Differential equations are one of the most important tools in the mathematical toolbox. A differential equation is a mathematical equation that links an unknown function y of a dependent variable x with its derivative dy/dx, which satisfies the initial conditions y(0) = f(x). A classic example is given by Newton's second law for a particle. Differential equations play an important role in modeling physical phenomena such as economics. In engineering, they are used to model dynamic systems such as heat conduction and generation, combustion engines and turbo-compressors. In mathematics, differential equations arise everywhere but they are most commonly encountered in algebraic number theory and vector analysis or calculus on manifolds. Differential equations occur in the following situations:

Many differential equations can be represented as special cases of other differential equations, and vice versa. These include:

This is a slightly different version of the first equation. The constant c was set at 1.0 to make it easier to write the variables as fractions without the need for radicals. This second equation is a special case where formula_4, which represents a boundary condition. We know that formula_5 because we know that formula_6 for all values of x at exactly one point of y, namely y = 0. This is a generalization of the first equation. In this second equation, we have y'(0) = 0 instead of y(0) = 0. In the following equation, we have , which means that at any arbitrary point formula_9, there are two distinct solutions. Here, the differential operator is formula_10, which is an operator with several possible values depending on how it is defined. We will get to this later. The single differential operator in the preceding equation has only one possible value for all points except for at one point formula_11 where it vanishes. This means that at formula_11, the differential equation becomes 0 = 0. This type of differential equation is called autonomous, because the y' variable is not explicitly dependent on time. The following equation is also autonomous even though it contains the time dependent terms e and e. At any given point in time (t) there are two solutions for this equation. However, these two solutions will always be the same at every point in time (t). This means that there are different types of differential equations; some are dependent on both space and time while remaining dependent only on space (autonomous) while others depend explicitly on time (nonautonomous or nonautonomous). This is a special case of the above equation. In this case, we know that formula_14 and formula_15 because of the integrating factor of 1/2. This is a special case where we also know that formula_16. This is the most basic of the differential equations we will encounter. Ohnemus' identity relates two fixed point theorems: where "f" = $(1 - \lambda)f(x)$, $\lambda > 0$ and $\lambda > 0$.

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