**PROJECT** **The XOR Encryption Process**

**Objective** To understand the XOR encryption process.

***PROJECT DESCRIPTION***

According to the following instructions, implement an MS Excel worksheet that demonstrates XOR logic and encryption.

# Information About this Project

In cryptography, an XOR encryption process is one that operates according to the following principles, where P and Q represent logic conditions of True ( 1 ) or False ( 0 ) :

P (+) Q = True ( when P is True and Q is False and vice versa )

P (+) Q = False ( when P and Q are either both True or both False )

The symbol (+) denotes the exclusive disjunction ( XOR ) operation.

For example, when encrypting 01000001 , the 8 - bit ASCII equivalent of the English character " A " , with the key 10011001 the result is

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | **plaintext character** |
|  |  |  |  |  |  |  |  |  |
| 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | **key** |
|  |  |  |  |  |  |  |  |  |
| **1** | **1** | **0** | **1** | **1** | **0** | **0** | **0** | **encrypted character** |

The encrypted letter equivalent to the 8 - bit ASCII number 11011000 is the symbol Ø .

Here, we are using " 1 " for True and " 0 " for False, as is typical for binary numbers.

# Steps to Complete this Project

**STEP 1 Open Excel and Copy the Worksheet**

Open MS Excel and copy the spreadsheet shown in **Figure 1** .

## Figure 1 Template for the XOR Spreadsheet

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | A | B | C | D | E | F | G | H | I | J | K | L |
| 1 | given character | **H** |  |  |  |  |  |  |  |  |  |  |
| 2 | ASCII equivalent | 72 |  | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |  |
| 3 |  |  |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 |  |  |
| 4 | given key | **z** |  |  |  |  |  |  |  |  |  |  |
| 5 | ASCII equivalent | 122 |  | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |  |
| 6 |  |  |  |  |  |  |  |  |  |  |  |  |
| 7 | XOR result |  |  |  |  |  |  |  |  |  |  |  |
| 8 | XOR binary |  |  |  |  |  |  |  |  |  |  |  |
| 9 | cipher character |  |  |  |  |  |  |  |  |  |  |  |
| 10 |  |  |  |  |  |  |  |  |  |  |  |  |

The above worksheet displays a given character to be encoded, the ASCII decimal equivalent of the character and the 8 - bit binary equivalent of the character.

The above worksheet also displays a given character key, the ASCII decimal equivalent of the key and the 8 - bit binary equivalent of the character key.

**PROJECT The XOR Encryption Process**

The purpose of the worksheet is to utilize XOR encryption logic to encode the given character via the given key.

**STEP 2** **Formulate the Worksheet**

In cell D7 , type and enter the following formula, which performs an XOR operation on the binary digits located within cells D2 and D5 .

=NOT ( OR ( AND ( D2 , D5 ) , NOT ( OR ( D2 , D5 ) ) ) )

Note that MS Excel does not have an intrinsic ( built - in ) XOR function but an XOR operation can be simulated using the above formula.

Perform a " drag - and - fill " worksheet row seven and similarly formulate the cells across the cell range E7 : K7 .

Notice that the formula either returns TRUE or FALSE for the cells in the range

D7 : K7 .

You will now convert a TRUE to a " 1 " and a FALSE to a " 0 " .

To accomplish this, type and enter the following formula in cell D8 .

=IF ( D7 = TRUE , 1 , 0 )

Perform a " drag - and - fill " worksheet row eight and similarly formulate the cells across the cell range E8 : K8 .

Use the Window’s **Calculator** program, in the [ Programmer ] view, to convert the 8 - bit number in row eight to a decimal number.

Then, click cell B9 and type the following formula in this cell, replacing the word

" decimal " with the number that you just computed.

=CHAR ( decimal )

You have just encoded the given character, using the given key, of the lower case letter " z " , with XOR encryption.

**STEP 3 Encrypt Another Character**

Highlight the cell range A1 : K9 . Copy this range. Click cell A11 and paste the copied range.

Within the newly pasted section of your worksheet, change the given character from " H " to " E " and apply the procedure of **STEP 2**  to determine the cipher character equivalent to the letter " E " .

Repeat this procedure until you encrypt the four characters in the word " HELP " . Use an ASCII chart of characters to assist you, if necessary.

Note: keep the same key for each of the letters in " HELP " .

**STEP 4 Modify the Worksheet**

With your worksheet showing the plain text letters and cipher text letters equivalent to the word in the word " HELP " , change the given four plain text characters from " HELP " to the first four characters in your own first name, in upper case. If your first name is less than four characters, use " X " characters to fill the gap. Also change the key character from " z " to the first character in your last name, in lower case.

**STEP 5** **Submit Your Project**

Submit your modified, completed worksheet for credit.

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**STEP 6 Questions and Answers Concerning this Computer Laboratory Project**

Open MS Word and, within a new document, place your responses to these questions. Submit your completed MS Word document for credit.

**(1) ( The Logical XOR Operation )**

Complete the following truth table for the logical XOR operation.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| expr1 | expr2 |  | expr1 XOR exp2 |  |
|  |  |  |  |  |
| 1 | 1 |  |  |  |
| 1 | 0 |  |  |  |
| 0 | 1 |  |  |  |
| 0 | 0 |  |  |  |

**(2) ( The MS Excel XOR Function )**

In a blank MS Excel worksheet execute the following formula, observe the result and explain the reason why the particular value was returned.

=XOR(0, 1)

**(3) ( The MS Excel BITXOR Function )**

In a blank MS Excel worksheet execute the following formula, observe the result and explain the reason why the particular value was returned.

=BITXOR(57, 19)

**(4) ( Computer Programs and the XOR Operation )**

Review the following Visual Basic program segment, examine the XOR operations therein and determine the outputs that appear in the message boxes when the program is executed.

**Dim x As Integer = 12**

**Dim y As Integer = 9**

**Dim z As Integer = 15**

**Dim firstResult, secondResult, thirdResult As Boolean**

**firstResult = (x > y) Xor (y < z)**

**secondResult = (y < x) Xor (y > z)**

**thirdResult = (y > x) Xor (z < y)**

**MessageBox.Show("first result = " & firstResult)**

**MessageBox.Show("second result = " & secondResult)**

**MessageBox.Show("third result = " & thirdResult)**

**(5) ( Encryption / Decryption )**

Review the XOR encryption process that you learned for this computer laboratory project and explain how you could decrypt an encrypted character.