COMPUTER SCIENCE & IT

DIGITAL LOGIC

Lecture No: 08

Miscellaneous Topics

By- Chandan Gupta Sir

Recap of Previous Lecture

Concept of Delay

Functionally complete Function

Functionally complete Function

$\boxed{f \rightarrow \text{if it does not belong to any class of functions} \rightarrow T_0, T_1, L, M, S \text{ then it will be functionally complete function}}$

$f \longrightarrow \{f_1, f_2, \cdots\}$

$f \longrightarrow \{\text{AND}, \text{NOT}\}$

$f_1(A,B) = A \cdot B$

$f_2(A) = \overline{A}$

$f_2(A) = \Sigma(0)$
$= \Pi(1)$

$\underline{S_D}, \underline{L}$ Not T_0 Not M
Not T_1,

A	f_2
0	1
1	0

$f_1(A,B) = \Sigma(3) \longrightarrow T_0, T_1$, M
$= \Pi(0,1,2)$

Not S_D –
Not L –

0	0	0
0	1	0
1	0	0
1	1	1

$\longrightarrow$ Monotonic M

If there is set of functions :

then
- If there exist atleast one function which does not belong to T_0.
- If there exist atleast one function which does not belong to T_1.
- If there exist atleast one function which does not belong to L
- If there exist atleast one function which does not belong to M
- If there exist atleast one function which does not belong to S_D

then we will say that this set of functions are functionally complete.

$f(A,B,C) = A + \bar{B}\bar{C} \quad = \Sigma(0,4,5,6,7)$

NOT L
NOT S_D
NOT T_0

NOT M

T_1

$\downarrow$ $A \longrightarrow (4,5,6,7)$

functionally not complete function

1	0	0
1	0	1
1	1	0
1	1	1

$\bar{B}\bar{C}$

$000 \rightarrow 0$

$100 \rightarrow 4$

$(2^n - 1)$

000 (1)

100 (1)

010 (0)

001

$\# \quad f(A,B,\bar{C}) = \bar{A} + \bar{B}C \longrightarrow$ functionally complete function

$f(A,B,D) = \bar{A} + \bar{B}\,\bar{D} = \Sigma(0,1,2,3,4) \longrightarrow$

NOT L

NOT S

NOT T_0

NOT T_1

NOT M

$\bar{A} \longrightarrow (0,1,2,3)$

0	0	0
0	0	1
0	1	0
0	1	1

$\bar{B}\,\bar{D}$

$0\,0\,0 \rightarrow 0$

$1\,0\,0 \rightarrow 4$

000 (1)

- 001 — (1)
- 010 → (1)
- 100 → (1)

001 (1)

- 011 — (1)
- 101 → (0)

\# $f(A,B,C) = AB + BC + CA = \Sigma(3,5,6,7) \longrightarrow$ Self Dual (S_D)

$(2,2,2,3)$

Not L

$\Pi(0,1,2,4)$

even, odd, odd, odd

↓

Not functionally Complete

T_0 011 ⟵ (111)

T_1 (1)   (1)

M   101 ⟶ (111)

(1)   (1)

111   110 ⟶ 111

(1)   (1)

---

001 (1) — 011 (0), 101 (0)

\# $f(A,B,C) = \Sigma(1,2,4,7) \longrightarrow S_D, T_0, T_1$

$(1,1,1,3) \longrightarrow L$

$\longrightarrow$ Non Monotonic

↓

Not functionally Complete function.

$f(A,B) = \bar{A}B = \Sigma(1) = \pi(0,2,3)$

$\Downarrow$

Not functionally Complete function

Not L

Not S_D

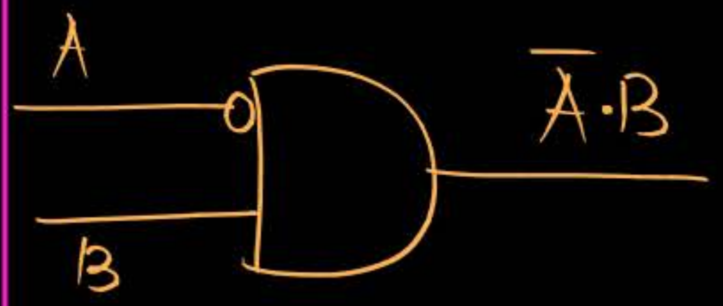
T_0

Not T_1

Not M

01 —— 11

(1) (0)



Universal gate

here 0, 1 are bydefault available.

$f(\underline{\bar{A}}, \underline{B}) = (\bar{A} + B) \longrightarrow$ Not functionally complete function

$f(D, B) = (D + B) = \Sigma(1, 2, 3) = \Pi(0) \longrightarrow$ Not S_D

Not L

T_0

T_1

M

D

1 0 $\rightarrow$ 2

1 1 $\rightarrow$ 3

B

0 1 $\rightarrow$ 1

1 1 $\rightarrow$ 3

01 —— 11

(1) (1)

10 —— 11

(1) (1)

11 $\longrightarrow$

$f(A,B,C) = \bar{A} + \bar{B}C = \sum(0,1,2,3,5)$

Not L   Not M

Not S_D

Not T_0

Not T_1

$\bar{A} \longrightarrow (0,1,2,3)$

0 00
0 01
0 10
0 11

functionally Complete function

$000\ (1) \to 001\ (1),\ 010\ (1),\ 100\ (0)$

$\bar{B}\ C$

$0\ 0\ 1 \to 1$

$1\ 0\ 1 \to 5$

Implication function: $\rightarrow$

$$00\,(1) \begin{cases} 01 & (1) \\ 10 & (0) \end{cases}$$

Not S_D Not T_0 NOT M

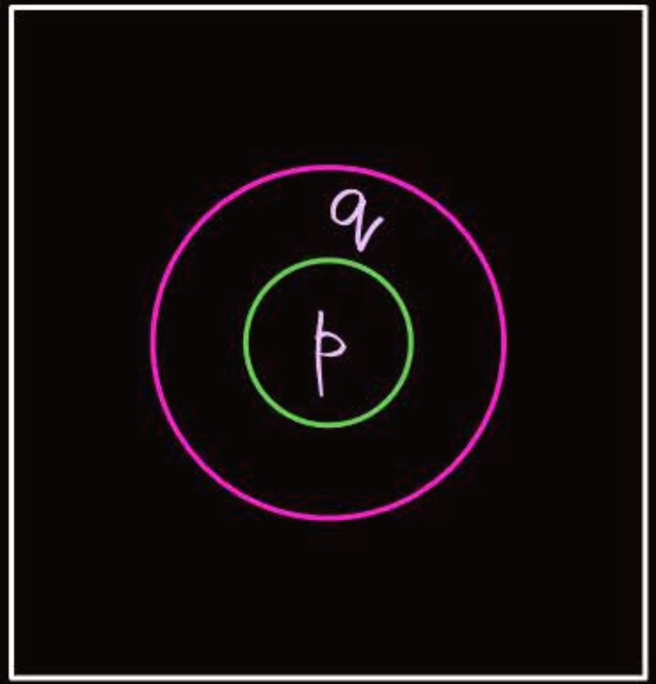
Not L T_1

$$P \longrightarrow Q$$

P	Q	f
0	0	1
0	1	1
1	0	0
1	1	1

$$f(P,Q) = \Sigma(0,1,3)$$
$$= \pi(2)$$
$$= (\overline{P} + Q)$$

Not functionally Complete function



$$Q \longrightarrow P \longrightarrow f(P,Q) = \overline{Q} + P$$

Negation F →

$$f(A) = \overline{A} = \Sigma 0 = \pi(1)$$

S_D

L

Not M ,

NoT T_0

NoT T_1

$$\begin{array}{ccc} 0 & \longrightarrow & 1 \\ (1) & & (0) \end{array}$$

$f = \{$ Impliation, Negation $\}$

↓

functionally complete function

$$f(A,B) = \bar{A}B + A\bar{B} = \Sigma(1,2) = \Pi(0,3)$$

$$(1,1)$$

$\downarrow$

Not functionally complete function

01 —— 11

(1) $\quad$ (0)

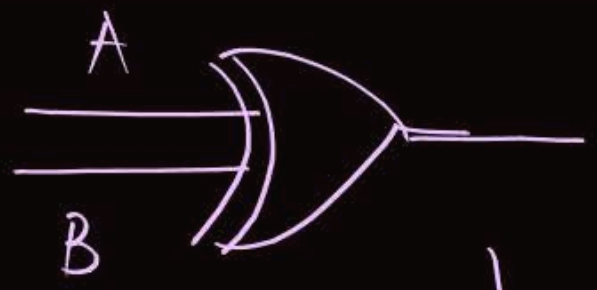
$\boxed{T_0}$

NOT T_1

Not S_D

$\boxed{L}$

Not M



$\bar{A}B + A\bar{B}$

Non universal gate

H.W :→

Q.1. $f(A,B,C) = \left\{ f_1(A,B,C) = A + \bar{B}C, \quad f_2(A,B,C) = \bar{A} + \bar{B}C \right\}$

Q.2. $f(A,B) = \left\{ f_1(A,B) = \bar{A} + B, \quad f_2(A,B) = A\bar{B} \right\}$

Q.3 $f(A,B) = \left\{ f_1(A,B) = A + B, \quad f_2(A,B) = A \cdot B \right\}$

Q.4 $f(A, B) = \{ f_1(A,B) = A\overline{B}, \quad f_2(A,B) = \overline{A} \}$

Q.5. $f(A, B) = \{ f_1(A,B) = \overline{A}B, \quad f_2(A,B) = \overline{A} \}$

[Conversion of one FF into another FF]

- Procedure :

→ Write down the characteristic table of desired FF on i/p side

→ Excitation table of available on o/p side

→ Then form truth and simplify and then implement it

→

- JK to D ⟶ desired FF

available FF

Table :

D	Q(n)	Q(n+1)	J	K
0	0	0	0	X
0	1	0	X	1
1	0	1	1	X
1	1	1	X	0

$$J[D, Q(n)] = \Sigma(2) + d\Sigma(1,3)$$

$$K[D, Q(n)] = \Sigma(1) + d\Sigma(0,2)$$

J

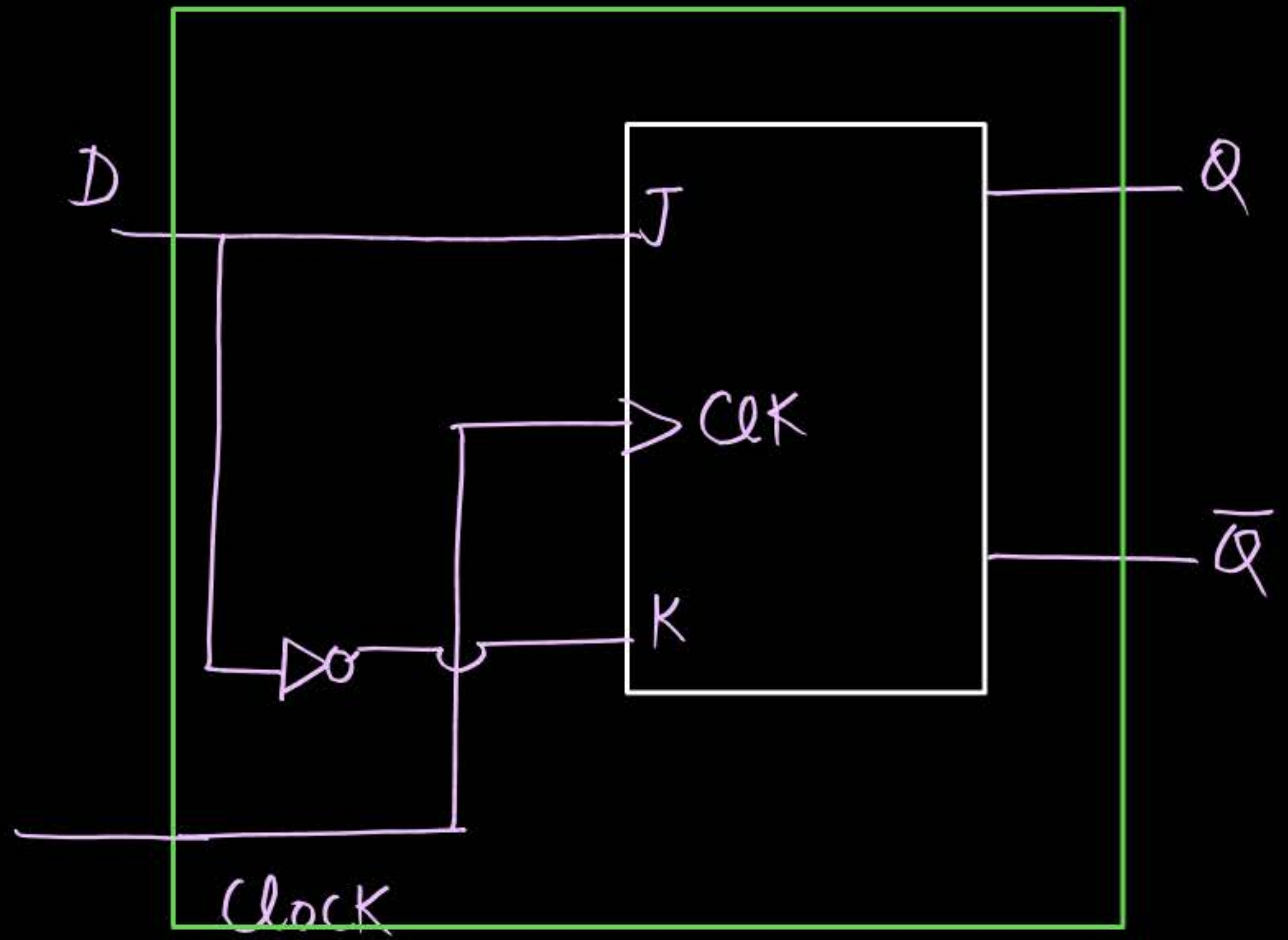
	$\bar{Q}(n)$	$Q(n)$
$\bar{D}$		X
D	1	X

$J = D$

K

	$\bar{Q}(n)$	$Q(n)$
$\bar{D}$	X	1
D	X	

$K = \bar{D}$



$$Q(n+1) = J\overline{Q}(n) + \overline{K}Q(n)$$

$$= D\overline{Q}(n) + DQ(n)$$

$$Q(n+1) = D(1) = D$$

- SR to JK : → derived FF

available FF

Table :

	J	K	Q(n)	Q(n+1)	S	R
0	0	0	0	0	0	X
1	0	0	1	1	X	0
2	0	1	0	0	0	X
3	0	1	1	0	0	1
4	1	0	0	1	1	0
5	1	0	1	1	X	0
6	1	1	0	1	1	0
7	1	1	1	0	0	1

S

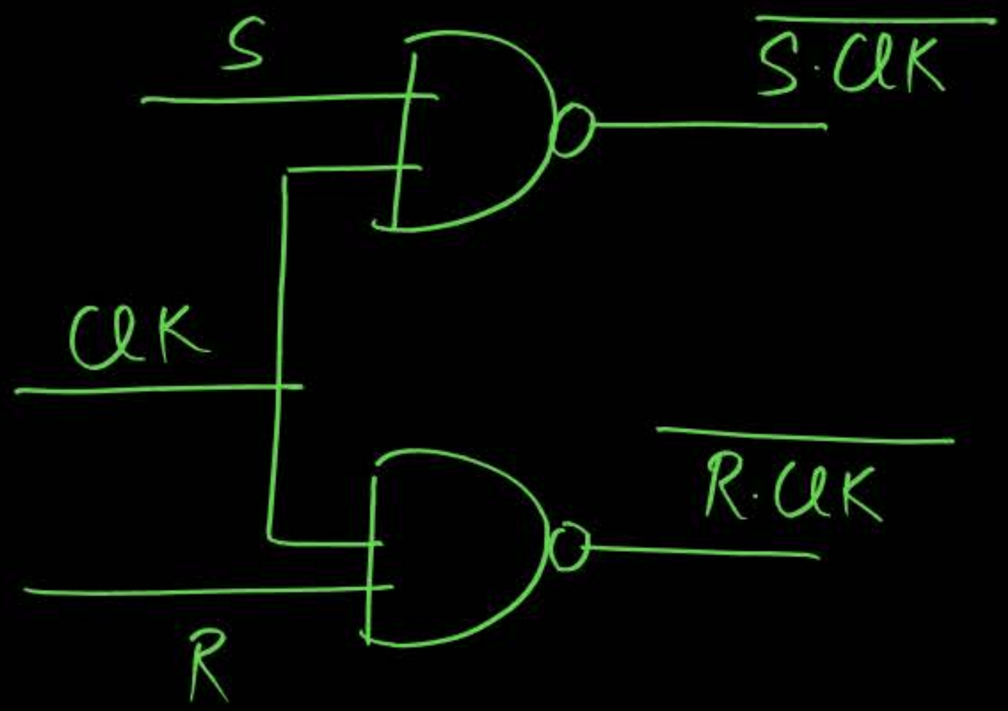
	$\bar{K}\bar{Q}$	$\bar{K}Q$	KQ	$K\bar{Q}$
$\bar{J}$		X		
J	1	X		1

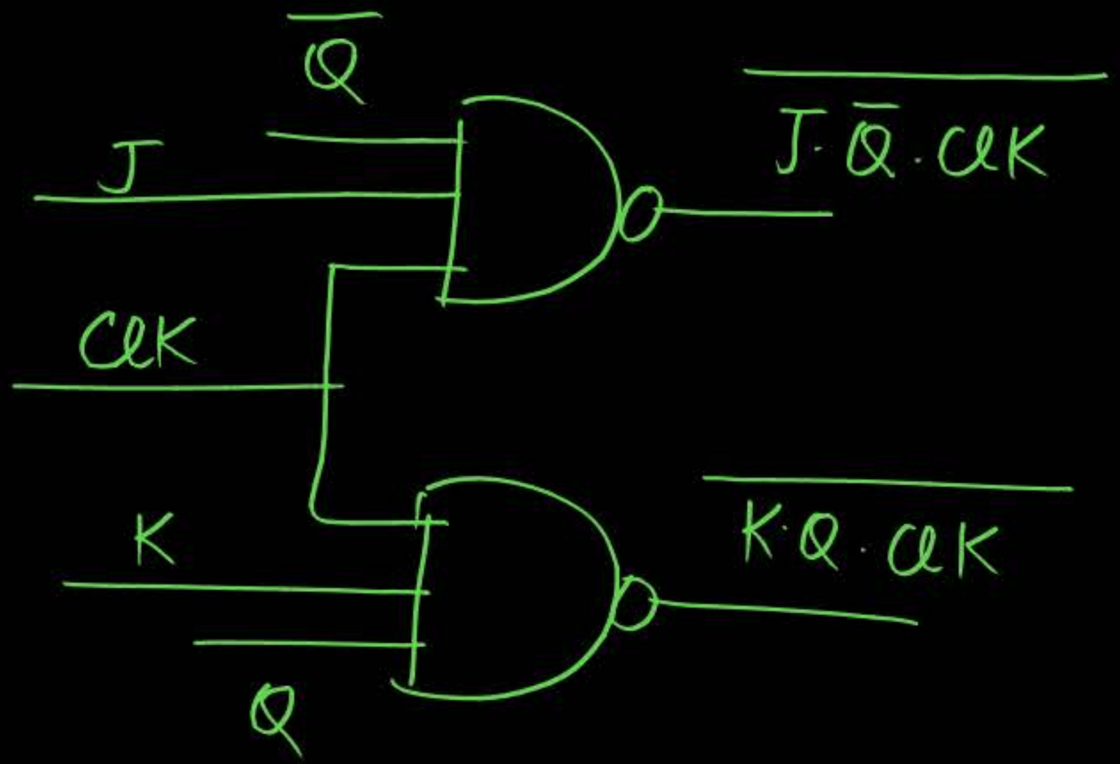
$S = J\bar{Q}$

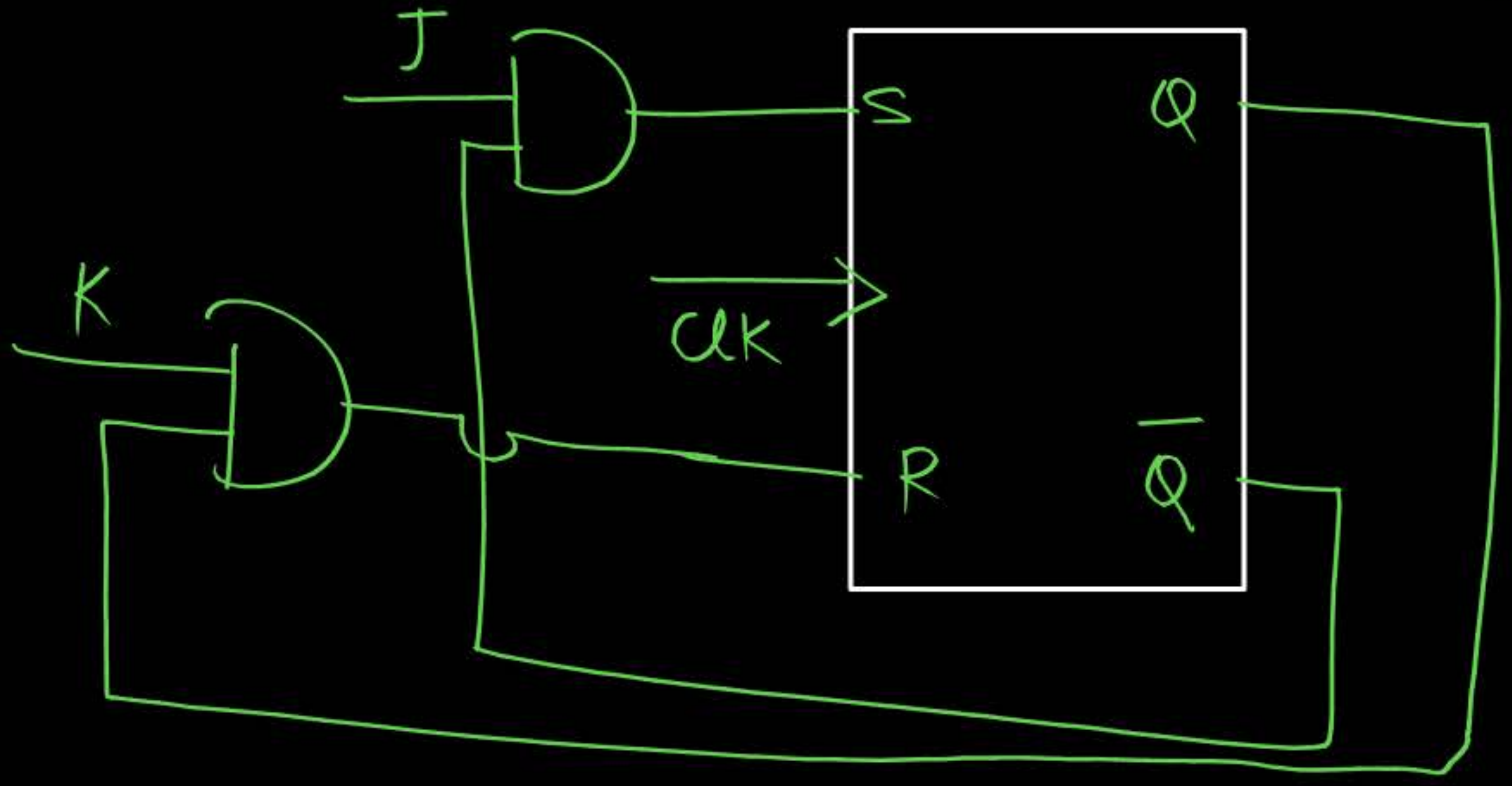
R

	$\bar{K}\bar{Q}$	$\bar{K}Q$	KQ	$K\bar{Q}$
$\bar{J}$	X		1	X
J			1	

$R = KQ$


S
$\overline{S\cdot CLK}$
CLK
$\overline{R\cdot CLK}$
R


$\bar{Q}$
J
$\overline{J\cdot\bar{Q}\cdot CLK}$
CLK
K
$\overline{K\cdot Q\cdot CLK}$
Q


J
S
Q
K
CLK
R
$\bar{Q}$

All Conversion Results

SR - JK	$S = J\bar{Q}$, $R = KQ$
SR - D	$S = D$, $R = \bar{D}$
SR - T	$S = T\bar{Q}$, $R = TQ$
JK - SR	$J = S$, $K = R$
JK - D	$J = D$, $K = \bar{D}$
JK - T	$J = T$, $K = T$
D - JK	$D = J\bar{Q} + \bar{K}Q$ $\quad Q(n+1) = D = J\bar{Q}(n) + \bar{K}Q(n)$
D - T	$D = T \oplus Q(n)$ $\quad Q(n+1) = D = T \oplus Q(n)$
T - JK	$T = J\bar{Q}(n) + KQ(n)$
T - SR	$T = S\bar{Q}(n) + RQ(n)$
T - D	$T = D \oplus Q(n)$

Topic : 2 Min Summary

- Functionally Complete function
- Conversion one FF into another FF.

Thank you

GW Soldiers !