

## BINARY COUNTER PROJECT (LOGIC LEVEL)

### Project requirements

1. The counter should count continuously in loop from its minimum value to its maximum value or from its maximum value to its minimum value, according to the table below.
2. The output should be in NBC (Natural Binary Code).
3. Internal states should be the same as the output states (no additional encoding/decoding).
4. T-type flip-flops should be used.
5. NAND and NOR gates should be used in first place (as opposed to AND and OR gates).

### How you should proceed (and what you should show in your report)

1. Draw the state graph with unused states left unconnected.
2. Fill in the truth table for the system.
3. Minimize Boolean functions for T3..T0 using Karnaugh maps. Make proper use of the unused states.
4. Check if no loop involving the unused states has been generated during minimization. There should now be a path from any of the unused states to a state belonging to the normal operation loop (not necessarily the minimum or the maximum one). Make changes to the equations if necessary.
5. Using De Morgan's laws, transform your equations so as NAND and NOR gates could be used (except when you can justify that this is not optimal in your case).
6. Draw the digital circuit schematic (flip-flops and gates) that corresponds to the equations.

The project is due for the 4th class. You will enter and simulate your digital circuit using DSch during this class. The report from task 2 will be due the week after.

### Counters' limiting values

Acct. no.	Lower limit	Upper limit	Counting direction
74	1	10	downwards
75	2	14	upwards
76	2	12	upwards
77	2	13	downwards
78	2	11	downwards
79	3	14	downwards
80	3	12	downwards
81	3	13	upwards
82	4	13	upwards
83	4	13	downwards
84	5	14	downwards
85	6	14	downwards
86	5	14	upwards
87	4	14	downwards

Acct. no.	Lower limit	Upper limit	Counting direction
88	1	13	downwards
89	1	9	downwards
90	1	11	downwards
91	1	11	upwards
92	2	13	upwards
93	1	9	upwards
94	1	14	upwards
95	4	14	upwards
96	3	12	upwards
97	3	13	downwards
98	3	14	upwards
99	2	12	downwards
100	2	11	upwards