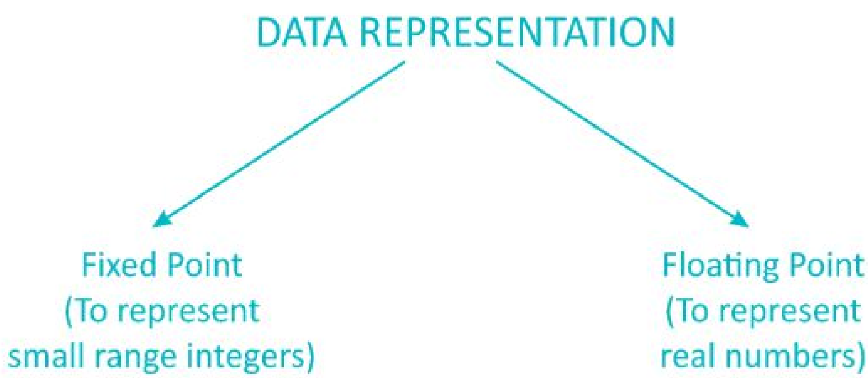
Data Representation for GATE - Study Notes in PDF

Data Representation is considered as one of the most important topics for GATE Exam. Questions from this section are asked every year for GATE. It also holds a good weight in the GATE Paper. Hence, it becomes very necessary for the aspirants of GATE to be well acquainted with this topic. Read this article to know all about Data Representation for GATE and fetch qualifying marks in your upcoming GATE exam. Moreover, check your exam preparations by taking [Testbook GATE Test Series](). Also, you can also download the article as PDF.

What is Data Representation for GATE?

The Data Representation is broadly classified into two categories:

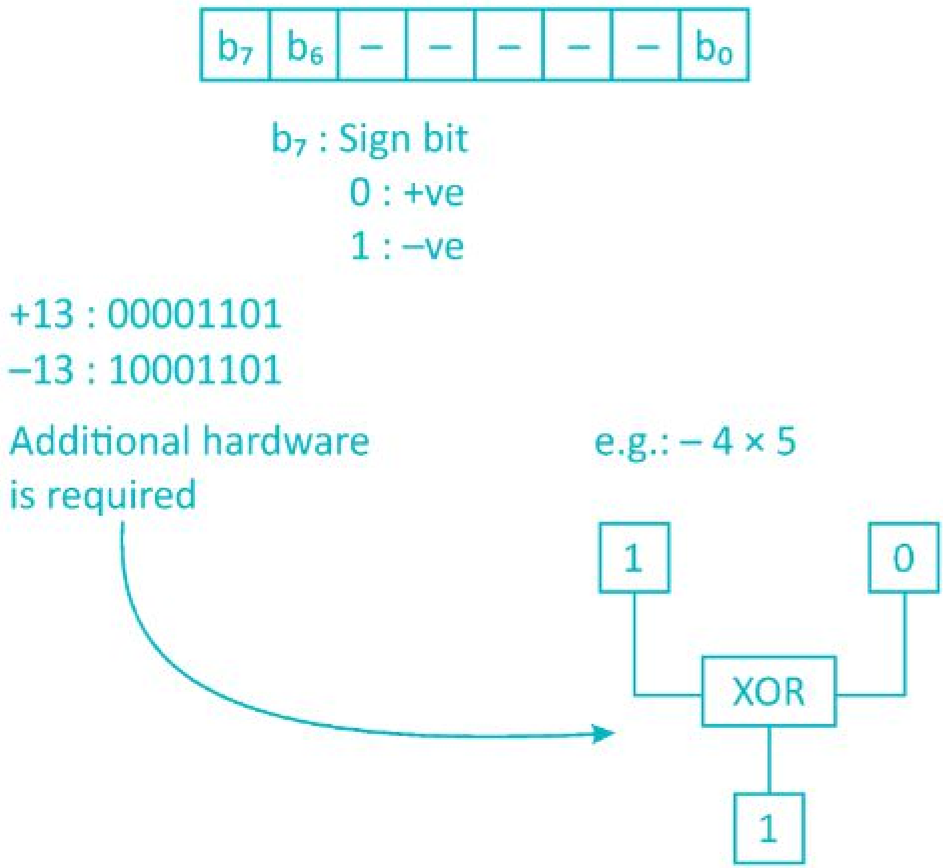


<u>Fixed Point Representation:</u>

A value of a fixed-point data type is essentially an integer, scaled by an implicit weighing factor depending upon its type.

Different forms of representing fixed-point number are:

A.) Signed Magnitude Form: In this form, the sign bit is considered explicitly.



- Addition and Subtraction are performed on separation hardware.
- Zero has 2 representations.

+0 : 0 0000000
–0 : 1 0000000

B) 1's Compliment Form: Negative of a number is represented as 1's complement of that number.

e.g.

$$+13 : 00001101$$
$$-13 : 11110010$$

- The sign bit is not considered explicitly.
- No additional hardware is required for the resultant sign.
- Again zero has 2 representations.

$$+0 : 0000\ 0000$$
$$-0 : 1111\ 1111$$

C) 2's Compliment Form: Negative of a number is represented as the 2's complement of that number.

e.g.

$$+13 : 00001101$$
$$-13 : 11110011$$

- The sign bit is not considered explicitly.
- Addition and subtraction are performed using adder only.

$$-B = \overline{B} + 1$$
$$A - B = A + \overline{B} + 1$$

- Zero has only one representation.

+0 : 00000000

−0 : 2's compliment of + 0 $\Rightarrow$ 00000000

Box-model

4 bit

	-8	4	2	1
+6 :	0	1	1	0
−6 :	1	0	1	0
+7 :	0	1	1	1
−7 :	1	0	0	1

6 bit

	-32	16	8	4	2	1
+13	0	0	1	1	0	1
−13	1	1	0	0	1	1

Overflow condition in 2's complement form representation:

<u>CASE 1:</u> If there is carry in the MSB (Most Significant Bit) but not the carryout.

E.g.

$$\begin{array}{lrl} & +5: & 0101 \\ \text{Addition:} & +4: & 0100 \\ \hline & & \text{Overflow} \end{array}$$

CASE 2: If there is carry out at MSB but not carry in

E.g.

$$\begin{array}{rl} -5: & 1011 \\ -4: & 1100 \\ \hline & \text{Overflow} \end{array}$$

Hence overflow flag V is set as follows:

$$V = C_n \oplus C_{n+1}$$

Where Cn represents carry in at MSB and Cn+1 represents carry-out at MSB.

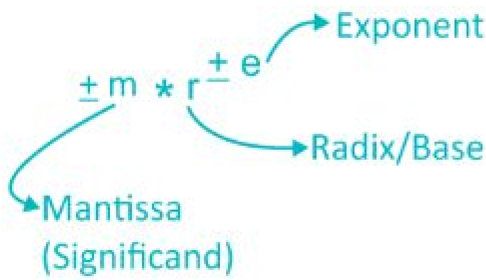
Also, ⊕ represents X-OR operation

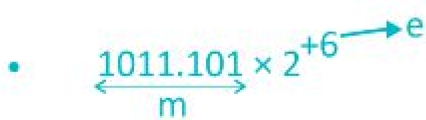
The range of numbers represented using x bits is:

1) Signed Magnitude : $-2^{x-1}-1$ to $+2^{x-1}-1$
2) 1's Compliment : $-2^{x-1}-1$ to $+2^{x-1}-1$
3) 2's Compliment : -2^{x-1} to $+2^{x-1}-1$

Floating Point Representation:

To represent the approximation of very small and very large real numbers, floating point representation is used. There is always a trade-off between range and precision.

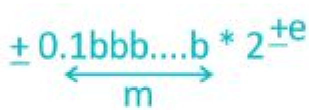




Radix/Base is assumed. (As numbers are represented in binary)

Standard Forms:

1) Normalized Form



- Radix is assumed
- Position of decimal point is also assumed

E.g.

$$0.\underbrace{101101}_{m} * 2^{+7} \longrightarrow e$$

Note: Zero cannot be normalized.

2) Standard Form:

$$\pm 1.\underbrace{bbb....b}_{m} * 2^{\pm e}$$

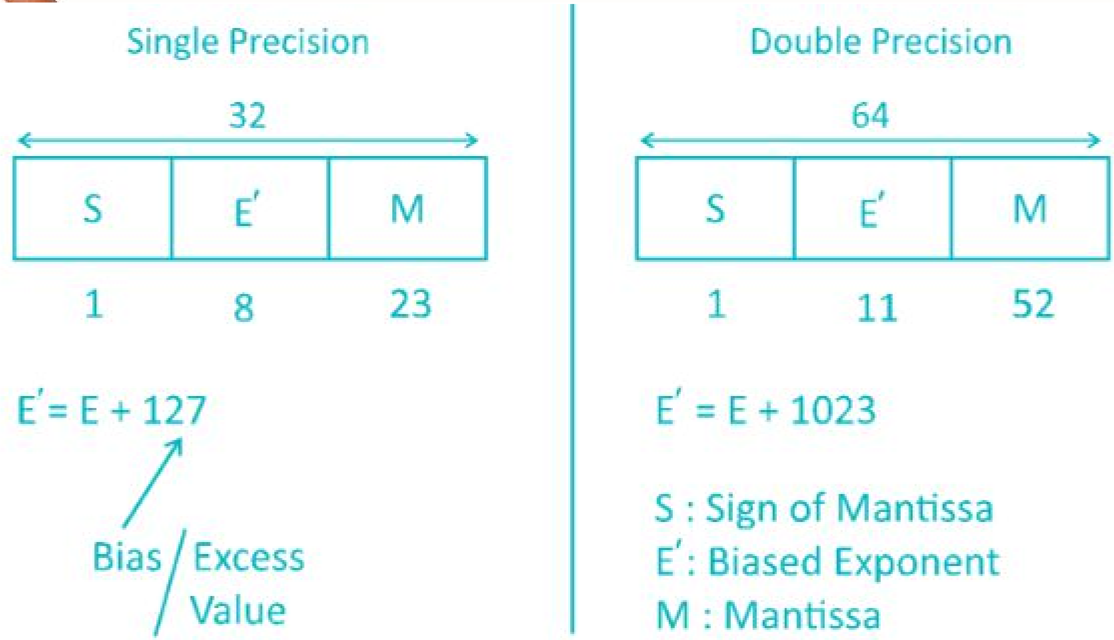
- Radix is assumed
- Position of decimal point is assumed
- 1 is also assumed

Eg. If mantissa is 011 then processor interprets it as 1.011.

E.g.

$$0.\underbrace{1001101}_{m} * 2^{+6} \longrightarrow e$$

IEEE Standard for Floating-Point Representation (IEEE 754):



E.g. 1.01101 2+6

M = 01101

E' = 6 + 127 = 133

S = 0

Single Precision	Double Precision
$0 < E' < 255$	$0 < E' < 2047$
Excludes 0 and 255 i.e all 0's and all 1's	Excludes 0 and 2047
$-127 < E < +128$	$-1023 < E < 1024$
Exponent Underflow / Exponent Overflow	

23. Represent – (23.875) 10 in single precision representation:

Sol.

$$-(23.875)_{10} = -(10111.111)_2$$

Standardization

$$\underbrace{-1.0111111}_{M} * 2^{+4} \rightarrow E$$

So we have

S = 1

M = 0111111

E' = E + 127 = 4 + 127 = 131

S	E'	M
(1)	(8)	(23)

S	E'	M
(1)	(8)	(23)

TABLE (Single Precision)

S	E′	M	Value
0/1	000...000 (All zeros)	000...000 (All zeros)	± 0
0/1	111...111 (All one's)	000...000 (All zeros)	$\pm \infty$
0/1	111...111	other then (All zeros)	(NAN) Not a Number
0/1	other than All 0's and all 1's	xx...x (Any bits)	$(-1)^s * (1.M) * 2^{E'-127}$
0/1	000...000 (All zeros)	Other than (All zeros)	$(-1)^s * (0.M) * 2^{-126}$

Now that you know about Data Representation for GATE, do visit the articles mentioned below and read more informative matters to strengthen your General Knowledge for all bank, SSC and government examinations.

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