**PROJECT Numbers, Codes and Ciphers - Mod 11 Application**

**Objective** To examine various topics concerning computer security.

***PROJECT DESCRIPTION***

Computer security often involves the use of numbers, codes and ciphers.

One topic that usually is included is " check digit verification " . This project, described below, is an example of this subject of determining check digits for a coded number.

Books are assigned identification numbers called ISBNs. Each ISBN is a ten - digit number such as 1 - 55953 - 407 - 9 . The final digit is called the check digit which is determined on the basis of modular arithmetic. The final ( check ) digit is obtained as follows: start at the left and multiply the first nine digits of the ISBN number by 10 ,

9 , 8 , 7 , 6 , 5 , 4 , 3 and 2 , respectively. Then add these products. The check digit is

the smallest number that must be added to the result to arrive at a multiple of 11 .

( If the number to be added is a 10 , then the letter " X " is used for the check digit. )

Construct an MS Excel worksheet that will find the check digit for a textbook such as the following: ISBN : 0 - 13 - 089367 - \_\_

***Information About this Project***

Here is an example involving a ten - digit ISBN number and its check digit.

Consider the following ISBN number: 0 - 619 - 21515 - 1

To verify that the check digit is indeed 1 , the last digit on the right, perform the following mathematical operations:

10 × **0** + 9 × **6** + 8 × **1** + 7 × **9** + 6 × **2** + 5 × **1** + 4 × **5** + 3 × **1** + 2 × **5** = 175

The check sum 175 is between 165 and 176 , which are both multiples of 121 .

Since 1 is the number that must be added to the check sum of 175 in order to arrive at the next multiple of 11 , which is 176 in this case, 1 is the check digit.

***Steps to Complete this Project***

**STEP 1 Opening a New MS Excel Worksheet**

First, open MS Excel on your computer.

**STEP 2 Construct the Worksheet**

Construct a worksheet that will be formulated to determine or verify the check digit for any book ISBN number. You can use the sample worksheet below as a design template.

**Figure 1 ISBN MS Excel Worksheet**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | A | B | C | D | E | F |
| 1 | ***Number Digit*** | ***ISBN Digit*** | ***Multiplier*** | ***Product*** |  |  |
| 2 |  |  |  |  |  |  |
| 3 |  |  |  |  |  |  |
| 4 |  |  |  |  |  |  |
| 5 |  |  |  |  |  |  |

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**STEP 3 Populate the Worksheet**

In your worksheet Column A enter 1 in cell A2 , 2 in cell A3 , 3 in cell A4 and so on until you have entered all the digits from 1 to 10 . These 10 digits will represent reference digits for determining the proper check digit.

In your worksheet Column B enter, starting with cell B2 , the 10 digits of a textbook ten - digit ISBN number. Enter one digit per cell.

In your worksheet Column C enter, starting with cell C2 , the digit multipliers 10 , 9 , 8 , and so on until you have entered all the digits from 10 to 1 . Enter one digit per cell.

**STEP 4 Formulate the Worksheet**

Now formulate your worksheet.

In cell D2 , type and enter a formula that will multiply cells B2 and C2 .

Drag and fill the formula down Column D to determine the remaining products.

Now highlight cells D2 through D11 in Column D . Click the AutoSum icon on the Excel **Standard** Toolbar to have Excel calculate the sum and display it in cell D12 .

To determine the check digit, construct an Excel formula in one of the empty cells of your worksheet.

One way to determine the check digit is to subtract the number 11 by the modulus ( with divisor of 11 ) of the integer sum of the cell range D2 through D10 . Use the Excel **Mod()** function to do this. The format of the **Mod()** function is:

= Mod ( integer, divisor )

Next, construct an **If()** function to verify the check digit. The format of the **If()** function is:

= If ( condition to test, value if condition is true, value if condition is false )

Enter the **If()** function in one of the empty cells in your worksheet.

Your **If()** function is to return " Yes " when your computed check digit matches

that of the given book and " No " otherwise.

**STEP 5 Modify the Worksheet**

With your spreadsheet working properly, modify it such that it will include a provision for if the ISBN is such that the check digit is the letter " X " .

Test your worksheet with a valid ISBN that uses a check digit of " X " .

You can find some textbooks for ISBN testing purposes at the following Web site:

[**http://www.course.com**](http://www.course.com)

**STEP 6 Check Your Results**

Visit the following Web site where you can verify the results of computing an ISBN check digit.

[**http://www.hahnlibrary.net/libraries/isbncalc.html**](http://www.hahnlibrary.net/libraries/isbncalc.html)

Also, locate the ISBN 13 number of a book in your collection and verify the check digit at the above Web site.

**STEP 7 Submit the Worksheet**

When you have finished designing and testing your worksheet, submit copies of the worksheet showing check digit verifications of sample ISBN numbers.

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**Step 8 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) ( MOD 11 )**

What is meant by a MOD 11 operation?

**(2) ( MOD Operations )**

In Computer Science, the MOD arithmetic operation has many uses. Try executing this formula in WolframAlpha.com , examine the output and take a snapshot of the result.

DiscretePlot[Mod[n, 8], {n, 50}]

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

If divisor is 0 , MOD ( number, divisor ) returns the #DIV/0! error value.

Which of these Excel MOD formulas will return such an error?

(a) =MOD(3, 4) \* 0

(b) =MOD(8, 0)

(c) =MOD(0, 8)

**(4) ( The MS Excel MOD Function )**

The MS Excel MOD function can be expressed in terms of the INT function:

MOD(n, d) = n − d \* INT(n / d)

Show the veracity of the above equation by choosing appropriate values of n and d .

**(5) ( Computer Programming and the MOD Operation )**

In some computer programming languages, the MOD operation is represented by a % percent sign. Even WolframAlpha will recognize both 17 MOD 2 and 17 % 2 , as an example. A MOD operation has a left to right associativity, similar to division and multiplication.

Review this program code segment and predict the output when the program segment is executed.

**System.*out*.println(" first " + (29 % 5));**

**System.*out*.println(" second " + (7 % 9));**

**System.*out*.println(" third " + (-73 % 37));**

**System.*out*.println(" fourth " + (13 + 31 % 4));**

**System.*out*.println(" fifth " + (19 % 61 % 3));**