Course Structure

1) Itroduction
2 Floationg point Representation
3 Basic of computer system & Microoperations
4 Instruction & Addressing Mode
5 CPU , Data-path & Control unit
6 IO Organization
7. Memory & cache
8 pipelining

(items 1–5: CA; items 6–8: CO)

~~Books~~

~~Computer system Architecture~~

* **Sign Magnitude**

| S | m | n-bits

S → Sign → 0 +ve, 1 -ve

m → Magnitude

+5 = — $(0101)_2$

-5 = — $(1101)_2$

+0 = 0000

-0 = 1000

1's Complement

jo 1 hai usko 0 krod, jo 0 h usko 1 krdo

most signiticat bit, LSB Least significat bit

+5 = (0101)

-5 = 1010

(11001) → -6

1's complement

00110 = 6

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$+0 = 0000$
$-0 = 1111$

* 2's Complement

Take the 1's complement of value and plus one

$+5 = (0101)_2$

⇓

2's complement

$$\begin{array}{r} 1010 \\ +1 \\ \hline (1011)_2 \end{array} = -5$$

- $(11010)_2 = -6$

$$\begin{array}{r} 00101 \\ +1 \\ \hline 00110 \end{array} = +6$$

* Stored program Architecture

The program which processor executes should be stored in a memory. (RAM)

* von-neumann's
* ~~Hoooo~~ Havard arch

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* Floating point Representation

Why is it needed?
example → 8 - bits

Range -2^7 to $+(2^7-1)$. 2's comp
-128 to $+127$

It provides larger range of numbers with limited no. of bits.

The number is represented in format:

S	E	M

S = Sign { 0 +ve, 1 -ve

E = Exponent
M = Mantissa (fraction)

- Mantissa is signed normalized fraction number (implicit/Explicit)

- Exponent is stored in biased form. → unsigned value/number only

* Biased

S	E	M

Assume → 5 bits

Range of a number with 5 bits → -16 to $+15$ → Transform to unsigned 0 to 31

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Original exponent (e)	Stored exponent (E) excess - 16
-16	0
-15	1
-14	2
⋮	⋮
0	16
⋮	⋮
+15	31

$E = e + 16 \longrightarrow E = e + \text{bias}$

$\text{bias} = 16$

if k-bits are used to store $E \Rightarrow \text{Bias} = 2^{k-1}$

* Normalization

101.11 → Explicit Normalization $\Rightarrow 0.10111 * 2^3$

101.11 → Implicit Normalization

* In Explicit, after the point we "must" have "1"

M = Number after the point = 10111

$e = 3$

$E = 3 + \text{bias}$

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In implicit normalization before point we must have '1'

$101.11 \longrightarrow 1.0111 * 2^{2}$

$M = 0111$
$e = 2$
$E = 2 + bias$

→ Explicit is the default normalization.

$\boxed{S \mid 3+bias \mid 10111}$ explicit

$\boxed{S \mid 2+bias \mid 0111}$ implicit

→ Point is not stored
→ Bits before point is not stored
→ Base of system not stored

* Value formula [Something to the power of 0 is always '1'

Value (explicit) $= (-1)^{S} * 0.M * 2^{E-bias}$

Value (implicit) $= (-1)^{S} * 1.M * 2^{E-bias}$

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Q Consider a 16 bit register used to store floating point numbers. The mantissa is normalized signed fraction number. Exponent is represented in excess-32 form. What is the 16 bit value of $(+19.25)_{10}$ in this register?

$\xleftarrow{\quad 16 \quad}$

S	E	M
1	6	9

Bias = 32 = 2^{k-1}, 6

$+(19.25)_{10}$ Sign = +ve
S = 0

$(10011.01)_2 \Rightarrow$ explicit Normlization $= 0.1001101 \times 2^5$

e = 5

E = 5 + 32 = 37

37 = (100101)

M = 1001101

S	E	M
0	100101	100110100

↓ ↓ ↓ ↓

4 B 3 4

$(4B34)_{16}$

0x 4B34

Representation of hexa decimal

What is the maximum value that can be represented in above register?

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[S | E | M] Value $= (-1)^0 \times 0.111111111 \times 2^{63}$

0 1--1 1---1

$= (2^9 - 1) \times 2^{-9} \times 2^{31}$

$= 511 \times 2^{22}$

what is the minimum value that can be represented in above register.

[S | E | M] Value $= +0.1 \times 2^{0-32}$

0 00--0 10--0

$= 1.0 \times 2^{-1} \times 2^{-32}$

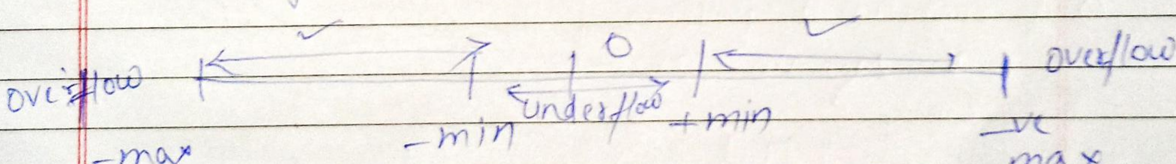
$= +2^{-33}$

what is the negative maximum possible value that can be represented above register

[S | E | M] Value $= -2^{-33}$

1 00--0 10--0

* Range and precision



More bit in M => Better Precision

More bit in E => Better Range

If cannot store 0

If cannot store very small values (underflow)

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