Excitation Table

Creating an Excitation Table

The output of a flip-flop at a given instant depends on both its input(s) as well as its present-state, defined by the information summarized and presented by its truth table. In other words, in the truth table of a flip-flop, the next-state output will be the last column. That column is determined by the combination of bits in its preceding columns, which will be the input(s) followed by its present-state.

Now, just imagine that we want to know the sequence of the input combination which results in a definite output state. The information pertaining to this can be obtained by back-tracing (in terms of columns) the information presented by the truth table of the flip-flop. That is, we will have the first two columns as the present- and the next-states of the flip-flop which will be followed by the column(s) representing the flip-flop inputs.

Such a table can be aptly referred to as an "excitation table" as it indicates the excitations to be provided at the input pins of the flip-flop to result in the expected outcome for a known present-state.

The concept explained can be further made clear by the following example, where we obtain the excitation table for the SR flip-flop from its truth table:

i/p		Present	Next state
S	R	Q	Q(t+1)
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	X
1	1	1	X

S	R	Q	Q(t+1)
0	0	0	0
0	1	0	0
0	X	0	0

Excitation table for SR

Present State Q	Next State Q(t+1)	S	R
0	0	0	X
0	1	1	0
1	0	0	1
1	1	X	0

Inputs		Outputs	
		Present State	Next State
S	R	Q_n	Q_{n+1}
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	invalid	
1	1	invalid	

Truth Table of SR Flip-Flop

Outputs		Inputs	
Present State	Next State		
Q_n	Q_{n+1}	S	R
0	0	0	X
0	1	1	0
1	0	0	1
1	1	X	0

Excitation Table of SR Flip-Flop

Figure 1: Truth table and excitation table of an SR flip-flop

The first row in the truth table above shows that the present- and the next-states of the flip-flop will be 0 and 0 if its inputs are S = 0 and R = 0.

The same output combination also appears even when the inputs are given as S = 0 and R = 1 as evident from the third row of the truth table. This indicates that, in order to obtain the SR flip-flop's output as 0, we must drive the input pin, S, to low (i.e. S = 0) while the other input, R, may be pulled either low or high (i.e. R = 0 or 1), provided its present state is 0. In other words, the input combination S = 0 and R = X (Don't Care) results in the next-state of the flip-flop to be 0 from its current state, which is equal to 0.

Now, note that the same information is successfully conveyed by the entries (shown in the red colour) in the first row of the excitation table.

Similarly, the present-state and next-state combination of 0 and 1 is obtained for the SR flip-flop when its inputs are S = 1 and R = 0. This information is concisely represented by the second row of the excitation table (shown in the blue colour).

Following on the same grounds, we find that to obtain present- and next-states of the flip-flop as 1 and 0, we should have S = 0 and R = 1, as indicated by the entries in the black colour corresponding to the third row of the excitation table.

Lastly, note that S can be either 1 or 0 (i.e. S = X) and R should be 0 in order to obtain the present- and next-states of the flip-flop as 1 and 1. This is shown by the green colour entries in the fourth row of its excitation table.

Having done this, all the information present in the truth table is transferred appropriately into the excitation table, completing it.

By employing the same procedure, the excitation tables can be obtained for all other types of flip-flops viz., JK flip-flop, D flip-flop, and T flip-flop as shown by Figures 2, 3 and 4, respectively:

J	K	Q	Q(t+1)
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

J=0 k=x

J=X k=0

J=1 k=x

J=X k=1

Excitation table for Jk

Q	Q(t+1)	J	k
0	0	0	X
0	1	1	X
1	0	X	1
1	1	X	0

Inputs		Outputs	
		Present State	Next State
J	K	Q_n	Q_{n+1}
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

Truth Table of JK Flip-Flop

Outputs		Inputs	
Present State	Next State		
Q_n	Q_{n+1}	J	K
0	0	0	X
0	1	1	X
1	0	X	1
1	1	X	0

Excitation Table of JK Flip-Flop

Figure 2: Truth table and excitation table of a JK flip-flop

Input	Outputs	
	Present State	Next State
D	Q_n	Q_{n+1}
0	0	0
0	1	0
1	0	1
1	1	1

Truth Table of D Flip-Flop

Outputs		Input
Present State	Next State	
Q_n	Q_{n+1}	D
0	0	0
0	1	1
1	0	0
1	1	1

Excitation Table of D Flip-Flop

Figure 3: Truth table and excitation table of a D flip-flop

Input	Outputs	
	Present State	Next State
T	Q_n	Q_{n+1}
0	0	0
0	1	1
1	0	1
1	1	0

Truth Table of T Flip-Flop

Outputs		Input
Present State	Next State	
Q_n	Q_{n+1}	T
0	0	0
0	1	1
1	0	1
1	1	0

Excitation Table of T Flip-Flop

Figure 4: Truth table and excitation table of a T flip-flop