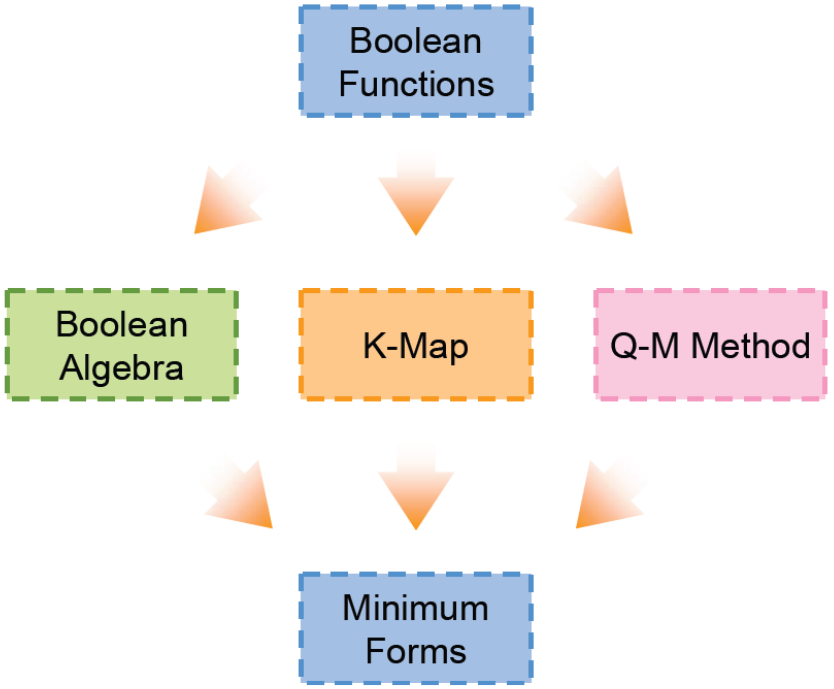
EE2000 Logic Circuit Design

Lecture 3 – Combinational System Design



Exercise

Determine the Hamming code using both odd and even parity bit for a data code of 11100

Step 1: Calculate extra bit (***k***) needed for a ***n*** bit of code.

For a 5-bit data $d_5 d_4 d_3 d_2 d_1$, $n = 5$

$$2^k \geq 6 + k$$

Therefore, minimum value of *k* is 4. We need **4 parity bits**!

Step 2: Place Parity Bits in the positions of powers of 2.

Hamming Code	H_9	H_8	H_7	H_6	H_5	H_4	H_3	H_2	H_1
	d_5	p_4	d_4	d_3	d_2	p_3	d_1	p_2	p_1
Bit	9	**8**	7	6	5	**4**	3	**2**	**1**

Exercise

Step 2: Place Parity Bits in the positions of powers of 2.

data code: 11100

Hamming Code	H_9	H_8	H_7	H_6	H_5	H_4	H_3	H_2	H_1
	d_5	p_4	d_4	d_3	d_2	p_3	d_1	p_2	p_1
Bit	9	8	7	6	5	4	3	2	1
Binary Code	1001	1000	0111	0110	0101	0100	0011	0010	0001
p_1	1		1		0		0		
p_2			1	1			0		
p_3			1	1	0				
p_4	1								
Even Parity	1	1	1	1	0	0	0	0	0
Odd Parity	1	0	1	1	0	1	0	1	1

Step 3: Calculate the number of '1' in each parity bits

Step 4: Place '1' if odd number of '1' for even parity; else '0'; Place '0' if odd number of '1' for odd parity; else '1'

Exercise

Example: data $d_4d_3d_2d_1$ = 1000

Hamming Code	H_7	H_6	H_5	H_4	H_3	H_2	H_1
	d_4	d_3	d_2	p_3	d_1	p_2	p_1
Bit	7	6	5	4	3	2	1
Binary Code	111	110	101	100	011	010	001
p_1	1		0		0		
p_2	1	0			0		
p_3	1	0	0				
Even Parity	1	0	0	1	0	1	1
Odd Parity	1	0	0	0	0	0	0

Consider odd parity and if we receive a code of 1001000, check the parity bits

$$c_1 = (H_7, H_5, H_3, H_1) = (1, 0, 0, 0) = 0$$
$$c_2 = (H_7, H_6, H_3, H_2) = (1, 0, 0, 0) = 0$$
$$c_3 = (H_7, H_6, H_5, H_4) = (1, 0, 0, 1) = 1$$
$$c_3c_2c_1 = (100)_2 = 4$$