19IT202T / Computer Architecture
Unit II Arithmetic for Computers
Part B

1. **Define ALU.** **(April 2016)**

   It is hardware unit that performs arithmetic operations such as addition, subtraction, multiplication, division and logical operations AND and OR.

2. **What are the main features of Booth's algorithm?** **(Nov 2019)**

   The Booth algorithm has two attractive features.

   - First, it handles both positive and negative multipliers uniformly.
   - Second, it achieves some efficiency in the number of additions required when the multiplier has a few large blocks of 1s.

3. **What is overflow and underflow?** **(Nov 2016)**

   Overflow: A situation in which a positive exponent becomes too large to fit in the exponent field.

   Underflow: A situation in which a negative exponent becomes too large to fit in the exponent field.

4. **How overflow and underflow occur in floating point arithmetic operations? (April 2015)**

   Underflow: In a single precision, if the number requires an exponent less than -126 or in a double precision, if the number requires an exponent less than -1022 to represent its normalized form the underflow occurs.

   Overflow: In a single precision, if the number requires an exponent greater than -127 or in a double precision, if the number requires an exponent greater than +1023 to represent its normalized form the underflow occurs.

5. **Write the rules to perform addition on floating point numbers.** **(April 2017)**

   Steps:

   - Choose the number with the smaller exponent.
   - Shift its fraction right until the exponents of both the numbers are equal.
   - Add the fraction values.
   - Normalize the result if necessary.
   - Truncate / round to the number of fraction bits

6. **What are the overflow/underflow conditions for addition and subtraction? (Nov 2015)**

Operation	Operand A	Operand B	Result indicating overflow
$A + B$	≥ 0	≥ 0	< 0
$A + B$	< 0	< 0	≥ 0
$A - B$	≥ 0	< 0	< 0
$A - B$	< 0	≥ 0	≥ 0

7. **What is scientific notation?**

A notation that renders numbers with a single digit to the left of the decimal point.

Ex. $1.0_{10} \times 10^{-9}$ (seconds in a nanosecond)

8. **What is normalized number?**

A number in scientific notation that has no leading 0s is called a normalized number.

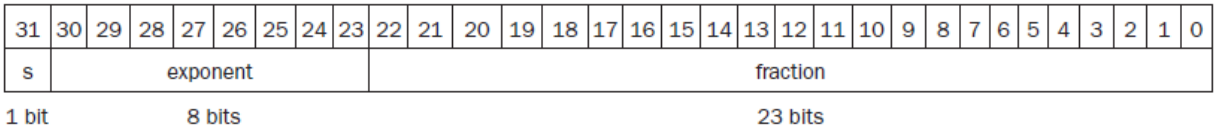
Ex. $1.0_2 \times 2^{-1}$

9. **State the representation of single and double precision floating point number.** **(Nov 2015, April 2018)**

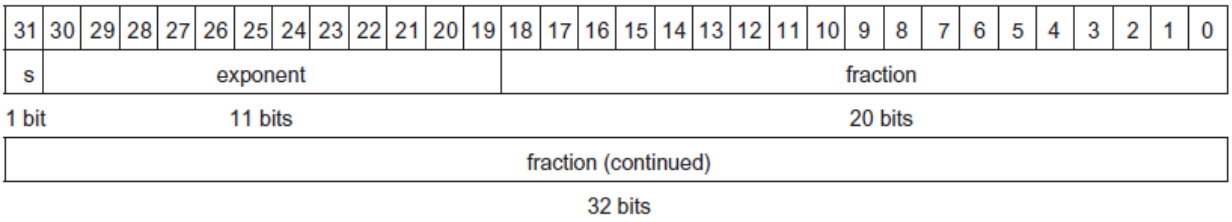
IEEE 754 standard floating-point representation:

$$x = (-1)^S \times (1 + \text{Fraction}) \times 2^{(\text{Exponent}-\text{Bias})}$$

Single Precision:



Double Precision:



10. **What is mean by fraction?**

The value, generally between 0 and 1, placed in the fraction field. The fraction is also called the mantissa.

11. **What is mean by exponent?**

In the numerical representation system of floating-point arithmetic, the value that is placed in the exponent field.

12. **What is guard bit and what are the ways to truncate guard bits? (Nov 2016)**

The first of two extra bits kept on the right during intermediate calculations of floating point numbers; used to improve rounding accuracy.

There are several ways to truncate the guard bits:

- Chopping
- Von Neumann rounding
- Rounding

13. **When can you say that a number is normalized?**

When the decimal point is placed to the right of the first (nonzero) significant digit, the number is said to be normalized.

14. Write down the floating point MIPS arithmetic instructions.

Category	Instruction	Example	Meaning	Comments
Arithmetic	FP add single	add.s $f2,$f4,$f6	$f2 = $f4 + $f6	FP add (single precision)
	FP subtract single	sub.s $f2,$f4,$f6	$f2 = $f4 - $f6	FP sub (single precision)
	FP multiply single	mul.s $f2,$f4,$f6	$f2 = $f4 x $f6	FP multiply (single precision)
	FP divide single	div.s $f2,$f4,$f6	$f2 = $f4 / $f6	FP divide (single precision)
	FP add double	add.d $f2,$f4,$f6	$f2 = $f4 + $f6	FP add (double precision)
	FP subtract double	sub.d $f2,$f4,$f6	$f2 = $f4 - $f6	FP sub (double precision)
	FP multiply double	mul.d $f2,$f4,$f6	$f2 = $f4 x $f6	FP multiply (double precision)
	FP divide double	div.d $f2,$f4,$f6	$f2 = $f4 / $f6	FP divide (double precision)

15. What decimal number is represented by this single precision float?

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	.	.

Answer:

The sign bit is 1, the exponent field contains 129, and the fraction field contains $1 \times 2^{-2} = 1/4$, or 0.25. Using the basic equation,

$$\begin{aligned}(-1)^S \times (1 + \text{Fraction}) \times 2^{(\text{Exponent}-\text{Bias})} &= (-1)^1 \times (1 + 0.25) \times 2^{(129-127)} \\ &= -1 \times 1.25 \times 2^2 \\ &= -1.25 \times 4 \\ &= -5.0\end{aligned}$$

16. Subtract $(11010)_2 - (10000)_2$ using 1's complement and 2's complement method.(April 2017)

17. Show the IEEE 754 binary representation of the number $(-0.75)_{10}$ in single precision.

18. Subtract $(11011)_2 - (10011)_2$ using 2's complement. (Nov 2017)

19. Divide $(1001010)_2$ / $(1000)_2$. (Nov 2017)

20. Convert $(1.00101)_2$ to decimal. (April 2019)

21. Perform subtraction with the unsigned binary numbers by two's complement method:100-110000 (April 2019)