JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

Year & Semester - B.Tech I year (I Semester)

Subject - Programming for Problem Solving

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VISION OF INSTITUTE

To become a renowned centre of outcome based learning, and work towards academic, professional, cultural and social enrichment of the lives of individuals and communities

MISSION OF INSTITUTE

- ❖ Focus on evaluation of learning outcomes and motivate students to inculcate research aptitude by project based learning.
- ❖ Identify, based on informed perception of Indian, regional and global needs, the areas of focus and provide platform to gain knowledge and solutions.
- ❖ Offer opportunities for interaction between academia and industry.
- ❖ Develop human potential to its fullest extent so that intellectually capable and imaginatively gifted leaders can emerge in a range of profession.

Programming for Problem Solving : Course Outcomes

Students will be able to:

CO1: Understand concept of low-level and high-level languages, primary and secondary memory. Represent algorithm through flowchart and pseudo code for problem solving.

CO2: Represent and convert numbers & alphabets in various notations.

CO3: Analyze and implement decision making statements and looping.

CO4: Apply pointers, memory allocation and data handling through files in 'C' Programming Language.

Converting from one Number System to Another

✓ Converting from Another Base to Decimal

We use the following steps to convert a number in any other base to a base 10 -

Step 1: Determine the column (positional) value of each digit.

Step 2: Multiply the obtained column values by the digits in the corresponding columns.

Step 3: Calculate the sum of these products.

Examples –

(i) $4706_8 = ?_{10}$

Column values multiplied by the corresponding digits

$4706_8 = 4 \times 8^3 + 7 \times 8^2 + 0 \times 8^1 + 6 \times 8^0$

$= 4 \times 512 + 7 \times 64 + 0 + 6 \times 1$

$= 2048 + 448 + 0 + 6$

$= 2502_{10}$

Column Number (from right)	Column Value
1	$8^0 = 1$
2	$8^1 = 8$
3	$8^2 = 64$
4	$8^3 = 512$

Contd….

(ii) $11001_2 = ?_{10}$

Column values multiplied by the corresponding digits

$$11001_2 = 1 \times 2^4 + 1 \times 2^3 + 0 \times 2^2 + 0 \times 2^1 + 1 \times 2^0$$

$$= 1 \times 16 + 1 \times 8 + 0 + 0 + 1 \times 1$$

$$= 16 + 8 + 1$$

$$= 25_{10}$$

Column Number (from right)	Column Value
1	$2^0 = 1$
2	$2^1 = 2$
3	$2^2 = 4$
4	$2^3 = 8$
5	$2^4 = 16$

iii) $1AC_{16} = ?_{10}$

Column values multiplied by the corresponding digits

$$1AC_{16} = 1 \times 16^2 + A \times 16^1 + C \times 16^0$$

$$= 1 \times 256 + 10 \times 16 + 12 \times 1$$

$$= 256 + 160 + 12$$

$$= 428_{10}$$

Column Number (from right)	Column Value
1	$16^0 = 1$
2	$16^1 = 16$
3	$16^2 = 256$

Contd….

(iv) $11001_4 = ?_{10}$

Column values multiplied by the corresponding digits

$$11001_4 = 1 \times 4^4 + 1 \times 4^3 + 0 \times 4^2 + 0 \times 4^1 + 1 \times 4^0$$
$$= 1 \times 256 + 1 \times 64 + 0 + 0 + 1 \times 1$$
$$= 256 + 64 + 1$$
$$= 321_{10}$$

Column Number (from right)	Column Value
1	$4^0 = 1$
2	$4^1 = 4$
3	$4^2 = 16$
4	$4^3 = 64$
5	$4^4 = 256$

v) $4052_6 = ?_{10}$

Column values multiplied by the corresponding digits

$$4052_6 = 4 \times 6^3 + 0 \times 6^2 + 5 \times 6^1 + 2 \times 6^0$$
$$= 4 \times 216 + 0 + 5 \times 6 + 2 \times 1$$
$$= 864 + 30 + 2$$
$$= 896_{10}$$

Column Number (from right)	Column Value
1	$6^0 = 1$
2	$6^1 = 6$
3	$6^2 = 36$
4	$6^3 = 216$

Converting from one Number System to Another

- ✓ **Converting from Decimal to Another Base**

Division – Remainder Method

We use the following steps to convert a base 10 to a number in any other base -

Step 1: Divide the decimal number by the value of the new base.

Step 2: Record the remainder from step 1 as the rightmost digit.

Step 3: Divide the received quotient by the value of the new base.

Step 4: Record the remainder from step 3 as the next digit.

Repeat the step 3 & 4 (with recording remainders from right to left) until the quotient becomes zero in step 3.

Note that the last remainder , thus obtained, will be the most significant digit (MSD) of the new base number.

Contd….

Example -

(i) $952_{10} = ?_8$

8	952	
8	119	0
8	14	7
8	1	6
	0	1

↑ Remainders

Now write Remainders 0,7, 6, 1 in reverse order, making the first remainder(0) the least significant digit (LSD) and the last remainder(1) the most significant digit (MSD).

Hence, $952_{10} = 1670_8$

Contd….

(ii) $42_{10} = ?_2$

2	42	
2	21	0
2	10	1
2	5	0
2	2	1
2	1	0
	0	1

↑ Remainders

Now write Remainders 0,1, 0, 1,0,1 in reverse order, making the first remainder(0) the least significant digit (LSD) and the last remainder(1) the most significant digit (MSD).

Hence, $42_{10} = 101010_2$

Contd….

Example -

(iii) $100_{10} = ?_4$

4	100	
4	25	0
4	6	1
4	1	2
	0	1

Remainders ↑

Now write Remainders 0,1, 2, 1 in reverse order, making the first remainder(0) the least significant digit (LSD) and the last remainder(1) the most significant digit (MSD).

Hence, $100_{10} = 1210_4$

Contd….

Example -

(iv) $428_{10} = ?_{16}$

16	428	
16	26	12
16	1	10
	0	1

↑ Remainders

Now write Remainders 12(C),10(A),1 in reverse order, making the first remainder(C) the least significant digit (LSD) and the last remainder(1) the most significant digit (MSD).

Hence, $428_{10} = 1AC_{16}$

Contd….

Example -

(v) $1715_{10} = ?_{12}$

12	1715	
12	142	11
12	11	10
	0	11

Remainders

Now write Remainders 11(B),10(A),11(B) in reverse order, making the first remainder(B) the least significant digit (LSD) and the last remainder(B) the most significant digit (MSD).

Hence, $1715_{10} = BAB_{12}$

Converting from one Number System to Another (Contd…)

✓ Converting from a Base(other than 10) to Another Base (other than 10)

We use the following steps to convert a number in a base other 10 to a number in any other base other than 10-

Step 1: Convert the original number to a decimal number (base 10).

Step 2: Convert the decimal number so obtained to the new base number.

Examples –

(i) $56_8 = ?_2$

Step 1 : Convert 56_8 to base 10

$$56_8 = 5 \times 8^1 + 6 \times 8^0$$

$$= 5 \times 8 + 6 \times 1$$

$$= 40 + 6$$

$$= 46_{10}$$

Contd….

Step 2 : Convert 46_{10} to base 2

$46_{10} = ?_2$

2	46	
2	23	0
2	11	1
2	5	1
2	2	1
2	1	0
	0	1

↑ Remainders

$56_8 = 46_{10} = 101110_2$

Contd….

(ii) $545_6 = ?_4$

Step 1 : Convert 545_6 to base 10 –

$$545_6 = 5 \times 6^2 + 4 \times 6^1 + 5 \times 6^0$$

$$= 5 \times 36 + 4 \times 6 + 5 \times 1$$

$$= 180 + 24 + 5$$

$$= 209_{10}$$

Step 2 : Convert 209_{10} to base 4

4	209	
4	52	1
4	13	0
4	3	1
	0	3

Remainders ↑

$545_6 = 209_{10} = 3101_4$

Contd….

(iii) $11010011_2 = ?_{16}$

Step 1 : Convert 11010011_2 to base 10 –

$$11010011_2 = 1 \times 2^7 + 1 \times 2^6 + 0 \times 2^5 + 1 \times 2^4 + 0 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0$$

$$= 1 \times 128 + 1 \times 64 + 0 + 1 \times 16 + 0 + 0 + 1 \times 2 + 1 \times 1$$

$$= 128 + 64 + 0 + 16 + 0 + 0 + 2 + 1$$

$$= 211_{10}$$

Step 2 : Convert 211_{10} to base 16

16	211	
16	13	3
	0	13

↑ Remainders

$11010011_2 = 211_{10} = D3_{16}$

- **Shortcut Method for Binary to Octal Conversion**

Method

Step 1: Divide the digits into groups of three starting from the right.

Step 2: Convert each group of three binary digits to one octal digit using the method of binary to decimal conversion.

Example –

$1101010_2 = ?_8$

Step 1: Divide the binary digits into from right groups of 3 starting

$\underline{001}\ \underline{101}\ \underline{010}$

Step 2: Convert each group into one octal digit

$001_2 = 1$

$101_2 = 5$

$010_2 = 2$

Hence $1101010_2 = 152_8$

- **Shortcut Method to Octal to Binary Conversion**

Method

Step 1: Convert number decimal each octal digit to a 3 digit binary.

Step 2: Combine all the resulting binary single groups (of 3 digits each) into a binary number.

Example –

$562_8 = ?_2$

Step 1: Convert each octal digit to 3 binary digits

$5_8 = 101_2$, $6_8 = 110_2$, $2_8 = 010_2$

Step 2: Combine the binary groups

$$562_8 = \underset{5}{\underline{101}}\ \underset{6}{\underline{110}}\ \underset{2}{\underline{010}}$$

Hence $562_8 = 101110010_2$

- **Shortcut Method for Binary to Hexadecimal Conversion**

Method

Step 1: Divide the binary digits into groups of four starting from the right

Step 2: Combine each group of four binary digits to one hexadecimal digit

Example –

$111101_2 = ?_{16}$

Step 1: Divide the binary digits into groups of four starting from the right

<u>0011</u> <u>1101</u>

Step 2: Convert each group into a hexadecimal digit

$0011_2 = 3_{16}$

$1101_2 = D_{16}$

Hence $111101_2 = 3D_{16}$

- **Shortcut Method to Hexadecimal to Binary Conversion**

Method

Step 1: Convert the decimal equivalent of each hexadecimal digit to a 4 digit binary number.

Step 2: Combine all the resulting binary groups (of 4 digits each) in a single binary number.

Example -

2AB16 = ?2

Step 1: Convert each hexadecimal binary number digit to a 4 digit

$2_{16} = 0010_2$

$A_{16} = 1010_2$

$B_{16} = 1011_2$

Step 2: Combine the binary groups

$2AB_{16} = \underset{2}{\underline{0010}}\ \underset{A}{\underline{1010}}\ \underset{B}{\underline{1011}}$

Hence $2AB_{16} = 001010101011_2$

Fractional Numbers

In Binary Number System, Fractional Numbers are formed in the same way as in decimal number system. For example, in decimal number system –

$0.235_{10} = (2 \times 10^{-1}) + (3 \times 10^{-2}) + (5 \times 10^{-3})$ and $68.53_{10} = (6 \times 10^{1}) + (8 \times 10^{0}) + (5 \times 10^{-1}) + (3 \times 10^{-2})$

Similarly, in binary number system

$0.101_{2} = (1 \times 2^{-1}) + (0 \times 2^{-2}) + (1 \times 2^{-3})$ and $10.01_{2} = (1 \times 2^{1}) + (0 \times 2^{0}) + (0 \times 2^{-1}) + (1 \times 2^{-2})$

Hence , Some positional values in binary number system are given below –

Position	4	3	2	1	0	.	-1	-2	-3	-4
Position Value	2^4	2^3	2^2	2^1	2^0		2^{-1}	2^{-2}	2^{-3}	2^{-4}
Quantity	16	8	4	2	1		$^1/_2$	$^1/_4$	$^1/_8$	$^1/_{16}$

Hence, as per the above mentioned general rule -

$46.23_8 = (4 \text{ x } 8^1) + (6 \text{ x } 8^0) + (3 \text{ x } 8^{-1}) + (2 \text{ x } 8^{-2})$ and $5A.3C_{16} = (5 \text{ x } 16^1) + (10 \text{ x } 16^0) + (3 \text{ x } 16^{-1}) + (12 \text{ x } 16^{-2})$

Example –

(i) $110.101_2 = (1 \text{ x } 2^2) + (1 \text{ x } 2^1) + (0 \text{ x } 2^0) + (1 \text{ x } 2^{-1}) + (0 \text{ x } 2^{-2}) + (1 \text{ x } 2^{-3})$

$= 4 + 2 + 0 + 0.5 + 0 + 0.125$

$= 6 + 0.5 + 0.125$

$= 6.625_{10}$

(ii) $2B.C4_{16} = (1 \text{ x } 16^1) + (11 \text{ x } 16^0) + (12 \text{ x } 16^{-1}) + (4 \text{ x } 16^{-2})$

$= 32 + 11 + 12/16 + 4/256$

$= 43 + 0.75 + 0.015625$

$= 43.765652_{10}$

Thank You