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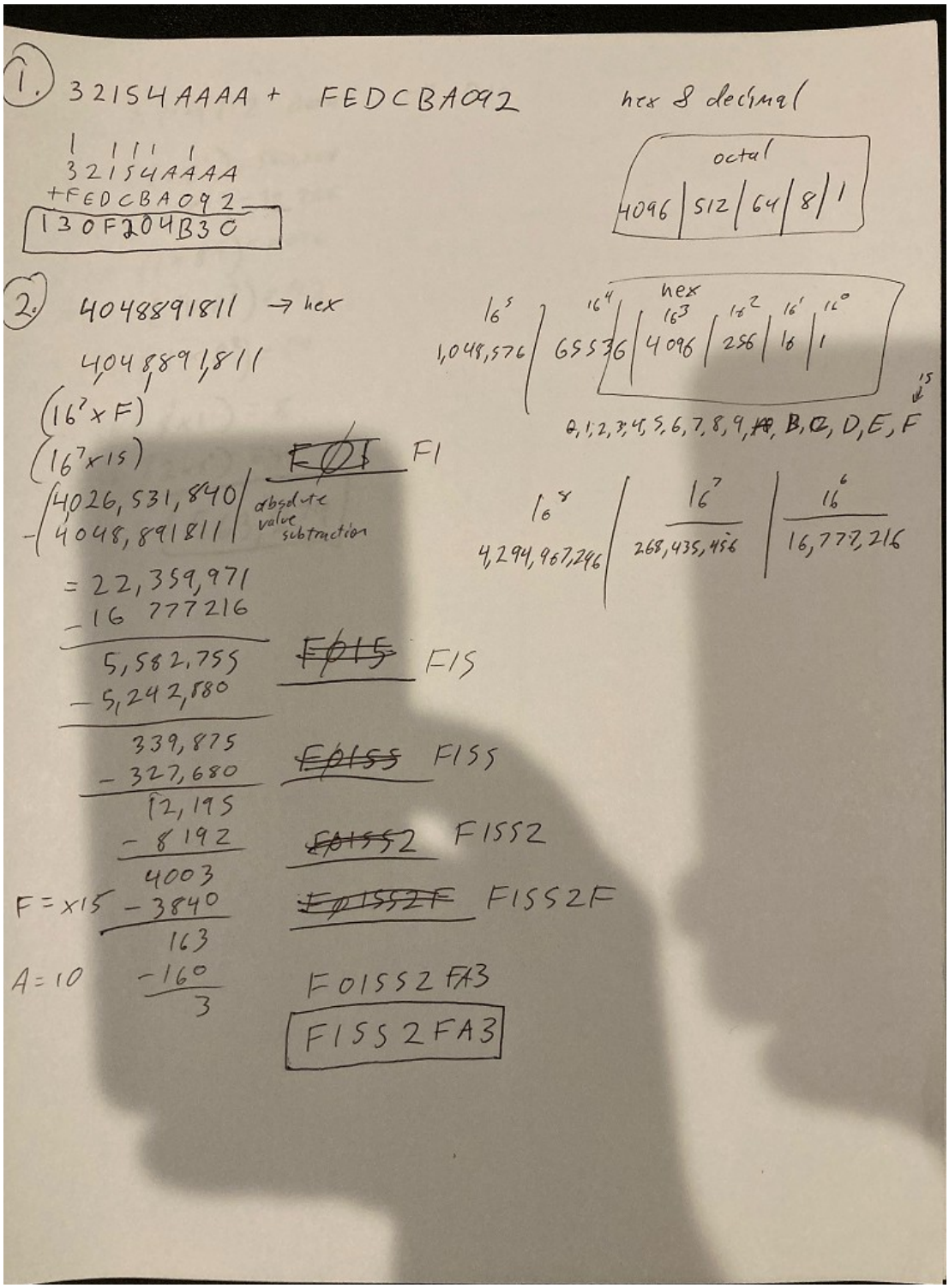
Computer Architecture - Assignment 2: Converting Numbers & Truth Tables

Part 1



3. 2114112 octal → Dec

$(2 \times 8^6) = 524,288$

$+ (1 \times 8^5) - 32\,768$

$+ (1 \times 8^4) - 4096$

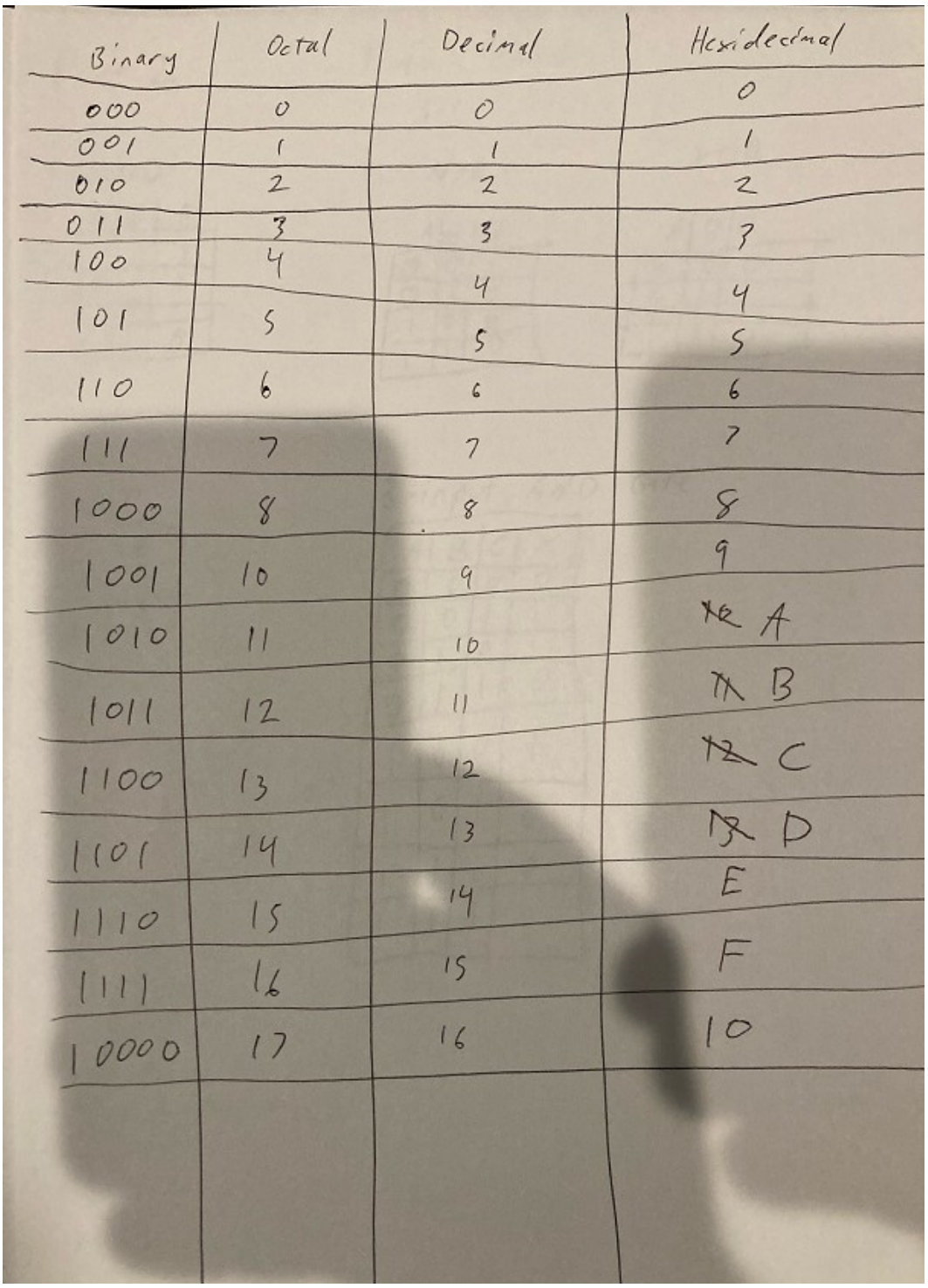
$+ (4 \times 8^3) = 512$

$+ ((1 \times 8^2) = 64$

$+ (8^1 \times 1) = 8$

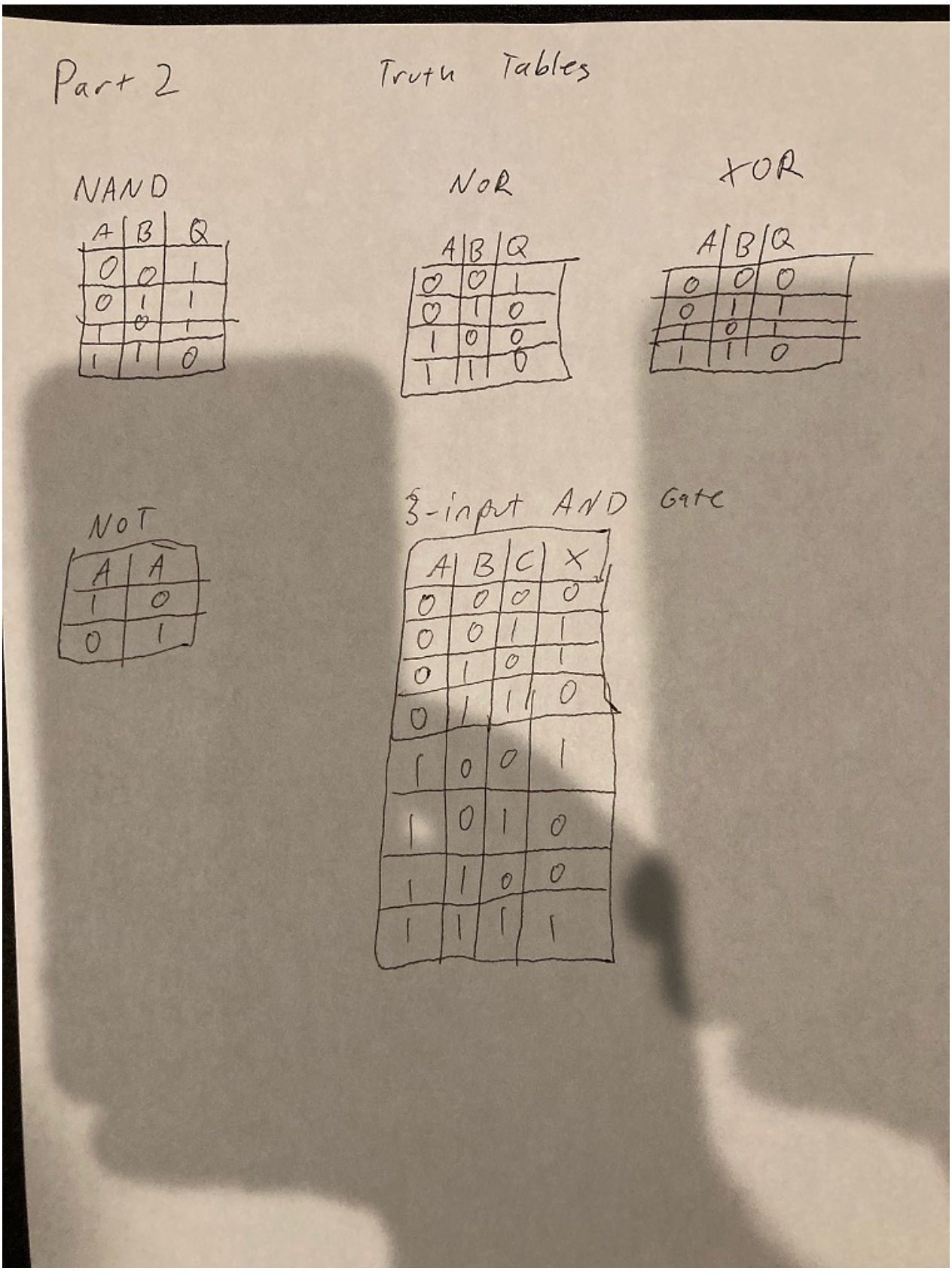
$+ (2 \times 8^0) = 1$

563,274



Binary	Octal	Decimal	Hexidecimal
000	0	0	0
001	1	1	1
010	2	2	2
011	3	3	3
100	4	4	4
101	5	5	5
110	6	6	6
111	7	7	7
1000	8	8	8
1001	10	9	9
1010	11	10	A
1011	12	11	B
1100	13	12	C
1101	14	13	D
1110	15	14	E
1111	16	15	F
10000	17	16	10

Part 2


Part 2
Truth Tables
NAND
A B Q
0 0 1
0 1 1
1 0 1
1 1 0
NOR
A B Q
0 0 1
0 1 0
1 0 0
1 1 0
XOR
A B Q
0 0 0
0 1 1
1 0 1
1 1 0
NOT
A Ā
1 0
0 1
3-input AND Gate
A B C X
0 0 0 0
0 0 1 1
0 1 0 1
0 1 1 0
1 0 0 1
1 0 1 0
1 1 0 0
1 1 1 1

Part 3

Why is it important to study how to manipulate fixed-point numbers? Provide examples of these systems in use.

The manipulation of fixed point numbers is important in the field of computer science and is regularly in use at the cutting edge of technology. Technologies such as game development, artificial intelligence, and cryptocurrency are all dependent on the use of fixed-point numbers and the math that goes along with their manipulation. As computing continues to grow and improve and the end of Moores law becomes a reality new technologies focused around the use of fixed-point number manipulation are essential to avoid what is called dark silicon valley. (Johnson)

Fixed point arithmetic is important in gaming engines. In 3D gaming movement and rendering of 3D objects is all conducted with code that executes fixed-point number arithmetic. An understanding of this math is important for the programmer as they must develop algorithms that execute functions like camera zoom and redraw for example.(Griggs)

The ability to convert from binary, octal, hexadecimal, and decimal is paramount to programmers because there are frequently conversions that must take place. For example different data types require different number systems. Pixels often use hexadecimal for coloring, while the pixel position might be in decimal. These numbers might need to go through arrays for storage or matrices for on the fly changes during game play. Fixed-point number manipulation is important for many tasks in software development. Griggs)

The most cutting edge research in computer science such as AI is very tied to the use on fixed-point arithmetic. The ability for computers to complete fixed-point arithmetic is important in bench-marking and is embedded in nearly all computational fields and applications. Silicon valley is currently developing new chip architectures that focus heavily on improving efficiency in completing fixed-point arithmetic. Artificial intelligence and computer learning models are being devoted to improvements in this regard. “The ResNet-50 convolutional neural network, are trained using floating point arithmetic.” (Johnson)

There are important security issues regarding fixed-point arithmetic in computer science. The entire field of cyber security is heavily dependent on this mathematics. When data is encrypted and decrypted for transmission over the internet or for security purposes on a computer fixed-point math is used. As AI continues to advance there is a an emphasis on making cryptography for complex. Hash functions are being reevaluated to include chaos based cryptography. (Teh)

Cryptography is also important in the field of block-chain technology. These technologies utilize math to create and distribute their products such as cryptocurrency and NFTs. The block-chain technologies are still growing people are starting to realize they power they possess. There are applications in currency, money transfer, contracts, the internet of things, healthcare, logistics, government, and media. All of these applications will need development software and technologies that will involve the use of fixed-point number manipulation in their applications since the block-chain itself is a mathematics based technology. Even chips like GPUs which were initially only thought to be useful in certain industries like gaming and certain applications like weather forecasting are now focused on fixed-point number manipulation. After all one of the main differences in an CPU and a GPU is its ability to focus heavily in one area like crunching the numbers of fixed-point number manipulation.

Cited

Grigg, Robert. 2020 Feb 4. C++ Fast Track for Games Programming Part 14: Fixed Point. https://www.3dgep.com/cpp-fast-track-14-fixed-point/. cited 6/6/2023.

Johnson, Jeff. 2018 Nov 8. Engineering at Meta. Making floating point math highly efficient for AI hardware. https://engineering.fb.com/2018/11/08/ai-research/floating-point-math/. cited 6/6/2023.

Teh, J.S., Alawida, M. & Ho, J.J. Unkeyed hash function based on chaotic sponge construction and fixed-point arithmetic. Nonlinear Dyn 100, 713–729 (2020). https://doi.org/10.1007/s11071-020-05504-x.