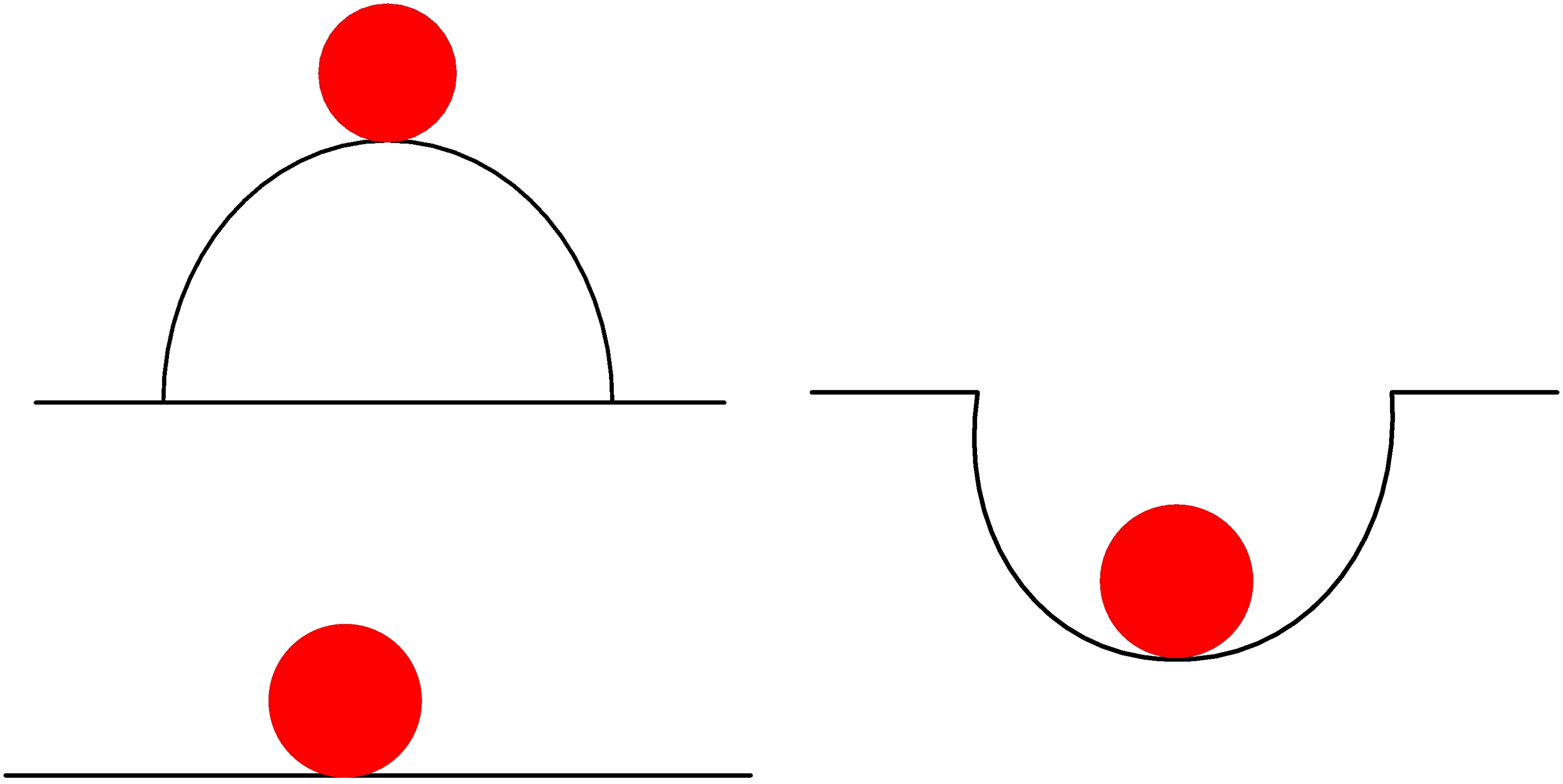
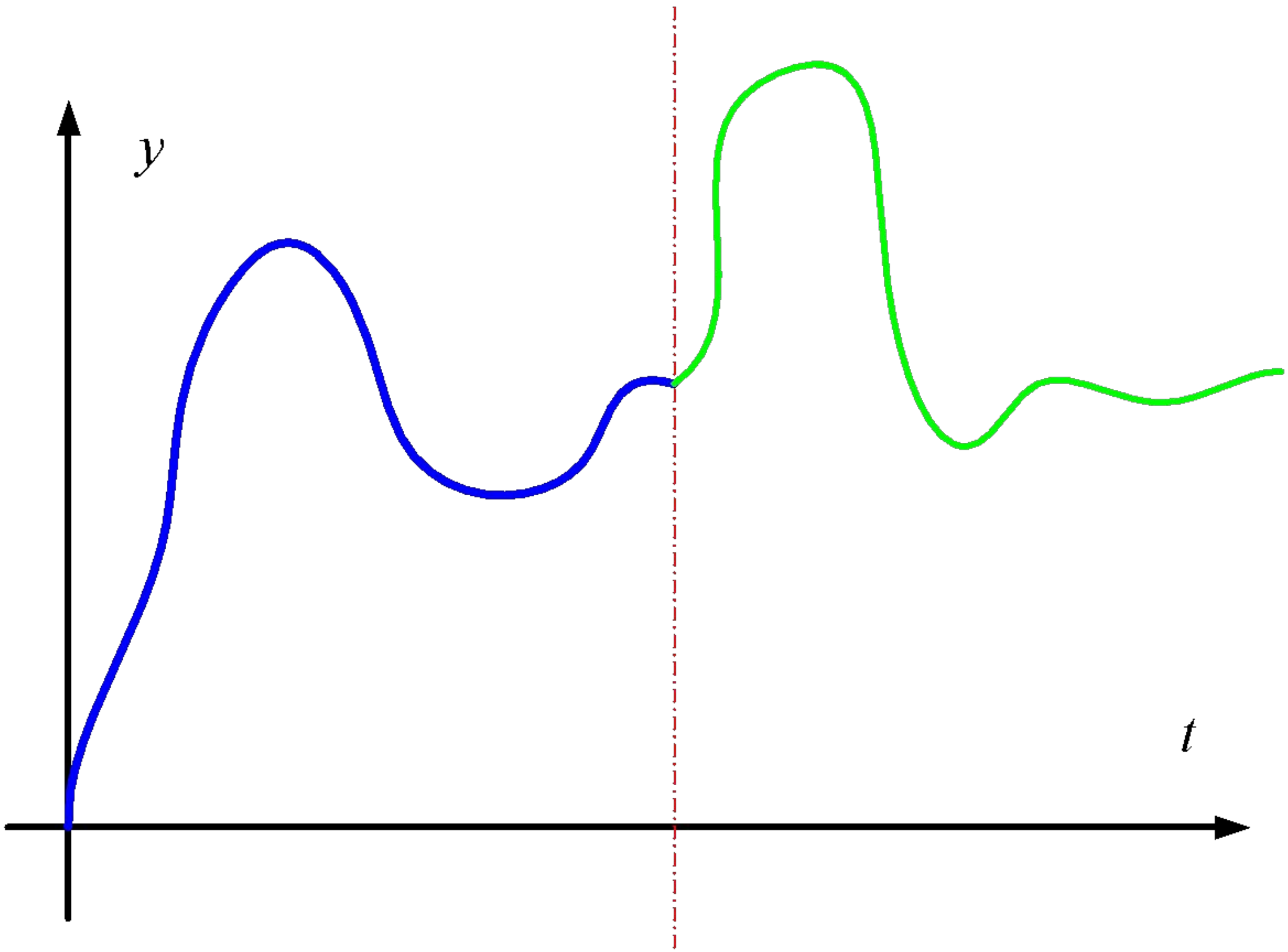
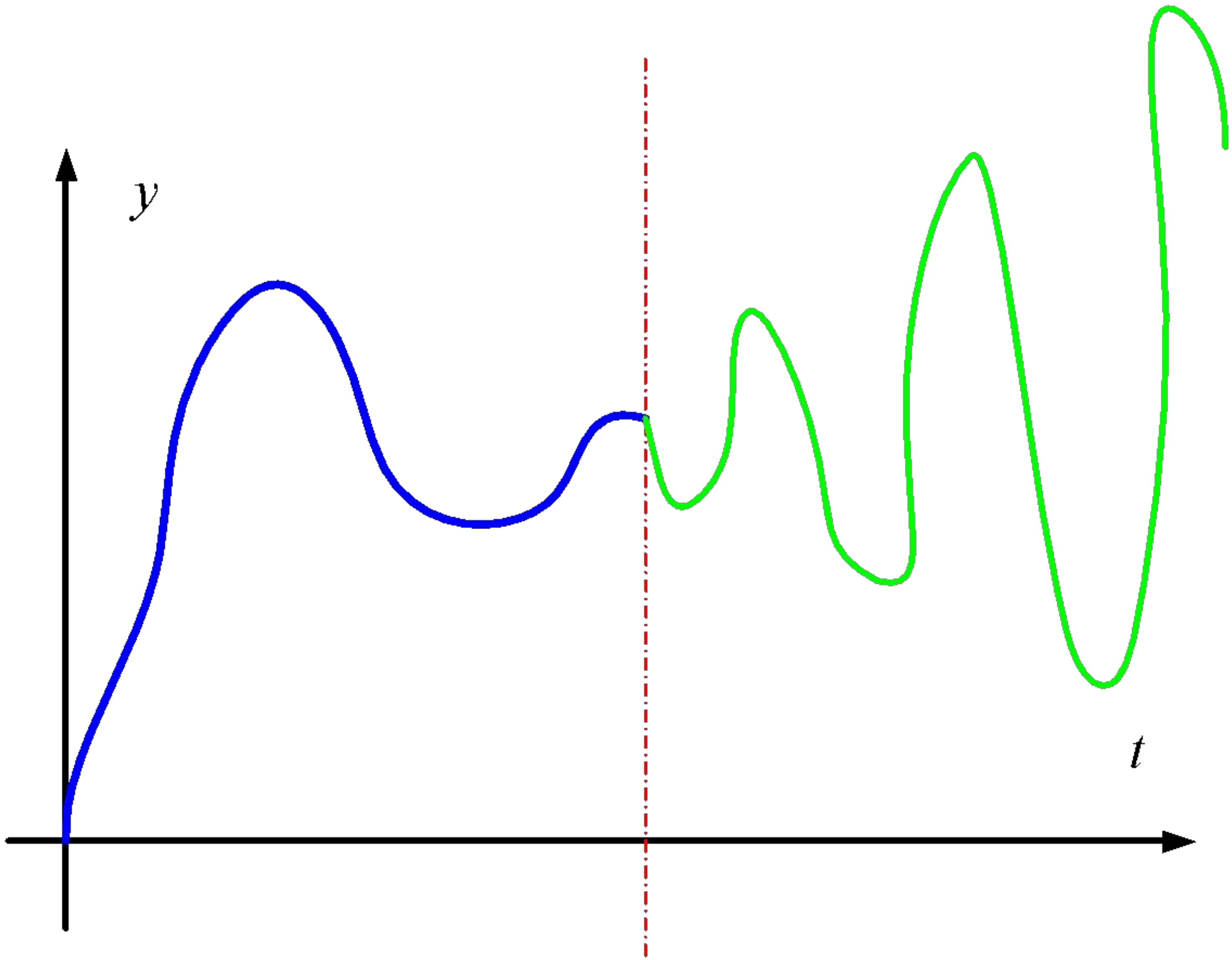
Устойчивость состояния



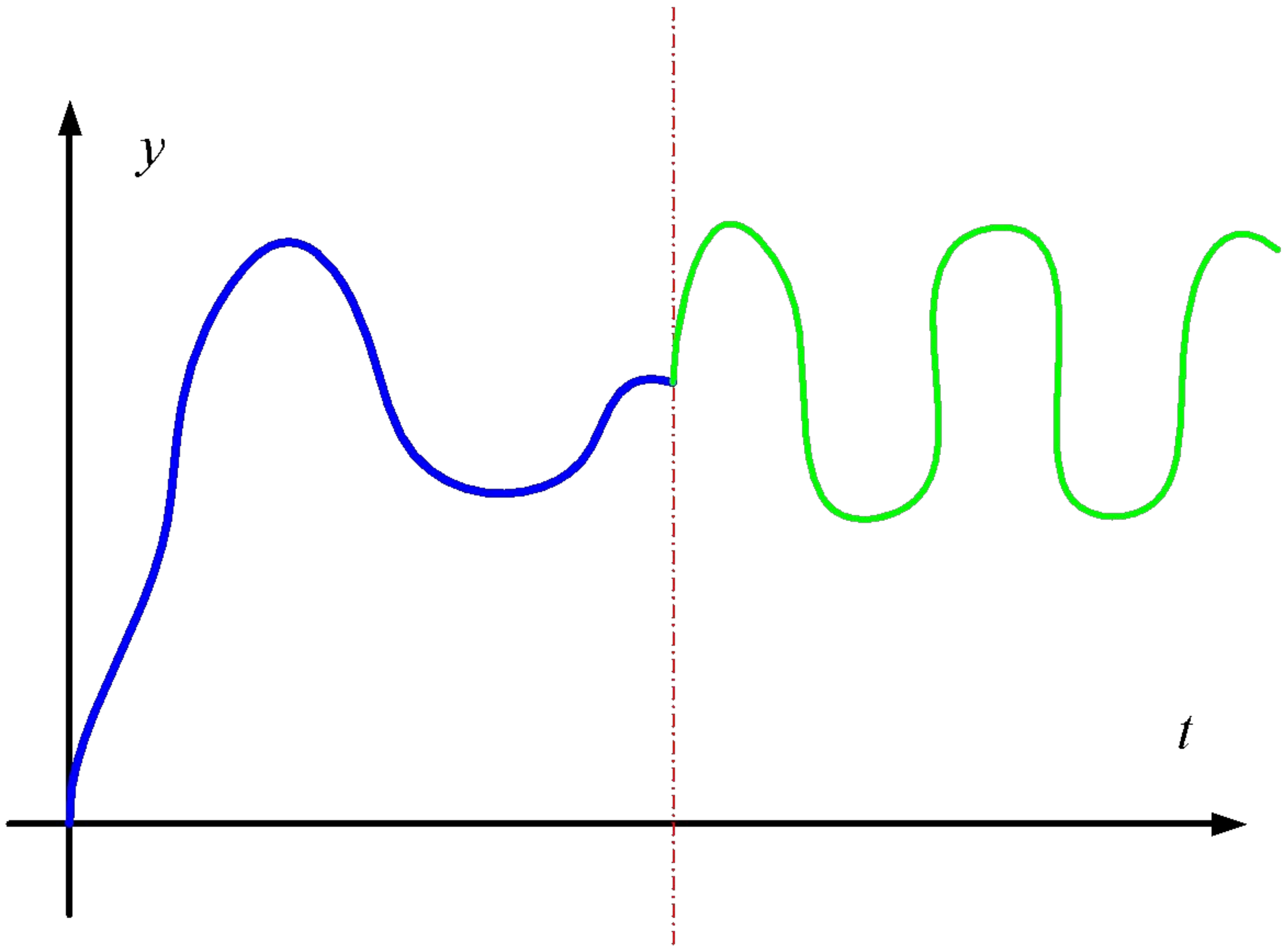
Устойчивость движения



Устойчивость движения



Устойчивость движения



$$a_0 \frac{d^n y(t)}{dt^n} + a_1 \frac{d^{n-1} y(t)}{dt^{n-1}} + \ldots + a_n y(t) =$$

$$= b_0 \frac{d^m x(t)}{dt^m} + b_1 \frac{d^{m-1} x(t)}{dt^{m-1}} + \ldots + b_m x(t)$$

$$y(t) = y_{общ}(t) + y_{част}(t)$$

$$y(t) = y_{св}(t) + y_{вын}(t)$$

Устойчивость по Ляпунову

$$\lim_{t\to\infty} y_{св}(t) = 0 \quad уст \quad -$$

$$\lim_{t\to\infty} y_{св}(t) \to \infty \quad неуст \quad -$$

.

$$\lim_{t\to\infty} y_{св}(t) \left| \begin{matrix} \neq 0 \\ \neq \infty \end{matrix} \right. \quad на\ границе\ уст \quad -$$

.

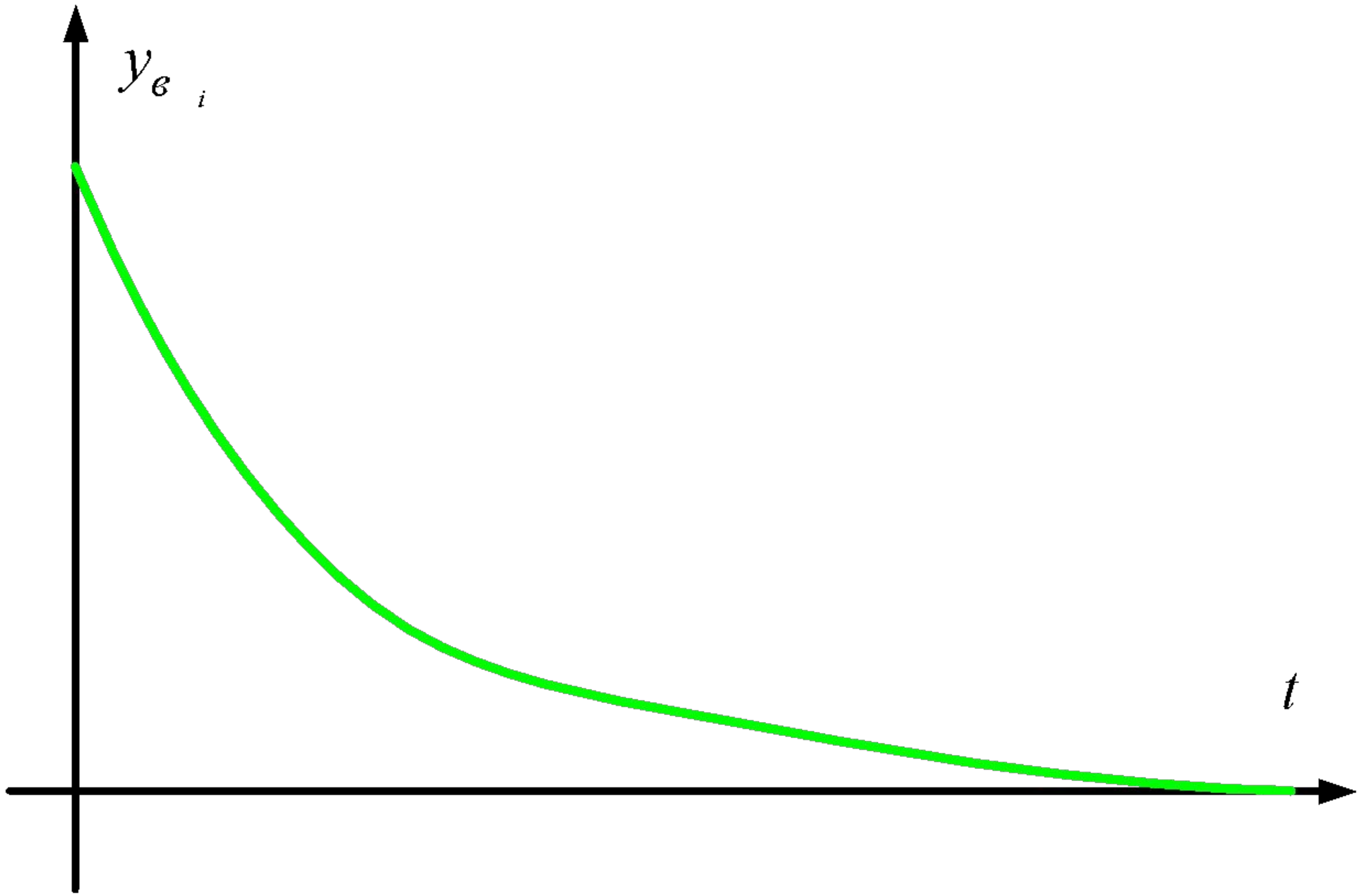
Связь корней характеристического уравнения с устойчивостью

$$a_0 \frac{d^n y(t)}{dt^n} + a_1 \frac{d^{n-1} y(t)}{dt^{n-1}} + \ldots + a_n y(t) = 0$$

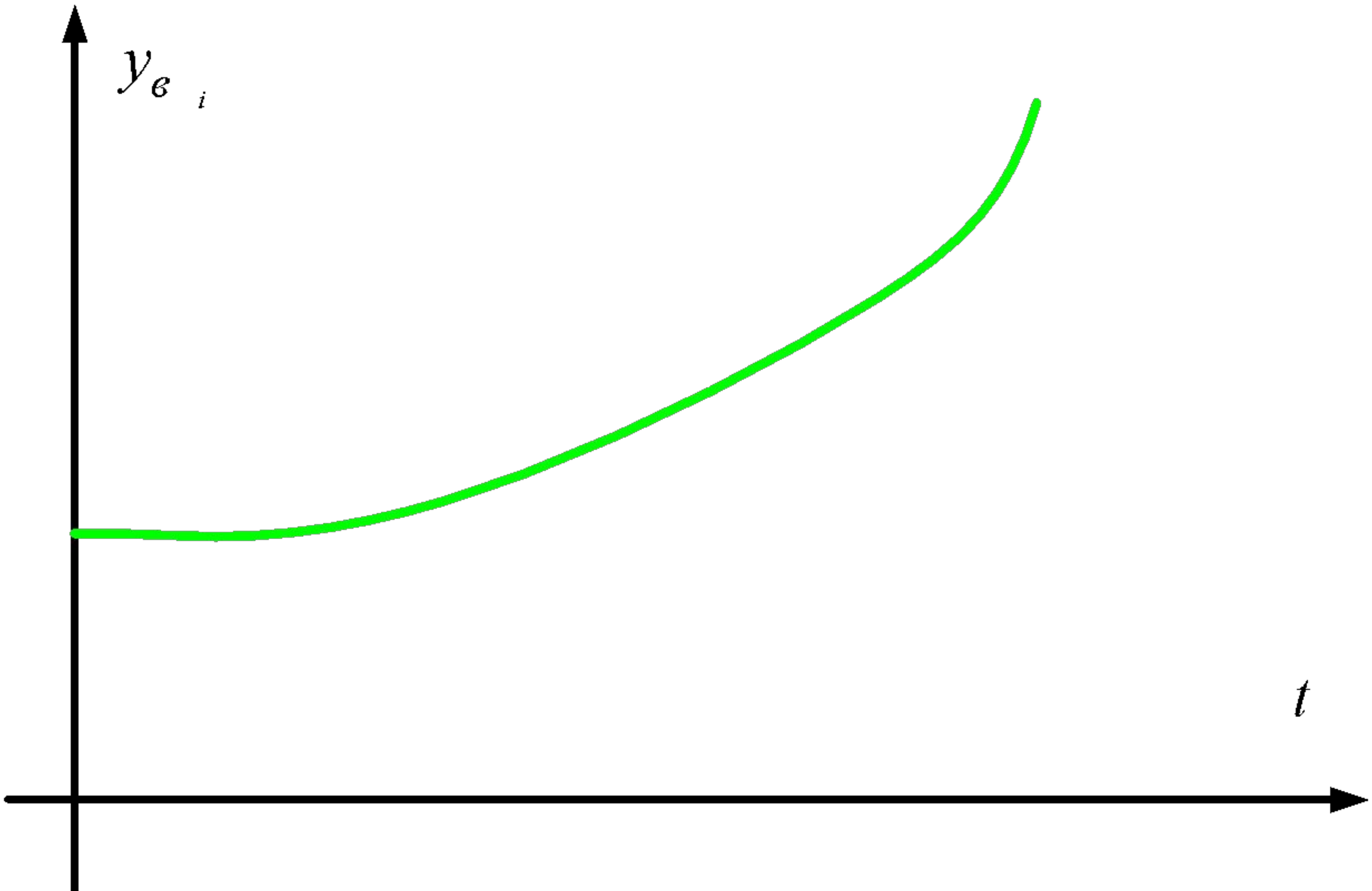
$$a_0 p^n y(p) + a_1 p^{n-1} y(p) + \ldots + a_n y(p) = 0$$

$$y_{св}(t) = \sum_{i=1}^{n} C_i e^{p_i t}$$

$$p_{iсв} = -\alpha_i \qquad y_i(t) = C\,e^{-\alpha t}$$

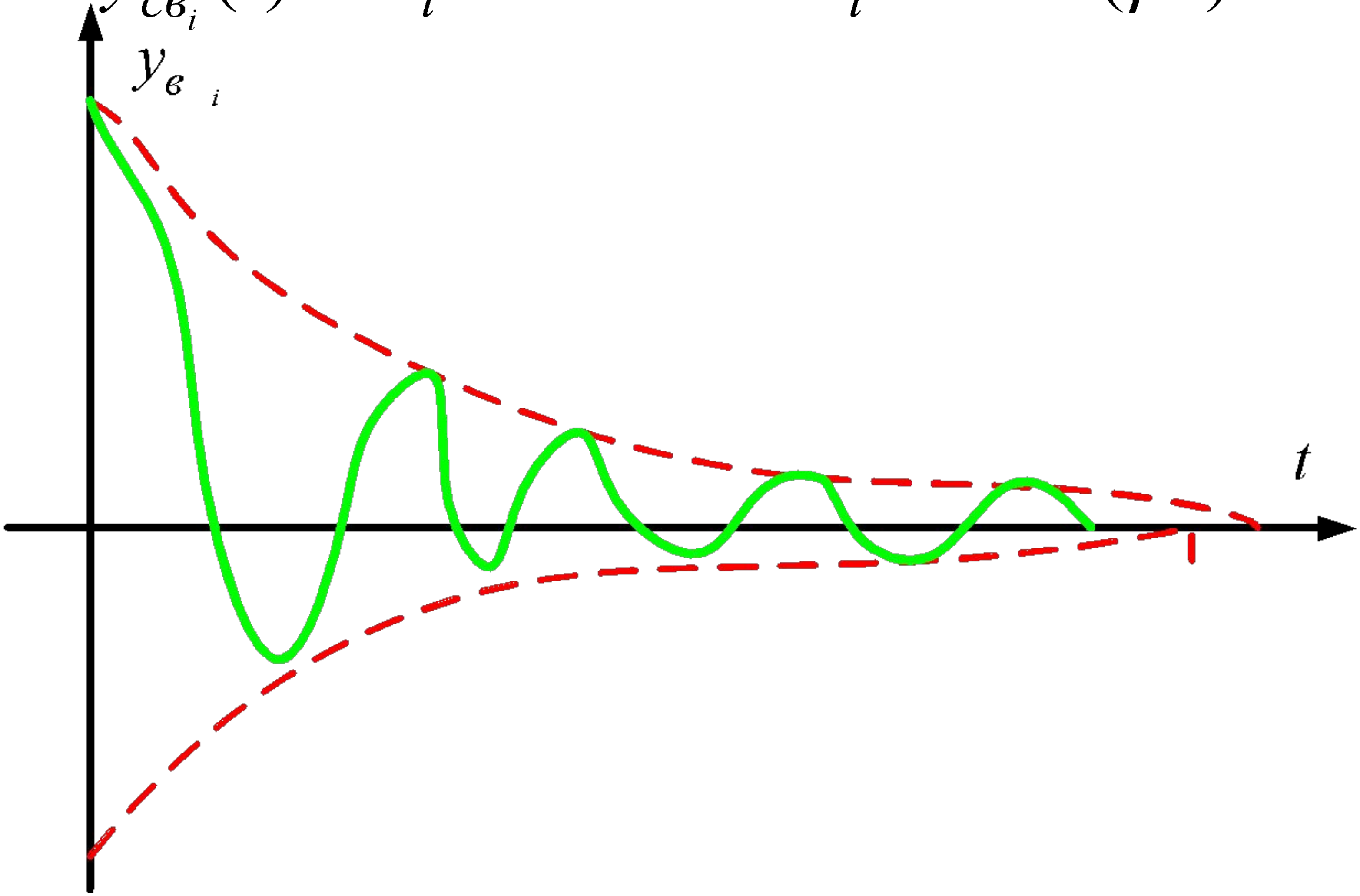


$$p_{i св} = +\alpha_i \qquad y_{i}(t) = C\, e^{+\alpha t}$$



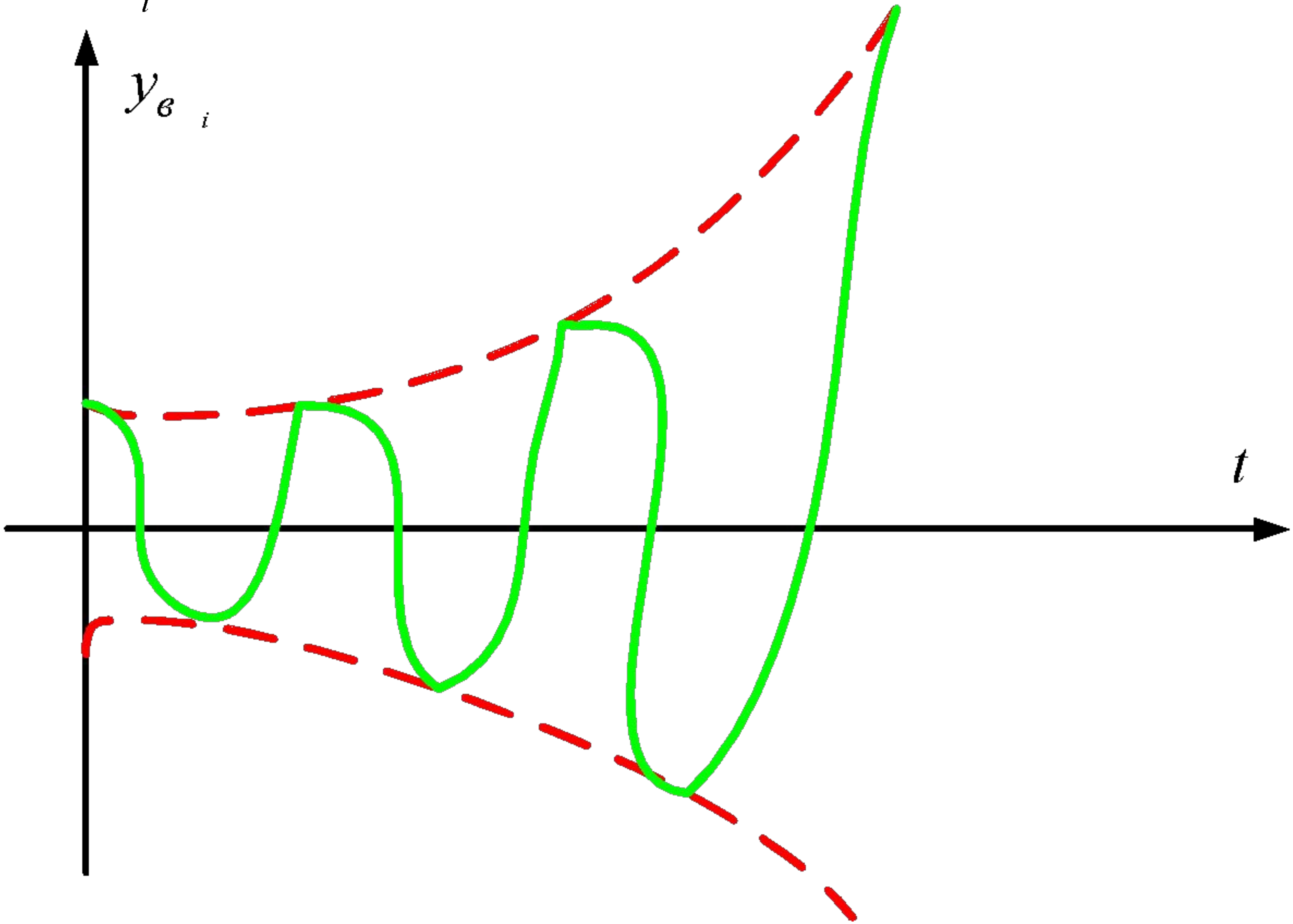
$$p_i = -\alpha \pm j\beta$$

$$y_{св_i}(t) = C_i e^{(-\alpha \pm j\beta)t} = C_i e^{-\alpha t} \sin(\beta t)$$



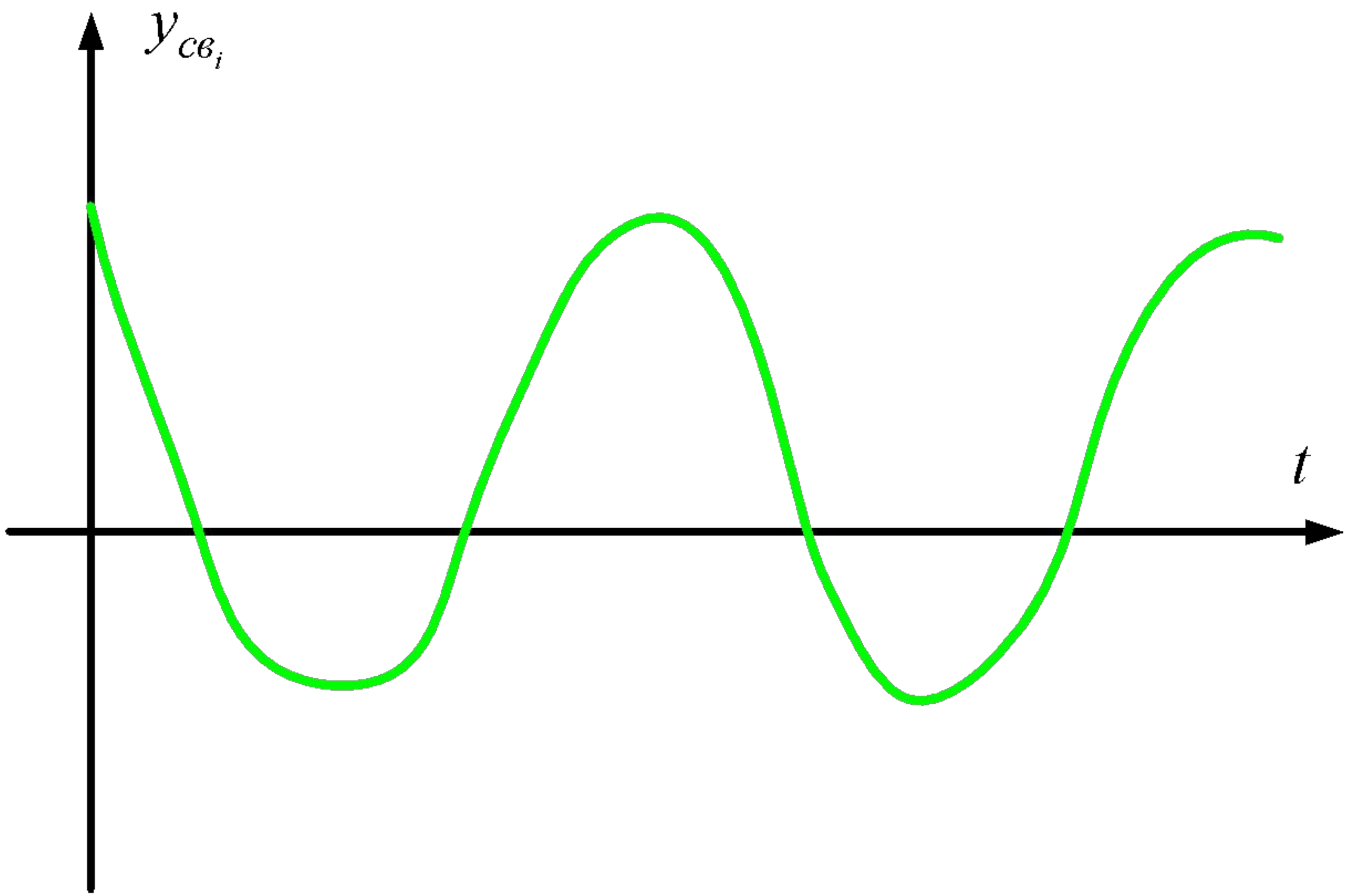
$$p_i = +\alpha \pm j\beta$$

$$y_{св_i}(t) = C_i e^{(+\alpha \pm j\beta)t} = C_i e^{+\alpha t}\sin(\beta t)$$



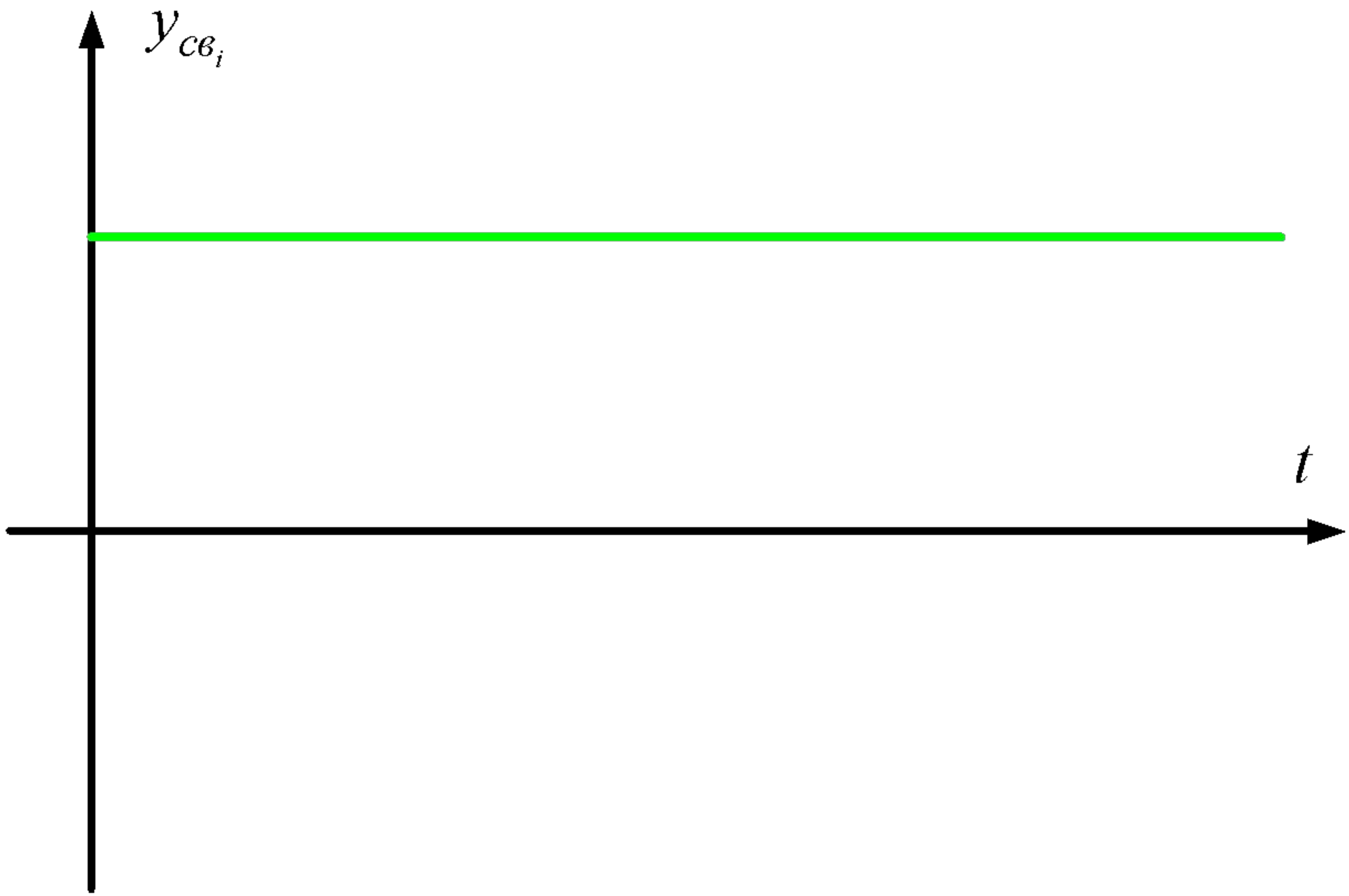
$$p_i = \pm j\beta$$

$$y_{св_i}(t) = C_i e^{\pm j\beta t} = C_i \sin(\beta t)$$



$$p_i = 0$$

$$y_{св_i}(t) = C_i e^{0t} = C_i$$



Геометрическая формулировка