X$

c.) $(X + \overline{Y})Y = XY$
$= XY + \overline{Y}Y$
$= XY + 0$
$= XY$

d.) $(X + Y)(\overline{X} + Z) = XZ + \overline{X}Y$
$= X\overline{X} + XZ + \overline{X}Y + YZ$
$= 0 + XZ + \overline{X}Y + YZ$
$= XZ + \overline{X}Y + YZ(1)$
$= XZ + \overline{X}Y + YZ(X + \overline{X})$
$= XZ + \overline{X}Y + XYZ + \overline{X}YZ$
$= (XZ + XYZ) + (\overline{X}Y + \overline{X}YZ)$
$= XZ(1 + Y) + \overline{X}Y(1 + Z)$
$= XZ(1) + \overline{X}Y(1)$
$= XZ + \overline{X}Y$

2.10

a.)
$$f = A\,(B + C\,D)$$
$$\overline{f} = \overline{A\,(B + C\,D)}$$
$$\overline{f} = \overline{A} + \overline{(B + C\,D)}$$
$$\overline{f} = \overline{A} + \overline{B} \bullet \overline{(C\,D)}$$
$$\overline{f} = \overline{A} + \overline{B}\,(\overline{C} + \overline{D})$$

b.)
$$f = A\,B\,C + B(\overline{C} + \overline{D})$$

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

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

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

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

g.) $f = X(Y + Z\overline{W} + \overline{V}S)$

$\overline{f} = \overline{X(Y + Z\overline{W} + \overline{V}S)}$

$\overline{f} = \overline{X} + \overline{(Y + Z\overline{W} + \overline{V}S)}$

$\overline{f} = \overline{X} + \overline{Y}\,\overline{(Z\overline{W})}\,\overline{(\overline{V}S)}$

$\overline{f} = \overline{X} + \overline{Y}\,(\overline{Z} + W)\,(V + \overline{S})$

$\overline{f} = [A + \overline{BCD}]\,[\overline{AD} + B\,(\overline{C} + A)]$

2.15

a.) Canonical minterm form:
$$\overline{A}\,\overline{B}\,\overline{C}\,\overline{D} + \overline{A}\,\overline{B}\,\overline{C}\,D + \overline{A}\,\overline{B}\,C\,\overline{D} + \overline{A}\,B\,C\,D + A\,\overline{B}\,\overline{C}\,\overline{D} + A\,\overline{B}\,\overline{C}\,D + A\,\overline{B}\,C\,\overline{D} + A\,B\,C\,D$$

b.) Canonical maxterm form:
$$\Pi M(3, 4, 5, 6, 11, 12, 13, 14)$$
$$= (A + B + \overline{C} + \overline{D}) \bullet (A + \overline{B} + C + D) \bullet (A + \overline{B} + C + \overline{D}) \bullet (A + \overline{B} + \overline{C} + D) \bullet (\overline{A} + B + \overline{C} + \overline{D})$$
$$\bullet (\overline{A} + \overline{B} + C + D) \bullet (\overline{A} + \overline{B} + C + \overline{D}) \bullet (\overline{A} + \overline{B} + \overline{C} + D)$$

c.) Complement of f in "little m" notation and as a canonical minterm expression:
$$\bar{f} = \Sigma m(3, 4, 5, 6, 11, 12, 13, 14)$$
$$= \overline{A}\,\overline{B}\,C\,D + \overline{A}\,B\,\overline{C}\,\overline{D} + \overline{A}\,B\,\overline{C}\,D + \overline{A}\,B\,C\,\overline{D} + A\,\overline{B}\,C\,D + A\,B\,\overline{C}\,\overline{D} + A\,B\,\overline{C}\,D + A\,B\,C\,\overline{D}$$

d.) Complement of f in "big M" notation as a canonical maxterm expression:
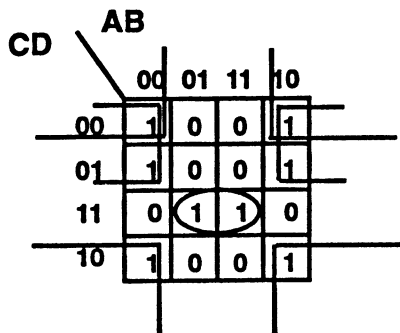$$\bar{f} = \Pi M(0, 1, 2, 7, 8, 9, 10, 15)$$
$$= (A + B + C + D) \bullet (A + B + C + \overline{D}) \bullet (A + B + \overline{C} + D) \bullet (A + \overline{B} + \overline{C} + \overline{D}) \bullet (\overline{A} + B + C + D)$$
$$\bullet (\overline{A} + B + C + \overline{D}) \bullet (\overline{A} + B + \overline{C} + D) \bullet (\overline{A} + \overline{B} + \overline{C} + \overline{D})$$

2.17

a.) Minimum sum of products form and its complement:

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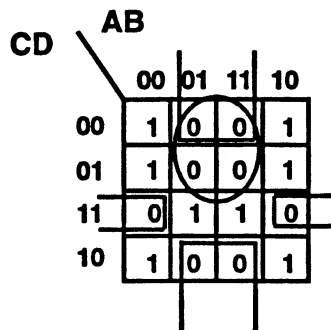
$$\overline{F} = B\,\overline{C} + B\,\overline{D} + \overline{B}\,C\,D$$

b.) Minimum product of sums form and its complement:

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

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

b.)
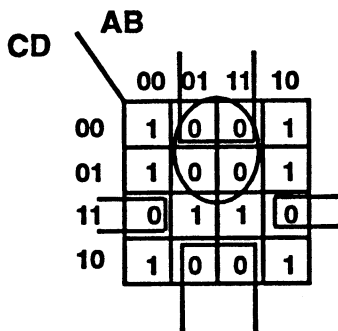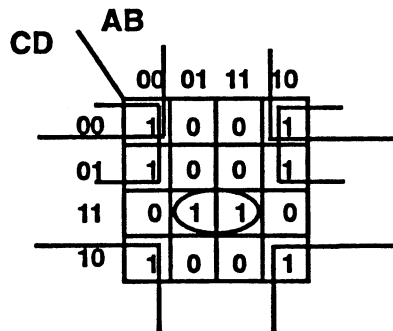
$$f(W, X, Y, Z) = \overline{Z} + X\,\overline{Y}$$

Three literals

c.)

$V = 0$

$$f(V, W, X, Y, Z) = \overline{V}\,Y + \overline{V}\,Z + W\,\overline{Z} + W\,Y + V\,\overline{W}\,\overline{Y}$$

Eleven literals

$V = 1$

d.)

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

Two literals

e.)

CD　AB

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

Four literals

f.)

BC

DE

A = 0

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

Eleven literals

BC

DE

A = 1

g.)

EF \ CD, A B = 00

	00	01	11	10
00	0	0	1	0
01	0	0	0	0
11	1	1	1	0
10	0	0	1	0

EF \ CD, A B = 01

	00	01	11	10
00	0	0	1	0
01	0	0	1	0
11	1	1	1	1
10	0	0	0	0

$$f(A, B, C, D, E, F) = \overline{A}BEF + \overline{B}CD\overline{F} + AB\overline{C}\overline{E} + \overline{B}\,\overline{C}EF +$$
$$AB\overline{D}\overline{E} + \overline{C}DEF + \overline{A}DEF + \overline{A}BCD\overline{E} +$$
$$ABC\overline{D}F + A\overline{B}CD\overline{E} + AB\overline{C}\,\overline{D}\,\overline{F}$$

Forty-eight literals

EF \ CD, A B = 10

	00	01	11	10
00	1	1	0	1
01	1	1	0	1
11	0	1	0	1
10	1	0	0	0

EF \ CD, A B = 11

	00	01	11	10
00	0	0	1	0
01	0	0	1	0
11	1	1	0	0
10	0	0	1	0

2.19

a.)

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

b.)

$$f(W, X, Y, Z) = \overline{W}\,\overline{X}\,\overline{Y} + XZ + W\,\overline{X}\,Y$$

2.22

  a.)

Σm	X	Y	Z	F
0	0	0	0	0
1	0	0	1	0
2	0	1	0	1
3	0	1	1	1
4	1	0	0	1
5	1	0	1	1
6	1	1	0	0
7	1	1	1	0

Column I	Column II
010/ 100/	01 - 10 -
011/ 101/	

Prime implicates found by Quine-McCluskey method:
$$X \bar{Y} + \bar{X} Y$$

b.)

Σm	A	B	C	D	F
0	0	0	0	0	1
1	0	0	0	1	1
2	0	0	1	0	0
3	0	0	1	1	0
4	0	1	0	0	1
5	0	1	0	1	1
6	0	1	1	0	0
7	0	1	1	1	0
8	1	0	0	0	0
9	1	0	0	1	0
10	1	0	1	0	0
11	1	0	1	1	0
12	1	1	0	0	1
13	1	1	0	1	1
14	1	1	1	0	0
15	1	1	1	1	0

$f(A,B,C,D) = \sum m(0,1,4,5,12,13)$

0 0 0 0 ✓	0 0 0 - ✓	0 - 0 -
	0 - 0 0 ✓	
0 0 0 1 ✓	0 - 0 1 ✓	- 1 0 -
0 1 0 0 ✓	0 1 0 - ✓	
	- 1 0 0	
0 1 0 1 ✓	- 1 0 1 ✓	
1 1 0 0 ✓	1 1 0 - ✓	
1 1 0 1 ✓		

	0	1	4	5	12	13
0 - 0 -	X	X	X	X		
1 - 1 0 -			X	X	X	X

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

2.27

a.)

Σm	A	B	C	D	W	X	Y	Z
0	0	0	0	0	0	0	0	1
1	0	0	0	1	0	0	1	0
2	0	0	1	0	0	0	1	1
3	0	0	1	1	0	1	0	0
4	0	1	0	0	0	1	0	1
5	0	1	0	1	0	1	1	0
6	0	1	1	0	0	1	1	1
7	0	1	1	1	1	0	0	0
8	1	0	0	0	1	0	0	1
9	1	0	0	1	1	0	1	0
10	1	0	1	0	1	0	1	1
11	1	0	1	1	1	1	0	0
12	1	1	0	0	1	1	0	1
13	1	1	0	1	1	1	1	0
14	1	1	1	0	1	1	1	1
15	1	1	1	1	0	0	0	0

b.)
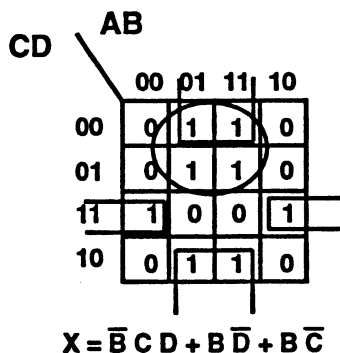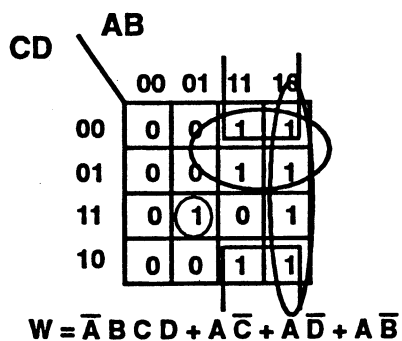
$$W = \overline{A} B C D + A \overline{C} + A \overline{D} + A \overline{B}$$

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

CD \ **AB**

	00	01	11	10
00	0	0	0	0
01	1	1	1	1
11	0	0	0	0
10	1	1	1	1

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

CD \ **AB**

	00	01	11	10
00	1	1	1	1
01	0	0	0	0
11	0	0	0	0
10	1	1	1	1

$$Z = \overline{D}$$

c.)

CD \ **AB**

	00	01	11	10
00	0	0	1	1
01	0	0	1	1
11	0	1	0	1
10	0	0	1	1

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

CD \ **AB**

	00	01	11	10
00	0	1	1	0
01	0	1	1	0
11	1	0	0	1
10	0	1	1	0

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

CD \ **AB**

	00	01	11	10
00	0	0	0	0
01	1	1	1	1
11	0	0	0	0
10	1	1	1	1

$$Y = (C + D)(\overline{C} + \overline{D})$$

CD \ **AB**

	00	01	11	10
00	1	1	1	1
01	0	0	0	0
11	0	0	0	0
10	1	1	1	1

$$Z = \overline{D}$$