Hardware Lab

Name: Sujan Biswas
Roll No: 30201050003
Course: BCSE (Lateral)

(Q) Design a clock in the format HH:MM:SS (Hour: Minute: seconds)

There are several several existing clocks in this world: analog and digital, which one may wonder what other uses the clock may have. A digital clock is a type of clock that displays the time digitally. Instead of the rotary mechanism of electromechanical clock, it uses digital counters that count second minute and hours. Each sixty seconds make a minute and each sixty minutes an hour. After twenty four hours the clock resets and starts from initial condition. The functional unit of a digital clock is a counter that represents a second, minute or hour block for designing the clock we use the JK flipflop. For represent second and minute i.e. for counting from 0 to 59, we use the mod 10 and mod 6 counter and for representing the hours ie for counting 0 to 23, we use mod 24 counter. The mod 6 counter counting from 0 to 5 and the mod 10 counter is counting from 0 to 9. A clear button is also used for reset the counter. To represent the clock or for displaying the clock we use a LED display, which is already designed by 7 segment display.

JK Flip Flop Transition Table:

Q_N	Q_{N+1}	J	K
0	0	0	X
0	1	1	X
1	1	X	0
1	0	X	1

	Initial state				Final state				Input Given			
S	Q_4	Q_3	Q_2	Q_1	Q_4^+	Q_3^+	Q_2^+	Q_1^+	x_1	x_2	x_3	x_4
0	0	0	0	0	0	0	0	1	1	0	0	0
0	0	0	0	1	0	0	1	0	1	1	0	0
0	0	0	1	0	0	0	1	1	1	0	0	0
0	0	0	1	1	0	1	0	0	1	1	1	0
0	0	1	0	0	0	1	0	1	1	0	0	0
0	0	1	0	1	0	1	1	0	1	1	0	0
0	0	1	1	0	0	1	1	1	1	0	0	0
0	0	1	1	1	1	0	0	0	1	1	0	1
0	1	0	0	0	1	0	0	1	1	0	0	0
0	1	0	0	1	0	0	0	0	1	1	0	1
1	0	0	0	0	1	0	0	1	1	0	0	1
1	0	0	0	1	0	0	0	0	1	1	0	0
1	0	0	1	0	0	0	0	1	1	0	1	0
1	0	0	1	1	0	0	1	0	1	1	0	0
1	0	1	0	0	0	0	1	1	1	0	1	0
1	0	1	0	1	0	1	0	0	1	1	0	0
1	0	1	1	0	0	1	0	1	1	0	1	0
1	0	1	1	1	0	1	1	0	1	1	0	0
1	1	0	0	0	0	1	1	1	1	0	1	0
1	1	0	0	1	1	0	0	0	1	1	0	0

Kmaps

For S = 0;

q_2	$\bar{Q}_2\bar{Q}_1$	$\bar{Q}_2Q_1$	Q_2Q_1	$Q_2\bar{Q}_1$
$\bar{Q}_4\bar{Q}_3$	0 0	1 1	1 3	0 2
$\bar{Q}_4Q_3$	0 4	1 5	1 7	0 6
Q_4Q_3	d 12	d 13	d 15	d 14
$Q_4\bar{Q}_3$	0 8	0 9	d 11	d 10

JK for $q_2 = Q_1\bar{Q}_4$

For S = 1,

q_2	$\bar{Q}_2\bar{Q}_1$	$\bar{Q}_2Q_1$	Q_2Q_1	$Q_2\bar{Q}_1$
$\bar{Q}_4\bar{Q}_3$	0 0	0 1	0 3	1 2
$\bar{Q}_4Q_3$	1 4	0 5	0 7	1 6
Q_4Q_3	d 12	d 13	d 15	d 14
$Q_4\bar{Q}_3$	1 8	0 9	d 11	d 10

JK for $q_2 = \bar{Q}_1Q_2 + \bar{Q}_1Q_3 + \bar{Q}_1Q_4$

For S=0

Q_3	$\bar{Q}_2\bar{Q}_1$	$\bar{Q}_2 Q_1$	$Q_2 Q_1$	$Q_2\bar{Q}_1$
$\bar{Q}_4\bar{Q}_3$	0 (0)	0 (1)	1 (3)	(2)
$\bar{Q}_4 Q_3$	0 (4)	0 (5)	1 (7)	0 (6)
$Q_4 Q_3$	d (12)	d (13)	d (15)	d (14)
$Q_4\bar{Q}_3$	0 (8)	0 (9)	d (11)	d (10)

JK for $Q_3 = Q_1 Q_2$

Q_4	$\bar{Q}_2\bar{Q}_1$	$\bar{Q}_2 Q_1$	$Q_2 Q_1$	$Q_2\bar{Q}_1$
$\bar{Q}_4\bar{Q}_3$	0	0	0	0
$\bar{Q}_4 Q_3$	0	0	1	0
$Q_4 Q_3$	d	d	d	d
$Q_4\bar{Q}_3$	0	1	d	d

JK for $Q_4 = Q_1 Q_2 Q_3 + Q_1 Q_4$

For S=1

Q_3	$\bar{Q}_2\bar{Q}_1$	$\bar{Q}_2 Q_1$	$Q_2 Q_1$	$Q_2\bar{Q}_1$
$\bar{Q}_4\bar{Q}_3$	0 (0)	0 (1)	0 (3)	0 (2)
$\bar{Q}_4 Q_3$	1 (4)	0 (5)	0 (7)	0 (6)
$Q_4 Q_3$	d (12)	d (13)	d (15)	d (14)
$Q_4\bar{Q}_3$	1 (8)	0 (9)	d (11)	d (10)

JK for $Q_3 = \bar{Q}_1\bar{Q}_2 Q_3 + \bar{Q}_1 Q_2 Q_4$

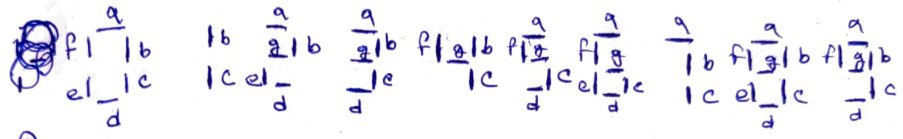
Q_4	$\bar{Q}_2\bar{Q}_1$	$\bar{Q}_2 Q_1$	$Q_2 Q_1$	$Q_2\bar{Q}_1$
$\bar{Q}_4\bar{Q}_3$	1	0	0	0
$\bar{Q}_4 Q_3$	0	0	0	0
$Q_4 Q_3$	d	d	d	d
$Q_4\bar{Q}_3$	1	0	d	d

JK for $Q_4 = \bar{Q}_1\bar{Q}_2\bar{Q}_3$

Seven segment Display

Name: Sujan Biswas
Roll No: 30201050100 3
CSE Lateral

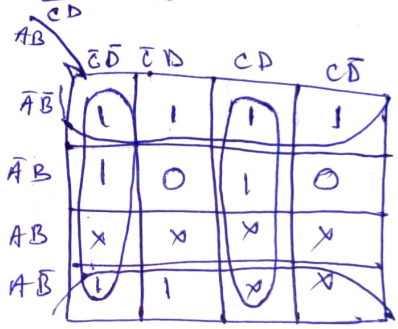
	A	B	C	D	a	b	c	d	e	f	g
0	0	0	0	0	1	1	1	1	1	1	0
1	0	0	0	1	0	1	1	0	0	0	0
2	0	0	1	0	1	1	0	1	1	0	1
3	0	0	1	1	1	1	1	1	0	0	1
4	0	1	0	0	0	1	1	0	0	1	1
5	0	1	0	1	1	0	1	1	0	1	1
6	0	1	1	0	1	0	1	1	1	1	1
7	0	1	1	1	1	1	1	0	0	0	0
8	1	0	0	0	1	1	1	1	1	1	1
9	1	0	0	1	1	1	1	1	0	1	1



Kmap for a

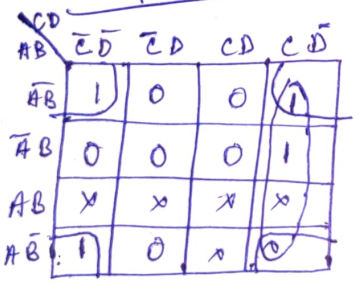
$a = c + A + \bar{B}\bar{D} + BD$

Kmap for b



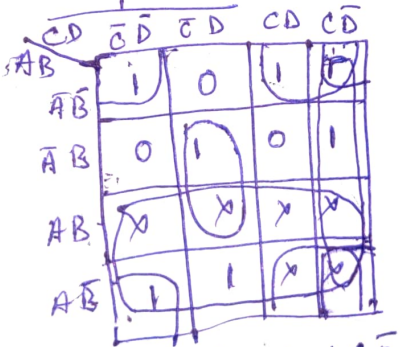
$b = \bar{B} + CD + \bar{C}\bar{D}$

Kmap for e



$e = C\bar{D} + \bar{B}\bar{D}$

Kmap for D



$d = \bar{B}\bar{D} + A + C\bar{D} + \bar{B}C + B\bar{C}D$

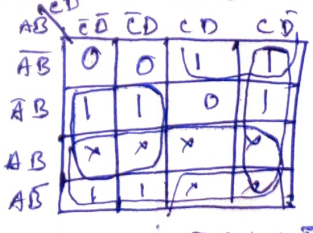
Kmap for C

$C = B + \bar{C} + D$

Kmap for f

$f = A + \bar{C}\bar{D} + B\bar{D} + B\bar{C}$

Kmap for g



$g = A + B\bar{C} + BC + C\bar{D}$

Designing mod 6 updown counter: →

mode	Initial state			Final state		
	Q_2	Q_1	Q_0	$\bar{Q}_2$	$\bar{Q}_1$	$\bar{Q}_0$
0	0	0	0	0	0	1
0	0	0	1	0	1	0
0	0	1	0	0	1	1
0	0	1	1	1	0	0
0	1	0	0	1	0	1
0	1	0	1	0	0	0
1	0	0	0	1	0	1
1	0	0	1	0	0	0
1	0	1	0	0	0	1
1	0	1	1	0	1	0
1	1	0	0	0	1	1
1	1	0	1	1	0	0

K map →

J_0	$\bar{Q}_2\bar{Q}_1$	$\bar{Q}_2Q_1$	Q_2Q_1	$Q_2\bar{Q}_1$
$\bar{Q}_0$	1	1	X	1
Q_0	X	X	X	X

$J_0 = 1$

K_0	$\bar{Q}_2\bar{Q}_1$	$\bar{Q}_2Q_1$	Q_2Q_1	$Q_2\bar{Q}_1$
$\bar{Q}_0$	X	X	X	X
Q_0	1	1	X	1

$K_0 = 1$

J_1	$\bar{Q}_2\bar{Q}_1$	$\bar{Q}_2Q_1$	Q_2Q_1	$Q_2\bar{Q}_1$
$\bar{Q}_0$	0	X	X	1
Q_0	0	X	X	0

$J_1 = Q_2\bar{Q}_0$

K_1	$\bar{Q}_2\bar{Q}_1$	$\bar{Q}_2Q_1$	Q_2Q_1	$Q_2\bar{Q}_1$
$\bar{Q}_0$	X	1	X	X
Q_0	X	0	X	X

$K_1 = \bar{Q}_0$

J_2	$\bar{Q}_2\bar{Q}_1$	$\bar{Q}_2Q_1$	Q_2Q_1	$Q_2\bar{Q}_1$
$\bar{Q}_0$	1	0	X	X
Q_0	0	0	X	X

$J_2 = \bar{Q}_1\bar{Q}_0$

K_2	$\bar{Q}_2\bar{Q}_1$	$\bar{Q}_2Q_1$	Q_2Q_1	$Q_2\bar{Q}_1$
$\bar{Q}_0$	X	X	X	1
Q_0	X	X	X	0

$K_2 = \bar{Q}_0$

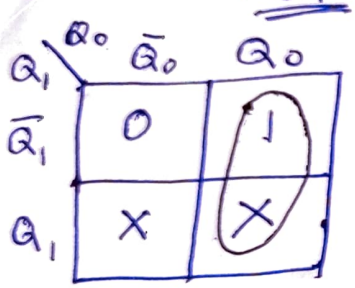
For counting 24, we can use mod 3 and mod 5

Mod-3

mod	Initial State		Final State		Inputs			
	Q_1	Q_0	Q_1^*	Q_0^*	J_1	K_1	J_0	K_0
0	0	0	0	1	0	X	1	X
0	0	1	1	0	1	X	X	1
0	1	0	0	0	X	1	0	X

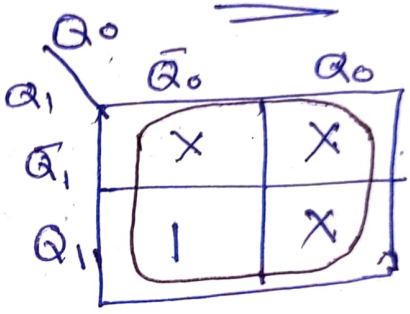
K map:

J_1



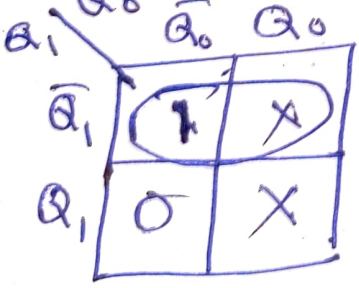
$J_1 = Q_0$

K_1

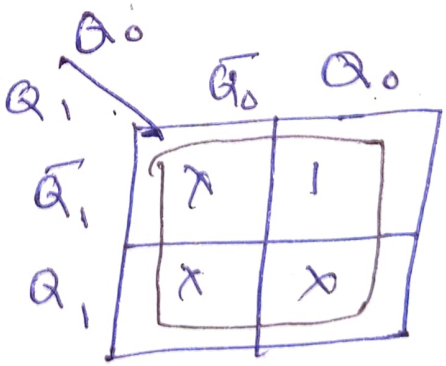


$K_1 = 1$

J_0



$J_0 = \bar{Q}_1$



$K_0 = 1$

Mod-5

Mode	Initial State			Final State			Inputs					
	Q_2	Q_1	Q_0	Q_2^*	Q_1^*	Q_0^*	J_2	K_2	J_1	K_1	J_0	K_0
0	0	0	0	0	0	1	0	X	0	X	1	X
0	0	0	1	0	1	0	0	X	1	X	X	1
0	0	1	0	0	1	1	0	X	X	0	1	X
0	0	1	1	1	0	0	1	X	X	1	X	1
0	1	0	0	0	0	0	X	1	0	X	0	X

Kmap

J_2

Q_0 \ Q_2Q_1	$\bar{Q}_2\bar{Q}_1$	$\bar{Q}_2Q_1$	Q_2Q_1	$Q_2\bar{Q}_1$
$\bar{Q}_0$	0	0	1	0
Q_0	X	X	X	X

$J_2 = Q_1Q_2$

K_2

Q_0 \ Q_2Q_1	$\bar{Q}_2\bar{Q}_1$	$\bar{Q}_2Q_1$	Q_2Q_1	$Q_2\bar{Q}_1$
$\bar{Q}_0$	X	X	X	X
Q_0	1	X	X	X

$K_2 = 1$

J_1

Q_0 \ Q_2Q_1	$\bar{Q}_2\bar{Q}_1$	$\bar{Q}_2Q_1$	Q_2Q_1	$Q_2\bar{Q}_1$
$\bar{Q}_0$	0	1	X	X
Q_0	0	X	X	X

$J_1 = Q_1$

K_1

Q_0 \ Q_2Q_1	$\bar{Q}_2\bar{Q}_1$	$\bar{Q}_2Q_1$	Q_2Q_1	$Q_2\bar{Q}_1$
$\bar{Q}_0$	X	X	1	0
Q_0	X	X	X	X

$K_1 = Q_1$

J_0

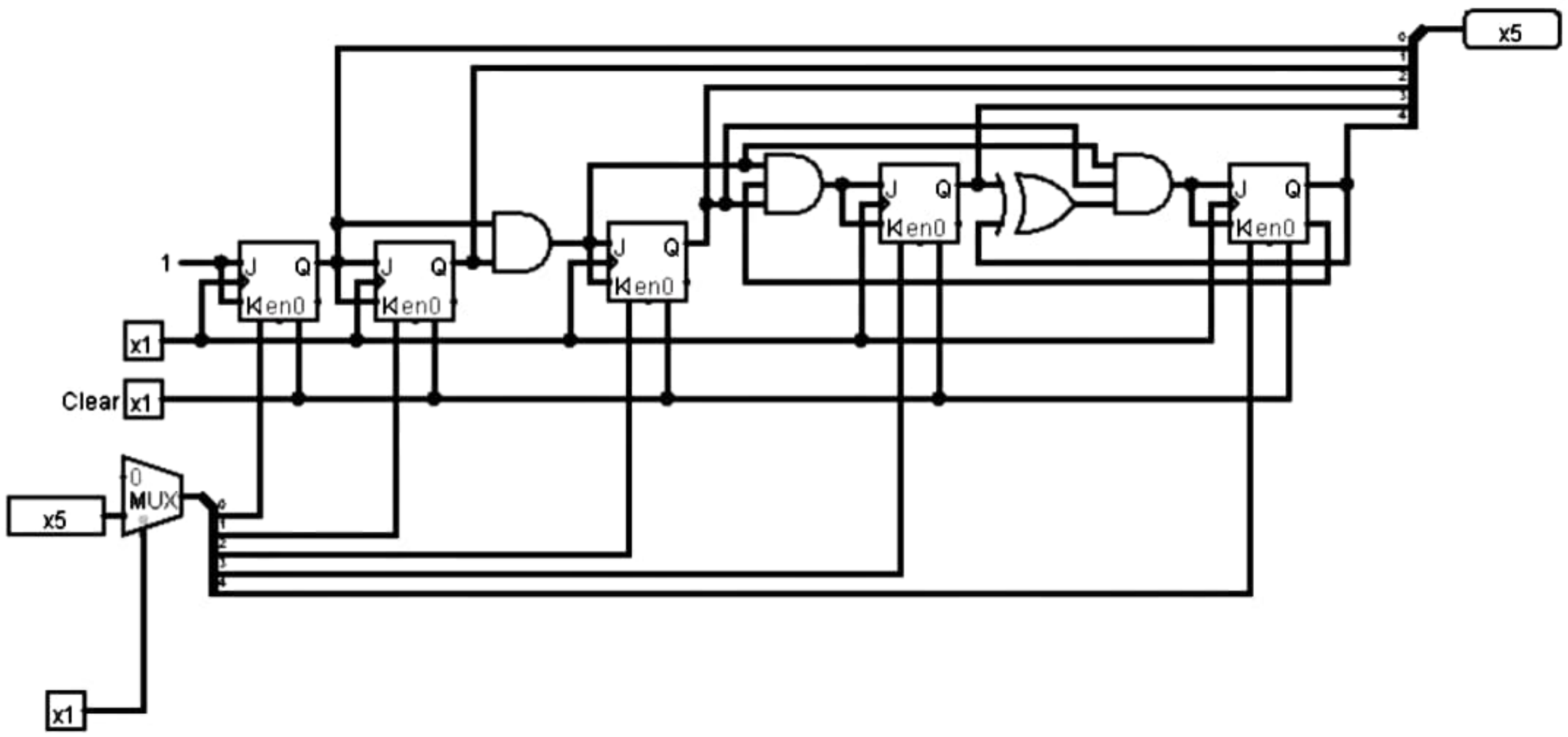
Q_0 \ Q_2Q_1	$\bar{Q}_2\bar{Q}_1$	$\bar{Q}_2Q_1$	Q_2Q_1	$Q_2\bar{Q}_1$
$\bar{Q}_0$	1	X	X	1
Q_0	0	X	X	X

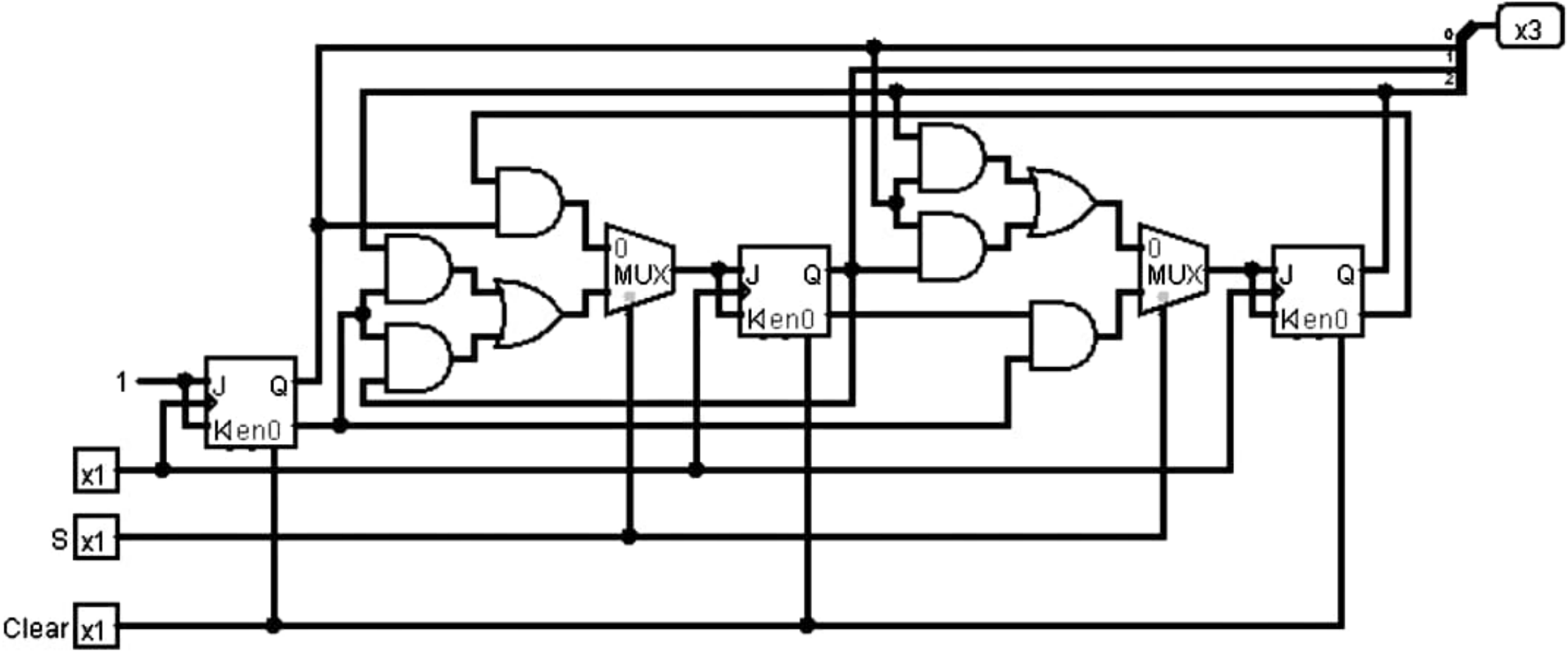
$J_0 = \bar{Q}_0$

K_0

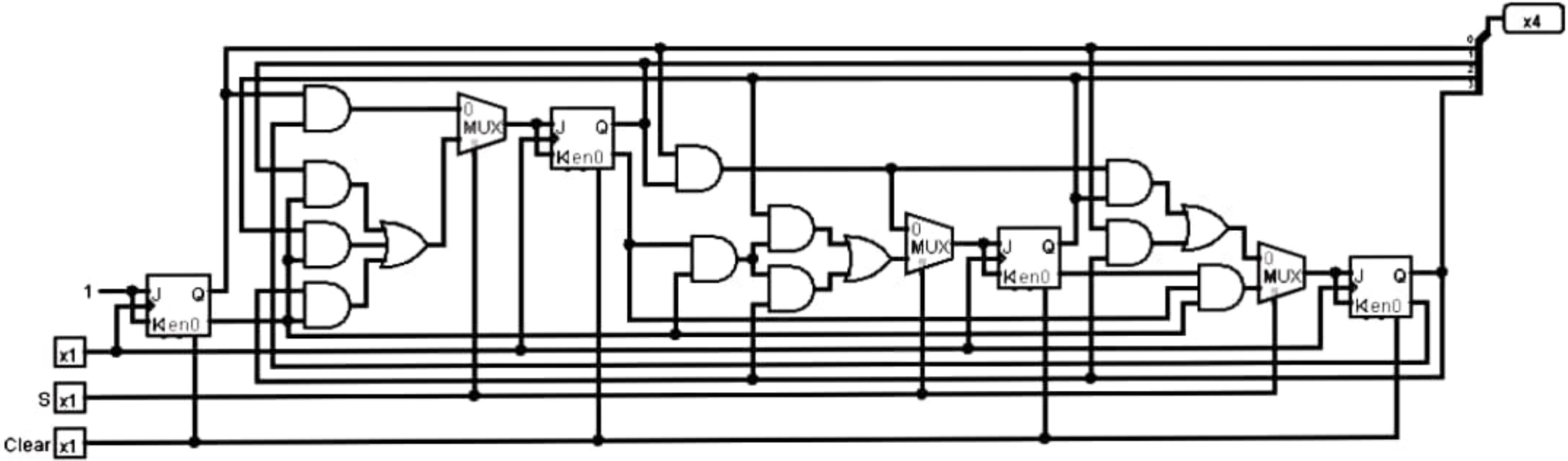
Q_0 \ Q_2Q_1	$\bar{Q}_2\bar{Q}_1$	$\bar{Q}_2Q_1$	Q_2Q_1	$Q_2\bar{Q}_1$
$\bar{Q}_0$	X	1	1	X
Q_0	X	X	X	X

$K_0 = 1$

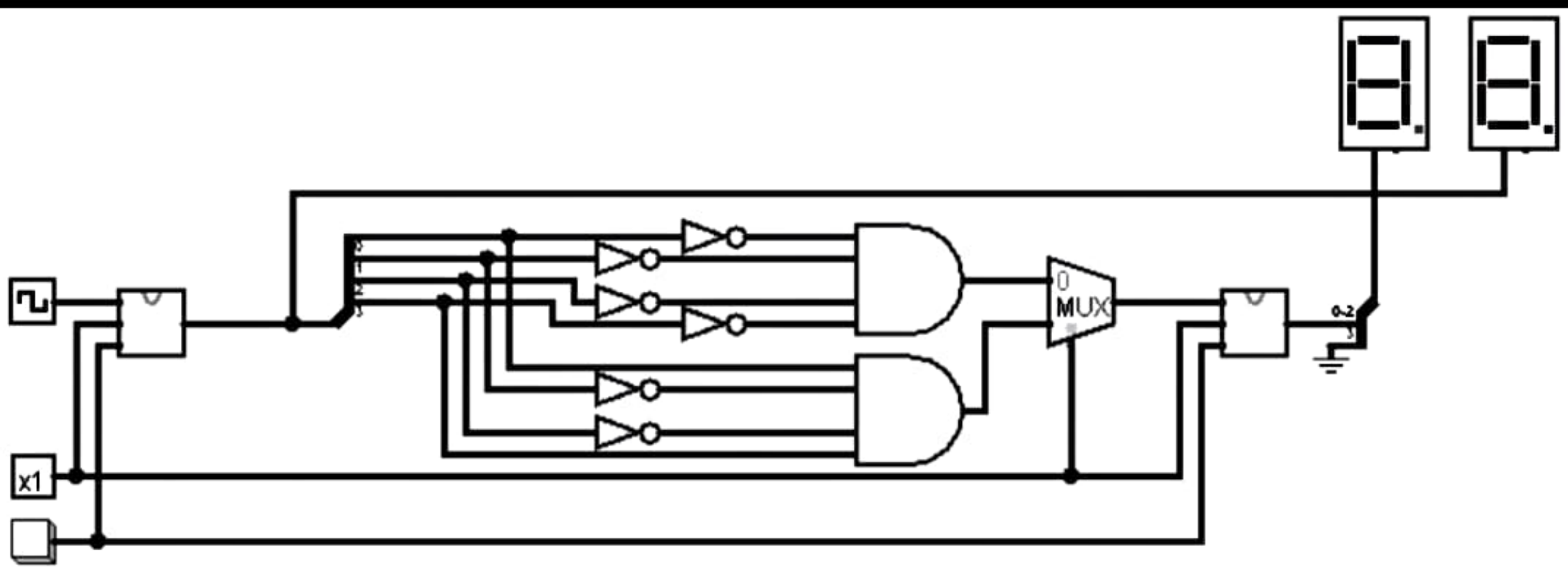

x5
1
J
Q
K
en
0
x1
Clear
x1
0
MUX
x5
x1



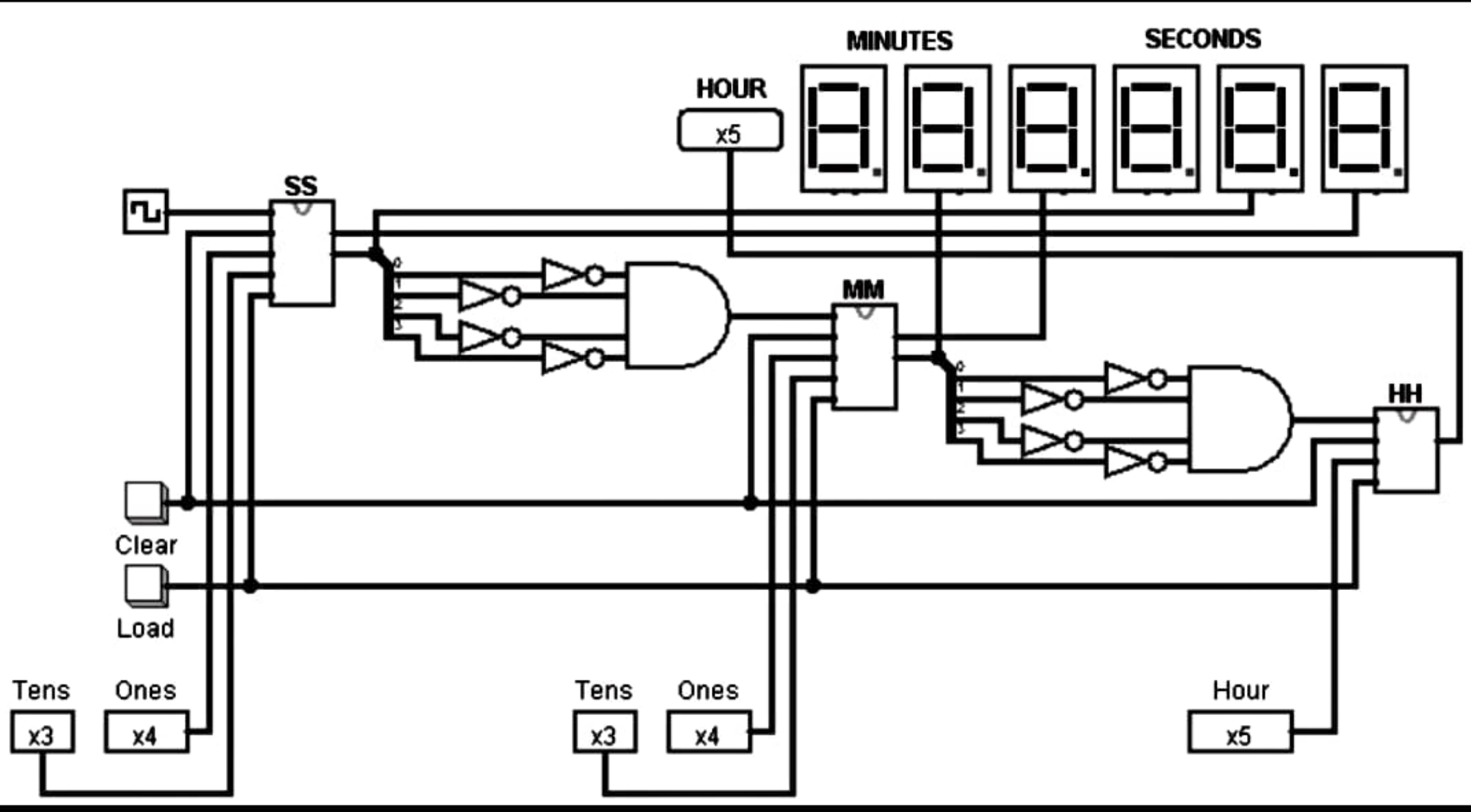
Mod 6 counter



Mod 10 counter



Mod 60 counter


MINUTES
SECONDS
HOUR
x5
SS
MM
HH
Clear
Load
Tens
Ones
x3
x4
Tens
Ones
x3
x4
Hour
x5