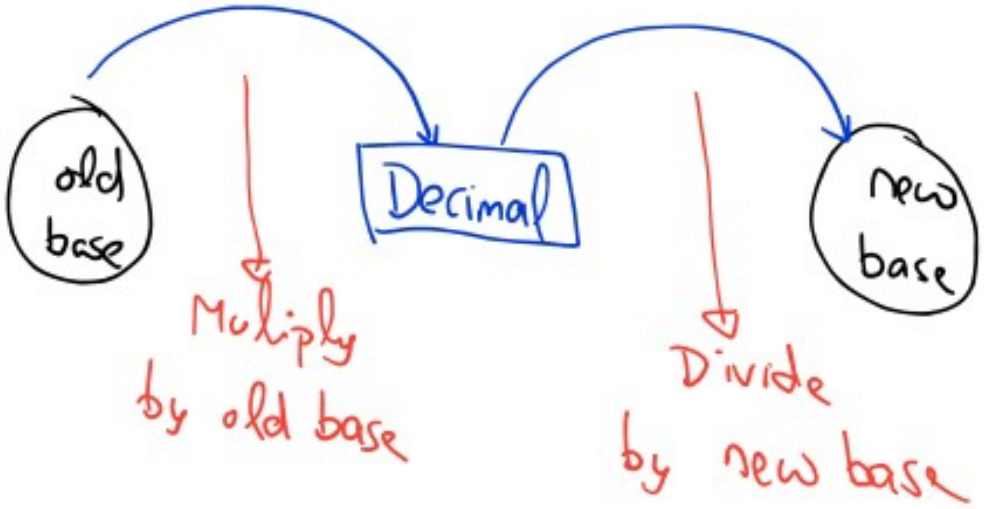
Binary 1

Decimal: Base 10: 0, 1, 2, ... 9

Binary : Base 2 : 0, 1

octal : Base 8 : 0, 1, ..., 7

HexaDecimal: Base 16 : 0, 1, ... , 15



Ex1: $(10110)_2 \longrightarrow (\dots)_{10}$

$$\begin{array}{ccccc} 1 & 0 & 1 & 1 & 0 \\ 2^4 & 2^3 & 2^2 & 2^1 & 2^0 \ * \end{array}$$

$$16 + 0 + 4 + 2 + 0 = (22)_{10}$$

Ex2: $(212)_3 \longrightarrow (\dots)_{10}$

$$\begin{array}{ccc} 2 & 1 & 2 \\ 3^2 & 3^1 & 3^0 \ * \end{array}$$

$$18 + 3 + 2 = (23)_{10}$$

Ex3: $(22)_{10} \longrightarrow (\dots)_2$

22	2	0
11	2	1
5	2	1
2	2	0
1	2	1
0		

$$(22)_{10} \longrightarrow (10110)_2$$

Ex4: $(45)_{10} \longrightarrow (\ldots)_4$

45	4	1
(11)	4	3
2	4	2
0		

$(45)_{10} \longrightarrow (231)_4$

Ex5: $(51)_6 \longrightarrow (\ldots)_8$

$$5\ 1$$
$$6^1\ 6^0 *$$
$$30 + 1 = (31)_{10}$$

31	8	7
3	8	3
0		

$(51)_6 \longrightarrow (37)_8$

Note: HexaDecimal Base 16

0, 1, 2, ..., 9, 10, 11, 12, 13, 14, 15

10 → A, 11 → B, 12 → C, 13 → D, 14 → E, 15 → F

Ex6: $(B2)_{16} \longrightarrow (\ldots)_2$

B 11 2

16^1 16^0 *

$176 + 2 = (178)_{10}$

178	2	0
89	2	1
44	2	0
22	2	0
11	2	1
5	2	1
2	2	0
1	2	1
0		

$(B2)_{16} \longrightarrow (10110010)_2$

Note:

Base 12: 0, 1, 1, - - - - - - - - -, 9, 10, 11

10 → A, 11 → B

Base 20: 0, 1, 1, - - - - -, 9, 10, 11, 12, 13, 14, 15, 16, 17

A B C D E F G H

18, 19

I J

Ex 7: $(78)_9 \longrightarrow (\dots)_{13}$

$$\begin{array}{r} 7\ \ 8 \\ 9^1\ \ 9^0\ * \\ \hline 63+8 \end{array} = (71)_{10}$$

71	13	6 ↑
5	13	5 ↑
0		

$$(78)_9 \longrightarrow (56)_{13}$$

Ex 8: $(10100010)_2 \longrightarrow (\text{---})_{16}$

1	0	1	0	0	0	1	0
7	6	5	4	3	2	1	0
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0 *

$128 + 0 + 32 + 0 + 0 + 0 + 2 + 0 = (162)_{10}$

162	16	2
10	16	10 (A)
0		

$(10100010)_2 \longrightarrow (A2)_{16}$

Alternative Rules:

$(---)_{16} \longrightarrow (---)_2^4$

$(---)_8 \longrightarrow (---)_2^3$

$(---)_{27} \longrightarrow (---)_3^3$

$(--)_6 \longrightarrow (--)_2$ ✗

Ex 9: Convert $(A2)_{16} \longrightarrow (---)_2^4$ without passing on Decimal

A(10) (2)

10 | 2	0	↑
5 | 2	1	
2 | 2	0	
1 | 2	1	
0		

2 | 2	0	↑
1 | 2	1	
0		

$(A\ \ 2)_{16}$

$(10100010)_2$

$A \equiv \underline{1010}$ $\quad 2 \equiv \underline{0010}$

Ex 10: $(217)_8 \longrightarrow (\ldots)_2$ (3 digits)

2 | 2	0	
1 | 2	1	
0		

$2 \equiv 010$

1 | 2	1	
0		

$1 \equiv 001$

7 | 2	1	
3 | 2	1	
1 | 2	1	
0		

$7 \equiv 111$

$(217)_8 \longrightarrow (010001111)$

Ex 11: $(A46)_{27} \longrightarrow (\ldots)_3$ (3 digits)

number of digits

$A(10)$

10 | 3	1	
3 | 3	0	
1 | 3	1	
0		

4 | 3	1	
1 | 3	1	
0		

6 | 3	0	
2 | 3	2	
0		

$A \equiv 101$ $\quad 4 \equiv 011$ $\quad 6 \equiv 020$

$(A46)_{27} \longrightarrow (101011020)_3$

Ex 12: $(10100010)_2 \rightarrow (\ldots)_{16}$

1010
$2^3\ 2^2\ 2^1\ 2^0$ *
$8+0+2+0 = (10)$
(A)

0010
$2^3\ 2^2\ 2^1\ 2^0$ *
$0+0+2+0 = (2)$

$(1010\ 0010)_2$
(A) (2)
$(A2)_{16}$

Ex 13: $(001010101011)_2 \rightarrow (\ldots)_{16}$

0010
$2^3\ 2^2\ 2^1\ 2^0$
(2)

1010
$2^3\ 2^2\ 2^1\ 2^0$
$8+2 = (10)$
(A)

1011
$2^3\ 2^2\ 2^1\ 2^0$
$8+2+1 = (11)$
(B)

0010 1010 1011
$(2AB)_{16}$

Ex 14: $(AB2)_{16} \longrightarrow (\dots)_4$

without passing on decimal

A

10	4	2
2	4	2
0		

$A \equiv (22)_4$

B

11	4	3
2	4	2
0		

$B \equiv (23)_4$

2

2	4	2
0		

$2 \equiv (02)_4$

A B 2

$(22\ 23\ 02)_4$

Ex 15: $(AB1)_{16} \longrightarrow (\dots)_8$

without passing on Decimal

$(AB1)_{16} \longrightarrow (\dots)_2 \longrightarrow (\dots)_8$

(4 between $(AB1)_{16}$ and $(\dots)_2$; 3 between $(\dots)_2$ and $(\dots)_8$)

$(AB1)_4 \longrightarrow (\dots)_2$

A

10	2	0
5	2	1
2	2	0
1	2	1
0		

$A \equiv 1010$

B

11	2	1
5	2	1
2	2	0
1	2	1
0		

$B \equiv 1011$

1

1	2	1
0		

$1 \equiv 0001$

$(AB1)_{16} \rightarrow (1010\ 1011\ 0001)_2$

101
$2^2\ 2^1\ 2^0$ *
4 + 1 = 5

010
$2^2\ 2^1\ 2^0$ *
0 + 2 + 0 = 2

110
$2^2\ 2^1\ 2^0$ *
4 + 2 + 0 = 6

001
$2^2\ 2^1\ 2^0$ *
0 + 0 + 1 = 1

$(AB1)_{16} \rightarrow (5261)_8$

Ex 16: $(521)_5 \rightarrow (\ldots)_{10}$

5 2 1
$5^2\ 5^1\ 5^0$
125 + 10 + 1 $= (136)_{10}$

Can't convert number $(521)_5$: Reason
5 is a wrong digit
sinc base 5 digits must be 0 to 4

Base 16

Exercise 8-6 To be Discussed in Tutorial

Given the following decimal representation of an IP address, represent its hexadecimal, binary and its corresponding decimal value. You can check more conversion on the online converter: www.silisoftware.com/tools/ipconverter.php

66.220.159.255

a)

66 | 16 → 2
4 | 16 → 4
0

$(66)_{10} \rightarrow (42)_{16}$

220 | 16 → 12 (C)
13 | 16 → 13 (D)
0

$(220)_{10} \rightarrow (DC)_{16}$

159 | 16 → 15 (F)
9 | 16 → 9
0

$(159)_{10} \rightarrow (9F)_{16}$

255 | 16 → 15 (F)
15 | 16 → 15 (F)
0

$(255)_{10} \rightarrow (FF)_{16}$

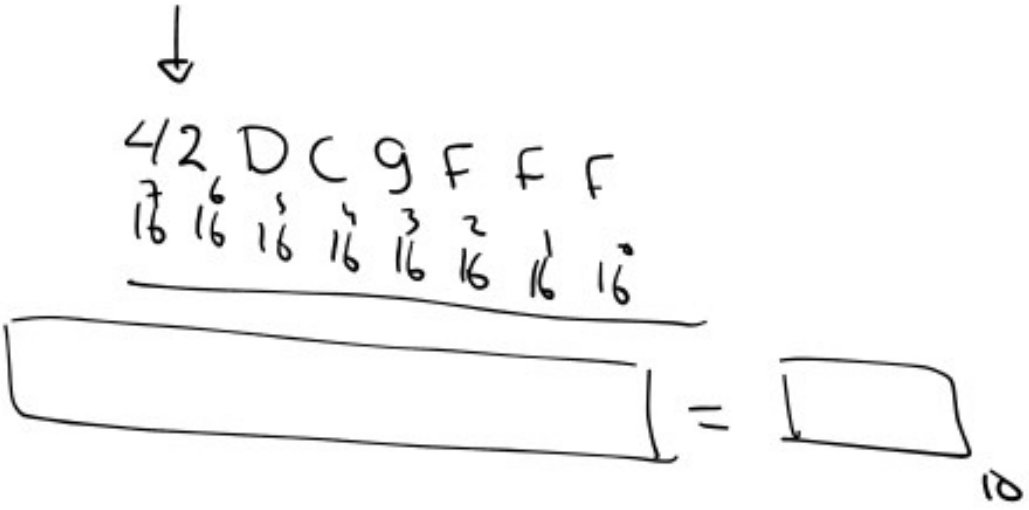
a) 66.220.159.255 → 42.DC.9F.FF

Lazem teb2a 2 digits

b) 42.DC.9F.FF

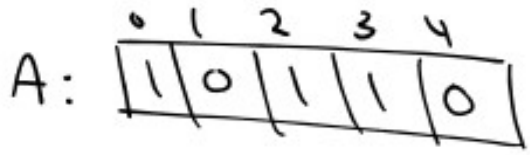
01000010.11011100.10011111.11111111

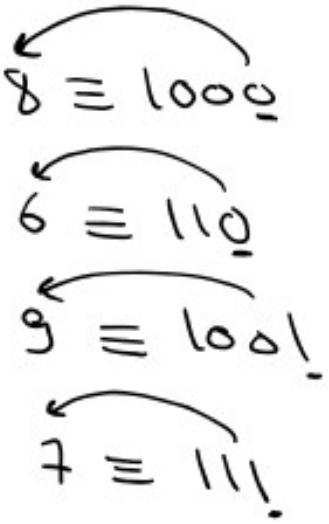
c) 42.DC.9f.FF



Exercise 8-8 To be Solved in Lab

Given a list of `0`s and `1`s, write a Python program that checks whether the number is even or odd without converting into decimal.

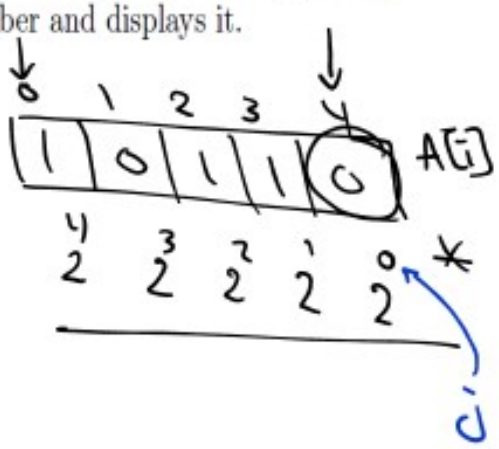





```
A = eval(input())
n = len(A)
if( A[n-1] == 0):
    print("Even")
else:
    print("odd")
```

Exercise 8-10 To be Solved in Lab

Write a Python algorithm that given a list `binary` of 0s and 1s representing a binary number, converts it into the equivalent decimal number and displays it.




```
A=eval(input())
n=len(A)
i=n-1
j=0
sum=0
while(i>=0):
        sum=sum+A[i]*(2**j)
        j=j+1
        i=i-1
print(sum)
```

(base)

Exercise 8-7 To be Solved in Lab

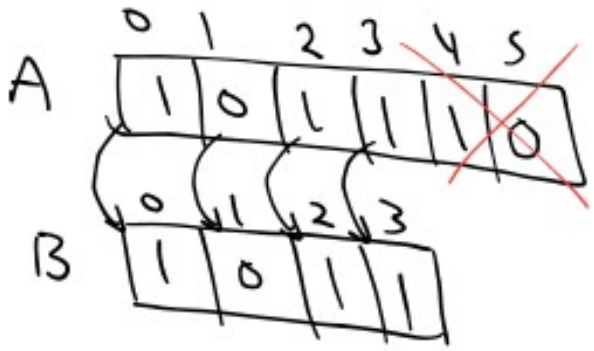
Given a list of `0`s and `1`s, write a Python program to perform the integer division by 4 for the number represented in the list.

Note: $12 \equiv 1100$ $\quad 12//_4 = 3$

$3 \equiv 11$

$\rightarrow 10 \equiv 1010$ $\quad 10//_4 = 2$

$2 \equiv 10$




```
A = eval(input())
n = len(A)
B = [0]*(n-2)
i = 0
while(i < n-2):
    B[i] = A[i]
    i = i+1
print(B)
```