DLCOA

Q) Binary to decimal

$(1\underset{7}{}0\underset{6}{}1\underset{5}{}0\underset{4}{}0\underset{3}{}1\underset{2}{}1\underset{1}{}1\underset{0}{})$

(10100111)
7 6 5 4 3 2 1 0

$\cancel{2^7 +}\ 2^7 \times 1 + 2^6 \times 0 + 2^5 \times 1 + 2^4 \times 0 + 2^3 \times 0 + 2^2 \times 1$
$+ 2^1 \times 1 + 2^0 \times 1$

$= 128 + 32 + 4 + 2 + 1$

$= (167)_{10}$

Q) Decimal to binary

$(88)_{10}$

2	88	
2	44	0
2	22	0
2	11	0
2	5	1
2	2	1
2	1	0
	0	1

$(88)_{10} = (1011000)_2$

$(56.25)_{10}$

2	56	
2	28	0
2	14	0
2	7	0
2	3	1
2	1	1
	0	1

$0.25 \times 2 = 0.5 \quad 0$
$0.5 \times 2 = 1 \quad 1$

$(56.25)_{10} = (111000.01)_2$

② Binary to octal

$(\underline{001}\,\underline{101}\,\underline{101})_2$
$\downarrow \quad \downarrow \quad \downarrow$
$1 \quad 5 \quad 5$

$(155)_8$

$(\underline{010}\,\underline{110}\,.\,\underline{011}\,\underline{000})_2$
$\downarrow \quad \downarrow \quad \downarrow \quad \downarrow$
$2 \quad 6 \quad 3 \quad 0$

$(26.30)_8$

Q) Binary to Hexadecimal

$(\underline{1010}\,\underline{0110}\,\underline{1111})_2$

$\downarrow \quad \downarrow \quad \downarrow$

A 6 F

$(A6F)_{16}$

Q) Decimal to octal

$(19.35)_{10}$

8	19	
8	2	3
	0	2

$0.35 \times 8 = 2.8 = 2$
$0.8 \times 8 = 6.4 = 6$
$0.4 \times 8 = 3.2 = 3$
$0.2 \times 8 = 1.6 = 1$
$0.6 \times 8 = 4.8 = 4$
$0.8 \times 8 = 6.4$

$(23.26314)_8$

Q) Decimal to Hexadecimal

$(19.35)_{10}$

$$\begin{array}{r|ll} 16 & 19 & \\ 6 & 1 & 3 \uparrow \\ & 0 & 1 \end{array}$$

$0.35 \times 16 = 5.6 = 5$
$0.6 \times 16 = 9.6 = 9$
$0.6 \times 16 = 9.6 = 9$ ↓

$(13.599)_{16}$

Q) Octal to Decimal

$(\underset{1}{1}\underset{0}{7}.\underset{-1}{4})_8$

$8^1 \times 1 + 8^0 \times 7 + 4 \times 8^{-1}$

$(15.5)_{10}$

Q) ~~De~~ Hexadecimal to decimal

$(\underset{1}{A}\underset{0}{7}.\underset{-1}{C})_{16}$

$A \times 16^1 + 7 \times 16^0 + C \times 16^{-1}$
$= 10 \times 16 + 7 + 12 \times 16^{-1}$
$= (167.75)_{10}$

Q) BCD Arithmetic

$(57)_{10}$ and $(26)_{10}$

$57 \rightarrow 0101\ 0111$

$26 \rightarrow 0010\ 0110$

~~1 0101 0111~~

~~+ 1 0010 0110~~

$$
\begin{array}{rll}
 & 0101 & 0111 \\
+ & 0010 & 0110 \\
 & & 11 \\
\hline
 & 0111 & 1101 \rightarrow \text{Invalid BCD} \\
+ & 0000 & 0110 \rightarrow \text{Add } 6 \\
\hline
 & \underbrace{1000}_{8} & \underbrace{0011}_{3}
\end{array}
$$

$(57)_{10} + (26)_{10} = (83)_{10}$

Q) Add $(569)_{10}$ and $(687)_{10}$

```
     0101  0110  1001
  +  0110  1000  0111
     1        1  111
     ----------------
     1011  1111  0000
  +  0110  0110  0110
     ----------------
  1  0010  0101  0110
  1   2     5     6
```

$(1256)_{10}$

Q) $(56)_{10}$ & $(65)_{10}$

```
    0101  0110
 +  0110  0101
     1     1
    ----------
    1011  1011
 +  0110  0110
  1 1111  11
    ----------
  1 0010  0001
  1   2     1
```

$(121)_{10}$

Q) BCD Subtraction

$(4)_{10} - (7)_{10}$

9's complement of 7

~~999~~

$$\begin{array}{r} 9 \\ -7 \\ \hline 2 \end{array} \rightarrow \text{9's complement}$$

Add 4 to 9's complement of 7

$$\begin{array}{r} 0100 \\ +0010 \\ \hline 0110 \end{array}$$

carry → $\boxed{0}$

carry is 0 so result is negative Take 9's complement of result

$$\begin{array}{r} \cancel{1001} \\ \cancel{-0110} \\ \hline \cancel{011} \end{array} \qquad \begin{array}{r} 9 \\ -6 \\ \hline 3 \end{array} \qquad \begin{array}{r} 1001 \\ -0110 \\ \hline 0011 \end{array}$$

$(4)_{10} - (7)_{10} = (-3)_{10}$

Q) $(83)_{10} - (21)_{10}$

9's complement of 21

$$\begin{array}{r} 99 \\ -21 \\ \hline 78 \end{array}$$

83 → ~~0~~ 1000 0011

~~21 → 0010 0001~~

78 → 0111 1000

~~1000 0011~~

~~+ 0010 0001~~

~~1010 0100~~

$$\begin{array}{rr} 1000 & 0011 \\ +\ 0111 & 1000 \\ \hline \underbrace{1111}_{\text{Invalid}} & \underbrace{1011}_{\text{Invalid}} \end{array}$$

$$\begin{array}{rrr} & 1111 & 1011 \\ + & 0110 & 0110 \\ & 1\ 1111 & 11 \\ \hline \text{carry } & \boxed{1}\ 0110 & 0001 \\ & & 1 \\ \hline & \underbrace{0110}_{6} & \underbrace{0010}_{2} \end{array}$$

~~0110~~ $(62)_{10}$

Q) 15' complement

$(D8A)_{16} - (426)_{16}$

15's C of 426

$$\begin{array}{rrr} 15 & 15 & 15 \\ - 4 & 2 & 6 \\ \hline 11 & 13 & 9 \end{array}$$

Add $(D8A)_{16}$ to 15's Com of $(426)_{16}$

$$\begin{array}{rrrr} & D\}13 & 8 & A\}10 \\ + & 11 & 13 & 9 \\ & 1 & 1 & \\ \hline 1 & 25 & 22 & 19 \\ & -16 & -16 & -16 \\ \hline & 1\ 9 & 1\ 6 & 1\ 3 \end{array}$$

$$\begin{array}{r} 963 \\ 1 \\ \hline (964)_{16} \end{array}$$

Q) Represent $(1259.125)_{10}$ in single & double precision format

→ Step 1 :- Convert decimal into binary

$(1259.125)_{10}$

$1259 = 10011101011$

$0.125 \times 2 = 0.25 - 0$
$0.25 \times 2 = 0.5 = 0$
$0.5 \times 2 = 1 = 1$

$(1259.125)_{10} = (10011101011.001)_2$

Step 2 :- Normalize the number

Single precision :- $1.N \times 2^{E-127}$

Double precision :- $1.N \times 2^{E-1023}$

$1.\underbrace{0011101011}_{10}.001$

$1.0011101011001 \times 2^{10}$

Step 3 :- Single precision format

$1.N \times 2^{E-127}$

$1.0011101011001 \times 2^{10}$

$E - 127 = 10$

$E = 10 + 127$

$E = 137$

$E = (10001001)_2$

31	30 … 23	22 … 0
0	10001001	0011101011001 00
Sign bit 1 bit	Exponent 8 bits	Mantissa 23 bits

Step 4 :- Double precision format

$$1.N \times 2^{E-1023}$$

$$1.0011101011001 \times 2^{10}$$

$$E - 1023 = 10$$

$$E = 10 + 1023$$

$$E = 1033$$

$$E = (10000001001)_2$$

63	62 … 52	51 … 0
0	10000001001	0011101011001 00
Sign bit 1 bit	Exponent 11 bits	Mantissa 52 bits.

Booth's multiplication

$8 \times 4 \leftarrow$ multiplier (Q)

$\uparrow$

multiplicand (m)

$n = 4$

$m = (8)_{10} = (1000)_2$

$Q = (4)_{10} = (0100)_2$

$-m \rightarrow$ 2's complement

$$\begin{array}{r} 1000 \\ \downarrow 1\text{'s} \\ 0111 \\ +\quad 1 \\ \hline 1000 \rightarrow 2\text{'s} \end{array}$$

A	Q	Q-1	n	Operation
0000	0100	0	4	ASR n=n-1
0000	0010	0	3	ASR ~~A=A-1~~ n=n-1
0000	0001	0	2	A=A-m 0000 +1000 1000
1000	0001	0	2	ASR n=n-1
1100	0000	1	1	A=A+m 1100 +1000 (1) 0100 Discard
0100	0000	1	1	ASR n=n-1
$\boxed{0010 \quad 0000 \quad 0}$			0	

$(00100000)_2$

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

$= (32)_{10}$

$(8)_{10} \times (4)_{10} = (32)_{10}$

Q) Restoring division

4 ÷ 2
↑ ↑
Dividend Divisor
(Q) (m)

$Q = (4)_{10} = (0100)_2$

$m = (2)_{10} = (00010)_2$

↓ 1's

11101

\+ 1

11110 → 2's

C	A	Q	n	operation
0	0000	0100	4	~~A=~~ Shift left
0	0000	100 $\square$		A = A − m
				C,A = 00000
				−m = 11110
				11110
1	1110	100 $\boxed{0}$ (Q_0)		$Q_0 = 0$
				A = A + m
				C,A = 11110
				m = 00010
				100000
0	0000	1000	3	n = n − 1

C	A	Q	n	operation
0	0000	1000	3	Shift left
0	0001	000☐		A = A − m
				C,A = 00001
				−m = 11110
				11111
1	1111	000 $\boxed{0}$ (Q_0)		$Q_0 = 0$
				A = A + m
				C,A = 11111
				m = 00010
				100001
0	0001	0000	2	n = n−1
0	0001	0000	2	Shift left
0	0010	000☐		A = A − m
				C,A = 00010
				−m = 11110
				100000
0	0000	000 $\boxed{1}$ (Q_0)	1	$Q_0 = 1$
				n = n−1
0	0000	0001		Shift left
0	0000	001☐		A = A − m
				C,A = 00000
				−m = 11110
				11110
1	1110	001 $\boxed{0}$ (Q_0)	1	$Q_0 = 0$
				A = A + m
				C,A = 11110
				m = 00010
				100000

C	A	Q_0	n	Operation
0	0000	0010	0	n=n-1
	Remainder	Quotient		

$R = (00000)_2$
$R = (0)_{10}$

$Q = (0010)_2$
$Q = (2)_2$

Q) Non-Restoring Division

$9 \div 8$

$Q = (9)_{10} = (1001)_2$

$m = (8)_{10} = (01000)_2$

$$
\begin{array}{l}
-m \rightarrow 01000 \\
\quad\quad\quad\ \ \downarrow 1\text{'s} \\
\quad\quad\quad 10111 \\
\quad\quad + \quad\quad\ 1 \\
\hline
\quad\quad\quad 11000
\end{array}
$$

1 1001 000 $\boxed{0}$ 0 $m = \underline{010}$

110

$n = n -$

Q) $7 \div 2$

Dividend Divisor

$Q = (7)_{10} = (0111)_2$

$M = (2)_{10} = (00010)_2$

$\downarrow$ 1's

11101

+ 1

$-M \rightarrow 11110 \rightarrow 2's$

C	A	Q	n	operation
0	0000	0111	4	Shift left
0	0000	111☐		$C=0$ $A=A-m$ $C,A = 00000$ $-m = \underline{11110}$ 11110
1	1110	111$\boxed{0}$	3	$n=n-1$
1	1110	1110		Shift left
1	1101	110☐		$C=1$ $A=A+m$ $C,A = 11101$ $m = \underline{00010}$ 11111
1	1111	110$\boxed{0}$	2	$n=n-1$
1	1111	1100		Shift left
1	1111	100☐		$C=1$ $A=A+m$ $C,A = 11111$ $m = \underline{00010}$ 100001

C	A	Q	n	operation
0	0001	100 $\boxed{1}$	1	n=n-1
0	0001	1001		Shift left
0	0011	001 $\square$		C=0

A=A-m

$C, A = 00011$

$-m = 11100$

(1) 00001

0

Remainder		Quotient		
0	0001	001 $\boxed{1}$	0	n=n-1

$R = (00001)_2$

$R = 2^0 \times 1$

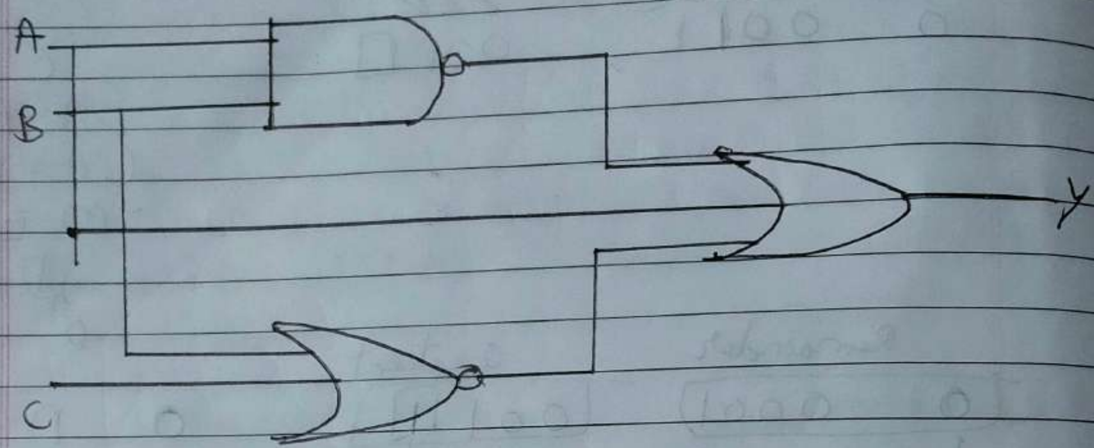
$R = (1)_{10}$

$Q = (0011)_2$

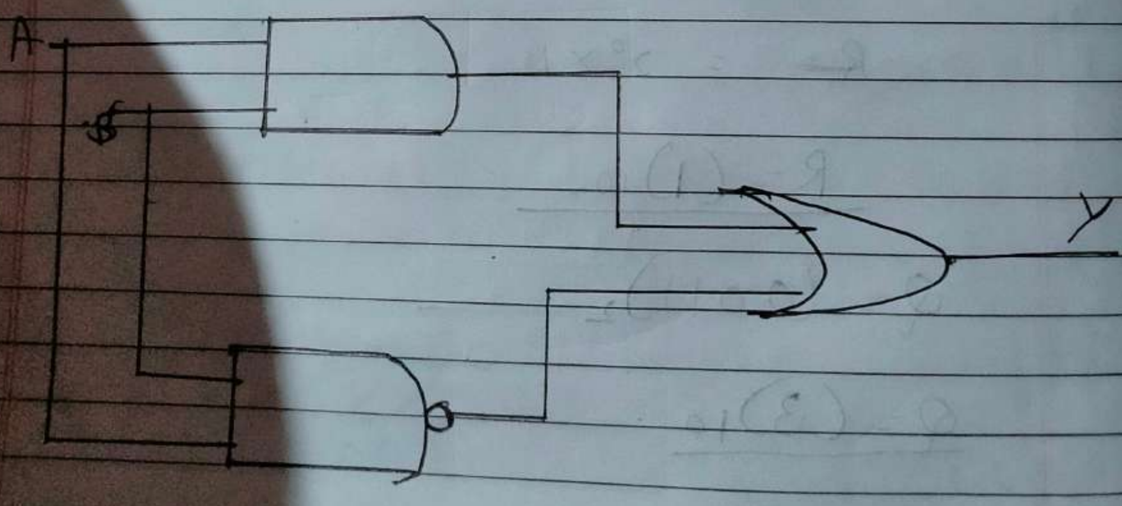
$Q = (3)_{10}$

Q) Realization of logical expression

$Y = \overline{AB} + A + (\overline{B+C})$



$Y = AB + \overline{AB}$



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Q) A block set associative cache consists of 64 blocks divided in 4 blocks sets. The main memory contains 4096 blocks, each 128 words of 16 bit length.
1) How many bits are there in main memory address?
2) How many bits are there in cache memory address (tag, set & word field)?

→ 4096 blocks
128 words

Memory size = Blocks × no. of words in each block

$$= 4096 \times 128$$

$$= 2^{12} \times 2^{7}$$

Memory size $= 2^{19}$

Main memory address line is 19

Cache = 64 blocks divided into 4 block sets

~~divi~~

$$\frac{64}{4} = 16$$

Each set has 16 blocks $= 2^4$, 4 address line

Each block has 128 words
$128 = 2^7$, 7 address line

$Tag = 19 - 4 - 7 = 8$

$\longleftarrow 19 \longrightarrow$

8 bits	4 bits	7 bits
Tag	Set	Word

Q) Consider a cache memory of 16 words. Each block consists of 4 words. Size of the main memory is 256 Blocks. Draw associative mapping & calculate Tag and word size

→ $4 \text{ words} = 2^2$

$\text{Main memory} = 256 = 2^8$

$Tag = 8 - 2 = 6$

$\longleftarrow 8 \longrightarrow$

6	2
Tag	Words