Convergence estimates for abstract second order
differential equations with two small parameters and
lipschitzian nonlinearities

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In a real Hilbert space $H$ endowed with the scalar product $(\cdot, \cdot)$ and the	norm $|\cdot|$, consider the following Cauchy problem:

$$
\begin{cases}
\varepsilon u''_{\varepsilon\delta}(t) + \delta u'_{\varepsilon\delta}(t) + Au_{\varepsilon\delta}(t) + B(u_{\varepsilon\delta}(t)) = f(t), & t \in (0, T), \\
u_{\varepsilon\delta}(0) = u_0, & u'_{\varepsilon\delta}(0) = u_1,
\end{cases}
(P_{\varepsilon\delta})
$$

where $A : V \subset H \to H$, is a linear self-adjoint operator, $V$ is a real Hilbert
space endowed with the norm $|| \cdot ||$, $B$ is nonlinear $A^{1/2}$ lipschitzian operartor,
u_0, u_1, f : [0, T] \to H$ and $\varepsilon, \delta$ are two small parameters.

We investigate the behavior of solutions $u_{\varepsilon\delta}$ to the problem $(P_{\varepsilon\delta})$ in two
different cases:

(i) $\varepsilon \to 0$ and $\delta \geq \delta_0 > 0$, relative to the solutions to the following unperturbed system:

$$
\begin{cases}
\delta l''_{\delta}(t) + Al_{\delta}(t) + B(l_{\delta}(t)) = f(t), & t \in (0, T), \\
l_{\delta}(0) = u_0,
\end{cases}
(P_{\delta})
$$

(ii) $\varepsilon \to 0$ and $\delta \to 0$, relative to the solutions to the following unperturbed system:

$$
Av(t) + B(v(t)) = f(t), & t \in [0, T),
(P_0)
$$