

Final exam DITE: Monday, January 17, 2022 – 14:15 to 17:15h

Task I (4 points): Perform the following 2 calculations:

A) Convert the BCD number **(0010 0101)_{BCD}** into a binary number;

B) Do the following arithmetic operation in the binary number system **by using the signed-1's complement representation** of the numbers:

$$\begin{array}{r} (-28) \\ - \\ (+36) \\ \hline ??? \end{array}$$

Important: Show and explain step-by-step how you perform the calculations.

Task II (5 points): Simplify the Boolean function

$F(A,B,C,D) = \sum m(0,1,2,4,5,10,11,13,15)$ by finding all prime implicants and essential prime implicants and applying the selection rule. After you have simplified the function, represent it using the **logic basis NAND**. Also, draw the combinational logic circuit corresponding to the function **using only 2-input NAND gates**.

Important: Show all prime implicants and essential prime implicants as well as explain all the steps you do to simplify and represent function $F(A,B,C,D)$.

Task III (6 points): Implement one JK flip-flop using the following components: one T flip-flop and one Multiplexer 4-to-1.

Important: Show and explain all the steps you do to implement the JK flip-flop.

Task IV (5 points): Design a Sequence Recognizer circuit that recognizes the occurrence of the sequence of bits "101", regardless of where it occurs in a longer sequence. This circuit has one input **X** and one output **Z**. An arbitrary long input sequence of bits enters the circuit via input **X**. Output **Z** equals to **0** when the previous three input bits to the circuit were **101**. Otherwise, **Z** equals to **1**.

Implement the circuit described above under the following conditions:

1. The Sequence Recognizer circuit **must be Moore Finite State Machine**;
2. Use **only** NOR gates, one SR Flip-Flop, and one D Flip-Flop.

Important: Show and explain all the steps you do to design and implement the Sequence Recognizer circuit.

The exam grade is equal to the obtained number of points divided by 2!