UNDERSTAND NUMBERING SYSTEM

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NUMBERING SYSTEM

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DIPLOMA TECHNOLOGY SYSTEM

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PREFACE

A numbering system is a writing system for expressing numbers; it's a mathematical notation for representing numbers of a given set, using digits or other symbols in a consistent manner. The most used numbering system is the decimal system, also known as the base-10 system, which uses the digits 0 through 9 to represent numbers. The chapter on the Numbering System in this eBook likely covers the fundamentals and applications of various numbering systems in the context of multimedia technology mathematics. The Numbering System eBook is intended for students at Sultan Mizan Zainal Abidin Polytechnic who are taking a general introductory course in the Multimedia Technology Department.

This chapter introduces the fundamental concepts and applications of multimedia. Madam Emilawati Binti Othman and Madam Norhafiza Binti Idris begin the chapter Numbering System with a quick, but rigorous, introduction to numbering. The themes' objectives are indicated at the beginning of each chapter. Each chapter segment includes relevant examples and self-assessments to help students obtain a better understanding of the different topics.

Expressing gratitude to ALLAH Almighty and acknowledging the collective effort of the writing team is a meaningful way to recognize the hard work put into developing the module. It's clear that the primary goal is to equip students with mathematical thinking and problem-solving skills, which are essential in various fields, especially in engineering mathematics. The openness to feedback and the desire for continuous improvement demonstrates a commitment to providing the best possible learning experience for students. In sha Allah, the module will serve its purpose well and contribute to the academic success of the students. The mention of validation procedures also reflects a commitment to ensuring the quality and accuracy of the content.

We wish the students success in their endeavours, and I hope the module proves to be an effective tool for learning and understanding the numbering system in the context of multimedia technology.

ABSTRACT

MATHEMATICAL COMPUTING course introduces students to numbering system, basic algebra, and complex numbers. Calculus covers the simple techniques of differentiation and integration. In addition, this course also exposed to basic concept of matrices and linear algebra to help them in solving mathematical problem in organizing data through theoretically. This workbook is a friendly gateway into the world of mathematical computing, crafted for learners seeking an accessible introduction to the synergy between mathematics and computer science. With simplicity as a guiding principle, it serves as a hands-on companion for individuals of various backgrounds and skill levels. This workbook contains 5 different topics: **Numbering System, Basic Algebra, Real and Complex Number System, Differentiation & Integration And Matrices And Linear Algebra.**

Our e-book focused on Topic 1 Numbering System. A numbering system is a writing system for expressing numbers; it's a mathematical notation for representing numbers of a given set, using digits or other symbols in a consistent manner. The most used numbering system is the decimal system, also known as the base-10 system, which uses the digits 0 through 9 to represent numbers. The chapter on the Numbering System in this eBook likely covers the fundamentals and applications of various numbering systems in the context of multimedia technology mathematics. The Numbering System eBook is intended for 1st semester Diploma Digital Technology Students (DDT) at PSMZA.

Whether you're a student or a lecturer this workbook is your companion for a delightful adventure in mathematical computing. Approach with curiosity, embrace the joy of discovery, and let the pages within be your guide to unlocking the potential of numbers and algorithms in the digital realm. Happy exploring! Top of Form

NUMBERING SYSTEM

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DEFINE NUMBERING SYSTEM

There are four basic numbering systems that are used in the human, networking, and computer science worlds.

NUMBERING SYSTEM		
SYSTEM	BASE	DIGITS
BINARY	2	01
OCTAL	8	01234567
DECIMAL	10	012345678
HEXADECIMAL	16	0123456789ABCDEF

The decimal number system is used in general. However, the computers use binary number system. The octal and hexadecimal number systems are also used in the computer.

DEFINE DATA ORGANIZATIONS

The size of a word varies from one computer to another, depending on the CPU. For computers with a 16-bit CPU, a word is 16 bits (2 bytes).

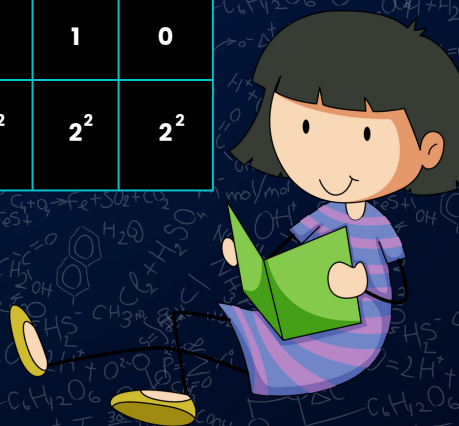
BIT	**A bit is a short for binary digit and is the smallest unit of data in a computer. A bit has a single binary value, either 0 or 1.**
NIBBLE	**A nibble is a group of 4 bits.**
BYTE	**A byte is a group of 8 bits.**
WORD	**A word is a group of 16 bits.**
DOUBLE WORD	**A double word is a pair of words. Therefore, a double word quantity is 32 bits long.**

On large mainframes, a word can be as long as 64 bits (8 bytes).Some computers and programming languages distinguish between shortwords and longwords. A shortword is usually 2 bytes long while a longword is 4 bytes

DETERMINE BINARY SYSTEM

- Binary Number System consists of two digits 0 and 1. Its base is 2. Each digit or bit in binary number system can be 0 or 1.
- A combination of binary numbers may be used to represent different quantities like 1001. The positional value of each digit in binary number is twice the place value or face value of the digit of its right side.
- The weight of each position is a power of 2. The place values of the digits according to position and weight is as follows:

BYTE	3	2	1	0
DOUBLE WORD	2^2	2^2	2^2	2^2



CONVERT BINARY TO DECIMAL AND DECIMAL TO BINARY

A. BINARY TO DECIMAL CONVERSION

The place values method is usually easier to convert a binary number to a decimal number

Example 1.3a :

a) 1101_2	b) 1110_2
c) 10111010_2	d) 111110_2
e) 1110110_2	f) 1100010_2
g) 11.1010_2	h) 1011.0101_2

Example 1.3.a.a :

Convert the following binary numbers to decimal number.

a) 10111

b) 101.11

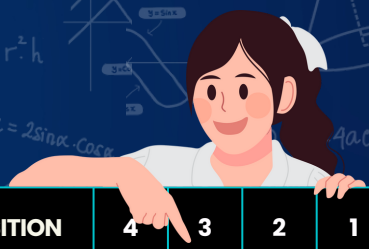
Solution :

a)

POSITION	4	3	2	1	0
WEIGHT	2^4	2^3	2^2	2^1	2^0
	1	0	1	1	1

$$10111_2 = 1 \times 2^4 + 0 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 1 \times 2^0$$
$$= 1 \times 16 + 0 + 1 \times 4 + 1 \times 2 + 1 \times 1$$
$$= 16 + 0 + 4 + 2 + 1$$
$$= 23_{10}$$

b)



POSITION	4	3	2	1	0
WEIGHT	2^2	2^1	2^0	2^{-1}	2^{-2}
	1	0	1	1	1

$$101.1012 = 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 + 1 \times 2^{-1} + 1 \times 2^{-2}$$
$$= 1 \times 4 + 0 + 1 \times 1 + \tfrac{1}{2} + \tfrac{1}{4}$$
$$= 4 + 0 + 1 + 0.5 + 0.25$$
$$= 5.751$$

Convert the following binary numbers to decimal number.

a) $101110102\ [186_{10}]$

b) $1011.01012\ [11.3125_{10}]$

CONVERT DECIMAL TO BINARY

Repeated division and noting the remainder at each stage is easiest and simple method used to convert decimal to binary numbers.

Example :

Convert the following decimal numbers to binary number.

a) 68_{10}

b) 68.68_{10} up to 4 decimal places.

a)

2	68	
2	34	0
2	17	0
2	8	1
2	4	0
2	2	0
2	1	0
	0	1

Answer = 1000100_2

We stop here as the number has been reduced to zero and collect the remainders in reverse order.

Note: The answer is read from bottom to top

b)

First convert 68 into its binary form which is 10001002.

Then convert 0.68 into binary form up to 4 decimal places.

0.68 x 2 = 1.36 integer part is 1

0.36 x 2 = 0.72 integer part is 0

0.72 x 2 = 1.44 integer part is 1

0.44 x 2 = 0.88 integer part is 0

Take the fractional part and continue the process

The digits are placed in the order in which they are generated, and not in the reverse order.

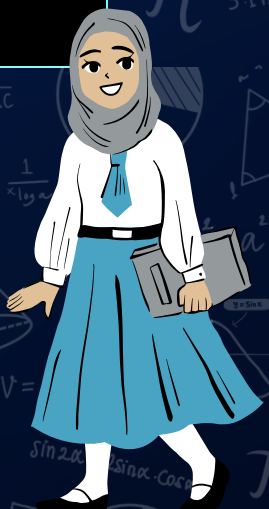
Answer = 0.1010.....

Now put the two parts together = 1000100.1010_2

B.DECIMAL TO BINARY CONVERSION

EXERCISE 1.3b :

a) 35_{10}	b) 57_{10}
c) 86_{10}	d) 69_{10}
e) 166_{10}	f) 321_{10}
g) 14.625_{10}	h) 40.365_{10}



UNDERSTAND OCTAL NUMBERING SYSTEM

Octal Number System consists of eight digits from 0 to 7. The base of octal system is 8.

POSITION	4	3	2	1	0
WEIGHTS	8^4	8^4	8^4	8^4	8^4

A. OCTAL TO DECIMAL CONVERSION

EXERCISE 1.4a:

a) 1258_8	b) 257_8
c)1468_8	d) 101_8
e) 315_8	f) 156_8
g) 63.42_8	h) 45.36_8

Example :

Convert the following octal numbers to decimal number.

a) 345_8

b) 63.42_8

a)

POSITION	2	1	0
WEIGHTS	8^2	8^1	8^0
	3	4	5

Answer :

$$345 = 3 \times 8^2 + 4 \times 8^1 + 5 \times 8^0$$
$$= 3 \times 64 + 4 \times 8 + 5 \times 1$$
$$= 229_{10}$$

b)

POSITION	1	0		-1	-2
WEIGHTS	8^1	8^0		8^{-1}	8^{-2}
	6	3	.	4	2

$$63.428 = 6 \times 8^1 + 3 \times 8^0 + 4 \times 8^{-1} + 2 \times 8^{-2}$$
$$= 48 + 3 + ½ + 1/32$$
$$= 51.53125_{10}$$

Convert the following octal numbers to decimal number.

a) 1258 [85_{10}]

b) 45.368 [37.46875_{10}]

B. DECIMAL TO OCTAL CONVERSION

EXERCISE 1.4b :

a) 25_{10}	b) 69_{10}
c) 110_{10}	d) 235_{10}
e) 166_{10}	f) 321_{10}
g) 0.523_{10} (3 decimal places)	h) 13.365_{10} (3 decimal places)

CONVERT OCTAL TO BINARY AND BINARY TO OCTAL

OCTAL TO BINARY CONVERSION :

Converting from octal to binary is as easy as converting from binary to octal. Simply look up each octal digit to obtain the equivalent **group of three binary digits.**

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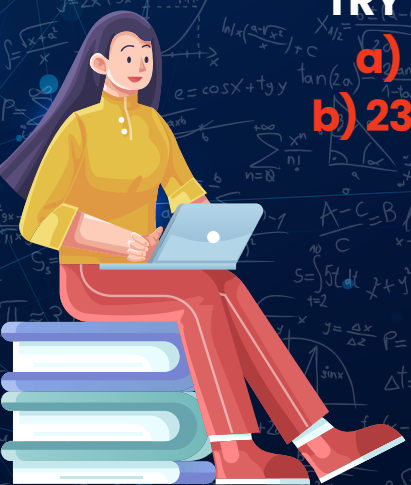
SOLUTION :

OCTAL	0	1	2	3	4	5	6	7
BINARY	000	001	010	011	100	101	110	111

$345_8 = 011100101_2$

$23.52_8 = 010011.101010_2$

Note : Drop any leading '0' and the last '0' after floating point because this '0' does not signify anything.



TRY THIS QUESTION :

a) $345_{10} = 11100101_2$

b) $23.52_{10} = 10011.10101_2$

C. OCTAL TO BINARY CONVERSION

EXERCISE 1.4c:

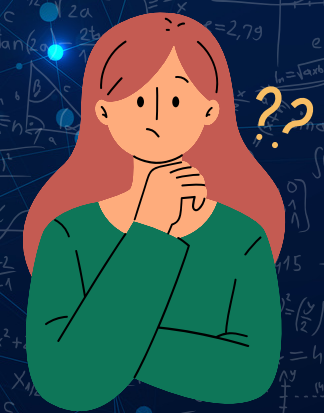
a) 173_8	b) 136_8
c) 357_8	d) 235_8
e) 443_8	f) 521_8
g) 23.52_8	h) 13.365_8

CONVERT CONVERT OCTAL TO BINARY AND BINARY TO OCTAL

BINARY TO OCTAL CONVERSION

- An easy way to convert from binary to octal is to group binary digits into sets of three, starting with the least significant digit.

- For example, in the number 2006, the 6 is the least significant digit.



EXAMPLE

Convert the following binary number to octal number.

a) 11011110_2

b) 10110.1011_2

SOLUTION

a) $11011110 = 11\ 011\ 110_2$

$= 011\ 011\ 110_2$

Add the '0' to complete a group of three digit

Then, look up each group in a table

BINARY	000	001	010	011	100	101	110	111
OCTAL	0	1	2	3	4	5	6	7

Thus, 011 011 110 = 3368_6

b) 10110.1011_2 = 010 110 . 101 100

Thus, 010 110 . 101 100 = 26.54_8

Add the '0' to complete a group of three digits

D. BINARY TO OCTAL CONVERSION

EXERCISE 1.4d:

a) 110110_2	b) 101010112_2
c) 1101100_2	d) 10000010_2
e) 1100010_2	f) 111110110_2
g) 10110.1011_2	h) 1101.01011_2

UNDERSTAND HEXADECIMAL NUMBERING SYSTEM

The Hexadecimal Number System consists of 16 digits from 0 to 9 and A to F.

POSITION	4	3	2	1	0
WEIGHTS	16^4	16^3	16^2	16^1	16^0

CONVERT HEXADECIMAL TO DECIMAL AND DECIMAL TO HEXADECIMAL

EXERCISE 1.5 a :

a) 98_{16}	b) 356_{16}
c) $E7_{16}$	d) 185_{16}
e) $1FF_{16}$	f) $2AF_{16}$
g) $1C4.E_{16}$	h) $2F.5_{16}$

B. DECIMAL TO HEXADECIMAL CONVERSION

EXERCISE 1.5b :

a) 63_{10}	b) 215_{10}
c) 139_{10}	d) 423_{10}
e) 975_{10}	f) 569_{10}
g) 0.52_{10}	h) 28.45_{10}

C. HEXADECIMAL TO BINARY CONVERSION

EXERCISE 1.5c

a) 54_{16}	b) 123_{16}
c) CD_{16}	d) $9F2_{16}$
e) $5EF_{16}$	f) $BA6_{16}$
g) $7C.5_{16}$	h) $48.2B_{16}$

D. BINARY TO HEXADECIMAL CONVERSION

EXERCISE 1.5d :

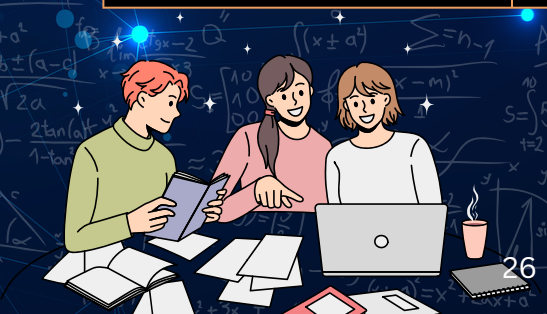
a) 10101001_2	b) 11100111_2
c) 10011101010_2	d) 1110111100_2
e) 111110110_2	f) 101010010001_2
g) 111110.1101_2	h) 1110.0101_2

CONVERT HEXADECIMAL TO OCTAL AND OCTAL TO HEXADECIMAL

E. HEXADECIMAL TO OCTAL CONVERSION

EXERCISE 1.5e:

a) $9A_{16}$	b) 64_{16}
c) 143_{16}	d) $E7_{16}$
e) CD_{16}	f) $5C5_{16}$
g) $5DF3_{16}$	h) $8CDF_{16}$



F. OCTAL TO HEXADECIMAL CONVERSION

EXERCISE 1.5f :

a) 446_8	b) 527_8
c) 715_8	d) 3052_8
e) 5401_8	f) 5115_8
g) 6202_8	h) 7272_8

DEFINE BINARY ARITHMETIC

How to perform addition, subtraction, and multiplication with binary numbers

UNDERSTAND BINARY ARITHMETIC OPERATIONS
UNDERSTAND BINARY ARITHMETIC OPERATIONS
A.BINARY ADDITION

EXERCISE 1.6a :

a) $1111_2 + 1001_2$	b) $10011_2 + 1110_2$
c) $11010_2 + 1100_2$	d) $1100001_2 + 110101_2$
e) $1011101_2 + 1100001_2$	f) $11001100_2 + 01001001_2$
g) $11001010_2 + 10011010_2$	h) $1011101_2 + 1100001_2 + 110101_2$

B. BINARY SUBTRACTION

EXERCISE 1.6b:

a) $11000_2 - 1111_2$	b) $10011_2 - 1101_2$
c) $10100100_2 - 1011101_2$	d) $100111_2 - 10110_2$
e) $10011100_2^2 - 01111001$	f) $11011100_2 - 01011010_2$
g) $11001011_2 - 10000011_2$	h) $11001011_2^2 - 10000011_2$

C. BINARY MULTIPLICATION

EXERCISE 1.6c:

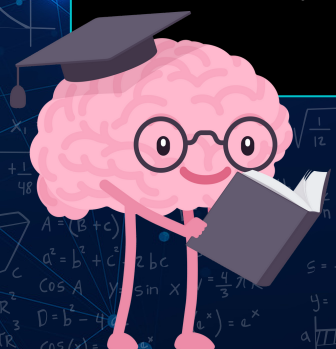
a) $11_2 \times 11_2$	b) $101_2 \times 101_2$
c) $111_2 \times 11_2$	d) $1011_2 \times 101_2$
e) $11010_2 \times 110_2$	f) a) $1010_2 \times 1101_2$
g) $1101_2 \times 111_2$	h) $110101_2 \times 1011_2$

ADD AND SUBTRACT IN OCTAL, AND HEXADECIMAL NUMBER SYSTEMS

ADDITION AND SUBTRACTION OF OCTAL NUMBERS

EXERCISE 1.7a:

a) $162_8 + 537_8$ [721_8]	b) $136_8 + 636_8$
c) $25.27_8 + 13.2_8$	d) $67.5_8 + 45.6_8$
e) $345_8 - 146_8$	f) $713_8 - 314_8$
g) $757.76_8 - 451.77_8$	h) $565.67_8 - 234.34_8$



B. ADDITION AND SUBTRACTION OF HEXADECIMAL NUMBERS

EXERCISE 1.7b:

a) $143_{16} + 64_{16}$	b) $(4\ A\ 6)_{16} + (1\ B\ 3)_{16}$
c) $(B\ A\ 3)_{16} + (5\ D\ E)_{16}$	d) $(C\ 6\ 2\ 9)_{16} + (9\ A\ 5\ 2)_{16}$
e) $143_{16} - 64_{16}$	f) $(4\ A\ 6)_{16} - (1\ B\ 3)_{16}$
g) $(B\ A\ 3)_{16} - (5\ D)_{16}$	h) $(E\ 7\ A\ C)_{16} - (8\ B\ 6\ F)_{16}$

THANK YOU

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