

EE2026 (Part 1)

Tutorial 3 - Questions

Boolean Algebra Manipulation and Logic gates

1. Use algebraic manipulation to find the most simplified expression (MSOP, minimum SOP) for

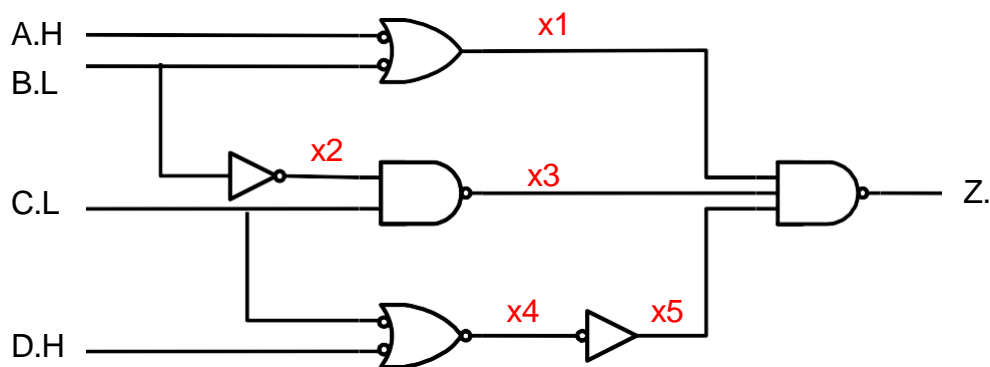
$$F = x_1x_3 + x_1\bar{x}_2 + \bar{x}_1x_2x_3 + \bar{x}_1\bar{x}_2\bar{x}_3$$

Write the Verilog code that describes the above function as a module (use dataflow description style).

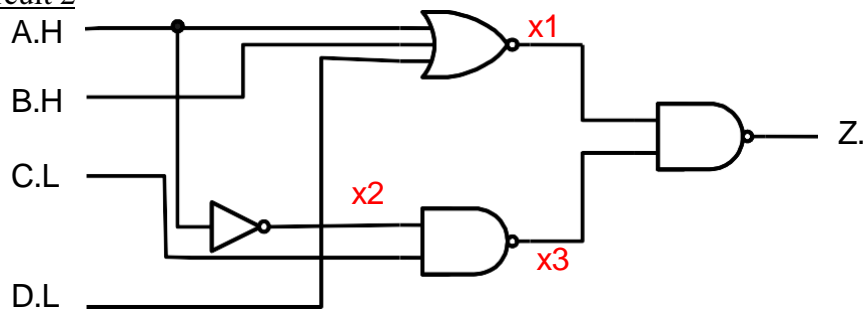
2. For circuits 1 and 2 below:

- (a) Fill in all the intermediate signal names using the positive logic convention
(b) Find the logic expression for Z for the two cases. (Simplification not necessary)

Circuit 1



Circuit 2



- (c) Using structural modeling style, write the Verilog code that describes Circuit 2. Assume that Verilog primitives are available: not(out,in), nand(out,in1,in2,...), nor(out,in1,in2,...).

3. Design a logic circuit implementing the following Boolean function, using a minimum number of NOR gates. NOT gates can also be used if required.

$$X = A \oplus B \oplus C,$$

where \oplus represents the 2-operand XOR operation.
Use alternate gate representation if necessary for clear circuit diagrams.

4. Design a circuit to realize $Z = \bar{A}B + \bar{B}\bar{C}D + \bar{B}\bar{D}$ in the positive logic convention.

A and B are active low signals while C , D and Z are active high.

Use a minimum of number of **only** NAND, or, **only** NOR gates. You may assume that the gates have no limits on the number of inputs. NOT gates can be used if required.

Draw clear circuit diagrams with alternate gate representations where necessary.

5. [Verilog Behavioural Style Modeling]

In the EE2026 design project, an OLED screen with 16-bit RGB colour resolution is used as a display device. The 16-bit signal colour resolution is represented through 5 bits for the red colour component, 6 bits for the green colour component, and 5 bits for the blue colour component. Write a Verilog program to switch between 4 display colours according to the table below.



The program receives a 2-bit input named SEL and produces a 16-bit output signal named PIXEL_COLOUR.

SEL	Colour To Display	PIXEL_COLOUR
"00"	Red	"11111 000000 00000"
"01"	Blue	"00000 000000 11111"
"10"	Green	"00000 111111 00000"
"11"	Magenta	"11111 000000 11111"