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Roll No. : 1901CS75

CS226 - Lab 8

Q1) Control bits : (4 x 1 MUX used)

I_0	I_1	Function
0	0	stop counting
0	1	count up by 1
1	0	Count down by 1
1	1	Count up by 2

i) SR flip flop :

Notations :
P → present state
N → next state
<sub> 1 → MSB
<sub> 0 → LSB

a) Count up by 1 :

We use the excitation table for each flip flop :

	P_1	P_0	N_1	N_0	S_1	R_1	S_0	R_0
0 → 1	0	0	0	1	0	x	1	0
1 → 2	0	1	1	0	1	0	0	1
2 → 3	1	0	1	1	x	0	1	0
3 → 0	1	1	0	0	0	1	0	1

Using K-map for S_1, R_1, S_0 and R_0, we get

S_1:

P_1 \ P_0	0	1
0	0	x
1	(1)	0

$S_1 = \bar{P_1} P_0$

R_1:

P_1 \ P_0	0	1
0	x	0
1	0	(1)

$R_1 = P_1 \bar{P_0}$

S_0:

P_1 \ P_0	0	1
0	(1 1)	
1	0 0	

$S_0 = \bar{P_0}$

R_0:

P_1 \ P_0	0	1
0	0	0
1		(1 1)

$R_0 = P_0$

b) Count down by 1:

P_1	P_0	N_1	N_0	S_1	R_1	S_0	R_0
0	0	1	1	1	0	1	0
0	1	0	0	0	X	0	1
1	0	0	1	0	1	1	0
1	1	1	0	X	0	0	1

$S_1 = \overline{P_1}\,\overline{P_0}$ $\quad R_1 = P_1\overline{P_0}$

$S_0 = \overline{P_0}$ $\quad R_0 = P_0$

c) Count up by 2:

P_1	P_0	N_1	N_0	S_1	R_1	S_0	R_0
0	0	1	0	1	0	0	X
0	1	1	1	1	0	X	0
1	0	0	0	0	1	0	X
1	1	0	1	0	1	X	0

$S_1 = \overline{P_1}$ $\quad R_1 = P_1$

$S_0 = 0$ $\quad R_0 = 0$

ii) JK Flip flop :

a) Count up by 1 :

P_1	P_0	N_1	N_0	J_1	K_1	J_0	K_0
0	0	0	1	0	X	1	X
0	1	1	0	1	X	X	1
1	0	1	1	X	0	1	X
1	1	0	0	X	1	X	1

$J_1 = P_0$ $\quad K_1 = P_0$

$J_0 = 1$ $\quad K_0 = 1$

b) Count down by 1 :

P_1	P_0	N_1	N_0	J_1	K_1	J_0	K_0
0	0	1	1	1	X	1	X
0	1	0	0	0	X	X	1
1	0	0	1	X	1	1	X
1	1	1	0	X	0	X	1

$J_1 = \overline{P_0}$ $\quad K_1 = \overline{P_0}$

$J_0 = 1$ $\quad K_0 = 1$

c) Count up by 2 :

P_1	P_0	N_1	N_0	J_1	K_1	J_0	K_0
0	0	1	0	1	X	0	X
0	1	1	1	1	X	X	0
1	0	0	0	X	1	0	X
1	1	0	1	X	1	X	0

$J_1 = 1$ $\quad K_1 = 1$

$J_0 = 0$ $\quad K_0 = 0$

iii) Using T and D flip flops :
(shown in the same table)

a) Count up by 1 :

P_1	P_0	N_1	N_0	T_1	T_0	D_1	D_0
0	0	0	1	0	1	0	1
0	1	1	0	1	1	1	0
1	0	1	1	0	1	1	1
1	1	0	0	1	1	0	0

For D flip flop :

$D_1 = P_1\overline{P_0} + P_0\overline{P_1} = P_1 \oplus P_0$

$D_0 = \overline{P_0}$

For T flip flop :

$T_1 = P_0$

$T_0 = 1$

b) Count down by 1:

P_1	P_0	N_1	N_0	T_1	T_0	D_1	D_0
0	0	1	1	1	1	1	1
0	1	0	0	0	1	0	0
1	0	0	1	1	1	0	1
1	1	1	0	0	1	1	0

$T_1 = \overline{P_0}$
$T_0 = 1$
} for T flip flop

$D_1 = P_1 P_0 + \overline{P_1}\,\overline{P_0} = P_1$ XNOR P_0
$D_0 = \overline{P_0}$
} For D flip flop

c) Count up by 2:

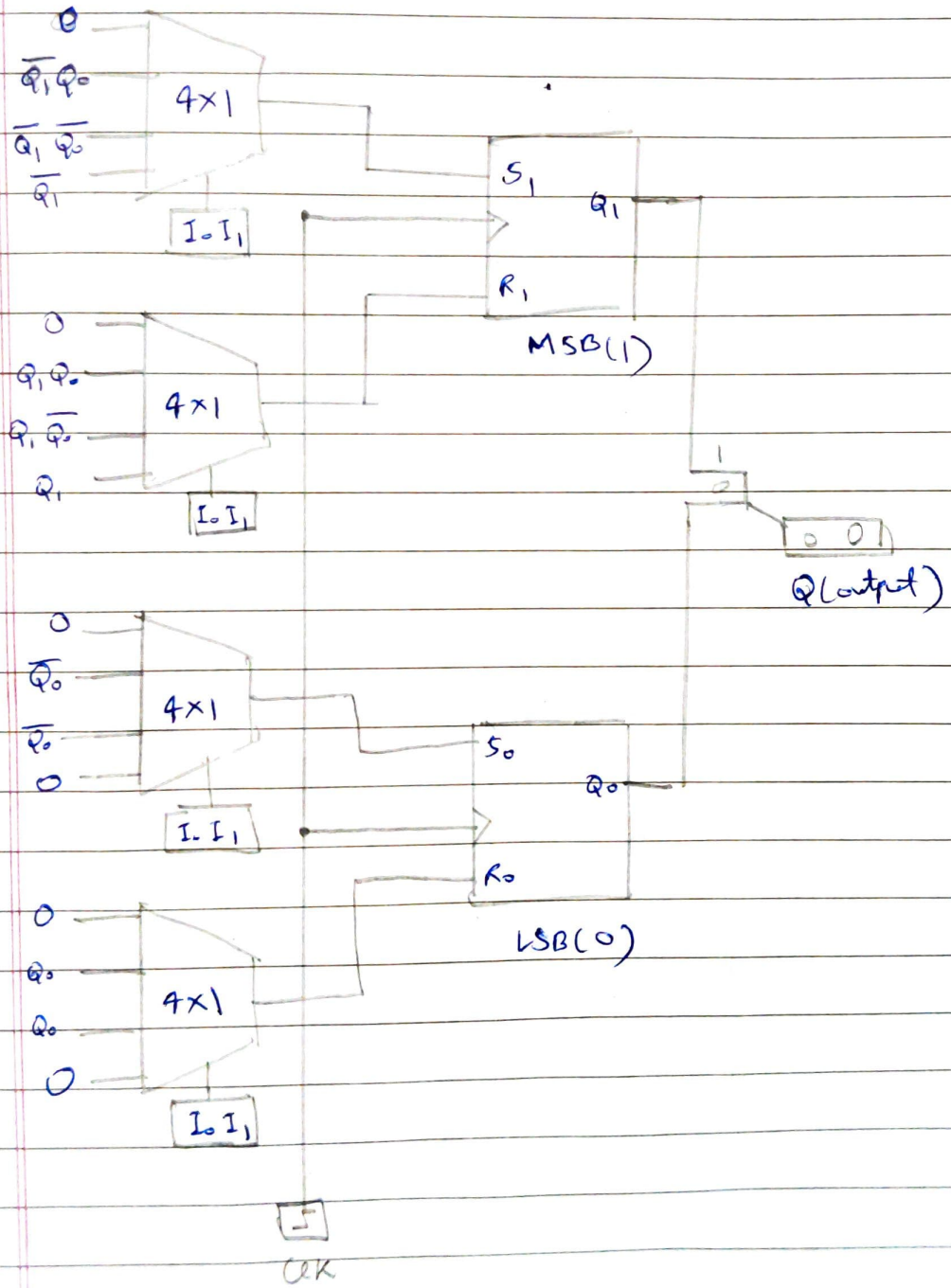
P_1	P_0	N_1	N_0	T_1	T_0	D_1	D_0
0	0	1	0	1	0	1	0
0	1	1	1	1	0	1	1
1	0	0	0	1	0	0	0
1	1	0	1	1	0	1	0 1

For D flip flop:
$D_1 = \overline{P_1}$ $\quad D_0 = P_0$

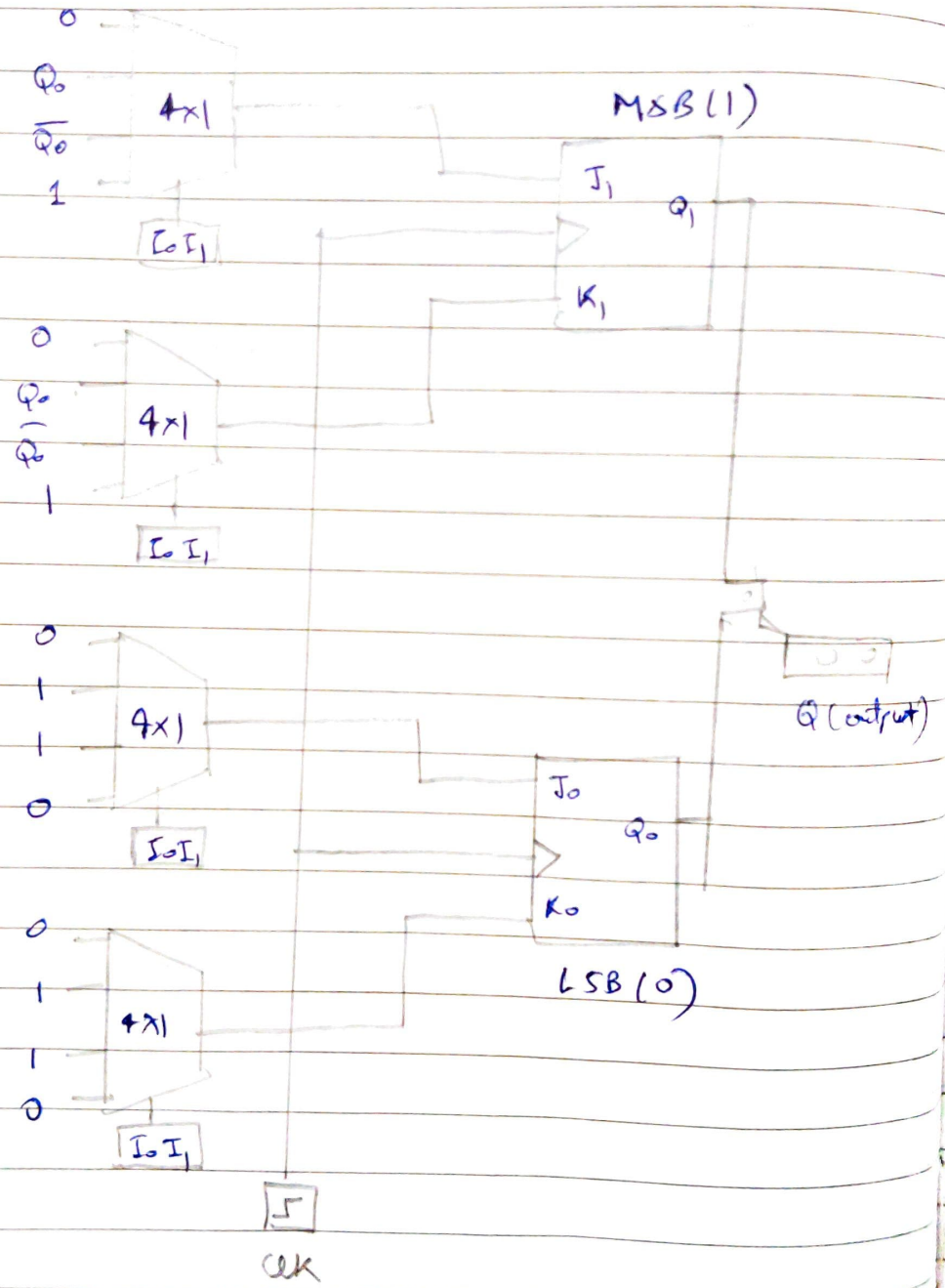
For T flip flop:
$T_1 = 1$ $\quad T_0 = 0$

Designs :

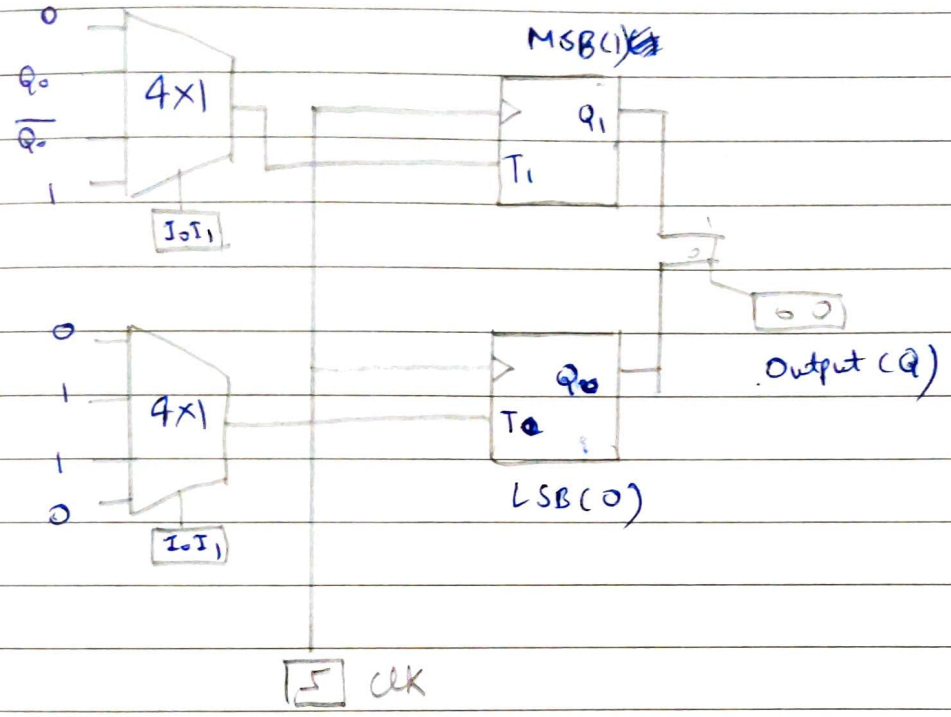
i) SR Flip Flop :



ii) JK flip flop:



iii) T flip flop :



iv) D flip flop :