

**Differential Equations, Part 1**  
*Jay Havaldar*



# 1 Part I: First Order Differential Equations

This post will be a brief overview of first-order differential equations. I won't be focusing mainly on proofs here, but instead techniques for solving equations, as well as existence and uniqueness theorems

## Integrating Factors

Integrating factors can be used to solve first order equations of degree 1, in other words equations of the form:

$$y' + P(t)y = Q(t)$$

The idea is to multiply through by a factor  $\mu(t)$  suitably chosen so that the left hand side is an instance of the product rule. This integrating factor turns out to be:

$$\mu(t) = e^{\int P(t)dt}$$

Multiplying through, we are left with the product rule on the left hand side, yielding a new simpler differential equation:

$$(\mu(t)y(t))' = \mu(t)Q(t)$$

And this shouldn't be difficult to integrate in general.

## Separable Equation

A separable differential equation can be rewritten in the form:

$$N(y) \frac{dy}{dx} = M(x)$$

*1 Part I: First Order Differential Equations*

Rewriting:

$$N(y)dy = M(x)dx$$

Integrating both sides gives a solution for  $y$ .