

Question 1: short answers

1.1) convert binary to hex

- $$\begin{array}{cc} 0110 & 1010 \\ \underbrace{\hspace{1cm}} & \underbrace{\hspace{1cm}} \\ 6 & A \end{array} \rightarrow 0x6A$$

- $$\begin{array}{cc} 1110 & 0011 \\ \underbrace{\hspace{1cm}} & \underbrace{\hspace{1cm}} \\ 14=E & 3 \end{array}$$

$$0xE3$$

- $$01101110 \rightarrow 0x6E$$

- $$00111101 \rightarrow 0x3D$$

1.2) convert hex to binary

- $0xF5 \rightarrow 1111\ 0101$

- $0x2D \rightarrow 0010\ 1101$

$$D=13$$

1.3) give formulas to convert the following numbers to decimal

- $0xF5 \rightarrow 15 \cdot (16)^1 + 5 \cdot (16)^0$
 $= 245$

- $1001 \rightarrow 2^3 + 0 \cdot 2^2 + 0 \cdot 2^1 + 0 \cdot 2^0$
 $= 8 + 1 = 9$

- $0644 \rightarrow 6 \cdot (8^2) + 4 \cdot (8^1) + 4 \cdot (8^0)$
 $= 420$

1.4) signed extension

1 hex digit = 4 binary digits

4 bytes = 32 bits

$\nearrow^{15}$
 $0xF5 = 1111 \ 0101$
 $\nearrow$

MSB is a one,
so # is negative

prepend upper bits with ones

1111 1111 1111 1111 1111 1111 1111 0101

1.5) little endian = LSB at lowest memory addr

Addr	Byte
0xfcee4e6	0x44
0xfcee4e6	0x33
0xfcee4e6	0x22
0xfcee4e6	0x11

1.6)

• $3 \ll 8$

$3 = 0011$

$$\begin{array}{r}
 0011 \\
 \ll 1 \\
 \hline
 0110 \\
 \ll 2 \\
 \hline
 1100
 \end{array}$$

$$\begin{array}{r}
 0011 \\
 \ll 3 \\
 \hline
 1000 \\
 \ll 4 \\
 \hline
 0000
 \end{array}$$

shifting
 another
 4 will
 still
 give 0000
 0x0

• 287

$$\begin{array}{r} 0010 \\ \& 0111 \\ \hline 0010 \rightarrow 0x2 \end{array}$$

• $-6 > 3$

6: 0110 $\rightarrow$ flip bits $\rightarrow$ 1001
 $\begin{array}{r} \\ + \\ \hline -6: 1010 \end{array}$

is negative, prepend with ones

$$1010 \gg 1 = 1101 \gg 2 = 1110 \gg 3 = 1111 = 0xF$$

• 3 ^ E ← XOR

3: 0011 XOR

E=14: 1110

1101 → 0XD

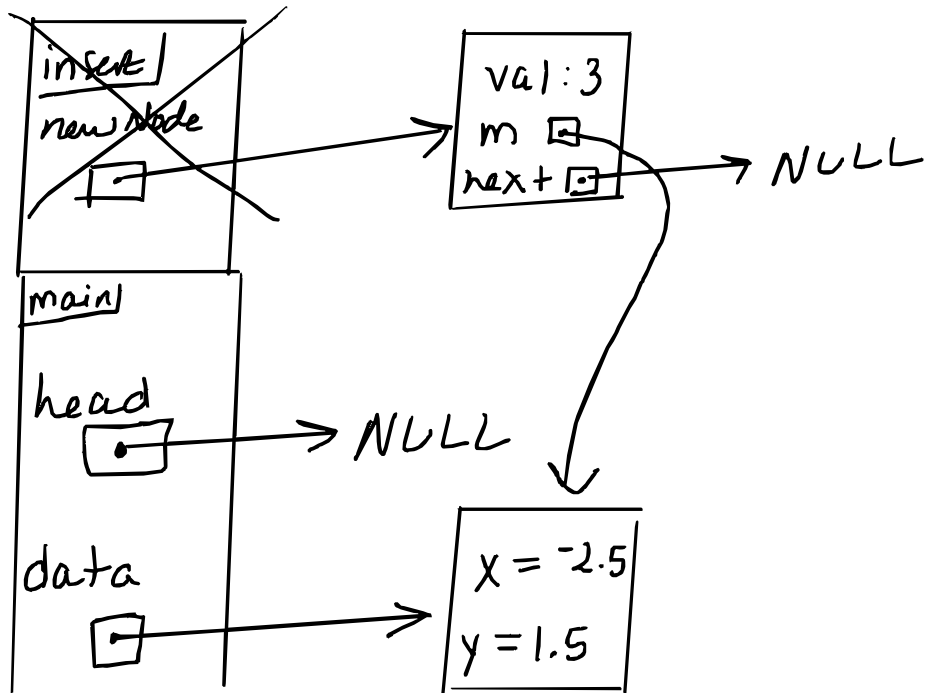
1.7)

float x	4 bytes	0xffffffffe40-43
c[0], c[1], c[2]	3 x 1 byte	0xffffffffe44-46
padding	1 byte	0xffffffffe47
struct foo* v	8 bytes (ptr)	0xffffffffe48-4f

this struct : at least $4 + 3 + 1 + 8$
 $= 16$ bytes

2.1)

newNode
is leaked



2.2)

Stack

data (ptr) $\rightarrow$ 8 bytes

heap

float x, y $\rightarrow$ 4 bytes $\times$ 2 = 8 bytes

2.3) newNode

int val 4 bytes

padding 4 bytes

struct mystery*
 m 8 bytes (ptr)

struct node*
 next 8 bytes (ptr)

24 bytes

2.4) yes. insert(3, head, data) loses the returned ptr returned.

free(head) $\rightarrow$ free(null) is a noop

to fix: head = insert(3, head, data)

$$3.1) \quad a = 0x7E$$

0111 1110

3.2)

$a : 0111 \ 1110$

$\&LM : 1100 \ 0000 \ (0xC0)$

left: $0100 \ 0000$

$\gg 4 : 0000 \ 0100 \rightarrow 0000 \ 0100$

$\text{OR} \rightarrow 0010 \ 0000$

$a : 0111 \ 1110$

$\&RM : 0000 \ 0011$

right: $0000 \ 0010$

$\ll 4 \ 0010 \ 0000$

$0010 \ 0100$

$= 0x24$

4.1) hello.c

-rw-r--r--
~~~~~

110 100 100

6 4 4 → 0644

4.2) hello

-rwxr-xr-x  
~~~~~

111 101 101

7 5 5 → 0755

4.3) hello → r/w access

rw-

110

6

5.1) bitfield 0x3

0x3 → 0011 → 0001 FLY
 ^{OR} 0010 SWIM

 0011

5.2) smallest C type: char
 1 byte, 8 bits

5.3) 0010 SWIM
 ^{OR} 0100 WALK

 0110 → 0x6

5.4) animal & (WALK | FLY)

6) $0 \times 3F\ C0\ 00\ 00$

- # in binary

0011 1111 1100 0000 0000 0000 0000 0000
↑
sign bit
exp bits
fractional bits

- convert to decimal

$$(-1)^{\text{sign}} \times 2^{(e-127)} \times 1.5$$

$$\begin{aligned} 0111\ 1111 &\rightarrow 2^6 + 2^5 + 2^4 + 2^3 + 2^2 + 2^1 + 2^0 \\ &= 64 + 32 + 16 + 8 + 4 + 2 + 1 \\ &= 127 = e \end{aligned}$$

$$\begin{aligned} S &= 1(2^{-1}) + 0(2^{-2}) + 0(2^{-3}) + \dots \\ &= \frac{1}{2} \end{aligned}$$

$$(-1)^0 (2^{(127-127)}) (1.5) = 1.5$$