

1)

0	IDLE	N=F D1=F, D2=F, D3=F, D4=F B=F, R=F, Y=F, G=F X=T	-	
1	N	N=T D1=V, D2=F, D3=F, D4=F B=T, R=F, Y=F, G=F X=T	D1	YES
	E	NULL	IDLE	
	C	N=F D1=F, D2=F, D3=F, D4=F B=F, R=F, Y=F, G=F X=T	IDLE	Yes
	U	NULL	IDLE	
	L	NULL	IDLE	
2	NN	N=T D1=V, D2=V, D3=F, D4=F B=F, R=T, Y=F, G=F X=T	D1D2	YES
	NE	NULL	-	

	NC	N=F D1=V, D2=F, D3=F, D4=F B=T, R=F, Y=F, G=F X=T	1	YES
	NU	NULL	-	
	NL	NULL	-	
3	NNN	N=T D1=V, D2=V, D3=V, D4=F B=F, R=F, Y=T, G=F X=T	D1D2D3	YES
	NNE	NULL	-	
	NNC	N=F D1=V, D2=V, D3=F, D4=F B=F, R=T, Y=F, G=F X=T	2	YES
	NNU	NULL	-	
	NNL	NULL	-	
4	NNNN	N=T D1=V, D2=V, D3=V, D4=V B=F, R=F, Y=F, G=T X=T	D1D2D3D4	YES
	NNNE	NULL	-	

	NNNC	N=F D1=V, D2=V, D3=V, D4=F B=F, R=F, Y=T, G=F X=T	3	YES
	NNNU	NULL	-	
	NNNL	NULL	-	
5	NNNNN	NULL	-	
	NNNNE	N=F D1=V, D2=V, D3=V, D4=V B=T, R=T, Y=T, G=T X=T	D1D2D3D4E	YES
	NNNNC	NULL	-	
	NNNNU	NULL	-	
	NNNNL	NULL	-	
6	NNNNEN	NULL	-	
	NNNNEE	NULL	-	
	NNNNEC	NULL	-	
	NNNNEU	N=F D1=V, D2=V, D3=V, D4=V B=T, R=T, Y=T, G=T X=T	D1D2D3D4EU	Yes
	NNNNEL	Null	-	

7	D1D2D3D4 !=CODE	N=F D1=null, D2=null, D3=null, D4=null B=F, R=F, Y=F, G=F X=T	0	Yes
	D1D2D3D4 ==CODE	N=F D1=null, D2=null, D3=null, D4=null B=T, R=T, Y=T, G=T X=T	D1D2D3D4EU	Yes
8	NNNNUN	NULL	-	
	NNNNUE	NULL	-	
	NNNNUC	NULL	-	
	NNNNUU	NULL	-	
	NNNNUL	N=F D1=F, D2=F, D3=F, D4=F B=F, R=F, Y=F, G=F X=T	Idle	YES

Test Case Table

Test Case No.	Current State	Inputs						Internal					Expected Outputs					Next State
		N	V	E	C	U	L	D1	D2	D3	D4	D1D2D3D4=Code	B	R	Y	G	X	
1	Start	-	-	-	-	-	-	null	null	null	null	null	F	F	F	F	T	S0
2	S0	T	V	-	-	-	-	V	null	null	null	null	T	F	F	F	T	S1
3	S0	-	-	T	-	-	-	null	null	null	null	null	F	F	F	F	T	S0
4	S0	-	-	-	T	-	-	null	null	null	null	null	F	F	F	F	T	S0
5	S0	-	-	-	-	T	-	null	null	null	null	null	F	F	F	F	T	S0
6	S0	-	-	-	-	-	T	null	null	null	null	null	F	F	F	F	T	S0
7	S1	T	V	-	-	-	-	V	V	null	null	null	F	T	F	F	T	S2
8	S1	-	-	T	-	-	-	null	null	null	null	null	F	F	F	F	T	S1
9	S1	-	-	-	T	-	-	V	null	null	null	null	F	F	F	F	T	S0
10	S1	-	-	-	-	T	-	null	null	null	null	null	F	F	F	F	T	S1
11	S1	-	-	-	-	-	T	null	null	null	null	null	F	F	F	F	T	S1
12	S2	T	V	-	-	-	-	V	V	V	null	null	F	F	T	F	T	S3
13	S2	-	-	T	-	-	-	null	null	null	null	null	F	F	F	F	T	S2
14	S2	-	-	-	T	-	-	V	V	null	null	null	F	F	F	F	T	S1
15	S2	-	-	-	-	T	-	null	null	null	null	null	F	F	F	F	T	S2
16	S2	-	-	-	-	-	T	null	null	null	null	null	F	F	F	F	T	S2
17	S3	T	V	-	-	-	-	V	V	V	V	null	F	F	F	T	T	S4
18	S3	-	-	T	-	-	-	null	null	null	null	null	F	F	F	F	T	S3
19	S3	-	-	-	T	-	-	V	V	V	null	null	F	F	F	F	T	S2
20	S3	-	-	-	-	T	-	null	null	null	null	null	F	F	F	F	T	S3
21	S3	-	-	-	-	-	T	null	null	null	null	null	F	F	F	F	T	S3
22	S4	T	V	-	-	-	-	V	V	V	V	null	F	F	F	F	F	S4
23	S4	-	-	T	-	-	-	V	V	V	V	null	F	F	F	F	T	S5
24	S4	-	-	-	T	-	-	null	null	null	null	null	F	F	F	F	T	S4
25	S4	-	-	-	-	T	-	null	null	null	null	null	F	F	F	F	T	S4
26	S4	-	-	-	-	-	T	null	null	null	null	null	F	F	F	F	T	S4
27	S5	T	V	-	-	-	-	V	V	V	V	null	F	F	F	F	T	S5
28	S5	-	-	T	-	-	-	null	null	null	null	null	F	F	F	F	T	S5
29	S5	-	-	-	T	-	-	null	null	null	null	null	F	F	F	F	T	S5
30	S5	-	-	-	-	T	-	V	V	V	V	null	F	F	F	F	T	S6

31	S5	-	-	-	-	-	T	null	null	null	null		null	T	T	T	T	T	S5
32	S6	-	-	-	-	-	-	V	V	V	V		T	T	T	T	T	T	S7
33	S6	-	-	-	-	-	-	V	V	V	V		F	F	F	F	F	T	S0
34	S7	T	V	-	-	-	-	nul I	nul I	nul I	nul I		null	T	T	T	T	T	S7
35	S7	-	-	T	-	-	-	null	null	null	null		null	T	T	T	T	T	S7
36	S7	-	-	-	T	-	-	null	null	null	null		null	T	T	T	T	T	S7
37	S7	-	-	-	-	T	-	null	null	null	null		null	T	T	T	T	T	S7
38	S7	-	-	-	-	-	T	null	null	null	null		null	nul I	nul I	nul I	nul I	nul I	S0

2)

Test Case Number	Input					Output
	Number of Drinks	Discount Type	Drink type	Size	Payment Type	Return
1	1	None	Coffee	Small	Cash	\$ 1.67
2	1	Student	Tea	Regular	CreditCard	\$ 1.14
3	1	Teacher	Soda	Large	DebitCard	\$ 1.79
4	4	None	Tea	Large	Cash	\$ 5.61
5	4	Student	Coffee	Grande	DebitCard	\$ 11.46
6	4	Teacher	Slushy	Small	CreditCard	\$ 5.04
7	7	None	Soda	Regular	CreditCard	\$ 11.58
8	7	Student	Slushy	Large	Cash	\$ 10.63
9	7	Teacher	Coffee	Regular	Cash	\$ 12.77
10	7	Military	Tea	Small	DebitCard	\$ 6.38
11	12	None	Slushy	Grande	DebitCard	\$ 28.60
12	12	Military	Coffee	Large	CreditCard	\$ 24.41
13	12	Frequent	Soda	Small	Cash	\$ 13.00
14	17	Military	Cappuccino	Regular	Cash	\$ 45.19
15	17	Frequent	Tea	Grande	CreditCard	\$ 27.77
16	17	Coupon	Soda	Grande	Cash	\$ 38.34
17	17	Employee	Slushy	Regular	DebitCard	\$ 18.89
18	20	Frequent	Cappuccino	Large	DebitCard	\$ 60.56
19	20	Coupon	Cappuccino	Small	CreditCard	\$ 51.98
20	20	Employee	Coffee	Grande	Cash	\$ 46.33
21	31	Coupon	Coffee	Regular	DebitCard	\$ 55.22
22	31	Employee	Cappuccino	Small	CreditCard	\$ 67.14
23	31	Student	Soda	Small	Cash	\$ 37.79
24	50	Teacher	Cappuccino	Grande	Cash	\$ 238.98
25	50	Military	Soda	Large	CreditCard	\$ 82.52
26	50	Frequent	Coffee	Regular	DebitCard	\$ 79.17
27	1	Military	Slushy	Grande	CreditCard	\$ 2.09
28	4	Coupon	Tea	Regular	Cash	\$ 4.30
29	7	Coupon	Slushy	Large	CreditCard	\$ 11.28
30	7	Employee	Tea	Grande	DebitCard	\$ 10.41
31	12	Employee	Soda	Regular	CreditCard	\$ 14.89
32	17	None	Coffee	Small	CreditCard	\$ 30.14
33	20	None	Soda	Regular	DebitCard	\$ 32.12
34	31	Teacher	Tea	Large	DebitCard	\$ 42.61
35	31	Frequent	Slushy	Grande	Cash	\$ 57.33
36	50	Student	Cappuccino	Small	DebitCard	\$ 126.17
37	1	Employee	Cappuccino	Large	Cash	\$ 2.75
38	4	Military	Soda	Grande	DebitCard	\$ 8.78
39	4	Frequent	Cappuccino	Regular	CreditCard	\$ 10.63
40	12	Student	Tea	Small	Cash	\$ 11.23
41	12	Teacher	Cappuccino	Grande	CreditCard	\$ 60.90
42	17	Student	Coffee	Large	CreditCard	\$ 36.62

43	20	Military	Slushy	Small	Cash	\$ 21.24
44	20	None	Tea	Large	CreditCard	\$ 29.80
45	50	None	Slushy	Regular	Cash	\$ 71.85
46	50	Coupon	Tea	Small	DebitCard	\$ 48.23
47	7	None	Cappuccino	Grande	DebitCard	\$ 36.31
48	1	Frequent	Slushy	Small	DebitCard	\$ 1.03
49	12	Coupon	Coffee	Large	DebitCard	\$ 25.09
50	17	Teacher	Tea	Small	DebitCard	\$ 17.31
51	31	Military	Coffee	Regular	CreditCard	\$ 53.72
52	50	Employee	Coffee	Large	CreditCard	\$ 89.75
53	1	Coupon	Soda	Grande	CreditCard	\$ 2.39
54	4	Employee	Soda	Small	Cash	\$ 4.06
55	7	Frequent	Coffee	Small	Cash	\$ 9.35
56	20	Student	Soda	Regular	DebitCard	\$ 28.91
57	20	Teacher	Slushy	Regular	CreditCard	\$ 28.99
58	31	None	Cappuccino	Large	Cash	\$ 113.81

B3)

a) $a'b'c + bc + bd + ac'$

cd \ ab	00	01	11	10
00			1	1
01		1		1
11	1	1	1	
10	1	1	1	

$a'c + bc + bd + ac'$

b) $a'b'c'd' + a'b'cd + a'b + ac'd' + acd$

cd \ ab	00	01	11	10
00	1	1	1	1
01		1		
11	1	1	1	1
10		1		

$e'd' + a'b + cd$

c) $a'b'c' + a'bd + a'bc' + abd + acd' + acd' + ab'cd$

cd \ ab	00	01	11	10
00	1	1		
01	1	1	1	
11		1	1	1
10			1	1

$a'c' + bd + ac$

d) $a'b'c' + a'b'd + c'd' + ac' + c'd + ab'cd$

		ab			
		00	01	11	10
cd	00	1	1	1	1
	01	1	1	1	1
	11	1			1
	10				

$c' + b'd$

e) $a'c' + abd + a'c + ac$

		ab			
		00	01	11	10
cd	00	1	1		
	01	1	1	1	
	11	1	1	1	1
	10	1	1	1	1

$a' + bd + c$

4)

a) $a'b'+c'$

Condition			Decision
a	b	c	$a'b'+c'$
F	F	F	T
F	F	T	T
F	T	F	T
F	T	T	F
T	F	F	T
T	F	T	F
T	T	F	T
T	T	T	F

C/D pair: (FFF, TTT)

C pair: (FFT, TTF)

D pair: (FFF, FTT)

TOF: $a'b'$, c'

TNF: $a+b+c'$, $a'b'+c$

b) $a'(b'+c) \rightarrow a'b' + a'c$

Condition			Decision
a	b	c	$a'b'+a'c$
F	F	F	T
F	F	T	T
F	T	F	F
F	T	T	T
T	F	F	F
T	F	T	F
T	T	F	F
T	T	T	F

C/D pair: (FFF, TTT)

C pair: (FTF, TFT)

D pair: (FFF, TFF)

TOF: $a'b'$, $a'c$

TNF: $a+b+a'c$, $a'b'+a+c'$

c) $abc + c'd' + a'b'$

Condition				Decision
a	b	c	d	$a'b' + c'$
F	F	F	F	T
F	F	F	T	T
F	F	T	F	T
F	F	T	T	T
F	T	F	F	T
F	T	F	T	F
F	T	T	F	F
F	T	T	T	F
T	F	F	F	T
T	F	F	T	F
T	F	T	F	F
T	F	T	T	F
T	T	F	F	T
T	T	F	T	F
T	T	T	F	T
T	T	T	T	T

C/D pair: (FFTF, TTFT)

C pair: (FFFF, TTTT)

D pair: (FTFF, FTFT)

TOF: $c'd + a'b'$, $abc + a'b'$, $abc + c'd'$

TNF: $a' + b' + c' + c'd' + a'b'$,

$abc + c + d + a'b'$,

$abc + c'd' + a + b$

d) $(a'b'c' \text{ XOR } (a'b'))' + abcd \rightarrow a + b'c$

	Condition		Decision
a	b	c	$a + b'c$
F	F	F	F
F	F	T	T
F	T	F	F
F	T	T	F
T	F	F	T
T	F	T	T
T	T	F	T
T	T	T	T

C/D pair: (FFF, TTT)

C pair: (FFT, TTF)

D pair: (FFT, FTF)

TOF: a, $b'c$

TNF: $a' + b'c$, $a + b + c'$

Q6)

i) a) $a = (b \geq 10) + c$
 $a = d + c$

CO1 $d \rightarrow$ c false
 $XF \rightarrow TF$
 FF

CO1 $c \rightarrow$ d false
 $Fx \rightarrow FT$
 FF

d	c	d+c
T	F	T
F	F	F
F	T	T

$b \geq 10$

T = 10

F = 9

$b < 10$

T = 9

F = 10

Test Case	Input		Output
	b	c	
1	9	F	T
2	10	F	F
3	10	T	T

b) $a = b \parallel (c \geq 5)$

$b + d$

CD1 $b \rightarrow$ XF = TF
FF

CD1 $d \rightarrow$ FX = FT
FF

b	d	b+d
T	F	T
F	F	F
F	T	T

$c \geq 5$

$T = 5$

$F = 4$

Test Case	Inputs		Output
	b	c (ini)	a
1	T	F (4)	T
2	F	F (4)	F
3	F	T (5)	T

c)

$$a = (b <= 5) \wedge (c >= 8)$$

$$d = b <= 5$$

$$e = c >= 8$$

$$a = d$$

$$a = e$$

↓

↓

XF

TX

TT

TT

FT

TF

d	e	d & e
T	T	T
F	T	F
T	F	F

$$d = (b <= 5)$$

$$e = (c >= 8)$$

$$T = 5$$

$$T = 8$$

$$F = 6$$

$$F = 7$$

Test case	Inputs		Output
	b(int)	c(int)	a
1	5	8	T
2	6	7	F
3	5	7	F

d) $a = (b > 5) \& (b \leq 15)$

Test case	Input	Output
	b	a
1	5	F
2	15	T
3	16	F
4	6	T

Q5)

2) a) $a'b' + c'$

$$\begin{aligned} \text{CDI} &= a = \text{XFT} = \text{FFT}, \text{TFT} \\ b &= \text{FXT} = \text{FFT}, \text{FTT} \\ c &= \text{TFX}, \text{FTX}, \text{ITX} \end{aligned}$$

$$VC = \{ \text{TFT}, \text{FTT}, \text{FFT}, \text{TFF} \}$$

b) $a'(b' + c) = ab' + a'c$

$$\begin{aligned} \text{CDI} &= a = \text{XFF}, \text{XT} \\ b &= \text{FXT}, \text{FFT}, \text{FTT} \\ c &= \text{FTX}, \text{FTF}, \text{FTT} \end{aligned}$$

$$VC = \{ \text{FFT}, \text{FTF}, \text{FTT}, \text{FFF} \}$$

c) $a + b' + c'd$

$$\begin{aligned} \text{CDI} &a = \text{XTTT}, \text{XTFT}, \text{XTTF} \\ b &= \text{FXTT}, \text{FXFT}, \text{FXTF} \\ c &= \text{FTXF}, \text{FTFF}, \text{FTTF} \\ d &= \text{FTFX}, \text{FTFF}, \text{FTFT} \end{aligned}$$

$$VC = \{ \text{FTFF}, \text{FTTF}, \text{FTFT}, \text{TTF}, \text{FFFT} \}$$

d) $(a'b'c' \text{ XOR } (a'b)') + abcd$
 $: a + b'c$

CDI: a: XTT, XTF, XFF
 b: FXF \rightarrow FTF, FFF
 c: FTX, FTF, FTT

UC: FTF, FFF, FTT, TTT

5

3

$a'b'c + d$

CDI: a: XTFF, XFFF, XTTF
 b: TXTF \rightarrow TTTF, TTTF
 c: TFXF, TFTF, TFFF
 d: TTFX, TTFX, TTTX

UC1: TTFE, TFFE, TTFE, TFFE, TFFT

UC2: TTFE, TFFE, TTFE, TTFE, TFFT, TFFT

M: TTFE, TFFE, TTFE, TTFE, TFFT, TFFT