TOPIC TITLE: NUMBER SYSTEMS

SPECIFIC OBJECTIVES:

At the end of the topic session, the students should be able to:

1. define number system,
2. identify the types of number systems, and
3. perform the conversion from one number system to another form of number system.

MATERIALS/EQUIPMENT:

- Computer
- LCD/OHP projector
- File/s (01 Number Systems)
    - 01 LCD Slides 1
    - 01 OHP Slides 1
    - 01 LCD Slide Handout 1
    - 01 OHP Slide Handout 1
    - 01 Activity 1
    - 01 Laboratory Exercise 1
    - 01 Laboratory Exercise Answer Key 1
    - 01 Quiz 1 Answer Key 1
- Software requirements
    - MS PowerPoint

TOPIC PREPARATION:

- Prepare handouts needed for the topic presentation and have them photocopied.
- Set up the computer and LCD/OHP projector. This will be used to show the slides presentation in class.
- It is imperative for the instructor to study the lecture materials and read other materials related to the topic to be able to fuse different sorts of teaching strategies depending on the needs of the students.
  Note: Instructor's input as academy expert and/or industry professional will be the best foundation in teaching the course effectively.
- Anticipate possible questions that students might raise during the discussion.

PRESENTATION OVERVIEW:

A. Introduction 24 min

B. Instructional Input
Number Systems Defined 24 min
a. Discuss what a number system is all about
Types of number systems 24 min
a. Discuss the different types of number systems
Conversion from Decimal Number Base System to Any Number Base System 24 min
a. Discuss the three different methods of converting a decimal number base system to any number base system
Conversion from Other Number Base System to Decimal Number System 24 min
a. Discuss the three different methods of converting a decimal number base system to any number base system
Conversion from Binary Number Base System to Octal and Hexadecimal Number System 30 min
a. Discuss the rules for converting a binary number base system to octal and hexadecimal number base system
Conversion from Octal and Hexadecimal Number Base System to Binary Number System 30 min
a. Discuss the rules for converting an octal and hexadecimal number base system to binary number base system
Conversion of Fraction: Decimal to Any Bases 30 min
a. Discuss the rules for converting a fractional decimal value to any bases
Conversion of Fractions: Any Bases to Decimal 30 min
a. Discuss the rules for converting any bases in fractional form to decimal value

C. Generalization 120 min

Total duration 360 min

TOPIC PRESENTATION:

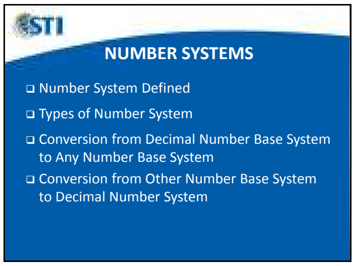
A. Introduction

1. After doing the usual “first day of class” session in the previous meeting, ask the students on what they can recall about their “Computer Fundamentals” course with regards to the following :

   - Number System Concepts
   - Digits in a Number System
   - Operations and Conversions of Number Systems

   Note: *The instructor may encourage the students to answer the question by telling them that there is no right or wrong answers; it is just a matter of assessing if they could still retrieve relevant knowledge from their past lessons.*

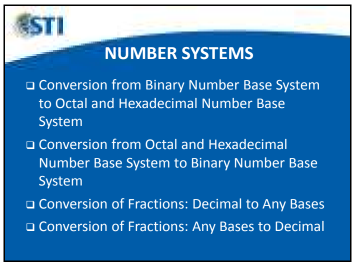
Slide 1



2. After the review, show *Slides 1* to *2* of *01 LCD Slides 1* and tell the students that the topic for the day is all about Number Systems, wherein they will be able to gain knowledge of:

   - What a number system is
   - What are its types
   - What are the ways to convert a decimal number base system to any number base systems and vice versa
   - What are the ways to convert a binary number base system to octal and hexadecimal base system and vice versa
   - What are the ways to convert a decimal number base system to any number base system in fractional form and vice versa

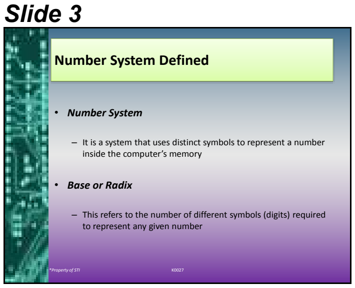
Slide 2



B. Instructional Input

Number Systems Defined

Slide 3



1. Show *Slide 3*. Discuss what a number system is all about.

   Moving forward, what do we mean by a number system? A ***number system*** (or numeral system) is a system that uses distinct symbols to represent a number inside the computer's memory. For example, the two numbers 52_8 and $2A_{16}$ both refer to the same quantity, 42_{10}, but their representations are different. This is the same as using the words "cheval" (French) and "equus" (Latin) to refer to the same entity, a "horse".

   The number of different symbols (digits) required to represent any given number is known as the **base** or **radix** of a number system.

   For example, with a given base, or radix that is equal to three (3) indicates that there are 3 symbols, | 0, 1, and 2 | used in the system. A number system using four symbols would be base 4 and so forth. The base of a number system is indicated by a subscript following the value of the number.

   Note: *The larger the base, the more numerals are required. The highest value symbol used in a number system is always one less than the base of the system.*

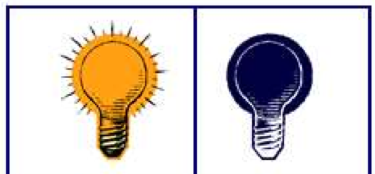
2. After discussing to the students the definition of number system, raise the question below and encourage them again to answer your question. Acknowledge their answers and thank them for their responses.

   What is the meaning of number system; why is it necessary for us to represent quantities or numbers to a set of symbols or codes? Any idea?

   Transition statement:

   It is a must for us to understand how computers represent numbers because numbers are the nature of a computer.

   Human beings think in decimal, while computers process in binary. Technically, a computer accepts data (e. g. audio, graphics, video, text, and numbers) in human readable form and converts them into sequences of **bits (Binary digITs)**. These bits correspond to sequences of on/off (equivalently True/False, Yes/No, or 1/0) signals (shown in Figure 1.1 below) that is an acceptable computer code.



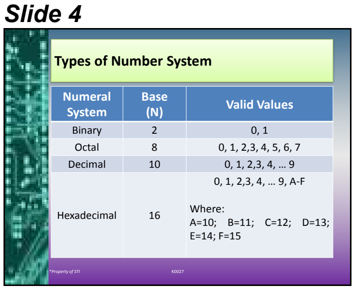
On	Off
True	False
Yes	No
1	0

Figure 1.1: How data is represented in the computer's memory

   Hence, a proficiency in number system is essential to understand how a computer works.

Types of a number system

Slide 4



1. Show *Slide 4*. Discuss the different types of number systems.

   Below are the different types of number systems:

   - ***Binary Number System*** – This is the number system that is the basic foundation of any computer machine. The word "binary" is derived from the Latin root "bini", which means "in twos" or "binarius", which means "related to two". In this system, the *base (n) = 2* and includes two symbols from 0 through 1.

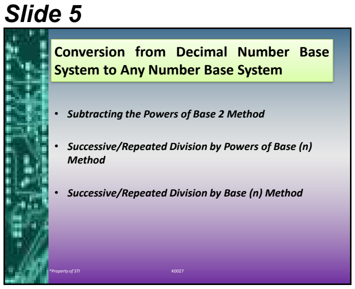
- ***Decimal Number System*** – This is the number system that we are all familiar with; it is used by our fore fathers basically for the simple reason that they started to learn to count with their ten fingers. The word "decimal" is derived from the Greek word "deka" and Latin word "decem" ", which means "ten" or "decimalis", ", which means "related to ten". In this system, the *base (n) = 10* and includes ten symbols from 0 through 9.

- ***Octal Number System*** – This is the number system that uses *base (n) = 8* and includes eight symbols from 0 through 7. The word "octal" is derived from the Latin root "octo", which means "eight" or "octalis", which means "related to eight".

- ***Hexadecimal Number System*** – This is the number system that uses *base (n) = 16* and includes sixteen symbols from 0 through 9 and the letters A = 10, B = 11, C = 12, D = 13, E = 14 and F = 15. The word hexadecimal is derived from the Greek root "hex", which means "six" and the Latin root "decem", which means "ten".

Conversion from Decimal Number Base System to Any Number Base System

Slide 5



1. Show *Slide 5*. Discuss the three different methods of converting a decimal number base system to other number base system.

   There are three ways to convert a decimal number into its representation in a different number base. These methods are:

   - ***Subtracting the Powers of Base 2 Method*** – This method is only applicable when converting a decimal number to a binary number (base 2). This is done by subtracting off the largest power of base 2 that is less than or equal to the decimal number. Then we subtract off the largest power of base 2 that is less than or equal to the difference, and so on, until we obtain 0.

   - ***Successive/Repeated Division by Powers of Base (n) Method*** – This method converts the decimal number to a desired base (n) by repeatedly dividing the decimal number by the largest power of base (n) that is less than or equal to the decimal number. Then we divide the largest power of base (n) that is less than or equal to the remainder, and so on, until we obtain 0.

- ***Successive/Repeated Division by Base (n) Method*** – This method converts the decimal number to a desired base (n) by dividing continuously the decimal number by the base (n) were converting to until the quotient equals zero (0). The first remainder (after the first division by base (n)) becomes the least significant bit (LSB) of the integer portion of the number, while the last remainder becomes the most significant bit (MSB), the leftmost bit, of the integer portion.

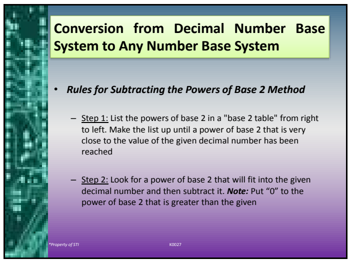
Note:

Methods discussed above are intended for converting the integral part (integer portion) of the decimal numbers only; the conversion of the fractional part of the decimal number to another number base system is accomplished using a ***successive multiplication method***.

In this method, the number to be converted is multiplied by the desired base (n), producing a product that has an integer part and a fractional part. The integer part of the product becomes a digit in the fractional binary number. The fractional part obtained is again multiplied by the desired base (n) and this process is repeated until the fractional part becomes zero (0) or the number of multiplication iteration equals the number of significant digits after the decimal point in the given fractional decimal number. The integer part of each product is read downward to represent the numerals in the fractional binary number i.e. the integer part obtained in the first multiplication iteration is the most significant bit (MSB) after the decimal point and the integer part obtained in the last multiplication iteration is the least significant bit (LSB).

This procedure is to be illustrated through a given sample problem in the topic Conversion of Fraction: Decimal to any bases.

Slide 6



2. Show *Slides 6* to *7*. Demonstrate to the students the rules for subtracting the powers of base 2 method through the given sample problem.

Rules for Subtracting the Powers of Base 2 Method

Sample Problem: Convert the decimal number 165 to binary:

Note: *The following steps will be illustrated by the instructor on the whiteboard for a step by step process.*

Step 1: List the powers of base 2 in a "base 2 table" from right to left. Make the list up until a power of base 2 that is very close to the value of the given decimal number has been reached.

In this case, starting at 2^0 (evaluating it as "1"), the exponent for each power is incremented by one (1). (Please see illustration below)

Place Value	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	$\mathbf{2^0}$
Binary Weight	256	128	64	32	16	8	4	2	1

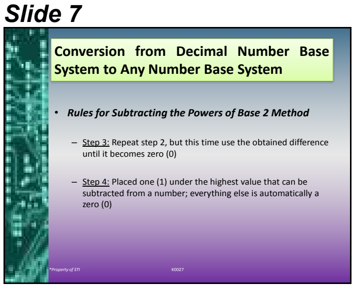
Step 2: Look for a power of base 2 that will fit into the given decimal number and then subtract it.

Note: *Put "0" to the power of base 2 that is greater than the given.*

In this case, by inspection, the 2^8 = 256 is greater than the given (165), while the 2^7= 128 is less than it. Thus, write "1" beneath the power of 2^7 for the leftmost binary digit.

Place Value	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Binary Weight	256	128	64	32	16	8	4	2	1
	0	**1**							

Slide 7



1. Then, 165 – 128 = 37

Step 3: Repeat step 2, but this time use the obtained difference from step 2.1 until it becomes zero (0).

1. 2^6 = 2 is greater than the difference (37), so we will put zero (0) under the 2^6 column
2. 2^5 = 32 is less than 37. Thus, 37 – 32 = 5

3. $2^4 = 16$ is greater than the difference (5), so we will put zero (0) under the 2^4 column

4. $2^3 = 8$ is greater than the difference (8), so we will put zero (0) under the 2^3 column

5. $2^2 = 4$ is less than 5. Thus, $5 – 4 = 1$

6. $2^1 = 2$ is greater than the difference (1), so we will put zero (0) under the 2^1 column

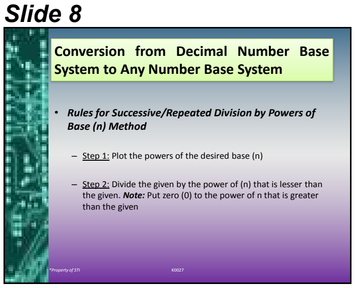
7. $2^0 = 1$ is equal to 1. Thus, $1 – 1 = 0$

Step 4: Placed one (1) under the highest value that can be subtracted from a number; everything else is automatically a zero (0). Thus,

	Step 2	Step 2.1	Step 3.1	Step 3.2	Step 3.3	Step 3.4	Step 3.5	Step 3.6	Step 3.7
Place Value	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Binary Weight	256	128	64	32	16	8	4	2	1
Bit	**0**	**1**	**0**	**1**	**0**	**0**	**1**	**0**	**1**

Final answer is 10100101_2.

Slide 8



3. Show *Slides 8* to *9*. Demonstrate to the students the rules for repeated division by powers of base (n) method through the using the same sample problem in procedure number 2.

Rules for Successive/Repeated Division by Powers of Base (n) Method

Note: *The following steps will be illustrated by the instructor on the whiteboard for a step by step process.*

Step 1: Plot the powers of the desired base (n). In this case, were going to plot the powers of 2, since were going to convert the given decimal number to its binary form.

Place Value	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Binary Weight	256	128	64	32	16	8	4	2	1

Step 2: Divide the given by the power of (n) that is lesser than the given.

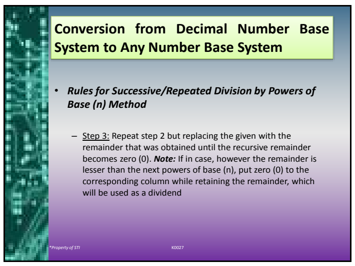
Note: *Put zero (0) to the power of n that is greater than the given.*

In this case, by inspection, the 2^8 = 256 is greater than the given (165), while the 2^7= 128 is less than it. Thus,

		Quotient (Q)	Remainder (R)
2.1	165/128	1	37

Place Value	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Binary Weight	256	128	64	32	16	8	4	2	1
Bit	**0**	**1**							

Slide 9



<u>Step 3:</u> Repeat step 2 but replacing the given with the remainder that was obtained until the recursive remainder becomes zero (0).

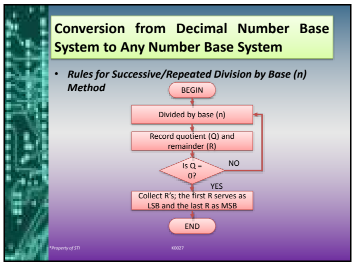
Note: *If in case, however the remainder is lesser than the next powers of base (n), put zero (0) to the corresponding column while retaining the remainder, which will be used as a dividend. Thus, 2^6 = 64, is greater than the remainder (37), so we will put zero (0) under the 26 column.*

		Quotient (Q)	Remainder (R)
	165/128	1	37
3.1	37/64	2^6 = 64 is greater than the remainder (37), thus put zero (0) under the 2^6 column	
3.2	37/32	1	5
3.3	5/16	2^4 = 16 is greater than the remainder (5), thus put zero (0) under the 2^4 column	
3.4	5/8	2^3 = 8 is greater than the remainder (5), thus put zero (0) under the 2^3 column	
3.5	5/4	1	1
3.6	1/2	2^1 = 2 is greater than the remainder (1), thus put zero (0) under the 2^1 column	
3.7	1/1	1	0

	Step 2	Step 2.1	Step 3.1	Step 3.2	Step 3.3	Step 3.4	Step 3.5	Step 3.6	Step 3.7
Place Value	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Binary Weight	256	128	64	32	16	8	4	2	1
Bit	**0**	**1**	**0**	**1**	**0**	**0**	**1**	**0**	**1**

Final answer is 10100101_2.

Slide 10



4. Show *Slides 10* to *13*. Show to the students the flowchart for successive/repeated division by base (n) method and demonstrate it through the sample problem in procedure number 2.

Rules for Successive/Repeated by Base (n) Method

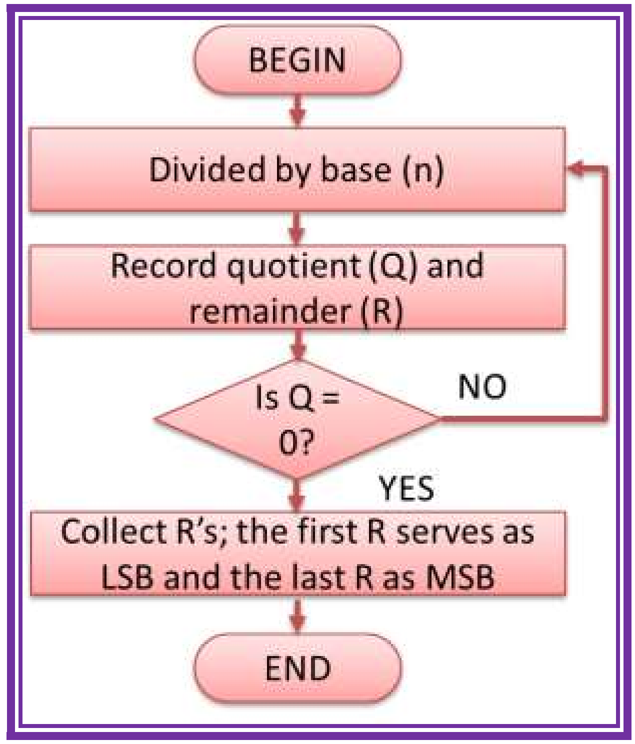
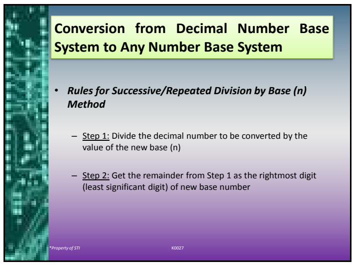


Figure 1.2 Flowchart for Successive/Repeated Division by Base (n) Method

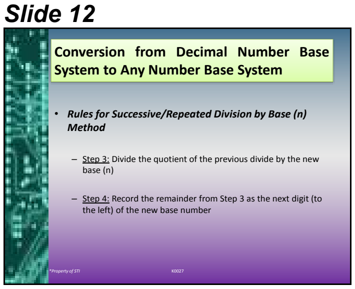
Figure 1.2 shows a flowchart for successive/repeated division by base (n) method, which requires repeatedly dividing the decimal number by base (n) and writing down the remainder after each division until a quotient of zero (0) is obtained. Note that the result is obtained by writing the first remainder as the LSB and the last remainder as the MSB.

Note: *The following steps will be illustrated by the instructor on the whiteboard for a step by step process.*

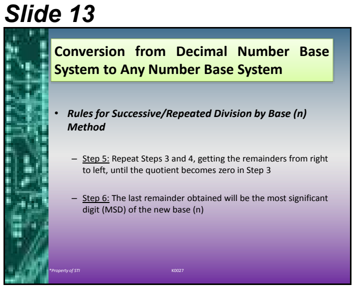
Slide 11



Slide 12



Slide 13



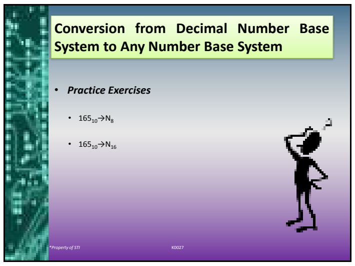
	Operation	Quotient	Remainder	
Step 1: Divide the decimal number to be converted by the value of the new base (n)	165/2	82	**1**	Step 2: Get the remainder from Step 1 as the rightmost digit (least significant digit) of new base number
Step 3: Divide the quotient of the previous divide by the new base (n)	82/2	41	**0**	Step 4: Record the remainder from Step 3 as the next digit (to the left) of the new base number
Step 5: Repeat Steps 3 and 4, getting the remainders from right to left, until the quotient becomes zero in Step 3	41/2	20	**1**	
	20/2	10	**0**	
	10/2	5	**0**	
	5/2	2	**1**	
	2/2	1	**0**	
	1/2	cannot be	**1**	Step 6: The last remainder obtained will be the most significant digit (MSD) of the new base (n)

Final answer is 10100101_2.

Step *5*
Target Attribute: Creative
Facet: Elaboration (Ability to systematize and organize the details of an idea and carry it out)
Strategy: Direct students to use the steps to carry out the details of an idea/solution
Learning Outcome/s: Students should be able to:

- perform conversions based on known methods

Slide 14



5. Show *Slide 14*. Let the student solve the following practice exercises using the successive/repeated division by powers of base (n) method and successive/repeated division by base (n) method.

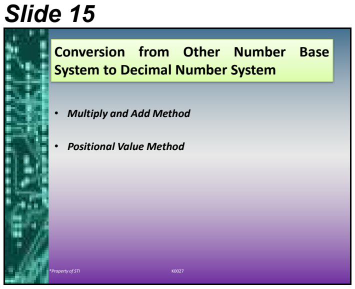
   Convert the following decimal numbers into octal and hexadecimal

   1. $165_{10} \rightarrow N_8$
   2. $165_{10} \rightarrow N_{16}$

   Note: *Please see 01 Activity 1 file for the solution for the above problem.*

Conversion from Other Number Base System to Decimal Number System

Slide 15

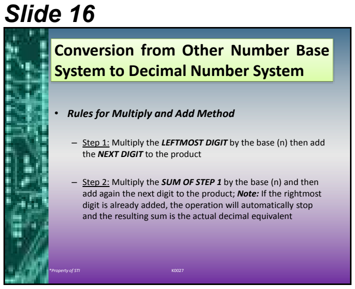


1. Show *Slide 15*. Discuss the two methods of converting other number base system to decimal number system.

   There are two methods for converting numbers in other bases to a decimal numbers. These methods are:

   - ***Multiply and Add Method***
   - ***Positional Value Method***

Slide 16



2. Show *Slide 16*. Demonstrate to the students the multiply and add method through reverting the final answer that we get in the sample problem above to its decimal value.

   Rules for Multiply and Add Method

   Sample Problem: Convert the binary number 10100101 to decimal:

   Note: *The following steps will be illustrated by the instructor on the whiteboard for a step by step process.*

   <u>Step 1:</u> Multiply the ***LEFTMOST DIGIT*** by the base (n) then add the ***NEXT DIGIT*** to the product.

   Thus,

1. **1** * 2 = 2
2. 2 + **0** = 2

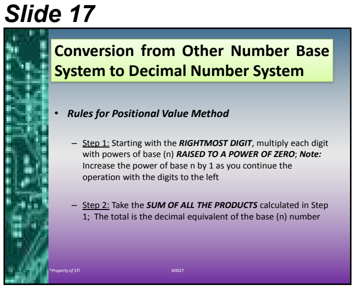
Step 2: Multiply the ***SUM OF STEP 1*** by the base (n) and then add again the next digit to the product.

Note: *If the rightmost digit is already added, the operation will automatically stop and the resulting sum is the actual decimal equivalent.*

1. 2 * 2 = 4
2. 4 + **1** = 5
3. 5 * 2 = 10
4. 10 + **0** = 10
5. 10 * 2 = 20
6. 20 + **0** = 20
7. 20 * 2 = 40
8. 40 + **1** = 41
9. 41 * 2 = 82
10. 82 + **0** = 82
11. 82 * 2 = 164
12. 164 + **1** = **165**

Thus, $\mathbf{165_{10}}$ is the decimal equivalent of 10100101_2

Slide 17



3. Show *Slide 17*. Demonstrate to the students the positional value method through the sample problem in procedure number 2.

Rules for Positional Value Method

Note: The following steps will be illustrated by the instructor on the whiteboard for a step by step process.

Step 1: Starting with the ***RIGHTMOST DIGIT***, multiply each digit with powers of base (n) ***RAISED TO A POWER OF ZERO***.

Note: *Increase the power of base n by 1 as you continue the operation with the digits to the left.*

Step 2: Take the ***SUM OF ALL THE PRODUCTS*** calculated in Step 1. The total is the decimal equivalent of the base (n) number.

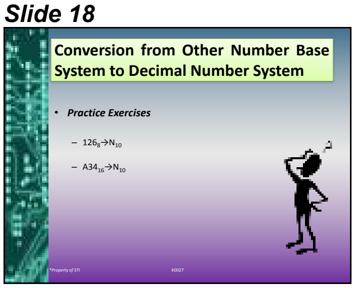
1 0 1 0 0 1 0 1

Step 1		Step 2
$1 * 2^0 =$	$1 * 1 =$	**1**
$0 * 2^1 =$	$0 * 2 =$	**0**
$1 * 2^2 =$	$1 * 4 =$	**4**
$0 * 2^3 =$	$0 * 8 =$	**+ 0**
$0 * 2^4 =$	$0 * 16 =$	**0**
$1 * 2^5 =$	$1 * 32 =$	**32**
$0 * 2^6 =$	$0 * 64 =$	**0**
$1 * 2^7 =$	$1 * 128 =$	**128**
		165

Step *4*
Target Attribute: Creative
Facet: Elaboration (Ability to systematize and organize the details of an idea and carry it out)
Strategy: Direct students to use the steps to carry out the details of an idea/solution
Learning Outcome/s: Students should be able to:

- perform conversions based on known methods

Slide 18



4. Show *Slide 18*. Let the student solve the following practice exercises using the two methods.

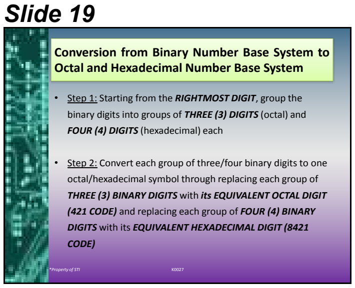
Convert the following octal and hexadecimal numbers to decimal number

1. $126_8 \rightarrow N_{10}$
2. $A34_{16} \rightarrow N_{10}$

Note: Please see 01 Activity 1 file for the solution for the above problem.

Conversion from Binary Number Base System to Octal and Hexadecimal Number Base System

Slide 19



1. Show *Slide 19*. Discuss the rules for converting a binary number base system to octal and hexadecimal number base system through the sample problem in procedure number 2.

Rules for converting a binary number base system to octal and hexadecimal number base system

Sample Problem: Convert the binary number 10100101 to octal and hexadecimal:

Note: *The following steps will be illustrated by the instructor on the whiteboard for a step by step process.*

Step 1: The conversion of a binary number base system to octal and hexadecimal number base system has a very similar rule, except in grouping of digits of binary numbers.

We know that the base for octal numbers is eight (8) and the base for binary numbers is two (2). The base for octal is the third power of the base for binary numbers; ($2^3 = 8$). Therefore, by dividing up the binary numbers into the groups of 3 bits and then converting each group digit to its octal equivalent we can convert binary number to its octal equivalent.

On the other hand, the base for hexadecimal numbers is the fourth power of the base for binary numbers; ($2^4 = 16$). Therefore, by dividing up the binary numbers into the groups of 4 bits and then converting each group digit to its hexadecimal equivalent we can convert binary number to its hexadecimal equivalent.

Hence, starting from the ***RIGHTMOST DIGIT***, group the binary digits into groups of ***THREE (3) DIGITS*** (when converting a binary number system to octal number system) and ***FOUR (4) DIGITS*** (when converting a binary number system to hexadecimal number system) each.

For Octal:

$10100101_2 \rightarrow N_8$

Group the bits into three´s starting from the right hand side

Zero (0) is added to the left side to complete the 3 – bit binary value

Group 3	Group 2	Group 1
010	100	101

For Hexadecimal:

$10100101_2 \rightarrow N_{16}$

Group the bits into four´s starting from the right hand side

Group 2	Group 1
1010	0101

Step 2: Convert each group of three/four binary digits to one octal/hexadecimal symbol

Hence, for octal, replace each group of ***THREE (3) BINARY DIGITS*** with ***its EQUIVALENT OCTAL DIGIT (421 CODE)***. The digit will range from 0 – 7.

Thus,

For Octal:

	Group 3	Group 2	Group 1
Group the bits into three´s starting from the right hand side Pad the most significant digits with zero (0) if necessary to complete the 3 – bit binary value	**0**10	100	101
	421	421	421
Octal Number form	**2**	**4**	**4+1=5**

Final answer is 245_8.

On the other hand, for hexadecimal, replace each group of ***FOUR (4) BINARY DIGITS*** with its ***EQUIVALENT HEXADECIMAL DIGIT (8421 CODE)***. The digit will range from 0 – 15.

For Hexadecimal:

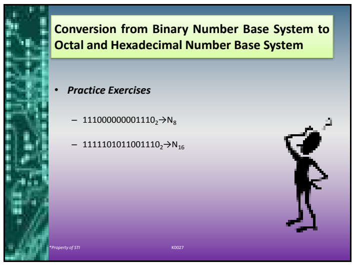
	Group 2	Group 1
Group the bits into four´s starting from the right hand side	1010	0101
	8421	8421
Hexadecimal Number form	**8+2=10=A**	**4+1=5**

Final answer is $A5_{16}$.

Step *2*
Target Attribute: Creative
Facet: Elaboration (Ability to systematize and organize the details of an idea and carry it out)
Strategy: Direct students to use the steps to carry out the details of an idea/solution
Learning Outcome/s: Students should be able to:

- perform conversions based on known methods

Slide 20



2. Show *Slide 20*. Let the student solve the following practice exercises.

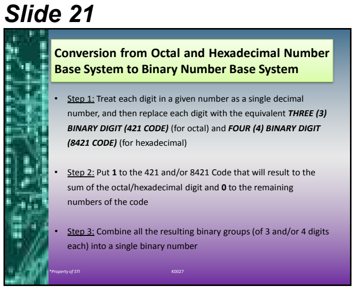
Convert the following binary numbers into octal and hexadecimal

1. $111000000001110_2 \rightarrow N_8$
2. $1111101011001110_2 \rightarrow N_{16}$

Note: *Please see 01 Activity 1 file for the solution for the above problem.*

Conversion from Octal and Hexadecimal Number Base System to Binary Number Base System

Slide 21



1. Show *Slide 21*. Discuss the rules for converting an octal and hexadecimal number base system to binary number base system through the given sample problems.

Sample Problem: Convert 513_8 and BAD_{16} to binary:

Note: *The following steps will be illustrated by the instructor on the whiteboard for a step by step process.*

<u>Step 1:</u> Treat each digit in a given number as a single decimal number, and then replace each digit with the equivalent ***THREE (3) BINARY DIGIT (421 CODE)*** (for octal) and ***FOUR (4) BINARY DIGIT (8421 CODE)*** (for hexadecimal).

<u>Step 2:</u> Put **1** to the 421 and/or 8421 Code that will result to the sum of the octal/hexadecimal digit and **0** to the remaining numbers of the code.

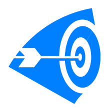
<u>Step 3:</u> Combine all the resulting binary groups (of 3 and/or 4 digits each) into a single binary number.

For Octal:

Step 1	5	1	3	
	421	421	421	
Step 2	**101**	**001**	**011**	
Step 3	**101001011_2**			Final Answer

For Hexadecimal:

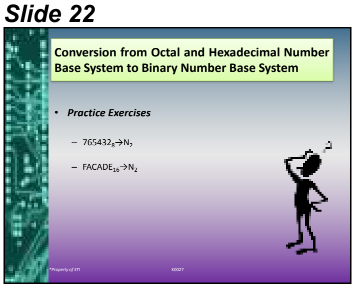
Step 1	B=11	A=10	D=13	
	8 4 2 1	8 4 2 1	8 4 2 1	
Step 2	**1011**	**1010**	**1101**	
Step 3	**101110101101_2**			Final Answer



Step *2*
Target Attribute: Creative
Facet: Elaboration (Ability to systematize and organize the details of an idea and carry it out)
Strategy: Direct students to use the steps to carry out the details of an idea/solution
Learning Outcome/s: Students should be able to:

- perform conversions based on known methods

Slide 22



2. Show *Slide 22*. Let the student solve the following practice exercises.

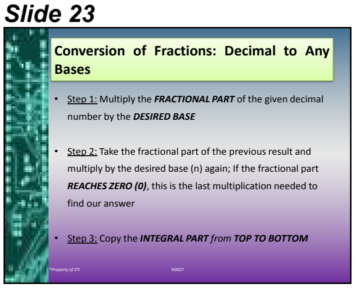
Convert the following octal and hexadecimal numbers into binary

1. $765432_8 \rightarrow N_2$
2. $FACADE_{16} \rightarrow N_2$

Note: *Please see 01 Activity 1 file for the solution for the above problem.*

Conversion of Fraction: Decimal to Any Bases

Slide 23



1. Show *Slide 23*. Discuss the rules for converting a fractional decimal value to any bases through the given sample problem.

Sample Problem 1: Convert 0.828125_{10} to binary number

Note: *The following steps will be illustrated by the instructor on the whiteboard for a step by step process.*

<u>Step 1:</u> Multiply the **FRACTIONAL PART** of the given decimal number by the **DESIRED BASE**.

<u>Step 2:</u> Take the fractional part of the previous result and multiply by the desired base (n) again. If the fractional part

REACHES ZERO (0), this is the last multiplication needed to find our answer.

Step 3: Copy the **INTEGER PART** from **TOP TO BOTTOM**

			Product		
			Integer Part		**Fractional Part**
Step 1	0.828125 * 2	=	**1**	.	65625
Step 2	0.65625 * 2	=	**1**	.	3125
	0.3125 *2	=	**0**	.	625
	0.625 * 2	=	**1**	.	25
	0.25 * 2	=	**0**	.	5
	0.5 * 2	=	**1**	.	**0**

Final answer is 0.110101_2 (exactly)

Sample Problem 2: Convert 0.1_{10} to hexadecimal

			Product		
			Integer Part		**Fractional Part**
Step 1	0.1 * 16	=	**1**	.	6
Step 2	0.6 * 16	=	**9**	.	6
	0.6 * 16	=	**9**	.	6

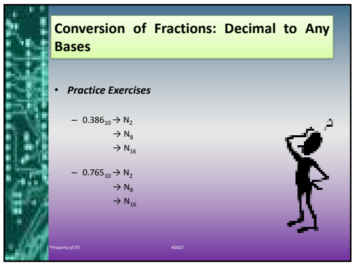
Repeat Detected

Final answer is $0.199..._{16}$ (approximately)

Step *2*
Target Attribute: Creative
Facet: Elaboration (Ability to systematize and organize the details of an idea and carry it out)
Strategy: Direct students to use the steps to carry out the details of an idea/solution
Learning Outcome/s: Students should be able to:

- perform conversions based on known methods

Slide 24



2. Show *Slide 24*. Let the student solve the following practice exercises.

Convert the following into the specified base notation

1. $0.386_{10} \rightarrow N_2$

   $\rightarrow N_8$

   $\rightarrow N_{16}$

2. $0.765_{10} \rightarrow N_2$

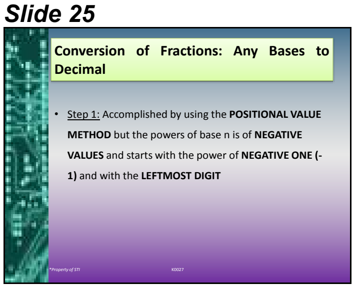
   $\rightarrow N_8$

   $\rightarrow N_{16}$

Note: *Please see 01 Activity 1 file for the solution for the above problem.*

Conversion of Fractions: Any Bases to Decimal

Slide 25



1. Show *Slide 25*. Discuss the rules for converting any bases in fractional form to decimal value through the given sample problems.

Sample Problem 1: Convert 0.237_8 to decimal number

Note: *The following steps will be illustrated by the instructor on the whiteboard for a step by step process.*

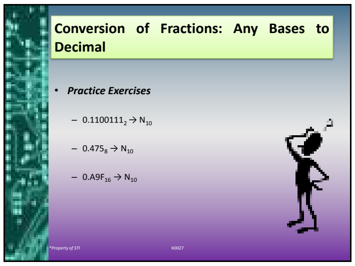
<u>Step 1:</u> Accomplished by using the **POSITIONAL VALUE METHOD** but the powers of base n is of **NEGATIVE VALUES** and starts with the power of **NEGATIVE ONE (-1)** and with the **LEFTMOST DIGIT**

0 . 2 3 7

$2 * 8^{-1} =$	$2 * 1/8^1 =$	$2 * 1/8 =$	2/8
$3 * 8^{-2} =$	$3 * 1/8^2 =$	$3 * 1/64 =$	3/64
$7 * 8^{-3} =$	$7 * 1/8^3 =$	$7 * 1/512 =$	<u>7/512</u>
			159/512

Final Answer: 159/512 = 0.310546875_{10}

Slide 26



2. Show *Slide 26*. Let the student solve the following practice exercises.

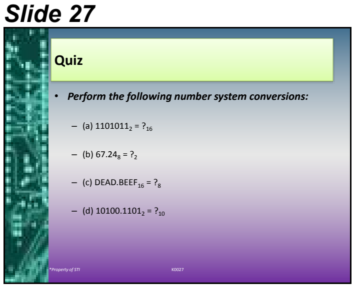
Convert the following fractional part into base 10 notation

1. $0.1100111_2 \rightarrow N_{10}$
2. $0.475_8 \rightarrow N_{10}$
3. $0.A9F_{16} \rightarrow N_{10}$

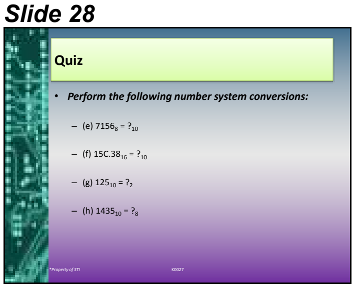
Note: *Please see 01 Activity 1 file for the solution for the above problem.*

C. Generalization

Slide 27



Slide 28



1. Ask the students to get a piece of paper and show *Slides 27* to *28.* On their seats, let them solve the quiz. Discuss the answers afterwards.

Perform the following number system conversions:

(a) $1101011_2 = ?_{16}$

(b) $67.24_8 = ?_2$

(c) $DEAD.BEEF_{16} = ?_8$

(d) $10100.1101_2 = ?_{10}$

(e) $7156_8 = ?_{10}$

(f) $15C.38_{16} = ?_{10}$

(g) $125_{10} = ?_2$

(h) $1435_{10} = ?_8$

Note: *Please see 01 Quiz 1 Answer Key file for the solution for the above problem.*

GRADUATE ATTRIBUTES CHECKLIST

Creative
- ☐ Fluency
- ☐ Flexibility
- ☐ Originality
- ☑ Elaboration

Conscientious
- ☐ Orderly
- ☐ Dutiful
- ☐ Self-disciplined

Emotionally-Mature
- ☐ Self-awareness
- ☐ Self-management
- ☐ Social Awareness
- ☐ Relationship Management

Effective Communicator

- Speaking
- Listening
- Body Language
- Reading
- Writing

Team Player

- Networking
- Coordinating
- Cooperating
- Collaborating

Critical Thinker

- Challenged Thinker
- Beginning Thinker
- Practicing Thinker

Proactive

- Anticipatory
- Plan - oriented
- Action - directed

Lifelong Learner

- Self-motivated
- Self-regulated
- Self-directed

REFERENCES:

Karim, M., & Chen, X. (2008). *Digital design: Basic concepts and principles*. Boca Raton, FL: CRC Press/Taylor & Francis.

Mano, M., & Ciletti, M. (2013). *Digital design: With a introduction to the Verilog* HDL (5th ed.). Upper Saddle River, N.J.: Pearson.

Marcovitz, A. (2010). *Introduction to logic design* (3rd ed.). Dubuque, IA: McGraw-Hill

Tocci, R. (2011). *Digital systems: Principles and applications* (11th ed.). Upper Saddle River, N.J.: Prentice Hall.

Tokheim, R. (2014). *Digital electronics: Principles and applications* (8th ed.). New York, NY: McGraw-Hil.