2 Number System

Operations on Binary Numbers

1. What is the sum of the two numbers $(11110)_2$ and $(1010)_2$? *[2014-I]*

(*a*) $(101000)_2$ (*b*) $(110000)_2$
(*c*) $(100100)_2$ (*d*) $(101100)_2$

2. The number 251 in decimal system is expressed in binary system by: *[2014-I]*

(*a*) 11110111 (*b*) 11111011 (*c*) 11111101 (*d*) 11111110

3. What is $(1001)_2$ equal to? *[2014-II]*

(*a*) $(5)_{10}$ (*b*) $(9)_{10}$ (*c*) $(17)_{10}$ (*d*) $(11)_{10}$

4. The decimal number $(127.25)_{10}$, when converted to binary number, takes the form *[2015-I]*

(*a*) $(1111111.11)_2$ (*b*) $(1111110.01)_2$
(*c*) $(1110111.11)_2$ (*d*) $(1111111.01)_2$

5. If $(11101011)_2$ is converted decimal system, then the resulting number is *[2015-I]*

(*a*) 235 (*b*) 175 (*c*) 160 (*d*) 126

6. What is $(1000000001)_2 - (0.0101)_2$ equal to? *[2015-II]*

(*a*) $(512.6775)_{10}$ (*b*) $(512.6875)_{10}$
(*c*) $(512.6975)_{10}$ (*d*) $(512.0909)_{10}$

7. What is the binary equivalent of the decimal number 0.3125? *[2016-I]*

(*a*) 0.0111 (*b*) 0.1010 (*c*) 0.0101 (*d*) 0.1101

8. If the number 235 in decimal system is converted into binary system, then what is the resulting number? *[2016-II]*

(*a*) $(11110011)_2$ (*b*) $(11101011)_2$
(*c*) $(11110101)_2$ (*d*) (11011011)2

9. In the binary equation *[2017-I]*

$(1p101)_2 + (10q1)_2 = (100r00)_2$

where p, q and r are binary digits, what are the possible values of p, q and r respectively?

(*a*) 0, 1, 0 (*b*) 1, 1, 0 (*c*) 0, 0, 1 (*d*) 1, 0, 1

10. The remainder and the quotient of the binary division $(101110)_2 \div (110)_2$ are respectively *[2017-II]*

(*a*) $(111)_2$ and $(100)_2$ (*b*) $(100)_2$ and $(111)_2$
(*c*) $(101)_2$ and $(101)_2$ (*d*) $(100)_2$ and $(100)_2$

11. The binary number expression of the decimal number 31 is *[2018-I]*

(*a*) 1111 (*b*) 10111 (*c*) 11011 (*d*) 11111

12. The sum of the binary numbers $(11011)_2$, $(10110110)_2$ and $(10011x0y)_2$ is the binary number $(101101101)_2$. What are the values of x and y? *[2018-II]*

(*a*) $x = 1, y = 1$ (*b*) $x = 1, y = 0$
(*c*) $x = 0, y = 1$ (*d*) $x = 0, y = 0$

13. A binary number is represented by $(cdccddcccddd)_2$, where $c > d$. What is its decimal equivalent? *[2019-II]*

(*a*) 1848 (*b*) 2048 (*c*) 2842 (*d*) 2872

14. The number $(1101101 + 1011011)_2$ can be written in decimal system as *[2020-I & II]*

(*a*) $(198)_{10}$ (*b*) $(199)_{10}$ (*c*) $(201)_{10}$ (*d*) $(200)_{10}$

15. What is $(1110011)_2 \div (10111)_2$ equal to ? *[2022-I]*

(*a*) $(101)_2$ (*b*) $(1001)_2$ (*c*) $(111)_2$ (*d*) $(1011)_2$

16. If $x^3 + y^3 = (100010111)_2$ and $x + y = (11111)_2$, then what is $(x-y)^2 + xy$ equal to? *[2022-I]*

(*a*) $(1101)_2$ (*b*) $(1001)_2$
(*c*) $(1011)_2$ (*d*) $(1111)_2$

17. What is the binary number equivalent to decimal number 1011? *[2023-I]*

(*a*) 1011 (*b*) 111011 (*c*) 11111001 (*d*) 111110011

ANSWER KEY

1. (*a*)	2. (*b*)	3. (*b*)	4. (*d*)	5. (*a*)	6. (*b*)	7. (*c*)	8. (*b*)	9. (*a*)	10. (*b*)
11. (*d*)	12. (*b*)	13. (*d*)	14. (*d*)	15. (*a*)	16. (*b*)	17. (*)			

EXPLANATIONS

1. (*a*) $(11110)_2 = 2^4 \times 1 + 2^3 \times 1 + 2^2 \times 1 + 2^1 \times 1 + 2^0 \times 0$
$= 16 + 8 + 4 + 2 + 0 = 30$
$(1010)_2 = 2^3 \times 1 + 2^2 \times 0 + 2^1 \times 1 + 2^0 \times 0$
$= 8 + 0 + 2 + 0 = 10$
Adding their decimal equivalent, we have
Sum = 30 + 10 = 40
Now, converting 40 to binary

2	40	
2	20	0
2	10	0
2	5	0
2	2	1
	1	0

$\therefore 40 = (101000)_2$

2. (*b*)

2	251	
2	125	1
2	62	1
2	31	0
2	15	1
2	7	1
2	3	1
	1	1

Therefore, $(251)_{10} = (11111011)_2$

3. (*b*) $(1001)_2 = (2^3 \times 1 + 2^2 \times 0 + 2^1 \times 0 + 2^0 \times 1)_{10} = (8 + 1)_{10} = (9)_{10}$

4. (*d*) $(127.25)_{10}$
Now,

2	127	
2	63	1
2	31	1
2	15	1
2	7	1
2	3	1
	1	1

$127 = (1111111)_2$
Now,
$0.25 \times 2 = 0.5$ carry 0
$0.5 \times 2 = 1.0$ carry 1
$\therefore (127.25)_{10} = (1111111.01)_2$

5. (*a*) $(11101011)_2$
$= (1 \times 2^7 + 1 \times 2^6 + 1 \times 2^5 + 0 \times 2^4 + 1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0)_{10}$
$= (128 + 64 + 32 + 8 + 2 + 1)_{10}$
$= (235)_{10}$

6. (*b*) $(1000000001)_2$
$= 1 \times 2^9 + 0 \times 2^8 + 0 \times 2^7 + \ldots + 1 \times 2^0$
$= 512 + 0 + 0 + \ldots + 1$
$= (513)_{10}$
$(0.0101)_2 = 0 \times 2^{-1} + 1 \times 2^{-2} + 0 \times 2^{-3} + 1 \times 2^{-4}$
$= \frac{1}{4} + \frac{1}{16} = \frac{5}{16} = (0.3125)_{10}$
$\therefore (1000000001)_2 - (0.0101)_2$
$= 513 - 0.3125 = (512.6875)_{10}$

7. (*c*)
$0.3125 \times 2 = 0.6250$
$0.6250 \times 2 = 1.2500$
$0.2500 \times 2 = 0.5000$
$0.5000 \times 2 = 1.0000$
$\therefore (0.3125)_{10} = (0.0101)_2$

8. (*b*)

2	235	
2	117	1
2	58	1
2	29	0
2	14	1
2	7	0
2	3	1
	1	1

So, $(235)_{10} = (11101011)_2$

9. (*a*) $(1p101)_2 + (10q1)_2 = (100r00)_2$
$\Rightarrow (1 \times 2^4 + p \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0) + (1 \times 2^3 + 0 \times 2^2 + q \times 2^1 + 1 \times 2^0)$
$= 1 \times 2^5 + 0 + 0 + r \times 2^2 + 0 + 0$
$\Rightarrow 16 + 8p + 4 + 1 + 8 + 2q + 1 = 32 + 4r$
$\Rightarrow 30 + 8p + 2q = 32 + 4r$
$\Rightarrow 8p + 2q = 2 + 4r$
from options, substitute $p = 0, q = 1, r = 0$ we get
$0 + 2(1) = 2 + 0 \Rightarrow 2 = 2.$

10. (*b*) $(101110)_2 = 1 \times 2^5 + 0 \times 2^4 + 1 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 0 \times 2^0 = (46)_{10}$
Similarly, $(110)_2 = 1 \times 2^2 + 1 \times 2^1 + 0 \times 2^0 = (6)_{10}$
Quotient $= 7 = (111)_2$
Remainder $= 4 = (100)_2$

11. (*d*)

2	31	
2	15	1
2	7	1
2	3	1
	1	1

So, binary form of 31 is $(11111)_2$

12. (*b*) On substraction, we get

$$\begin{array}{r} 101101101 \\ -10110110 \\ \hline 10110111 \\ -11011 \\ \hline 10011100 \end{array}$$

$\Rightarrow x = 1, y = 0$

13. (*d*) Binary number $= (cdccddcccddd)_2$
Where $c > d$ we know, only two bit (digits) 0 and 1 be any binary numbers.
$(cdccddcccddd)_2 = (101100111000)_2$
$(101100111000)_2 = (1 \times 2^{11})_{10} + (0 \times 2^{10})_{10} + (1 \times 2^9)_{10} + \ldots\ldots\ldots + (0 \times 2^0)_{10} = (2872)_{10}$

14. (*d*) The value of $(1101101)_2$ is obtained as: 109
The value of $(1011011)_2$ is obtained as: 91
The sum is then obtained as:
$(1101101 + 1011011)_2$
$= (109 + 91)_{10} = (200)_{10}$

15. (*a*) $(1110011)_2 = (115)_{10}$
$(10111)_2 = (23)_{10}$
$(1110011)_2 \div (10111)_2$
$= (115)_{10} \div (23)_{10} = (5)_{10} = (101)_2$

16. (*b*) $x^3 + y^3 = (100010111)_2$
$x^3 + y^3 = (279)_{10}$ ...(i)
$x + y = (11111)_2 = (31)_{10}$ ...(ii)
$x^3 + y^3 = (x + y)(x^2 - xy + y^2)$
$\Rightarrow 279 = (31)[(x - y)^2 + xy]$
$\therefore (x - y)^2 + xy = 9 = (1001)_2$

17. (*)

2	1011	
2	505	1
2	252	1
2	126	0
2	63	0
2	31	1
2	15	1
2	7	1
2	3	1
	1	1

Binary equivalent of 1011 is $(1111110011)_2$