Assignment–4

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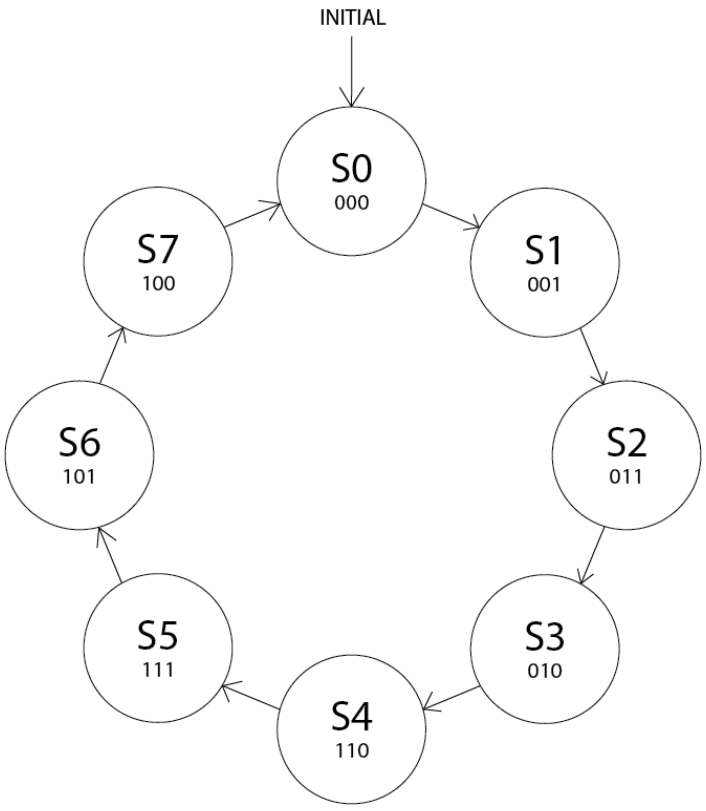
Question 1

a) States Assignment

S0 - 000
S1 - 001
S2 - 011
S3 - 010
S4 - 110
S5 - 111
S6 - 101
S7 - 100

State Diagram



State Table

Current State	Next State
S0	S1
S1	S2
S2	S3
S3	S4
S4	S5
S5	S6
S6	S7
S7	S0

Transition and Output Table

Current State			Next State		
q_2	q_1	q_0	q^*_2	q^*_1	q^*_0
0	0	0	0	0	1
0	0	1	0	1	1
0	1	1	0	1	0
0	1	0	1	1	0
1	1	0	1	1	1
1	1	1	1	0	1
1	0	1	1	0	0
1	0	0	0	0	0

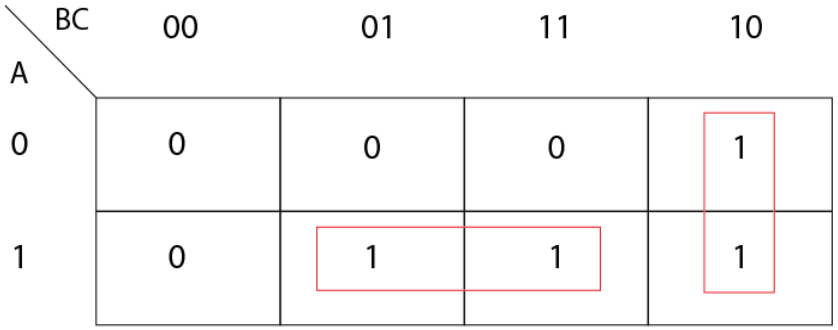
Excitation Table

Current State			Next State			Excitation Inputs		
A	B	C	A*	B*	C*	D_A	D_B	D_C
0	0	0	0	0	1	0	0	1
0	0	1	0	1	1	0	1	1
0	1	1	0	1	0	0	1	0
0	1	0	1	1	0	1	1	0
1	1	0	1	1	1	1	1	1
1	1	1	1	0	1	1	0	1
1	0	1	1	0	0	1	0	0
1	0	0	0	0	0	0	0	0

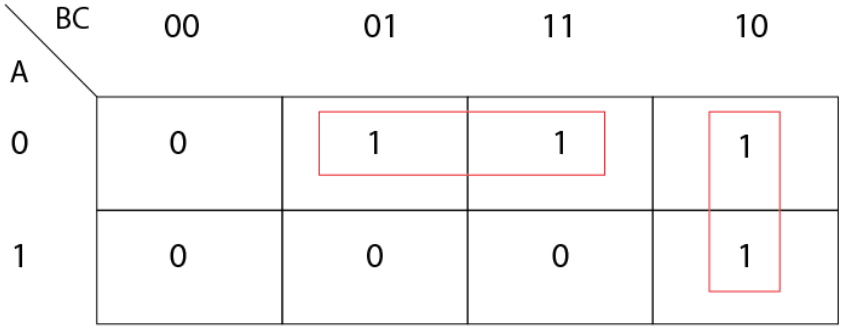
Where A, B, and C are the third, second and first bit of input respectively, and A*, B*, C* are the output values.
eg. 011 → 101
A = 0; B = 1; C = 1
A* = 1; B* = 0; C* = 1

b) K-map

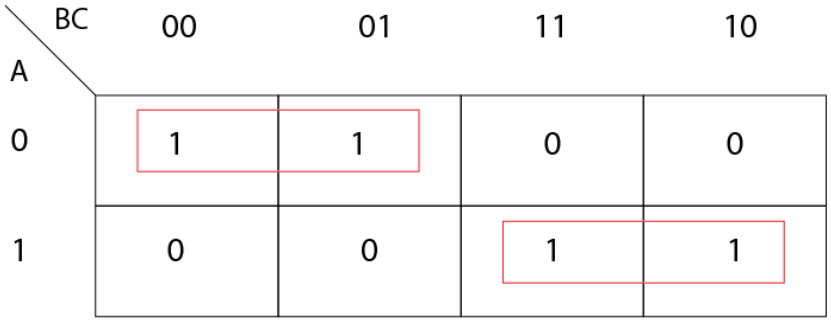
For each bit of the output, it will depend on the three bits of input according to the K-map shown below.



$$A^* = A.C + B.\overline{C}$$

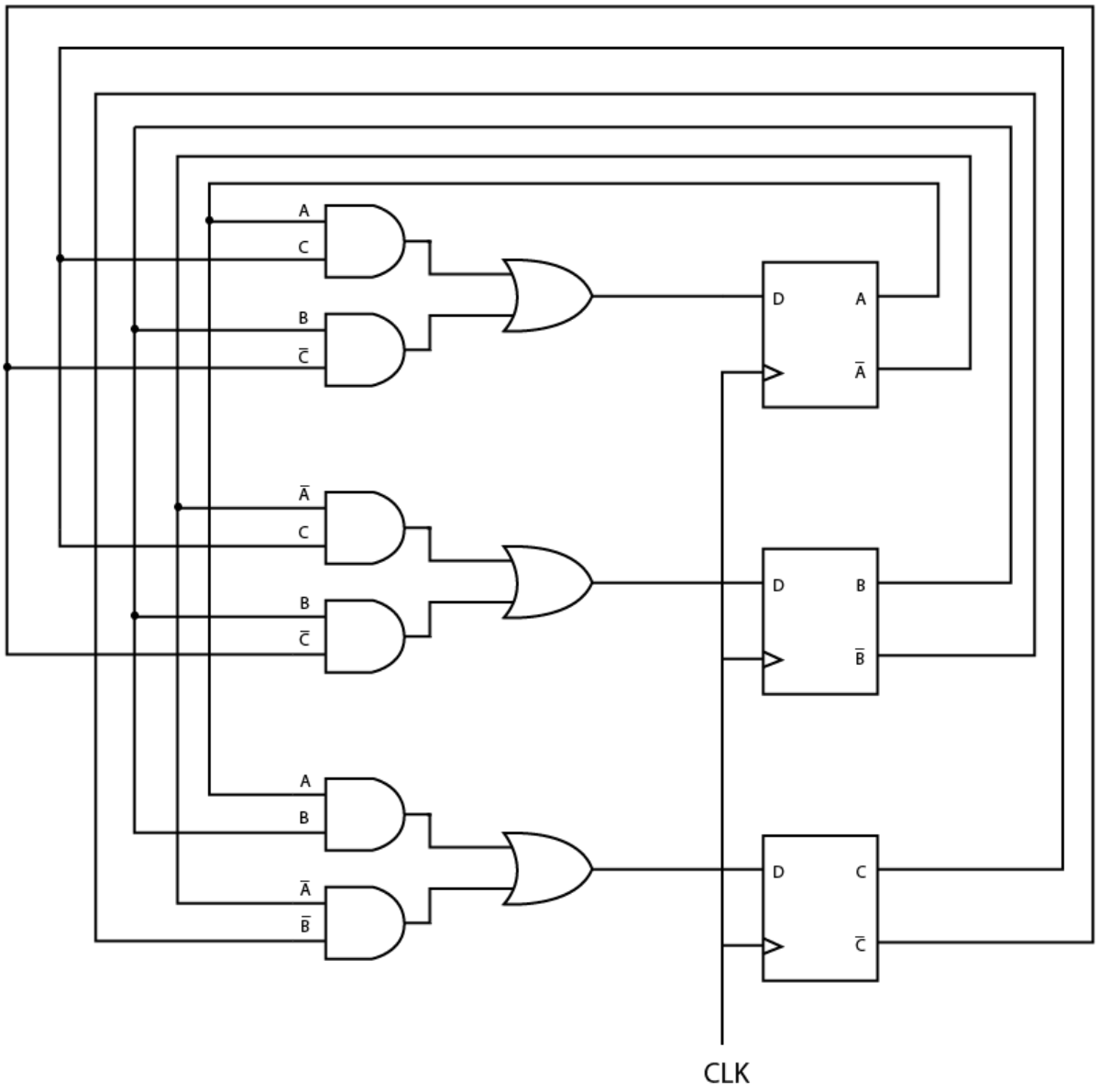


$$B^* = \overline{A}.C + B.\overline{C}$$



$$C^* = A.B + \overline{A}.\overline{B}$$

Logic Diagram



Logic Circuit made using AND Gates, OR Gates and D-flip flops.

Question 2

To get 2's complement of a binary number, simply invert the given number and add 1 to the least significant bit of the given result; in other words, you have to add 1 to the 1's complement to obtain 2's complement.

The most significant bit denotes the sign of the number i.e. if the MSB is 1 then the number is negative else the number is either 0 or positive
For k bits register, the positive largest number that can be stored is $(2^{(k-1)}-1)$ and the negative lowest number that can be stored is $-(2^{(k-1)})$.
In 2's complement, the number 0 does not have two signs however the most negative number does not have a corresponding positive number.

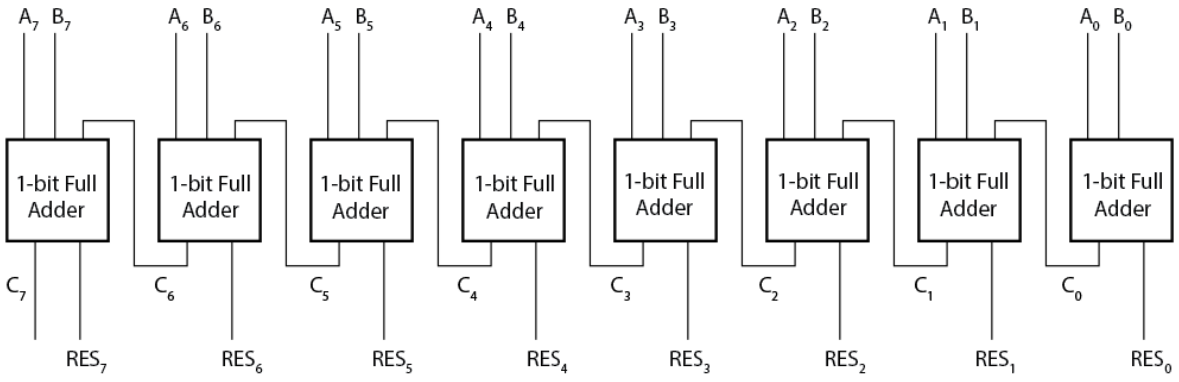
Addition in 2's Complement-

- When the positive number has greater magnitude, then take simply 2's complement of the negative number and carry bit 1 is dropped and this result will be a positive number.
- When the negative number has greater magnitude, then take 2's complement of the negative number and add it with the given positive number. Since there will not be any end-around carry bit, take 2's complement of the result and this result will be negative.
- With both negative numbers, you can add both of these Binary numbers and take results that will be negative only.

Subtraction in 2's Complement-

- Let the numbers be a,b and we want to find a-b.
- Take 2's complement of b.
- Add 2's complement of b with a.
- If the result of the above addition has carry bit 1, then it is dropped and this result will be a positive number.
- If there is no carry bit 1, then take 2's complement of the result which will be negative.

Working



The result obtained by the adder would be correct until there is a case of an overflow, which is needed to be checked by looking at C_6 and C_7 carry bits. If these two bits are different an overflow occurs.