Linearization

Taylor series expansion:

$$f(x) = f(x_0) + f'(x_0)(x - x_0) + \frac{1}{2}f''(x_0)(x - x_0)^2 + \dots$$
$$\approx f(x_0) + f'(x_0)(x - x_0) \qquad \text{linear approximation around } x = x_0$$

Control systems are generally *nonlinear*:

$$\dot{x} = f(x, u) \qquad\qquad \text{nonlinear state-space model}$$

$$x = \begin{pmatrix} x_1 \\ \vdots \\ x_n \end{pmatrix} \qquad u = \begin{pmatrix} u_1 \\ \vdots \\ u_m \end{pmatrix} \qquad f = \begin{pmatrix} f_1 \\ \vdots \\ f_n \end{pmatrix}$$

Assume $x = 0, u = 0$ is an *equilibrium point*: $f(0, 0) = 0$

This means that, when the system is at rest and no control is applied, the system does not move.