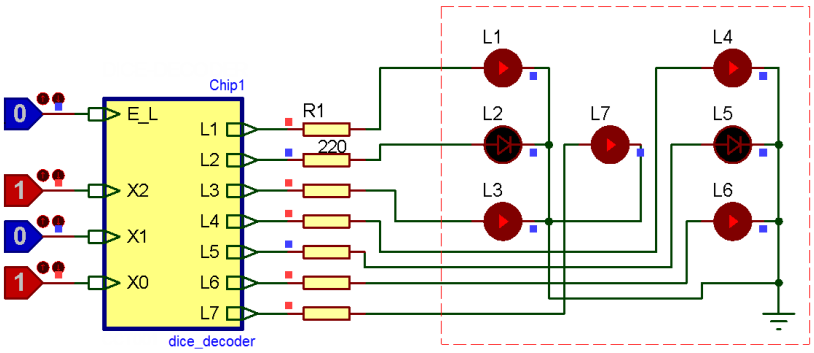
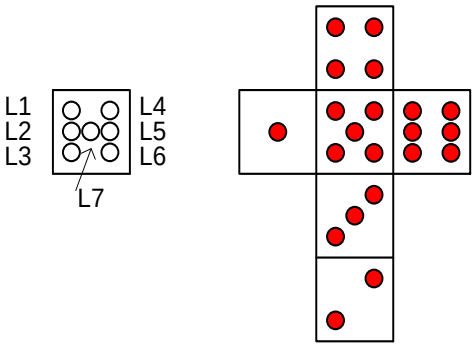
BACHELOR DEGREE IN TELECOMMUNICATIONS, Digital Circuits and Systems (CSD), March 21, 2017. Grades will be available on March 25. Questions about the exam: Instructors' office time. **It is mandatory to explain all the steps that you follow to solve each exercise in order to get grades. A student interview about the submitted work can also be requested.**

## Individual Test 1

The entity represented in Fig. 1a is an electronic dice decoder, a combinational block for adapting the binary numbers from 1 to 6 to a 7-LED display that has the typical layout shown in Fig. 1b. Codes "000" and "111" don't care.




a)




b) *The six faces of a dice.*

*Fig. 1 Circuit for driving an electronic dice decoder. A version of this circuit runs here* in Proteus.

1. Deduce the decoder truth table of all the outputs **L***i* = *f* (E_L, X2, X1, X0).
2. Describe the algebraic expression of **L3** as a product of maxterms.
3. Describe the algebraic expression of **L1** as a sum of minterms.
4. Express the output **L6** using only NAND.
5. Implement the output **L7** using the method of multiplexers and a MUX4 component.
6. Draw a behavioural flow chart and translate it to a VHDL file for the *dice_decoder*.
7. Using the method of decoders and a *Decoder_3_8* component, draw a schematic for the *dice_decoder* and write it in VHDL file. How many files are required?
8. If the following table in Fig. 2 represents the output from Minilog when inputting the *dice_decoder* truth table and simplifying by **PoS**, write down the equations for the outputs **L4** and **L6**.

```
E
 XXX    LLLLLLL
L210    1234567
===============
-11-  |  ..11...
---1  |  ......1
--1-  |  .1..1..
-1--  |  11..11.
0---  |  1111111
```

*Fig. 2 Output table format from Minilog.exe.*

a) Addition: (+116) + (-33)

b) Subtraction: (-33) - (+100)

c) Subtraction: (-100) - (-33)

d) Addition: (-125) + (+125)

*Fig. 3 Add and subtract in 8-bit 2C convention.*

9. Solve the arithmetic operations in Fig. 3 using 8-bit 2C (two's complement) number representation. Indicate when there is an overflow situation (OV flag). Which is the valid range of the operands and operations?
10. Propose a circuit structure able to perform the 8-bit 2C operations in *9)*.