Digital System Design

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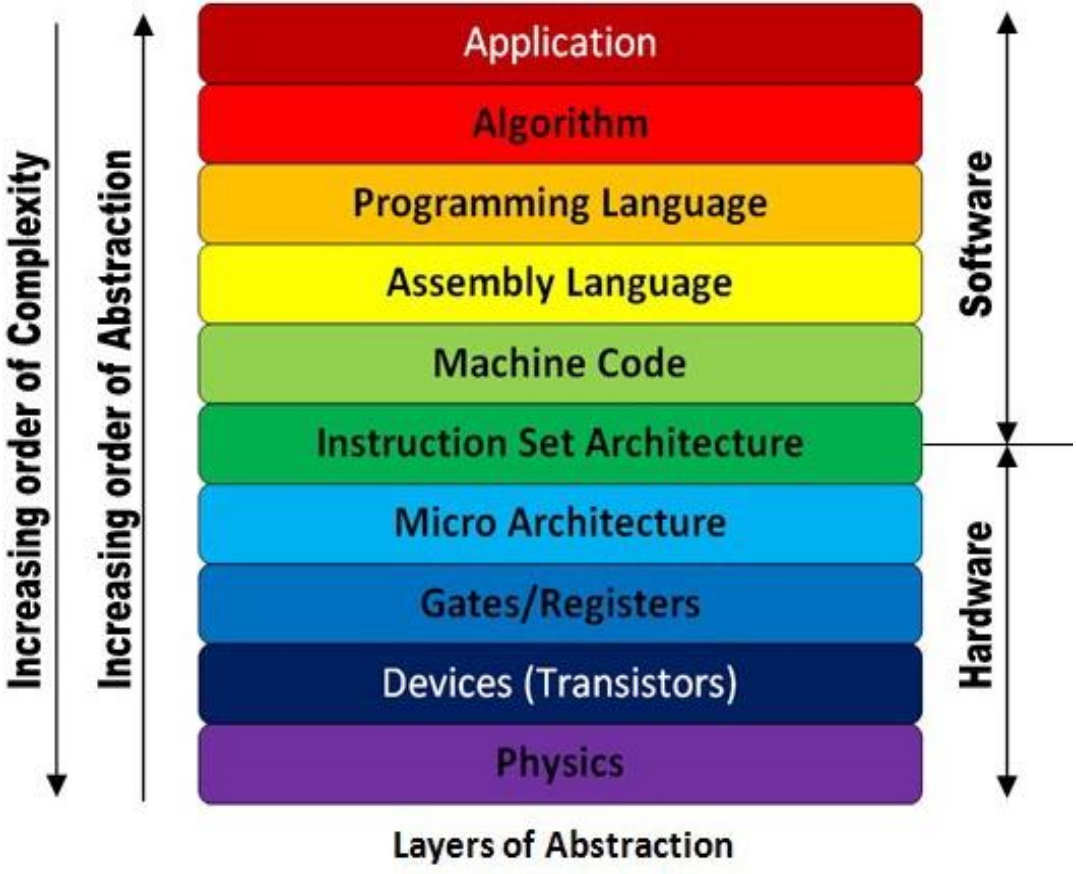
Abstraction Levels

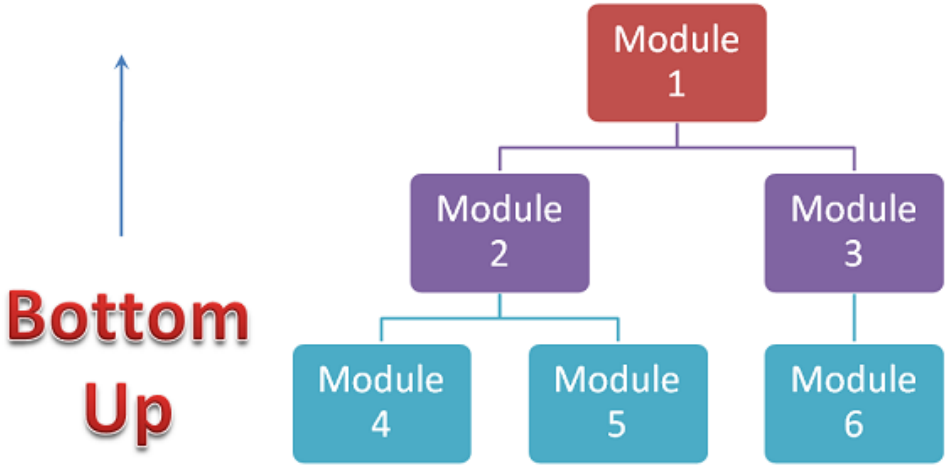
- To comprehend these complicated systems

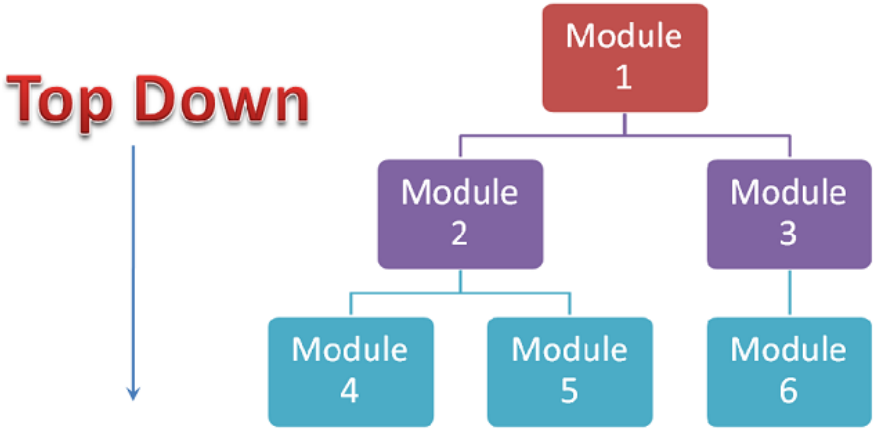


Design Approaches

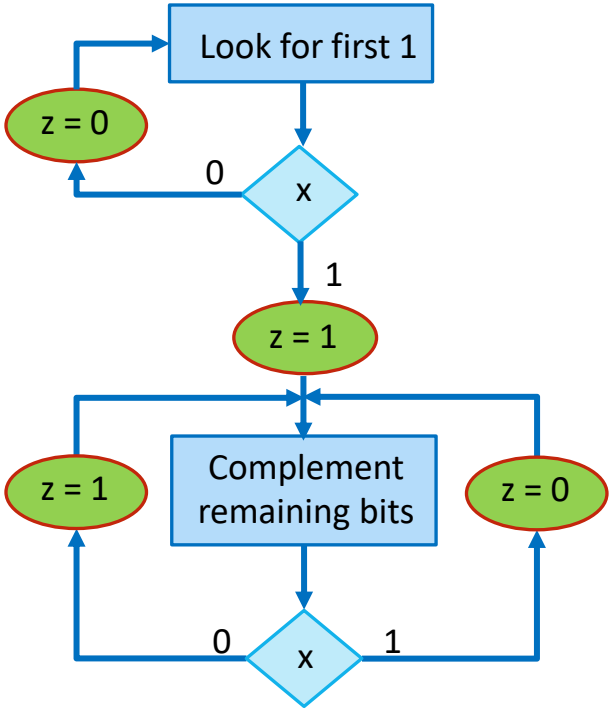
- Piecing together of systems to give rise to more complex systems

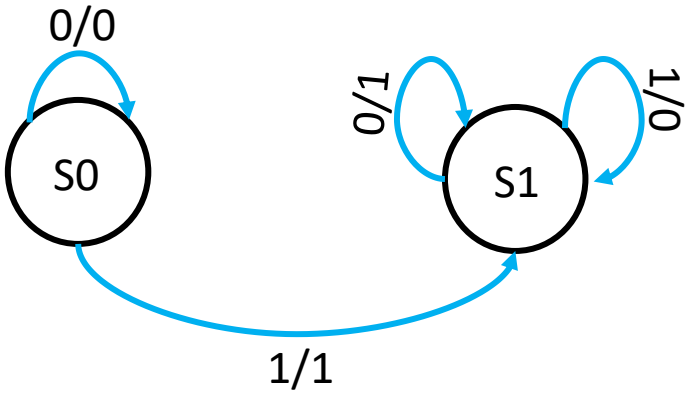
- More optimized
- More realistic





Modeling


Look for first 1
z = 0
0
x
1
z = 1
z = 1
Complement
remaining bits
z = 0
0
x
1


0/0
S0
0/1
S1
1/0
1/1

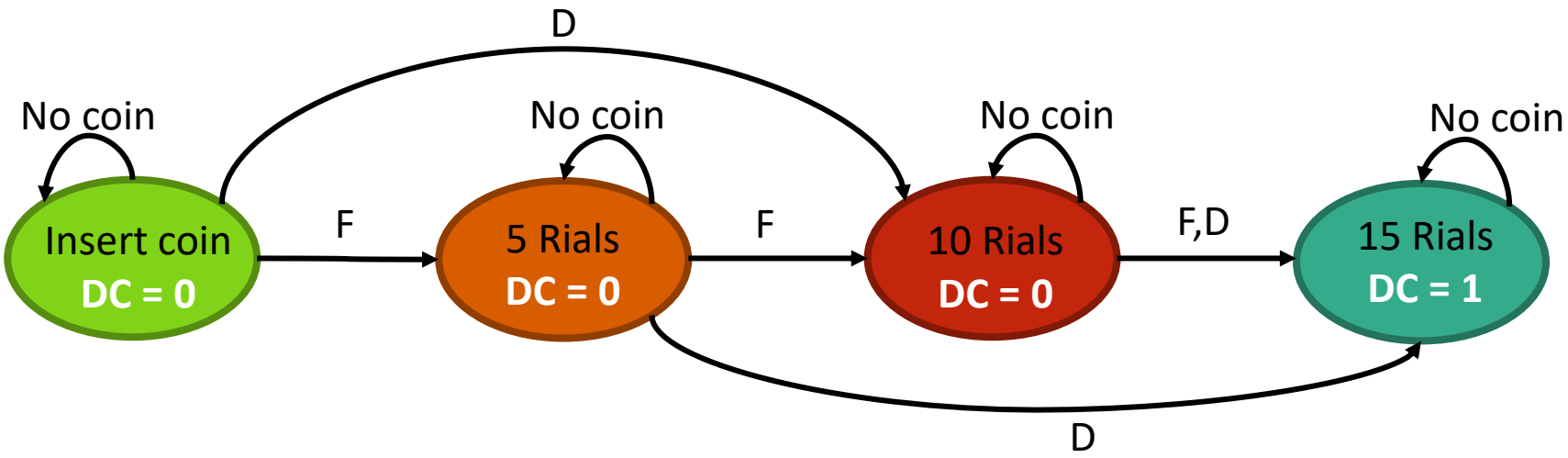
Outline

- Samples

Vendor Realization

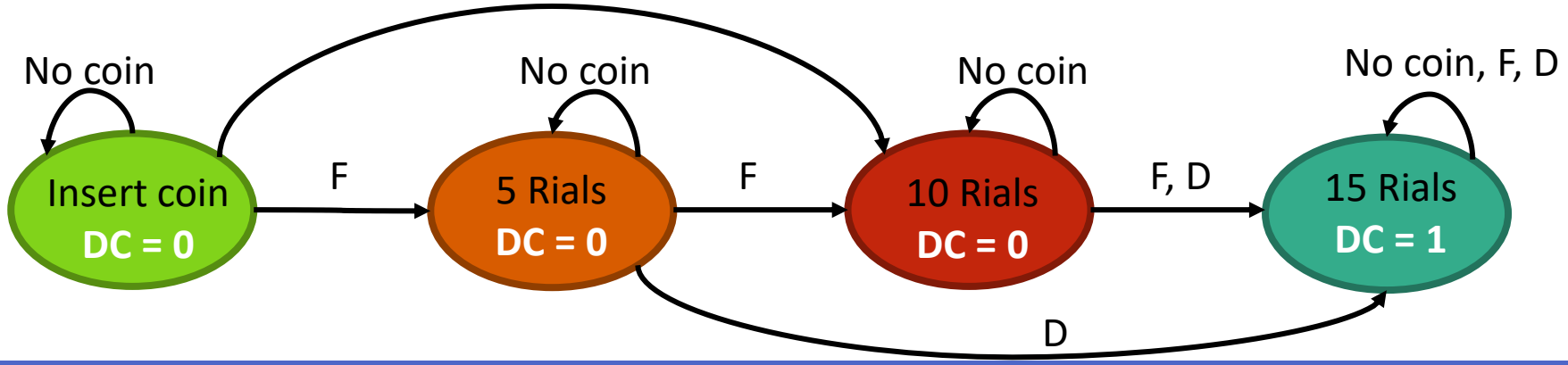
Vending Machine: FSM

- **Insert coin**
  - Default state
  - No money has been inserted
- **5 Rials**
  - A 5 Rial coin has been inserted
- **10 Rials**
  - A 10 Rial coin has been inserted
- **15 Rials**
  - Total money has been reached to 15 Rial
  - Done!



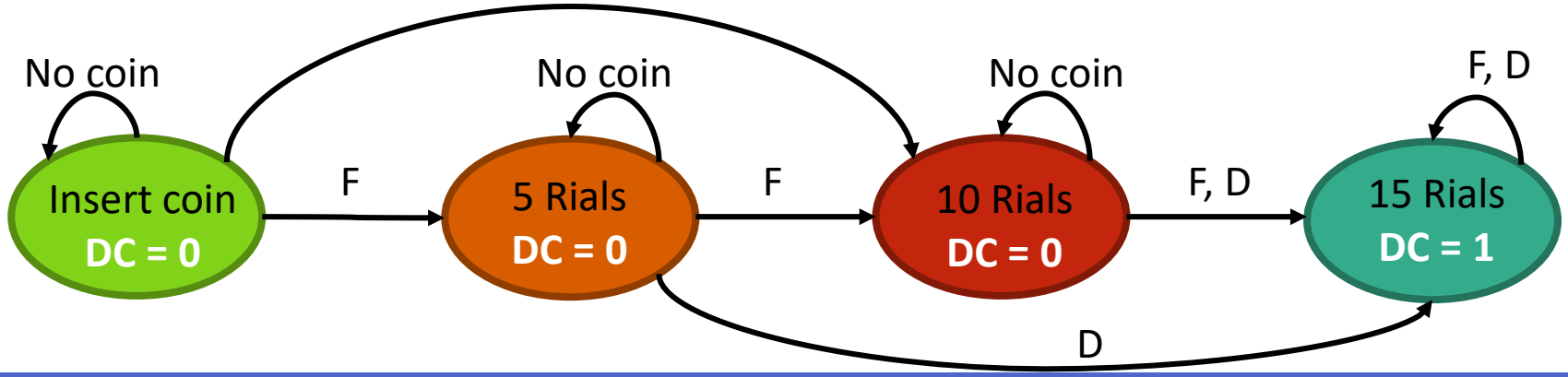
Vending Machine: Excitation Table

State Inputs		Insert coin	5 Rial	10 Rial	15 Rial
D	**F**	**Next State/ Output**	**Next State/ Output**	**Next State/ Output**	**Next State/ Output**
0	0	Insert coin/ DC=0	5 Rial/ DC=0	10 Rial/ DC=0	15 Rial/ DC=1
0	1	5 Rial/ DC=0	10 Rial/ DC=0	15 Rial/ DC=0	15 Rial/ DC=1
1	0	10 Rial/ DC=0	15 Rial/ DC=0	15 Rial/ DC=0	15 Rial/ DC=1
1	1				



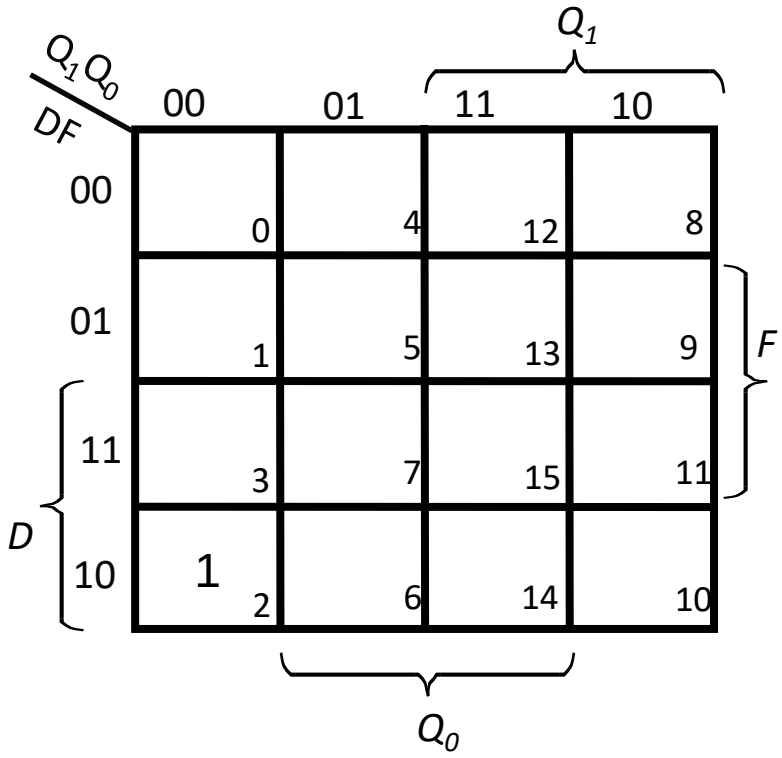
Vending Machine: Coded Excitation Table

State / Inputs		0 0	0 1	1 0	1 1
D	**F**	**Next State/ Output**	**Next State/ Output**	**Next State/ Output**	**Next State/ Output**
0	0	0 0/ 0	0 1 / 0	10 / 0	1 1 / 1
0	1	0 1/0	1 0 / 0	1 1 / 0	1 1 / 1
1	0	1 0/ 0	1 1 / 0	15 / 0	1 1 / 1
1	1				



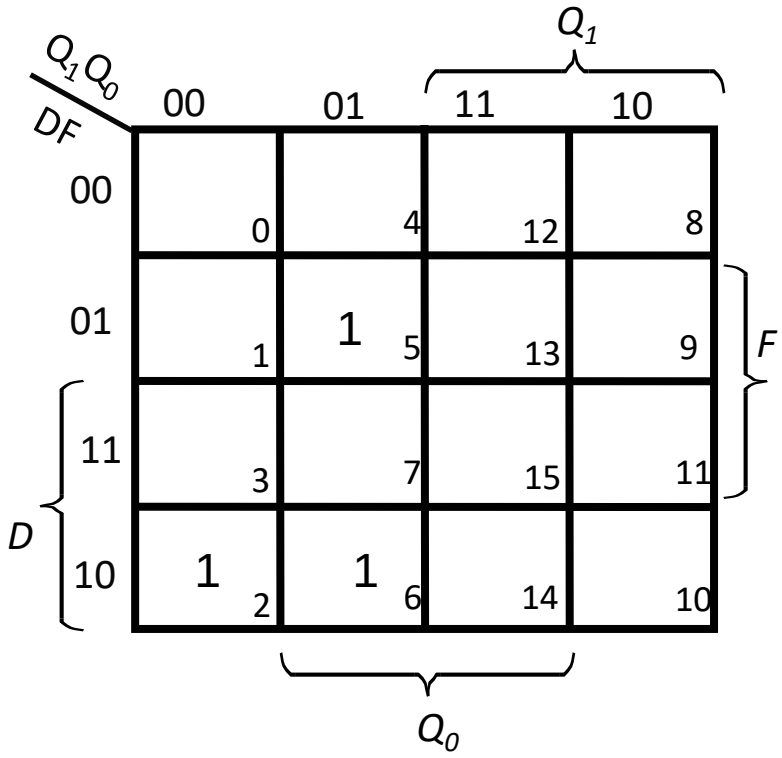
Vending Machine: D1

Inputs		State (Q_0Q_1)			
		0 0	**0 1**	**1 0**	**1 1**
D	**F**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**
0	0	00/ 0	01 / 0	10 / 0	11 / 1
0	1	01/0	10 / 0	11 / 0	11 / 1
1	0	10/ 0	11 / 0	11 / 0	11 / 1
1	1				



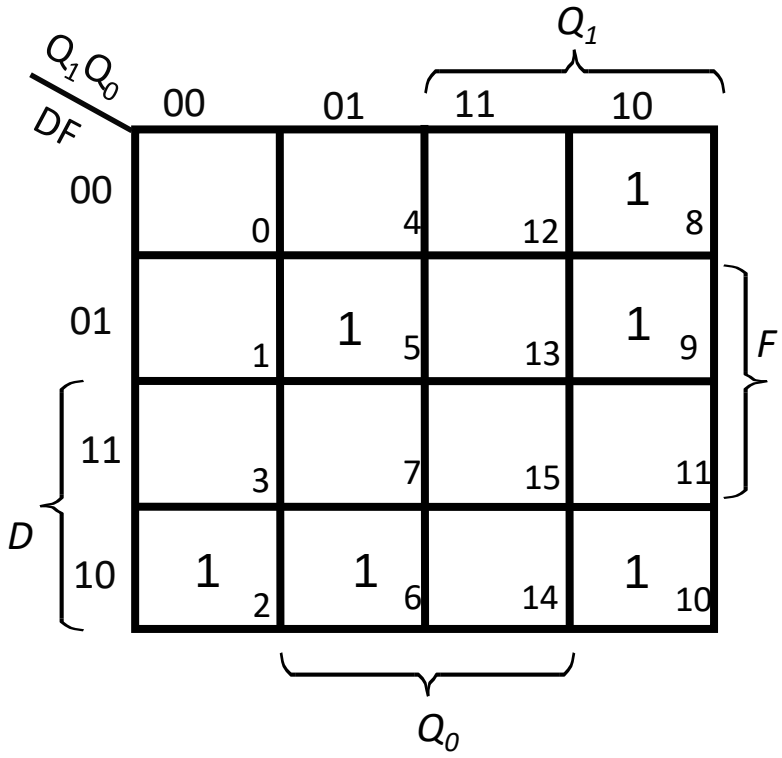
Vending Machine: D1

Inputs		State (Q_0Q_1)			
		0 0	**0 1**	**1 0**	**1 1**
D	**F**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**
0	0	00/ 0	01 / 0	10 / 0	11 / 1
0	1	01/0	10 / 0	11 / 0	11 / 1
1	0	10/ 0	11 / 0	11 / 0	11 / 1
1	1				



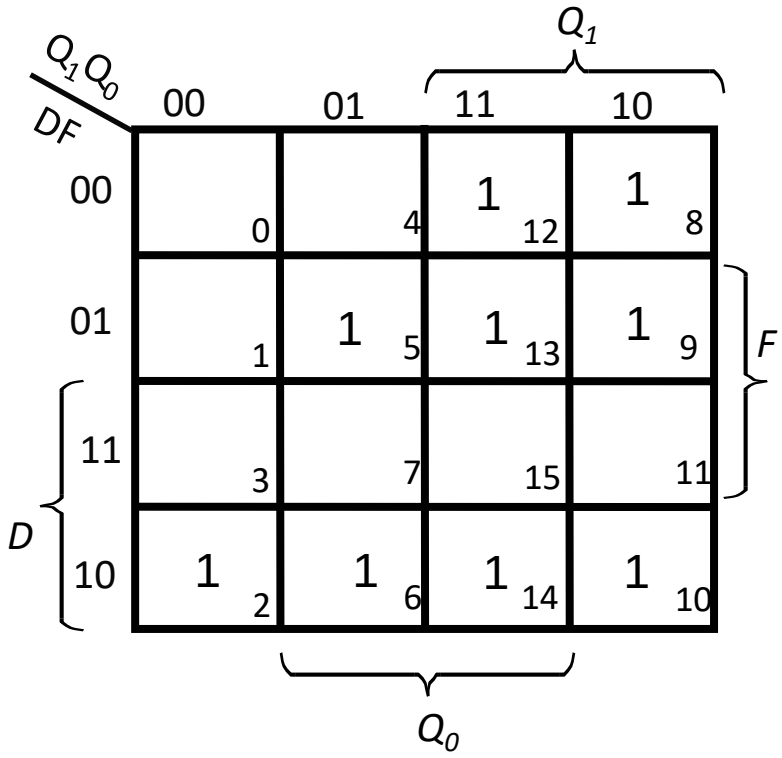
Vending Machine: D1

Inputs		State (Q_0Q_1)			
		0 0	**0 1**	**1 0**	**1 1**
D	**F**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**
0	0	00/ 0	01 / 0	10 / 0	11 / 1
0	1	01/0	10 / 0	11 / 0	11 / 1
1	0	10/ 0	11 / 0	11 / 0	11 / 1
1	1				



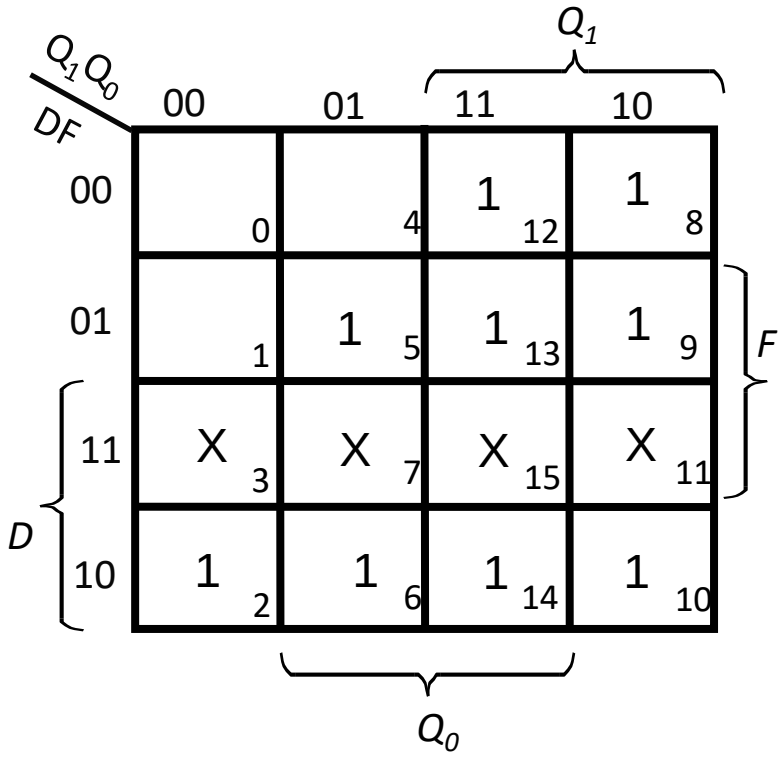
Vending Machine: D1

Inputs		State (Q_0Q_1)			
		0 0	**0 1**	**1 0**	**1 1**
D	**F**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**
0	0	00/ 0	01 / 0	10 / 0	11 / 1
0	1	01/0	10 / 0	11 / 0	11 / 1
1	0	10/ 0	11 / 0	11 / 0	11 / 1
1	1				



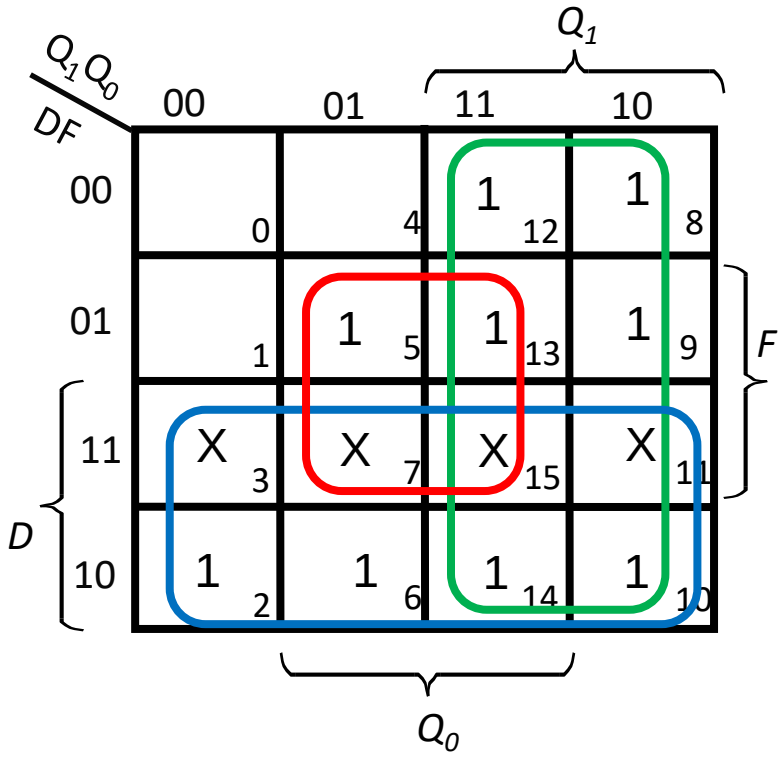
Vending Machine: D1

Inputs		State (Q_0Q_1)			
		0 0	**0 1**	**1 0**	**1 1**
D	**F**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**
0	0	00/ 0	01 / 0	10 / 0	11 / 1
0	1	01/0	10 / 0	11 / 0	11 / 1
1	0	10/ 0	11 / 0	11 / 0	11 / 1
1	1				



Vending Machine: D1

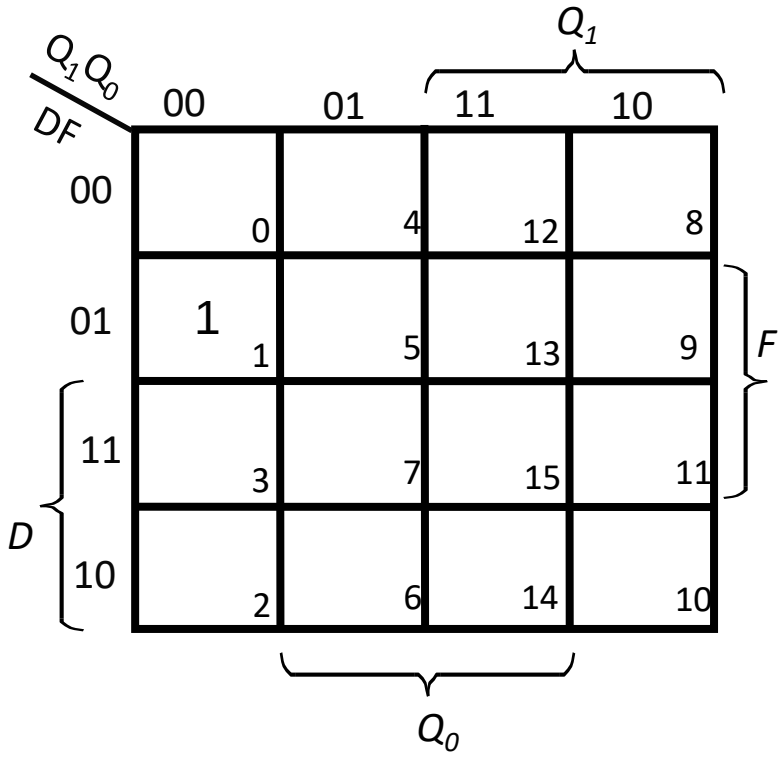
Inputs		State (Q_0Q_1)			
		0 0	**0 1**	**1 0**	**1 1**
D	**F**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**
0	0	00/ 0	01 / 0	10 / 0	11 / 1
0	1	01/0	10 / 0	11 / 0	11 / 1
1	0	10/ 0	11 / 0	11 / 0	11 / 1
1	1				



$$D_1 = Q_1 + D + Q_0F$$

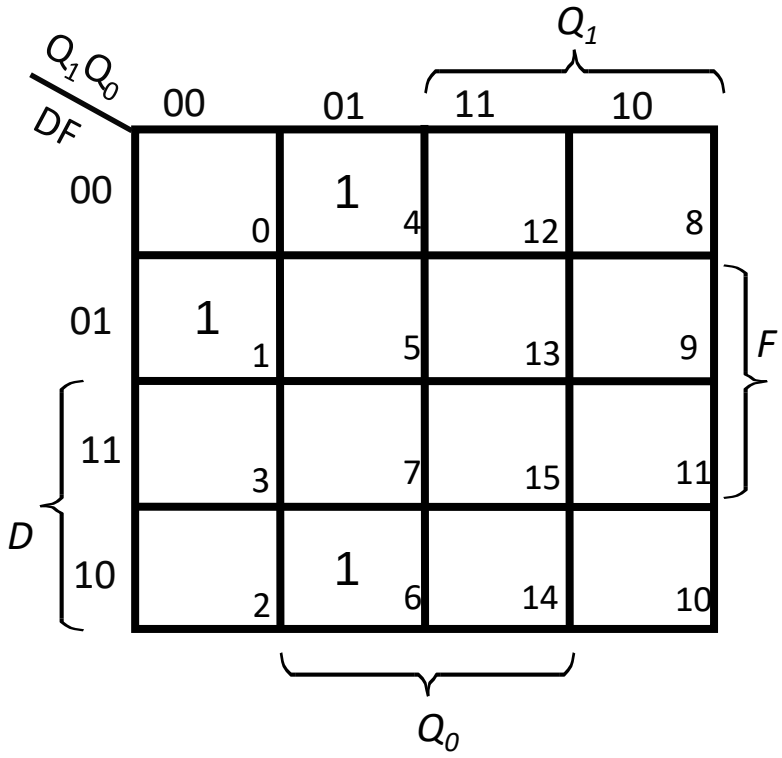
Vending Machine: D0

Inputs		State (Q_0Q_1)			
		0 0	**0 1**	**1 0**	**1 1**
D	**F**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**
0	0	00/ 0	01 / 0	10 / 0	11 / 1
0	1	01/0	10 / 0	11 / 0	11 / 1
1	0	10/ 0	11 / 0	11 / 0	11 / 1
1	1				



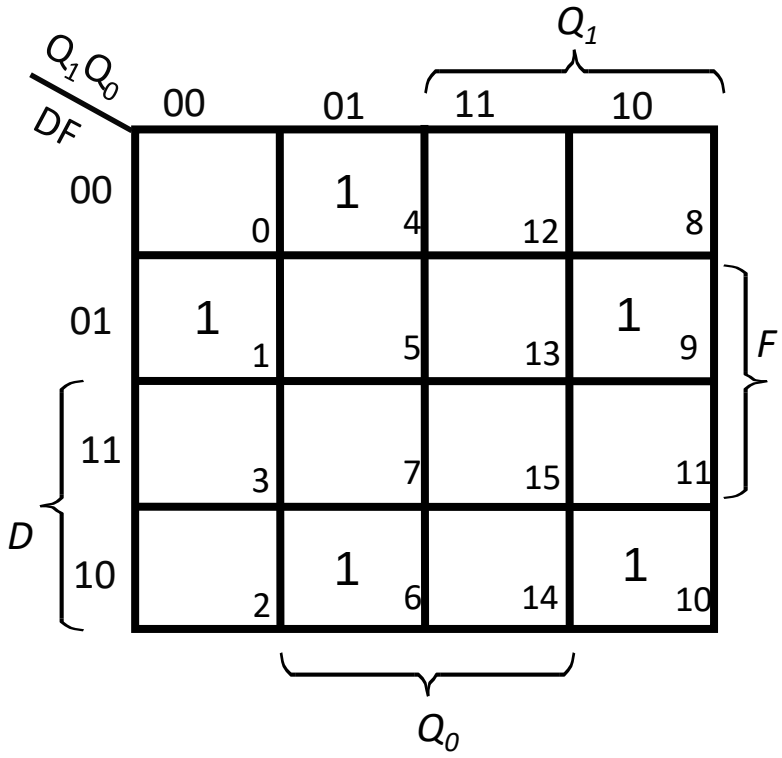
Vending Machine: D0

Inputs		State (Q_0Q_1)			
		0 0	**0 1**	**1 0**	**1 1**
D	**F**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**
0	0	00/ 0	01 / 0	10 / 0	11 / 1
0	1	01/0	10 / 0	11 / 0	11 / 1
1	0	10/ 0	11 / 0	11 / 0	11 / 1
1	1				



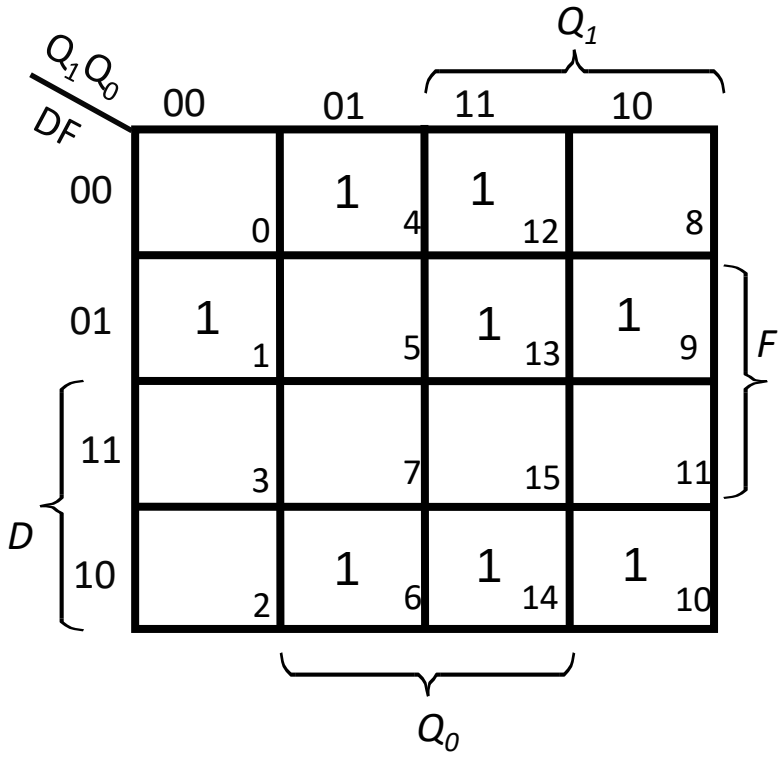
Vending Machine: D0

Inputs		State (Q_0Q_1)			
		0 0	**0 1**	**1 0**	**1 1**
D	**F**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**
0	0	00/ 0	01 / 0	10 / 0	11 / 1
0	1	01/0	10 / 0	11 / 0	11 / 1
1	0	10/ 0	11 / 0	11 / 0	11 / 1
1	1				



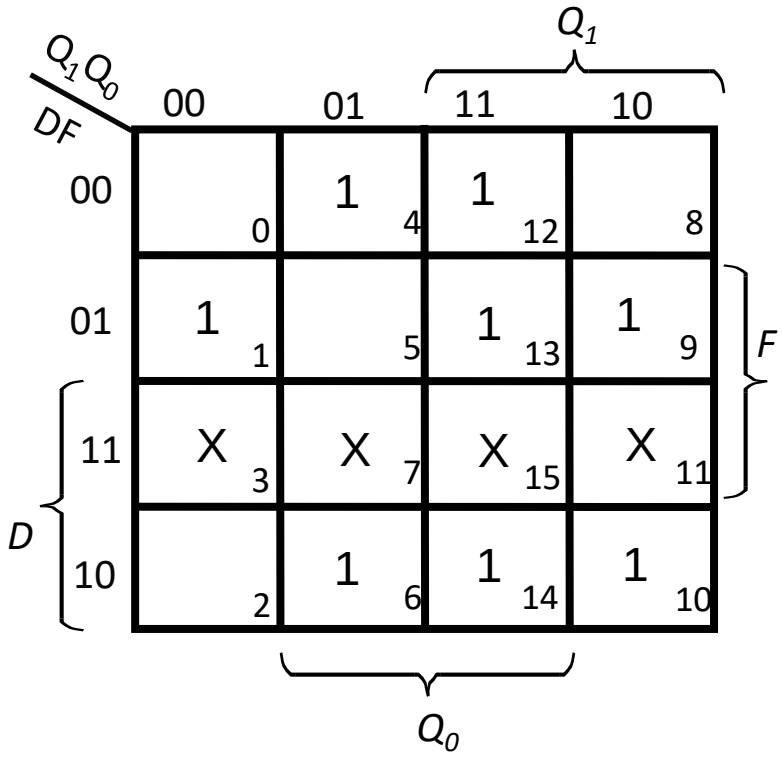
Vending Machine: D0

Inputs		State (Q_0Q_1)			
		0 0	**0 1**	**1 0**	**1 1**
D	**F**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**
0	0	00/ 0	01 / 0	10 / 0	11 / 1
0	1	01/0	10 / 0	11 / 0	11 / 1
1	0	10/ 0	11 / 0	11 / 0	11 / 1
1	1				



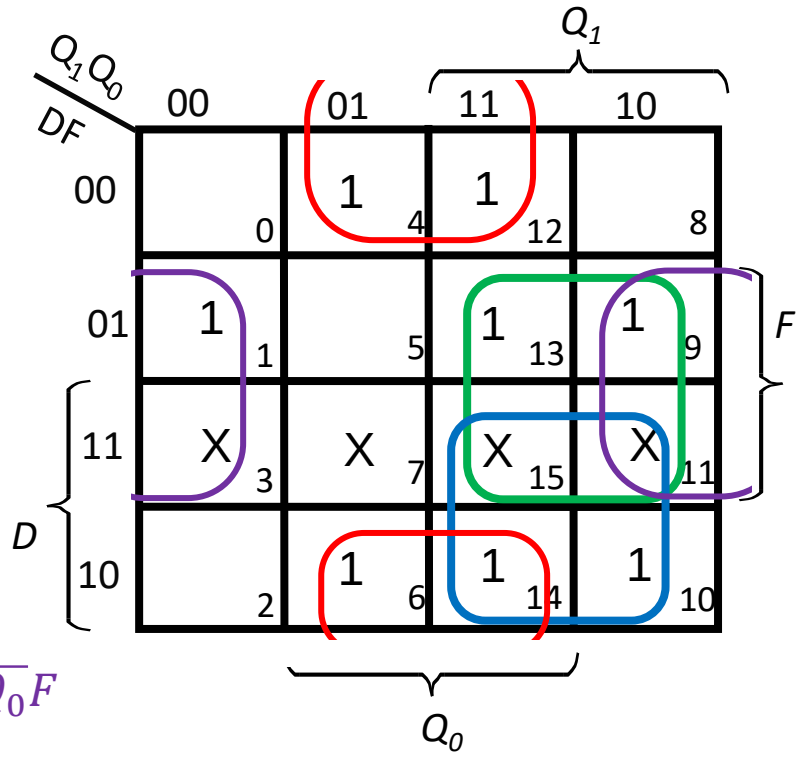
Vending Machine: D0

Inputs		State (Q_0Q_1)			
		0 0	**0 1**	**1 0**	**1 1**
D	**F**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**	**Q_1Q_0/ Out**
0	0	00/ 0	01 / 0	10 / 0	11 / 1
0	1	01/0	10 / 0	11 / 0	11 / 1
1	0	10/ 0	11 / 0	11 / 0	11 / 1
1	1				



Vending Machine: D0

Inputs		State (Q_0Q_1)			
		0 0	0 1	1 0	1 1
D	F	Q_1Q_0/ Out	Q_1Q_0/ Out	Q_1Q_0/ Out	Q_1Q_0/ Out
0	0	00/ 0	01 / 0	10 / 0	11 / 1
0	1	01/0	10 / 0	11 / 0	11 / 1
1	0	10/ 0	11 / 0	11 / 0	11 / 1
1	1				

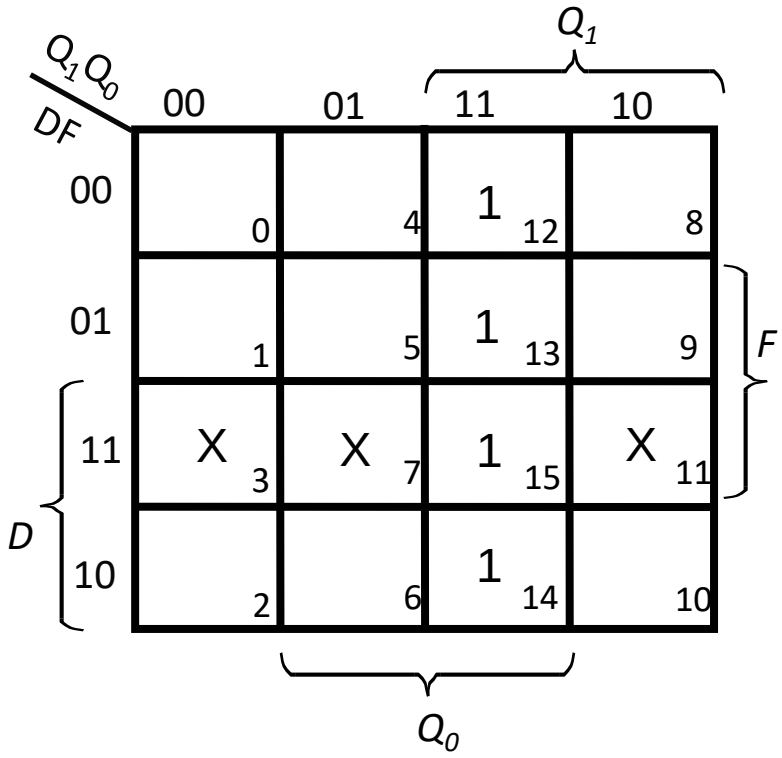


$$D_0 = Q_1F + Q_1D + Q_0\overline{F} + \overline{Q_0}F$$

Vending Machine: DC

Inputs		State (Q_0Q_1)			
		0 0	0 1	1 0	1 1
D	F	Q_1Q_0/ Out	Q_1Q_0/ Out	Q_1Q_0/ Out	Q_1Q_0/ Out
0	0	00/ 0	01 / 0	10 / 0	11 / 1
0	1	01/0	10 / 0	11 / 0	11 / 1
1	0	10/ 0	11 / 0	11 / 0	11 / 1
1	1				

$$Open = Q_1Q_0$$

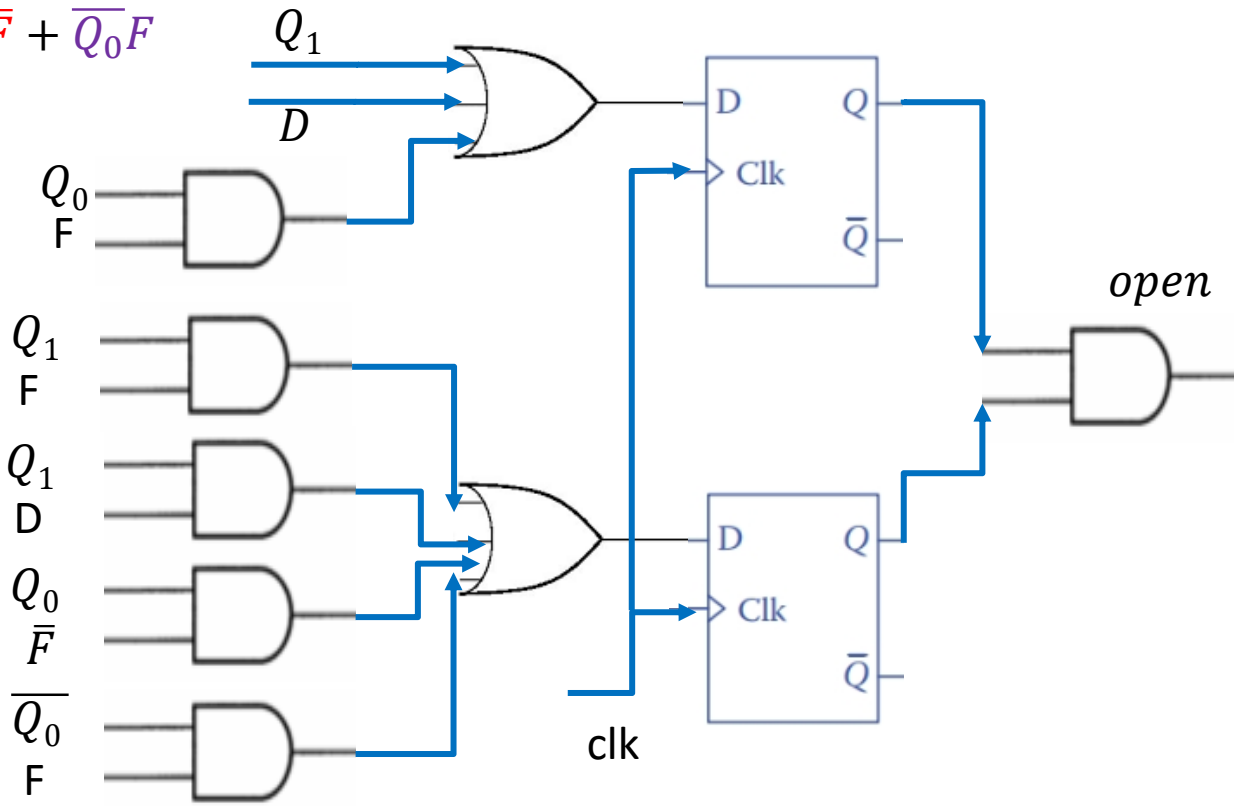


Vending Machine: DC

$D_1 = Q_1 + D + Q_0F$

$D_0 = Q_1F + Q_1D + Q_0\bar{F} + \overline{Q_0}F$

$Open = Q_1Q_0$



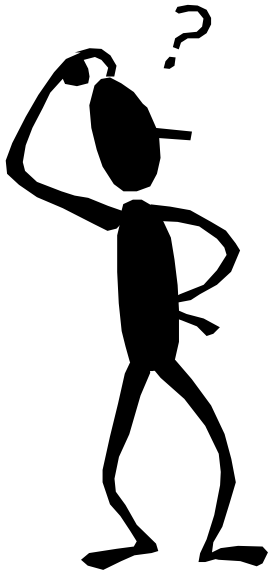
Check Yourself ☺

Vending Machine

- The computer department need a new soda machine.
- Please define a controller for new vending machine.
- Characteristics
  - All selections cost 30 cent
  - Machine returns changes!
- Input
  - Q: quarter inserted (25 cent)
  - D: dim inserted (10 cent)
  - N: nickle inserted (5 cent)
- Output
  - DC: dispense can

Chess Match Timer

- We wants to measure how much time each chess player thinks to select next movies in a chess match and show the thinking time of each player at the end of the match.
- We have a limited money budget and can afford only the cost of one timer for both players!
- Upload by Sunday 1399/1/17



Thank You