Homework Number 3

Telmen Enkhbold

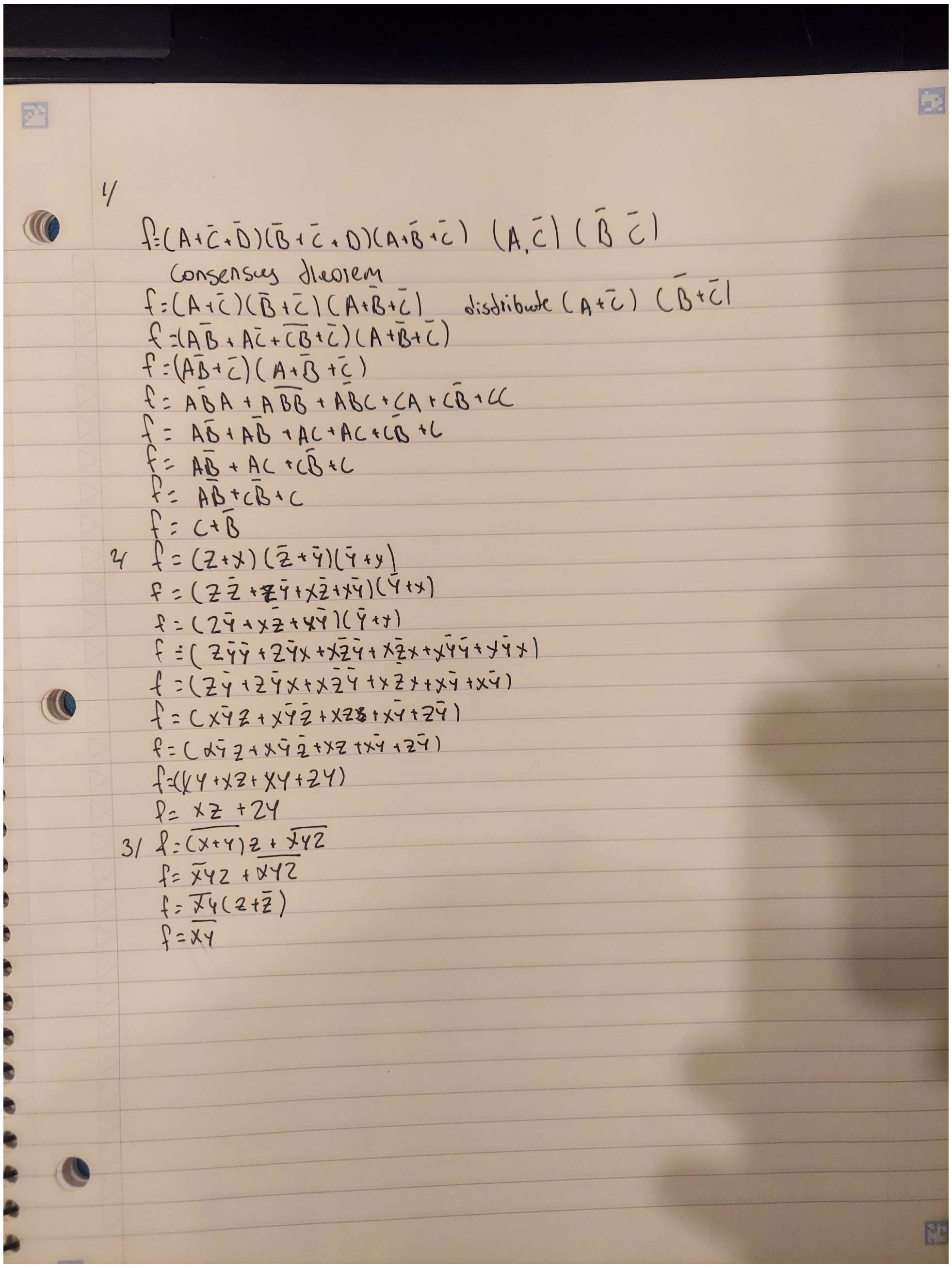
San Francisco Bay University

1.

$$f = (A + \bar{C} + \bar{D})(\bar{B} + \bar{C} + D)(A + \bar{B} + \bar{C})$$

$$f = (Z + X)(\bar{Z} + \bar{Y})(\bar{Y} + X)$$

$$f = \overline{(X + Y)}Z + \bar{X}\bar{Y}\bar{Z}$$



1/

$f = (A+\bar{C}+\bar{D})(\bar{B}+\bar{C}+D)(A+\bar{B}+\bar{C})$ $(A, \bar{C})$ $(\bar{B}\ \bar{C})$

Consensus theorem

$f = (A+\bar{C})(\bar{B}+\bar{C})(A+\bar{B}+\bar{C})$ distribute $(A+\bar{C})$ $(\bar{B}+\bar{C})$

$f = (A\bar{B} + A\bar{C} + \bar{C}\bar{B} + \bar{C})(A+\bar{B}+\bar{C})$

$f = (A\bar{B} + \bar{C})(A + \bar{B} + \bar{C})$

$f = A\bar{B}A + A\bar{B}\bar{B} + A\bar{B}\bar{C} + \bar{C}A + \bar{C}\bar{B} + \bar{C}\bar{C}$

$f = A\bar{B} + A\bar{B} + A\bar{C} + A\bar{C} + \bar{C}\bar{B} + \bar{C}$

$f = A\bar{B} + A\bar{C} + \bar{C}\bar{B} + \bar{C}$

$f = A\bar{B} + \bar{C}\bar{B} + \bar{C}$

$f = \bar{C} + \bar{B}$

2/ $f = (Z+X)(\bar{Z}+\bar{Y})(\bar{Y}+X)$

$f = (Z\bar{Z} + Z\bar{Y} + X\bar{Z} + X\bar{Y})(\bar{Y}+X)$

$f = (Z\bar{Y} + X\bar{Z} + X\bar{Y})(\bar{Y}+X)$

$f = (Z\bar{Y}\bar{Y} + Z\bar{Y}X + X\bar{Z}\bar{Y} + X\bar{Z}X + X\bar{Y}\bar{Y} + X\bar{Y}X)$

$f = (Z\bar{Y} + Z\bar{Y}X + X\bar{Z}\bar{Y} + X\bar{Z}X + X\bar{Y} + X\bar{Y})$

$f = (X\bar{Y}Z + X\bar{Y}\bar{Z} + X\bar{Z} + X\bar{Y} + Z\bar{Y})$

$f = (X\bar{Y}Z + X\bar{Y}\bar{Z} + X\bar{Z} + X\bar{Y} + Z\bar{Y})$

$f = (X\bar{Y} + X\bar{Z} + X\bar{Y} + Z\bar{Y})$

$f = X\bar{Z} + Z\bar{Y}$

3/ $f = \overline{(X+Y)}Z + \bar{X}\bar{Y}\bar{Z}$

$f = \bar{X}\bar{Y}Z + \bar{X}\bar{Y}\bar{Z}$

$f = \bar{X}\bar{Y}(Z+\bar{Z})$

$f = \bar{X}\bar{Y}$

2.

Adder-Subtractor Operation:

1. **Full Adders (FA)**: There are four full adder (FA) blocks in the circuit. Each full adder takes in three inputs: two bits from the numbers **A** and **X** to be added and a carry input from the previous stage. It outputs a sum **S** and a carry **C**.
2. **Add/Subtract Control (S)**: The control input **S** determines whether the circuit performs addition or subtraction.
    - If **S=0**: The circuit adds the numbers **A** and **B**.
    - If **S=1**: The circuit subtracts **B** from **A**.
3. **XOR Gates**: The XOR gates (with inputs **B** and **S**) are used to determine the value of **X** based on **B** and the control signal **S**.

Implementation:

1. **When S=0 (Addition)**
    - **X** is equal to **B**, meaning $Xi = Bi$.
    - **C_0** (initial carry) is set to **0**.
    - The circuit adds **A** and **B**.
2. **When S=1 (Subtraction)**
    - **X** is the bitwise NOT of **B**, meaning $Xi = \bar{B}i$.
    - **C_0** (initial carry) is set to **1**.
    - This operation effectively adds **A** to the two's complement of **B**, performing subtraction.

Test Cases:

1. **A + B = 7 + (-3) = 4**
    - Convert the numbers to 4-bit binary: A (7) = 0111 B (-3) = 2's complement of 3 = 1101
    - Set **S = 0** for addition: The circuit adds 0111 + 1101 = 10100. The result is 0100 (4 in decimal) with an overflow.
2. **A - B = -6 - (-1) = -5**
    - Convert the numbers to 4-bit binary: A (-6) = 2's complement of 6 = 1010 B (-1) = 2's complement of 1 = 1111
    - Set **S = 1** for subtraction: The circuit adds 1010 + 0001 (because of two's complement) = 1011. The result is 1011 (-5 in decimal when interpreted as two's complement).

3.

1.

Load 104

Opcode - 0001

Int - 104, Hex – 68, Binary – 1000100, 12 bits – 0001 000100

Machine Code - 0010 0001 000101

2.

Add 105

Opcode – 0010

Int – 105, Hex – 69, Binary – 1000101, 12 bits – 0001 000101

Machine Code – 0010 0001 000101

3.

Store 106

Opcode – 0011

Int - 106, Hex – 6A, Binary – 1001010, 12 bits – 0001 001010

Machine Code – 0011 0001 001010

4.

Halt

Opcode – 0100

Machine Code – 0100 0000 000000