Module 1.

Computer Fundamentals

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**Module Outcomes**

✔ Convert the given number into the specified number system.

✔ Perform the binary airthmetic operation on the given binary numbers.

✔ Convert the given coded number into other specified code.

✔ Add the given two decimal numbers using BCD code. 2

**Analog Vs Digital**

**Analog Signal**

• Continuous

• Infinite range of values • More exact values, but more difficult to work with

**Example:**

**Digital Signal**

• Discrete

• Finite range of values (2) • Not as exact as analog, but easier to work with

A digital thermostat in a room displays a temperature of 72°. An analog thermometer measures the room temperature at 72.482°. The analog value is continuous and more accurate, but the digital value is more than adequate for the application and significantly easier to process electronically.

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**Example of Analog Vs Digital System**

Digital 

advantages:

Battery life

Programmability

Accuracy 4

**The World is Analog**

✔ The world we live in is analog.

✔ We are analog.

✔ Any inputs we can perceive are analog.

✔ For example,

– sounds are analog signals; they are continuous time and continuous value.

– Our ears listen to analog signals and we speak with analog signals. – Images, pictures, and video are all analog at the source and our eyes are analog sensors.

– Measuring our heartbeat, tracking our activity, all requires processing analog sensor information.

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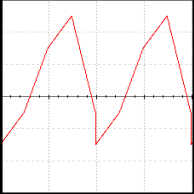
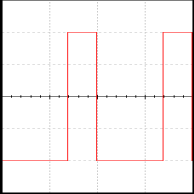
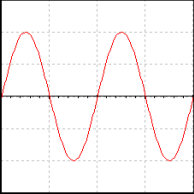
**Examples of Analog Signal**

✔ An analog signal can be any time-varying signal.

✔ Minimum and maximum values can be either positive or negative. ✔ They can be periodic (repeating) or non-periodic.

✔ Sine waves and square waves are two common analog signals. ✔ Note that this square wave is not a digital signal because its minimum value is negative.

✔ Video and Audio

0 

volts

Sine

Wave

Random Periodic

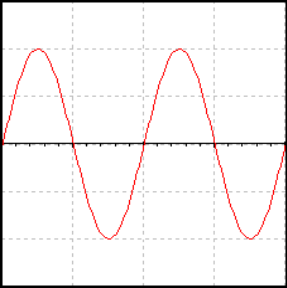
2 3

**Parts of Analog Signal**

Period

(T)

Amplitude (peak-to-peak)

Amplitude (peak) 

Frequency:F =1 Hz

T

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**Pros and Cons Analog Signal**

⮚ **Advantages**

✔ Major advantages of the Analog signal is infinite amount of data.

✔ Density is much higher.

✔ Easy processing.

⮚ **Disadvantages**

✔ Unwanted noise in recording.

✔ If we transmit data at long distance then unwanted disturbance is there.

✔ Generation loss is also a big con of analog signals. 8

**Logic Levels**

Before examining digital signals, we must define logic levels. A logic

level is a voltage level that represents a defined digital state. ✔ Logic HIGH: The higher of two voltages, typically 5 volts ✔ Logic LOW: The lower of two voltages, typically 0 volts

5.0 v

2.0 v

0.8 v 0.0 v

Logic High

Invalid

Logic

Level

Logic Low

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Logic Level** | **Voltage** | **True/False** | **On/Off** | **0/1** |
| HIGH | 5 volts | True | On | 1 |
| LOW | 0 volts | False | Off | 0 |

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**Examples of Digital Signal**

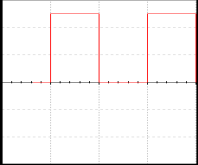
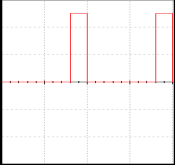
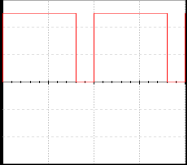
✔ Digital signal are commonly referred to as square waves or clock signals.

✔ Their minimum value must be 0 volts, and their maximum value must be 5 volts.

✔ They can be periodic (repeating) or non-periodic.

✔ The time the signal is high (tH) can vary anywhere from 1% of the period to 99% of the period.

✔ Text and Integers.

5 volts 

0 volts

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**Parts of Digital Signal**

**Amplitude:**

For digital signals, this will ALWAYSbe 5 volts.

**Period:**

The time it takes for a periodic signal to repeat. (seconds)

**Frequency:**

A measure of the number of

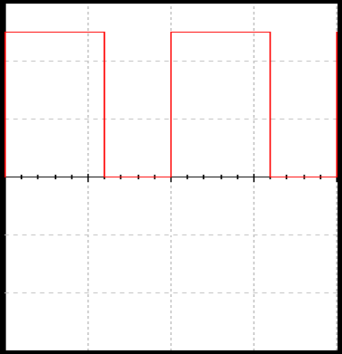
occurrences of the signal per second. (Hertz, Hz)

**Time High (tH):**

The time the signal is at 5 v.

**Time Low (tL):**

The time the signal is at 0 v.

AmplitudeTime  

High

(tH)

~~Period (T)~~

Frequency:

Time Low (tL)

Falling Edge Rising Edge

**Duty Cycle:**

The ratio of tH to the total period (T). **Rising Edge:**

A 0-to-1 transition of the signal.

**Falling Edge:**

A 1-to-0 transition of the signal.

F =1 Hz T

*DutyCycle* =*tH* ×100%*T*

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**Pros and Cons Digital Signal**

⮚**Advantages**

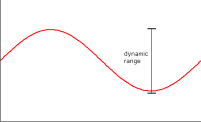
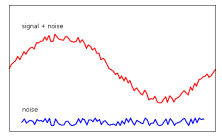
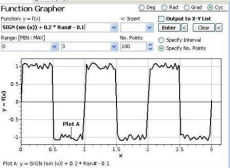
✔Because of their digital nature they can travel faster in over digital lines.

✔Ability to transfer more data as compared to analog.

⮚**Disadvantages**

✔Greater bandwidth is essential.

✔Systems and processing is more complex. 12

**Example of using digital over analog: **Noisy channel Noisy channel 

✔ Digital systems are less sensitive to

noise

✔ As long as 0 is distinguishable from 1

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**Analog Vs Digital**

⮚Analog system

✔The physical quantities or signals continuously over a specified range.

⮚Digital system

may vary

✔The physicalquantities or signals can assume only discrete values.

✔Greater accuracy

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**Analog Vs Digital***X*(*t*)

*t*

Analog signal

*X*(*t*)

*t*

Digital signal

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**Advantages of Digital System over Analog System**

✔Digital Systems are easier to design ✔Information storage is easy

✔Accuracy & Precision are greater

✔Digital systems are more versatile

✔Digital circuits are less affected by noise

✔More digital circuitry can be fabricated on IC chips

✔Reliability is more

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**Number System and Codes**

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**Number System**

✔A number system defines a set of values used to represent quantity.

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**Different Number Systems**

✔ Decimal Number System

- Base/Radix 10

✔ Binary Number System

- Base/Radix 2

✔ Octal Number System

- Base/Radix 8

✔ Hexadecimal Number System

Base/Radix 16

**Decimal Number System**

✔ Decimal number system contains ten unique symbols

0,1,2,3,4,5,6,7,8 and 9

✔ Since counting in decimal involves ten symbols, we can say that its base or radix is ten.

✔ It is a positional weighted system

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**Decimal Number System**

✔In this system, any number (integer, fraction or mixed) of any magnitude can be represented by the use of these ten symbols only

✔Each symbols in the number is called a “**Digit**”

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**Decimal Number System**

**Structure:**

MSD LSD

Decimal No. ...... *d*3

*d*2 *d*1 *d*0 . *d* − 1 *d* − 2

....

Positional Weights

103 102 101 100 10−1 10−2

Decimal Point

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**Decimal Number System**

✔ **MSD:** The leftmost digit in any number representation, which has the greatest positional weight out of all the digits present in that number is called the “**Most Significant Digit**” (MSD)

✔ **LSD:** The rightmost digit in any number representation, which has the least positional weight out of all the digits present in that number is called the “**Least Significant Digit**” (LSD)

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**Decimal Number System**

⮚Examples

1214

1897

9875.54

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**Binary Number System**

✔Binary number system is a positional weighted system

✔It contains two unique symbols 0 and 1 ✔Since counting in binary involves two symbols, we can say that its base or radix is two.

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**Binary Number System**

✔A binary digit is called a **“Bit”**

✔A binary number consistsof a sequenceof bits, each of which is either a 0 or a 1. ✔The binary point separatesthe integer and fraction parts

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**Binary Number System Structure:**

Binary No.

MSB LSB*b*2 *b*1 *b*0 ...... *b*3. *b* − 1 *b* − 2

....

Positional Weights

23 22 21 202−1 2−2

Binary Point

**Binary Number System**

✔**MSB:** The leftmost bit in a given binary number with the highest positional weight is called the “**Most Significant Bit**” (MSB)

✔**LSB:** The rightmost bit in a given binary number with the lowest positional weight is called the “**Least Significant Bit**” (LSB) 28

**Binary Number System**

|  |  |
| --- | --- |
| **Decimal No.** | **Binary No.** |
| 0 | 0000 |
| 1 | 0001 |
| 2 | 0010 |
| 3 | 0011 |
| 4 | 0100 |
| 5 | 0101 |
| 6 | 0110 |
| 7 | 0111 |

|  |  |
| --- | --- |
| **Decimal No.** | **Binary No.** |
| 8 | 1000 |
| 9 | 1001 |
| 10 | 1010 |
| 11 | 1011 |
| 12 | 1100 |
| 13 | 1101 |
| 14 | 1110 |
| 15 | 1111 |

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**Terms related to Binary Numbers**

✔**BIT:** The binary digits (0 and 1) are called bits.

- Single unit in binary digit is called “Bit”

- Example 1

0

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**Terms related to Binary Numbers**

✔**NIBBLE:** A nibble is a combination of 4 binary bits.

Examples, 1110

0000

1001

0101

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**Terms related to Binary Numbers**

✔ **BYTE:** A byte is a combination of 8 binary bits.

✔The number of distinct values represented by a byte is 256 ranging from 0000 0000 to 1111 1111.

*b*7 *b*6 *b*5

Higher order nibble

MSB

*b*4 *b*3 *b*2 *b*1 *b*0

Lower order

nibble

LSB

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**Terms related to Binary Numbers**

✔**WORD:** A word is a combination of 16 binary bits. Hence it consists of two bytes.

*b*15 *b*14 *b*13 *b*12 *b*11 *b*10 Higher order byte

*b*9 *b*8 *b*7

*b*6 *b*5 *b*4 *b*3 *b*2 *b*1 *b*0 Lower order byte

MSB LSB

33

**Terms related to Binary Numbers**

✔**DOUBLE WORD:** A double word is exactly what its name implies, two words.

-It is a combination of 32 binary bits. 34

**Octal Number System**

✔Octal number system system

is a positional weighted

✔It containseight unique symbols0,1,2,3,4,5,6 and 7

✔Since counting in octal involves eight symbols, we can say that its base or radix is eight.

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**Octal Number System**

✔The largest value of a digit in the octal system will be 7.

✔That means the octal number higher than 7 will not be 8, instead of that it will be 10.

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**Octal Number System Structure:**

Octal No.

MSD LSD*O*2 *O*1 *O*0 ...... *O*3. *O*− 1 *O* − 2

....

Positional Weights

80 83 82 81 8−1 8−2

Radix Point37

**Octal Number System**

✔Since its base 8 = 23 , every 3 bit group of binary can be represented by an octal digit.

✔An octal number is thus 1/3rd the length of the corresponding binary number

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**Octal Number System**

|  |  |  |
| --- | --- | --- |
| **Decimal No.** | **Binary No.** | **Octal No.** |
| 0 | 0000 | 0 |
| 1 | 0001 | 1 |
| 2 | 0010 | 2 |
| 3 | 0011 | 3 |
| 4 | 0100 | 4 |
| 5  6 | 0101  0110 | 5  6 |
| 7 | 0111 | 7 |
| 8 | 1000 | 10 |
| 9 | 1001 | 11 |
| 10 | 1010 | 12 |
| 11 | 1011 | 13 |
| 12 | 1100 | 14 |
| 13 | 1101 | 15 |

**Hexadecimal Number System (HEX)**

✔Binary numbers are long. These numbers are fine for machines but are too lengthy to be handled by human beings. So there is a need to represent the binary numbers concisely.

✔One number system developed with this objective is the hexadecimal number system (or Hex)

**Hexadecimal Number System (HEX)**

✔Hex number system is a positional weighted system

✔It contains sixteen unique 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E and F.

symbols

✔Since counting in hex involves sixteen symbols, we can say that its base or radix is sixteen.

**Hexadecimal Number System (HEX)**

**Structure:**

Hex No.

MSD LSD...... *H*3 *H*2 *H*1 *H*0. *H*− 1 *H* − 2

163 162 161 16−1 16−2

....

Positional Weights

160

Radix Point

**Hexadecimal Number System (HEX)**

✔Since its base16 = 24, every 4 bit group of binary can be represented by an hex digit.

✔An hex number is thus 1/4th the length of the corresponding binary number

✔The hex system is particularly useful for human communications with computer

**Hexadecimal Number System (HEX)**

|  |  |  |
| --- | --- | --- |
| **Decimal No.** | **Binary No.** | **Hex No.** |
| 0 | 0000 | 0 |
| 1 | 0001 | 1 |
| 2 | 0010 | 2 |
| 3 | 0011 | 3 |
| 4 | 0100 | 4 |
| 5 | 0101 | 5 |
| 6 | 0110 | 6 |
| 7 | 0111 | 7 |

|  |  |  |
| --- | --- | --- |
| **Decimal No. Binary No.** |  | **Hex No.** |
| 8 | 1000 | 8 |
| 9 | 1001 | 9 |
| 10 | 1010 | A |
| 11 | 1011 | B |
| 12 | 1100 | C |
| 13 | 1101 | D |
| 14 | 1110 | E |
| 15 | 1111 | F |

**Conversion Among Bases**

Possibilities

Decimal Octal

Binary

Hexadecimal

**Conversion of Decimal number into Binary number (Integer Number)**

**Procedure:**

1. Divide the decimal no by the base 2, noting the remainder.

2. Continue to divide the quotient by 2 until there is nothing left, keeping the track of the remainders from each step.

3. List the remainder values in reverse order to find the number‟s binary equivalent

**Example: Convert 105 decimal number in to it’s equivalent binary number.**

Example: Convert 105 decimal number in to it‟s equivalent binary number.

2 105

Example: Convert 105 decimal number in to it‟s equivalent binary number.

2 105

2 52 1

Example: Convert 105 decimal number in to it‟s equivalent binary number.

2 105

2 52 2 26

1 0

Example: Convert 105 decimal number in to it‟s equivalent binary number.

2 105

2 52 2 26 2 13

1 0 0

Example: Convert 105 decimal number in to it‟s equivalent binary number.

2 105

2 52 2 26 2 13 2 6

1 0 0 1

Example: Convert 105 decimal number in to it‟s equivalent binary number.

2 105

2 52 2 26 2 13 2 6 2 3

1 0 0 1 0

Example: Convert 105 decimal number in to it‟s equivalent binary number.

2 105

2 52 2 26 2 13 2 6

2 3 2 1

1 0 0 1 0 1

Example: Convert 105 decimal number in to it‟s equivalent binary number.

2 105

2 52 2 26 2 13 2 6

2 3 2 1 0

1 0 0 1 0 1 1

Example: Convert 105 decimal number in to it‟s equivalent binary number.

2 105

2 52 2 26 2 13 2 6

2 3 2 1 0

1 0 0 1 0 1 1

LSB

MSB

(105)10 = (1101001)2

**Conversion of Decimal number into Binary number (Fractional Number)**

**Procedure:**

1. Multiply the given fractional number by base 2. 2. Record the carry generated in this multiplication as MSB.

3. Multiply only the fractional number of the product in step 2 by 2 and record the carry as the next bit to MSB.

4. Repeat the steps 2 and 3 up to 5 bits. The last carry will represent the LSB of equivalent binary number

**Example: Convert 0.42 decimal number in to it’s equivalent binary number.**

Example: Convert 0.42 decimal number in to it‟s equivalent binary number.

0.42 X 2 = 0.84 0

Example: Convert 0.42 decimal number in to it‟s equivalent binary number.

0.42 X 2 = 0.84 0

0.84 X 2 = 1.68 1

Example: Convert 0.42 decimal number in to it‟s equivalent binary number.

0.42 X 2 = 0.84 0

0.84 X 2 = 1.68 1

0.68 X 2 = 1.36 1

Example: Convert 0.42 decimal number in to it‟s equivalent binary number.

0.42 X 2 = 0.84 0

0.84 X 2 = 1.68 1

0.68 X 2 = 1.36 1

0.36 X 2 = 0.72 0

Example: Convert 0.42 decimal number in to it‟s equivalent binary number.

0.42 X 2 = 0.84 0

0.84 X 2 = 1.68 1

0.68 X 2 = 1.36 1

0.36 X 2 = 0.72 0

0.72 X 2 = 1.44 1

Example: Convert 0.42 decimal number in to it‟s equivalent binary number.

0.42 X 2 = 0.84 0 0.84 X 2 = 1.68 1 0.68 X 2 = 1.36 1 0.36 X 2 = 0.72 0 0.72 X 2 = 1.44 1

MSBLSB

(0.42)10 = (0.01101)2

**Exercise**

• Convert following Decimal Numbers in to its equivalent Binary Number:

1. (1248.56)10 = ( ? )2

2. (8957.75)10 = ( ? )2

3. (420.6)10 = ( ? )2

4. (8476.47)10 = ( ? )2

**Conversion of Decimal Number into Octal Number (Integer Number)**

**Procedure:**

1. Divide the decimal no by the base 8, noting the remainder.

2. Continue to divide the quotient by 8 until there is nothing left, keeping the track of the remainders from each step.

3. List the remainder values in reverse order to find the number‟s octal equivalent

**Example: Convert 204 decimal number in to it’s equivalent octal number.**

Example: Convert 204 decimal number in to it‟s equivalent octal number.

8 204

Example: Convert 204 decimal number in to it‟s equivalent octal number.

2 5

8 204

8 25 4

8

204

- 16

44

- 40 4

Example: Convert 204 decimal number in to it‟s equivalent octal number.

3

8 204 8 25 8 3

8

4

1

25

- 24 1

Example: Convert 204 decimal number in to it‟s equivalent octal number.

8 204

8 25 8 3 0

4 1 3

Example: Convert 204 decimal number in to it‟s equivalent octal number.

8 204

LSD

8 25 8 3 0

4

1

3 MSD

(204)10 = (314)8

**Conversion of Decimal Number into Octal Number (Fractional Number)**

**Procedure:**

1. Multiply the given fractional number by base 8. 2. Record the carry generated in this multiplication as MSD.

3. Multiply only the fractional number of the product in step 2 by 8 and record the carry as the next bit toMSD. 4. Repeat the steps 2 and 3 up to 5 bits. The last carry will represent the LSD of equivalent octal number

**Example: Convert 0.6234 decimal number in to it’s equivalent Octal number.**

Example: Convert 0.6234 decimal number in to it‟s equivalent Octal number.

0.6234 X 8 = 4.9872 4

Example: Convert 0.6234 decimal number in to it‟s equivalent Octal number.

0.6234 X 8 = 4.9872 4

0.9872 X 8 = 7.8976 7

Example: Convert 0.6234 decimal number in to it‟s equivalent Octal number.

0.6234 X 8 = 4.9872 4

0.9872 X 8 = 7.8976 7

0.8976 X 8 = 7.1808 7

Example: Convert 0.6234 decimal number in to it‟s equivalent Octal number.

0.6234 X 8 = 4.9872 4

0.9872 X 8 = 7.8976 7

0.8976 X 8 = 7.1808 7

0.1808 X 8 = 1.4464 1

Example: Convert 0.6234 decimal number in to it‟s equivalent Octal number.

0.6234 X 8 = 4.9872 4

0.9872 X 8 = 7.8976 7

0.8976 X 8 = 7.1808 7

0.1808 X 8 = 1.4464 1

0.4464 X 8 = 3.5712 3

Example: Convert 0.6234 decimal number in to it‟s equivalent Octal number.

0.6234 X 8 = 4.9872 4 0.9872 X 8 = 7.8976 7 0.8976 X 8 = 7.1808 7 0.1808 X 8 = 1.4464 1

MSD

0.4464 X 8 = 3.5712 3 LSD (0.6234)10 = (0.47713)8