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M.Sc. CS / AI & CS
Computer Systems
Floating Point Numbers, Memory, Program Execution

Question #1: Find out the equivalent 32-bit Floating point representation for the following?

Decimal Fraction	Binary Fraction	Floating Point Representation (32 bit)
104.1875	1101000.0011	
-213.4375	−11010101.0111	
-0.15625	−0.00101	

Question #2: An address space is a range of valid addresses in memory that are available for a program or process. That is, it is the memory that a program or process can access. The memory can be either physical or virtual and is used for executing instructions and storing data.
Considering the memory address sizes given in the table below, find out the maximum memory that could be installed in a given system. Also mention the minimum and maximum addresses in Hexadecimal.

1 Bit	= Binary Digit
8 Bits	= 1 Byte
1024 Bytes	= 1 KB [Kilo Byte]
1024 KB	= 1 MB [Mega Byte]
1024 MB	= 1 GB [Giga Byte]
1024 GB	= 1 TB [Terra Byte]
1024 TB	= 1 PB [Peta Byte]
1024 PB	= 1 EB [Exa Byte]
1024 EB	= 1 ZB [Zetta Byte]
1024 ZB	= 1 YB [Yotta Byte]

$2^{16} = 65536/1024$

Address Size	Max Supported Memory (Address Space)	Minimum Memory Address	Maximum Memory Address
8 bits	256 bytes	0x00	0xFF
16 bits	64 KB	0x0000	0xFFFF
32 bits	4 GB	0x0000 0000	0xFFFF FFFF
64 bits			

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15×10^{18} bytes

$16 \times 10^{18} \Rightarrow 2^4 \times (10^3)^6$

$\Rightarrow 2^4 \times (2^{10})^6 \Rightarrow 2^4 \times 2^{60} \Rightarrow 2^{64}$

Question #3: Google have been estimated as having a total storage capacity of about 15 exabytes (a couple of years ago). We didn't get as far as the exabyte during our lectures, but it's 10^{18} bytes. If Google's storage were made into a single byte-addressed memory, how many bytes would the addresses have to be?

Question #4: What is the value stored in 'z' after the execution of the following MIPS assembly code, if x=5?

```
    li $6, 1
    li $7, 2
    lw $8, &x
L1: bgt $7, $8, L2
    mult $6, $6, $7
    addi $7, $7, 1
    j L1
L2: sw $6, &z
```

$6	$7	$8
1	2	5
2	3	
6	4	
120		

Question #5: A processor is operating at 30MHz. Each instruction takes a minimum of 6 cycles to execute. The processor has a six stage pipeline. If a program starts execution at time 0, what is the theoretical maximum number of instructions that will have completed their execution at the end of 1 millisecond?

30 MHz $\Rightarrow$ 30,000,000 cycles / second

$\Rightarrow$ 30,000 cycles / ms

First Instr (30,000 − 6)

$\Rightarrow$ 1 + 29994 $\Rightarrow$ 29,995 instr / ms