

## Notes for March 24

### History:

Maple is a Computer Algebra System (CAS). One of the earliest prototypes of a CAS program was MACSYMA which was developed at MIT in the late 1960's. (MACSYMA was an acronym related to the words MACHINE, SYMBOLIC and Algebra). Around 1982, MIT decided to market versions of MACSYMA commercially. In 1988, Stephen Wolfram introduced his computer algebra system Mathematica, and about the same year Waterloo Software released Maple. These systems were inspired by MACSYMA in terms of their capabilities, but they proved to be typically much better at providing accessible user interfaces. Today, there are four major CAS programs commercially available:

<u>Program</u>	<u>Company</u>	<u>Notes</u>
Maple	MapleSoft	Originally developed in conjunction with a research project at University of Waterloo
Mathematica	Wolfram Research	
Derive	Texas Instruments	A variant of which is used in the TI-92 calculator
MathCad	MathSoft	

### Prompts:

Maple has two prompts from which the user can enter information:

- [> formula entry prompt for entering calculations, formulas, equations
- [ text entry prompt for entering text, comments, notes

New formula prompts are generated every time Maple executes a calculation at the last available formula prompt. New formula prompts can be created by clicking the [> button on the tool bar. Blank formula prompts can be converted to text prompts by clicking the [ button on the too bar.

Maple is case sensitive. Generally speaking, elementary commands in Maple are lower case, e.g., *factor*, *solve*, *plot*, *gcd*, etc.

### Operators:

Operator	Action	Examples
+	addition	3+4, $f + g$
-	subtraction	189-34, $a - b$
*	multiplication	2*3, $2*x$ , $f*g$
/	division	8/3, $f/g$
^	exponentiation	2^3, $x^5$
!	factorial	5!

### Notes:

1. There is no implied multiplication. You cannot write  $2(3+5)$  and have Maple understand that to be  $2*(3+5)$
2. Order of Operations. Maple employs algebraic order of operations rules which apply standard precedence rules for implementing calculations where parentheses have been omitted
  - !, ^ highest precedence
  - \*, / next highest precedence
  - +, - lowest precedence

### Examples

$2+3^2$	=	11 not 25
$2+3*4$	=	14 not 20
$2*3^2$	=	18 not 36

### Assignment:

Constants, values, expressions, etc. can be assigned to variables for future reference. The assignment operator is the symbol `:=`. The assignment statement typically takes the following form:

*variable* := expression

### Examples

```
f := x^3 - 2*x;  
a := ifactor(23452356);
```

### Termination of Expressions/Statements:

Each statement at the formula entry prompt [`>`] must be ended with a semicolon (`;`) or a colon (`:`) before Maple will execute the statement. The difference between the two is that when a colon is used to terminate the statement, Maple suppresses the output after executing the statement.

### Built-in Functions:

There are hundreds or thousands of functions built into Maple (typically, each has various options). Most built-in functions require arguments, e.g. the square function, `sqrt`, requires an argument (a constant or expression) on which to act – `sqrt(13)`, `sqrt(x^2+1)`. Many functions require more than one argument:

### Examples

<code>sqrt(arg)</code>	<code>trunc(x)</code> or <code>trunc(n,x)</code>
<code>sin(arg)</code>	<code>round(x)</code> or <code>round(n,x)</code>
<code>cos(arg)</code>	<code>frac(x)</code> or <code>frac(n,x)</code>
<code>tan(arg)</code>	<code>floor(x)</code> or <code>floor(n,x)</code>
<code>log(arg)</code>	<code>ceil(x)</code> or <code>ceil(n,x)</code>
<code>exp(arg)</code>	

binomial(arg<sub>1</sub>, arg<sub>2</sub>)

gcd(arg<sub>1</sub>, arg<sub>2</sub>)

lcm(arg<sub>1</sub>, arg<sub>2</sub>)

factor(arg)

ifactor(arg)

expand(arg)

simplify(arg, options)

evalf(arg)

solve(eqn, var)

fsolve(eqn, var, options)

isprime(arg)

coeffs(expr)

coeff(expr, var, arg)

### Prime Numbers:

A prime number is a positive integer  $> 1$  for which the only positive integers factors are 1 and itself. E.g., 29, 43, 301. The boolean command `isprime(arg)` will return of a value of true or false depending on whether arg is a prime integer or not, resp. Prime numbers are the building blocks for constructing all integers, which is what is conveyed in the Fundamental Theorem of Arithmetic.

### Fundamental Theorem of Arithmetic:

The Fundamental Theorem of Arithmetic says that every positive integer  $> 1$  can be written as a unique (up to order) product of primes and powers of primes.

#### Examples

$$60 = (2)^2 (3) (5)$$

$$234345456 = (2)^4 (3)^2 (373) (4363).$$

Such prime power decompositions can be used to find greatest common divisors and least common multiples of pairs of integers.

#### Example

$$1936 = (2)^4 (11)^2 \text{ and } 1320 = (2)^3 (3) (5) (11)$$

hence,

$$\gcd(1936, 1320) = (2)^3 (11) \text{ and } \text{lcm}(1936, 1320) = (2)^4 (3) (5) (11)^2$$