\[ x(\tau) = a_1 \cos \tau + \frac{a_1^3}{2 \omega_0^3} \cos 2 \tau \]

Initial condition \( x'(0) = 0 \) \( \Rightarrow \) \( a_1 = -\frac{a_1^3}{2 \omega_0^3} \)

\[ x(\tau) = \frac{a_1^3}{2 \omega_0^3} (\cos 2 \tau + \cos 3 \tau) \]

No divergence

dangerous resonances are typical for perturbation theory in classical mechanics.