Computer Architecture

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Exercise: Compute the truth table for NOT:

X	NOT X
0	1
1	0

Exercise: Compute the truth table table for AND.

X	Y	X AND Y
0	0	0
1	0	0
0	1	0
1	1	1

Exercise: Compute the truth table for exclusive-or, defined by the formula: XOR(X, Y) = (X OR Y) AND NOT (X AND Y)

X	Y	X XOR Y
0	0	0
1	0	1
0	1	1
1	1	0

Exercise: Prove De Morgan's theorem, NOT(X OR Y) = NOT(X) AND NOT(Y), by completing the table and checking the last two columns are the same.

X	Y	NOT(X OR Y)	NOT(X) AND NOT(Y)
0	0	1	1
1	0	0	0
0	1	0	0
1	1	0	0

Exercise: using truth tables, check these three equations

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NOT(X) = NAND(1, X)
AND(X, Y) = NOT(NAND(X, Y))
OR(X, Y) = NAND(NOT(X), NOT(Y)))
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X	Y	NAND(1, X)	NOT(X)
0	0	1	1
1	0	0	0
0	1	1	1
1	1	0	0

X	Y	AND(X, Y)	NOT(NAND(X, Y))

0	0	0	0
1	0	0	0
0	1	0	0
1	1	1	1

X	Y	OR (1, X)	NAND (NOT(X), NOT(Y))
0	0	0	0
1	0	1	1
0	1	1	1
1	1	1	1

Exercise: why NOT and OR can't be expressed in terms of AND? Explain.
NOR cannot be expressed because it is a function for one operator (and is for two operators). OR cannot be expressed because it mostly depends on each operator separately while AND depends on both operators.

Exercise: Without listing explicitly, how many possible 8-bit binary numbers are there?
256 (as 2^8)

Exercise: Convert X = 110 to decimal.
6

Exercise: Convert 11 to binary.
1011

Exercise: Convert these powers of 2 into binary: 2, 4, 8, 16, 32. What do you notice?
10, 100, 1000, 10000, 100000. I noticed that the amount of zeros in each number equals the power of 2 in that number (for 32 (2^5) there are 5 zeros)

Exercise: Convert these numbers into binary: 1, 3, 7, 15, 31 (they are all 2^n - 1 for some n). What do you notice?
1, 11, 111, 1111, 11111. All results consist of number “1”. The amount of “1” equals n.

Exercise: check that these numbers all have the same 3-bit representation: 3 = 11 = 17, 0 = 8 = 16, 2 = 10 = 18.

1) **011** | 001 **011** | 010 **001** no
2) **000** | 001 **000** | 010 **000** yes
3) **010** | 001 **010** | 010 **010** yes

Exercise: complete the table by converting 2 into single-bit binary:

X0	Y0	Z0
0	0	0
1	0	1
0	1	1
1	1	0

Exercise: do the same for single-bit multiplication: write down the table of binary numbers for X0, Y0, and the binary representation of their product Z0, and find the logical operation which matches. We say this operation *implements single-bit multiplication*.

X0	Y0	Z0
0	0	0
1	0	0
0	1	0
1	1	1

It matches logical operation NOR

Exercise: Using A and B as the inputs, and OUT as the output, explain how this circuit acts as NAND(A,B); for each entry in the truth table, follow the explanation above. True is "high energy" and False is "low energy".

A	B	NAND(A,B)
0	0	0
1	0	1
0	1	1
1	1	0

Exercise: show that every IPv4 can be represented by four 8bit unsigned integers, and that every 8bit unsigned integer is between 0 and 255.
I did not quite understand the question. But I can tell that in IPv4 we can represent the address as x.x.x.x were x is number in range(0, 255). For example: 127.0.0.1 (localhost)

Exercise: use ping in a terminal to resolve a domain name. Copy-paste the command you used, and the result.
My command: ping google.com
The answer:
Pinging google.com [216.58.209.174] with 32 bytes of data:
Reply from 216.58.209.174: bytes=32 time=77ms TTL=108
Reply from 216.58.209.174: bytes=32 time=96ms TTL=108
Reply from 216.58.209.174: bytes=32 time=138ms TTL=108
Reply from 216.58.209.174: bytes=32 time=78ms TTL=108

Ping statistics for 216.58.209.174:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 77ms, Maximum = 138ms, Average = 97ms

Exercise: how many IPv4 addresses are there? Is it enough? Explain. –
There are 2^32 variants. I think it is not enough and because of that we have now IPv6 addresses.

Exercise: The Multipath TCP project aims to allow TCP packets to be split across multiple network links and reassembled at the destination. For example, if you were uploading a 100 megabyte file to a server from your phone, it would allow you to send 75 megabytes by WiFi and 25 megabytes by cellular automatically. How should the ratio be chosen if you want to minimise transmission time? Minimise cellular bandwidth use? Explain.

Exercise: UDP is popular for streaming media; explain why.

Udp does not require confirmation, searching for lost packets and re-requesting them when receiving the data, in contrast to TCP.
Moreover, speed is very important for streaming, while codecs can outlive the lost of some packages.

Exercise: Read the Wikipedia articles on multicast and anycast routing. Why is anycast good for content delivery networks, and why is multicast good for live-streaming? What are some other uses for these?

Anycast is good choice for delivery networks because it allows device to sent data to nearest receiver. It is made in such scheme: one to one. Anycast is used for balancing dns-servers.
Multicast is a "one to many" form of casting. So it can be used for life streaming . radio and video conferences.