

# DOC Course 112: Hardware: Tutorial 5 Solution

Q1.

C1	Q3	Q2	Q1	Curr. State	Next State	Q3	Q2	Q1
0	0	0	0	0	2	0	1	0
0	0	0	1	1	3	0	1	1
0	0	1	0	2	OV	1	1	1
0	0	1	1	3	OV	1	1	1
0	1	0	0	UN	0	0	0	0
0	1	0	1	don't care	don't care	X	X	X
0	1	1	0	don't care	don't care	X	X	X
0	1	1	1	OV	OV	1	1	1
1	0	0	0	0	UN	1	0	0
1	0	0	1	1	UN	1	0	0
1	0	1	0	2	0	0	0	0
1	0	1	1	3	1	0	0	1
1	1	0	0	UN	UN	1	0	0
1	1	0	1	don't care	don't care	X	X	X
1	1	1	0	don't care	don't care	X	X	X
1	1	1	1	OV	0	0	0	0

Q2.

**D3**

C1	Q3	Q2	Q1
00	0	0	1
01	0	X	1
11	1	X	0
10	1	1	0

**D2**

C1	Q3	Q2	Q1
00	0	1	1
01	0	X	1
11	0	X	0
10	0	0	0

**D1**

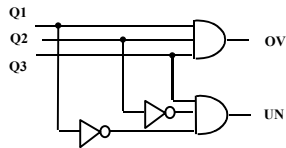
C1	Q3	Q2	Q1
00	0	1	1
01	0	X	1
11	0	X	0
10	0	0	1

**D3 =**  $C1' \cdot Q2 + C1 \cdot Q2' = C1 \lt;+> Q2$      $\lt;+> = \text{XOR}$

**D2 =**  $C1' \cdot Q3' + C1 \cdot Q2 = C1' \cdot (Q2 + Q3')$

**D1 =**  $C1' \cdot Q1 + C1 \cdot Q2 + Q3' \cdot Q2 \cdot Q1 = C1' \cdot (Q1 + Q2) + Q3' \cdot Q2 \cdot Q1$

Q3 The obvious solution is to decode the minterms for the state:



By K-map design we obtain a better solution (NB Other solutions are possible):

**UN**

Q2	Q1
00	0
01	X
11	0
10	X

$UN = Q3 \cdot Q2'$

**OV**

Q2	Q1
00	0
01	0
11	1
10	X

$OV = Q3 \cdot Q2$

Optional:

**D3**

C1	Q3	Q2	Q1
00	0	0	1
01	0	0	1
11	1	1	0
10	1	1	0

**D2**

C1	Q3	Q2	Q1
00	1	1	1
01	0	0	1
11	0	0	0
10	0	0	0