Number Systems-Basics, Base-R Representations

Comprehensive Course on Digital Circuits

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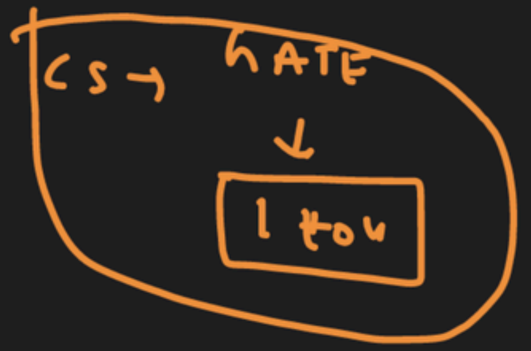
1. Class Duration → 2hrs → 5:45 pm to 7:45 pm
2. Language → English + Hindi
3. Notes → I will provide Hand written
4. Oct-20 to Dec-15
5. Course : EC/EE/IN/CS
6. Every week Sunday → Exam
7. GATE/ESE

Syllabus

1. Number Systems
2. Boolean Algebra, Logic Gate KMAP.
3. Comb ckts
4. Seq ckts
5. DATA Conv
6. Logic Families & semi Cond memories.



EC ↓
GATE/ESE → 1-6

EE :-
GATE :- 3,4,5
ESE :- 1,2,3,4,5

Source of Prepn. :

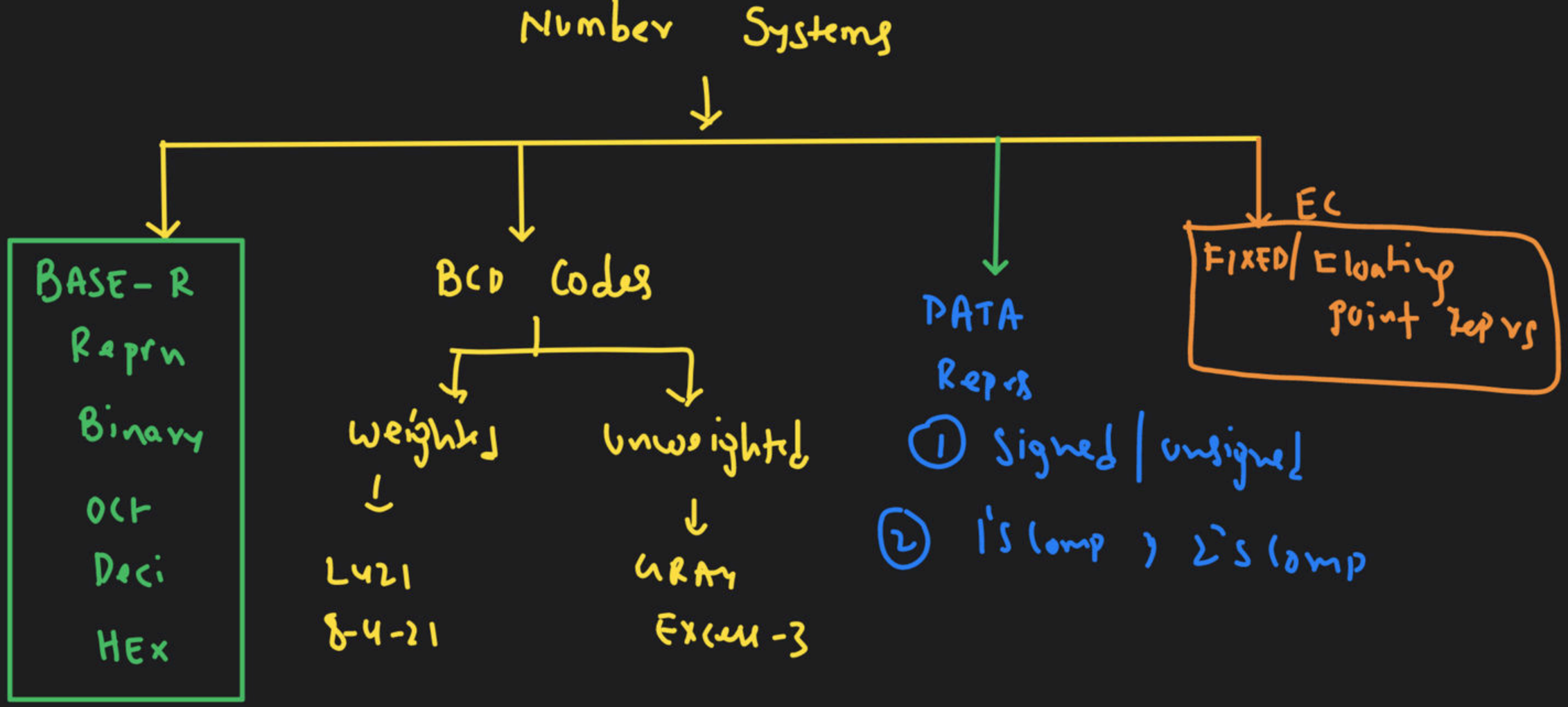
Text Books :-

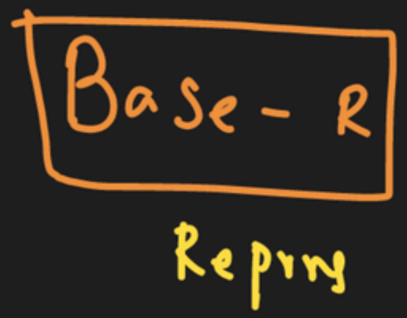
1. DIGITAL Design by Morris Mano.
2. Digital ckts by Tocci
3. M.D.ckts by R.P.JAIN
4. NPTEL → IITM.

GATE

EC → 8-12 Marks

EE/CS → 4-8 Marks

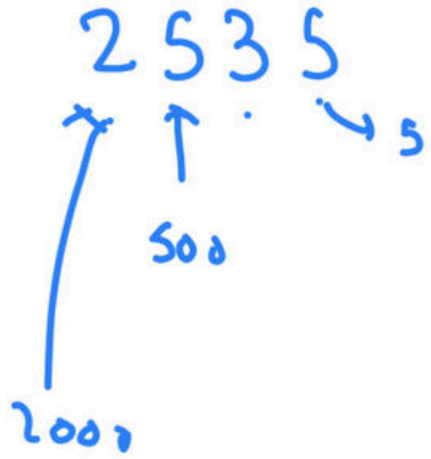

Number Systems
BASE-R Reprn
Binary
OCT
Deci
HEx
BCD Codes
Weighted
8421
8-4-21
Unweighted
GRAY
Excess-3
DATA Reprs
① Signed / unsigned
② 1's comp) 2's comp
EC
FIXED / Floating point reprs


Base - R
Repry

Base or Radix of the number system is no of different symbols in a number system.

In any number system with base(r), we have ‘r’ different symbols and each digit can be in the range of ‘0’ to ‘ r-1’.

Any number can be represented with these ‘r’ symbols by multiplying with it’s positional value.


2535
5
500
2000

$$\cdots - X_3 X_2 X_1 X_0 \cdot Y_1 Y_2 Y_3 \cdots \gamma$$

$$\downarrow$$

$$---X_3 * \gamma^3 + X_2 * \gamma^2 + X_1 * \gamma^1 + X_0 * \gamma^0 + Y_1 * \gamma^{-1} + Y_2 * \gamma^{-2} + Y_3 * \gamma^{-3} \cdots$$

Base	Symbols
2 → Binary	0, 1
3 → Terinary	0, 1, 2
4	0, 1, 2, 3
⋮	
8 → oct	0, 1, 2, 3, 4 ... 7
10 → Decimal	0, 1, 2 ... 9
⋮	
16 → Hexa	0, 1, 2, ... 9, A, B, C, ... F

Decimal :- 0, 1, 2, -- 9,

10^1 → 10, 11, - - - 19,

20, - - . 29

⋮

90, - - . 99

10^2 → 100

Octal :- 0, 1, 2, .. 7,

8 → 10, 11, 12, - - . 17

20, - - . 27

⋮

70, - - - . 77

100 . . . -

8^2

Base-4

4 → 0, 1, 2, 3

10, 11, 12, 13

20, - - .

Conversions

Decimal to any:

To convert a decimal number to any other base divide the integer part repeatedly with required base and multiply the fractional part repeatedly with required base.

Any to Decimal:

To convert Any base to Decimal multiply each digit with the required base. its positional value.

$37.3125 = (\ ?\ )_2$

2 |	37
2 |	18 = 1
2 |	9 - 0
2 |	4 - 1
2 |	2 - 0
2 |	1 - 0
	0 - 1

$37_{10} = 100101_2$

$0.3125 * 2 = 0.625$

$0.625 * 2 = 1.25$

$0.25 * 2 = 0.5$

$0.5 * 2 = 1.0$

$0.3125_{10} = 0101_2$

$37.3125_{10} = 100101.0101_2$

$$100101.0101_2 = (?)_{10}$$

$$= 2^5 * 1 + 2^4 * 0 + 2^3 * 0 + 2^2 * 1 + 2^1 * 0 + 2^0 * 1 + 2^{-1} * 0 + 2^{-2} * 1 + 2^{-3} * 0 + 2^{-4} * 1$$

$$= 32 + 4 + 1 + \frac{1}{4} + \frac{1}{16} = 37.3125_{10}$$

$37.3125_{10} = (?)_8$

8 | 37	
8 | 4	5
	0	4

$\Rightarrow 0.3125 * 8 = 2.5$
$0.5 * 8 = 4.0$

$37_{10} = 45_8$

$0.3125_{10} = 0.24_8$

$37.3125_{10} = 45.24_8$

$37.3125_{10} = 0045.2400_8$

We can add any no zero's before Integer Part & After Fractional Part

When Base Decreases Integer Part Incr &

Fractional Part Decr. & Vice Versa

$$45.24_8 = (?)_{10}$$

$$4 * 8^1 + 5 * 8^0 + 2 * 8^{-1} + 4 * 8^{-2}$$

Decimal	Binary 8421
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001
10	1010
11	1011
⋮	⋮
15	1111

12 → 1100

10 → 8421
1010

Any to Any:

To covert to Binary to Octal replace every 3 bits with its Octal equivalent.

To covert to Binary to Hexa replace every 4 bits with its Hexa equivalent.

To covert to Octal to Binary replace every digit with its 3 bit Binary equivalent.

To covert to Hexa to Binary replace every digit with its 4 bit Binary equivalent.

$1100101.1011_2 = (?)_8$

2^3

$001\,100\,101 . 101\,100$

1 4 5 . 5 4 $_8$

$1100101.10111_2 = (?)_{16}$

2^4

$0110\,0101 . 1011\,1000$

6 5 . B 8 $_{16}$

$252.13_8 = (?)_2$

$010\,101\,010 . 001\,011_2$

1 → 1

→ 01

→ 001

→ 0001

$25AF.F1_{16} = (?)_2$

$0010\,0101\,1010\,1111 . 1111\,0001_2$

$CAFE_{16} = (?)$

↳ 1100 1010 1111 1110

$BAD.DAD_{16} = (?)$

CAB

FACE

0.01 = $\frac{1}{4} = \frac{1}{2^2} = 2^{-2}$

0.25 * 2 = 0.5

0.5 * 2 = 1.0

0.01

The decimal value 0.25

(a) is equivalent to binary value 0.1

(b) is equivalent to binary value 0.01

(c) is equivalent to binary value 0.00111....

(d) can not be represented precisely in binary

BASE 4 :- 0, 1, 2, 3, 10, 11, 12, 13, 20, 21 ....

unacademy

Digital Circuit

1. If $(2.3)_{base4} + (1.2)_{base4} = (y)_{base4}$; what is the value of y?

A.10.1 B.0.01

C.10.2 D. 1.02

$5_{10} = 11_4$

$4_{10} = 10_4$

2.3_4

1.2_4

10.1_4

2.3

1.2

3.5

135
144
9

Base > 5

4. Given $(135)_{baseX} + (144)_{baseX} = (323)_{baseX}$

What is the value of base X?

A. 5

B. 3

C. 12

D. 6

Base-5

0, 1, 2, 3, 4

Base-12

0, 1, 2, ... 9, A, B

$$135_x + 144_x = 323_x$$

$$x^2*1 + x^1*3 + x^0*5 + x^2*1 + x^1*4 + x^0*4 = x^2*3 + x^1*2 + x^0*3$$

$$x^2 + 3x + 5 + x^2 + 4x + 4 = 3x^2 + 2x + 3$$

$$x^2 - 5x - 6 = 0$$

$x = 6$ → Base - 6 →

$9_{10} = 13_6$

$6^1*1 + 6^0*3$

Given $(125)_R = (203)_5$. The value of radix R will be

(a) 16 (b) 10 (c) 8 (d) 6

$R^2 + 2R + 5 = 5^1 * 2 + 0 + 3$

$R^2 + 2R + 5 - 53 = 0 \Rightarrow R^2 + 2R - 48 = 0$

$R = 6$

6. What are the values respectively of R_1 and R_2 in the expression $(235)_{R1} = (565)_{10} = (1065)R_2$?

A. 8, 16

B. 16, 8

C. 6, 16

D. 12, 8

$R_1 > 10$ $\quad 10 > R_2$

$2R_1^2 + 3R_1 + 5 = 565$

$2R_1^2 + 3R_1 - 560 = 0$

$R_1 = 16$

$\therefore 16 \quad R_1 = 16$

$\rightarrow 235_{16} = 1065_8$

(OV)

$0010\ 0011\ 0101 = 0010001101$

10 → 0-9
8 → 0-7

0 - y-1

① y > 8
② y > x

Consider the equation $(123)_s = (x8)_y$ with x and y as unknown. The number of possible solutions is ____.

a) 3 b) 4 c) 6 d) 8 e) none

$5^2 + 2*5 + 3 = xy + 8$

$38 = xy + 8$

$xy = 30$

① $y > x$; $y \geq 8$

x = 1 y = 30

x = 2 y = 15

x = 3 y = 10

x = 5 y = 6

x = 6 ; y = 5

x = 15, y = 2

a) 4 b) 5 c) 6 d) 7 e) none

The base (or radix) of the number system such that the following equation holds is _____ $\frac{312}{20} = 13.1$

$\frac{312_x}{20_x} = 13.1_x$

$x \mid \frac{3x^2 + x + 2}{2x} = x + 3 + x^{-1} + 1$

$\frac{3}{2}x + \frac{1}{2} + \frac{1}{x} = x + 3 + \frac{1}{x}$

$$\frac{3}{2}x + \frac{1}{2} = x + 3$$

$$3x + 1 = 2x + 6$$

$$x = 5$$

2. Which one of the following is the correct sequence of the numbers represented in the series given below?

$(2)_3, (10)_4, (11)_5, (14)_6, (22)_7, \ldots\ldots$

A. 2, 3, 4, 5, 6,…

B. 2, 4, 6, 8, 10….

C. 2,4,6,10,12….

D. 2, 4, 6, 10, 16,…..

$$\frac{5b+4}{4} = b+3$$

$$5b+4 = 4b+3*4$$

$$b = 3*4-4 = 8$$

What is the base of the numbers for the following operation to be correct?

$$\frac{(54)_b}{(4)_b} = (13)_b$$

(a) 2 (b) 4 (c) 8 (d) 16

If $(11X1Y)_8 = (12C9)_{16}$ then the values X and Y are

(a) 3 and 1

(b) 5 and 7

(c) 7 and 5

(d) 1 and 5

0001 0010 1100 1001

1 1 3 1 1

$11311_8 = 11 \times 14 = 8$

$x = 3$

$y = 1$

AB...

12

!

AD