NAME:

This is an open notes and open-book exam. Write all your answers on these pages. Do all the problems within 55 minutes.

Solutions: 65 points total

1 Numerical Conversions and Arithmetic Operations (16 points)

A. Do the following *octal* subtraction problems using 8'complement arithmetic. Make sure you show your intermediate steps for full credit.

$$\begin{array}{r} 12_8 \\ -23_8 \\ \hline \end{array} \qquad \begin{array}{r} 23_8 \\ -12_8 \\ \hline \end{array}$$

$$\begin{array}{r} 12_8 \\ \text{8's-complement} \quad \underline{\qquad} \end{array} \qquad \begin{array}{r} 23_8 \\ \text{8's-complement} \quad \underline{\qquad} \end{array}$$

Answer Answer

B. Repeat the problem in Part A using *6-bit 2's-complement numbers.* Make sure you show your intermediate steps for full credit.

Base 2 equivalent of 12_8 Base 2 equivalent of 23_8

Base 2 equivalent of -23_8 _____ Base 2 equivalent of -12_8 _____

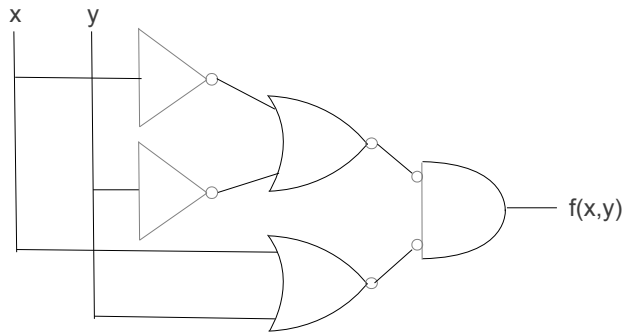
Base 2 equivalent of 12_8 Base 2 equivalent of 23_8

2's-complement of -23_8 _____ 2's-complement of -12_8 _____

Answer Answer

2 Analysis (18 Points)

Consider the schematic shown below.



A. Using the schematic, what is *simplest* logical formula for $f(x, y)$? *Hint: no minimization is necessary.*

$$f(x, y) =$$

B. Express $f(x, y)$ as a sum of **minterms** (m_0, m_1, m_2, m_3) and as a product of **maxterms** (M_0, M_1, M_2, M_3).

$$f(x, y) = \Sigma(\qquad\qquad)$$
$$f(x, y) = \Pi(\qquad\qquad)$$

C. Complete the timing diagram for $f(x, y)$ below.

x	0	0	1	1
y	0	1	0	1
f(x,y)				

3 Design Problem (7 Points)

Implement the following function *using only two 2-input nand gates.*

$$f(x, y, z) = x' + y \cdot z$$

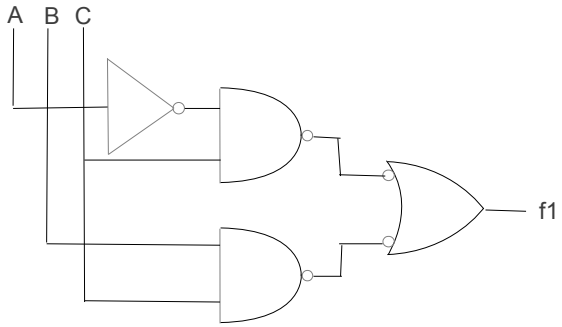
Draw your schematic below clearly showing all the (1) inputs, (2) connections between the gates, and (3) the output $f(x, y, z)$. *Hint: remember because of DeMorgan's Law, there are two gate symbols for nand.*

4 Verification Problem (24 Points)

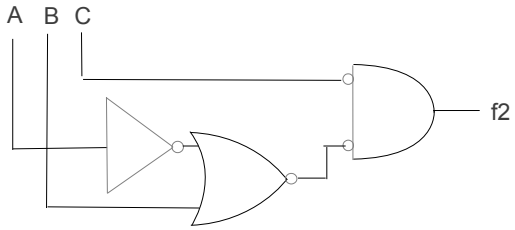
Alice and Bob are junior hardware engineers reporting to you. Their task is the implement the following function:

$$f(A, B, C) = \Sigma(1, 3, 7).$$

Alice returns with the design shown below in (a), Bob returns with the design shown below in (b).



(a) Alice's Design



(b) Bob's Design

Whose design is correct? For full credit, you must provide convincing evidence that Alice's and Bob's designs are either correct or flawed.