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Mathematical Methods: more complex numbers and summation

Python

Remember to start with

```
from sympy import *
```

Factorising

First define a variable x.

```
from sympy.abc import x
```

We can factorise a polynomial using `factor`. We must take care with `**` for power and to include `*` for multiplication even when we wouldn't in written maths. For example:

```
factor(x**3 - 19*x - 30)
```

This works too with functions involving complex numbers.

First let's define z as this is commonly used as a variable in complex mbers

First let's define z, as this is commonly used as a variable in complex fibers (similar to how x is used in real numbers).

```
from sympy.abc import z
```

Now we can solve a function in $\mathbb{C}$ using `solve`:

```
factor(z**3 + z**2 - 3*I*z**2 - 2*z - 3*I*z + 6*I)
```

Complex numbers example

To find the roots of $z^3 = 2i$, we first rewrite the equation to be solved so one side is zero:

$$z^3 - 2i = 0.$$

To enter the left hand side into sympy, we would write is as `z**3 - 2*I`.

Sympy's `solve` function solves what we give it equal to zero, so we can find the roots using

```
solve(z**3 - 2*I)
```

LaTeX

Functions: exp and ln

You can write the exponential function as e^x or $\exp(x)$. The first of these is

```
\[ e^x \]
```

If there is more than one character in the index, you need to put it in `{...}`, like this:

```
\[ e^{2x} \]
```

To write $\exp(x)$ use

```
\[ \exp(x) \]
```

We write the natural logarithm as $\ln(x)$. To do this write

```
\[ \ln(x) \]
```

Subscript and superscript

We have already seen how to raise something to a power using `^`. For example:

```
\[ f(x) = e^{2 x} \]
```

This is called superscript. We can also use subscripts such as the 1 in x_1 using _:

```
\[ x_1 \]
```

This can apply to functions, for example to do logarithms to base 2 we would write $\log_2(x)$ using

```
\[ \log_2(x) \]
```

In some situations we use both subscripts and superscripts, for example in summation notation we use _ to indicate what goes below the sigma and ^ to indicate what goes above. For example

```
\[ \sum_{i=0}^10 i^2 \]
```