

Number Theory Project

Application of Number Theory in real life:

The International Standard Book Number (ISBN) is a numeric commercial book identifier which is intended to be unique and helps in identifying a book.^[1]

The present system follows the ISBN-13-digit system.

The first 12 digits are digits which are decided upon the region of publication, language and other parameters. The last digit or the 13th digit acts as the “valid bit” or the “check bit”. It ensures that the digits in the ISBN are right and are in place i.e., no digit is interchanged with the other. It helps in error checking.

The check bit is calculated using the rules given below, we apply the knowledge of congruences [2].

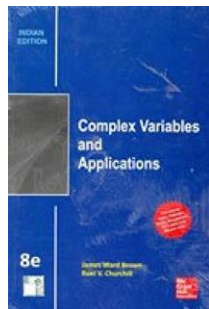
- (a) The 12 digits from left are multiplied by weights (1 or 3).
- (b) The 1st digit is multiplied by 1, 2nd by 3, 3rd by 3 and so on.
- (c) The total of this is calculated and we take modulo 10.
- (d) If the remainder matches the 13th digit, the check bit, then the ISBN has been read correctly. If not then there's an error in the ISBN.

If the ISBN is lets say $x_1x_2x_3 - x_4x_5 - x_6x_7x_8 - x_9x_{10}x_{11}x_{12} - x_{13}$, then

$$(x_1 + 3x_2 + x_3 + x_4 + x_5 + x_6 + x_7 + x_8 + x_9 + x_{10} + x_{11} + x_{12}) \equiv x_{13} \pmod{10}$$

Example:

We want to check the ISBN of “*Complex Variables and Applications*” by James Ward and V. Churchill.



The correct ISBN is 978-93-392-0515-7

Suppose the ISBN received is 978-93-932-0515-7, we can check and find the error.

Received bits = 978-93-932-0515-7

Using formula,

$$\Rightarrow (9 + 3 \cdot 7 + 8 + 3 \cdot 9 + 3 + 3 \cdot 9 + 3 + 3 \cdot 2 + 0 + 3 \cdot 5 + 1 + 3 \cdot 5) = ? \pmod{10}$$

$$\Rightarrow (9 + 21 + 8 + 27 + 3 + 27 + 3 + 6 + 0 + 15 + 1 + 15) = ? \pmod{10}$$

$$\Rightarrow 135 = ? \pmod{10}$$

$$\Rightarrow 135 = 5 \pmod{10}$$

\therefore error as $x_{13} = 7 \neq 5$

References:

1. https://en.wikipedia.org/wiki/International_Standard_Book_Number
2. <https://isbn-information.com/check-digit-for-the-13-digit-isbn.html>