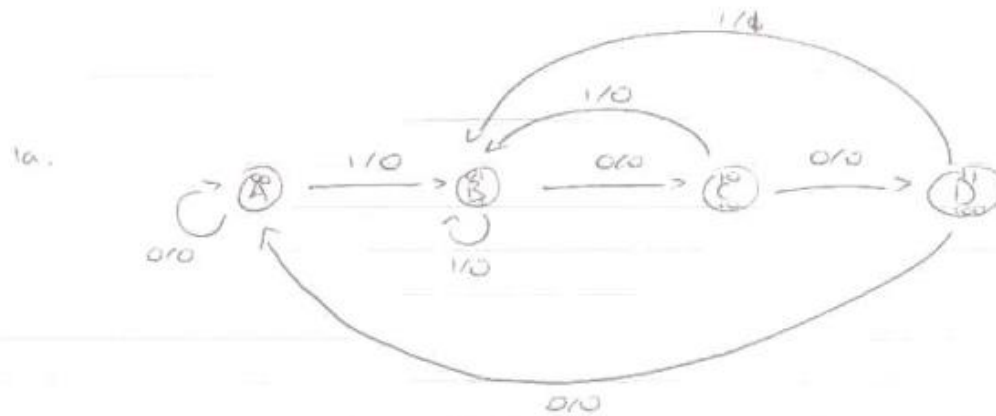


Homework 2 - Solutions

Q1.



1b.

	Present State	I_{A1}	Next State	FF	Q_1	Q_0	Z
	$Q_1 Q_0$	x	$Q_1' Q_0'$	$J K_1 J_0 K_0$			
A	00	0	00	0 x 0 x	0	0	0
	00	1	01	0 x 1 x	0	0	1
B	01	0	10	1 x x 1	0	1	0
	01	1	01	0 x x 0	0	1	1
C	10	0	11	x 0 1 x	0	x	0
	10	1	01	x 1 1 x	0	x	1
D	11	0	00	x 1 x 1	0	0	0
	11	1	01	x 1 x 0	1	0	1

1c. Simplification (K-Maps)

J_1

Q_0	00	01	11	10
x	0	0	1	0
0	0	1	0	x
1	0	0	x	x

$\therefore J_1 = Q_0 \bar{x}$

J_0

Q_0	00	01	11	10
x	0	0	x	1
0	0	x	x	1
1	0	x	x	1

$\therefore J_0 = Q_1 + x$

K_1

Q_0	00	01	11	10
x	0	0	1	0
0	0	x	0	0
1	0	x	1	1

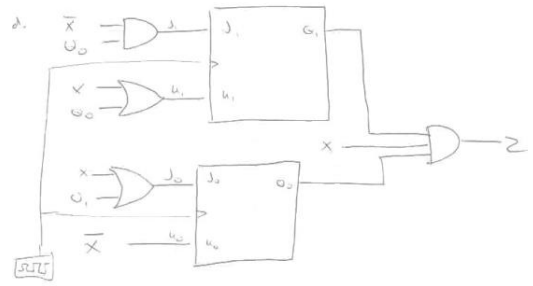
$\therefore K_1 = x + Q_0$

K_0

Q_0	00	01	11	10
x	0	0	1	0
0	0	x	1	x
1	0	x	0	x

$\therefore K_0 = \bar{x}$

$\therefore Z = Q_1 Q_0 x$



Q2.

(1) Assume:

input: X ; output: Y

state variables:

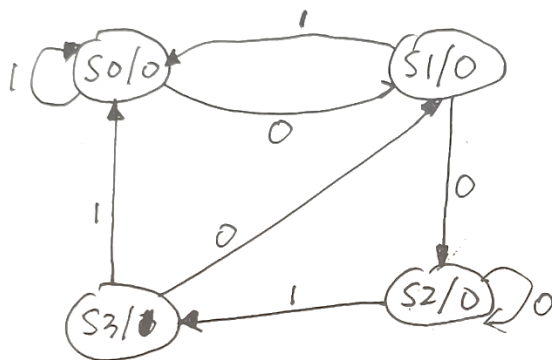
S_0 : no valid input; $Y=0$

S_1 : "0" was detected; $Y=0$

S_2 : "00" was detected; $Y=0$

S_3 : "001" was detected; $Y=1$

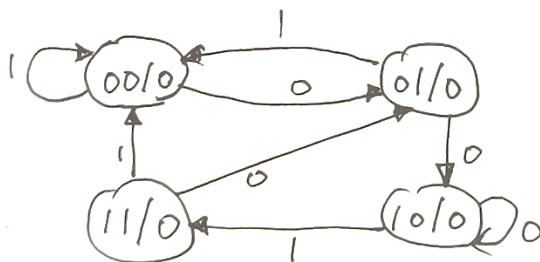
(2) state diagram:



minimized states

There are 4 states totally, so the number of bits for FF is $n=2$,

Assign: $S_0=00$, $S_1=01$, $S_2=10$, $S_3=11$



(3)

		$(Q_1^{n+1} Q_0^{n+1})$			
X	$Q_1^n Q_0^n$	00	01	11	10
	0	01	10	01	10
	1	00	00	00	11

		(Q_1^{n+1})			
X	$Q_1^n Q_0^n$	00	01	11	10
	0	0	1	0	1
	1	0	0	0	1

		(Q_0^{n+1})			
X	$Q_1^n Q_0^n$	00	01	11	10
	0	1	0	1	0
	1	0	0	0	1

$$\begin{cases} Q_1^{n+1} = Q_1^n \bar{Q}_0^n + \bar{X} \bar{Q}_1^n Q_0^n \\ Q_0^{n+1} = X Q_1^n \bar{Q}_0^n + \bar{X} (Q_1^n \odot Q_0^n) \end{cases}$$

The simplified state equations.

choose D-FF: $Q^{n+1} = D$

We can derive the excitation equations:

$$\begin{cases} D_1 = Q_1^n \bar{Q}_0^n + \bar{X} \bar{Q}_1^n Q_0^n \\ D_0 = X Q_1^n \bar{Q}_0^n + \bar{X} (Q_1^n \odot Q_0^n) \end{cases}$$

output equations:

$$Y = Q_1^n Q_0^n$$

(4)

(5) There is on invalid state for the circuit, so it can startup automatically.

Q3.

```
int cnt = 0;           // global variable for counting falling edge

ISR(PCINT0_vect)
{
    static int previous = 0b00000000;
    int current;

    current = PINB & 0b00000001;
    if(current == 0b00000000 && previous == 0b00000001); //falling edge
    {
        cnt ++;           // count interrupts
    }
    previous = current;
}
```