

Question 1: Convert the decimal number 97.7_{10} into a number with the same value represented in the following bases. The exact value requires an infinite repeating part in the fractional part of the number. Show the steps of your derivation.

(a) binary (b) octal (c) hexadecimal (d) base 3 (e) base 5

[1+1+1+1+1+3 = 8 marks]

Question 1: Convert the decimal number 97.7_{10} into a number with exactly the same value represented in the following bases. The exact value requires an infinite repeating part in the fractional part of the number. Show the steps of your derivation.

(a) binary (b) octal (c) hexadecimal (d) base 3 (e) base 5

Solution:

(a), (c)	$\begin{array}{r} 16 \overline{) 97} \\ 16 \overline{) 6} \quad r1 \\ \underline{0} \quad r6 \\ \hline \end{array}$	$\begin{array}{r} .7 \\ \underline{16} \\ (11).2 \\ \underline{16} \\ (3).2 \end{array}$	(d)	$\begin{array}{r} 3 \overline{) 97} \\ 3 \overline{) 32} \quad r1 \\ 3 \overline{) 10} \quad r2 \\ 3 \overline{) 3} \quad r1 \\ 3 \overline{) 1} \quad r0 \\ \underline{0} \quad r1 \end{array}$	$\begin{array}{r} .7 \\ \underline{3} \\ (2).1 \\ \underline{3} \\ (0).3 \\ \underline{3} \\ (0).9 \\ \underline{3} \\ (2).7 \end{array}$
	$\therefore 97.7_{10} = 61.B3333..._{16}$				
	$(a) 61.B3333..._{16}$				
	$= 110\ 0001.1011\ 0011\ 0011\ 0011..._2$				
	$(b) 1\ 100\ 001.101\ 100\ 110\ 011\ 001\ 100\ 11..._2$				
	$= 141.5\ 4631\ 4631..._8$				
					$\therefore 97.7_{10} = 10121.2002..._3$
(e)	$\begin{array}{r} 5 \overline{) 97} \\ 5 \overline{) 19} \quad r2 \\ 5 \overline{) 3} \quad r4 \\ \underline{0} \quad r3 \end{array}$	$\begin{array}{r} .7 \\ \underline{5} \\ (3).5 \\ \underline{5} \\ (2).5 \end{array}$			
	$\therefore 97.7_{10} = 342.322..._5$				

Question 2: Add the following numbers in binary using both 1's and then 2's complement to represent negative numbers. Use a word length of 6 bits (including sign) and indicate if an overflow occurs

Solution:

a)		
	<p><u>In 2's complement</u></p> $\begin{array}{r} (-10) + (-11) \\ 110110 \\ 110101 \\ \hline (1)101011 \quad (-21) \end{array}$	<p><u>In 1's complement</u></p> $\begin{array}{r} (-10) + (-11) \\ 110101 \\ 110100 \\ \hline (1)101001 \\ \xrightarrow{1} \\ 101010 \quad (-21) \end{array}$
		<p><u>In 2's complement</u></p> $\begin{array}{r} (-8) + (-11) \\ 111000 \\ 110101 \\ \hline (1)101101 \quad (-19) \end{array}$
b)		<p><u>In 1's complement</u></p> $\begin{array}{r} (-8) + (-11) \\ 110111 \\ 110100 \\ \hline (1)101011 \\ \xrightarrow{1} \\ 101100 \quad (-19) \end{array}$

Convert $(64^{1/3})_5$ to Hexadecimal. (if possible)

[3 marks]

$$[(4^3)^{1/3}]_5$$

$$= (4)_5 \rightarrow ?_{16}$$

Base 5 to decimal calculation:

$$(4)_5 = (4 \times 5^0) = (4)_{10}$$

Decimal to base 16 calculation:

Divide by the base to get the digits from the remainders:

Division	Quotient	Remainder (Digit)	Digit #
4/16	0	4	0

$= (4)_{16}$

Question 3: One of the following bit patterns is valid BCD (binary-coded decimal), but the other one is not, Which one is not valid? For credit to be given, you must give a correct reason. **[2 marks]**

1. 100110110100
2. 100100111000

Which one is valid? **2nd one**

Why is the other one not valid:

In BCD, each 4-bit group (nibble) represents a decimal digit from 0 to 9. Each nibble must be between 0000 and 1001.

Breaking down the given bit pattern into nibbles:

1. 1001
2. 1011
3. 0100

The second nibble, 1011, is not a valid BCD representation, as it exceeds the maximum value of 1001. Therefore, the entire bit pattern is invalid.

Question 4: Find the 9's and the 10's complement of the following decimal numbers:

[4 marks]

00,000,000
9s comp: 99,999,999
10s comp: 00,000,000

Step 1: Find the 9's Complement

We obtain the 9's complement of a decimal number by subtracting each digit from 9.

$$\begin{array}{r} 9999999 \\ - 5274630 \\ \hline 4725369 \end{array}$$

Step 2: Add 1 to the 9's Complement

We add 1 to the 9's complement to obtain the 10's complement.

$$\begin{array}{r} 4725369 \\ + 1 \\ \hline 4725370 \end{array}$$

Question 5: Add the signed numbers: 01000100, 00011011, 00001110, and 00010010 and write your final answer in the provided space. **[2 marks]**

Solution

The equivalent decimal additions are given for reference.

68	01000100	
+ 27	+ 00011011	Add 1st two numbers
95	01011111	1st sum
+ 14	+ 00001110	Add 3rd number
109	01101101	2nd sum
+ 18	+ 00010010	Add 4th number
127	01111111	Final sum

Final Answer:

(In Binary): **01111111**

(In Decimal): **127**

Question 6: Add the following BCD numbers:

[2 + 2 = 4 marks]

$$\begin{array}{r}
 \text{(c)} \quad \begin{array}{r} 0001 \quad 0110 \\ + 0001 \quad 0101 \\ \hline 0010 \quad 1011 \end{array} \\
 \quad \quad \quad + 0110 \\
 \hline
 \begin{array}{r} 0011 \quad 0001 \\ \downarrow \quad \downarrow \\ 3 \quad 1 \end{array}
 \end{array}$$

Right group is invalid (>9),
left group is valid.
Add 6 to invalid code. Add
carry, 0001, to next group.
Valid BCD number

$$\begin{array}{r}
 16 \\
 + 15 \\
 \hline
 31
 \end{array}$$

$$\begin{array}{r}
 \text{(d)} \quad \begin{array}{r} 0110 \quad 0111 \\ + 0101 \quad 0011 \\ \hline 1011 \quad 1010 \end{array} \\
 \quad \quad \quad + 0110 \quad + 0110 \\
 \hline
 \begin{array}{r} 0001 \quad 0010 \quad 0000 \\ \downarrow \quad \downarrow \quad \downarrow \\ 1 \quad 2 \quad 0 \end{array}
 \end{array}$$

Both groups are invalid (>9)
Add 6 to both groups
Valid BCD number

$$\begin{array}{r}
 67 \\
 + 53 \\
 \hline
 120
 \end{array}$$

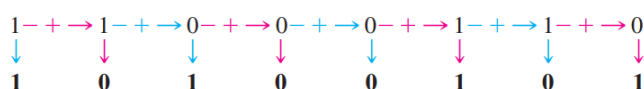
Question 7 Gray code conversions. Attempt the following parts carefully.

[1+1+2 =4 marks]

(a) Convert the binary number 11000110 to Gray code

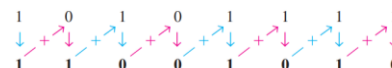
Solution

(a) Binary to Gray code:



(b) Convert the Gray code 10101111 to binary.

(b) Gray code to binary:



(c) The ten-bit Gray code for $(353)_{10}$ is 0111010001. Explain briefly but precisely why it cannot be true that 0111010100 is the ten-bit Gray code for $(354)_{10}$.

Also calculate gray code for 354_{10}

Gray Code for $(354)_{10}$:
111010011

Explanation:

In Gray code, consecutive numbers differ by only **one bit**.

Given that the Gray code for 353_{10} is 0111010001, the Gray code for 354_{10} must differ by **exactly one bit**.

If we compare 0111010100 to 0111010001, we see that **two bits** are different (positions 8 and 2). **This violates the fundamental property of Gray code. Therefore, 0111010100 cannot be the correct Gray code for 354_{10} .**

Question 8: Construct a 6-2-2-1 weighted code for decimal digits. What are all possible combinations through which the 9823_{10} can be constructed using the weight in 6-2-2-1? [4 + 3 = 7 marks]

	6	2	2	1	
0	0	0	0	0	
1	0	0	0	1	
2	0	0	1	0	(0100)
3	0	0	1	1	(0101)
4	0	1	1	0	
5	0	1	1	1	
6	1	0	0	0	
7	1	0	0	1	
8	1	0	1	0	(1100)
9	1	0	1	1	(1101)

$$1100\ 0011 = 83$$

Different Combinations to represent 9823_{10}

Digit 9 in 6-2-2-1 weighted code: 1011

Digit 8 in 6-2-2-1 weighted code: 1010

Digit 2 in 6-2-2-1 weighted code: 0010

Digit 3 in 6-2-2-1 weighted code: 0011

there were other combinations as well one is written here for simplicity:

1101 (9) 1100 (8) 0100 (2) 0101 (3)

... and so on.

If 4 written correctly , full marks are awarded.

