

Subject 03

# HISTORY OF MATHEMATICS

**Please do not write on this exam paper and give it back at the end of the test**

## HISTORY OF MATHEMATICS: FIBONACCI AND NUMERATION

### 1. Who was Fibonacci?



The "greatest European mathematician of the middle ages", his full name was Leonardo of Pisa, or Leonardo Pisano in Italian since he was born in Pisa, Italy (the city with the famous Leaning Tower), about 1175 AD. Pisa was an important commercial town in its day and had links with many Mediterranean ports. Leonardo's father, Guglielmo Bonacci, was a kind of customs officer.

So Leonardo grew up with a North African education under the Moors and later travelled extensively around the Mediterranean coast. He would have met with many merchants and learned of their systems of doing arithmetic. He soon realised the many advantages of the "Hindu-Arabic" system over all the others. He was one of the first people to introduce the Hindu-Arabic number system into Europe - the positional system we use today - based on ten digits with its decimal point and a symbol for zero:

1 2 3 4 5 6 7 8 9 0

His book on how to do arithmetic in the decimal system, called *Liber abbaci* (meaning *Book of the Abacus* or *Book of Calculating*) completed in 1202 persuaded many European mathematicians of his day to use this "new" system.

Let's look at the Roman number system still in use in Europe at that time (1200) and see how awkward it was for arithmetic.

**Question 1:** Do you know any other mathematical topic studied by Fibonacci?

### 2. Roman Numerals

The method in use in Europe until then used the Roman numerals:

I = 1, V = 5, X = 10, L = 50, C = 100, D = 500 and M = 1000

**Question 2:** Where can you still see this kind of numbers?

#### a) The Additive rule

The simplest system would be merely to use the letters for the values as in the table above, and add the values for each letter used. For instance, 13 could be written as XIII.

But some numbers are long and this is where, if we agree to *let the order of letters matter* we can also use *subtraction*.

#### b) The subtractive rule

If a smaller value came *before* the next larger one, it would be *subtracted* and if it came after, it would be *added*. For example, XI means  $10+1=11$  (since the smaller one comes after the larger ten) but IX means 1 less than 10 or 9. Using this method, 1998 would be written much more compactly as MCMXCVIII but this takes a little more time to interpret:  $1000 + (100 \text{ less than } 1000) + (10 \text{ less than } 100) + 5 + 1 + 1 + 1$ .

#### c) Arithmetic with Roman Numerals

Arithmetic was not easy in the Roman system: CLXXIII added to XXVIII is CCII, and CLXXIII less XXVIII is CXXXVI.

#### Question 3:

Could you translate the following numbers in the positional system we use today?

a) XXXVI      b) XXV      c) XXXIV

#### Question 4:

Could you compute the following operations, and give your result using Roman numerals?

a) XXVII – IV =      b) IX + X =      c) XXXI – VI =