REC 1: Number Representation

Problem 1 Binary

Compute each of the operations in the given base. (You're welcome to convert back to base 10 to check your work, but do give yourself the experience of computing in other bases. I admit that the experience feels kind of awkward at first, but these exercises build fluency and motivate essential questions).

i $(0110)_2 + (11100)_2$

ii $(0110)_2 * (101)_2$

iii $(123)_7 * (42)_7$

Suggestion: It might sound silly, but try doing a quick base-10 3-digit by 2-digit multiplication to prime your brain a bit before working in base-7

Problem 2 Base conversion

An IP address expresses the location of a computer within a network. IP addresses are 32-bit binary numbers, commonly expressed in the dotted-decimal format in which the 32 bits are sliced into four sections with 8 bits each. The table below shows a single IP address in different representations (i.e. they're all equivalent):

Notation	**Value**
Dotted decimal	192.0.2.235
Hexadecimal	0xC00002EB
Decimal	3221226219
Octal	$(030000001353)_8$
Binary	$(11000000000000000000001011101011)_2$

Table modified from Wikipedia on IPv4.

i Convert the IP address 179.55.223.12 from dotted decimal format to hexadecimal and decimal formats.

ii Convert the IP address $(BAC2A78F)_{16}$ to the dotted decimal and decimal formats.

Problem 3 Number Representation
Write a succinct, sufficient explanation (proof) which shows why Euclid's Division method correctly converts a number from base10 to binary.

Hint: while not a proof, it may help to look at a particular example (e.g. $14 = (1110)_2$). Do Euclid's Division Algorithm to convert and then see if you can be clever about substituting the equalities into each other to produce only powers of two.

Problem 4 More base conversion
Solve for x in each of the equalities below

i $(10)_{10} = (x)_2$

ii $(1100)_2 = (x)_{10}$

iii $(A9)_{16} = (x)_{10}$

Problem 5 Binary, 2's Complement

In this problem each operation has the second term converted already to binary. Your job is to convert the first term, perform the operation in binary, and verify the result.

- -39 + 92 = 53:

  + 0 1 0 1 1 1 0 0

- -19 + -7 = -26:

  + 1 1 1 1 1 0 0 1

- 44 + 45 = 89:

  + 0 0 1 0 1 1 0 1

- 104 + 45 = 149:

  + 0 0 1 0 1 1 0 1

- -75 + 59 = -16:

  + 0 0 1 1 1 0 1 1

- -103 + -69 = -172:

  + 1 0 1 1 1 0 1 1

- 10 + -3 = 7:

  + 1 1 1 1 1 1 0 1

- 127 + 1 = 128:

  + 0 0 0 0 0 0 0 1

- -1 + 1 = 0:

  + 0 0 0 0 0 0 0 1